State Water Resources Control Board
Hearing Name IID Transfer - Phase 1
Exhibit: 17
For Ident: _____ In Evidence: _____

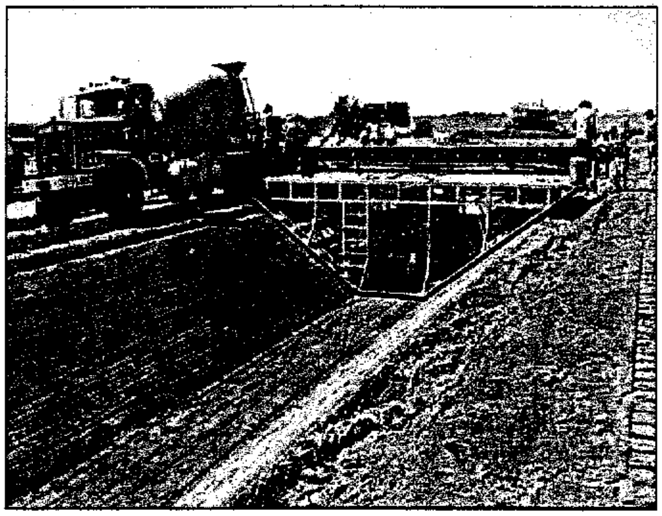
Imperial Irrigation District

and

Metropolitan Water District of Southern California

Water Conservation Program

Final Program Construction Report



IID Water Resources Unit

April 2000

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INTRODUCTION

1 Program Overview

1 Program Overview

January 1990 marked the inception of construction activities by the Imperial Irrigation District (IID) to implement 15 new projects in the Water Conservation Program (Program). These projects were identified in the landmark December 1988 Water Conservation Agreement (Agreement) between IID and the Metropolitan Water District of Southern California (MWD) and in the December 1989 Approval Agreement among IID, MWD, Palo Verde Irrigation District (PVID) and Coachella Valley Water District (CVWD). Major construction work was completed in December 1997 while construction of the last project was completed in September 1998. While the Program focused primarily on modernizing and rehabilitating IID's distribution system, it included on-farm water management projects that permit greater water management flexibility for farmers and opportunities for farmers to apply water more effectively. In some cases, distribution system and on-farm management improvements are so interrelated that they increase the effectiveness of each project in the Program.

The Agreement called for a Program Coordinating Committee (PCC) to secure effective cooperation and interchange of information and to provide consultation, review, and approval on a prompt and orderly basis between IID and MWD in connection with various financial, economic, administrative, and technical aspects of the Program. The PCC has three members, an IID representative, a MWD representative, and a chairperson who serves at the pleasure of the IID and MWD representatives. The Approval Agreement called for a Water Conservation Measurement Committee (WCMC) to provide an orderly basis, among the parties, for verification of the amount of water conserved and different amounts conserved by the individual projects. Membership of the WCMC is comprised of all members of the PCC, plus one representative each from PVID and CVWD. The PCC chairperson also serves as the WCMC chairperson.

All Program actions of the PCC are to be approved by a majority vote. WCMC decisions, however, are to be approved by unanimous vote. If unanimity is lacking, the matter is taken up according to a dispute resolution procedure set forth in the Approval Agreement. As part of its duties, the WCMC was to designate one or more consultants with recognized competence in water conservation and measurement activities to advise the WCMC on measuring devices and techniques to be used to measure water conserved from Program projects. In addition, the consultants, which group came to be known as the Conservation Verification Consultants (CVC), were to prepare and present to the WCMC an annual report on the estimated amount of water conserved by the Program and each project thereof. Membership of these committees is shown in Table 1.1.

In summary, the Agreement provided for water conservation from 17 projects constructed by IID under the Program – two pre-Program augmentation projects and 15 projects to be newly constructed. Projected water conservation when the final project was to be placed into operation was 106,110 acre-feet (AF) of water per year. MWD funded all costs of the 15 new projects in return for having this additional amount of Colorado River water available for diversion through its Colorado River Aqueduct. The IID and MWD service areas in relation to the Colorado River, and the MWD Colorado River Aqueduct are shown in Figure 1.1. The location of Program projects within IID's service area and the Program Cost Summary by Project are shown in Figure 1.2 and Table 1.2, respectively.

Table 1.1 IID/MWD Water Conservation Program Committee Membership

Program Coordinating Committee

Joseph Summers, Chairman (Summers Engineering, Inc.)
Jesse Silva (IID)
Kirk Dimmitt (MWD)

Water Conservation Measurement Committee

Joseph Summers, Chairman (Summers Engineering, Inc.)
Kirk Dimmitt (MWD)
Jesse Silva (IID)
Bob Krieger (Krieger & Stewart, CVWD)
Gerald Davisson (PVID)

Conservation Verification Consultants

Jack Keller (Keller-Bliesner Engineering)
Grant G. Davids (Davids Engineering, Inc.)
Joseph I. Burns (Murray, Burns and Keinlen)
John Teerink (Bookman-Edmonston Engineering, Inc., Deceased)

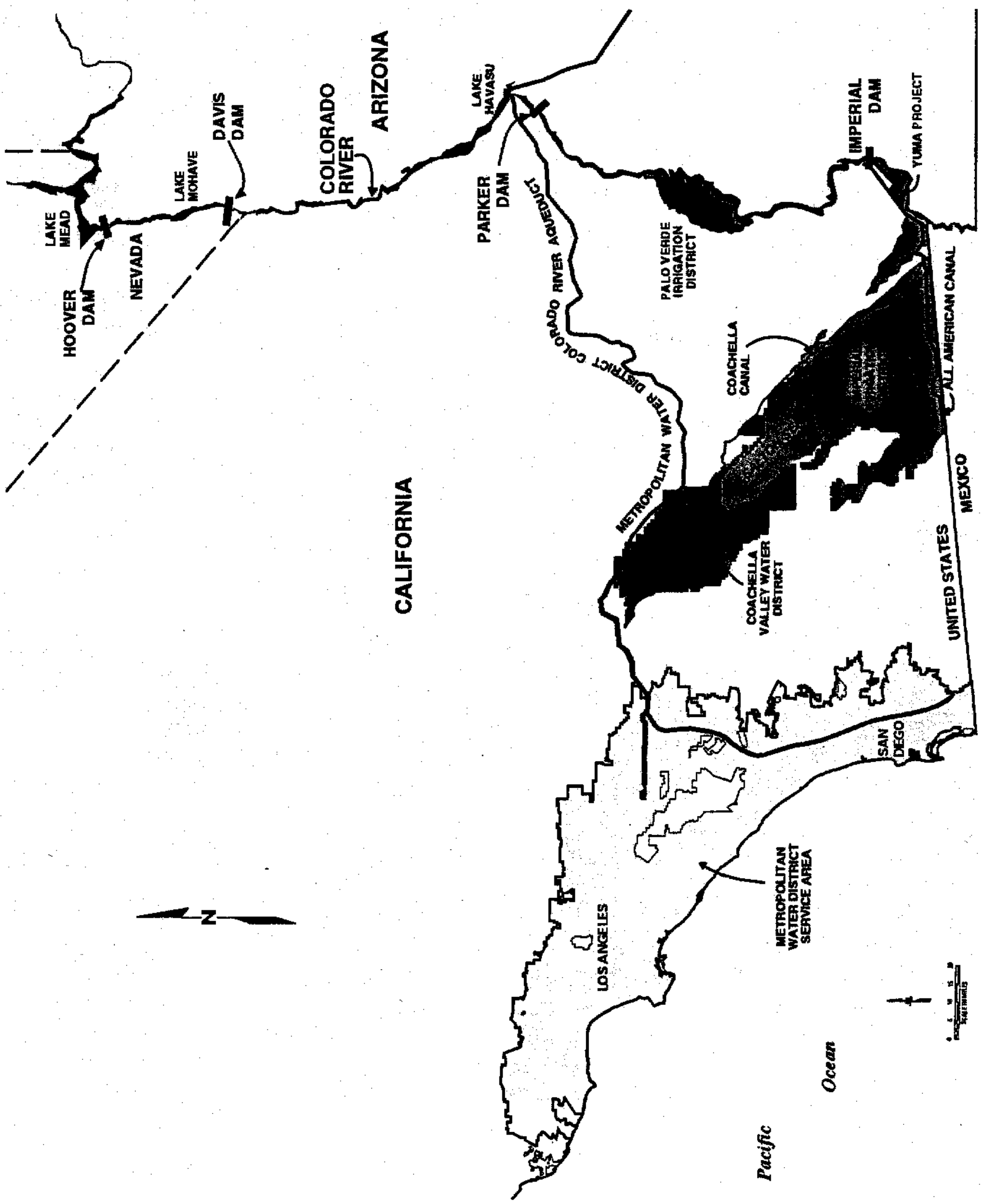

Figure 1.1 Location of IID and MWD Service Areas

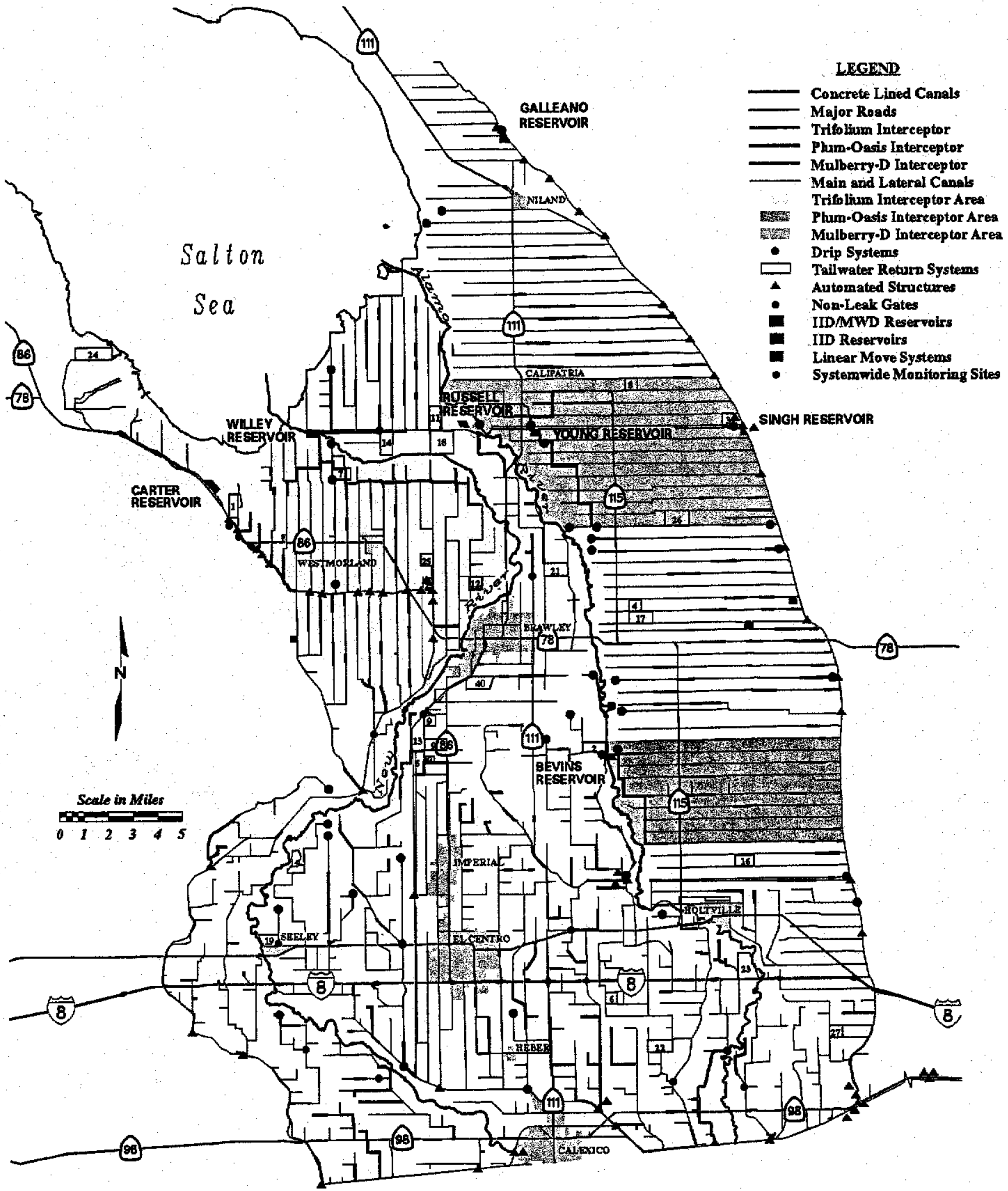

Figure 1.2 Location of IID/MWD Conservation Projects

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Table 1.2 Cost Summary by Project

Report Section	Project	Total Capital Cost	Budgeted 1999 O&M[1]	1999 Water Conservation	
				AF[1]	Cost $/AF[2]
3	1 Robert F. Carter Reservoir	$0	$0	4110	$0
	2 South Alamo Canal Lining Phase I	$0	$0	510	$0
4	3 Plum-Oasis Lateral Interceptor	$5,842,677 $5,173,429 (1988$)	$263,406 $195,159 (1988$)	9,000	$69 (1988$)
	8 Trifolium Lateral Interceptor	$14,097,856 $10,898,037 (1988$)	$381,142 $282,390 (1988$)	14,560	$81 (1988$)
	17 Mulberry-D Lateral Interceptor	$8,842,272 $7,117,278 (1988$)	$374,792 $277,685 (1988$)	8,500	$102 (1988$)
5	4 Galleano Reservoir	$2,257,927 $2,018,030 (1988$)	$61,485 $45,555 (1988$)	4,470	$48 (1988$)
6	5 South Alamo Canal Lining Phase II	$1,320,093 $1,196,797 (1988$)	$0 $0 (1988$)	900	$110 (1988$)
	7 Lateral Canal Lining	$42,066,923 $37,262,567 (1988$)	$1,500 $1,111 (1988$)	24,250	$127 (1988$)
	10 Vail Supply Canal Lining	$167,102 $150,560 (1988$)	$0 $0 (1988$)	10	$1,247 (1988$)
	11 Rositas Supply Canal Lining	$568,529 $506,622 (1988$)	$0 $0 (1988$)	130	$323 (1988$)
	16 Westside Main Canal Lining	$1,901,328 $1,681,099 (1988$)	$0 $0 (1988$)	260	$536 (1988$)
7	9 12-Hour Delivery	$0	$1,525,207 $1,130,034 (1988$)	21,750	(1988$)
	Singh Reservoir Improvements	$904,030 $689,736 (1988$)	$61,590 $45,632 (1988$)	-	$57 (1988$)
8	12 Non-Leak Gates	$212,595 $186,568 (1988$)	$10,421 $7,721 (1988$)	630	$37 (1988$)

continued, overleaf

Table 1.2 Cost Summary by Project, continued

Report Section	Project	Total Capital Cost	Budgeted 1999 O&M [1]	1999 Water Conservation AF [1]	Cost $/AF [2]
9	14 Irrigation Water Management	$0	$297,565 $220,468 (1988$)	280	$787 (1988$)
10	15 System Automation	$12,918,625 $11,295,562 (1988$)	$1,202,090 $890,635 (1988$)	14,600	$125 (1988$)
11	18 Additional Irrigation Water Management	$3,502,320 $3,066,012 (1988$)	$335,627 $248,668 (1988$)	4,540	$111 (1988$)
12	19 Program Coordination and Verification	$17,432,682 $14,978,883 (1988$)	$854,324 $558,883 (1988$)		
	6 Alternative Projects [3]	$68,743 $58,085 (1988$)	$0 $0 (1988$)		
	22 Pinto Wash Detention Reservoir [3]	$116,773 $97,066 (1988$)	$0 $0 (1988$)		
	23 WSM Canal Seepage Recovery [3]	$25,229 $21,475 (1988$)	$0 $0 (1988$)		
	24 EHL Canal Seepage Recovery [3]	$68,784 $57,481 (1988$)	$0 $0 (1988$)		
	Insurance [4]	$0	$229,000 $169,667 (1988$)		
TOTAL PROGRAM COSTS		$112,314,488 $96,455,287 (1988$)	$5,598,149 $4,147,699 (1988$)	**108,500**	**$127 (1988$)**

1988$ Cost per AF = $127

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[1] Budgeted O&M and water conservation volume are subject to change which will affect Annual Cost per AF calculated

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M (35 years), with an 8% discount rate. Capital Recovery Factor = 0.08285 (43.75 years at 8%)

[3] Capital expenditures for studies of potential completion projects not required to meet Program water conservation objectives

[4] Program costs for insurance through 35-year operation and maintenance agreement period

2 Imperial Irrigation District

2 Imperial Irrigation District

Each year between 2.6 to 3.2 million acre-feet of Colorado River water are diverted at Imperial Dam near Yuma, Arizona and conveyed westward 82 miles via the All-American Canal (AAC) into the Imperial Valley. Once in the Valley, the AAC more or less follows the district's southern boundary, near the United States-Mexico boundary. In addition to supplying water for municipal and industrial uses, IID delivers water year-around to some 5,600 farm turnouts that serve over 460,000 acres of irrigated cropland.

Distribution System

IID distributes water through a canal system that consists of approximately 200 miles of main canals and 1,475 miles of laterals of which over 1,100 miles are concrete lined. In addition, IID operates roughly 1,500 miles of drains that allow discharge to the Salton Sea of agricultural tile water and field runoff, or tailwater (see Figure 2.1).

The East Highline (EHL) Canal branches from the AAC and runs North along the eastern side of the Valley. Laterals, generally spaced at ½-mile intervals, originate from the EHL Canal and convey water westward to irrigated lands lying generally between the EHL Canal and the Alamo River. These laterals are mostly straight, non-branching canals.

The Central Main (CM) Canal branches from the AAC near the town of Calexico and runs northward through the central portion of the district, serving land lying generally between the Alamo and New Rivers. Laterals from the Central Main Canal run mostly northward and are typically branching laterals.

The Westside Main (WSM) Canal is essentially an extension of the AAC. It begins at the district's southwest corner and runs northward along the Valley's western side. Branching laterals serve the area from the WSM Canal Heading to WSM No. 8 Heading at Sheldon Reservoir. Downstream of the No. 8 Heading, WSM laterals are mostly non-branching. Lands served by these laterals generally lie between the WSM Canal and the New River.

The canal system includes ten regulating reservoirs with a combined capacity of 3,372 AF (see Figure 2.1). Characteristics of IID's main canal and lateral interceptor regulating reservoirs, five constructed under the IID/MWD Program and five by IID prior to the Agreement, are provided in Table 2.1.

Operating Organization and Procedures

IID's main canals are operated through the Water Control Center (WCC), located at IID Headquarters. Each Wednesday WCC staff prepares a master water order for the upcoming week (Monday through Sunday) and submits the order to the Bureau of Reclamation. The master order is based on the IID's Watermaster's judgement and historical deliveries. The master order can be, and typically is, modified according to trends in water orders, weather conditions and other factors. Master schedule modifications require four days of advance notice to the Bureau of Reclamation.

Three decentralized divisions operate the lateral canal distribution system. Divisions receive water orders from growers, consolidate the orders and submit them to the WCC daily at noon for development of the

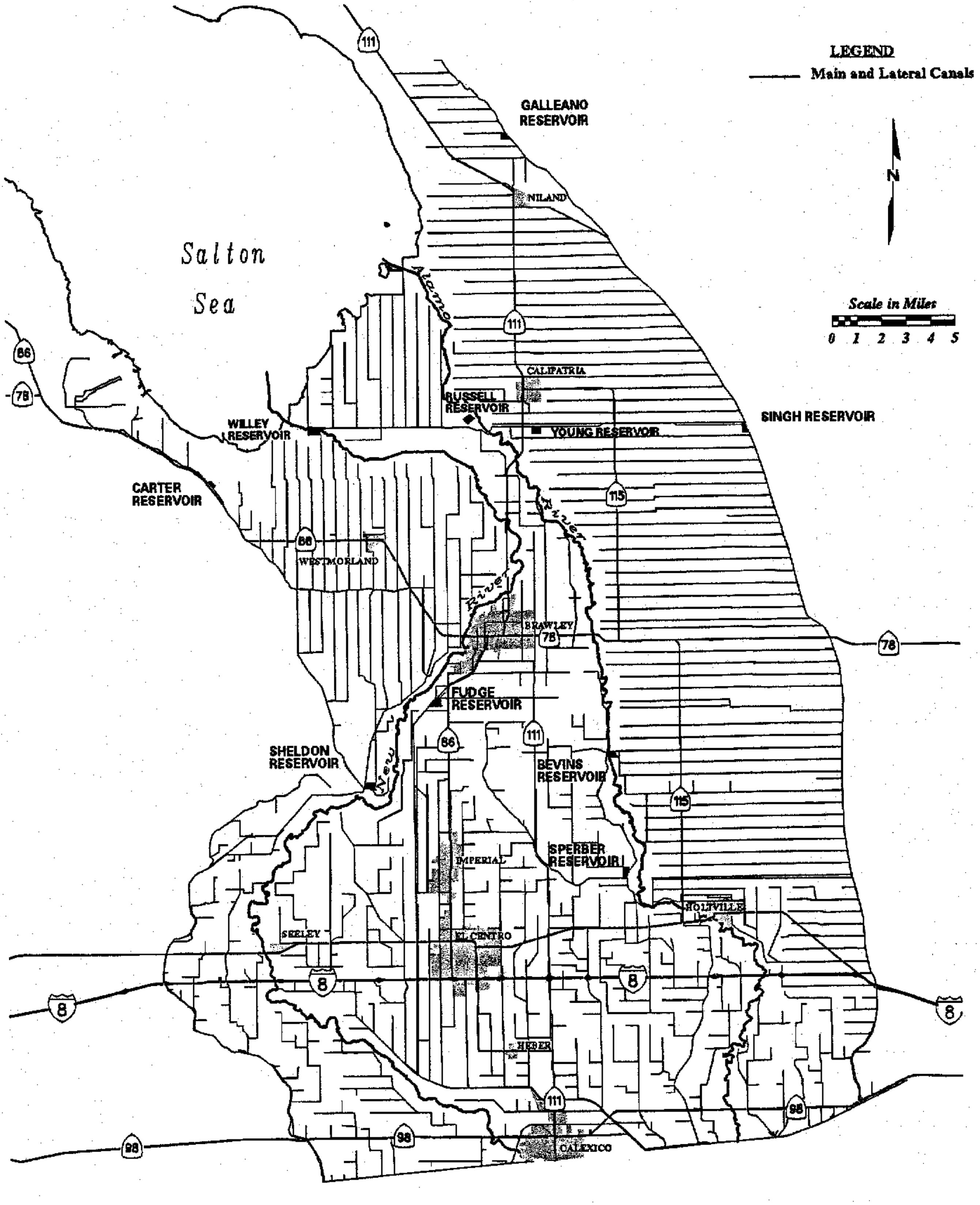

Figure 2.1 IID Main and Lateral Canals and Reservoirs

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Table 2.1 Characteristics of IID Main and Lateral Interceptor Canal Regulating Reservoirs

Reservoir Name	1st Year of Operation	Capacity (AF)	Principal Function	Comments
Program-Sponsored Reservoirs				
Robert F. Carter	1988	350	Regulates flow in Westside Main Canal; reduces main canal operational discharge into Trifolium Storm Drain.	Completed prior to implementation of IID/MWD Program but included in the Program.
Bernard Galleano	1991	425	Regulates flow in East Highline Canal; reduces operational discharge into Z Spill.	
Carl C. Bevins	1992	253	Regulates flow from Plum-Oasis Interceptor for supply into Redwood Canal system.	Reservoir discharge is automated to maintain constant discharge in Redwood Canal at Lateral 5.
Milas Russell, Sr.	1996	200	Regulates flow in Vail Supply Canal at head of Vail Main Canal, including flow from Mulberry-D North Interceptor.	Operates with Young Reservoir. Also regulates operational discharges from Rockwood Canal into Vail Supply Canal at Vail Main Heading.
Young	1996	275	Regulates flow from Mulberry-D South Interceptor.	Operates in conjunction with Russell Reservoir.
Louise K. Willey	1998	300	Regulates flow from Trifolium Interceptor for supply into Vail Main Canal system	Reservoir discharge is automated to maintain constant discharge in Vail Main Canal at Lateral 3.
IID Reservoirs				
Kakoo Singh	1976	323	Regulates flow in East Highline Canal; reduces main canal operational discharge.	
J. M. Sheldon	1977	476	Regulates flow in Westside Main Canal; reduces main canal operational discharge.	
Oscar Fudge	1982	300	Regulates flow in Central Main Canal; reduces main canal operational discharges at No. 4 Spill.	
H. "Red" Sperber	1983	470	Regulates flow in Rositas Supply Canal; reduces main canal operational discharge.	

next day's operating plan. Because total available flow for the upcoming operational day is fixed according to the modified master schedule, demand for water and available supply typically do not match. If demand exceeds supply, orders are carried over to a future operating day, usually no more than two days beyond when the water was desired. When supply is greater than demand, a carryover order from preceding days is added to demand. By shifting water orders forward and backward in this way, daily demand for water is matched to the available supply from the Colorado River. Storage levels in main canal regulating reservoirs are also adjusted to help balance supply and demand discrepancies.

Despite the intent to balance each day's supply with demand, a number of operational factors can cause differences between actual supply and demand within the system. Influential factors include variances between water orders and actual demand due to farmers reducing or shutting off delivery early, changes in canal losses from day to day; measurement or operator error in distributing flows, and other factors. Drawing water from or putting water into main canal regulating storage reservoirs accommodates mismatches between actual water demand and supply. The extent to which water deliveries are made both reliably and flexibly while minimizing operational spillage depends primarily on the volume of regulating storage available in the system and the ability to move flow changes smoothly through the canals to the reservoirs.

IID's main canal system is segmented into six operating reaches defined by the location of the regulating reservoirs (see Figure 2.2). The reservoirs absorb flow mismatches from the main canal reach upstream and allow delivery of scheduled flows into the next reach downstream. The six operating reaches, along with their associated regulating reservoirs, are listed below.

1. All-American Canal, Drop 1 to Central Main Canal Check, pool upstream of the check serves as a small regulating reservoir.
2. East Highline Canal Reach 1, Heading at the AAC to Nectarine Check, Singh Reservoir.
3. East Highline Canal Reach 2, Nectarine Check to Niland Extension Heading, Galleano Reservoir.
4. Central Main Canal, Heading at the AAC to No. 4 Check, Fudge Reservoir.
5. Westside Main Canal Reach 1, AAC Central Main Check to No. 8 Check, Sheldon Reservoir.
6. Westside Main Canal Reach 2, No. 8 Check to Trifolium Extension Heading, Carter Reservoir.

The operational procedures described above constitute an upstream canal control process, where scheduled water deliveries are released into canals and routed from upstream to downstream according to the operations schedule. The objective at flow control locations, such as main canal and lateral headings, is to maintain scheduled deliveries. Between flow control locations, the objective is to use check structures to maintain a targeted water level.

Program Accomplishments

Water conservation projects are listed in Table 2.2 and the 1999 water conservation accomplishments for each project are summarized in Table 2.3. Facility and cost summary details are provided in Sections 3 through 11. The Systemwide Monitoring (SWM) procedure developed to identify and explain IID system performance trends and the automated data collection, quality control and retrieval capabilities are described in Sections 12 and 13.

