Water Supply

The entire water supply of the District is from the Colorado River. It takes 5 days for water released from Lake Mead to reach Imperial Dam. An estimate of the water to be diverted at Imperial Dam must be made 6 to 11 days in advance of the time the farmer intends to irrigate. After diversion, it takes more than a day for the water to reach many of the farm turnouts. Unpredicted rains may occur while the irrigation water is en route thereby changing crop needs, soil moisture storage capacity, and result in increased surface runoff and/or drainage return flows.

Colorado River water contains from 750-900 parts per million of total dissolved solids, thereby requiring leaching water over and above consumptive use requirements to maintain salt balance in the root zone. While the leaching requirement can be calculated by theoretical formulae to be only 12-15 percent of consumptive use, the fact remains that the soils within fields, or even within borders, are not homogeneous. Generally, the soils most needing leaching are those with the lowest intake rate and permeability. As a result, a high percent of the water in excess of that required to replace soil moisture depleted by consumptive use will drain from lands already leached, and extra water must be applied if the remaining soils are to be kept in salt balance.

Imperial Irrigation District and Coachella Valley Water District are distinctive among all of the irrigation districts receiving Colorado River pursuant to contracts with the Secretary of the Interior as authorized by the Boulder Canyon Project Act of 1928. The March 9, 1964 Supreme Court Decree in Arizona v. California defines "consumptive use" as:

> "...diversions from the stream less such return flow thereto as is available for consumptive use in the United States or in satisfaction of the Mexican treaty obligation;"

All or most of the return flows from other districts get back to the Colorado River above Morelos Dam and are credicted to the districts. (See annual reports pursuant to Article V of said Decree.) However, in the case of IID and Coachella District, essentially all of the return flows go to the Salton Sea and their diversions become their consumptive use under the Court's definition.

Water Quality

The quality of water from the Colorado River at Imperial Dam varies from about 750 to 900 ppm total dissolved solids (TDS). The level of future salinity will depend upon the implementation and success of the Federal Colorado River Salinity Control Program. If that program is successful, the salinity is expected to remain at about current levels. Representative salinity levels of District diversions are shown in the appendix. Any salinity increase will require application of more water to insure salt leaching.

Ground water underlying the District area varies greatly, ranging from a few hundred to more than 10,000 ppm. Within most of the area, ground water is unusable and must be maintained below the root zone to produce successful crops.

The Salton Sea which is the repository of all drainage water in the Valley has no outlet and is highly saline. At current water levels, it is on the order of 40,000 ppm TDS. The salinity concentration varies greatly with the quantity of inflow, since the inflow is much less saline than the Sea.

The quality of water from the Colorado River is suitable for use on the crops grown in the District, but require extremely careful management in the difficult soils. Sufficient leaching water must be applied to maintain adequate soil salinity below the zone. More frequent water applications are required to maintain adequate soil moisture because the water salinities inhibit the water intake of the plant roots.

Water temperatures must be managed carefully to prevent plant damage. Tailwater is often at 85 to 95°F during summer months and, because of surface evaporation during water application, salinity increases as much as 20 percent. Consequently, tailwater may have limited reuse potential in particular cases. Dead level fields with rapid application and standing water may cause plant damage.

Tile drain water may range in quality from 3,000 to 6,000 ppm TDS. Water entering in the New and Alamo rivers from Mexico averages about 4000 ppm TDS. Water entering the Salton Sea from these sources averages 3,200 TDS. This water is generally unusable for irrigation purposes.

Over a long-term period, there must be demonstration that salts are not accumulating in the soils. One measure of this is an analysis of salts entering and leaving the District area. An annual salt balance has been calculated for the District for a number of years. This, as defined in the annual reports of the District, demonstrates a favorable salt balance. That is, more salt is leaving the District than is contained in the inflow. This indicates that some ground water is being discharged and salt loading in the soils generally is being leached.

Water Balance

Water balances have been prepared for the Imperial ID area. These water balances are an inventory of the water supply with an effort made to identify each of the components of flow. Recently a water balance for the IID area were made by the Department of Water Resources in its December 1981 report entitled, "Investigation Under California Water Code Section 275 of Use of Water by Imperial Irrigation District." The Bureau of Reclamation in its work on water conservation opportunities has also prepared a water balance. Presented

in this section are summaries of these two water balances along with additional summary information.

Many of the quantities in the water balance are unmeasured and must be at least partially estimated. A prime example of this is evapotranspiration or consumptive use of crops. In preparing these water balances several of the items of information are obtained by subtraction. This information is, therefore, subject to considerable variation.

Department of Water Resources

Presented in Table 1 is a summary of the water balance prepared by the Department of Water Resources in December 1981. This balance was prepared for the five-year period from 1975 through 1979. The data shown in Table 1 was not presented in a table form in the report but was extracted by Bookman-Edmonston from tabular and text material. Source of the data is set forth in footnotes in Table 1.

The DWR balance essentially started with an average annual flow of water in the All American Canal at Drop No. 1 of 2,791,000 acre-feet. The amount reported by IID to be delivered to water users was 2,537,000 acre-feet. DWR estimated that of the deliveries to users approximately 53,000 acre-feet was not actually taken by the users, remained in the Canal system and spilled into drainage ditches. The estimate by the Department was based on a very limited number of actual measurements.

The Department estimated the crop evapotranspiration (ET) as 1,664,000 acre-feet. The estimate was made by taking the difference between the deliveries to the farms less the component of flow to Salton Sea derived by farm deliveries. Thus, referring to Table 1, evapotranspiration can be determined as the total farm delivery (2,484,000 acre-feet) less the flow to the Salton Sea from farms (820,000 acre-

TABLE 1

SUMMARY OF WATER BALANCE
FROM DWR REPORT
1975-1979(1)

	Amounts in 1,000 Acre-feet
Inflow Data	
Inflow at Pilot Knob	2,839
Loss Pilot Knob to Drop No. 1 (p. 34)	48
Flow at Drop No. 1 (p. 13)	2,791
Operational Losses (p. 13)	254
Total Deliveries to Users(2)	2,537
Balance Derived from Report	
Inflow at Drop No. 1	2,791
Canal Seepage	
Drop 1 to E.H.L. 29 (p. 13)	
E.H.L. to W.S.M. 16 (p. 13)	
Other Main Canals 62 (p. 37)	
Laterals 122 (p. 37)(10)	229
Other Loss(3)	25
Canal Spills(8)	53
Farm Delivery(9)	2,484
Crop E.T.(4)	1,664
Leaching (5)	262
Tailwater(6)	380
Excess Leaching (7)	178
Inflow to Salton Seal from IID (p.42)	1,073
Less Excess Storm Water (p. 42)	100
Return Flow to Sea from Diversions (p.42)	973
Less Canal Seepage (1/2 of 200) (p.42)	100
Less Canal Spills	53
Return Flow to Sea from Farms	820

(1) DWR Report "Investigation Under California Water Code Section 275 of Use of Water by Imperial Irrigation District dated December 1981. Data shown hereon was taken from numerous pages of the report and in several places was derived from the data.

(2) Appears as if DWR considered that 53,000 acre-feet of this amount was not actually turned onto the farms but was left in the canals and subsequently spilled.

(3) Required to balance data.

(4) DWR determined by subtraction. DWR's estimate of E.T. by unit value was 1,815,585 acre-feet. In an August 1983 internal report, DWR presented other estimates on the order of 1,600,000 acre-feet.

TABLE 1 (Cont'd.)

SUMMARY OF WATER BALANCE
FROM DWR REPORT
1975-1979

(5) DWR used 15% of E.T. (using average E.T. of 1,750,000 acre-feet).
(6) DWR used minimum tailwater as 15% of delivered water.
(7) Determined as delivery less E.T., less minimum required leaching and tailwater.
(8) Estimated by DWR as 2% of deliveries based on very limited measurements.
(9) DWR amount shown to be delivered to users less 53,000 acre-feet which is water which users do not take and subsequently spills to drains.
(10) Includes deliveries through 1,600 minor service pipes.

feet) resulting in a crop ET of 1,664,000 acre-feet. The flow to the sea derived from District deliveries from farms was also obtained by subtraction. This amount of 820,000 acre-feet was divided into components by the Department into leaching (15% of ET), tailwater (15% of deliveries) and the remainder assigned to excess leaching (178,000 acre-feet).

It's important to note that the majority of the items shown on Table 1 are not measured and merely represent estimates. It is further important to note that many of the estimates of items such as seepage represent the difference of very large amounts. These amounts may be the sum of measured amounts, the accuracy of which may lead to erroneous results when subtractions are made.

U.S. Bureau of Reclamation

Shown in Table 2 is a summary of the water balance prepared by the U.S. Bureau of Reclamation. U.S. Bureau of Reclamation is in the process of preparing a comprehensive report on the water conservation opportunities of the Imperial Irrigation District. Thus far nearly $1,000,000 has been expended on this report. Progress reports and portions of the report drafts are available to Bookman-Edmonston Engineering, Inc. Shown on Table 2 is a summary of the most recent water balance used by the Bureau of Reclamation as extracted by Bookman-Edmonston from data in the available drafts. The principal data relied upon was the Bureau's water balance shown in Table 1 on page 2 of the recently released Executive Summary, Draft Special Report. This was supplemented by information shown in the Bureau's "Canal Seepage Study" dated December 1981.

The Bureau estimated the inflow to the water balance for the four-year period 1977 through 1980. Total inflow was estimated to be 3,125,000 acre-feet including the All

American Canal at Drop No. 1 (2,734,000 acre-feet), surface and subsurface inflow from Mexico (141,000 acre-feet), infiltration of seepage from the Coachella Canal (100,000 acre-feet) and direct precipitation of 150,000 acre-feet. Estimated outflow items included consumptive use of phreatophytes (96,000 acre-feet), surface flow to Salton Sea (1,157,000 acre-feet), underflow to Salton Sea (50,000 acre-feet) and evaporation from canal surfaces of 25,000 acre-feet. The subtotal of the estimated outflow items was 1,328,000 acre-feet. The difference of 1,797,000 acre-feet was assumed to be consumptive use of crops. This value is somewhat higher than determined by DWR from their water balance calculation. There was no allowance made for the change in storage.

Shown in Table 2 is a summary of the operations in the water balance study. In preparing Table 2, the differences were noted between the Bureau's December 1981 report and the more recent Executive Summary. Data contained in the Executive Summary was utilized. It is noted that the principal amounts in the Executive Summary such as inflow at Drop 1, consumptive use, inflow to the Salton Sea, have not changed from the December 1981 report. Adjustments have been made in other items including canal seepage, operational spill, leaching and tailwater.

In our review of the USBR water balance, we believe that the seepage from the Coachella Canal may be overstated, as it appears that for the study period a large quantity of this water was developing a ground water mound and hence, going into storage. It also appears that the underflow to the Salton Sea from the IID area has been overstated and is probably on the order of 2,000 acre-feet per year. It is also possible that the consumptive use of precipitation has not been fully included. Making these adjustments would indicate a crop consumptive use on the order of 1,700,000

acre-feet which is more in line with other derivations. Again, we note that the amounts are being determined by subtraction of estimates of questionable accuracy.

In studying the amounts shown in Table 2, more accurate determinations and measurements can actually be made of certain items. These items include canal seepage (whereby ponding measurements could be performed), operational spills (where greater accuracy is currently being obtained by the recent installation of recorders). The Bureau intends to make these measurements.

Summary of Water Balances

Whereas time and data does not allow for an accurate water balance, estimates of the disposal of water have been prepared by DWR and USBR. Based on those estimates as shown in Table 1 and Table 2, there is compiled in Table 3 a summary of the disposal of water in the IID area. Whereas the accuracy of the information is subject to further refinement, it does indicate the orders of magnitude in the various studies.

For purposes of evaluation, the water balance information developed by the USBR generally has been utilized.

Consumptive Use

A major item in evaluating the water balance is the consumptive use of crops or evapotranspiration (ET). Two procedures are available for determining the consumptive use.

Consumptive use can be determined by multiplying unit values of consumptive use (acre-feet per acre per year) times the irrigated area for each type of crop. The unit values are based on empirical studies adjusted for a climatic area.

The second procedure for determining consumptive use is to determine all other factors in a water balance and obtain

TABLE 2

SUMMARY OF WATER BALANCE
FROM USBR
1977-1980[1]

			:Amounts in 1,000 Acre-Feet
Inflow[2]			
Inflow at Drop No. 1			2,734
Mexico - Surface	128		
Subsurface[6]	13		141
Coachella Canal Seepage			100
Precipitation[7]			150
Total			3,125
Outflow[2]			
Crop Consumptive Use			1,797[3]
Consumptive Use of Phreatophytes[8]			96
Surface Flow to Salton Sea			1,157
Underflow to Salton Sea[9]			50
Canal Evaporation			25
Total			3,125
Operations[4]			
Inflow at Drop No. 1	2,734		
Seepage Recovery		36[5]	2,770
Less Canal Seepage			274
Less Operation Spill[10]			136
Delivery to Users			2,360
Less Crops Consumptive Use			1,797
Less Leaching			236
Less Tailwater			327
Total Unused (Flows to Sea)			937
Other Flow to Salton Sea			
Mexico		141	
Coachella Canal		100	
Precipitation		150	
Less C.U. of Phreatophytes		96	
Less Evaporation from canals		25	270
Total Inflow to Salton Sea			1,207

(1) From drafts of USBR Water Conservation Opportunities Study including Draft Special Report - Executive Summary and Canal Seepage Study - December 1981. Most recent data for amounts shown are used.
(2) From Canal Seepage Study, page 16.
(3) Determined by Subtracting 3125-96-1157-50-25 = 1797
(4) From Canal Seepage Study, Table 4, most probable present conditions adjusted to page 2 of Executive Summary.

TABLE 2 (Cont'd.)

SUMMARY OF WATER BALANCE
FROM USBR
1977-1980

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(5) Net seepage is 238,000 AF.
(6) Estimated as 10 percent of surface flow.
(7) Four inches on 450,000 Acres.
(8) Six feet times 16,000 Acres.
(9) USGS estimate in Professional Paper 486-C.
(10) Probably based on increased use of recorders on ends of laterals.

TABLE 3

DISPOSITION OF COLORADO RIVER WATER
IN IMPERIAL IRRIGATION DISTRICT

		Apparent Amount in Acre-Feet
Canal Seepage		
All-American Canal		
Pilot Knob to Drop No. 1		48,000
Drop No. 1 to East Highline		29,000
East Highline to West Side Main		16,000
East Highline Canal		78,000
Laterals and other Canal Seepage	- low	130,000
	- high	300,000
Canal Evaporation		25,000
Operation Losses	- low	53,000
	- high	136,000
Consumptive Use of Crops	- low	1,622,000
	- high	1,815,585 (1)
Leaching water - about		250,000
Tailwater - about		350,000
Excess Leach Water (DWR)		178,000

(1) DWR Report, December 1981, using unit values applied to DWR land use amounts. Annual amounts of up to 2,200,000 acre-feet have been determined by use of unit values based on lysimeter studies at Imperial Valley Research Center and on the Blaney-Criddle formula.

consumptive use by subtraction. In other words, it is the item necessary to balance the equation.

Several different values of consumptive use have been determined by various investigations for Imperial ID in the last few years. At this time, Bookman-Edmonston has not had time to sort out the data. The various results are shown in Table 4.

Some reasons for the differences in computed crop consumptive use by the unit method include variation in unit values from different investigations and differences in areas of crops, especially alfalfa. Various investigators report the ET of alfalfa ranging from 46 inches to 80.6 inches in the Imperial Valley.

Irrigation and Drainage System

Water is diverted from the Colorado River at Imperial Dam through the District's All-American Canal headworks and desilting basins, thence into the All-American Canal for transporting to Imperial, Yuma and Coachella Valleys. Yuma Project water is diverted from the All-American Canal at Siphon Drop. Coachella Valley Water District water is diverted at Drop No. 1 to the Coachella Branch of the All-American Canal. All water passing below Drop No. 1 in the All-American Canal is for use by Imperial Irrigation District.

The District's gravity-flow canal and drainage system serves an area of 507,325 acres of irrigated farm land. The total gross area within the District's boundaries is 1,062,290 acres, including undeveloped area; cities, towns, airports, feed lots, etc., area below the -230 contour Salton Sea Reserve Boundary and area covered by Salton Sea; and area in canals, drains, rivers and railroads.

Water Department's reponsibilities include operation and

TABLE 4

ESTIMATES OF CONSUMPTIVE USE OF CROPS
IN IMPERIAL IRRIGATION DISTRICT

Investigator	Source or Report	Amount in Acre-feet
	Unit Value Method	
DWR	Section 275 Report - December 1981	1,815,585
DWR	August 1983 (Preliminary value based on Donovan-Meek Method)	1,622,000
IID	1977 (Unit values from Kaddah and Rhoades, 1976)	2,190,000
	1978	2,052,500
	1979	2,162,500
	Water Balance Method	
DWR	Section 275 Report - December 1981	1,664,000
USBR	Water Conservation Opportunity Studies	1,797,000

maintenance of the All-American Canal headworks and desilting basins at Imperial Dam, 80 miles of All-American Canal, 3 miles of New Briar Canal, a 1,625-mile network of other main canals and laterals, 52 miles of drains in All-American Canal Section and 1,402 miles of main and lateral drains. Due to the concrete lining of the Coachella Branch of the All-American Canal in 1980, the Coachella Valley Water District now operates and maintains this 49-mile section.

Water conveyed in the District's canal system serves agricultural, industrial and domestic purposes. All cities and towns in Imperial Valley receive raw water supplied from District canals.

The irrigation and drainage systems are shown on the following pages.

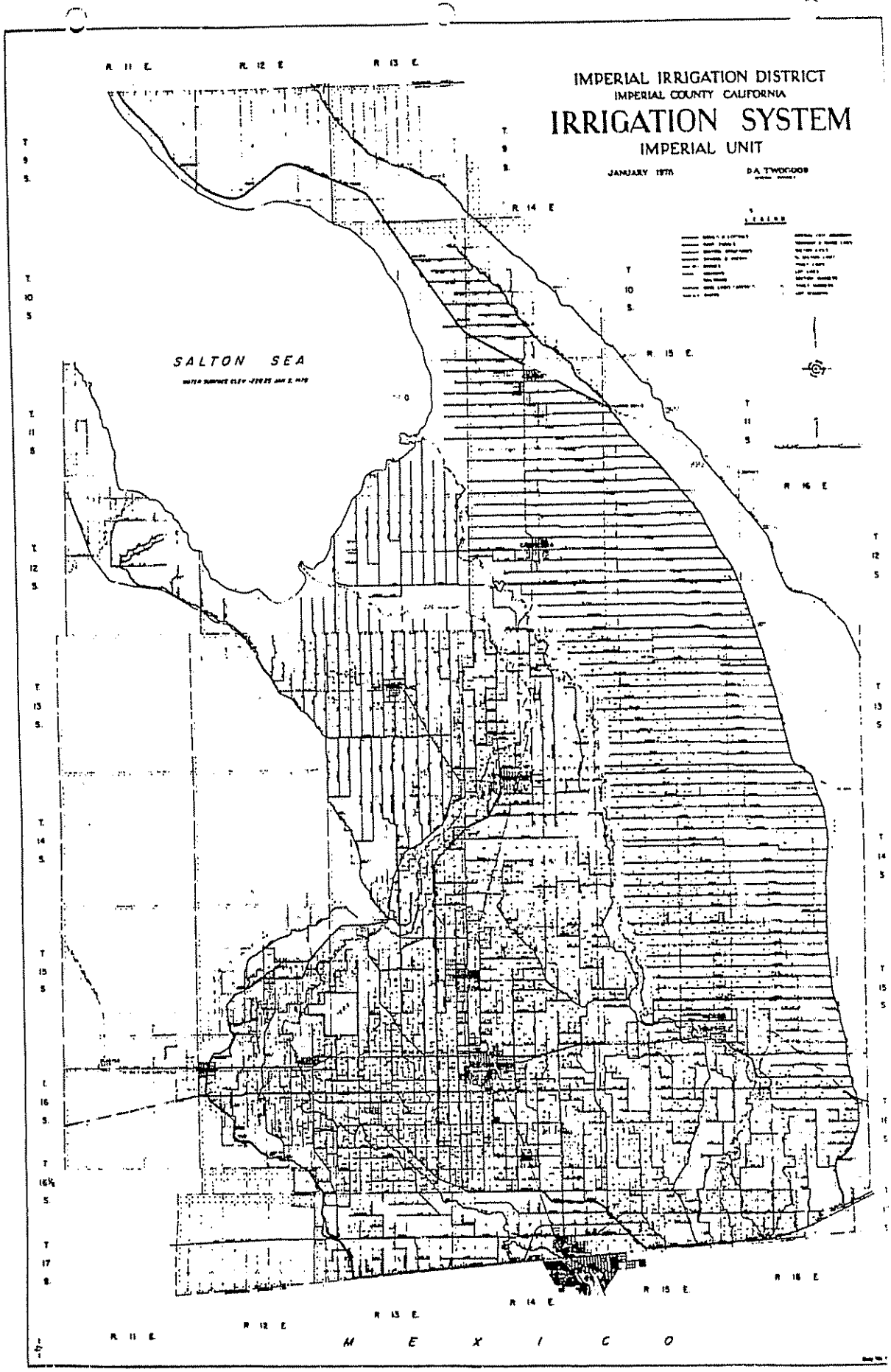
Irrigation System

On-farm irrigation is mostly by basin and furrow methods. Water not consumptively used is discharged to wasteboxes at the lower end of the field or percolates to on-farm tile drains and thence, to lateral and main drains. Size of fields and layout is governed by land ownership and the irrigation and drainage system.

The irrigation and drainage system is described by the Bureau of Reclamation in connection with their "Canal Seepage Study" December 1981 as follows.

The District operates and maintains 1,627 miles of irrigation canals, of which about 740 miles are concrete-lined; two regulating reservoirs; and appurtenant structures, including gates, checks, drops, wasteways, spillways, and customer turnouts. All of these features, except the All-American Canal and the New Briar Canal, were designed and constructed by the District.

Each landowner is responsible for the construction, operation, and maintenance of all irrigation features below


IMPERIAL IRRIGATION DISTRICT
IMPERIAL COUNTY CALIFORNIA
IRRIGATION SYSTEM
IMPERIAL UNIT
JANUARY 1970
D.A. TWOGOOD
SALTON SEA
R. 11 E.
R. 12 E.
R. 13 E.
R. 14 E.
R. 15 E.
R. 16 E.
T. 9 S.
T. 10 S.
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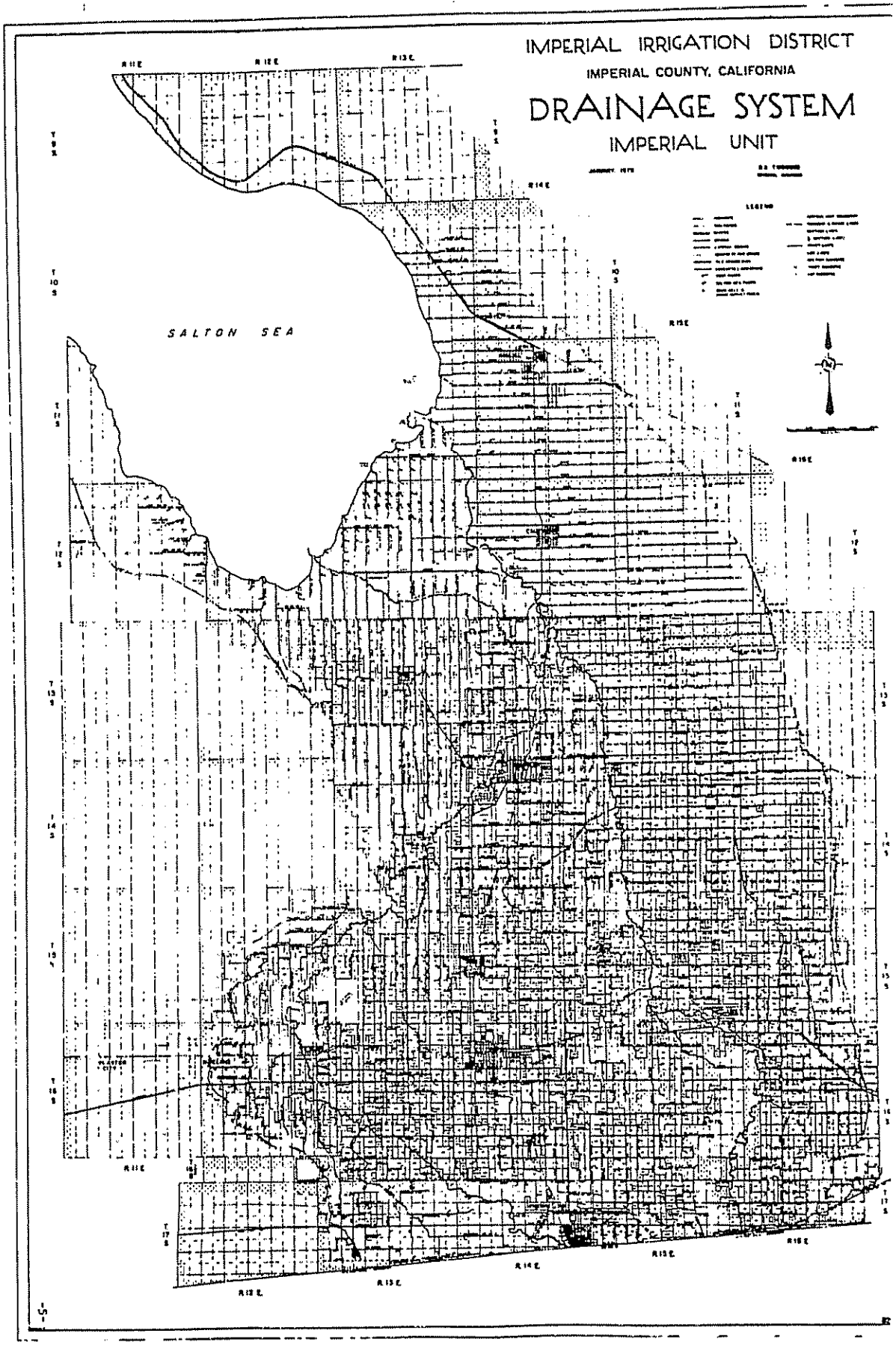
M E X I C O


IMPERIAL IRRIGATION DISTRICT
IMPERIAL COUNTY, CALIFORNIA
DRAINAGE SYSTEM
IMPERIAL UNIT
SALTON SEA
LEGEND
R 11 E
R 12 E
R 13 E
R 14 E
R 15 E
R 16 E
T 9 S
T 10 S
T 11 S
T 12 S
T 13 S
T 14 S
T 15 S
T 16 S
T 17 S

the customer turnouts beginning at the edge of the District's right-of-way. These features include ditches, holding basins, field siphons, and other appurtenant structures.

Water from the Colorado River is diverted at Imperial Dam into the All-American Canal. About 36 miles downstream from the dam, immediately above Drop No. 1, part of the canal's flow is diverted into the Coachella Canal and is transported to the Coachella Valley for delivery to agricultural and M&I customers. All of the remaining flow is delivered to agricultural and M&I customers in the Imperial Valley.

About 56.5 miles, 63 miles, and 68 miles, respectively, downstream from Imperial Dam, flows are diverted into the East Highline Canal, the New Briar Canal, and the Central Main Canal. About 82 miles downstream, the remaining flow is diverted into the Westside Main Canal. Additional flows are also diverted into laterals and customer turnouts at various locations along the All-American Canal.

The design capacity of the canal at Imperial Dam is 15,155 ft^3/s, with diversions at Siphon Drop and Pilot Knob. It has a capacity of 10,155 ft^3/s below the turnout to the Coachella Canal. Additional diversions gradually reduce the canal's capacity to 2,655 ft^3/s at the Westside Main Turnout.

The East Highline Canal supplies water to the Rositas and Vail Supply Canals, laterals, and customer turnouts in the Holtville, El Centro-Calexico, Brawley, and Calipatria Divisions. The remaining flows in the Vail Supply Canal empty into the Old Vail Canal, which supplies water to a portion of the Calipatria Division. The New Briar Canal supplies water to the Briar Canal, laterals, and customer turnouts in the Holtville and El Centro-Calexico Divisions. The remaining flows in the Briar Canal empty into the Central Main Canal. The Central Main Canal supplies water to the laterals and customer turnouts in the El Centro-Calexico,

Imperial, and Brawley Divisions. The Westside Main Canal supplies water to the laterals and customer turnouts in the El Centro-Calexico, Imperial, and Westmorland Divisions.

The approximate capacities of these main canals, based on the available highest mean daily flows recorded during the study period, are as follows:

East Highline Canal	2,700 ft^3/s
Rositas Supply Canal	300 ft^3/s
Vail Supply Canal	300 ft^3/s
Old Vail Canal	300 ft^3/s
Central Main Canal	1,300 ft^3/s
Westside Main Canal	1,300 ft^3/s

Laterals are all other canals other than the All-American Canal and the main canals described previously. A lateral supplies water to customer turnouts and may supply water to other laterals or main canals. About 90 percent of the laterals in the service area have bottom widths of 2 feet and side slopes of 1-1/4:1.

Drainage System

The District operates and maintains 1,453 miles of surface drains. Individual landowners have installed about 26,000 miles of tile drains and thousands of tailwater wasteboxes.

Surface drains are used to collect excess surface flows from the fields (tailwater), tile drain discharges, and spills from the canals and laterals. Most of these drains discharge their return flows into the Alamo or New rivers, which then empty into the Salton Sea. Thirty-four surface drains discharge about 104,000 acre-feet per year directly into the Salton Sea.