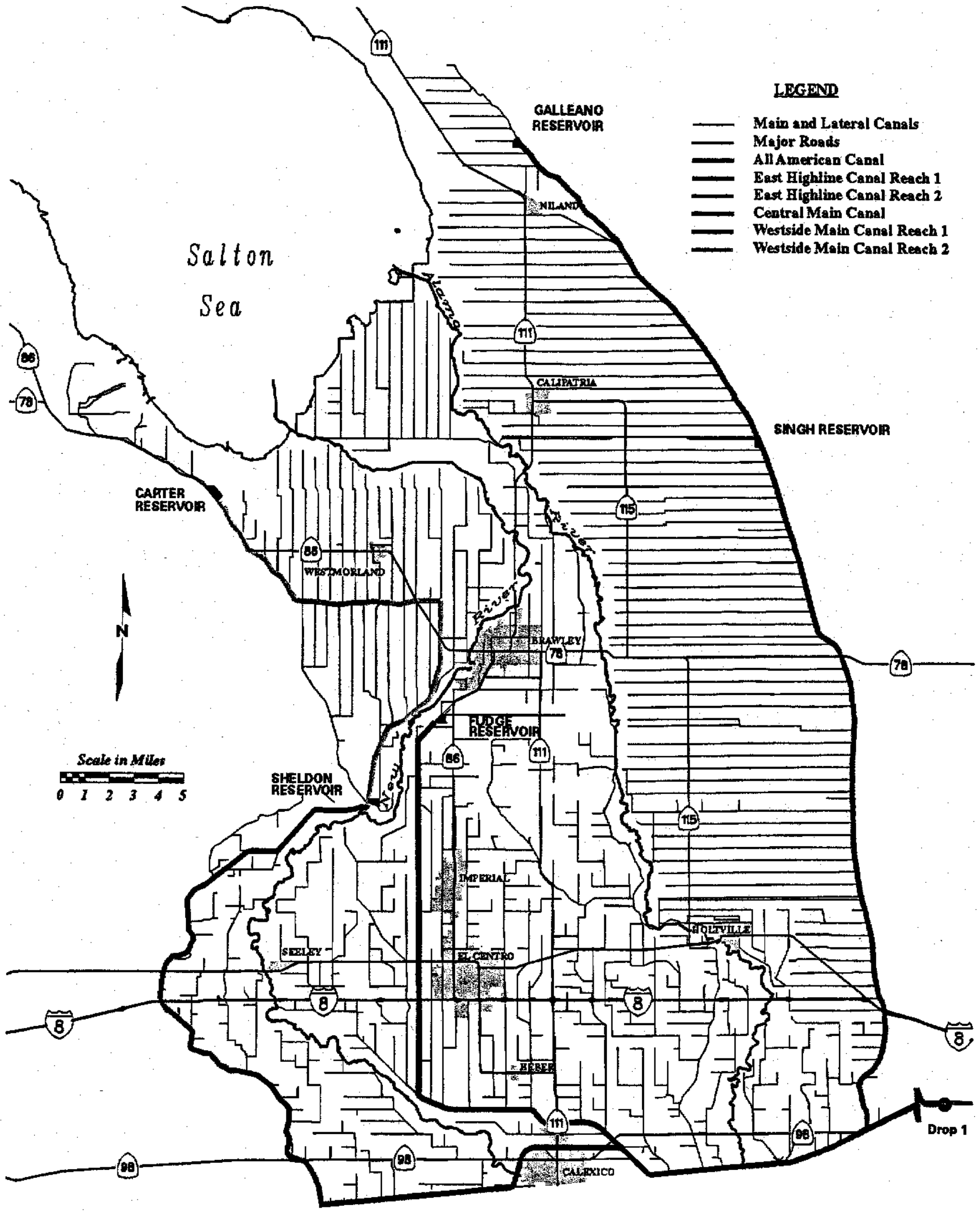

Figure 2.2 IID Main Canal Operating Reaches

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Table 2.2 Projects Included in IID/MWD Water Conservation Program

Project	Name	Status
1	Robert F. Carter Reservoir	Augmentation, Completed [1]
2	South Alamo Canal Lining, Phase I	Augmentation, Completed [1]
3	Plum-Oasis Lateral Interceptor	Completed
4	Bernard Galleano Reservoir	Completed
5	South Alamo Canal Lining, Phase II	Completed
6	Sperber Reservoir Outlet	Deleted by PCC [2]
7	Lateral Canal Lining	Completed
8	Trifolium Lateral Interceptor	Completed
9	12-Hour Delivery (12-HD)	Completed
10	Vail Supply Canal Lining	Completed
11	Rositas Supply Canal Lining	Completed
12	Non-Leak Gates	Completed
13	Tailwater Assessment	Deleted in Approval Agreement [3]
14	Irrigation Water Management	Completed
15	System Automation	Completed
16	Westside Main Canal Lining, North	Completed
17	Mulberry-D Lateral Interceptor	Completed
18	Additional Irrigation Water Management	Completed [1]

[1] Pursuant to Approval Agreement

[2] Savings were found to be insufficient

[3] Projects 17 and 18 were added to achieve the required savings

Table 2.3 Project Water Conservation Summary for 1999 and 2000

Projects	1999 Water Conservation Savings (AF)	Projected 2000 Water Conservation Savings (AF)
Augmentation Program (Projects 1 and 2)	4,620	4,610
Lateral Interceptors (Projects 3, 8, and 17)	32,060	34,230
Reservoirs (Project 4)	4,470	4,530
Concrete Lining - Main and Lateral Canals (Projects 5, 7, 10, 11 and 16)	25,550	25,550
12-Hour Delivery (Project 9)	21,750	21,730
Non-Leak Gates (Project 12)	630	630
Irrigation Water Management (Project 14)	280	110
System Automation (Project 15)	14,600	14,000
Additional Irrigation Water Management (Project 18)	4,540	4,070
TOTAL	**108,500**	**109,460**

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CONSERVATION PROGRAM PROJECTS

3 Augmentation Program (1,2)

3 Augmentation Program (Projects 1 and 2)

IID used a State loan to construct Carter Reservoir (see Figure 3.1) and complete South Alamo Canal Lining Phase I. These projects were completed prior to finalizing the Approval Agreement. However, the Approval Agreement provided that IID would make water conserved from Projects 1 and 2 available for MWD's use, and designated these projects as an augmentation program. IID pays all annual direct costs for these two projects. For full descriptions of Carter Reservoir and of South Alamo Canal Lining Phase I, see Sections 5 and 6, respectively.

The Carter Reservoir Project and South Alamo Canal Lining Phase 1 Facility Summary details are provided in Table 3.1.

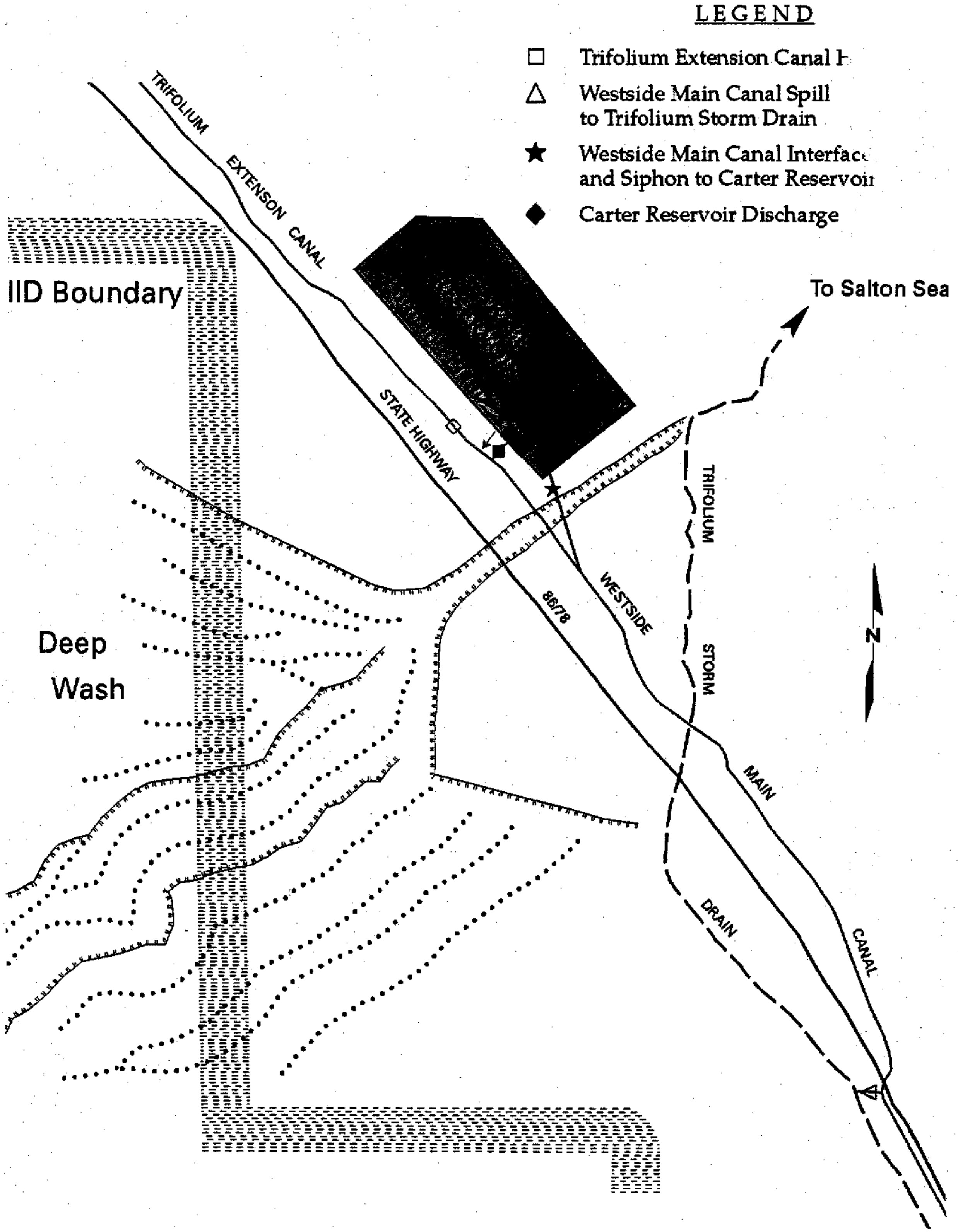

Figure 3.1 Carter Reservoir Project Site Map

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Table 3.1 Augmentation Program Facilities Summary

Reservoir	Robert F. Carter
Area (acres)	32
Capacity (AF)	350
Maximum Depth (ft)	11.3
Inlet capacity (cfs)	150
Outlet	Pump
Outlet capacity (cfs)	50
Inlet	Westside Main Canal
Outlet	Trifolium Extension Canal
Date of Completion	September 1988

Canal Lining	South Alamo Canal Phase I		
Reach, Length & Cross-section	Delivery 31 to Alamo River Spill	2.05 miles	6' x 70" @ 1.5:1
	Lateral 5A, Delivery 43 to 43E	0.5 miles	2' x 38" & 2' x 36" @ 1.25:1
Date of Completion	September 1989		

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4 Lateral Interceptors (3,8,17)

4 Lateral Interceptors (Projects 3, 8, 17)

A lateral interceptor consists of an open, concrete-lined canal that collects and transports both operational discharge and farm delivery water that remains in the distribution system when a farm turnout is closed (returned water). The operational discharge and returned water flows into the interceptor canal from the ends of several laterals and is transported to a storage reservoir to be used in another part of the distribution system. Three lateral interceptor projects were constructed, which serve some 83,436 acres, approximately 18 percent of IID's irrigated service area.

The Plum-Oasis, Trifolium, and Mulberry-D lateral interceptor projects were constructed as part of the IID/MWD Program (see Figure 4.1, map). Interceptor canal and reservoir sizes were based on IID's historical delivery data and field measurements of operational spill for the included laterals. By analyzing these data, expected flow rates were forecast, as was the duration and timing of return deliveries and operational spill. Initial sizing of the Plum-Oasis Lateral Interceptor was based on accommodating 100 percent of early shutoffs 90 percent of the time. Experience with the Plum-Oasis Lateral Interceptor showed that this sizing criterion was too liberal, and the criterion was adjusted downwards for the Trifolium and Mulberry-D Lateral Interceptor Canals.

All reservoir facilities are automated, and automated drop-leaf gates (ADLGs) control flow from each intercepted lateral (see Figure 4.2). When raised, these gates provide delivery head for farm gates near the ends of the laterals. When lowered, they allow water to flow into the interceptor canal. This instantaneous flow control essentially eliminates operational spill to drains other than for the purpose of flushing water to remove silt and algae growth or when deliveries from laterals are required downstream of the lateral interceptor. Water collected in the lateral interceptor canal is transported to a reservoir from which it is discharged into another part of the distribution system.

An ADLG located near the end of each lateral allows spill to the drain, as needed. These gates function as measurement structures for determining the amount of flow from the laterals to the drains. When the interceptor canal is located at the end of the lateral, the gate that controls flow to the drain or river is also at the end of the lateral.

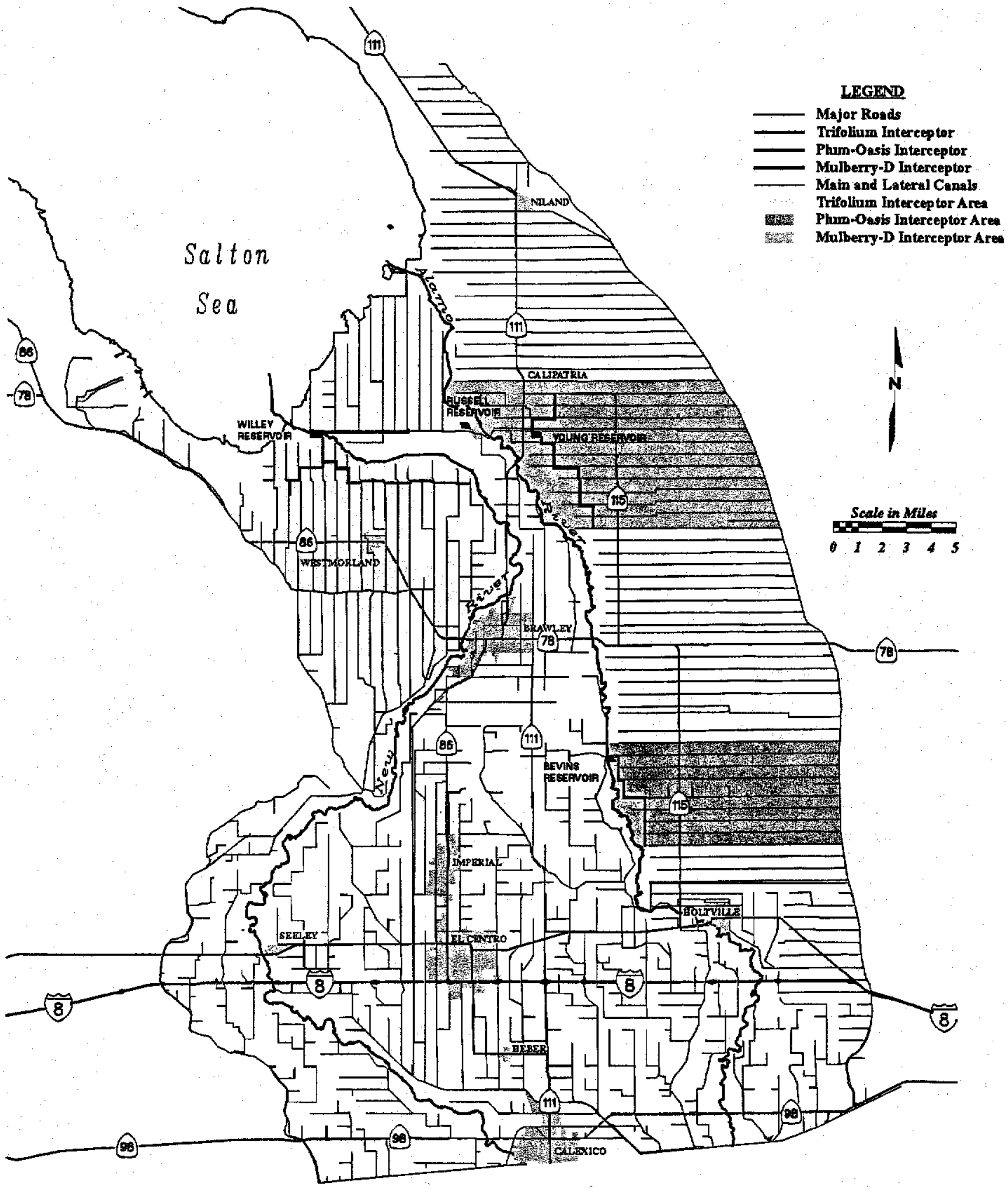

Figure 4.1 Location of IID/MWD Lateral Interceptor Projects

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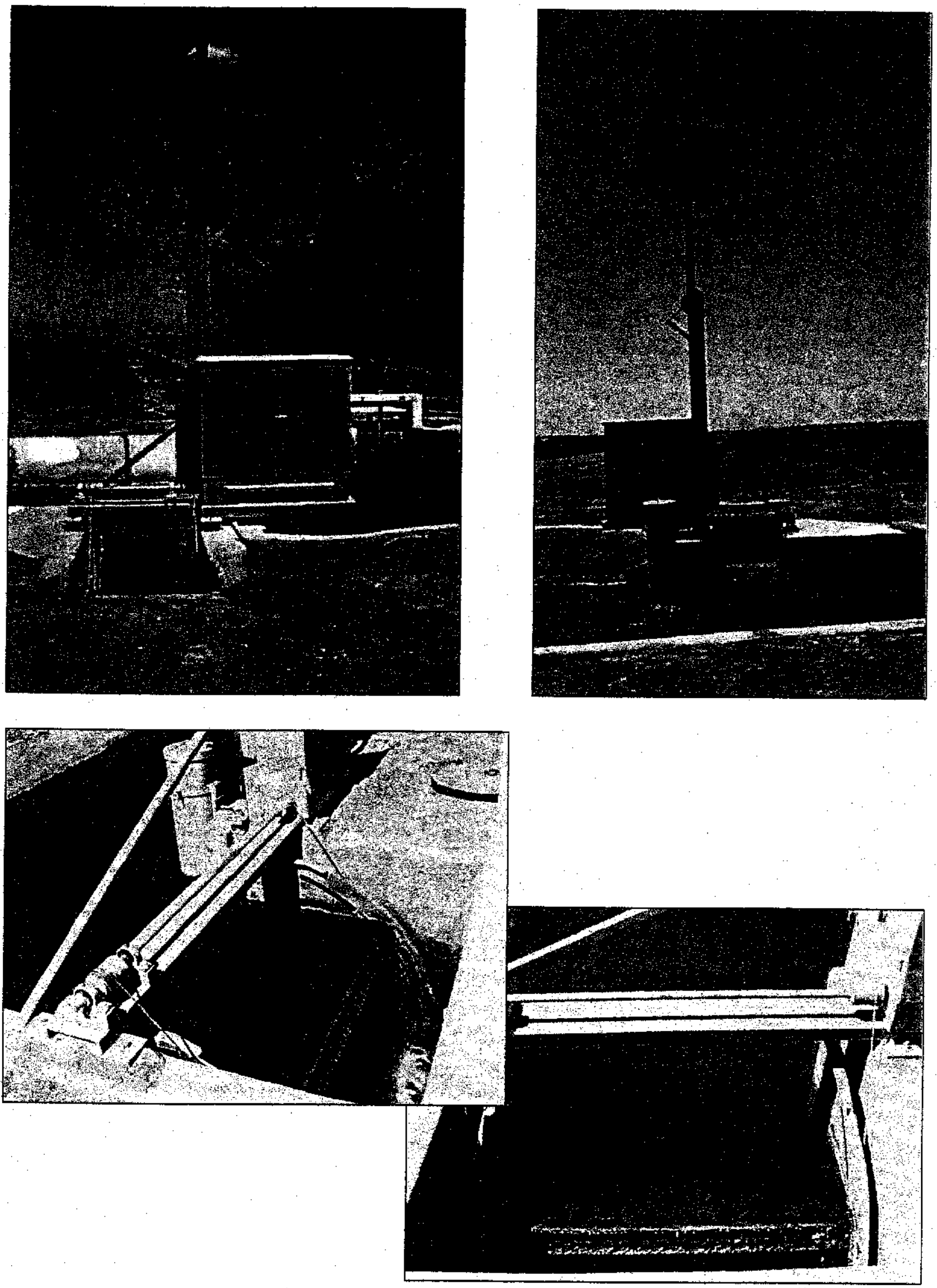

Figure 4.2 Automated Drop-Leaf Gate (ADLG) Sites

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Plum-Oasis Lateral Interceptor Project Description

The Plum-Oasis Lateral Interceptor Project serves eight East Highline Canal laterals. Main project features are the Plum-Oasis interceptor canal, which collects water from the Plum, Pine, Palm, Pomelo, Pepper, Township, Oat and Oasis Laterals; the Bevins Reservoir; and a pumping plant and piping system that deliver water from the Bevins Reservoir to the Redwood Canal (See Figures 4.3 and 4.4).

Re-regulated water from the Bevins Reservoir is pumped across the Alamo River into the Redwood Canal allowing IID to more effectively meet demands in the service area downstream of Redwood Lateral 5. The Redwood Canal check at Lateral 5 is automated to allow Water Control to set the pond level, with water level sensors installed at the check controlling the pumps in Bevins Reservoir. With this control, flow passing the check automatically meets downstream flow requirements. Thus, in addition to capturing water from the Plum-Oasis service area, service is improved in the area downstream of Redwood Lateral 5, and Redwood Canal spillage reduced.

A broad-crested weir (BCW) was constructed in the interceptor canal downstream of the inflow from the Oasis Lateral and upstream of the discharge into Bevins Reservoir. An automated drop-leaf gate at the end of the interceptor canal is used to measure any interceptor canal spill to the Alamo River. The difference between the BCW measurement and interceptor canal spill measurement provides an estimate of discharge into Bevins Reservoir.

Automated gates located at the end of the laterals maintain head for deliveries and measure any lateral spill. These automated facilities provide information via telemetry directly to IID's Water Control Center. Data required for conservation verification are transmitted from the Water Control Center to IID's Water Information System (WIS) where they are processed to determine rate and volume of flow.

Representative features are shown in Figures 4.5 and 4.6. Plum-Oasis Lateral Interceptor Facility and Cost Summary details are provided in Tables 4.1 and 4.2.

A complete description of Bevins Reservoir is provided in Section 5.

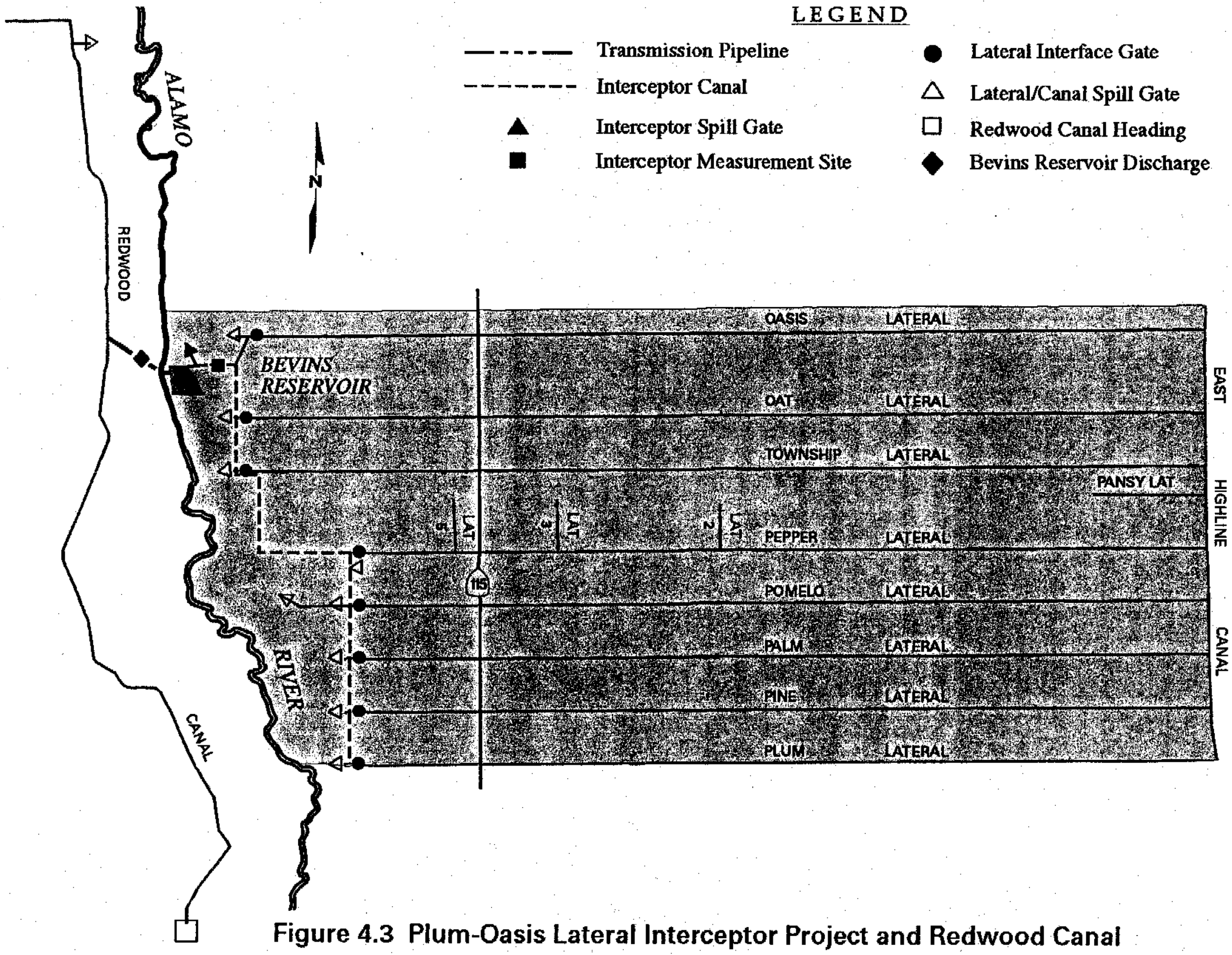

Figure 4.3 Plum-Oasis Lateral Interceptor Project and Redwood Canal

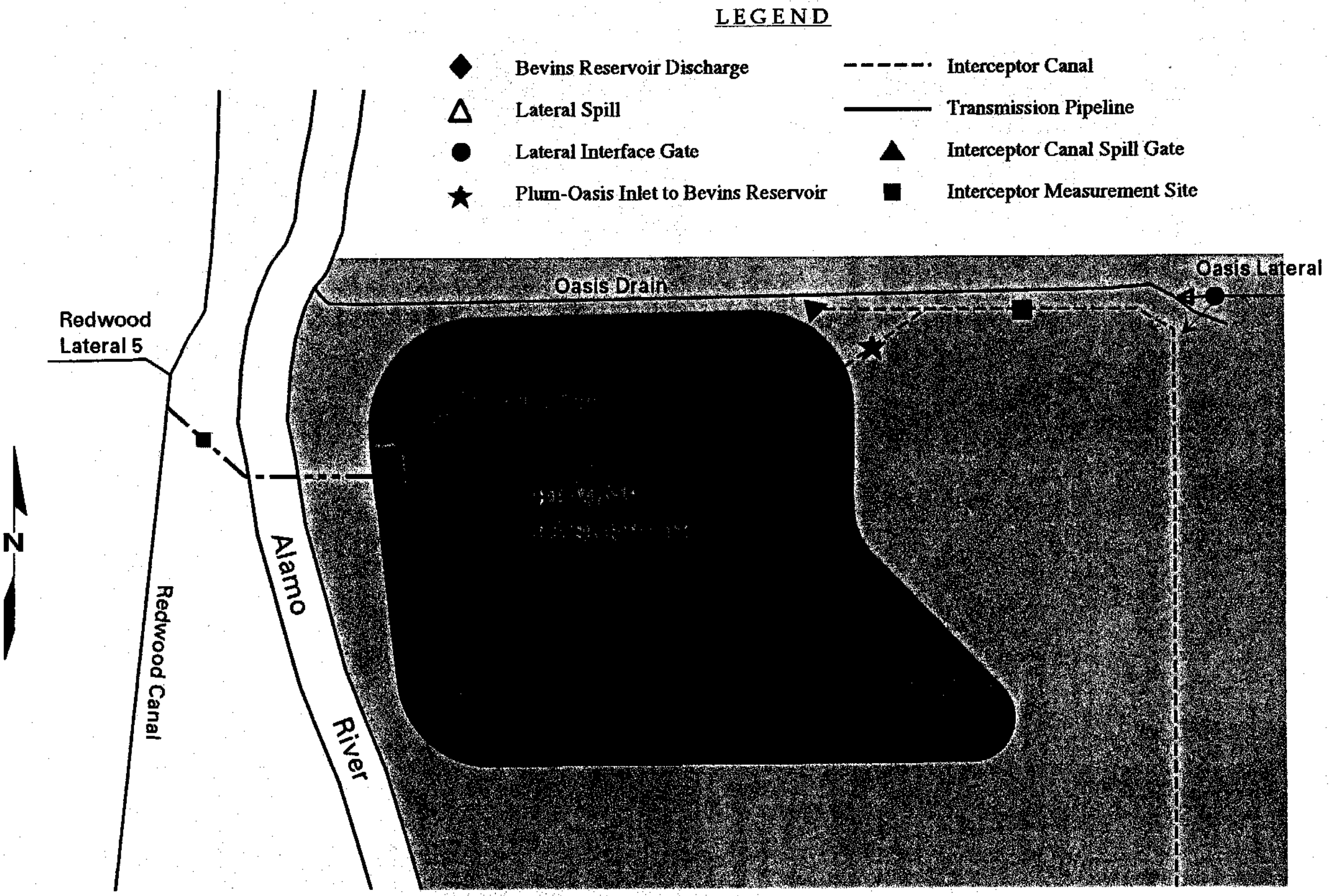

Figure 4.4 Plum-Oasis Lateral Interceptor Project, Bevins Reservoir Area

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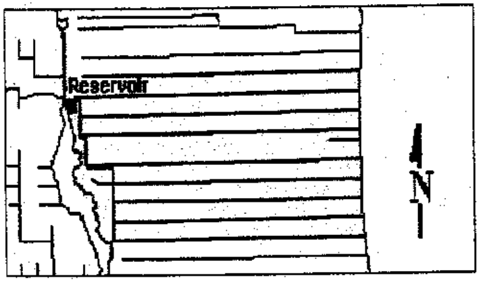
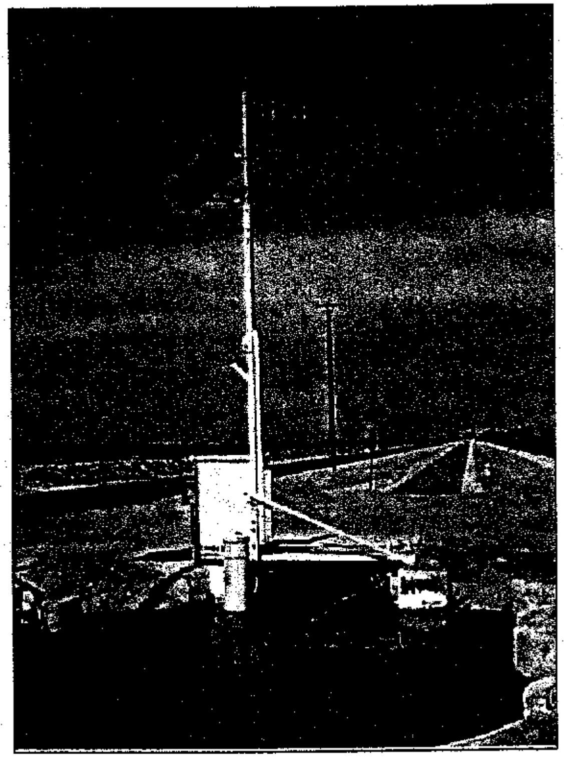
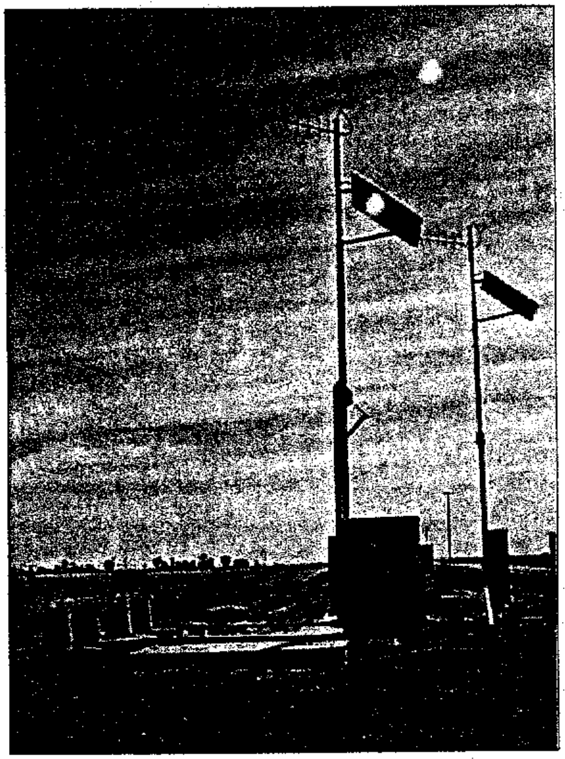


Plum-Oasis Lateral Interceptor Area Map

Bevins Reservoir

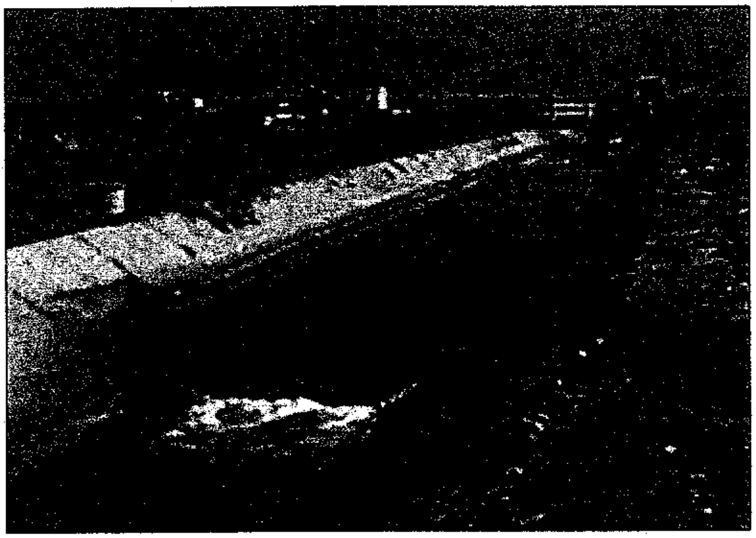


Pepper Interface Gate from Upstream

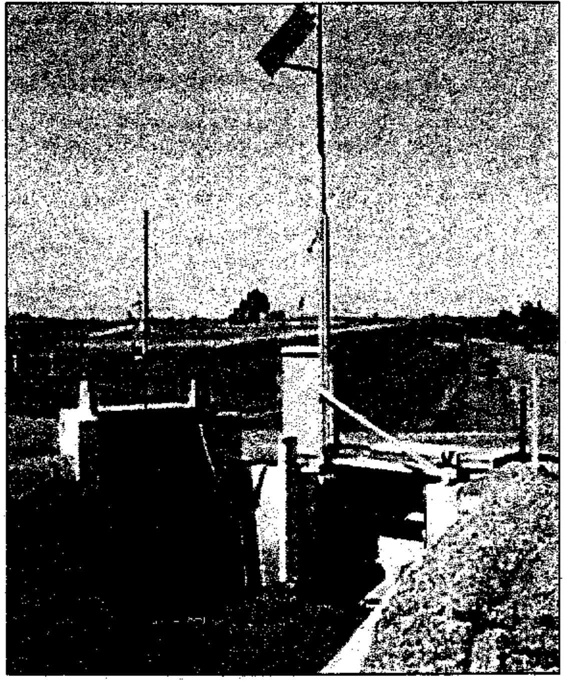


Pepper Interface Gate and Spill from Downstream

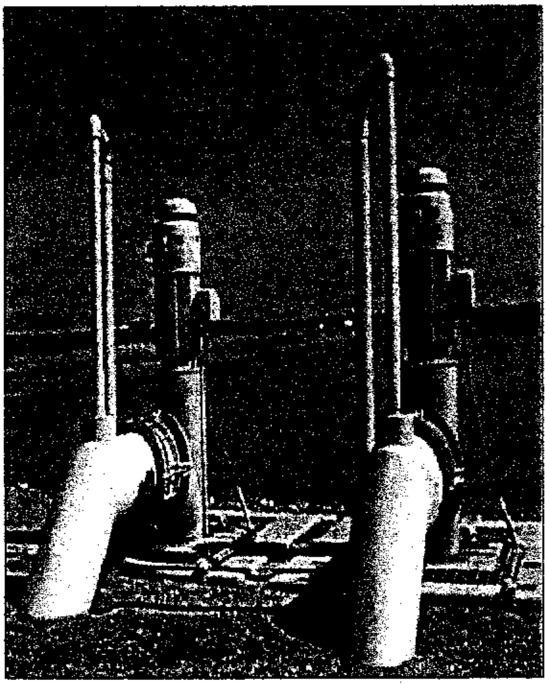
Figure 4.5 IID/MWD Project 3 Plum-Oasis Lateral Interceptor



Plum-Oasis Lateral Interceptor BCW



Bevins Reservoir Gravity Inlet and Plum-Oasis Lateral Interceptor Spill



Bevins Reservoir Pump Outlet to Redwood Canal System

Figure 4.6 IID/MWD Project 3 Plum-Oasis Lateral Interceptor

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Trifolium Lateral Interceptor Project Description

The Trifolium Lateral Interceptor Project, which has an East and a West interceptor canal, serves 14 Westside Main Canal laterals and two main canals. The East interceptor canal flows westward, capturing flow from 11 laterals and one main canal: Spruce Lateral 6, Spruce Main Canal, Tamarack Lateral, Timothy Lateral, and Trifolium Laterals 2 through 9. The West interceptor canal collects flow from Trifolium Laterals 10, 11 and 12. From the confluence of the East and West interceptor canals, flow is conveyed northward by gravity to Willey Reservoir. Intercepted spill originating in the Vail Main Canal is conveyed at Vail Lateral 7 Heading by gravity via pipeline southward across the New River into Willey Reservoir (see Figures 4.7 and 4.8).

All flows captured by the Trifolium Lateral Interceptor Project are re-regulated in the Willey Reservoir. Pumps provide the pressure needed to convey water northward from Willey Reservoir across the New River into the Vail Main Canal upstream of Vail Lateral 3 Check. Since the Trifolium Transmission Pipeline connects to the Vail System at Vail Lateral 3 Heading, the yield from Willey Reservoir is used to help meet the demand for delivery gates on Vail Laterals 3 through 7 and to direct deliveries from the Vail Main Canal downstream of Lateral 3.

A broad-crested weir (BCW) was constructed downstream of the confluence of the East and West interceptor canals and upstream of the Willey Reservoir discharge. An automated gate at the end of the interceptor canal is used to measure any spill that may occur. The difference between the BCW and interceptor canal spill measurements provides an estimate for flow into Willey Reservoir. Automated gates located at the end of the laterals are used to measure any lateral spill. These automated facilities provide information via telemetry to IID's Water Control Center. Each night, data are transmitted from the Water Control Center to IID's Water Information System (WIS). Processed data are used to determine rate and volume of flow for conservation verification determinations.

Willey Reservoir, Pumping Plant and Pipeline are shown in Figures 4.9 and 4.10. Trifolium Lateral Interceptor Facility and Cost Summary details are provided in Tables 4.1 and 4.2.

A complete description of Willey Reservoir is provided in Section 5.

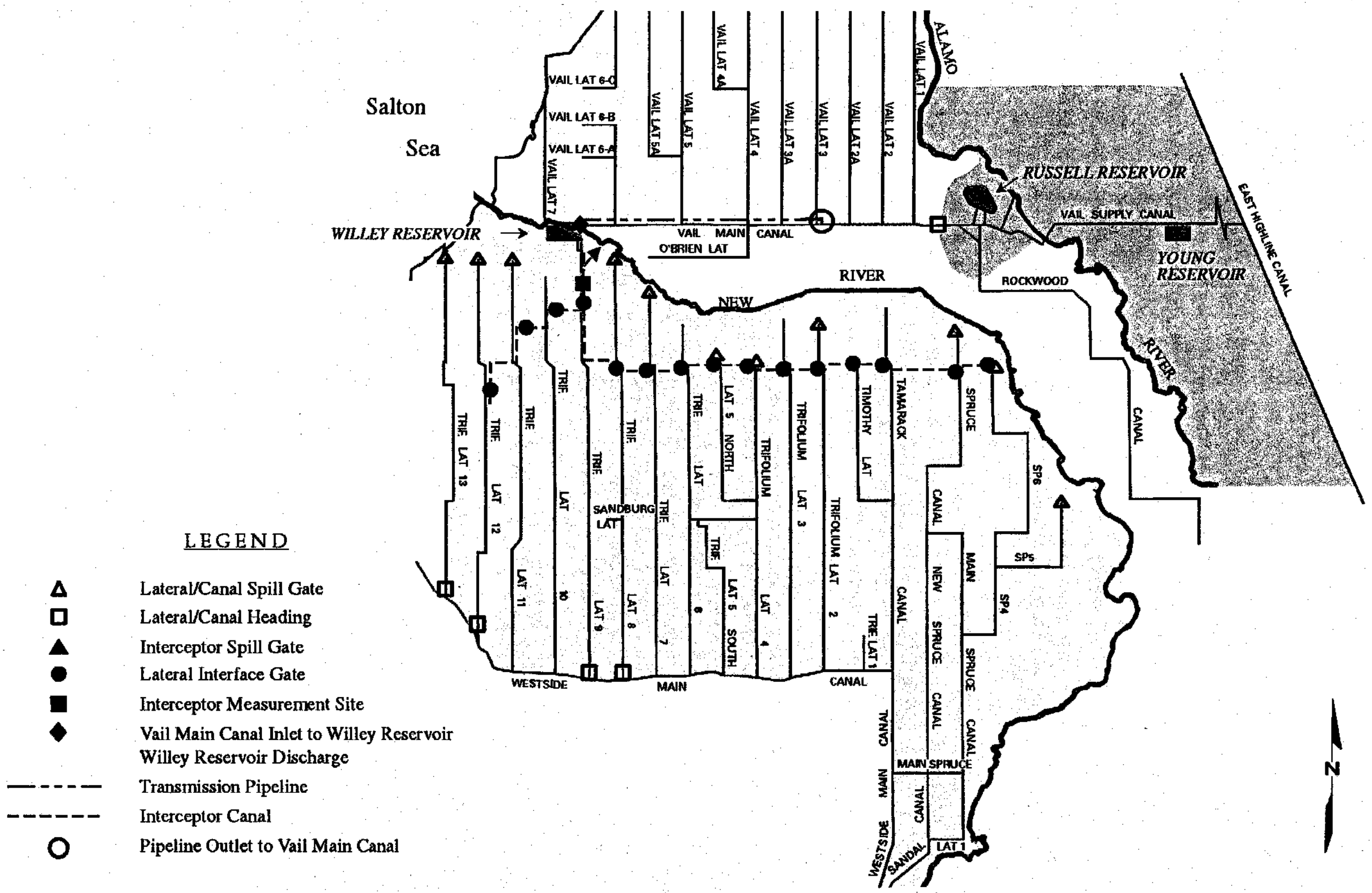

Figure 4.7 Trifolium Lateral Interceptor Project and Related Facilities

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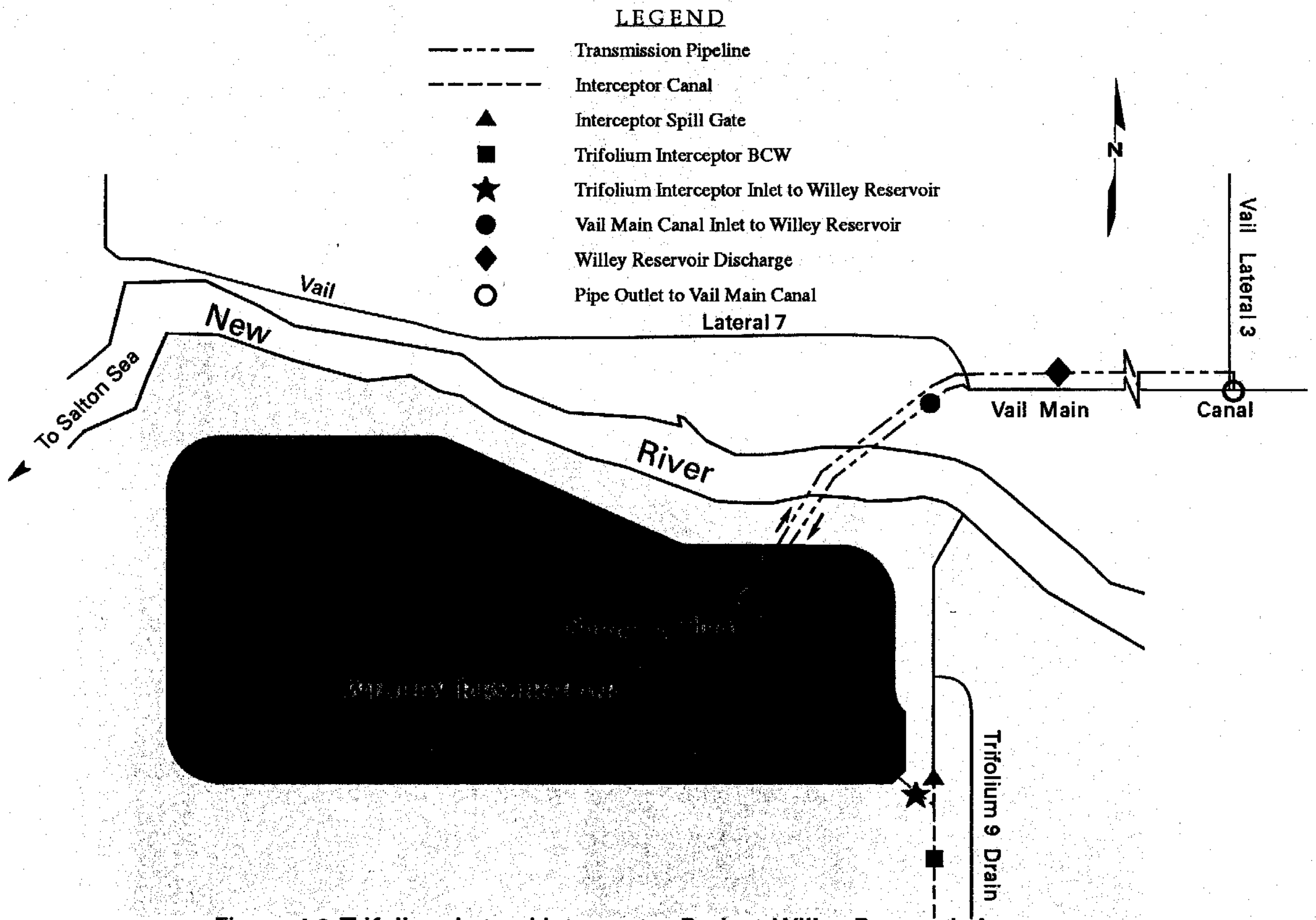

Figure 4.8 Trifolium Lateral Interceptor Project, Willey Reservoir Area

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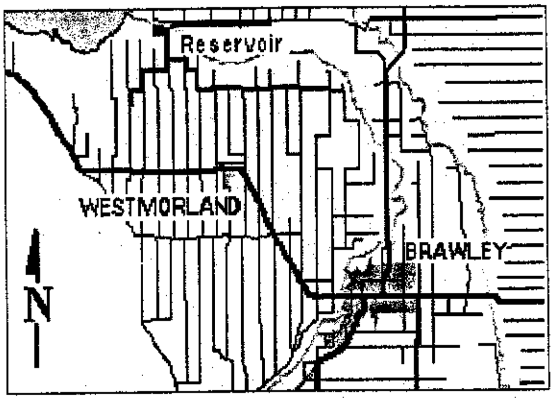
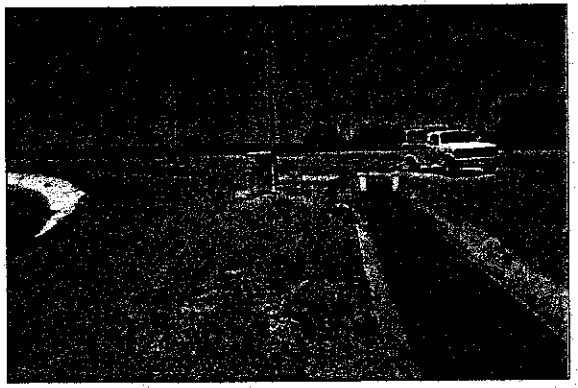
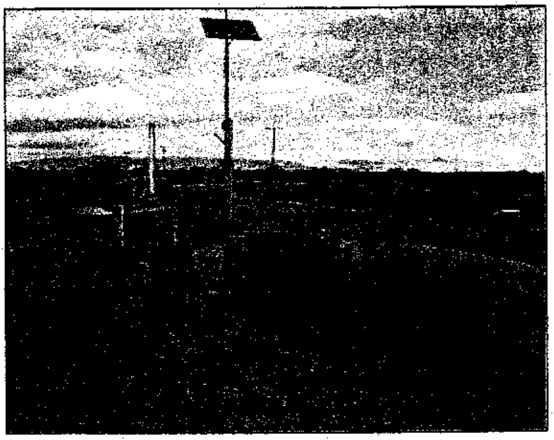


Trifolium Lateral Interceptor Project Area Map

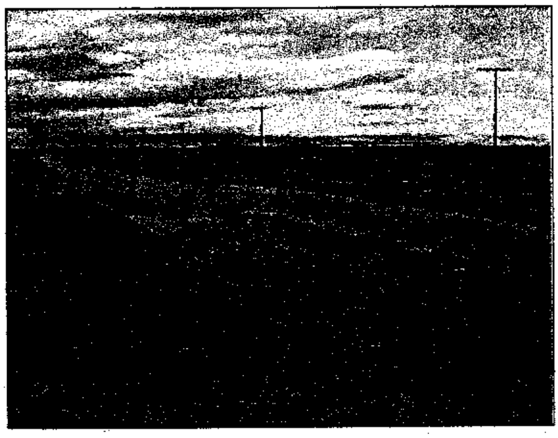
Trifolium Lateral Interceptor Canal, downstream of Trifolium Lateral 4



Trifolium Lateral 4 Interface to Trifolium Lateral Interceptor Canal

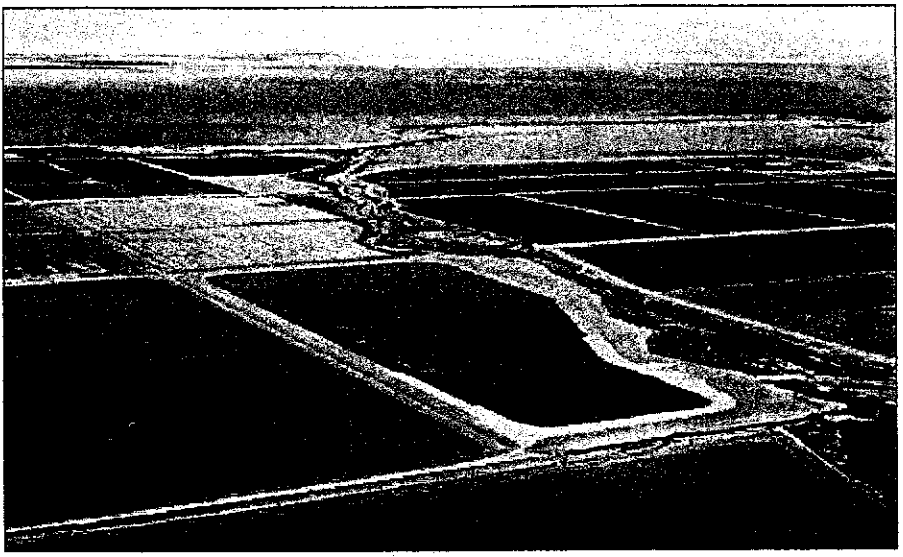


Trifolium Lateral Interceptor Canal Spill just downstream of the BCW

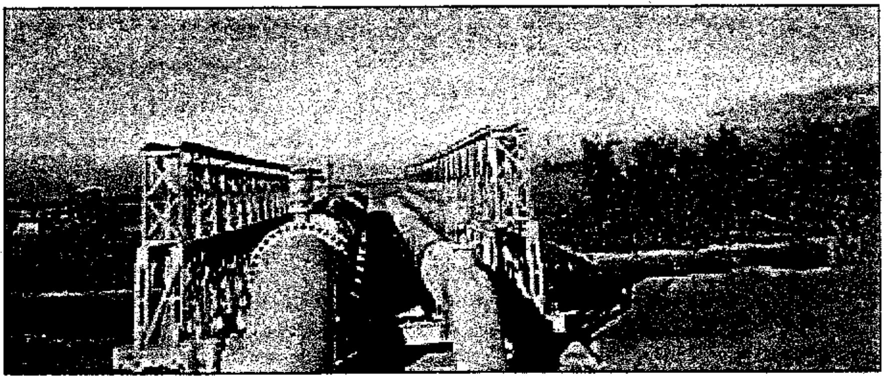


Trifolium Lateral Interceptor BCW just upstream of Willey Reservoir

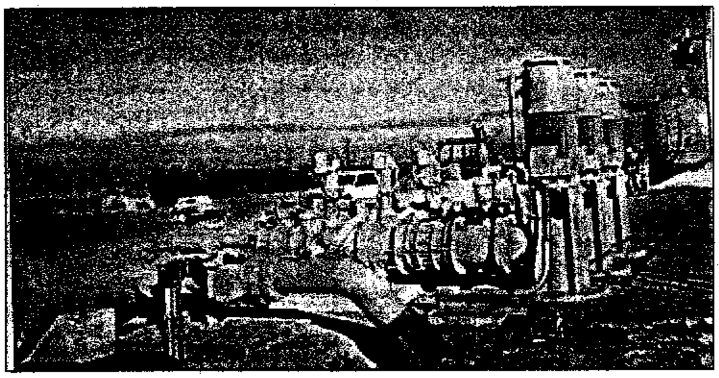
Figure 4.9 IID/MWD Project 8 Trifolium Lateral Interceptor



Willey Reservoir



Bridge and Transmission Pipelines



Pumping Plant at Willey Reservoir

Figure 4.10 IID/MWD Project 8 Trifolium Lateral Interceptor

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Mulberry-D Lateral Interceptor Project Description

The Mulberry-D Lateral Interceptor Project captures flow from 13 East Highline laterals and the Vail Supply Canal. Captured water, re-regulated in the Young and Russell Reservoirs, is released to help meet demands in the Vail Main Canal service area, downstream of Russell Reservoir (see Figures 4.11 through 4.13).

The project features a South and a North interceptor canal. The South interceptor canal captures water from the Mulberry, Malva, Mayflower, Marigold, Standard, Narcissus, Nettle and Nutmeg Laterals. This water is stored in the Young Reservoir. Re-regulated water flows from Young Reservoir into the Vail Supply Canal by gravity. Nutmeg Lateral has no spill, as it discharges directly into the Vail Supply Canal downstream of the Young Reservoir interconnection and upstream of Drop 41. Similarly, intercepted water collected in the North interceptor canal from the B, C, and D Laterals discharges directly into the Vail Supply Canal upstream of Drop 41 and downstream of the Young Reservoir interconnection.

Automation at Vail Supply Canal Drop 41, which is actually a weir, allows Water Control to set a level such that a constant flow is maintained over the weir. When this level fluctuates, the automated gate at the Young Reservoir interconnection with the Vail Supply Canal adjusts automatically so flow at Drop 41 will equal the flow set by Water Control. Young and Russell Reservoirs are operated to regulate flow fluctuations due to discharge from Nutmeg Lateral and from the North interceptor canal, which collects discharge from the B, C and D Laterals, into the Vail Supply Canal.

A broad-crested weir (BCW) was constructed in the South interceptor canal between the inflow from the last lateral and the interceptor canal. The weir measures flow to the Young Reservoir or to Vail Supply Canal through the emergency spill. A sharp-crested weir (SCW) constructed in the North interceptor canal just upstream of the outlet to the Vail Supply Canal allows measurement of that flow. Given the design of the Mulberry-D Lateral Interceptor, there is no possibility of interceptor spillage. As with the Plum-Oasis Lateral Interceptor, an automated drop-leaf gate (ADLG) located at the end of each lateral is used to measure lateral spillage. These automated facilities provide information via telemetry to IID's Water Control Center, transmitting data required for conservation verification from the site to IID's Water Information System (WIS) where they are processed to determine rate and volume of flow.

Young and Russell Reservoirs and the Mayflower Interface Gate are shown in Figure 4.14. Mulberry-D Lateral Interceptor Facility and Cost Summary details are provided in Tables 4.1 and 4.2.

A complete description of Young and Russell Reservoirs is provided in Section 5.