The tile drains are located in the fields and are buried at depths ranging from 6 to 10 feet. The tile drains are used to draw off the excess water derived from percolated surface flows in order to prevent the water table from encroaching into the root zone. Most of these drains are constructed of perforated plastic pipes in gravel envelopes and are connected to 8-inch transite collector pipes. Most of these drains discharge directly into surface drains; a few discharge directly into the Alamo and New rivers. Tile drains have been installed on about 418,000 acres of farmland.

Surface flows which run off the ends of the fields are referred to as tailwater. Tailwater flows are collected by the wasteboxes and, in most cases, are discharged into surface drains through pipes.

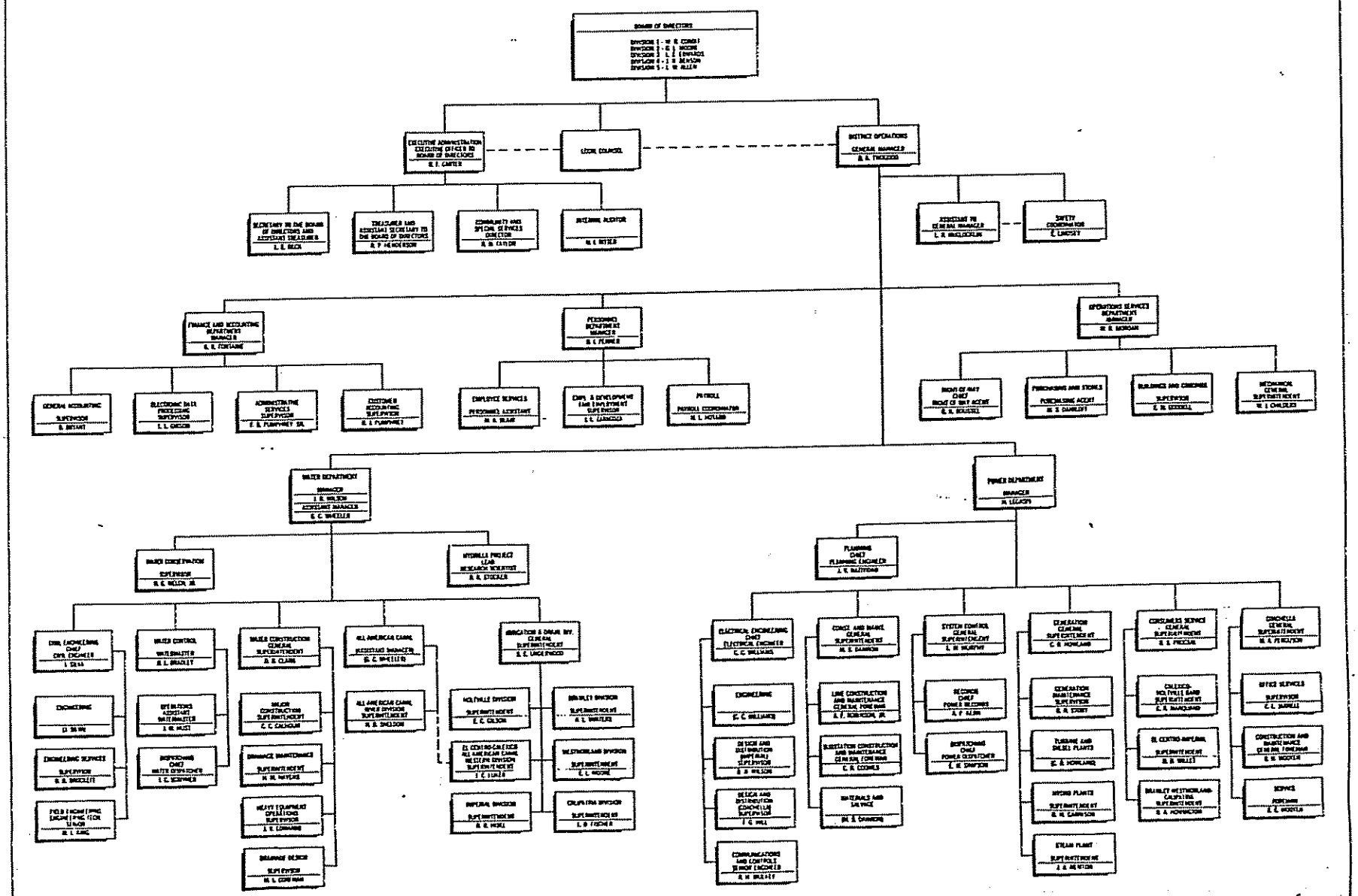
District Administrative Organization

The Imperial Irrigation District is governed by a five-man Board of Directors elected by the area's registered voters. Shown on the following Figure is the organization of the District.

Shown on a following tabulation is the revenue and expense statement for the Water Department for the years 1981 and 1982. As can be seen, the operating expenses of the Water Department totalled $18,321,640 for 1982.

Department organization includes Irrigation and Drainage Sections, All-American Canal Section, Water Control Section, Civil Engineering Section, Drainage Construction and Maintenance Section, Hydrilla Control Research, Water Conservation and Heavy Equipment Operations Section.

IMPERIAL IRRIGATION DISTRICT



WATER DEPARTMENT
REVENUE AND EXPENSE STATEMENT

	1982	1981
OPERATING REVENUES:		
Sales of:		
Power	(363 557)	-
Water	17 099 599	17 737 042
Water Availability Charge	1 008 107	1 065 670
Rentals	107 107	306 034
Interdepartmental Charge for Use of All-American Canal	334 499	334 499
Other	89 784	4 770
Total Operating Revenues	$18 275 539	$19 448 015
OPERATING EXPENSES:		
Provision for loss on contingent litigation	1 500 000	-
Operation & Maintenance of All-American Canal	1 233 137	1 168 470
Operation & Maintenance of Irrigation System	11 351 853	9 393 897
General and Administration	2 725 408	2 504 209
Provision for Loss on Experimental Farms	31 648	110 354
Depreciation	1 479 594	1 531 249
Total Operating Expenses	$18 321 640	$14 708 179
Net Operating Revenue	(46 101)	$ 4 739 836
OTHER REVENUES (EXPENSE):		
Interest Income	994 097	1 199 961
Interest Expense	(5 855)	(584)
Net Other Revenues (Expense)	$ 988 242	$ 1 199 377
Net Revenues (loss) retained to finance operations & plant additions	942 141	-
Net Income	$ 942 141	$5 939 213

( ) Credit Balance

Number of Employees in Water Department
December 31, 1982

Water Administration	6
Hydrilla Control Research	3
Water Conservation	4
Water Engineering	24
Water Control	63
Heavy Equipment Operators Pool	60
Drainage Construction, Maintenance and Design	40
Irrigation and Drainage Sections	206
All-American Canal	38
Total	444

Water Scheduling and Delivery

The Imperial Irrigation District is responsible for scheduling and delivering water to over 450,000 acres of irrigated lands growing over 120 types of crops as requested by the individual water users. The District orders water from the Colorado based on the projected needs of the users related to experience, existing climatological conditions, irrigation cycles, seasons and crop patterns.

The District must order daily increments of water on a weekly basis well in advance of receiving actual water orders from its users because of the extensive travel time involved in delivering water from storage on the Colorado River to the District. It takes five days from the time water is released from Hoover Dam before it reaches Imperial Dam, which is a diversion dam with no storage. Any regulation of deliveries must be done upstream at Parker Dam, 2-1/2 days water travel time above Imperial Dam. Thus, any adjustments to diversions at Imperial Dam must be made 72 hours in advance.

The system is complex with 235 miles of main canal and 1,469 miles of laterals. The system operation is guided by rules and regulations which set forth the basic criteria for scheduling and delivery water. There is, however, a great

deal of flexibility within these guidelines for operating the District. Much of this flexibility is in the physical capacity of the system but the dedication and long experience of the District personnel in managing this complex system and adjusting to specific conditions is the key to the successful operation.

The following procedures govern scheduling and delivery of water in the Imperial Irrigation District.

Water Scheduling

User Water Orders - The water scheduling process begins with the individual signed order from the user which is submitted to the division office or the zanjero in charge of the delivery.

Orders can be placed for delivery not less than one or more than three days in advance on any day between 8:00 a.m. and 5:00 p.m. and may be placed by phone on weekends and holidays. Orders received before noon may be for water delivery the following day. Orders placed after 12 noon are considered to be received the following day and effective the second following day. Each order pertains to only one account or delivery location. A landowner must submit one order for each headgate. Each headgate can serve a maximum of 160 acres.

The District is required to begin delivery of the water ordered within the three-day period starting with the day for which water is ordered.

Before an order can be delivered, it must be confirmed or verified by the Division. The following verification procedures are used to notify the users the date delivery is to start.

1. The user designates a telephone number where he can be contacted between the hours of 3:00 p.m. and 5:00 p.m.
2. The user makes arrangements to call the District himself between 3:00 p.m. and 5:00 p.m.
3. If methods 1 and 2 are not possible, the District and the user may make other arrangements as long as verification takes place between the hours of 3:00 p.m. and 5:00 p.m.
4. If the water user desired, he may order on the basis that delivery will be accepted at any date within the three-day period mentioned previously, without further verification.

With the exception of number 4 above, no irrigation run will begin until verification has taken place.

Scheduling by Division - As the individual water orders are received, the division water clerks log each order for the following day by lateral and individual zanjero run, listing the account number, the amount of order and how many days the order is to run. This is done on the Division Water Order Register. By 12 noon, the water clerk knows what orders need to be satisfied for the following day and what the flow requirement will be for each canal.

If requested, flows exceed the lateral canal capacity, certain orders can be delayed by the water clerks within the three-day limit described above. Highest priority for service goes to those orders already running. The next group scheduled are those that have been delayed or "carried over" from previous day's scheduling with the longest carryover receiving the higher priority. Priority for the other orders not on carryover is based on the time the order was received. It should be noted that other than for running orders or

orders that must be delivered to stay within the three-day limit, the priority system described above may be altered at the discretion of water clerk.

The flow required in each canal for the following day is then recorded on the division's Daily Water Distribution Work Sheet and compared with the estimated order for that canal. The estimated order is based upon total water estimated for each division by the Water Control Section and distributed among the division's lateral canals based on the current use pattern.

Total orders for the division are determined and compared with the amount estimated by Water Control. The Division Water Clerk then calls Water Control to verify the estimated order or request a change. Water Control, after analyzing similar data from all the divisions in light of current capabilities of the system, will notify each division of their revised allotment. The division then allocates the revised allotment among the various canals and enters the revised orders on the Daily Water Distribution Work Sheet. The water clerks then make any final adjustments to individual deliveries on each zanjero run. With the following day delivery now set, the water clerks estimate the orders for the second and third following days, based on running orders and carryovers, and summarize this data for the entire division. This data is then phoned in to the Water Control Section where it is entered on their Daily Water Allotment.

Daily Scheduling by the Water Control Section - The Water Control Section is responsible for allocating the next day's water supply among the various divisions. On a daily basis, Water Control performs the same function as the division water clerks but on a District-wide basis.

Water Control begins by allocating the water scheduled to arrive for the following day, less 300 cfs reserved for carryover orders, among the various divisions based on each division's use pattern and estimates of flow submitted on previous days. This data is entered on the Daily Water Allotment Sheet.

Each division is asked to "line up" on or attempt to schedule their water orders to meet this supply. As discussed in the previous section, after determining their water orders, the various divisions will call the dispatcher at Water Control to request revised allotments. Water Control analyzes these requests in-lieu of system capabilities and determines how the 300 cfs reserved for carryover should be allocated among the divisions. The dispatcher then notifies each division of its revised allotment for the next day. Each division then prepares its adjusted schedules for the next day and estimates for the two days following. This information is called back to Water Control and logged on the Daily Water Allotment Sheet for use in scheduling the following day's deliveries and determining allotments for subsequent days. These Daily Water Allotment Sheets are also used in the process of scheduling releases from Imperial Dam explained in the following section.

Scheduling Diversions at Imperial Dam - The Scheduling of diversions at Imperial Dam has two components. One involves determining the weekly order or "Master Schedule" and the other is modifying that Master Schedule on a daily basis.

On Wednesday of each week, the District orders its diversions from Imperial Dam for each day, Monday through Sunday, of the following week. This becomes the "Master

Schedule" for that week. Daily adjustments can be made to this Master Schedule providing notice is given 72 hours prior to the time Imperial Dam diversions are to begin for the day being revised. There appears to be little or no restrictions placed on IID for making adjustments to their Master Schedule for a particular day.

The daily modifications are based upon three considerations, with the main component being the Daily Water Allotment Sheets. These allotment sheets indicate the current trend of water orders up to the day being adjusted. The Watermaster then considers the day of the week (weekends generally require less water) and current and projected weather conditions before deciding on any final adjustments to make in the daily water order.

The weekly order, or Master Schedule, also relies heavily on the Daily Water Allotment Sheets to set out the recent weekly trends in water orders. Weather too is considered but in a more general fashion (10 to 12-day forecast instead of a 2 or 3 day forecast). The Watermaster analyzes the seasonal crop demands or the irrigation cycle. The seasonal crop demands are based on time of year, cropping pattern and status of the various crops (i.e., which crops are being planted, cultivated or harvested at that time). The irrigation cycle, or seasonal crop demand, is also monitored by annual charts showing weekly fluctuations of water orders over the last two or three years. These charts allow comparison of the current weekly order to that made the previous two years at the same time of year. This creates a historical, as well as seasonal perspective for determining the weekly order. Finally, the Watermaster estimates what the conveyance losses will be in the system for the amount of

water required. After considering all of the above, the Master Schedule is prepared and called into Imperial Dam.

Water Delivery

The Daily Water Allotment Sheet (from Water Control) and the divisions' Daily Water Distribution Work Sheets and Water Order Registers together provide the framework for daily deliveries throughout the District.

The Water Control Section hydrographers, under the direction of the District Watermaster, are responsible for delivering water into the main and lateral canal systems to meet the required flows to the various divisions.

The zanjeros are responsible for making the deliveries from laterals to each individual farm headgate in accordance with the Water Order Register prepared for each lateral system zanjero run.

The District currently employs about 140 hydrographers and zanjeros.

With the exception of a few deliveries made by the hydrographers to farm headgates on the main canals, the zanjeros make the deliveries to the farmers. Each zanjero operates a number of lateral canals better known as a zanjero run or district.

Farm deliveries are made through a standard outlet structure. Flow rate is determined by setting the gate opening in relation to the difference in water elevation upstream and downstream of the gate. Rating curves have been developed so the zanjero can set the proper gate opening to achieve the ordered head.

At the start of each daily run, the zanjero sets the headgates for the appropriate flows. He returns later in the day to adjust each headgate to maintain the ordered flow.

The zanjero is required to leave a printed notice of water delivered at the place of measurement every day water is run. Information included on this notice is the date and time of day run was begun, the amount ordered, the gate opening, for whom the water is turned on and the zanjero's signature. On subsequent days during a run, any changes in amount ordered, and therefore gate opening changes, will be noted and signed off by the zanjero. Water charges are made daily for each 24-hour period for the amount delivered. These charges are discussed in more detail in a subsequent section.