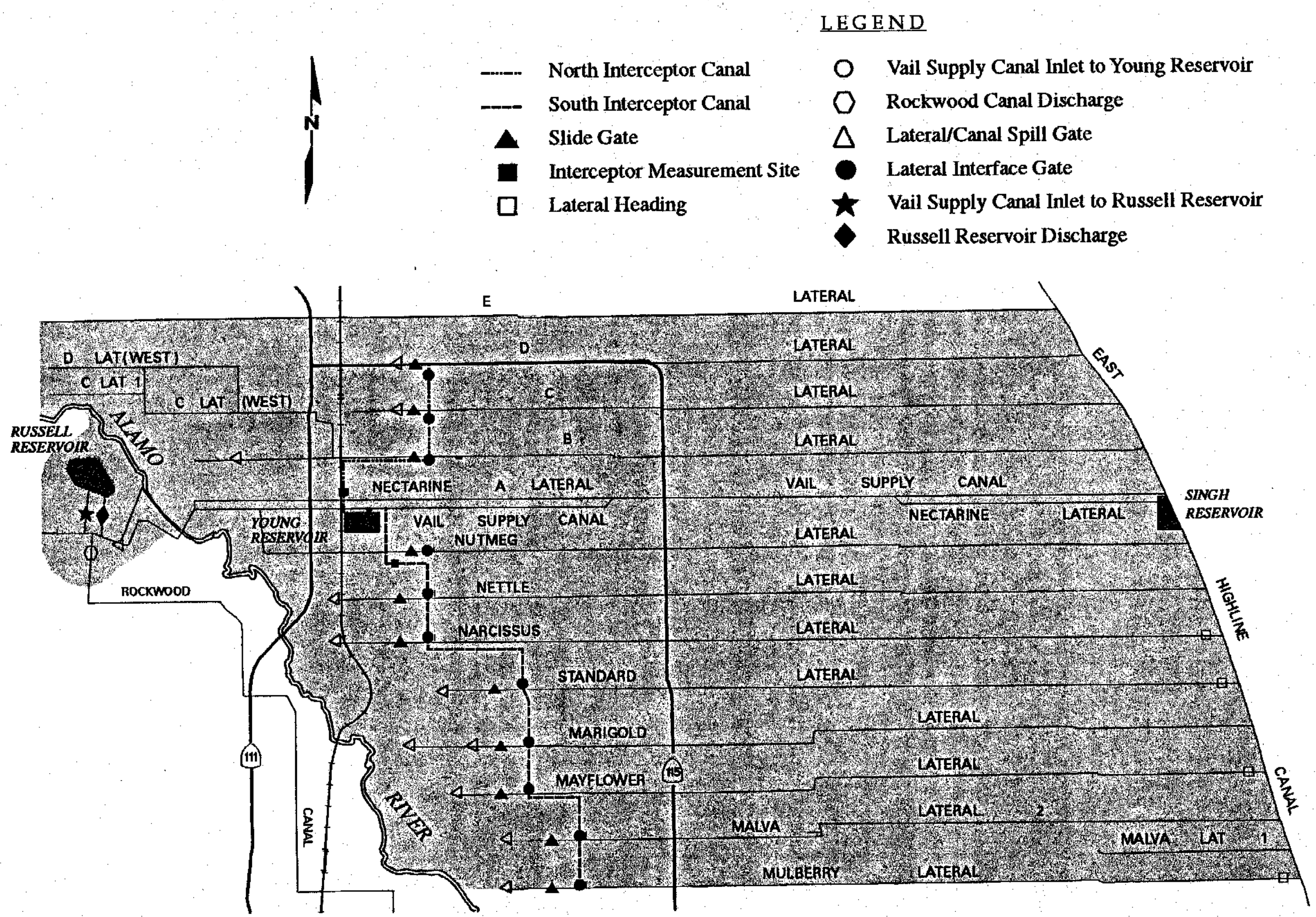

Figure 4.11 Mulberry-D Lateral Interceptor Project and Vail Supply Canal

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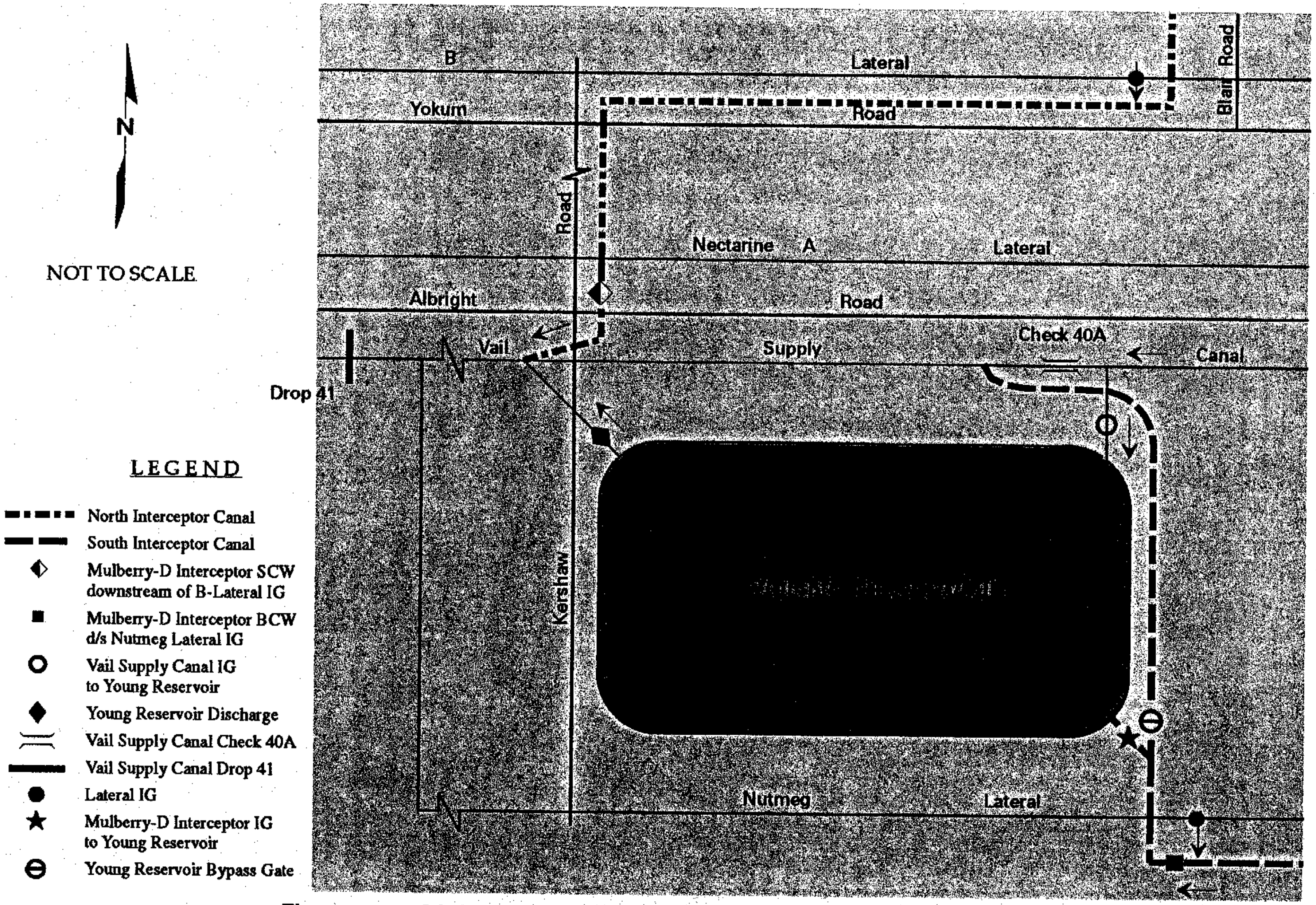

Figure 4.12 Mulberry-D Lateral Interceptor Project, Young Reservoir Area

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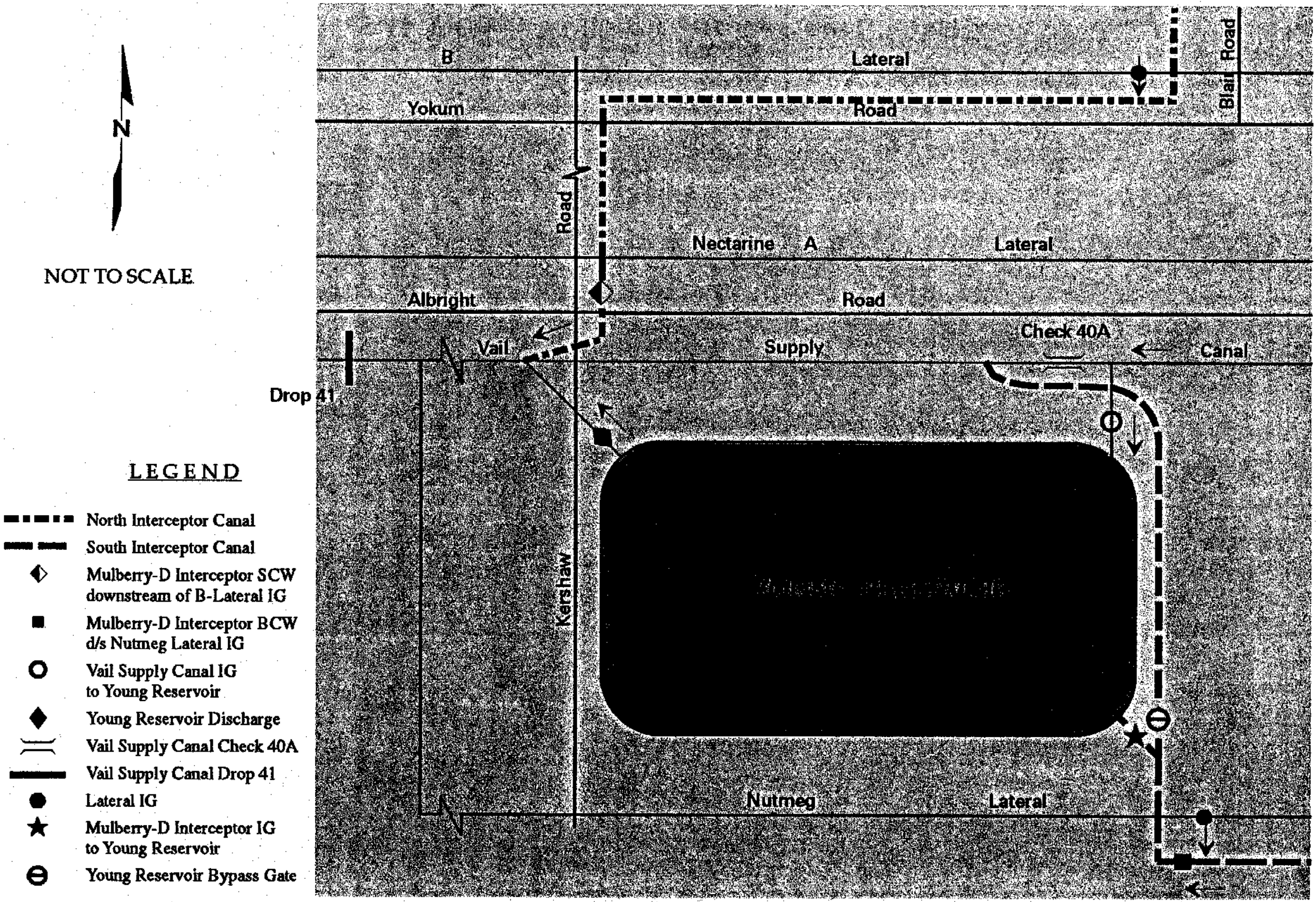

Figure 4.12 Mulberry-D Lateral Interceptor Project, Young Reservoir Area

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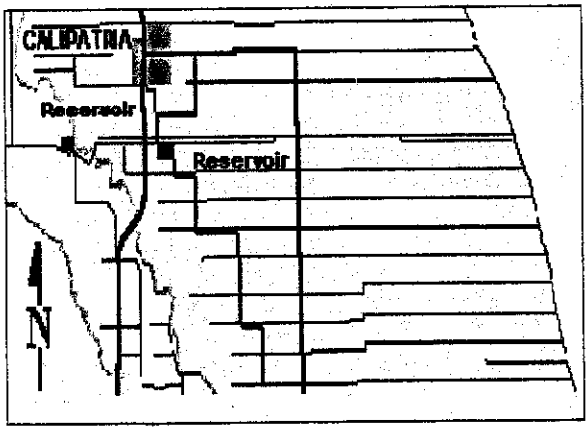

Mulberry-D Lateral Interceptor Project Area Map

Young Reservoir, Vail Supply Canal Check 41A

Russell Reservoir, Vail Main Canal

Mayflower Interface Gate, Mulberry-D Interceptor, PLC Terminal, Solar Panel, Antenna, Automated Drop-Leaf Gate (ADLG), and Stilling Well

Figure 4.14 IID/MWD Project 17 Mulberry-D Lateral Interceptor

Table 4.1 Lateral Interceptor Facilities Summary

Interceptor	**Plum-Oasis**	**Mulberry-D**	**Trifolium**
Length (miles)	5	8.25	10.9
Intercepted Laterals	8	11	15
Service Area (acres)	22,246	31,000	30,000
Reservoir(s)	Bevins	Young & Russell	Willey
Pipeline	975 feet of 24" diameter	—	21,900 feet of 45" diameter
Date of Completion	November 1992	February 1996	January 1998

Reservoirs	**Bevins**	**Young**	**Russell**	**Willey**
Area (acres)	37	47	29	51
Capacity (AF)	253	275	200	300
Maximum Depth (ft)	12.9	9	8.3	7
Inlet capacity (cfs)	165	100	100	190
Outlet	Pump	Gravity	Pump	Pump
Outlet capacity (cfs)	50	100	50	51
Outlet	Redwood Canal	Vail Supply Canal	Vail Main Canal	Vail Main Canal
Date of Completion	November 1992	February 1996	December 1996	January 1998

Table 4.2 Lateral Interceptor Cost Summary

Interceptor System	Total Capital Cost	Budgeted 1999 O&M [1]	1999 Water Conservation	
			AF [1]	Cost $/AF [2]
Plum-Oasis	$5,842,677 (Actual) $5,173,429 (1988$)	$263,406 (Actual) $195,159 (1988$)	9,000	$69 (1988$)
Trifolium	$14,097,856 $10,898,037 (1988$)	$381,142 $282,390 (1988$)	14,560	$81 (1988$)
Mulberry-D	$8,842,272 $7,117,278 (1988$)	$374,792 $277,685 (1988$)	8,500	$102 (1988$)
Total	$28,782,805 $23,188,744 (1988$)	$1,019,340 $755,234 (1988$)	**32,060**	**$84 (1988$)**

1988$ Cost per AF = $84

[1] Budgeted O&M and water conservation volume are subject to change which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

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5 Reservoirs (1,3,4,8, 9, 17)

5 Reservoirs (Projects 1, 3, 4, 8, 9, 17)

All reservoirs that are part of the IID/MWD Program are described in this section. These include two regulating reservoirs, Carter and Galleano; a pumping plant addition at Singh Reservoir; and four interceptor reservoirs, Bevins, Young, Russell, and Willey. IID/MWD reservoir locations are shown in Figure 5.1.

Carter Reservoir was included under the IID/MWD Augmentation Program, while Galleano Reservoir was a stand-alone project built under the IID/MWD Agreement. A pumping plant was installed at the existing Singh Reservoir, as part of the 12-Hour Delivery Project, to offset East Highline Canal fluctuations caused by increased flexibility. Bevins, Young, Russell, and Willey Reservoirs were constructed as part of the three IID/MWD lateral interceptor projects.

Carter Reservoir, constructed in 1988 by IID, was funded by a loan from the State of California under the Clean Water Bond Law of 1984. The reservoir project was subsequently incorporated into the IID/MWD Conservation Agreement as an Augmentation Program project to conserve 4,600 af/year. The reservoir and related Westside Main Canal spill facilities are described in IID's December 1990 *Carter Reservoir Water Conservation Verification – Report I*, which was submitted to the California Department of Water Resources, Office of Water Conservation, as required by the reservoir construction loan.

Carter Reservoir has an operating capacity of 350 acre-feet, a maximum surface area of 31 acres and a depth of 10.4 feet. Water enters the reservoir through a 150 cubic feet per second (cfs) gravity inlet and is discharged through a pumping plant with a capacity of 50 cfs. Water was first diverted into Carter Reservoir in September 1988. Carter Reservoir is designed to conserve operational discharge from the end of the Westside Main Canal. The conserved water is discharged from the reservoir into the Trifolium Extension Canal. The reservoir features a computerized control system and a specially designed area for recreational fishing. A five-foot dike impounds water within the fish habitat area, with a sandy beach for fishing access (see Figure 5.2). Carter Reservoir Facility Summary details are provided in Section 3, Table 3.1.

Galleano Reservoir has an operating capacity of 425 acre-feet, a maximum surface area of 40 acres and a maximum depth of 21 feet. Water enters the reservoir through a 150-cfs gravity inlet and is discharged through a pumping plant with a capacity of 75 cfs. The reservoir, which was placed in operation in October 1991, allows IID to conserve excess flow previously discharged to Z Spill and, thence, directly into the Salton Sea. Galleano Reservoir, which is located at the terminus of the East Highline Canal, supplies water to farmland beyond this point via the Niland Lateral Canal Extension. The reservoir location and the fact that it is totally automated and self-controlled allow IID to balance shortfalls and overages in the East Highline Canal, providing more uniform water delivery to downstream users. The reservoir was designed with an enhanced fisheries habitat and a test site for waterfowl habitat development (see Figures 5.3, 5.4 and 5.5). Galleano Reservoir Facility and Cost Summary details are provided in Tables 5.1 and 5.2.

Singh Reservoir, which was built by IID, is located next to the East Highline Canal, near the Vail Supply Heading and above the Nectarine Check (see Figures 5.6 and 5.7). The reservoir was designed to receive surplus water from the East Highline Canal that would be diverted into the Vail Supply Canal when required. The reservoir's operating capacity is 323 acre-feet, with a maximum surface area of 32 acres and a maximum depth of 11 feet. The reservoir was constructed with a gravity inlet-outlet that has a flow

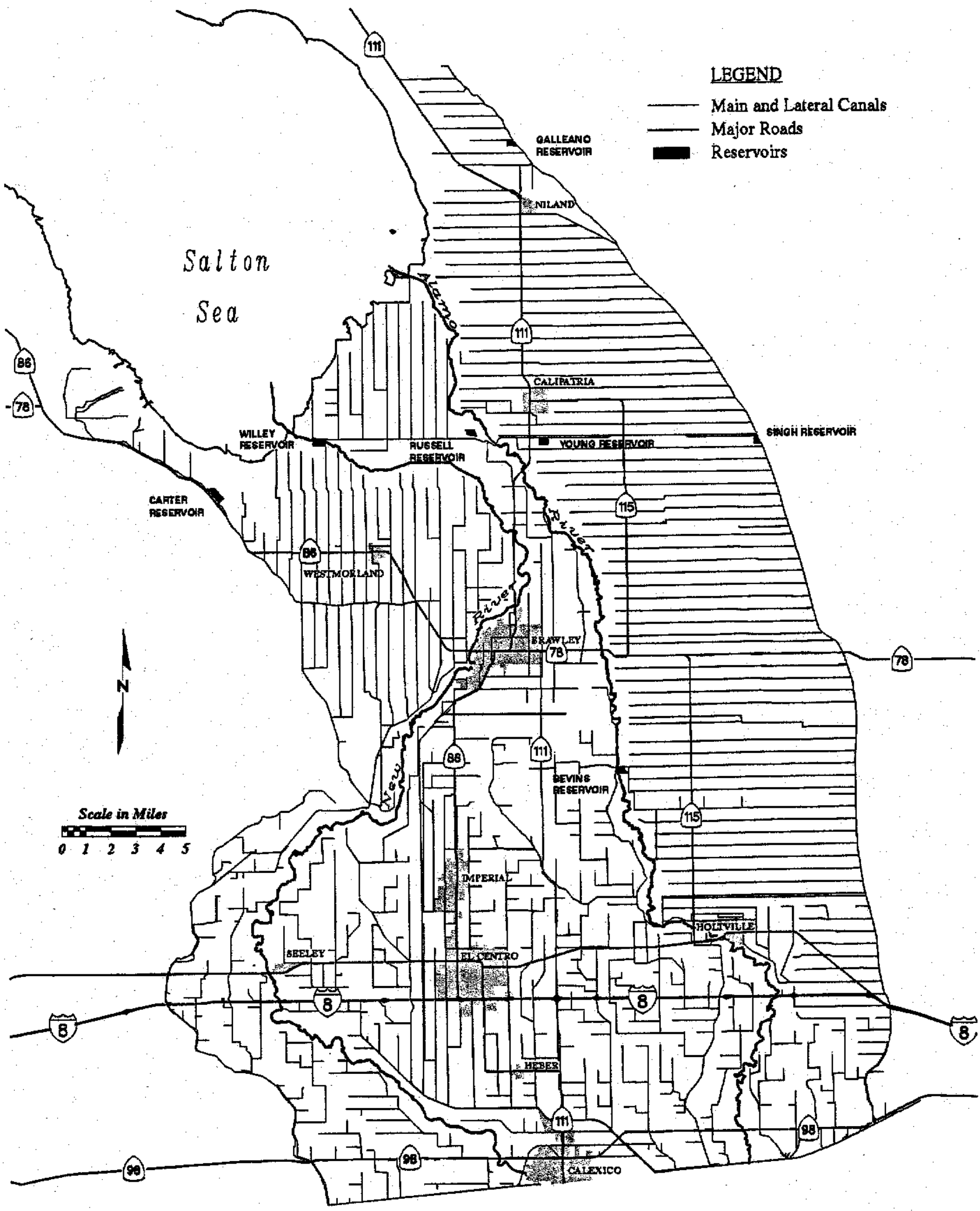

Figure 5.1 Location of IID/MWD Reservoirs

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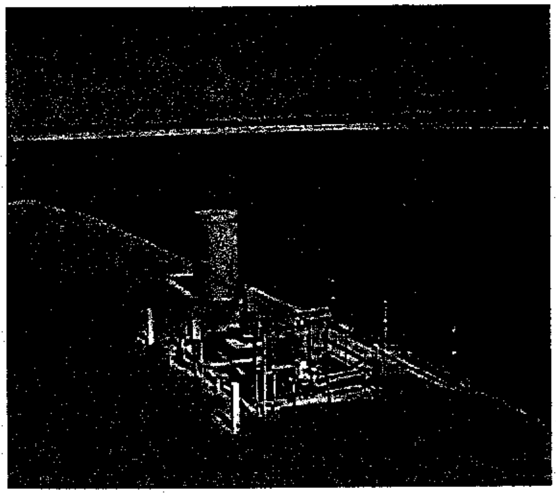
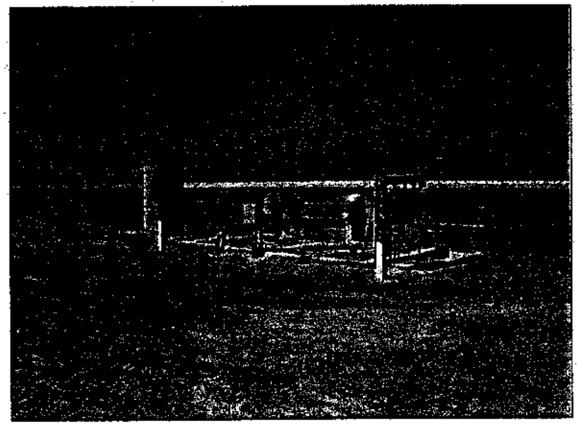
Carter Reservoir

Outlet Structure and Pumping Plant



Carter Reservoir Pumping Plant



Carter Reservoir Pumping Plant

Figure 5.2 IID/MWD Project 1 Carter Reservoir

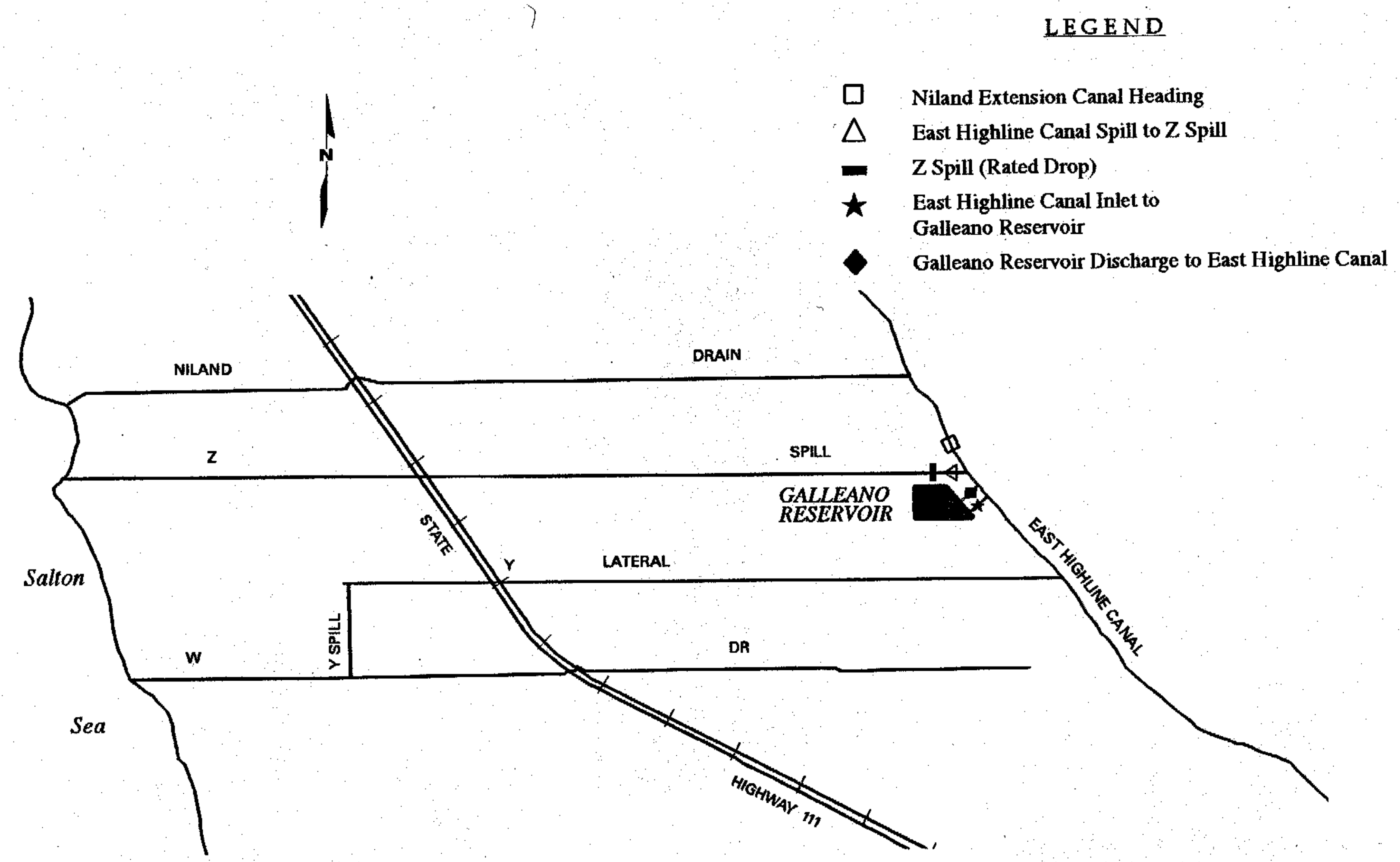


Figure 5.3 Galleano Reservoir Project Site Map

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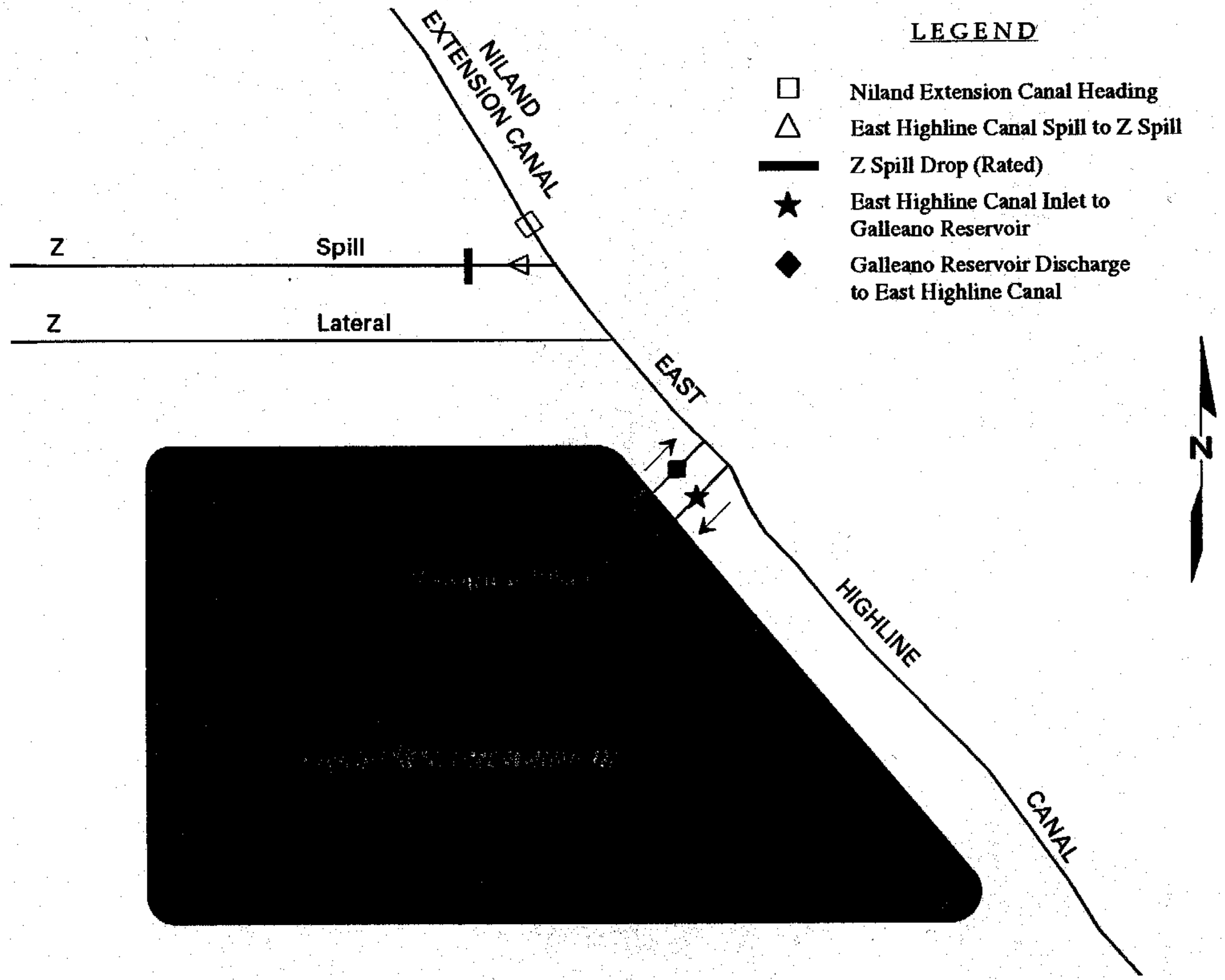

Figure 5.4 Galleano Reservoir Project Area

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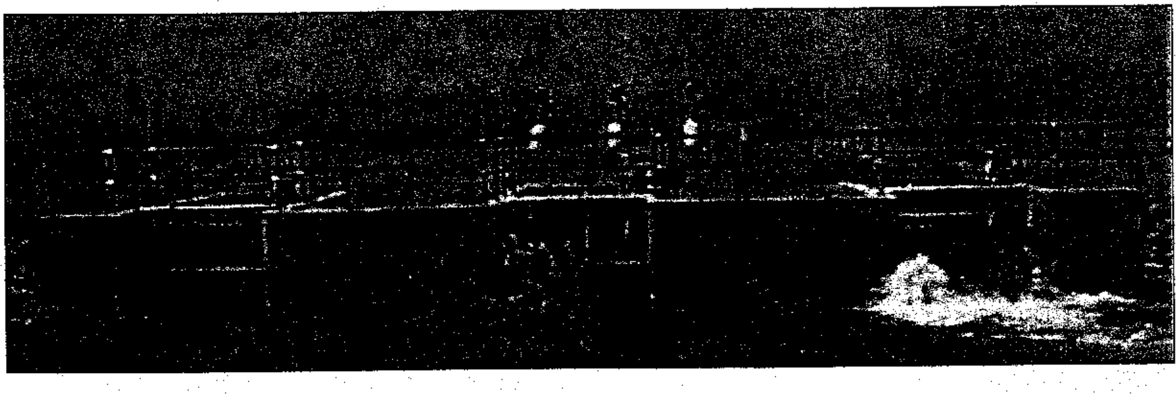
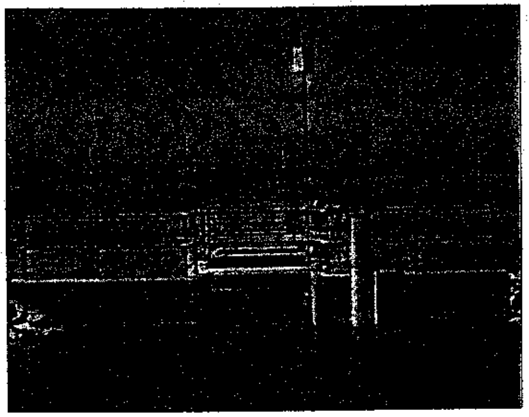
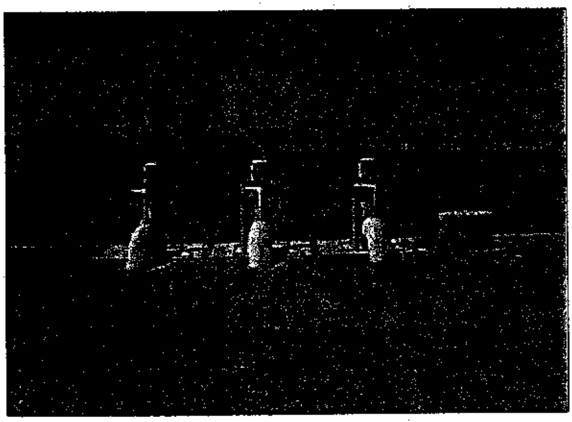
Galleano Reservoir



Galleano Reservoir Outlet from Upstream



East Highline Canal Inlet to Galleano Reservoir



Galleano Reservoir Pumping Plant

Figure 5.5 IID/MWD Project 4 Galleano Reservoir

Table 5.1 Galleano Reservoir Facilities Summary

Reservoir	Galleano
Area (acres)	40
Capacity (AF)	425
Maximum Depth (ft)	21
Inlet capacity (cfs)	150
Outlet	Pump
Outlet capacity (cfs)	75
Outlet	Niland Extension Canal
Date of Operation	October 1991

Table 5.2 Galleano Reservoir Cost Summary

Reservoir	Total Capital Cost	Budgeted 1999 O&M[1]	1999 Water Conservation	
			AF[1]	Cost $/AF [2]
Galleano	$2,257,927 (Actual) $2,018,030 (1998$)	$61,485 (Actual) $45,555 (1988$)	4,470	$48 (1988$)
Total	$2,257,927 $2,018,030 (1988$)	$61,485 $45,555 (1988$)	**4,470**	**$48 (1988$)**

1988$ Cost per AF = $48

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

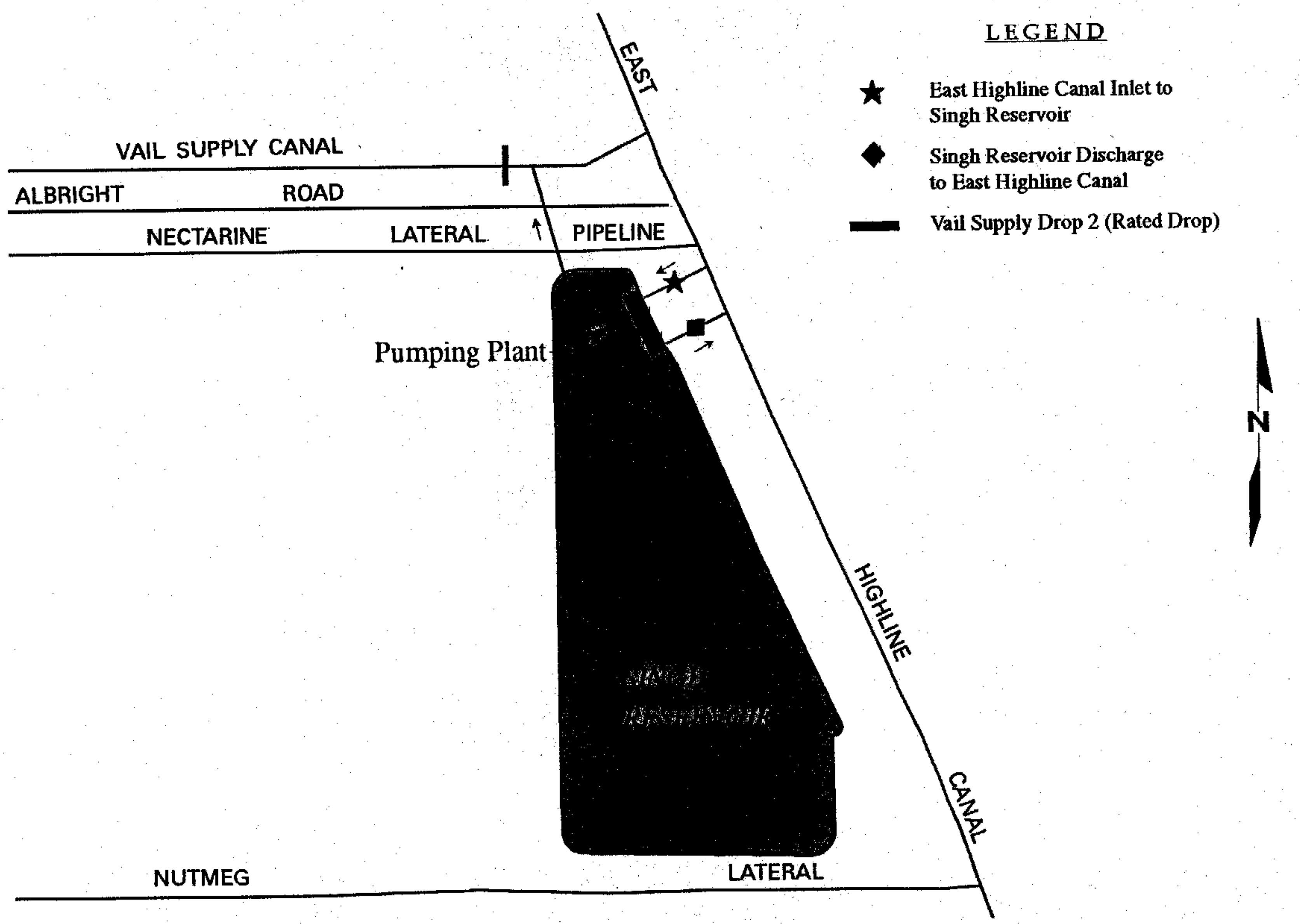


Figure 5.6 12-Hour Delivery Project, Singh Reservoir Pumping Plant

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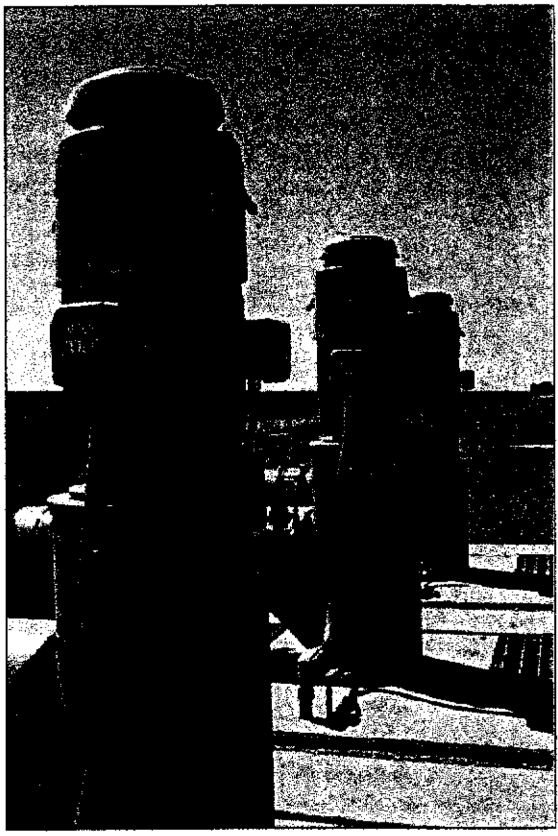

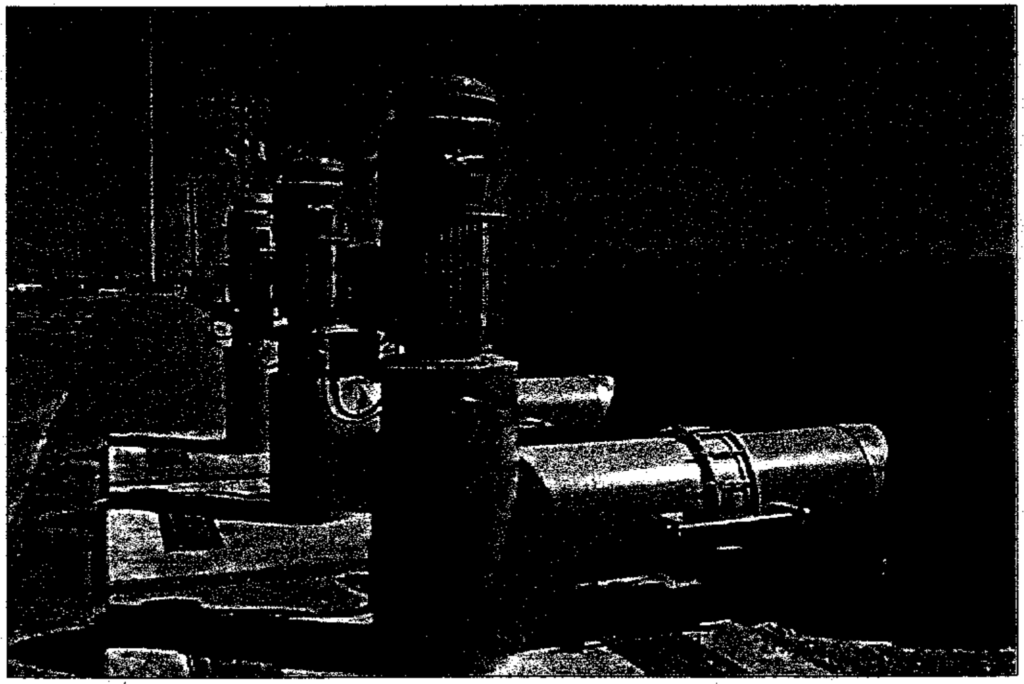

Pumping Plant at Singh Reservoir

Figure 5.7 IID/MWD Project 9 Singh Reservoir Pumping Plant capacity of 100 cfs. In 1997, a pumping plant with a capacity of 75 cfs was approved as a facilities improvement under the IID/MWD Agreement. The pumping plant, completed in September 1998, allows water to be pumped from the reservoir back into the East Highline Canal. In this way fluctuations resulting from additional on-farm flexibility are reduced. A discussion of on-farm flexibility may be found on page 65. Singh Reservoir Pumping Plant Facility and Cost Summary details are provided in Section 7, Tables 7.1 and 7.2.

A project involving the outlet of **Sperber Reservoir** was deleted from the Program when the water savings potential was found to be inadequate to meet Program guidelines.

Descriptions of the four reservoirs -- Bevins, Young, Russell, and Willey -- constructed as part of the three IID/MWD lateral interceptor projects follow.

Bevins Reservoir, part of the Plum-Oasis Lateral Interceptor Project (see Section 4), has an operating capacity of 253 acre-feet, a maximum surface area of 37.36 acres and a maximum depth of 12.9 feet. Water enters the reservoir through a 165 cfs gravity inlet and is discharged through a pumping plant with 50 cfs capacity. The reservoir, placed in operation in November 1992, allows IID to conserve flow that previously discharged to the Alamo River and, thence, directly into the Salton Sea. Bevins Reservoir is located near the mid-point of the Redwood Canal, and supplies water to farmland downstream of this point via the Redwood Canal and its laterals. The reservoir location and the fact that it is totally automated allow IID to balance shortfalls and overages in the lower Redwood Canal service area, thus providing more uniform water delivery to downstream users. The reservoir was designed to provide farmers with a virtual demand delivery system where they can shut off or receive water whenever the need arises.

Young Reservoir, which is part of the Mulberry-D Lateral Interceptor Project (see Section 4), has an operating capacity of 275 acre-feet, a maximum surface area of 47 acres and a maximum depth of 9 feet. Water enters the reservoir through a 100-cfs gravity inlet. Water can enter the reservoir both from the South Mulberry-D Interceptor Canal and from the Vail Supply Canal. A gravity outlet with a flow capacity of 100 cfs is used to discharge reservoir storage into the Vail Supply Canal, as needed, for downstream users. The reservoir, which is located at the end of the South interceptor canal, stores water for downstream users in the Vail Main Canal. Young Reservoir was placed in operation in February 1996.

Russell Reservoir, constructed as part of the Mulberry-D Lateral Interceptor Project (see Section 4), is located immediately West of the Vail Supply Canal Spill to the Alamo River (near the previous location of Northend Dam). Russell Reservoir is designed to capture flow that historically spilled to the Alamo River, primarily from Rockwood Canal and Nectarine Lateral A discharge. Nectarine Lateral A discharges directly to the Vail Supply Canal downstream of Drop 41. Rockwood Canal discharge is just upstream of the reservoir inlet. The regulating capability of the Russell Reservoir also allows reduction of Vail Main Canal spills to the New River near the Vail Lateral 7 Heading. The 8.3-foot deep, 29-acre reservoir has an active storage capacity of 200 acre-feet. Its inlet flow capacity is 100 cfs; and two outlet pumps provide an outlet flow capacity of 50 cfs. Russell Reservoir was placed into operation in December 1996.

Willey Reservoir, which is part of the Trifolium Lateral Interceptor Project (see Section 4), has an active storage capacity of 300 acre-feet (AF). The reservoir area is 51.2 acres and its maximum depth is seven feet. It has an inlet flow capacity of 190 cfs, and two pumps provide an outlet flow capacity of 51 cfs. Willey Reservoir was placed into operation in January 1998. Each afternoon, IID Water Control Center operators estimate the yield that can be delivered from Willey Reservoir during the next operational day. That yield (along with yields from Young and Russell Reservoirs) is subtracted from the next day's water orders for the Vail Canal system to establish the amount of water to be delivered to the Vail Supply Canal from the East Highline Canal. The yield is determined by converting the Willey Reservoir storage, as observed each afternoon, into a constant flow rate that can be sustained during the next operational day. No allowance is made for captured flows that may occur the next day.

Interceptor Reservoirs' Facility and Cost Summary details are provided in Section 4, Tables 4.1 and 4.2.

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6 Concrete Lining (5,7,10,11,16)

6 Concrete Lining – Main and Lateral Canals (Projects 5, 7, 10, 11, and 16)

To reduce seepage from IID's delivery system, concrete lining of selected sections of main and lateral canals was included in the IID/MWD Agreement. Main canal lining projects included portions of the South Alamo, Rositas Supply, Vail Supply, and Westside Main Canals. For lateral canals, the objective was to line sections throughout IID's service area where the cost per projected acre-foot (AF) of conservation savings would have a total life-cycle cost of $125/AF per year or less in 1988 dollars. The locations of sections of main and lateral canals that were lined are shown in Figure 6.1.

Main canal lining activities, initiated in 1989, were completed in 1992. In all 13.3 miles of main canals were lined including 2.55 miles of South Alamo Canal, Phase 1 by IID (Augmentation Project) and 10.75 miles under the IID/MWD Program. Concrete lining of lateral canals began in 1990 and was completed in 1994. In all a total of 199.7 miles of lateral canal were lined under this program.

Typical concrete canal sections and representative photos of main and lateral canal lining are shown in Figures 6.2 and 6.3. Concrete Lining – Main and Lateral Canals' Facility and Cost Summary details are provided in Tables 6.1 and 6.2.

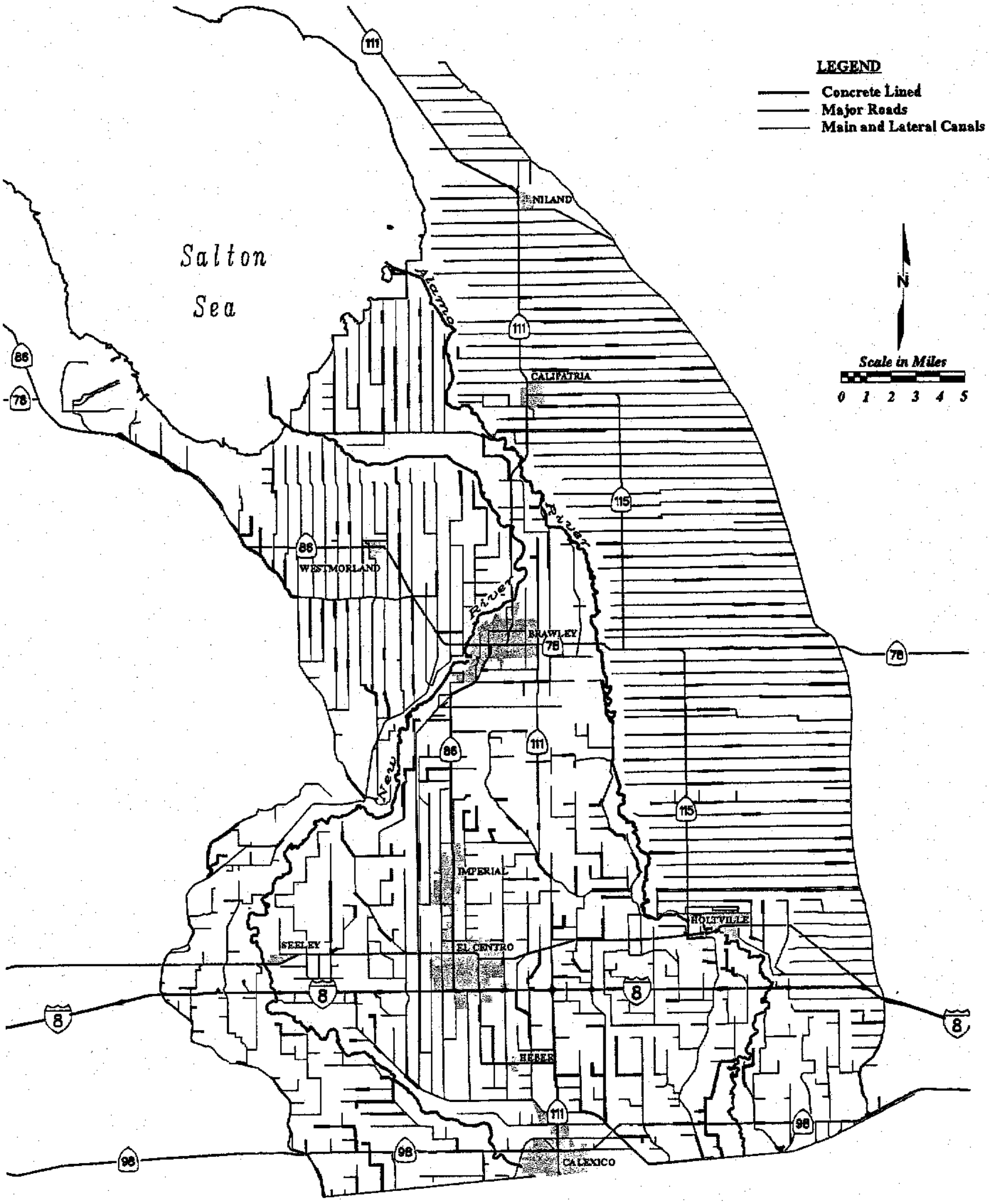

Figure 6.1 Location of IID/MWD Main and Lateral Canal Lining Projects

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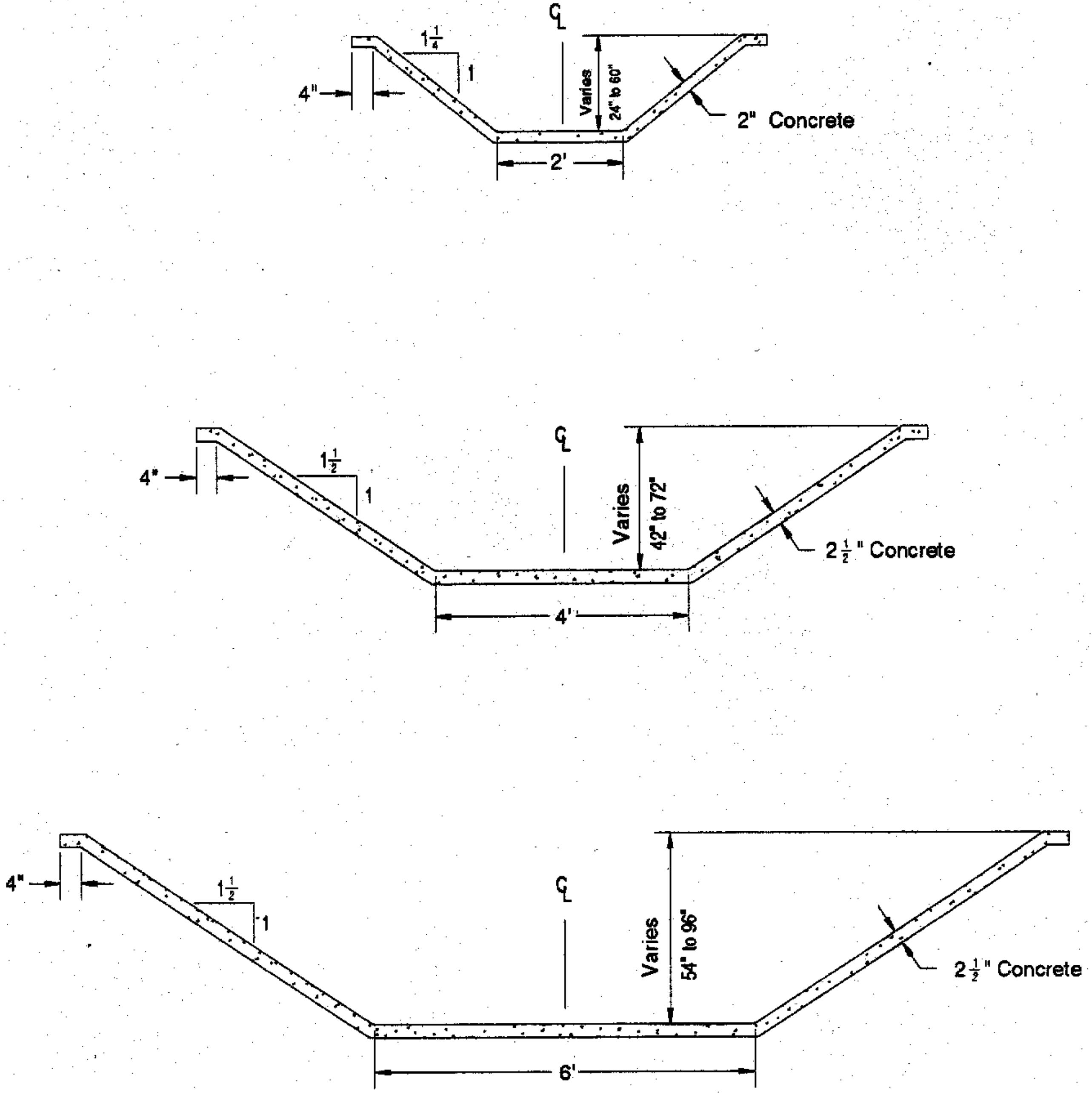
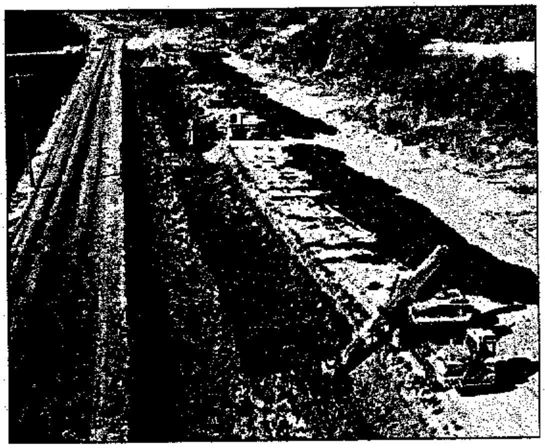
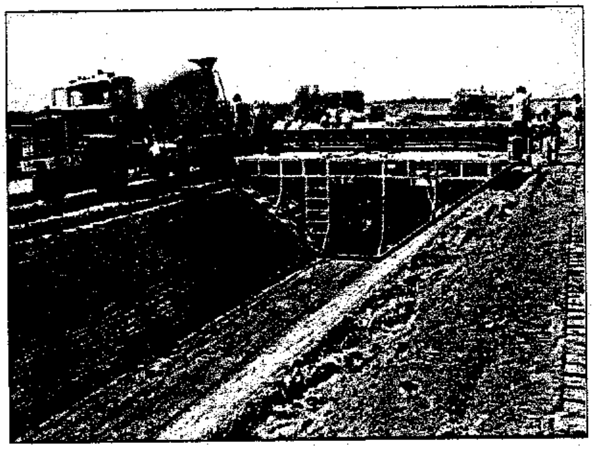


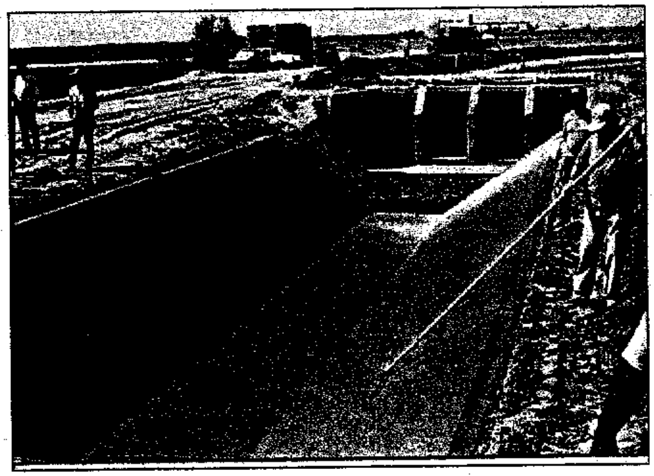
Figure 6.2 Typical Concrete Canal Sections



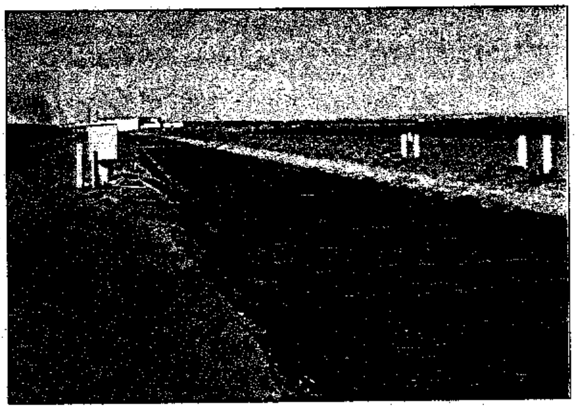
Main Canal Lining, South Alamo Canal



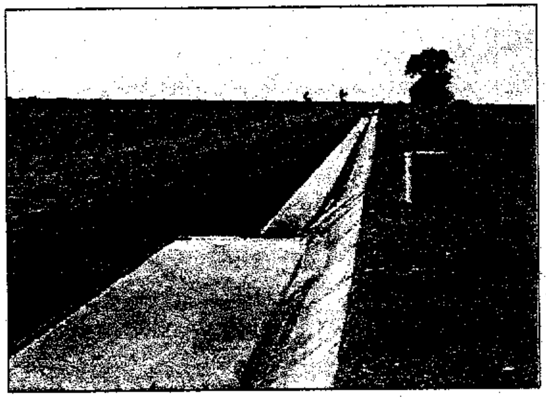
Main Canal Lining, South Alamo Canal



Main Canal Lining, South Alamo Canal



Main Canal Lining, South Alamo Canal



Lateral Canal Lining, Orange Lateral Heading BCW

Figure 6.3 IID/MWD Projects 1, 2 and 7 Concrete Lining

Table 6.1 Canal Lining - Main and Lateral Canals' Facilities Summary

Canal Lining	South Alamo Phase 2	Lateral Canals	Vail Supply, Rositas, & Westside Main North	Total
Length (miles)	3.2	199.7	7.55	210.45
Completion Date	1991	1994	1992	

Typical Cross-sections	2' Bottom Width	4' Bottom Width	6' Bottom Width
Depth (inches)	24 - 60	42 - 72	54 - 96
Thickness of Concrete (inches)	2.0	2.5	2.5
Side-slope	1.25:1	1.5:1	1.5:1
Berm Width (inches)	4	4	4

Table 6.2 Canal Lining - Main and Lateral Canals Cost Summary

Lining	Total Capital Cost	Budgeted 1999 O&M[1]	1999 Water Conservation	
			AF[1]	Cost $/AF[2]
South Alamo II	$1,320,093 (Actual) $1,196,797 (1988$)	$0 (Actual) $0 (1988$)	900	$110 (1988$)
Lateral Canal	$42,066,923 $37,262,567 (1988$)	$1,500 $1,111 (1988$)	24,250	$127 (1988$)
Vail Supply Canal	$167,102 $150,560 (1988$)	$0 $0 (1988$)	10	$1,247 (1988$)
Rositas Supply Canal	$568,529 $506,622 (1988$)	$0 $0 (1988$)	130	$323 (1988$)
Westside Main Canal	$1,901,328 $1,681,099 (1988$)	$0 $0 (1988$)	260	$536 (1988$)
Total	$46,023,975 $40,797,645 (1988$)	$1,500 $1,111 (1988$)	**$25,550**	**$132 (1988$)**

1988$ Cost per AF = $132

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

7 12 – Hour Delivery (9)

7 12-Hour Delivery (Project 9)

At the inception of the IID/MWD Program, IID's delivery requirement was that a water order must last for a 24-hour period. To provide an added element of flexibility for on-farm water management and to conserve water resulting therefrom, the 12-Hour Delivery Project was included in the IID/MWD Agreement

Flexible water delivery, properly managed, will enhance on-farm irrigation efficiency. IID has historically provided growers with flexibility in delivery frequency and rate by generally providing water within a day of its being ordered and by allowing growers to order almost any flow rate. However, until the 12-Hour Delivery Project was adopted, the IID requirement was that water be taken in increments of 24-hours. This 24-Hour delivery requirement limited flexibility in duration and did not always allow growers to make the most efficient use of delivered water.