Delivery Requirements - There are a few restrictions the District and/or zanjero require be met before deliveries will be made.

1. Water cannot be delivered unless ordered by the landowner or his authorized agent.
2. Delivery can be refused if the user's ditch is not in a condition to carry the water.
3. Deliveries are made in 24-hour periods or multiples thereof with adjustments as outlined in the following section.
4. Water cannot be delivered while there is a delinquent bill outstanding.
5. The zanjero can reduce the water delivery to an amount he judges feasible if the amount ordered would exceed the capacity of the farmers ditch. Water charges are adjusted to water actually delivered.

Delivery Flexibility - The standard water order is for a certian flow in cubic feet per second (ordered as "feet") delivered in multiple periods of 24 hours at a particular headgate. The farmer, however, can revise his order within certain guidelines (i.e., without incurring a penalty) as set out in detail in the Rules and Regulations and the 21-point Water Conservation Program (see Appendix). These guidelines are listed below:

1. The user can make any changes he desires for the last day of his run as long as he notifies the District before 3:00 p.m. of the preceding day.
2. The user can have his order adjusted up to two feet any day of his run as long as he notifies the zanjero before he begins his daily run. The zanjero must also get approval before this change can be made.
3. During the last day of his run, the water user can adjust the last 12 hours of his run up to 50 percent or five feet, whichever is less, as long as the District is notified before 3:00 p.m. on that day.
4. A user can change his water order from one gate to another on the same canal at any time as long as the switch is coordinated with the zanjero. The zanjero needs to be sure the new gate is set properly and the proper accounts are credited correctly.
5. A user can extend his order an additional day (finish head) if done prior to 3:00 p.m. of last day of his original order.

A system of penalties has been set up for users who do not stay within these limitations. These penalties are discussed in a subsequent section.

Operation Flexibility - The two previous sections set out in general the major components of the Rules and Regulations and the 21-point Water Conservation Plan as they affect water orders and deliveries. These guidelines control operating deliveries. However, the District attempts seek to be flexible within these guidlines.

For the most part, the zanjero and his supervisors play the key role in this added flexibility. For example, all deliveries are to be made in 24-hour periods, yet in the case of finish heads (see Item 5 of Delivery Flexibility) a user may need only two more hours to finish an irrigation. If the zanjero can work it into the system, say by delaying another users' order by two hours, he will schedule that and the user will be billed for the extra two hours. This can be done because the zanjero can communicate with the affected users directly and knows the individual needs of users on his run.

Water Charges - The current water rates charged by the District for agricutlural water service are as follows:

Annual Water Availability Charge effective October 1970	$1.90 per net irrigated acre
Water Rate August 1, 1983	$9.00 per acre-foot
Current Assessment July 1, 1983	$0.50 per net irrigated acre per month

Of the 9.00 per acre-foot water rate, $1.75 is allocated for water conservation. The current assessment of $0.50 per net irrigated acre per month was imposed because of a budget deficit estimated at $2 million caused by acreage reduction and subsequent water use reduction under the PIK program and

by the current wet year. Water charges are based on the flow rate recorded by the zanjero as delivered for that day, reduced to acre-feet. For billing purposes, a flow of 1 cfs for 24 hours is considered as 2 acre-feet.

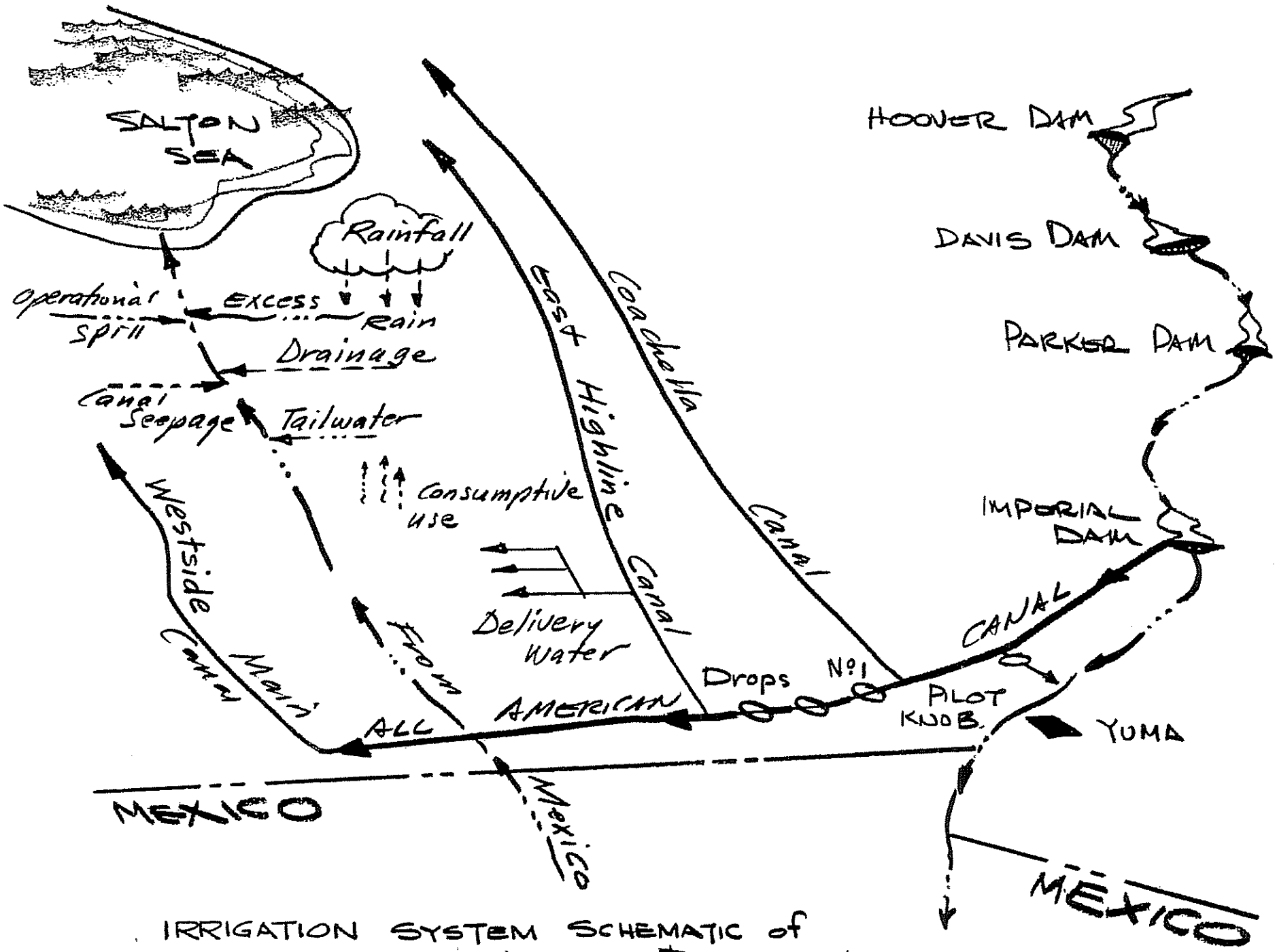
Charges for water are not as flexible as the operations for delivery. Unless the zanjero must deliver a different flow rate due to physical limitations, the user is billed for the amount he orders each day. If, under the guidelines set forth previously, the user increases his order, he is billed for the extra water delivered.

Order reductions, however, are not billed conversely. When a user must reduce his ordered delivery, he still pays for his entire order unless the amount of water he rejects can be sold to another user on the same lateral system. This prevents any double charge for water.

There do exist some exceptions to the above procedures which are summarized following:

1. If a reduction is made for the last day of a run by 3:00 p.m. of the preceding day (item 1 under "Delivery Flexibility"), the user is billed only for the reduced amount, not the original order. This is because sufficient time is given to the District to reroute the rejected flows.
2. If a user has his delivery changed from one headgate to another on the same canal, the charge is prorated between the two accounts based on time of run for each headgate (see item 4 under "Delivery Flexibility").
3. If, as described above in Operational Flexibility, a user is allowed an additional few hours for a "finish head", the user is billed only for those hours of flow delivered.

4. If water rejected by a user and not resold in that same system is returned to the main canal and can be used in another area, the original user will be charged for his full order and the water may be sold again in another division or lateral downstream. This situation occurs rarely throughout the District and is the only time water can be sold "twice".



IRRIGATION SYSTEM SCHEMATIC of
IMPERIAL IRRIGATION DISTRICT

TABLE 4
IMPERIAL IRRIGATION DISTRICT CONVEYANCE SYSTEM EFFICIENCIES, 1955-79
In thousand cubic dekametres
(thousand acre-feet)

Year	Water received by District at Drop 1		Total deliveries* to users		Operational losses**		Conveyance system efficiency (%)
1955	3610	(2,927)	2419	(1,961)	1191	(966)	67.0 %
1956	3586	(2,907)	2482	(2,012)	1104	(895)	69.2 %
1957	3431	(2,782)	2404	(1,949)	1027	(833)	70.1 %
1958	3369	(2,731)	2394	(1,941)	975	(790)	71.1 %
1959	3503	(2,840)	2522	(2,045)	981	(795)	72.0 %
1960	3681	(2,984)	2687	(2,178)	994	(806)	73.0 %
1961	3647	(2,957)	2709	(2,196)	938	(761)	74.2 %
1962	3640	(2,951)	2743	(2,224)	897	(727)	75.4 %
1963	3689	(2,991)	2819	(2,285)	870	(706)	76.4 %
1964	3417	(2,770)	2959	(2,399)***	458	(371)	86.6 %***
1965	3237	(2,624)	2852	(2,312)	385	(312)	88.1 %
1966	3476	(2,818)	3047	(2,470)	429	(348)	87.7 %
1967	3355	(2,720)	2917	(2,365)	438	(355)	87.0 %
1968	3461	(2,806)	3054	(2,476)	407	(330)	88.2 %
1969	3301	(2,676)	2901	(2,352)	400	(324)	87.9 %
1970	3398	(2,755)	2983	(2,418)	415	(337)	87.8 %
1971	3557	(2,884)	3127	(2,535)	430	(349)	87.9 %
1972	3512	(2,847)	3122	(2,531)	390	(316)	88.9 %
1973	3646	(2,956)	3293	(2,670)	353	(286)	90.3 %
1974	3789	(3,072)	3425	(2,777)	364	(295)	90.4 %
1975	3702	(3,001)	3335	(2,704)	367	(297)	90.1 %
1976	3434	(2,784)	3102	(2,515)	332	(269)	90.3 %
1977	3322	(2,693)	3028	(2,455)	294	(238)	91.2 %
1978	3296	(2,672)	3011	(2,441)	285	(231)	91.3 %
1979	3457	(2,803)	3171	(2,571)	286	(232)	91.7 %
1980 (1)		(2,769)		(2,520)		(249)	91.0 %
1981 (1)		(2,769)		(2,500)		(269)	90.3 %
1982 (1)		(2,516)		(2,248)		(268)	89.3

SOURCE: Imperial Irrigation District, Annual Summary, Water Diversion, Transportation, Distribution and Drainage, United States and Mexico, 1955-79.

* This is water released to canals adjacent to farmers' headgates for subsequent delivery through the headgates. Portions of this water which are rejected by farmers and not diverted to others as a supplemental delivery may spill at the end of the canal. This type of loss (included here as part of "Deliveries") has been approximated at 1 to 2 percent of the "delivery" amount (J. R. Wilson telephone interview March 26, 1981).

** Operational losses include evaporation, seepage, leakage, and approximately 1600 minor service pipes which are unmeasured.

*** In 1964, the District changed calibration on the flow measurements to water users by 10 percent.

(1) Data added by Beckman-Edmonston Engineering.

IMPERIAL IRRIGATION DISTRICT
IMPERIAL COUNTY, CALIFORNIA

REPORT ON

WATER CONSERVATION PROGRAM

IV

Bookman-Edmonston Engineering, Inc.
Glendale, California

September 1983

FORWARD

This report has been prepared for presentation on behalf of Imperial Irrigation District at hearings on an "alleged waste and unreasonable use of water by Imperial Irrigation District," to be held in El Centro, California on September 27, 28 and 29, 1983.

Bookman-Edmonston Engineering, Inc. was retained by the District in late July 1983 to provide technical assistance to the attorneys regarding water use and operations of the District, and present testimony at the scheduled hearing.

Five reports have been prepared, namely:

1. Statewide Water Perspective
2. Water Conservation Opportunities in Imperial Irrigation District
3. Imperial Irrigation District - Water Operations
4. Imperial Irrigation District - Water Conservation Program
5. Water Use Efficiency Comparison

In addition, supplemental and supporting data are contained in the Appendix to the Reports.

Because of the time constraints, the complexity of the factual data and issues addressed, the reports are reconnaissance type in scope. The conclusions expressed are considered sound, but are subject to revision as more detailed information and more complete analysis become available.

Bookman-Edmonston Engineering, Inc.
Glendale, California
September 1983

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INTRODUCTION

The Imperial Irrigation District was formed in 1911 and at that time, encompassed an area of more than one-half million acres. There are now over one million acres within the District boundaries of which about 461,000 acres received water in 1982.

The sole source of water to the District is the Colorado River. Water is conveyed to the District in the All-American Canal constructed by the U.S. Bureau of Reclamation in the early 1940's. Water not consumptively used within the District flows to the Salton Sea as subsurface flow or in an extensive system of drainage canals. Since 1929, nearly 28,000 miles of tile drains have been installed by District landowners and connected to the drainage canal system.

The District is an irrigation district formed under the laws of the State of California. It is the policy of the State that the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented. Furthermore, the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare.

The District obtains water from and through a federal reclamation project and must also comply with federal policies regarding reasonable use of water. Annual reports are prepared by the U.S. Bureau of Reclamation and within the Lower Colorado River Region, the Imperial Irrigation District has consistently been found to have the highest water use efficiency.

Water conservation programs including structural (construction) and non-structural (operational) measures are

reflected by the rules and regulations adopted by the District Board to encourage efficient water use. These rules and regulations are continually reviewed by the District Board and revised as necessary to reflect conditions within the District, advancements in the technology of irrigation and District operations.

History of Water Conservation

It was recognized in the early 1900's that the water table and salinity in the Imperial Valley must be controlled for the area to remain agriculturally productive. In 1922, landowners in the valley authorized a $2.5 million bond issue to provide funds for the construction of drainage canals. At present, the District maintains a system of over 1,400 miles of open drainage ditches. Tiled drainage systems were introduced in the area in 1929 and by 1979 nearly 26,000 miles of on-farm tile drains were in place, draining an area of over 400,000 acres. Water introduced into the drainage system is discharged to the Salton Sea.

The principal sources of drainage flows which discharge to the Salton Sea and originate within the Imperial Irrigation District are listed below:

1. Applied irrigation water not consumptively used by crops which percolates and enters the on-farm drainage systems.
2. Applied irrigation water which runs off the lower end of the fields and is discharged into the open drains by gravity or pumpage.
3. Operational spills from the District's distribution system which result from an imbalance of canal flow and diversions to landowners.

4. Seepage from the District canal distribution system.

Items 1 and 2 are not directly controlled by the District and farmers must be relied upon to use their water in a reasonable manner. However, the District historically has encouraged efficient on-farm water use by enforcement of rules and regulations designed to limit overapplication of water at the on-farm level.

Operational spills (Item 3) and control thereof is the District's responsibility. Rules and regulations have been adopted governing the placement of water orders to (1) meet landowner needs for irrigation water, (2) provide equity of service to landowners, and (3) provide operational flexibility of the water distribution system. A principal responsibility of any irrigation district is to meet the irrigation demands of its landowners who annually risk large sums of money based on the assumption that irrigation water will be available when needed. Since scheduling of irrigation needs is mainly dependent on daily weather conditions, it is reasonable if not mandatory that the water supply system be designed to provide maximum operational flexibility. This is particularly important in the Imperial Irrigation District where due to high temperatures an entire crop could be lost as a result of a one or two-day delay in receiving water.

Seepage from the District canal distribution system (Item 4) is also recognized by the District Board as contributing to Salton Sea inflow and potential drainage problems within the District. As early as 1959, District funds were set aside for the lining of canals which commenced in 1960.

Clearly, the viability of agricultural production in the service area of the Imperial Irrigation District is dependent

on efficient water use at the on-farm level and in the operation of the facilities that deliver water to the farmers. This was historically recognized by the District Board and was reflected in the rules and regulations that govern water deliveries by the District.

The right to divert water from the Colorado River for use in the Imperial Irrigation District has been discussed in other reports and will not be repeated here in detail. It is expected that Colorado River diversions by California agricultural water users may be reduced by the Secretary of the Interior in the near future to 3,850,000 acre-feet and that Imperial Irrigation District would share in the anticipated cutback. This pending reduction in water supplies to the District is recognized by the Board and has affected their policies regarding water conservation. In 1964, the Secretary of the Interior requested that diversions from the lower basin states' entitlement be reduced by 10 percent in order to expedite filling of Lake Powell. The Imperial Irrigation District succeeded in reducing their diversions and was commended by the Regional Director of the Lower Colorado River Region of the U.S. Bureau of Reclamation by letter dated May 19, 1964. Although this reduction in diversion was not related to the pending cutback discussed earlier, it demonstrated the Board's willingness to pursue water conservation measures.

Initial Water Conservation Programs

The principal purpose of a water conservation plan is to encourage efficient water use. Secondary benefits include, in addition to water savings, a more dependable system by providing more operational flexibility and reducing the operation and maintenance requirements and costs. Moreover,

water conservation measures improve control of water distribution, which in the case of Imperial Irrigation District, would reduce inflow to the Salton Sea.

Major water conservation programs by an irrigation district usually require changes in routine at the policy and management level, at the operation and maintenance level, and at the water user level. Changes must be accomplished in a well planned and orderly fashion, especially in a large and complex district such as Imperial, where large quantities of water are handled; lands are located far from the water source and are irrigated 12 months out of the year; and where high value crops are produced which are often highly sensitive to management of soil, moisture and salinity. Any program measure that disrupts established practices and procedures or attempts to implement structural changes to existing distribution systems more rapidly than can be accommodated within the capability of District personnel and landowners to adapt may well result in an overall failure of the water conservation program. The degree of failure can be measured in crop losses, excessive district costs, and poor relations between the District and landowners it serves.

Districts often proceed with certain water conservation programs desirable both to water users and a district, without an in-depth feasibility study as to benefit-cost or best order of priority. IID's canal lining program has been somewhat in this category. It was obvious to the District that in addition to reducing seepage losses, lined canals were more economic to operate and maintain than dirt ditches. Farmers prefer lined canals because they reduce seepage damage to adjacent lands, reduce the lands needed for right of may and increase land available for farming. Where farmers are responsible for maintenance, costs are reduced. The rate at which mutually financed programs can proceed is

influenced by funds available, canal delivery schedules, and availability of contractors to do a timely job.

Operational changes that result in water conservation such as some of those under IID's 13-point and 21-point programs can be made without benefit-cost analysis, but will succeed only if done gradually, include educational and training sessions of both district operating personnel and water users, and provide for effective communications by district supervising and operating personnel and water users.

Specific Water Conservation Measures

Although the District had no formal water conservation program prior to the mid-1970's, policy reflected in Board resolutions indicated an awareness of the need to put the water supply available to the District to reasonable and beneficial use. The severe water shortage in the northern portion of the State of California during the historic 1976-77 drought provided impetus for the District to implement its first formal water conservation program with the adoption of Board Resolution 45-76, setting forth a stringent 13-point program for water conservation. This program and additional water conservation measures implemented since 1976 are discussed in the following sections:

13-Point Program. Imperial Irrigation District in July 1976 supplemented its existing water conservation efforts with a stringent 13-point program. Included in the program are:

1. Construction of a water-regulating reservoir on the Westside Main Canal.
2. Reconstruction of farm outlet boxes, as required.
3. Employment of an adequate number of water-regulating personnel to effect more efficient deliveries, as the system will permit.

4. Daily inventory of surface field discharge, charging users who needlessly waste water an assessment for that day equal to three times the scheduled water rate.
5. Development of surface water evaporation ponds.
6. Preliminary studies for a regulating reservoir on the Central Main Canal.
7. Studying the feasibility of installing additional water recovery lines paralleling the main canals to increase salvage of seepage water now entering the drainage system and the Salton Sea.
8. Providing free drainage water to persons willing to pump and use same.
9. Continuing the concrete lining program.
10. Initiating a record of accrued water use per acre per parcel per annum through computerized billing.
11. Installation of radio equipment in all water-conservation-related vehicles to afford immediate communication with supervision.
12. Initiation of an irrigation management services program.
13. Delivery of water off-schedule when and wherever possible.

The overall goal of the 13-point program is to improve water use efficiency within the District and reduce inflow to the Salton Sea. Set forth in the following tabulation are the specific objectives of each of the 13 points included in the initial water conservation plan:

Specific Objectives of 13-Point Program

Point Number	Objective
1.	Reduce operational spills
2.	Reduce tailwater runoff
3.	Reduce operational spills and tailwater runoff
4.	Reduce tailwater runoff
5.	Reduce inflow to Salton Sea
6.	Reduce operational spills
7.	Reduce canal seepage
8.	Reduce inflow to Salton Sea
9.	Reduce canal seepage
10.	Reduce deep percolation and tailwater runoff
11.	Reduce operational spills
12.	Reduce deep percolation
13.	Reduce operational spills

Water Conservation Advisory Board. The Board of Directors of the District recognize the need to continue and expand water conservation efforts and in 1979 appointed a Water Conservation Advisory Board made up primarily of District farmers. The purpose of the Advisory Board was to make recommendations to the District Board regarding the implementation of further water conservation measures. Meetings of the Advisory Board were held on a regular basis and resolutions were adopted by that Board, setting forth suggested additional water conservation measures. The recommendations presented by the Water Conservation Advisory Board were reviewed by the District Board and in 1980 the District Board adopted a 21-point program proposed by the Advisory Board and intended to supplement the original 13-Point Water Conservation Program which was adopted in 1976.

The Water Conservation Advisory Board has remained active since its formation and continues to work with the Board of Directors of the District in order to obtain more efficient water use within the District.

21-Point Program. The 21-Point Water Conservation Program recommended by the Water Conservation Advisory Board and adopted by the Board of Directors of the Imperial Irrigation District is set forth following:

1. The District shall establish a penalty of one hundred dollars ($100.00) for the unauthorized adjusting of delivery gates which results in a change in the amount of water being delivered.

   Furthermore, whenever a water order is in the process of being pumped through a sprinkler or gated pipe system and the operator-user experiences a mechanical failure of the subject equipment, said operator-user shall be permitted to discontinue his water delivery for a period of not more than three (3) hours. The free time permitted under this schedule shall be considered as separate instances, but in no event shall the combined hours so considered exceed three (3) hours before a triple charge is to be assessed.

2. The concept of installing gate control devices of a standard design is recommended and supported, such devices to be installed on structures accommodating gates which are owned, operated and maintained, as well as regulated, under the jurisdiction of the District and its personnel.

3. Application of the assessment charge shall apply on the same basis to all types of irrigation, with the following exceptions:

(a) The percentages of surface runoff allowed when water is being used to irrigate plowed or flat unseeded ground shall be five percent (5%) for the last day of said irrigation; no measurable waste shall be allowed for any previous days.

(b) When water is being run in furrows to germinate crop seeds and establish a stand, no assessment charge shall be made unless one of the two consecutive measurements showing fifteen percent (15%) or more runoff is made between 12:00 noon and 6:00 p.m.

4. In the event a water user is receiving more than his confirmed order, said surplus shall be subtracted from his surface runoff for the purpose of determining if his runoff is excessive.

5. In no event shall any water user be assessed unless his runoff is fifteen percent (15%) or more of his running order irrespective of the quantity of water the user is receiving.

6. Any surface runoff measurement made within four (4) hours after the District has reduced the quantity of water delivered shall apply to the order in effect before said change.

7. The application of an assessment charge based on waste measured after the delivery gate is closed shall apply on the same basis as when water was actually running. Any assessment made after the gate is closed shall be based on the order last running.

8. In no event shall the user pay more than triple the normal charge for water, except when he adjusts the delivery gate without permission.

9. All net proceeds from surface runoff assessment charges shall go into a special fund for conservation purposes other than the concrete lining of ditches.

10. All District personnel whose duties include checking of surface runoff will initial any waste assessment sheets issued.

11. Changes can be made for the last day of a run by notifying the District not later than 3:00 p.m. of the preceding day.

12. When a water user requests an adjustment in the quantity of water delivered not to exceed two (2) feet, the District shall be obliged to honor the same if it is within the ability of the District's system to accommodate such request and the water user notifies the zanjero in advance of beginning his daily run. The zanjero of said run shall obtain approval to make said change from his respective superior or section.

13. A reduction in the water order shall be made to apply to the last twelve (12) hours water is run, providing that the District is notified in advance but not later than 3:00 p.m. preceding the time the order is changed. No penalty shall be charged for said reduction as long as the same does not exceed fifty percent (50%) or five (5) feet of the order as confirmed, whichever is less. Water returned with notice after 3:00 p.m. or which exceeds the quantity that this rule authorizes shall be subject to an assessment equal to two times the regular water rate.

14. By notifying the District before 3:00 p.m., orders can be adjusted for the last twelve (12) hours of the run, up to fifty percent (50%) of the confirmed order or five (5) cubic feet/second, whichever is less.

15. Finish heads can be ordered up to 3:00 p.m. of the day preceding the day of delivery.
16. By notifying the District before 7:30 a.m. of the last day of a run, an order can be adjusted up to fifty percent (50%), without penalty.
17. One-day orders shall be checked by the appropriate District employees on the same basis as any other water order. For the application of the assessment charge, the first waste measurement shall not be made later than eighteen (18) hours after the beginning of the day's water delivery.
18. The District shall secure whatever additional radio equipment that is necessary to improve communications between the farmers and Water Department personnel.
19. The Water Department of the District shall make six (6) wastewater recorders available to be installed at various locations within the service area boundaries as defined.
20. The District shall prepare a monthly water information bulletin for distribution which shall include information submitted to the District by a committee to be appointed by the Water Conservation Advisory Board, and from other sources as required for the purpose of assisting the water user in using all water beneficially.
21. Routine canal cutouts shall be accomplished once every eight (8) weeks, except when special circumstances require more frequent cutouts.

The 21-Point Water Conservation Program does not generally expand upon the water conservation measures set forth in the 13-point program but rather, defines policies adopted

by the Board for administering and enforcing the 13-point program.

Present Water Conservation Program and Practices

Review of the previous sections of this report clearly indicates that the Board of Directors of the Imperial Irrigation District historically recognized the need for water conservation in the District and has acted to implement specific measures to increase water use efficiency. Summarized in the following sections are structural and non-structural measures which make up the present program for water conservation in the Imperial Irrigation District.

Structural Measures

1. Continuance of a canal lining program initiated in the early 1960's to reduce seepage losses from the District water distribution system.
2. Continuance of a program initiated in the mid-1970's for construction of regulatory reservoirs along the canal system to provide operational flexibility and reduce the amount of water discharged to drains from operational spills which occur as a result of an imbalance between inflow to the District and water delivered to farms. This program also includes studies of reservoir sites for possible future construction.
3. Continuance of a seepage recovery program initiated in 1967. Drainage pipelines (installed parallel to major distribution canals) discharge to sumps where water is pumped back into the canal and delivered to farmers. This program also includes studies to

identify additional locations where water recovery lines could be installed.

4. Continuance of a program to reconstruct or install farm delivery boxes of standard design to provide accurate measurement and control of water deliveries to farms.
5. Implementation of a program to install gate control devices in the canal distribution system to reduce operational spills, provide more uniform farm deliveries and reduce tailwater runoff.
6. Continuance of a program initiated in the mid-1970's to develop evaporation ponds in the drainage system. This program is directed to reducing inflow to the Salton Seal, rather than water conservation in the District.

Nonstructural Measures

1. Continuance of the irrigation management services program initiated in 1981 to assist farmers in scheduling irrigations and determination of amount of water to apply per irrigation. A water conservation supervisor and several technicians were retained to administer the program.
2. Continuation of a program to provide better communications between operators and supervisors by installation of radio equipment in vehicles. Better communications result in more rapid response to unanticipated events in the field such as failure in on-farm systems or the District system

and climatic changes which cause farmers to irrigate longer or shorter than planned. Better communications would also permit greater operational flexibility in switching water deliveries from one farmer to another, thereby reducing operational spills.

3. Continuance of a program to continually review personnel requirements and duty assignments to provide more efficient operation of District facilities, to provide more frequent measurements of deliveries and tailwater runoff, and to collect and analyze data regarding District operations, on-farm deliveries, tailwater runoff, etc.
4. Continuance of programs to penalize farmers who tamper with water delivery structures or have excessive tailwater runoff.
5. Continue to encourage farmers to take water deliveries off-schedule to reduce operational spills.
6. Continuance of a program initiated in 1976 to permit farmers to utilize drainage water, free of charge, for irrigation or reclamation. The effect of this program is to reduce inflow to the Salton Sea and District diversions.
7. Continuance of educational programs developed to instruct farmers and District personnel in efficient water use and system operations.
8. Continuance of program of working together with the Water Conservation Advisory Board to review current conservation practices and revise as necessary.
9. Continuance of support of studies (USBR and others) to identify future opportunities for water conservation and associated costs.

Accomplishments of Water Conservation Program

The estimated total capital expenditure by Imperial Irrigation District through 1982 for structural water conservation facilities is on the order of $27.3 million. At present, approximately $620,000 is included in the District budget for nonstructural measures. Presented in the following sections are discussions of specific water conservation measures.