The 12-Hour Delivery Project, which allows growers to take water deliveries in 12-hour increments (either day or night), was designed to allow growers to match crop requirements by providing flexibility in irrigation duration. Under the provisions of this project, farmers can terminate delivery and leave any unused water in the IID system after 12 hours or at any time upon 3 hours notification to IID. The unused water can then be delivered to another user, routed to one of IID's regulating reservoirs, which are described in Section 5, or returned to the main canal system.

12-Hour Delivery Rules

- Growers must indicate the intent to take delivery for 12 hours at the time of order, and the delivery rate must not exceed 7 cfs.
- Growers may arrange for a flow reduction in the last 12 hours of a 24-hour delivery, not to exceed 5 cfs or ½ the delivery rate.

Studies based on field data and records show that most unused water is effectively captured and re-delivered, resulting in net positive savings from the 12-Hour Delivery Project. As noted in Section 5, at the Singh Reservoir a pumping plant with an outlet capacity of 75 cfs was added as part of the IID/MWD Program in order to mitigate fluctuations in the East Highline Canal downstream of the Reservoir due to increasing use of the 12-hour deliveries by growers.

12-Hour Delivery Facility and Cost Summary details are provided in Tables 7.1 and 7.2.

Table 7.1 12-Hour Delivery Facilities Summary

Reservoir Upgrade	Singh Reservoir Pumping Plant
Area (acres)	32
Capacity (AF)	323
Maximum Depth (ft)	11
Inlet capacity (cfs)	100
Outlet	Pump
Outlet capacity (cfs)	75
Outlet	East Highline Canal
Date of Operation	Oct-98

12-Hour Deliveries	No. of Irrigation Events
2/1/90 - 12/31/98	181,518

Table 7.2 12-Hour Delivery Cost Summary

Project	Total Capital Cost	Budgeted 1999 O&M [1]	1999 Water Conservation	
			AF [1]	Cost $/AF [2]
12-Hour Delivery	$0	$1,525,207 (Actual) $1,130,034 (1988$)	21,750	$57 (1988$)
Singh Reservoir Pumping Plant	$904,030 (Actual) $689,736 (1988$)	$61,590 $45,632 (1988$)		(1988$)
Total	$904,030 $689,736 (1988$)	$1,586,797 $1,175,666 (1988$)	**21,750**	**$57 (1988$)**

1988$ Cost per AF = $57

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

8 Non-Leak Gates (12)

8 Non-Leak Gates (Project 12)

Non-leak gates conserve water by reducing the volume lost to leakage through distribution system control structures. At selected water control sites, aluminum non-leak gates were installed to replace leaking wooden gates.

Out of 127 potential non-leak gate sites, IID Water Resources staff selected 25 to be investigated for inclusion in the Non-Leak Gate project. These sites included 19 lateral headings, three mid-lateral spill sites, and three lateral check structures. Based on a flow leakage measurement prior to installation of the non-leak gate and the expected opportunity time for each site, projected savings were determined. Based on these analyses, non-leak gates were installed at 15 of the 25 investigated sites; however, in Fall 1996, the non-leak gate at Spruce Main Check at Lateral 4 was removed from the project, leaving a total of 14 sites in the project. These Non-Leak Gates have been determined to conserve 630 AF each year.

The location of the Project 12 non-leak gates is shown in Figure 8.1. A photo of a typical non-leak gate is shown in Figure 8.2. Non-Leak Gates Cost Summary details are provided in Table 8.1.

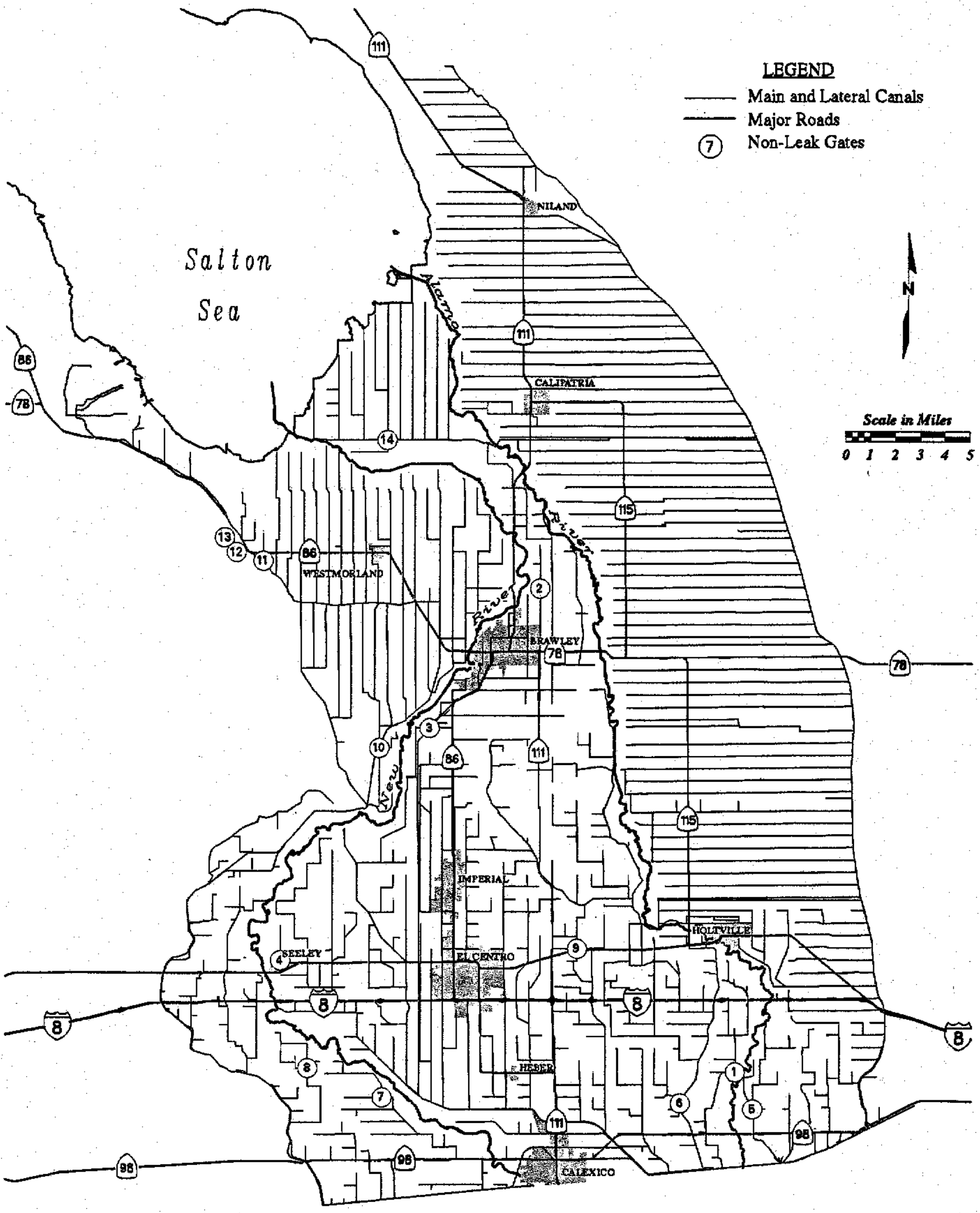


Figure 8.1 Location of IID/MWD Non-Leak Gate Sites

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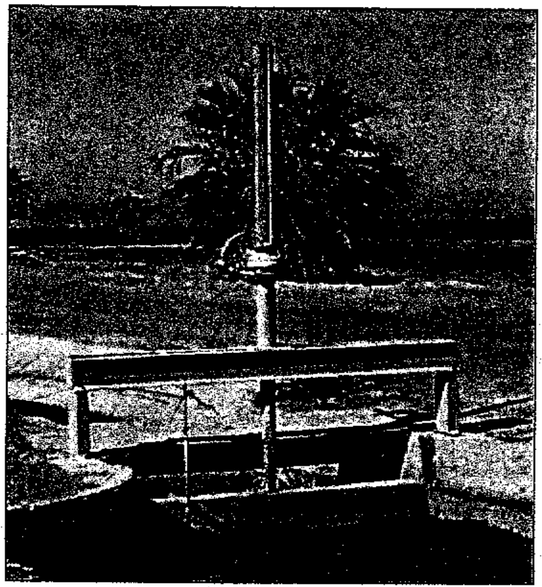
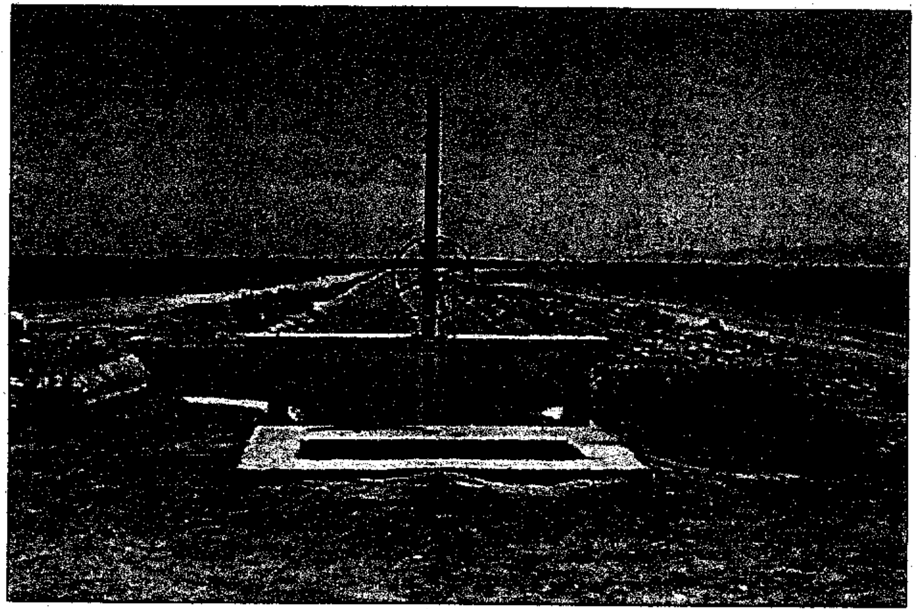
Wisteria Lateral 7 Heading Non-Leak Gate



Typical Non-Leak Gate



Hemlock Lateral 2B Heading Non-Leak Gate

Figure 8.2 IID/MWD Project 12 Non-Leak Gates

Table 8.1 Non-Leak Gates' Cost Summary

Project	Total Capital Cost	Budgeted 1999 O&M [1]	1999 Water Conservation AF [1]	Cost $/AF [2]
Non-Leak Gates	$212,595 (Actual) $186,568 (1988$)	$10,421 (Actual) $7,721 (1988$)	630	$37 (1988$)
Total	$212,595 $186,568 (1988$)	$10,421 $7,721 (1988$)	**630**	**$37 (1988$)**

1988$ Cost per AF = $37

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

9 Irrigation Water Mgmt. (14)

9 Irrigation Water Management (Project 14)

Irrigation evaluations continue to be performed using portable on-farm water level sensors to monitor delivery and tailwater flow on selected fields. These evaluations, which are to continue throughout the life of the project, support farmers in deciding what sort of irrigation management options they might adopt. In addition, linear move and drip irrigation systems were installed on a pilot project basis to study the water conservation potential of such systems in the Imperial Valley (see Figure 9.1).

Irrigation Evaluation Service

In 1995, 30 portable sensors, known as OWLS (On-Farm Water Level Sensors) were purchased to record the amount of water entering a field through the delivery gate and leaving the field through the tailwater box. The sensors, which take a reading every 10 minutes, are left in place for the duration of an irrigation event, after which they are moved to another field. To perform quality control, sensor readings are compared to field measurements, which are taken up to three times per day.

The information is processed to create an irrigation evaluation chart that is provided to the water user as a management tool. The evaluation chart, which clearly shows the amount of water used for a particular field, allows the water user to see the amount of water delivered, and the timing of that delivery. From this information, the water user can determine whether to employ any available options to change delivery and application practices in the future.

IID Operations and Division staff use the irrigation evaluation chart to compare the amount of water delivered as calculated by the sensors with their own flow measurements. The sensors measure the same components – upstream level, downstream level, and gate position – as the zanjero. Flow fluctuations are evident from the chart. With this information, IID Operations staff can target laterals that have more fluctuation than expected and take corrective measures, if needed.

The Irrigation Management Unit uses the irrigation evaluation chart information showing water delivered and tailwater for grower/irrigator educational purposes. In addition, depending on demand for information, fields with certain crops, soil types, or special irrigation practices are accurately monitored. To date, readings have been collected on 127 farm turnouts distributed throughout the District. When enough irrigation evaluations have been completed, this data may enhance or replace data currently used for IID delivery and tailwater averages.

Linear Move and Drip Systems

The linear move irrigation pilot project was designed to demonstrate and evaluate the long-term economic, agronomic and service viability of this technology for Imperial Valley conditions. In this context, a memorandum of understanding was developed among four interested groups: IID, Valmont Irrigation, Water Tech (local representative for Valmont Irrigation), and three participating growers. System design, installation, and operation training were the responsibility of Valmont. In addition, economic and agronomic conditions – such as soil sampling and irrigation evaluations – were to be documented and evaluated by Valmont. The IID/MWD Program funded one-third of the total cost of the equipment; and, in the event that the systems proved viable, the growers agreed to continue payments until paid off. Otherwise, the units were to be returned to Valmont.

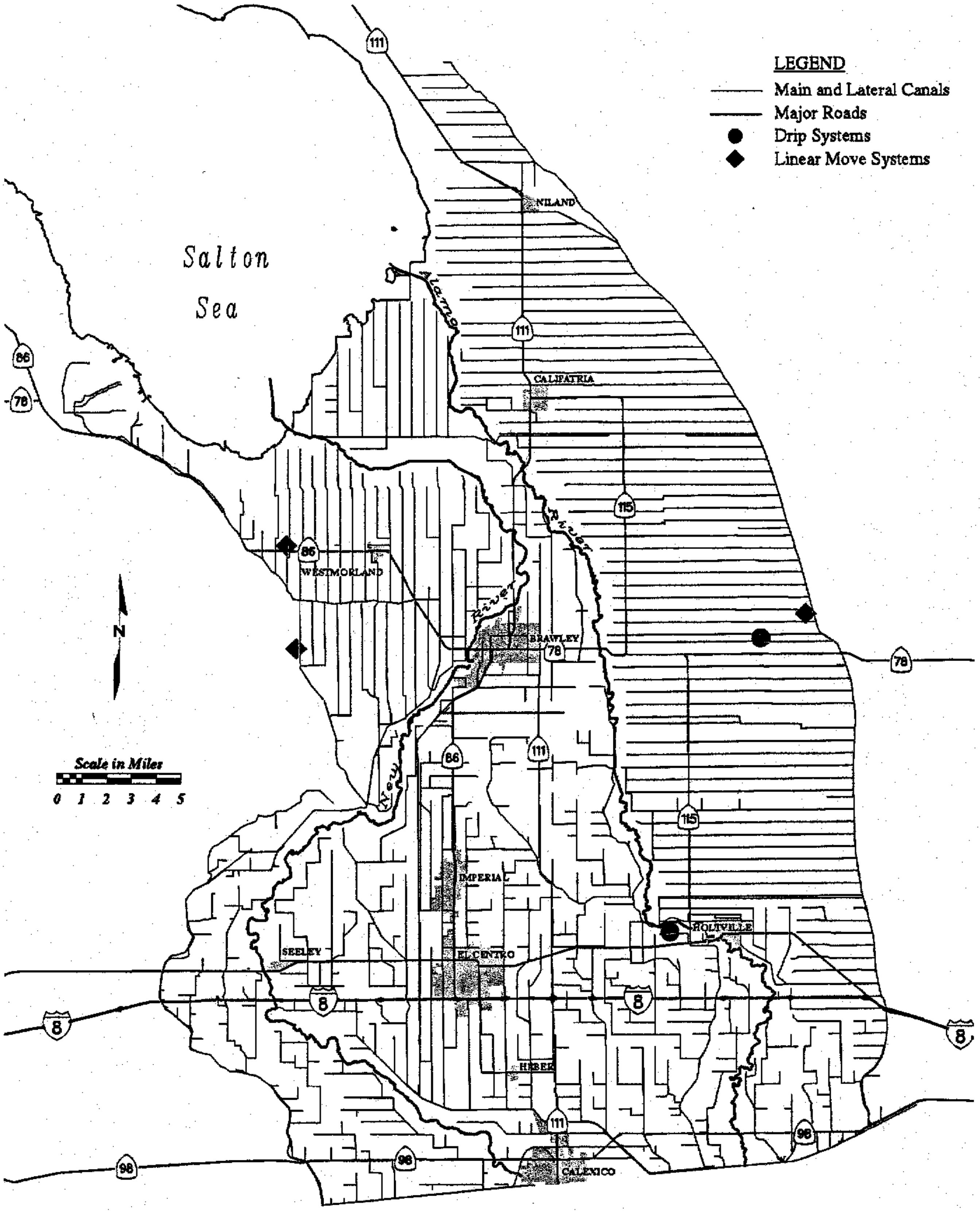


Figure 9.1 Location of IID/MWD Irrigation Water Management Projects

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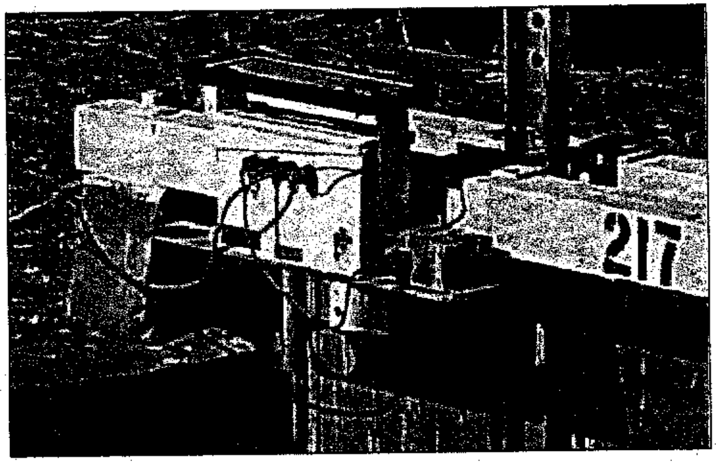
The IID/MWD Program implemented a pilot drip irrigation rebate (cost-sharing) project. In addition to water conservation, the project was designed to determine water conservation potential; obtain information about implementation, operation, and maintenance of drip (micro-irrigation) systems; develop recommendations based on collected data and information; and establish guidelines for implementation of future drip (micro-irrigation) programs. The Program was not involved in either system design nor component selection. However, the following features were required: a pump capable of delivering sufficient pressure and flow rate to efficiently operate the system; an appropriate filtration system; an inline flow meter with totalizing capacity; the ability to inject chemicals; and a distribution system that includes mainline, hoses, emitters and flushout valves.

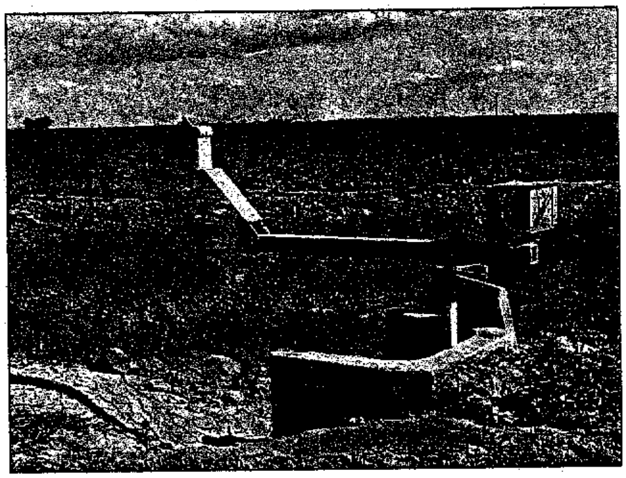
Photos of irrigation training and evaluation equipment and of a linear move and drip system are provided in Figures 9.2 and 9.3. Irrigation Water Management Cost Summary details are provided in Table 9.1.

Zanjero and Hydrographer Training



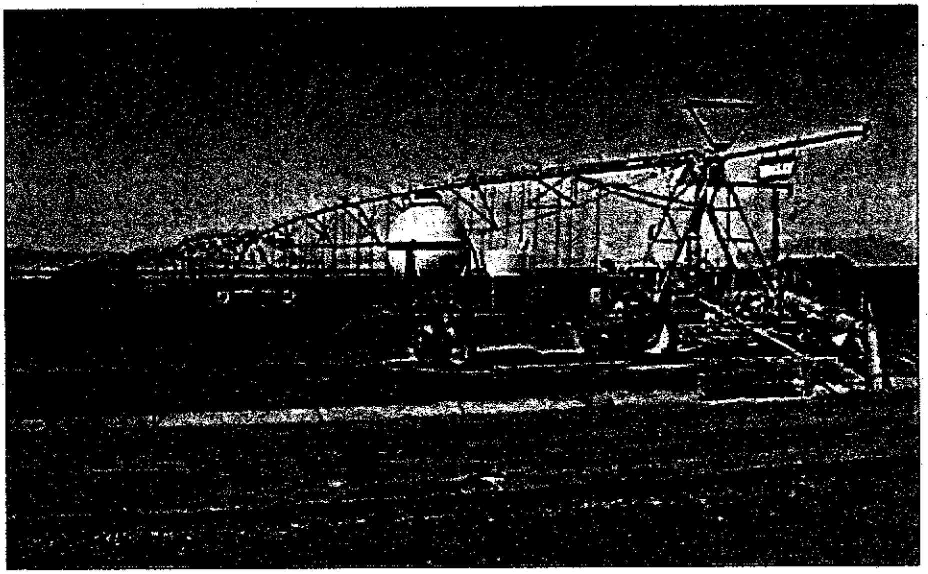
Close-up of Delivery Meter

Delivery Meter

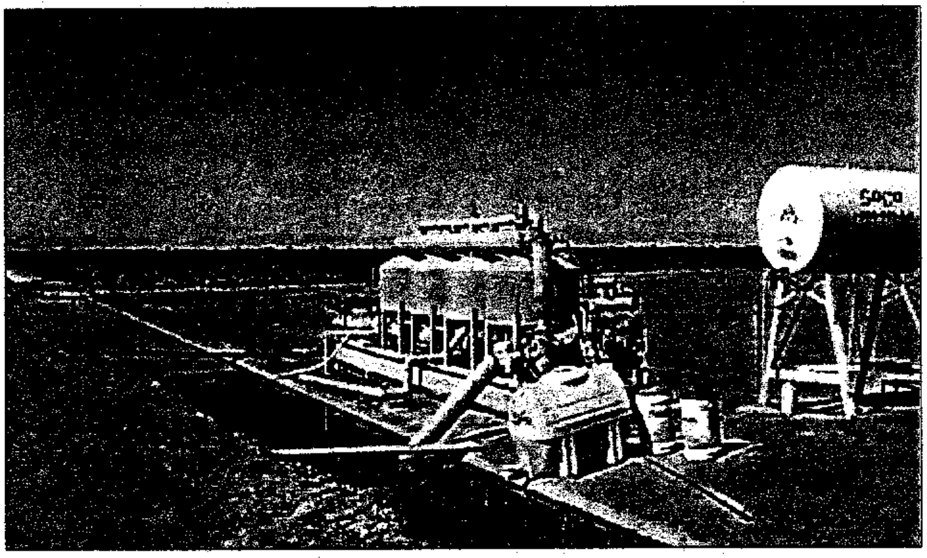


Tailwater Meter

Figure 9.2 IID/MWD Project 14 Irrigation Water Management



Linear Move System



Drip System

Figure 9.3 IID/MWD Project 14 Irrigation Water Management

Table 9.1 Irrigation Water Management Cost Summary

Project	Total Capital Cost	Budgeted 1999 O&M[1]	1999 Water Conservation AF[1]	1999 Water Conservation Cost $/AF[2]
Irrigation Evaluations, Training, & Linear & Drip Systems	$0	$297,565 (Actual) $220,468 (1988$)	280	$787 (1988$)
Total	$0	$297,565 $220,468 (1988$)	**280**	**$787 (1988$)**

1988$ Cost per AF = $787

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years) with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

10 System Automation (15)

10 System Automation (Project 15)

The Imperial Irrigation District operates numerous gated control level and/or flow structures in 200 miles of main canals. By 1990, when the IID/MWD Program was initiated, IID had already either partially or fully automated many structures on the upper reaches of its main canal system. However, the entire Westside Main Canal as well as the lower reaches of both the East Highline and Central Main Canals were entirely manually operated.

Pre-Program Automation Facilities

Partially automated structures were operated by local, hydraulically activated, constant upstream water level control systems. This partial automation allowed flow changes to be routed through the main canal system without having to manually adjust check structures. Twenty-five sites – which included check structures and turnouts along the All American Canal and checks on the upper reaches of the East Highline, Central Main, and Westside Main Canals – were operated by manual remote control using gauge readings of water level and gate opening and push buttons.