Canal Lining

Since this measure was initiated in the early 1960's, approximately 860 miles of canal distribution system has been lined with concrete. The canal lining program is done in cooperation with landowners who have contributed nearly $4.4 million. This District contribution is approximately $22.0 million for a total expenditure of over $26 million.

Regulatory Reservoirs

The District has four regulating reservoirs in operation providing a total storage of 1,570 acre-feet. One reservoir is located on each of the three main canals, East Highline, Central Main and Westside Main. The fourth and newest reservoir, the Herman "Red" Sperber Reservoir, began operating May 1, 1983 and stores water from the Rositas Canal.

The District has selected sites for two additional reservoirs. One is to be located at the terminus of the Westside Main Canal about 18 miles downstream of the J.M. Sheldon Reservoir. The other site is located at the terminus of the East Highline Canal about 16 miles downstream of the Kakoo Singh Reservoir. The estimated storage capacities of

these reservoirs are 400 acre-feet and 200 acre-feet, respectively. Approximately $3.3 million has been expended for construction of regulating reservoirs.

Seepage Recovery Lines

The District has constructed 6 miles (12-1/2 mile sections) of drainage lines parallel to the East Highline Canal to recover canal seepage losses. Water entering these drains is pumped back into the canal for delivery to farms. Through 1982, it is estimated that nearly 210,000 acre-feet has been returned to the distribution system. Total funds expended for seepage recovery lines is $492,000 and approximately $50,000 per year is budgeted for operation, maintenance and power costs associated with the seepage recovery program.

Farm Delivery and Outlet Boxes

Since 1976, farm delivery boxes have been installed or reconstructed using standard designs to provide for better water control and measurement of farm deliveries. Farm outlet boxes have also been installed or reconstructed to facilitate measurement of excessive tailwater runoff which is the basis for penalty assessments.

Automatic Controls

In the early 1980's, the District had installed remote electronic monitoring and control devices at 20 locations including the All-American Canal. Since then, remote control telemetry has been installed at the Oscar Fudge Reservoir outlet located at Check No. 4 of the Central Main Canal.

Automatic control of Sperber Reservoir's two outlets is to begin sometime in September 1983.

The Water Control Section and the Watermaster operate the remote control features in the District. The hydrographers and other field personnel can provide manual operation of these facilities in case of power outages and emergencies.

Automatic control and remote monitoring of operations will increase under the present District Plan as provisions for telemetry are built into every new or replacement structure.

Evaporation Ponds

Evaporation ponds have been constructed at 17 locations in the New and Alamo rivers to reduce inflow to the Salton Sea. Through 1982, $1.5 million have been expended on this measure.

Irrigation Management Services Program

The Irrigation Management Services Program (IMS) was begun in 1981 as a two-year program sponsored by the USBR to provide information to farmers to increase irrigation efficiency. The IMS program is voluntary and at present 12,000 acres are participating. The program is administered by the Water Conservation Supervisor who works with participating farmers to improve on-farm water use. The annual budget for this program is approximately $170,000.

Improved Communications

All operational mobile equipment and vehicles have radio equipment for immediate exchange of information with supervision and water control. The District also has installed radio equipment in all the Division offices (where water orders are received and processed) as well as in the operating headquarters. Effective communications between farmers and operating personnel, zanjeros and their supervisors and water clerks, and communications among the various operating entities within the District improves efficiency of daily operations as well as providing instant communications among personnel during emergencies. Approximately $80,000 has been expended to improve communication capability in the District.

Educational Programs

Educational programs and training sessions for farmers and District personnel are imperative to the overall success of a water conservation program. Structural and nonstructural changes in District operations require time to be accepted and to reach their full potential for water conservation. Imperial Irrigation District, through the Water Conservation Supervisor, has implemented an educational program for farmers participating in the IMS program.

Administration and Penalties

Specific accomplishments under this section are difficult to define as they are integrated with overall management of the District. Such activities as water user penalties for tampering with gates or for excessive tailwater runoff are clearly associated with the water conservation

program but review of personnel requirements and duties would be undertaken as part of prudent District management.

A "Modified Demand Irrigation Trial" was implemented on one zanjero run in August 1983 and includes about 11,000 acres. The purpose of the program is to put high priority on delivering water off schedule and varying the delivery time from the established 24-hour period. This is being done only on flat border check irrigation crops like alfalfa and wheat and not on row crops. This program is designed to allow a farmer to terminate deliveries early if his irrigation is complete or run an extra few hours if need be to finish an irrigation. Other farmers in this program may then begin irrigations sooner or later than normal depending on the canal system capabilities at any particular time.

This type of delivery program requires more involvement from operational staff, i.e., zanjeros and water clerks, to handle this added flexibility. A special communication station has been set up out of the Brawley division to handle the extra communication and coordination required by such a system.

Water charges under this program are prorated to the actual number of hours the ordered flow runs rather than in blocks of 24 hours.

It is still too early to have any significant data on the results of this program in terms of any water savings or its possible effects on District operations.

Water Savings

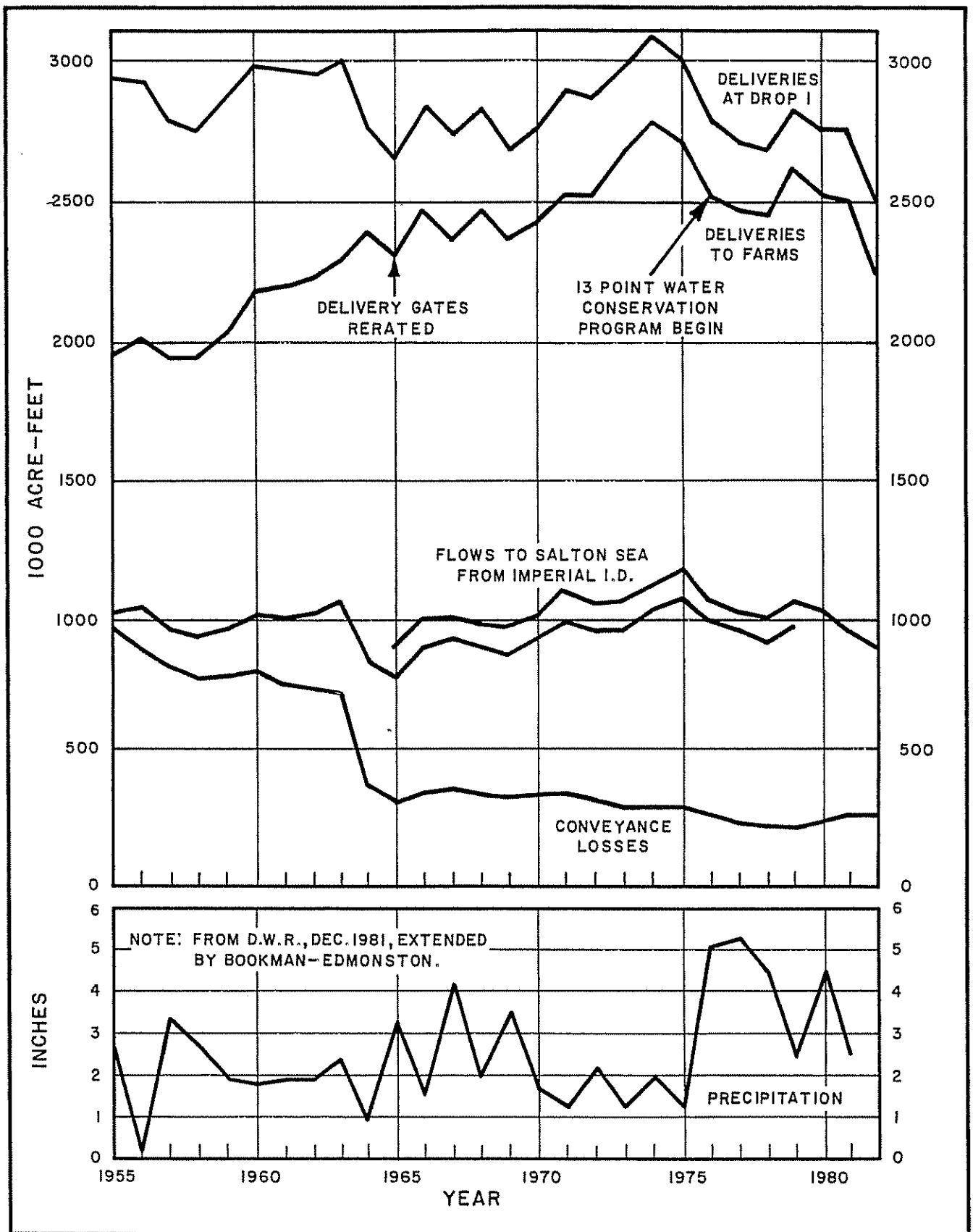
The total quantity of water saved by the individual water conservation measures has been presented earlier based on data supplied by the District. The total effect of the

water conservation program expressed either as total acre-feet per year or the accumulated water savings since 1976 has not been determined due to time constraints. However,there appears to be a downward trend in inflow to the Salton Sea as well as water deliveries at Drop 1 on the All-American Canal since the 13-Point Program was implemented in the mid-1970's. This is illustrated in the following figure entitled "Water Deliveries, Conveyance Losses, Precipitation and Flows to Salton Sea from Imperial Irrigation District, 1955-1982." Further evaluation is needed to estimate historic and projected future water savings from the existing water conservation program. In broad terms, the figure shows a trend of increasing diversion at Drop 1 and increasing inflow to the Salton Sea for the 1965-1974 period. The trend for both these items was reversed for the 1974-1982 period.

Summary

The Imperial Irrigation District has demonstrated, through actions and policies of its Board of Directors, an awareness of the need for efficient water use within the District and the need to reduce inflow to the Salton Sea from the District. Water conservation measures, both structural and nonstructural, have been implemented and have been effective to varying degrees.

Additional water conservation measures have been suggested by the Department of Water Resources and the U.S. Bureau of Reclamation. These measures are the subject of ongoing studies and when completed, will provide a basis for expanding current water conservation practices. The Board has, and will continue, to assure that available water supplies to the District will be utilized in a reasonable and beneficial manner.



WATER DELIVERIES, CONVEYANCE LOSSES, PRECIPITATION, AND FLOWS TO SALTON SEA FROM IMPERIAL IRRIGATION DISTRICT 1955–1982

BOOKMAN-EDMONSTON ENGINEERING, INC. SEPTEMBER 1983

IMPERIAL IRRIGATION DISTRICT
IMPERIAL COUNTY, CALIFORNIA

REPORT ON

WATER USE EFFICIENCY COMPARISONS

Bookman-Edmonston Engineering, Inc.
Glendale, California

September 1983

V

FORWARD

This report has been prepared for presentation on behalf of Imperial Irrigation District at hearings on an "alleged waste and unreasonable use of water by Imperial Irrigation District," to be held in El Centro, California on September 27, 28 and 29, 1983.

Bookman-Edmonston Engineering, Inc. was retained by the District in late July 1983 to provide technical assistance to the attorneys regarding water use and operations of the District, and present testimony at the scheduled hearing.

Five reports have been prepared, namely:

1. Statewide Water Perspective

2. Water Conservation Opportunities in Imperial Irrigation District

3. Imperial Irrigation District - Water Operations

4. Imperial Irrigation District - Water Conservation Program

5. Water Use Efficiency Comparison

In addition, supplemental and supporting data are contained in the Appendix to the Reports.

Because of the time constraints, the complexity of the factual data and issues addressed, the reports are reconnaissance type in scope. The conclusions expressed are considered sound, but are subject to revision as more detailed information and more complete analysis become available.

Bookman-Edmonston Engineering, Inc.
Glendale, California
September 1983

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Irrigation Efficency

Irrigation efficency can be defined by different terms. The terms commonly used, and as used in this report, are as follows:

Evapotranspiration (ET): The quantity of water transpired by plants, retained in plant tissue, and evaporated from adjacent soil surfaces in a specific time period. Usually expressed in depth of water per unit area. As used here, ET is synonymous with consumptive use.

Conveyance System Efficiency: The ratio of the volume of water delivered to users to the volume of water introduced into the conveyance system. The conveyance system for the Imperial Irrigation District service area starts at Drop 1 on the All-American Canal.

On-farm Irrigation Efficiency: The ratio of the volume of water used for ET in cropped areas to the volume of water delivered to farm (applied water).

District Irrigation Efficiency: The ratio of the volume of water used for ET in cropped areas to the volume of water delivered to the irrigation district service area conveyance system (Drop 1).

Unit Irrigation Efficiency: The ratio of the volume of water used for ET in cropped areas, plus that amount necessary to maintain a favorable salt balance in the soil (leaching fraction), to the volume of water delivered for these purposes (applied water).

The operations of the Imperial Irrigation District affect the Conveyance System efficiency and are discussed herein. Also discussed are the on-farm operations.

Operational Considerations

Imperial Irrigation District's operational procedures and its water users' on-farm irrigation practices relate closely to the history of irrigation development in the Imperial Valley. Physical arrangements for diversion of

water from the Colorado River at a point near the Mexican border and the facilities to bring that water through Mexico to the southern end of the valley shortly after the beginning of this century were made entirely by private enterprise. Land leveling for irrigation on farms was almost totally by horse drawn scrapers and wooden floats. The result is that most of the irrigation canals and laterals, and the on-farm ditches and leveling of fields are constructed to fit the general contour of the land which slopes toward the Salton Sea. Once the District distribution system and on-farm developments were in operation, it would be extremely difficult to make major changes because of the year-round cropping and irrigation.

Construction of Imperial Dam on the Colorado River and the All-American Canal in the late 1930's and early 1940's made little change in the irrigation distribution system within the Valley. From an operation and maintenance standpoint, water delivered through the All-American Canal system is more silt free than prior waters thereby resulting in more growth of moss, algae and aquatic weeds in the District's distribution system. Such growth can be controlled best by drying up the distribution canals and laterals about once a month.

The climate, soils, and land ownership pattern in the District lends itself to intensive commercial agriculture with relatively few small or part-time farming operations. As a result, there is little need for small or short-time irrigation water orders.

The general characteristic of the Districts' irrigation distribution system continues to be one that has limited water storage capacity in the canals; the water elevation in some canals has to be raised by the use of check gates so as to deliver adequate streams of water to farmers' headgates; and some canals can be drained for maintenance and so-called

moss control only by emptying them into wasteways or drains rather than delivering the so-called "run-down" water to water users.

On-farm ditches and land leveling generally slope toward the Salton Sea. This along with the low infiltration rate of the fine-textured clay soils which dominate the Valley, make it difficult to irrigate most crops without some runoff ("tail water") at the low end of the field. Fortunately, the fine-textured soils have a high water-holding capacity so that if an irrigator has irrigated an entire field before the end of his 24-hour water order, he is often able to "reirrigate" part of the land without losing excess water by deep percolation. As Colorado River water is relatively high in total dissolved solids (TDS), some downward percolation of water beyond the root zone is necessary to avoid accumulation of excess salts in the root zone after evapotranspiration, and such "reirrigation" may provide beneficial leaching.

It must be emphasized that each irrigation serves the basic purpose of replenishing the moisture that has been extracted from the soil by evapotranspiration. Any water applied in excess of this amount will eventually find its way to the Alamo or New River or directly to the Salton Sea through (1) runoff from the lower end of the farmer's fields; (2) as deep percolation drainage water; or (3) as wastewater from canals or laterals if deliveries to farmers are discontinued before the end of orders and there are no other water users to take the excess water.

The point of delivery to the All-American Canal is at Imperial Dam approximately 20 miles North of Yuma, Arizona. Scheduling of individual water orders in the District is closely related to the District's system of placing water orders with the Imperial Dam Supervisor of the Bureau of Reclamation. The farmers place their order for water one to three days in advance and the District places its order on

Wednesday for the block of deliveries the following week starting on Monday. Any daily changes must be made three days in advance in 24-hour increments. Similarly, the Imperial Dam Supervisor places orders for releases of upstream storage.

Irrigation Procedures in Other Western Areas

Water users on irrigation projects in the Western United States employ many different systems of placing water orders with irrigation districts. For efficient irrigation, an irrigator must know the depth of water needed to replenish the water that has been extracted from the root zone by plants and evaporation. Second, he must decide whether he is going to include additional water in each irrigation for salt leaching or whether that is to be accomplished by separate irrigations (often preplanting). Once the depth of water needed is determined and the acreage to be irrigated is known, it is a simple matter to calculate the total acre-inches or acre-feet of water for an order. Depending on the design of each district's system and its method of operation, a water user places an order combining (1) a rate of flow and (2) a length of time, the sum of which will yield the total quantity of water desired. For example, on the nearby Yuma Mesa Irrigation and Drainage District and Wellton-Mohawk Irrigation and Drainage District in Arizona, deliveries are made largely in units of 15-16 cfs and the time of irrigation varied accordingly. In the Imperial Irrigation District, the time is fixed in 24-hour units and the rate of flow varied to match the total quantity of water desired. In other words, the only difference in the system of ordering water in IID and other districts in the Lower Colorado River area is that IID holds the time in constant units (24 hours) and varies the rate of delivery (cfs) while other districts tend to hold

the rate of delivery in constant units and vary the time.

In each district in the Western United States, the system used for water users scheduling water orders has been developed around (1) the design of the project conveyance and distribution system in relation to the source and quantity of water supply; (2) the quality of water service the water users want and can afford; and (3) the local characteristics of soils, topography, drainage, and cropping patterns. In the case of Imperial Irrigation District, those characteristics are rather unusual. As pointed out heretofore, the District's distribution system and on-farm development predated the construction of major storage and diversion works on the Colorado River and the delivery of silt-free water. It takes five days for water releases from Lake Mead storage to reach Imperial Dam and another day or more for the water delivered to the District at Imperial Dam to reach most of the water users. Imperial Valley's agriculture involves high-cost and high-risk crops (i.e., lettuce, cabbage, tomatoes, onions, etc.) in which a shortage of water at critical periods can be disastrous. Therefore, a high level of service and reliability of water service is a must. The land characteristics of fine-textured soils with low water-intake rates and fields that slope toward the Salton Sea result in most excess water from field applications finding its way to the Sea in the form of surface runoff and spills rather than in unseen deep percolation such as occurs in districts with coarser textured soils.

Imperial Irrigation District Irrigation Efficiency

Despite the unusual and unfavorable characteristis for ease of operation as heretofore cited, the Imperial Irrigation District has perfected a system of estimating its water needs; placing its orders for diversions from Imperial Dam;

and delivering water to its water users that has resulted in the District having one of the highest (1) conveyance efficiencies; (2) on-farm irrigation efficiencies; and (3) over-all project irrigation efficiencies of all gravity irrigated projects in the United States.

District operational records and information developed by the Bureau of Reclamation for the period 1977 through 1980 has been reviewed. From that material, Bookman-Edmonston has prepared a summary sheet on "Efficiency of Water Conveyance and On-Farm Irrigation" which is attached as Table 1. It shows that the annual efficiencies of conveyance averaged 91 percent for the four-year period. The annual on-farm irrigation efficiencies during the same period averaged 72 percent. Overall district irrigation efficiencies averaged 66 percent for the four-year period.

Irrigation Efficiency in Other Western States

A preliminary summary sheet for the years 1975-78 prepared by the Water and Land Operations Division, Lower Colorado Regional Office, of the Bureau of Reclamation (USBR) concerning "Delivery Efficiencies" for districts in the Lower Colorado Region has been examined and is shown in Table 2. The information was computed from data in the USBR Crop Census and Monthly Water Distribution forms and the consumptive use data taken from Technical Bulletin 169, "Consumptive Use of Water by Crops in Arizona" dated September 1965, by University of Arizona Agricultural Experiment Station. In its computation of consumptive use, the USBR assumed that 80 percent of the rainfall recorded at gages in the vicinity of the District was effective in meeting plant needs. It is our opinion that far less than 80 percent of the rainfall is effective in meeting plant needs, and that the District's computation is more accurate than those reflected in Table 2.

TABLE 1

EFFICIENCY OF WATER CONVEYANCE AND ON-FARM IRRIGATION
IMPERIAL IRRIGATION DISTRICT, CALIFORNIA
1977 - 1980

	Amounts
Acres Irrigated	460,000
Diversions Below Drop No. 1 (acre-feet)	2,734,000
Diversions per acre irrigated (acre-feet)	5.94
Delivered to farms (total acre-feet)	2,496,500
Conveyance System Efficiency (in %)	91
On-Farm Consumptive Use (total acre-feet)	1,797,000
On-Farm Consumptive Use (acre-feet per acre)	3.90
On-Farm Irrigation Efficiency (in %)	72
District Irrigation Efficiency (in %)	66
Leaching Requirements (acre-feet)	270,000
Unit Irrigation Efficiency (in %)	83

TABLE 2

DELIVERY EFFICIENCIES OF IRRIGATION DISTRICTS

Irrigation Districts	1975	1976	1977	1978
Imperial Irrig. Dist.				
onfarm efficiency	73	80	81	77
district efficiency	65	71	73	70
Coachella Valley I.D.				
onfarm efficiency	51	50	55	53
district efficiency	43	44	46	46
Reservation Div. I.D.				
onfarm efficiency	45	47	58	60
district efficiency	36	38	47	50
Y.C.W.U.A. (Valley Div.)I.D.				
onfarm efficiency	64	80	71	72
district efficiency	49	60	54	52
Yuma Mesa Irr.&D.D.				
onfarm efficiency	33	33	29	32
district efficiency	30	30	27	30
Unit "B" Irrig. Dist.				
onfarm efficiency	33	32	35	38
district efficiency	32	31	33	36
Yuma Irrigation Dist.				
onfarm efficiency	62	63	61	61
district efficiency	59	61	59	53
North Gila Irrig. Dist.				
onfarm efficiency	29	40	46	42
district efficiency	28	30	43	40
Wellton-Mohawk Irrig. Dist.				
onfarm efficiency	55	52	63	64
district efficiency	50	47	57	57
Colorado Riv. Indian Tribes				
onfarm efficiency	57	65	76	64
district efficiency	44	50	58	48
Palo Verde Irrig. Dist.				
onfarm efficiency	46	33	45	42
district efficiency	36	26	35	33

However, regardless of this small difference, the USBR summary in Table 2 reflects that Imperial Irrigation District's on-farm irrigation efficiency and overall District irrigation efficiency are both higher than for any other water user organization diverting water in the Lower Colorado River Region.

Summary of Report on the Water Conservation Opportunities Study by the Bureau of Reclamation and Bureau of Indian Affairs, September 1978

We have also examined a "Report on the Water Conservation Opportunities Studies," dated September 1978, by the United States Department of Interior's Bureau of Reclamation (USBR) and Bureau of Indian Affairs (BIA).

This study covered 61 irrigation projects, including 46 USBR projects and 15 BIA projects, in 15 Western states. Table 3 in the report, on page 32 lists Imperial Irrigation District as having an overall water use efficiency of 70 percent, the highest of any of the 61 projects studied except for the Navajo Indian Irrigation Project in New Mexico. The latter is a new project still under construction where water is conveyed through lined canals and/or closed pipe systems and applied almost exclusively by sprinkler irrigation. The 70 percent overall project irrigation efficiency listed in the report is in agreement with the 10-year average listed in Table 1 as compiled from District records, and further confirms that the District's operational procedures, and the water users' scheduling and on-farm irrigation practices are outstanding when compared to other districts throughout the Western United States.

Table 1 on Page 17 of the 1978 Report describes an irrigation system with a farm efficiency of 70 percent as one on which the land leveling, delivery pipeline, and drainage system meet design standards. Imperial Irrigation District's

average on-farm irrigation efficiency exceeds this 70 percent design standard.

Since approximately 90 percent of the water diverted from streams in the 17 Continental Western United States is used for crop production, the USBR and BIA made this study in an attempt to identify irrigation projects having potential opportunities for conserving irrigation water. A total of 61 projects were identified (15 on BIA projects and 46 on USBR projects) as having such a potential. The 61 projects deliver approximately 12 million acre-feet of water annually to irrigate roughly 2.4 million acres.

The report points out that inclusion of a project in the report:

> "...should not infer that reasonable use of water is not presently being made on these projects under prevailing economic, legal, and institutional setting." (Emphasis added.) (p.1)

Average water use efficiency of the 61 projects was 44 percent, and in over one-third of the projects the water use efficiency was less than 30 percent.

IID is listed in the 1978 study mainly because of the large quantities of water involved and the unusual nature of its return flows not going back to the stream from which diverted. Of the 61 projects listed, IID had the highest overall water use efficiency (70 percent) except for the new Navajo Indian Irrigation Project (80 percent) which is still under construction, transports all of its water in concrete lined canals and pipelines, and uses only sprinkler irrigation.

Data gathered during the study were evaluated under four scenarios of future conditions: (1) status quo; (2) environmental-social-acceptability; (3) tight economic conditions; and (4) water-short. The report advises that IID:

> "...scores highest under all four scenaries and received no environmental-social-acceptability or legal and

institutional flags. It does not show economic benefits exceeding costs." (Emphasis added.) (p.51)

In specific regard to IID, the report further states in part:

"Water conveyance management and on-farm management are considered to be well above average, and water delivery facilities are estimated to be above average with respect to water loss." (p. c-23)

Conservation measures proposed for IID included lining of the main All-American Canal, lining on-farm ditches and providing an irrigation scheduling program. As of 1978, annual investment cost was estimated at $76 per acre-foot for conveyance system improvements and $65 per acre for on-farm activities for an average of $70 per acre-foot. Benefits were estimated at $51 per acre-feet. Hence, the above statement that economic benefits would not exceed costs.

Comparison of Use with Municipal Use

A comparison of agricultural use can be made with that of municipal and domestic use. The same principles apply including import, conveyance losses, deliveries and used water (sewage).

For an example, the water supply for the City of Los Angeles is shown in Table 3. Data is for the 1980-81 fiscal year. Annual amounts of sales and losses are shown in Table 4 for the past several years.

As can be seen on Table 3, the City of Los Angeles has a 91.6 percent conveyance system efficiency. A small part of the loss is reservoir evaporation. The majority of the loss includes meter discrepancies, reservoir seepage, main leaks and other minor uses and losses.

Relating sales to consumptive use as a measure of efficiency (the same measure as used for agriculture) indicates an efficiency of 34 percent.

TABLE 3

WATER USE IN CITY OF LOS ANGELES

		Amounts
Production		
Los Angeles Aqueduct(1)	476,000AF	
MWD(1)	46,000AF	
Local Wells(1)	95,000AF	617,000AF
Sales(1)		565,000AF
Losses		52,000AF
Losses in percent of Production		8.4%
Sewage (over 99% to Ocean)(2)		305,000AF
Sewage in percent of Sales		54%
Consumptive Use - (75% of outside use)		195,000AF
Conveyance System Efficiency	$\frac{565,000}{617,000}$ = 91.6%	
Efficiency of Use	$\frac{195,000}{565,000}$ = 34.5%	
Overall Efficiency	31.6%	

(1) LADWP Statistical Reports for 1980-81 fiscal year.

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TABLE 4

COMPARISON OF SYSTEM LOSSES AND SALES
FOR CITY OF LOS ANGELES (1)

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> "To meet the deficit in the SWP supply, the Department of Water Resources is currently considering new sources of water from the Sacramento Valley to expand the present capability of the SWP to meet contractor requests for water in future years. Another source which we believe also merits attention is the acquisition by the SWP of water presently being lost in the Imperial Irrigation District (IID) that could be salvaged, as shown in our December 1981 report. We realize that it's not presently economic for you to salvage much of this water for your own uses. This water could then be delivered by exchange to our Southern California contractors." (Emphasis added.)

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STATE OF CALIFORNIA — RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF WATER RESOURCES
P.O. BOX 388
SACRAMENTO
95802
(916) 445-9248

DEC 31 1982

Mr. Gerald L. Moore
President of the Board of Directors
Imperial Irrigation District
P. O. Box 1809
El Centro, CA 92244

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save water

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Sincerely,

(sgd) Ronald B. Robie

Ronald B. Robie
Director

cc: Ms. Carole Onorato, Chairwoman
State Water Resources Control Board
1416 Ninth Street, Room 605-2
Sacramento, CA 95814

Mr. Thorton Ibbetson, Chairperson
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107 South Broadway, Room 8103
Los Angeles, CA 90012

Mr. Myron B. Holburt, Chief Engineer
Colorado River Board of California
107 South Broadway, Room 8103
Los Angeles, CA 90012

bcc: Mr. John R. Benson ✓
426 West G Street
Brawley, CA 92227

Irrigation Efficency

Irrigation efficency can be defined by different terms. The terms commonly used, and as used in this report, are as follows:

Evapotranspiration (ET): The quantity of water transpired by plants, retained in plant tissue, and evaporated from adjacent soil surfaces in a specific time period. Usually expressed in depth of water per unit area. As used here, ET is synonymous with consumptive use.

Conveyance System Efficiency: The ratio of the volume of water delivered to users to the volume of water introduced into the conveyance system. The conveyance system for the Imperial Irrigation District service area starts at Drop 1 on the All-American Canal.

On-farm Irrigation Efficiency: The ratio of the volume of water used for ET in cropped areas to the volume of water delivered to farm (applied water).

District Irrigation Efficiency: The ratio of the volume of water used for ET in cropped areas to the volume of water delivered to the irrigation district service area conveyance system (Drop 1).

Unit Irrigation Efficiency: The ratio of the volume of water used for ET in cropped areas, plus that amount necessary to maintain a favorable salt balance in the soil (leaching fraction), to the volume of water delivered for these purposes (applied water).

The operations of the Imperial Irrigation District affect the Conveyance System efficiency and are discussed herein. Also discussed are the on-farm operations.