Communication with the 25 sites was achieved with land-based phone lines. This system, which consisted of overhead, open wires operating on a tone system, was installed and maintained by IID. Leased telephone data lines were also used on a limited basis. Field sites were connected via the communications link to five remote control panels in the original Water Control Room. The first panel was installed in 1958, while the last panel was commissioned in 1981. Each panel consisted of gauges and pushbuttons that provided remote control to each of the 25 sites.

The pre-Program communications link was unreliable and difficult to maintain. Landlines were subject to such events as vandalism, storms, and earthquakes, while hardwire communications were frequently interrupted. During 1990, prior to implementation of the IID/MWD system automation program, every site equipped with hardwire telemetry experienced communication outages. Communication outages at individual sites ranged from 14 to 118 days (an average of 47 days per site); that is, from 31 to 1,907 hours or 0.4 to 21.8 percent of the time (see Table 10.1). When interruptions occurred, human operators had to go to the site, which could not always be done in a timely manner, or the system was left to take care of itself. As would be expected, IID operators report that these outages strained operational resources and reduced the quality of water control operations.

Water Control Center (WCC)

Under the IID/MWD Program, a new building was constructed to house computer-based monitoring equipment, including workstations, a map board, file and database servers, and centralized communications equipment. The WCC is designed around personal computers connected to a real-time communication network as well as a local area network. This allows free flow of information from the field to any workstation computer.

The centerpiece of the WCC is the mapboard, a large schematic display of the canal and reservoir system. The mapboard, which consists of three side-by-side, 67-inch diagonal screens, uses rear projection screen technology. The same software used to develop operator screens is used for the mapboard. The mapboard

Table 10.1 Pre-Project Communication Outage in 1990 at Major Water Control Sites

Site No.	Associated Canal	Site Name	Days With Outage in 1990		Hours of Outage in 1990	
			Days	Days (%)	Hours	Hours (%)
1	AAC	Drop 1 Check	59	16.2	198	2.3
2	AAC	East Highline Check	118	32.3	1907	21.8
3	AAC	Allison Check	111	30.4	1728	19.7
4	AAC	New River Check	27	7.4	100	1.1
5	AAC	Wisteria Check	29	7.9	110	1.3
6	AAC	WSM Canal Heading	42	11.5	171	2.0
7	EHL	East Highline Check 11	51	14.0	325	3.7
8	EHL	Rositas Supply Canal Heading	91	24.9	1189	13.6
9	EHL	Orchid Check	89	24.4	1297	14.8
10	EHL	Oak Check	59	16.2	591	6.7
11	EHL	Myrtle Check	76	20.8	674	7.7
12	EHL	Standard Check	42	11.5	184	2.1
13	EHL	Nectarine Check	46	12.6	233	2.7
14	EHL	Singh Reservoir	50	13.7	263	3.0
15	RST	Rose Turnout	14	3.8	31	0.4
16	RST	Sperber Reservoir	14	3.8	31	0.4
17	CM	Dahlia Check	43	11.8	150	1.7
18	CM	Newside Check	20	5.5	42	0.5
19	CM	Fudge Reservoir - No. 4 Check	15	4.1	31	0.4
20	CM	Fudge Reservoir	14	3.8	36	0.4
21	WSM	Fern Check	49	13.4	300	3.4
22	WSM	Fillaree Check	28	7.7	114	1.3
23	WSM	Foxglove Check	43	11.8	255	2.9
24	WSM	Sheldon Reservoir - No. 8 Check	16	4.4	83	0.9
25	WSM	Sheldon Reservoir	17	4.7	96	1.1
			Days	**Days (%)**	**Hours**	**Hours (%)**
Maximum			**118**	**32.3**	**1907**	**21.8**
Minimum			**14**	**3.8**	**31**	**0.4**
Average			**47**	**12.7**	**406**	**4.6**

Abbreviations

AAC	All-American Canal
CM	Central Main
EHL	East Highline
RST	Rositas Canal
VAIL	Vail Supply Canal
WSM	Westside Main Canal

screen accesses Water Control operator PCs via the local area network (LAN) which permits easy updating of the mapboard. The display simultaneously provides real time operating conditions and trends throughout the system, including discharge rates at flow control sites and water levels at level control sites and reservoirs. These features enable IID Water Control Center staff to monitor flow, provide setpoints, exert supervisory control over each field site, and log data on a continuous, electronic basis.

Online programming, data analysis and a variety of other functions are performed using real-time or archived data. In addition, these computers serve to support supervisory control, graphics, trending and alarming; data acquisition; system wide mapboard display; as well as remote site configuration, programming and troubleshooting. Data are backed up daily on cassette tape for archival and security purposes.

Operations staff reports that, with the new system, they spend less time monitoring and manually controlling individual sites, allowing them to plan and operate the system in a strategic and integrated manner. This facilitates a systemwide view, an operational perspective that was not previously possible. Another benefit of the WCC is the improved reliability of the radio communications system compared with that of the old hardwire telemetry system it replaced.

Field Site Improvements

Under the IID/MWD Program, modernization of IID's pre-Program system automation facilities along with construction of new facilities resulted in improvements to 63 water control sites (see Figure 10.1 and Table 10.2). All of these sites, except five located at reservoirs constructed under the IID/MWD Program, had some automation prior to the IID/MWD Program.

Thirty-four sites are equipped with walk-in, air-conditioned steel enclosures and backup electrical generators. Before the IID/MWD Program, most of the structures at these sites were monitored and controlled from the Water Control Center using hardwire telemetry and manual control logic. Under the IID/MWD Program, this scheme was replaced with a microwave radio system and digital controllers. Benefits associated with this change include improved communications reliability and more precise and accurate control resolution. For example, the hydraulic automatic gates used at many main canal checks prior to the IID/MWD Program typically could maintain an upstream target water level within ±0.2 feet. In comparison, the new digital control systems maintain target levels within ±0.02 feet. This higher precision reduces fluctuations in main canal water levels and allows flow changes to move more quickly through the canals to reservoirs. In turn, reservoirs become reliable early indicators of flow mismatches in the system, allowing operators to implement appropriate corrective responses sooner than they previously could. This provides the potential for operating the system to better provide flexible, responsive water deliveries.

Six newly automated minor sites, not equipped with air-conditioned enclosures or backup generators, along with 21 automated overshot gates are concentrated along the lower reaches of the East Highline and Westside Main Canals. Each check, which was previously a manually operated grade-board structure, is now equipped with one locally controlled, automatic drop-leaf gate (ADLG). The ADLGs function to maintain an operator-set, constant, upstream water level. Complementary operation of grade boards in the other check bays is required to keep the ADLG within its operating range. Thus, the ADLGs allow flow changes to be passed automatically down these reaches with minimal water level fluctuation. The result is

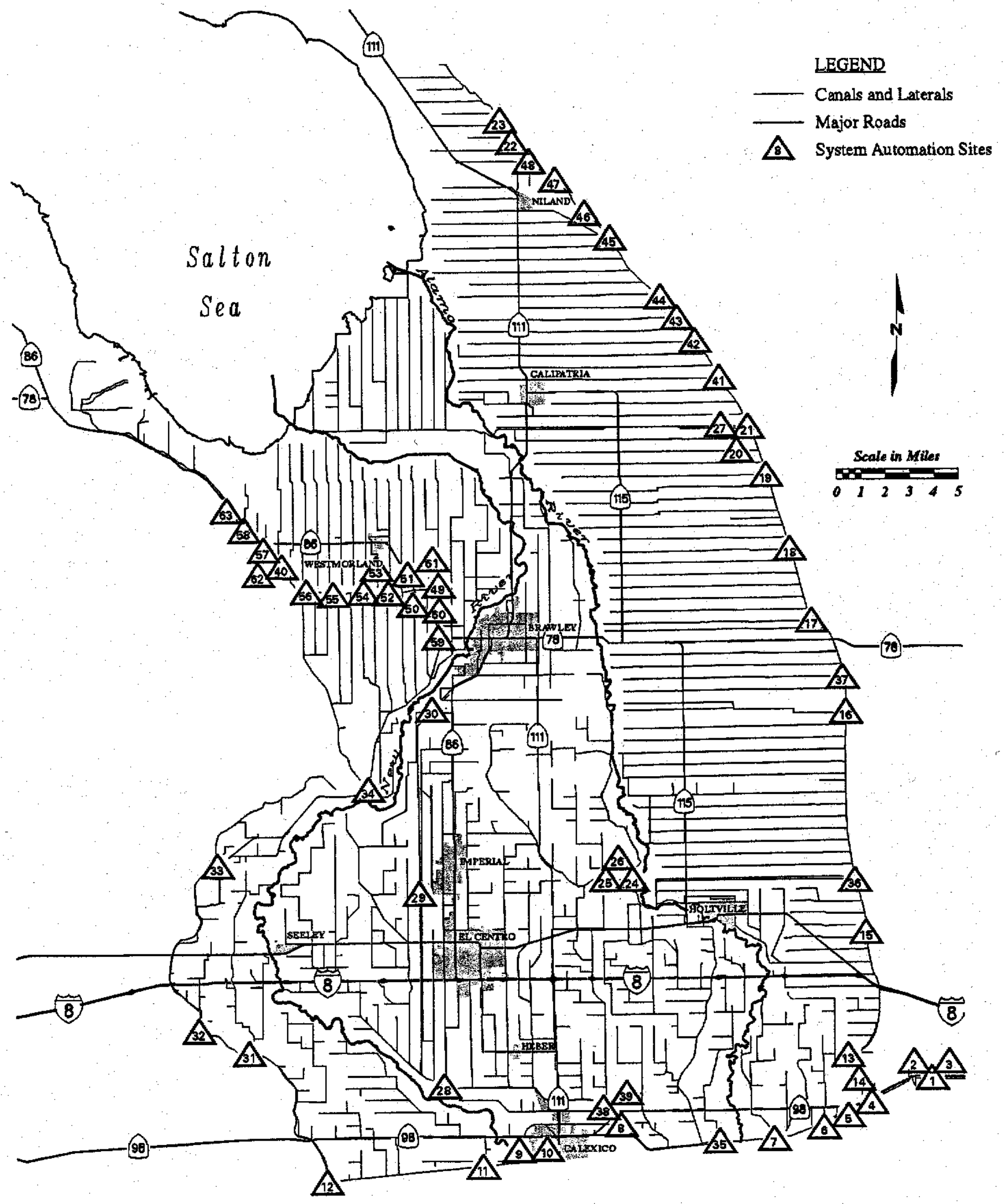


Figure 10.1 Location of IID/MWD System Automation Sites

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Table 10.2 IID Water Control Sites at which System Automation Was Modernized or Added under Project 15

Site No.	Associated Canal	Site Name	Site Type	Improvement Category
Major Sites (34)				
1	AAC	Coachella Turnout	major	upgrade
2	AAC	Drop 1 Check	major	upgrade
3	AAC	Drop 1 Power Plant	major	upgrade
4	AAC	East Highline Turnout	major	upgrade
5	AAC	East Side Main Heading	major	upgrade
6	AAC	East Highline Check	major	upgrade
7	AAC	Allison Check	major	upgrade
8	AAC	Central Main Check	major	upgrade
9	AAC	New River Check	major	upgrade
10	AAC	New River Spillway	major	upgrade
11	AAC	Wisteria Check	major	upgrade
12	AAC	Westside Main Turnout	major	upgrade
13	EHL	East Highline Check 1	major	upgrade
14	EHL	East Highline Power Plant	major	upgrade
15	EHL	East Highline Check 11	major	upgrade
16	EHL	Orchid Check	major	upgrade
17	EHL	Oak Check	major	upgrade
18	EHL	Myrtle Check	major	upgrade
19	EHL	Standard Check	major	upgrade
20	EHL	Singh Reservoir	major	upgrade
21	EHL	Vail Supply Turnout	major	upgrade
22	EHL	Z Lateral Heading	major	upgrade
23	EHL	Niland Extension Heading	major	upgrade
24	RST	Redwood Turnout	major	upgrade
25	RST	Rose Turnout	major	upgrade
26	RST	Rubber Turnout	major	upgrade
27	VS	Nectarine A Check	major	upgrade
28	CM	Dahlia Check	major	upgrade
29	CM	Newside Check	major	upgrade
30	CM	Fudge Reservoir - No. 4 Heading	major	upgrade
31	WSM	Fern Check	major	upgrade
32	WSM	Foxglove Check	major	upgrade
33	WSM	Fillaree Check	major	upgrade
34	WSM	Sheldon Reservoir - No. 8 Heading	major	upgrade

continued, overleaf

Table 10.2 IID Water Control Sites at which System Automation Was Modernized or Added under Project 15, continued

Site No.	Associated Canal	Site Name	Site Type	Improvement Category
Minor Sites (6)				
35	AAC	South Alamo Turnout	minor	new
36	EHL	Rositas Turnout	minor	new
37	EHL	Orange Heading	minor	new
38	BRI	Alder Turnout	minor	new
39	BRI	Acacia Turnout	minor	new
40	WSM	Trifolium 13 Check	minor	new
Overshot Gates (23)				
41	EHL	East Highline E Check	osgate	new
42	EHL	East Highline H Check	osgate	new
43	EHL	East Highline J Check	osgate	new
44	EHL	East Highline K Check	osgate	new
45	EHL	Flowing Wells Check	osgate	new
46	EHL	East Highline Check 37	osgate	new
47	EHL	East Highline Check 46	osgate	new
48	EHL	East Highline W Check	osgate	new
49	WSM	Tamarack Check	osgate	new
50	WSM	Trifolium 1 Check	osgate	new
51	WSM	Trifolium 2 Check	osgate	new
52	WSM	Trifolium 4 Check	osgate	new
53	WSM	Trifolium 5 Check	osgate	new
54	WSM	Trifolium 6 Check	osgate	new
55	WSM	Trifolium 9 Check	osgate	new
56	WSM	Trifolium 10 Check	osgate	new
57	WSM	Trifolium 14 Check	osgate	new
58	WSM	Trifolium 16 Check	osgate	new
59	WSM	Westside Main 60 Check	osgate	new
60	WSM	Westside Main 65 Check	osgate	new
61	WSM	Westside Main 67 Check	osgate	new
62	WSM	Westside Main 93 Check	osgate	new
63	WSM	Westside Main 99 Check	osgate	new

Abbreviations

osgate	Overshot Gate	EHL	East Highline Canal
AAC	All American Canal	RST	Rositas Canal
BRI	Briar Canal	VS	Vail Supply Canal
CM	Central Main Canal	WSM	Westside Main Canal

more control in East Highline Canal Operating Reach 2, from Nectarine Check to Galleano Reservoir and in Westside Main Operating Reach 2, from the No. 8 Check to Carter Reservoir. As a consequence, better use is made of Galleano and Carter Reservoirs for regulating flow mismatches and for managing rapid flow changes that result from the added on-farm flexibility.

Seven additional sites -- Alamo River Inlet and Alamo River Outlet, New River Inlet and New River Outlet, Rockwood Spill, Central Main Canal Heading Double Weir, and Rockwood Pond – are equipped with communication capabilities for monitoring pond level and/or flow rate.

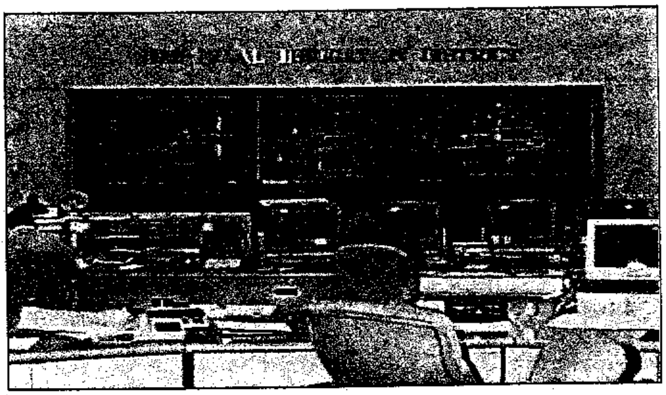
Communications Improvements

A comprehensive Supervisory Control & Data Acquisition (SCADA) communications system was developed to monitor and operate the irrigation distribution system. Elements needed to completely automate the irrigation distribution system included long-term water use forecasting, weekly and daily water scheduling, daily dispatching, supervisory control of the open channel irrigation network, and site control monitoring and operation. SCADA development was based on these requirements, as well as decisions related to microwave/radio communication system components, licensing, and data types; and field site control and monitoring philosophy and methodology.

Design of the SCADA system is based on a distributed approach to allow remote supervisory control of any site in the event of equipment failure or abnormal field conditions. With the ability to take remote supervisory control of any site, redundancy is built into the system. In addition to this, operation redundancy is built into field sites through a local man-machine interface (MMI) that allows complete operation of the control structure by field personnel.

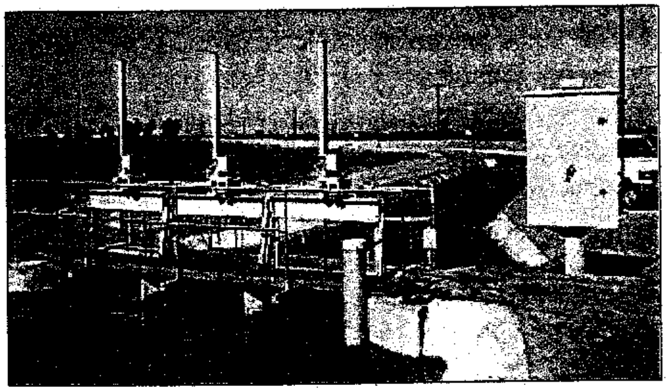
Field communication is accomplished using digital radios connected to the control room via an existing microwave system. Thus, local site information is monitored on a real-time basis throughout the system. Open-channel flow was recognized as a process that could benefit from standard industrial control technology; therefore, field sites were equipped with industrial process controllers programmed for stand-alone local control.

Photos of the Water Control Center, including the operations room and mapboard, as well as typical structures at system automation sites are shown in Figures 10.2 and 10.3. System Automation Cost Summary details are provided in Table 10.3.

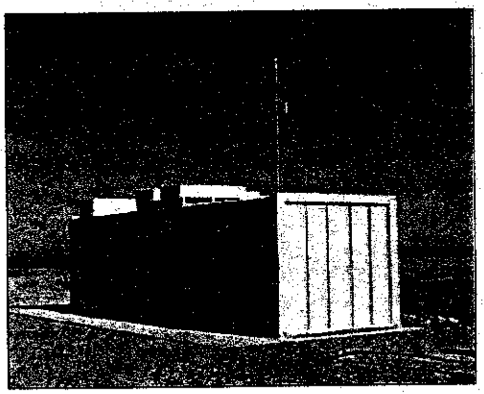


Water Control Center Panel

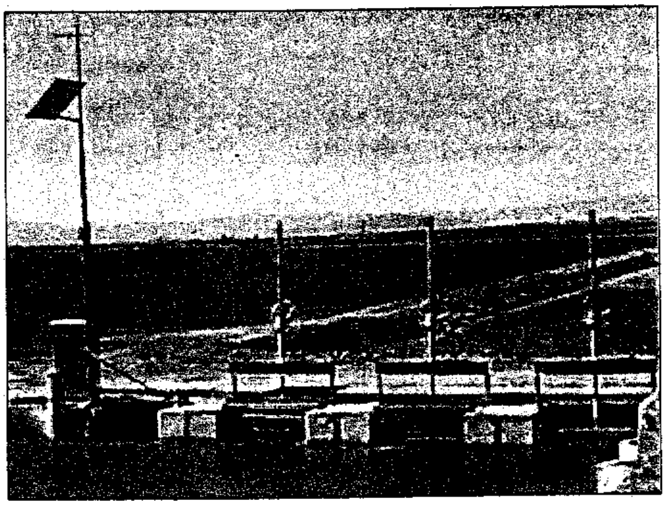
Water Control Center Entrance



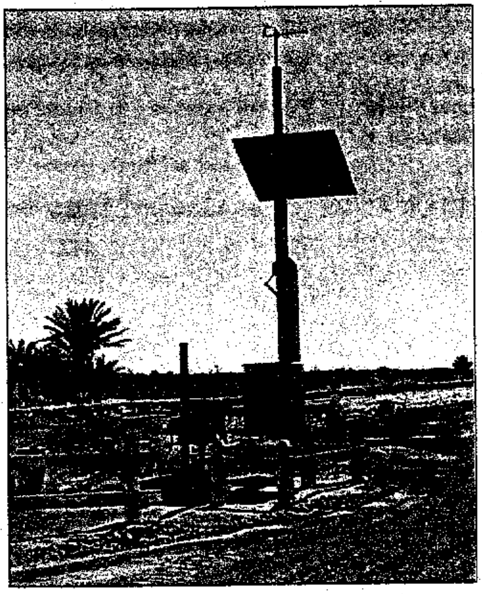
Automated Gates



Typical Control Building

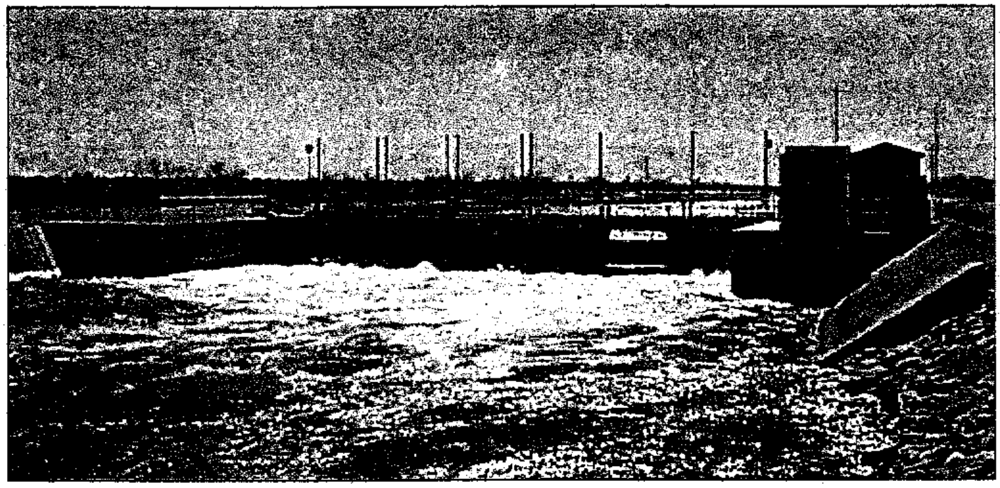


Solar Powered Gates

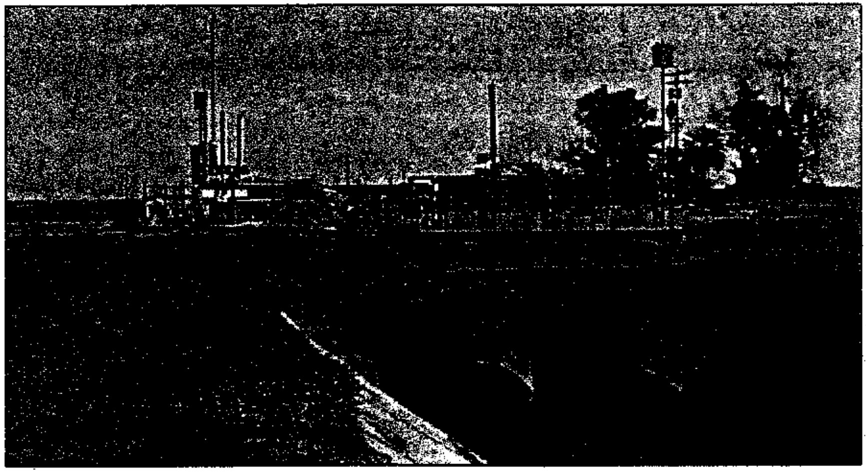


Solar Powered SCADA System

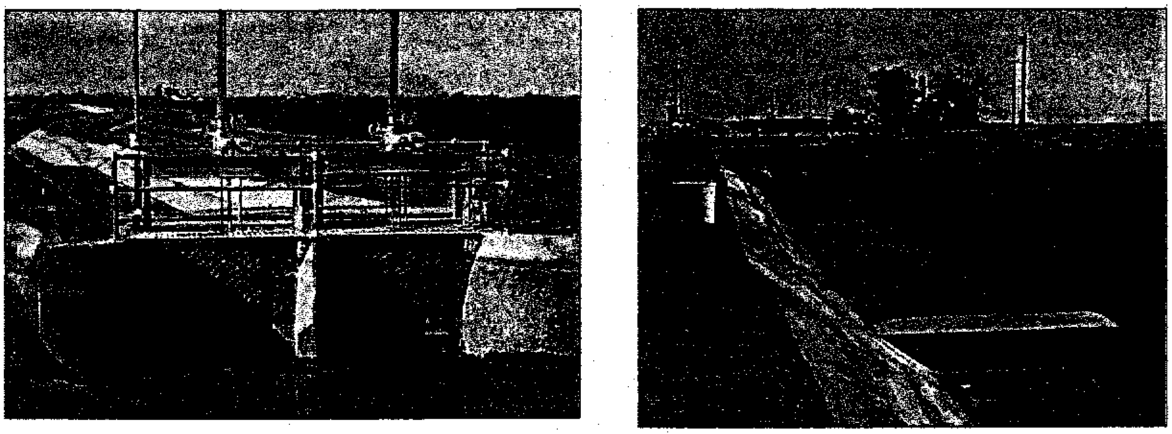
Figure 10.2 IID/MWD Project 15 System Automation



Automated Gates , East Highline Canal



Alder Canal Heading from Downstream



Alder Canal Heading from Upstream

Alder Canal Heading BCW

Figure 10.3 IID/MWD Project 15 System Automation

Table 10.3 System Automation Cost Summary

Project	Total Capital Cost	Budgeted 1999 O&M [1]	1999 Water Conservation	
			AF [1]	Cost $/AF [2]
Major Sites, Minor Sites, OS Gates, & WCC	$12,918,625 (Actual) $11,295,562 (1988$)	$1,202,090 (Actual) $890,635 (1988$)	14,600	$125 (1988$)
Total	$12,918,625 $11,295,562 (1988$)	$1,202,090 $890,635 (1988$)	**14,600**	**$125 (1988$)**

1988$ Cost per AF = $125

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

11 Additional Irr. Water Mgt. (18)

11 Additional Irrigation Water Management (Project 18)

Tailwater Return (or Recovery) Systems (TRSs) were developed under the Additional Irrigation Water Management project. Twenty-five TRSs, serving 6,779 acres, were installed through this project (see Figure 11.1).

Tailwater Return Systems (TRS)

A TRS is used to reduce the volume of surface irrigation tailwater discharged to IID drains; thereby, potentially reducing the delivery requirement. By pumping back all or part of the tailwater, less water needs to be ordered. Sensors that monitor the TRS pond level and pump flow are used to determine the amount of water returned to the system. To assist the users in effective system management, a delivery-tailwater hydrograph, which describes each irrigation event is provided to them.

Each TRS consists of three basic components: a pond (typically, 4 acre-foot capacity) to capture and regulate tailwater discharges; a pumping plant (typically, 3 to 4 cfs capacity) to lift tailwater from the pond; and a pipeline to convey tailwater from the pond to the head ditch(es) of the field(s) served by the system. Twenty-three permanent systems, with stationary pumping plants and buried pipelines, and two portable systems, with above ground pipelines and portable tractor-driven or trailer-mounted pumping plants, were installed. One permanent TRS was dropped in late 1998 due to a land sale which split the parcel into two separate units, leaving a total of 24 TRSs and 6,629 acres of service area in the IID/MWD Program (see Figures 11.2 and 11.3).

The first TRSs began operation in June 1991 and the last installation was completed in August 1995. The Program entered into a three-year or ten-year contract with TRS owners. Both types of contracts allow for early termination or extension of the term, subject to terms and conditions as specified in each contract. While it is anticipated that all or most cooperating growers will elect to extend the term of their agreements, some may not. Therefore, IID retained a portion of the original capital funding to construct additional systems with new cooperating growers, if necessary and desirable, to replace those that may drop out.

Tailwater Return System Cost Summary details are provided in Table 11.1.