Operational Considerations

Imperial Irrigation District's operational procedures and its water users' on-farm irrigation practices relate closely to the history of irrigation development in the Imperial Valley. Physical arrangements for diversion of

water from the Colorado River at a point near the Mexican border and the facilities to bring that water through Mexico to the southern end of the valley shortly after the beginning of this century were made entirely by private enterprise. Land leveling for irrigation on farms was almost totally by horse drawn scrapers and wooden floats. The result is that most of the irrigation canals and laterals, and the on-farm ditches and leveling of fields are constructed to fit the general contour of the land which slopes toward the Salton Sea. Once the District distribution system and on-farm developments were in operation, it would be extremely difficult to make major changes because of the year-round cropping and irrigation.

Construction of Imperial Dam on the Colorado River and the All-American Canal in the late 1930's and early 1940's made little change in the irrigation distribution system within the Valley. From an operation and maintenance standpoint, water delivered through the All-American Canal system is more silt free than prior waters thereby resulting in more growth of moss, algae and aquatic weeds in the District's distribution system. Such growth can be controlled best by drying up the distribution canals and laterals about once a month.

The climate, soils, and land ownership pattern in the District lends itself to intensive commercial agriculture with relatively few small or part-time farming operations. As a result, there is little need for small or short-time irrigation water orders.

The general characteristic of the Districts' irrigation distribution system continues to be one that has limited water storage capacity in the canals; the water elevation in some canals has to be raised by the use of check gates so as to deliver adequate streams of water to farmers' headgates; and some canals can be drained for maintenance and so-called

moss control only by emptying them into wasteways or drains rather than delivering the so-called "run-down" water to water users.

On-farm ditches and land leveling generally slope toward the Salton Sea. This along with the low infiltration rate of the fine-textured clay soils which dominate the Valley, make it difficult to irrigate most crops without some runoff ("tail water") at the low end of the field. Fortunately, the fine-textured soils have a high water-holding capacity so that if an irrigator has irrigated an entire field before the end of his 24-hour water order, he is often able to "reirrigate" part of the land without losing excess water by deep percolation. As Colorado River water is relatively high in total dissolved solids (TDS), some downward percolation of water beyond the root zone is necessary to avoid accumulation of excess salts in the root zone after evapotranspiration, and such "reirrigation" may provide beneficial leaching.

It must be emphasized that each irrigation serves the basic purpose of replenishing the moisture that has been extracted from the soil by evapotranspiration. Any water applied in excess of this amount will eventually find its way to the Alamo or New River or directly to the Salton Sea through (1) runoff from the lower end of the farmer's fields; (2) as deep percolation drainage water; or (3) as wastewater from canals or laterals if deliveries to farmers are discontinued before the end of orders and there are no other water users to take the excess water.

The point of delivery to the All-American Canal is at Imperial Dam approximately 20 miles North of Yuma, Arizona. Scheduling of individual water orders in the District is closely related to the District's system of placing water orders with the Imperial Dam Supervisor of the Bureau of Reclamation. The farmers place their order for water one to three days in advance and the District places its order on

Wednesday for the block of deliveries the following week starting on Monday. Any daily changes must be made three days in advance in 24-hour increments. Similarly, the Imperial Dam Supervisor places orders for releases of upstream storage.

Irrigation Procedures in Other Western Areas

Water users on irrigation projects in the Western United States employ many different systems of placing water orders with irrigation districts. For efficient irrigation, an irrigator must know the depth of water needed to replenish the water that has been extracted from the root zone by plants and evaporation. Second, he must decide whether he is going to include additional water in each irrigation for salt leaching or whether that is to be accomplished by separate irrigations (often preplanting). Once the depth of water needed is determined and the acreage to be irrigated is known, it is a simple matter to calculate the total acre-inches or acre-feet of water for an order. Depending on the design of each district's system and its method of operation, a water user places an order combining (1) a rate of flow and (2) a length of time, the sum of which will yield the total quantity of water desired. For example, on the nearby Yuma Mesa Irrigation and Drainage District and Wellton-Mohawk Irrigation and Drainage District in Arizona, deliveries are made largely in units of 15-16 cfs and the time of irrigation varied accordingly. In the Imperial Irrigation District, the time is fixed in 24-hour units and the rate of flow varied to match the total quantity of water desired. In other words, the only difference in the system of ordering water in IID and other districts in the Lower Colorado River area is that IID holds the time in constant units (24 hours) and varies the rate of delivery (cfs) while other districts tend to hold

the rate of delivery in constant units and vary the time.

In each district in the Western United States, the system used for water users scheduling water orders has been developed around (1) the design of the project conveyance and distribution system in relation to the source and quantity of water supply; (2) the quality of water service the water users want and can afford; and (3) the local characteristics of soils, topography, drainage, and cropping patterns. In the case of Imperial Irrigation District, those characteristics are rather unusual. As pointed out heretofore, the District's distribution system and on-farm development predated the construction of major storage and diversion works on the Colorado River and the delivery of silt-free water. It takes five days for water releases from Lake Mead storage to reach Imperial Dam and another day or more for the water delivered to the District at Imperial Dam to reach most of the water users. Imperial Valley's agriculture involves high-cost and high-risk crops (i.e., lettuce, cabbage, tomatoes, onions, etc.) in which a shortage of water at critical periods can be disastrous. Therefore, a high level of service and reliability of water service is a must. The land characteristics of fine-textured soils with low water-intake rates and fields that slope toward the Salton Sea result in most excess water from field applications finding its way to the Sea in the form of surface runoff and spills rather than in unseen deep percolation such as occurs in districts with coarser textured soils.

Imperial Irrigation District Irrigation Efficiency

Despite the unusual and unfavorable characteristis for ease of operation as heretofore cited, the Imperial Irrigation District has perfected a system of estimating its water needs; placing its orders for diversions from Imperial Dam;

and delivering water to its water users that has resulted in the District having one of the highest (1) conveyance efficiencies; (2) on-farm irrigation efficiencies; and (3) over-all project irrigation efficiencies of all gravity irrigated projects in the United States.

District operational records and information developed by the Bureau of Reclamation for the period 1977 through 1980 has been reviewed. From that material, Bookman-Edmonston has prepared a summary sheet on "Efficiency of Water Conveyance and On-Farm Irrigation" which is attached as Table 1. It shows that the annual efficiencies of conveyance averaged 91 percent for the four-year period. The annual on-farm irrigation efficiencies during the same period averaged 72 percent. Overall district irrigation efficiencies averaged 66 percent for the four-year period.

Irrigation Efficiency in Other Western States

A preliminary summary sheet for the years 1975-78 prepared by the Water and Land Operations Division, Lower Colorado Regional Office, of the Bureau of Reclamation (USBR) concerning "Delivery Efficiencies" for districts in the Lower Colorado Region has been examined and is shown in Table 2. The information was computed from data in the USBR Crop Census and Monthly Water Distribution forms and the consumptive use data taken from Technical Bulletin 169, "Consumptive Use of Water by Crops in Arizona" dated September 1965, by University of Arizona Agricultural Experiment Station. In its computation of consumptive use, the USBR assumed that 80 percent of the rainfall recorded at gages in the vicinity of the District was effective in meeting plant needs. It is our opinion that far less than 80 percent of the rainfall is effective in meeting plant needs, and that the District's computation is more accurate than those reflected in Table 2.

TABLE 1

EFFICIENCY OF WATER CONVEYANCE AND ON-FARM IRRIGATION
IMPERIAL IRRIGATION DISTRICT, CALIFORNIA
1977 - 1980

	Amounts
Acres Irrigated	460,000
Diversions Below Drop No. 1 (acre-feet)	2,734,000
Diversions per acre irrigated (acre-feet)	5.94
Delivered to farms (total acre-feet)	2,496,500
Conveyance System Efficiency (in %)	91
On-Farm Consumptive Use (total acre-feet)	1,797,000
On-Farm Consumptive Use (acre-feet per acre)	3.90
On-Farm Irrigation Efficiency (in %)	72
District Irrigation Efficiency (in %)	66
Leaching Requirements (acre-feet)	270,000
Unit Irrigation Efficiency (in %)	83

TABLE 2

DELIVERY EFFICIENCIES OF IRRIGATION DISTRICTS

Irrigation Districts	1975	1976	1977	1978
Imperial Irrig. Dist.				
onfarm efficiency	73	80	81	77
district efficiency	65	71	73	70
Coachella Valley I.D.				
onfarm efficiency	51	50	55	53
district efficiency	43	44	46	46
Reservation Div. I.D.				
onfarm efficiency	45	47	58	60
district efficiency	36	38	47	50
Y.C.W.U.A. (Valley Div.)I.D.				
onfarm efficiency	64	80	71	72
district efficiency	49	60	54	52
Yuma Mesa Irr.&D.D.				
onfarm efficiency	33	33	29	32
district efficiency	30	30	27	30
Unit "B" Irrig. Dist.				
onfarm efficiency	33	32	35	38
district efficiency	32	31	33	36
Yuma Irrigation Dist.				
onfarm efficiency	62	63	61	61
district efficiency	59	61	59	53
North Gila Irrig. Dist.				
onfarm efficiency	29	40	46	42
district efficiency	28	30	43	40
Wellton-Mohawk Irrig. Dist.				
onfarm efficiency	55	52	63	64
district efficiency	50	47	57	57
Colorado Riv. Indian Tribes				
onfarm efficiency	57	65	76	64
district efficiency	44	50	58	48
Palo Verde Irrig. Dist.				
onfarm efficiency	46	33	45	42
district efficiency	36	26	35	33

However, regardless of this small difference, the USBR summary in Table 2 reflects that Imperial Irrigation District's on-farm irrigation efficiency and overall District irrigation efficiency are both higher than for any other water user organization diverting water in the Lower Colorado River Region.

Summary of Report on the Water Conservation Opportunities Study by the Bureau of Reclamation and Bureau of Indian Affairs, September 1978

We have also examined a "Report on the Water Conservation Opportunities Studies," dated September 1978, by the United States Department of Interior's Bureau of Reclamation (USBR) and Bureau of Indian Affairs (BIA).

This study covered 61 irrigation projects, including 46 USBR projects and 15 BIA projects, in 15 Western states. Table 3 in the report, on page 32 lists Imperial Irrigation District as having an overall water use efficiency of 70 percent, the highest of any of the 61 projects studied except for the Navajo Indian Irrigation Project in New Mexico. The latter is a new project still under construction where water is conveyed through lined canals and/or closed pipe systems and applied almost exclusively by sprinkler irrigation. The 70 percent overall project irrigation efficiency listed in the report is in agreement with the 10-year average listed in Table 1 as compiled from District records, and further confirms that the District's operational procedures, and the water users' scheduling and on-farm irrigation practices are outstanding when compared to other districts throughout the Western United States.

Table 1 on Page 17 of the 1978 Report describes an irrigation system with a farm efficiency of 70 percent as one on which the land leveling, delivery pipeline, and drainage system meet design standards. Imperial Irrigation District's

average on-farm irrigation efficiency exceeds this 70 percent design standard.

Since approximately 90 percent of the water diverted from streams in the 17 Continental Western United States is used for crop production, the USBR and BIA made this study in an attempt to identify irrigation projects having potential opportunities for conserving irrigation water. A total of 61 projects were identified (15 on BIA projects and 46 on USBR projects) as having such a potential. The 61 projects deliver approximately 12 million acre-feet of water annually to irrigate roughly 2.4 million acres.

The report points out that inclusion of a project in the report:

> "...should not infer that reasonable use of water is not presently being made on these projects under prevailing economic, legal, and institutional setting." (Emphasis added.) (p.1)

Average water use efficiency of the 61 projects was 44 percent, and in over one-third of the projects the water use efficiency was less than 30 percent.

IID is listed in the 1978 study mainly because of the large quantities of water involved and the unusual nature of its return flows not going back to the stream from which diverted. Of the 61 projects listed, IID had the highest overall water use efficiency (70 percent) except for the new Navajo Indian Irrigation Project (80 percent) which is still under construction, transports all of its water in concrete lined canals and pipelines, and uses only sprinkler irrigation.

Data gathered during the study were evaluated under four scenarios of future conditions: (1) status quo; (2) environmental-social-acceptability; (3) tight economic conditions; and (4) water-short. The report advises that IID:

> "...scores highest under all four scenaries and received no environmental-social-acceptability or legal and

institutional flags. It does not show economic benefits exceeding costs." (Emphasis added.) (p.51)

In specific regard to IID, the report further states in part:

"Water conveyance management and on-farm management are considered to be well above average, and water delivery facilities are estimated to be above average with respect to water loss." (p. c-23)

Conservation measures proposed for IID included lining of the main All-American Canal, lining on-farm ditches and providing an irrigation scheduling program. As of 1978, annual investment cost was estimated at $76 per acre-foot for conveyance system improvements and $65 per acre for on-farm activities for an average of $70 per acre-foot. Benefits were estimated at $51 per acre-feet. Hence, the above statement that economic benefits would not exceed costs.

Comparison of Use with Municipal Use

A comparison of agricultural use can be made with that of municipal and domestic use. The same principles apply including import, conveyance losses, deliveries and used water (sewage).

For an example, the water supply for the City of Los Angeles is shown in Table 3. Data is for the 1980-81 fiscal year. Annual amounts of sales and losses are shown in Table 4 for the past several years.

As can be seen on Table 3, the City of Los Angeles has a 91.6 percent conveyance system efficiency. A small part of the loss is reservoir evaporation. The majority of the loss includes meter discrepancies, reservoir seepage, main leaks and other minor uses and losses.

Relating sales to consumptive use as a measure of efficiency (the same measure as used for agriculture) indicates an efficiency of 34 percent.

TABLE 3

WATER USE IN CITY OF LOS ANGELES

		Amounts
Production		
Los Angeles Aqueduct(1)	476,000AF	
MWD(1)	46,000AF	
Local Wells(1)	95,000AF	617,000AF
Sales(1)		565,000AF
Losses		52,000AF
Losses in percent of Production		8.4%
Sewage (over 99% to Ocean)(2)		305,000AF
Sewage in percent of Sales		54%
Consumptive Use - (75% of outside use)		195,000AF
Conveyance System Efficiency	$\frac{565,000}{617,000} = 91.6\%$	
Efficiency of Use	$\frac{195,000}{565,000} = 34.5\%$	
Overall Efficiency	31.6%	

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STATE OF CALIFORNIA — RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF WATER RESOURCES
P.O. BOX 388
SACRAMENTO
95802
(916) 445-9248

DEC 31 1982

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President of the Board of Directors
Imperial Irrigation District
P. O. Box 1809
El Centro, CA 92244

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Southern District, P. O. Box 6598, Los Angeles, CA 90055, telephone (213) 620-4108, if you would like to meet to discuss this possibility. I am sure if we work together we can arrive at a program of benefit to IID, the SWP, and all of California.

Sincerely,

(sgd) Ronald B. Robie

Ronald B. Robie
Director

cc: Ms. Carole Onorato, Chairwoman
State Water Resources Control Board
1416 Ninth Street, Room 605-2
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