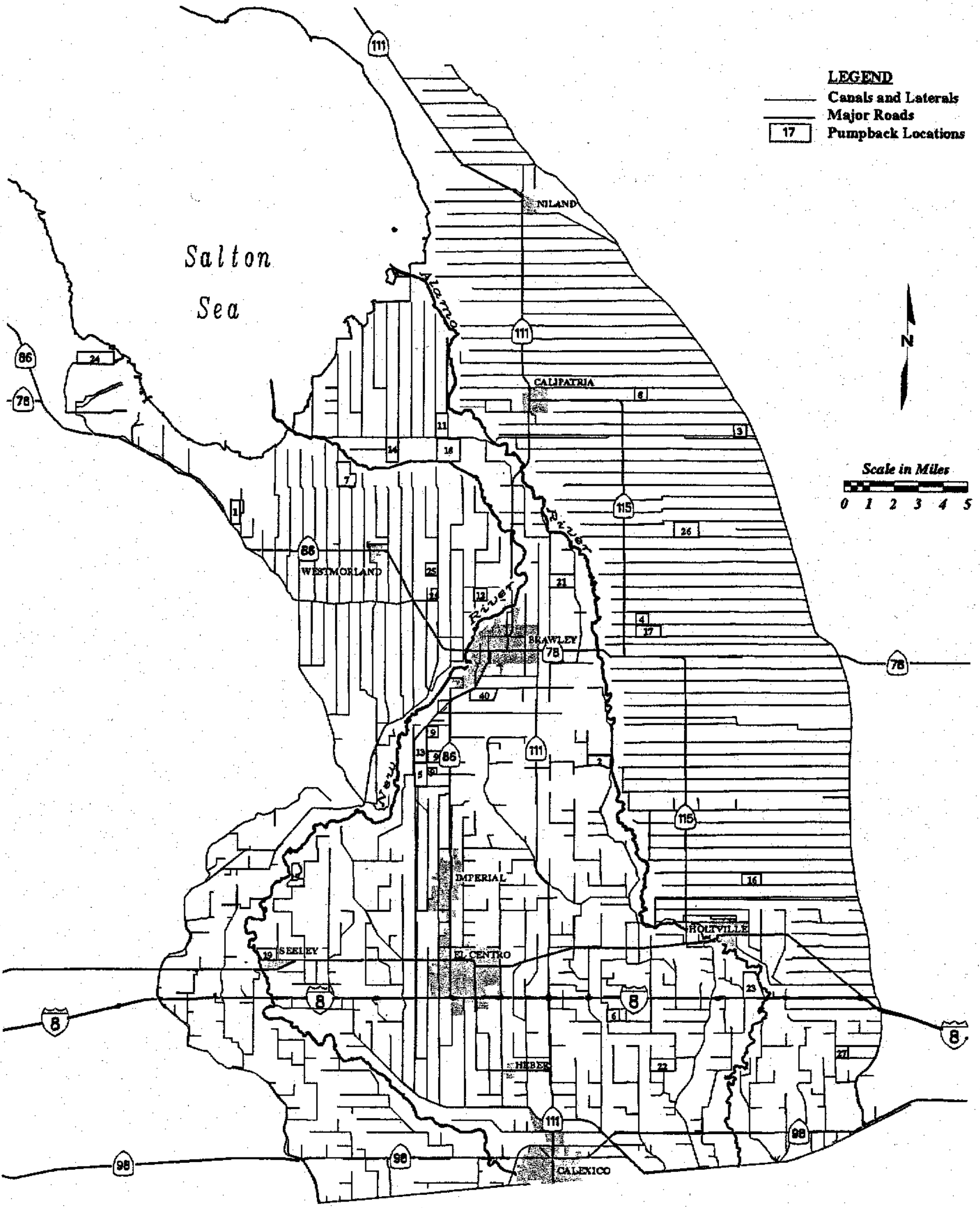


Figure 11.1 Location of IID/MWD Additional Irrigation Water Management Projects

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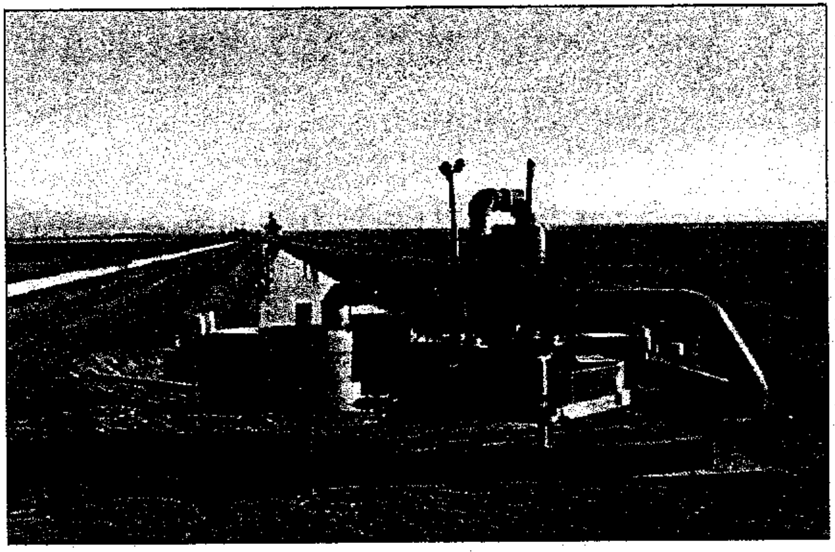
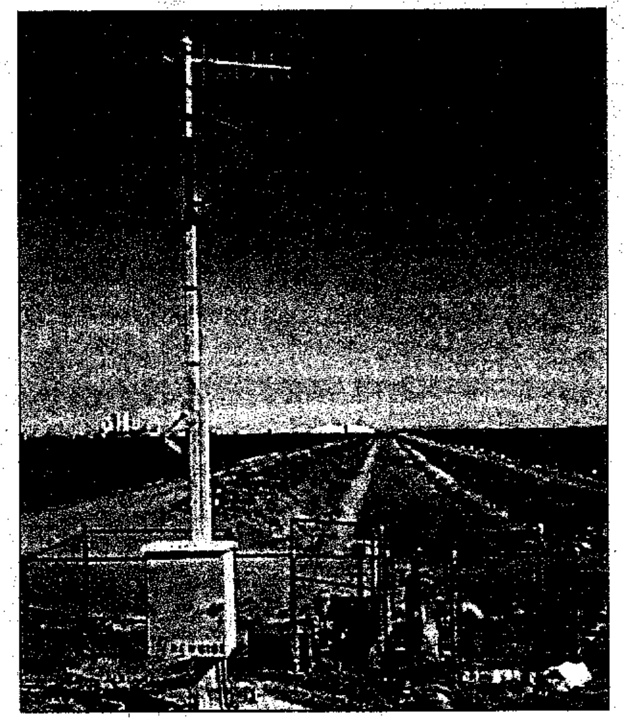
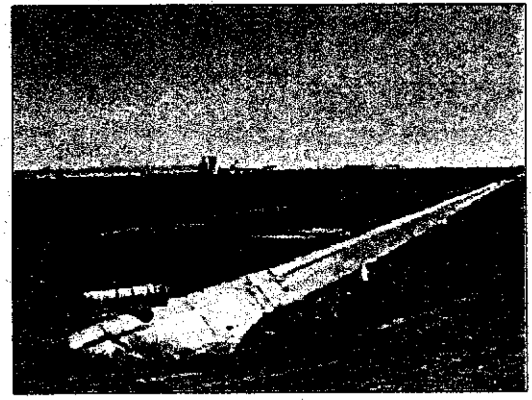
Information Systems - GIS



Permanent Tailwater Return System and Pond

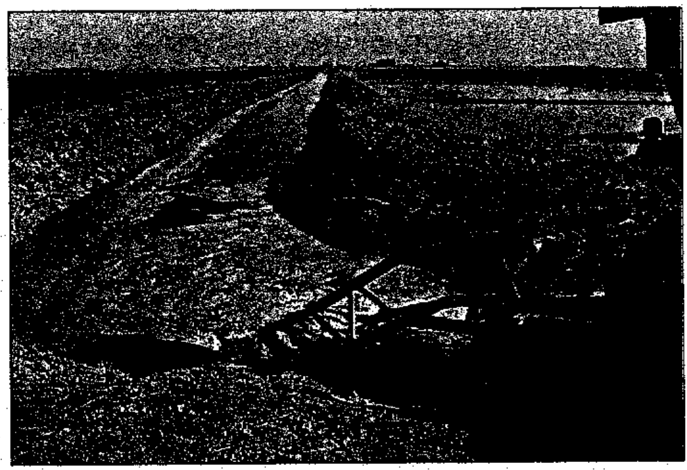


Permanent Tailwater Return System and Pond

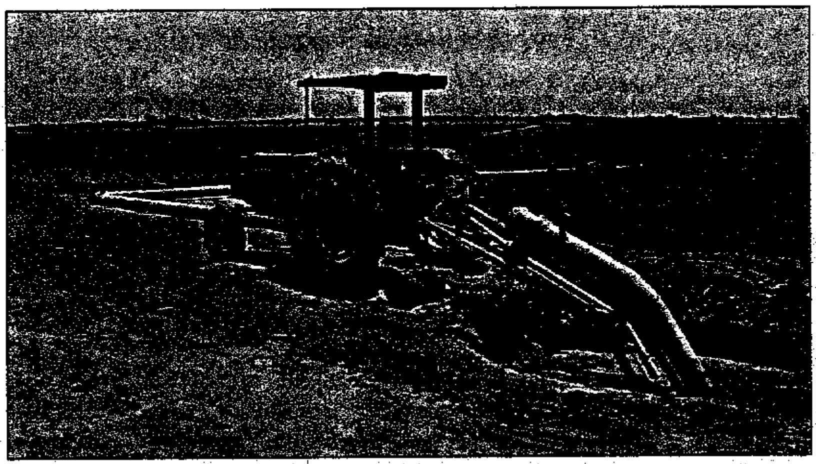


Tailwater Return System Outlet to Field Head Ditch

Figure 11.2 IID/MWD Project 18 Additional Irrigation Water Management



Portable Tailwater Return Pond



Portable Tailwater Return System

Portable Tailwater Return Flow to Head Ditch

Figure 11.3 IID/MWD Project 18 Additional Irrigation Water Management

Table 11.1 Additional Irrigation Water Management Cost Summary

Project	Total Capital Cost	Budgeted 1999 O&M [1]	1999 Water Conservation AF [1]	1999 Water Conservation Cost $/AF [2]
Tailwater Return Systems	$3,502,320 (Actual) $3,066,012 (1988$)	$335,627 (Actual) $248,668 (1988$)	4,540	$111 (1988$)
Total	$3,502,320 $3,066,012 (1988$)	$335,627 $248,668 (1988$)	**4,540**	**$111 (1988$)**

1988$ Cost per AF = $111

[1] Budgeted O&M and water conservation volume are subject to change, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in the Total Program Cost per AF

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M period (35 years), with an 8% discount rate.

Capital Recovery Factor = 0.08285 (43.75 years at 8%)

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PROGRAM COORDINATION AND WATER CONSERVATION VERIFICATION

12 Systemwide Monitoring

12 Systemwide Monitoring

A Systemwide Monitoring (SWM) program was developed to identify and explain trends in IID system performance as a function of the operational environment within which the IID/MWD conservation projects operated. The basic objective of the SWM program is to improve the consistency and accuracy of flow measurement in such a way as to narrow confidence intervals and enable more definite interpretations of performance trends than are currently possible.

The SWM program was designed to function over the life of the IID/MWD Program to:

- Identify changes in on-farm irrigation practices.
- Identify changes in main and lateral canal operations and zanjero accounting procedures.
- Provide data support for the ongoing 5-year verification updates.
- Provide a basis for separating water savings associated with IID/MWD-sponsored conservation measures from water savings associated with measures implemented by others. In this case the SWM program will provide valuable baseline data for separating the effects of a new program from those attributable to the IID/MWD Program and, thus, protect the interests of MWD, IID, the new sponsor, and junior water rights holders.
- Fulfill the requirement for overall verification as referenced on page 8 of the Approval Agreement.

Forty sites have been selected and developed to provide data required for systemwide monitoring (see Figure 12.1). Site details are provided in Table 12.1.

Photos of typical SWM sites are shown in Figures 12.2 and 12.3.

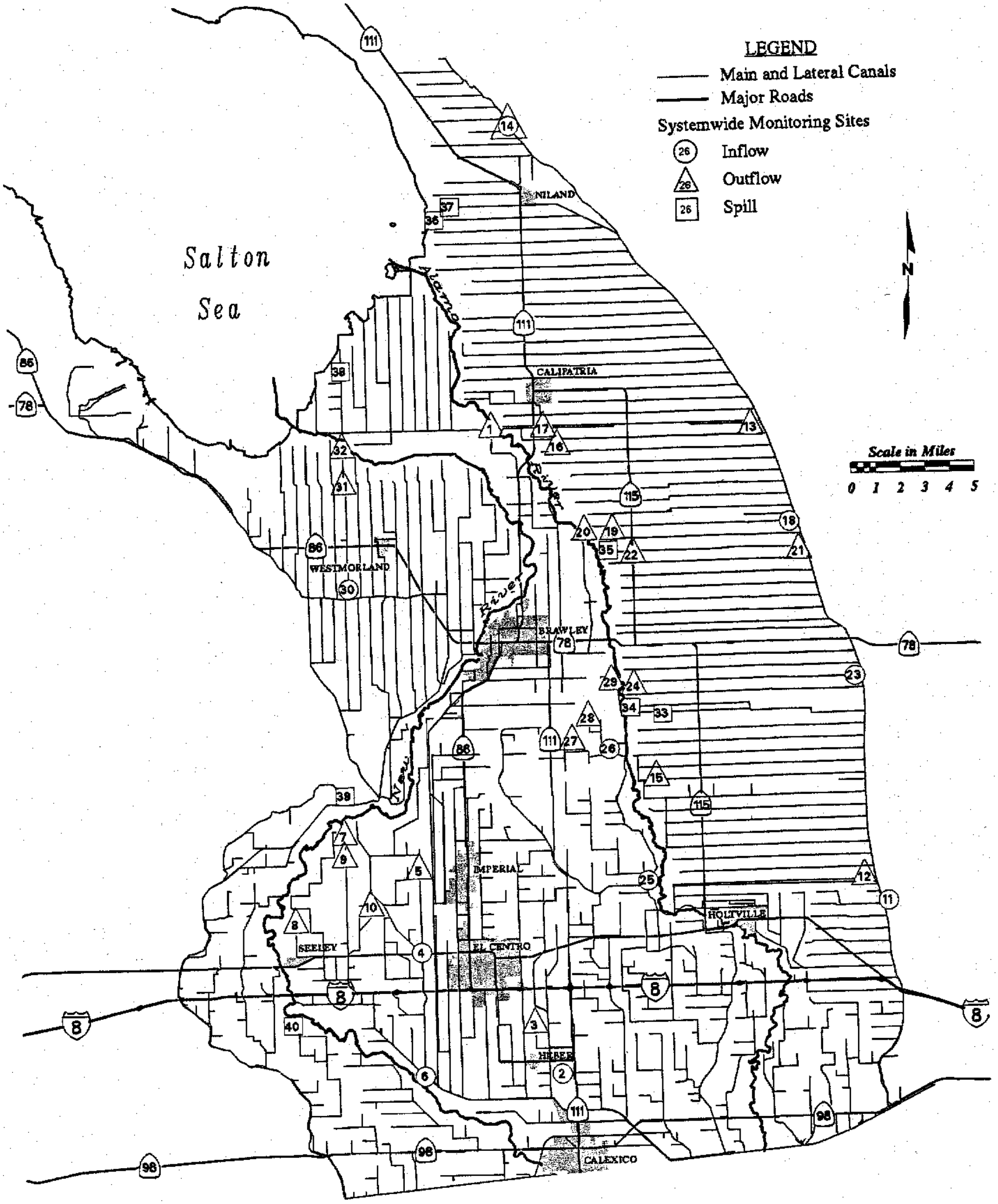

Figure 12.1 Location of IID/MWD Systemwide Monitoring Sites

Information Systems - GIS

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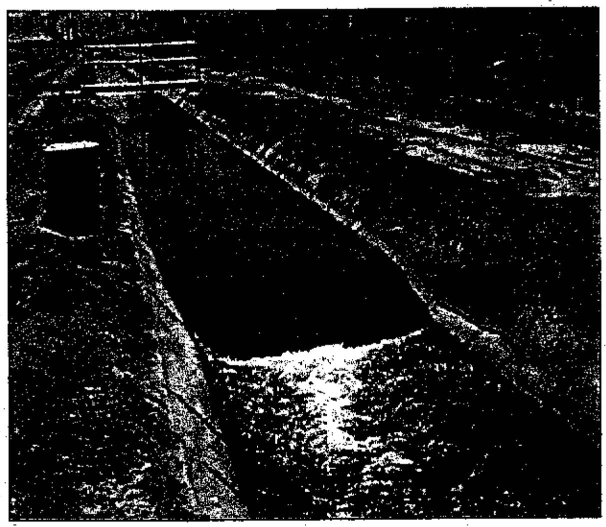
Table 12.1 IID/MWD Systemwide Monitoring (SWM) Site Summary Table

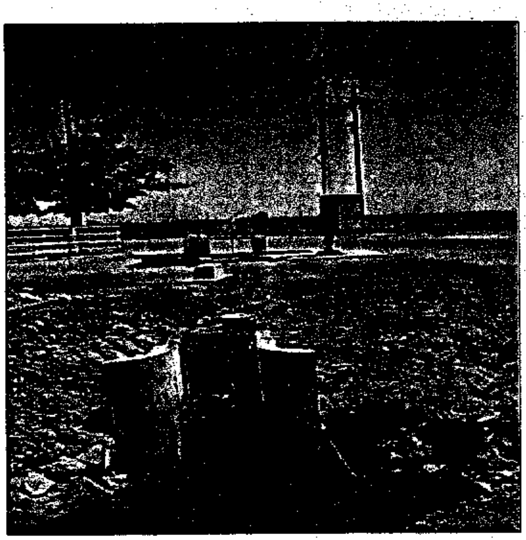
Site No.	Site Name	Flow Measurement Structure	Flow Measurement Recorder	SWM Area	Site Type	IID Division
1	Alamo River Drop 3	Drop	RTU	Alamo River	Outflow	Northend
2	Daffodil Canal Heading BCW	BCW	RTU	Daffodil	Inflow	Southwest
3	Daffodil Canal Spill	SCW	RTU	Daffodil	Outflow	Southwest
4	Ebony Canal Heading BCW	BCW	RTU	Ebony	Inflow	Southwest
5	Ebony Canal Spill	SCW	RTU	Ebony	Outflow	Southwest
6	Elder Canal Heading BCW	BCW	PLC	Elder & Elm	Inflow	Southwest
7	Elder Canal Spill	SCW	RTU	Elder & Elm	Outflow	Southwest
8	Elder Lateral 13 Spill	SCW	RTU	Elder & Elm	Outflow	Southwest
9	Elm Canal Spill	DLG	PLC	Elder & Elm	Outflow	Southwest
10	Elm Lateral 3 Spill	SCW	PLC	Elder & Elm	Outflow	Southwest
11	East Highline Canal Drop 16	Drop	RTU	EHL Below Drop 16	Inflow	Holtville
12	Rositas Supply Canal Heading BCW	BCW	PLC	EHL Below Drop 16	Outflow	Holtville
13	Vail Supply Canal Heading Drop 2	Drop	PLC	EHL Below Drop 16	Outflow	Northend
14	Niland Extension Heading BCW	BCW	PLC	EHL Below Drop 16	Outflow	Northend
15	Plum-Oasis Interceptor BCW	BCW	RTU	EHL Below Drop 16	Outflow	Holtville
16	Mulberry-D Interceptor South	BCW	RTU	EHL Below Drop 16	Outflow	Northend
17	Mulberry-D Interceptor North	SCW	RTU	EHL Below Drop 16	Outflow	Northend
18	Mulberry Lateral Heading BCW	BCW	RTU	Mulberry	Inflow	Northend
19	Mulberry Lateral Interface	DLG	PLC	Mulberry	Outflow	Northend
20	Mulberry Lateral Spill	DLG	PLC	Mulberry	Outflow	Northend
21	Myrtle Lateral Heading BCW	BCW	RTU	Myrtle	Outflow	Northend
22	Myrtle Lateral Spill	SCW	RTU	Myrtle	Outflow	Northend
14	Niland Extension Heading BCW	BCW	PLC	Niland Extension	Inflow	Northend
23	Orange Lateral Heading BCW	BCW	RTU	Orange	Inflow	Holtville
24	Orange Lateral Spill	ADLG	PLC	Orange	Outflow	Holtville
25	Redwood Canal Heading BCW	BCW	RTU	Redwood	Inflow	Southwest
26	Bevins Reservoir Discharge [1]	Pipes/AVM	PLC	Redwood	Inflow	Holtville
27	Redwood Lateral 5 Spill	SCW	RTU	Redwood	Outflow	Holtville
28	Redwood Lateral 8 Spill	SCW	RTU	Redwood	Outflow	Holtville
29	Redwood Canal Spill	DLG	RTU	Redwood	Outflow	Southwest
30	Trifolium Lateral 8 Heading BCW	BCW	RTU	Trifolium Lateral 8	Inflow	Northend
31	Trifolium Lateral 8 Interface	DLG	PLC	Trifolium Lateral 8	Outflow	Northend
32	Trifolium Lateral 8 Spill	DLG	PLC	Trifolium Lateral 8	Outflow	Northend
33	Orchid Lateral Spill	SCW	Logger	Misc. Spill	Spill	Northend
34	Olive Lateral Spill	SCW	RTU	Misc. Spill	Spill	Northend
35	Munyon Lateral Spill	SCW	RTU	Misc. Spill	Spill	Northend
36	R Lateral Spill	Boards	Logger	Misc. Spill	Spill	Northend
37	S Lateral Spill	Boards	Logger	Misc. Spill	Spill	Northend
38	Vail Lateral 6 Spill	SCW	RTU	Misc. Spill	Spill	Northend
39	Fillaree Lateral Spill	SCW	RTU	Misc. Spill	Spill	Southwest
40	Wormwood Canal Spill	Boards	Logger	Misc. Spill	Spill	Southwest

[1] AVM in each of 2 discharge pipes

East Highline Canal Drop 16, SWM Site

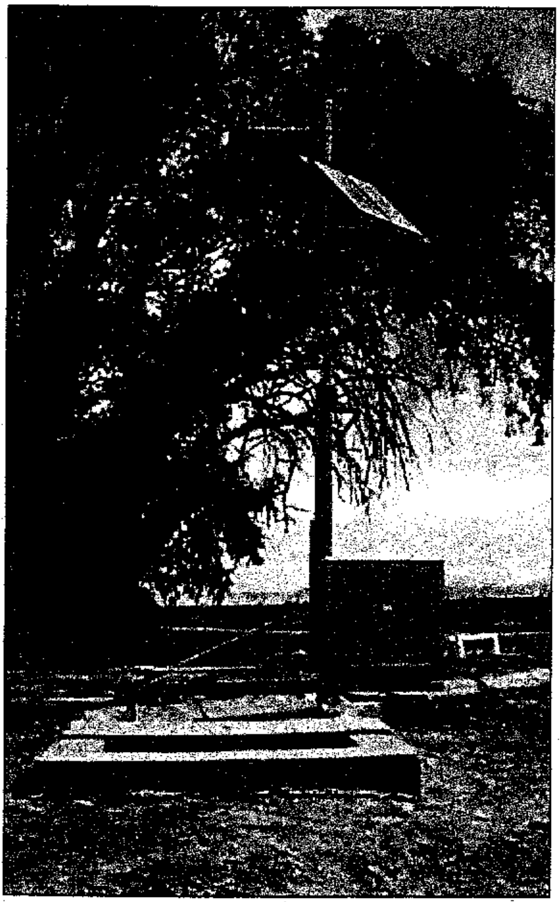


Daffodil Canal Heading, SWM Site

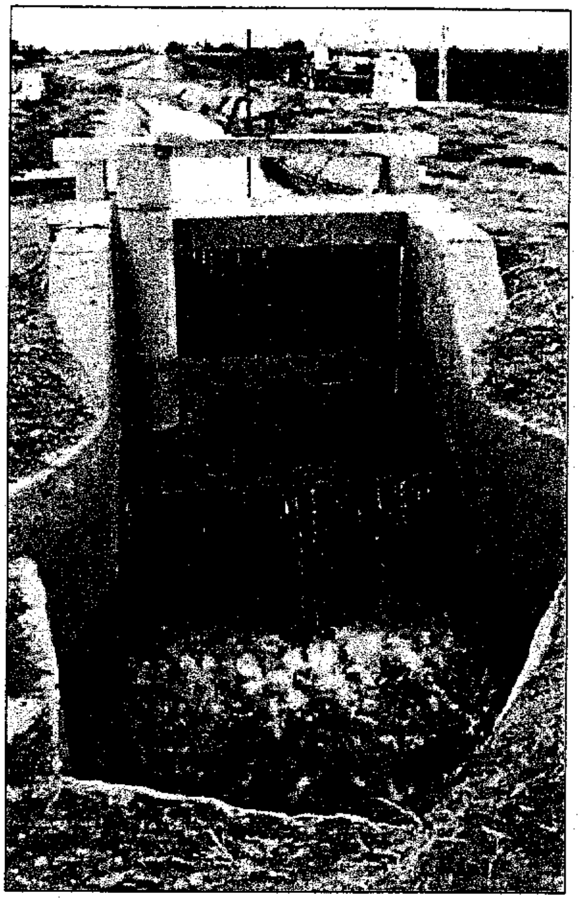


Daffodil Canal Spill, SWM Site

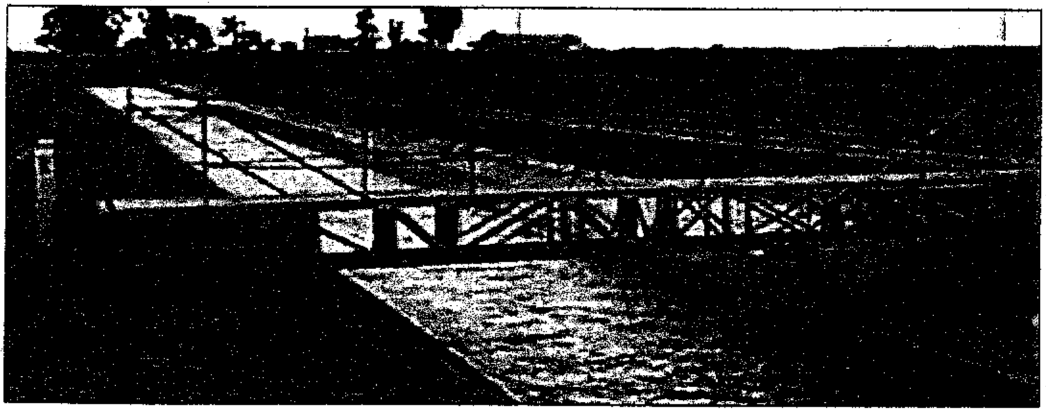
Figure 12.2 IID/MWD Systemwide Monitoring (SWM)



Orange Lateral Spill, SWM Site



Elder Lateral 13 Spill, SWM Site



Typical Current Metering Bridge

Figure 12.3 IID/MWD Systemwide Monitoring (SWM)

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13 Water Info. System (WIS)

13 Water Information System (WIS)

In order to collect and process the flow data needed in support of the water conservation verification activities for the IID/MWD Water Conservation Agreement Projects, an automated data collection, quality control, processing and retrieval system was developed under the IID/MWD Program. The system was designed to include many of the control sites for the various programs as well as the sites needed for systemwide monitoring. In December 1995, data processing procedures developed by the CVC were institutionalized and incorporated into the IID's Water Information System (WIS).

The IID Water Information System (WIS) was structured to incorporate quality control operations and a data storage warehouse function for site-specific, quality controlled, time-series data related to the flow of water through the IID irrigation and drainage system. The WIS was also developed to provide an audit trail of data elements as they flow through the quality control operation. Since January 1, 1996, Conservation Verification data have been processed and stored using WIS applications and capabilities. IID data collected prior to January 1, 1996, which have been processed by the Conservation Verification Consultants for use in determining annual projected water conservation savings over the life of the Program, are also stored in the WIS.

The WIS management system has been developed to generate daily, monthly, calendar year and water year tables, summary tables and bar charts that are presented in an annual Processed Flow Data document and the annual Projected Water Conservation Savings report.

GLOSSARY

Final Program Construction Report Abbreviations

AAC	All-American Canal
ADLG	Automated Drop-Leaf Gate
AF	Acre-foot OR Acre-feet
AVM	Acoustic Velocity Meter
BCW	Broad-Crested Weir
Boards	Grade Boards
BRI	Briar Canal
CM	Central Main Canal
CVC	Conservation Verification Consultants
CVWD	Coachella Valley Water District
EHL	East Highline Canal
IG	Interface Gate
IID	Imperial Irrigation District
IID/MWD	Imperial Irrigation District/ Metropolitan Water District
Info.	Information
Irr.	Irrigation
Logger	Automatic Data Logger (Easylogger)
Mgt.	Management
MMI	Man-Machine Interface
MWD	Metropolitan Water District of Southern California
O&M	Operation and Maintenance
osgate	Overshot Gate
OWLS	On-Farm Water Level Sensor
PCC	Program Coordinating Committee
PLC	Programmable Logic Controller
PVID	Palo Verde Irrigation District
RST	Rositas Canal
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SCW	Sharp-Crested Weir
SWM	Systemwide Monitoring
TRS	Tailwater Return (or Recovery) Systems
VS	Vail Supply Canal
WCC	Water Control Center
WCMC	Water Conservation Measurement Committee
WIS	Water Information System
WSM	Westside Main Canal