APPROVAL AGREEMENT

Imperial Irrigation District

The Metropolitan Water District of Southern California

Palo Verde Irrigation District

Coachella Valley Water District

INDEX

EXHIBITS

APPROVAL AGREEMENT

THIS AGREEMENT is made and entered into this 19th day of December 1989, by and among Imperial Irrigation District (IID), an irrigation district, the Metropolitan Water District of Southern California (MWD), a metropolitan water district, Palo Verde Irrigation District (PVID), an irrigation district, and Coachella Valley Water District (CVWD), a county water district, each of which is at times referred to individually as "Party" and which are at times collectively referred to as "Parties."

RECITALS

A. IID, MWD, PVID, and CVWD are each contractors with the United States for delivery of Colorado River water, as authorized by the Boulder Canyon Project Act (Act of December 21, 1928; 45 Stat. 1057, as amended).

B. IID and MWD have entered into the December 22, 1988 Agreement for the Implementation of a Water Conservation Program and Use of Conserved Water (Conservation Agreement).

C. In order to secure approval of the Conservation Agreement under the terms set forth in this Agreement (Approval Agreement) by all the Parties, IID is augmenting the Conservation Program set forth in the Conservation Agreement through an augmentation program (Augmentation Program).

D. Pursuant to the terms of the Conservation Agreement and this Approval Agreement, IID is to implement a Conservation

Program and Augmentation Program (C&A Programs) in order to annually conserve water and reduce its annual Colorado River diversions in an amount equal to the quantity conserved. MWD is to pay the costs as set forth in the Conservation Agreement, as modified in some respects by this Approval Agreement, in exchange for having made available to it the amount of water conserved from the C&A Programs, except as provided in the Conservation Agreement and this Approval Agreement.

E. "Conserved Water" made available pursuant to the terms of the Conservation Agreement as augmented by this Approval Agreement is an amount of water which is equal to the amount of water actually conserved by the C&A Programs.

F. IID, MWD, and CVWD recognize that they have differences of opinion over various legal questions. CVWD has filed a complaint entitled Coachella Valley Water District v. Imperial Irrigation District, et al. in the United States District Court for the Southern District of California alleging, among other things, that the Conservation Agreement is unlawful and void. Irrespective of these differences of opinion, each Party wishes to settle the pending litigation and allow the Conservation Agreement, as modified by this Approval Agreement, to be implemented without regard to current or future legal differences and without further proceedings in the pending litigation of the CVWD complaint. In entering into this Approval Agreement, each Party agrees that nothing in this Approval Agreement or in the Conservation Agreement, and no action or failure to act in connection with the adoption or implementation of this Approval Agreement or the Conservation Agreement, is intended to or should have the effect of adding to or subtracting from the legal positions heretofore or hereafter taken by any Party as to all water other than the Conserved Water, as if the Conservation Agreement and this Approval Agreement did not exist. All water owned, if any, or claimed by the Parties may be used and disposed of by the Parties in any lawful manner.

G. IID and MWD each wish to secure PVID's and CVWD's approval of the Conservation Agreement and their agreement not to use the Conserved Water generated by the C&A Programs, except as provided in this Approval Agreement, and PVID and CVWD each are willing to approve the Conservation Agreement and to agree not to use the Conserved Water, except in accordance with the terms and conditions contained in this Approval Agreement.

H. The extent of IID's, CVWD's, and PVID's obligation to make Conserved Water available for MWD's use is for IID to reduce its annual Colorado River diversions in an amount equal to the quantity of water conserved and for IID, CVWD, and PVID not to use the Conserved Water, except as provided in this Approval Agreement and the Conservation Agreement.

NOW, THEREFORE, for and in consideration of the mutual obligations and undertakings set forth herein, the Parties hereby agree as follows:

Article I

Priority to Use of Water

Section 1.1: The Parties agree that: (i) nothing in this Approval Agreement or the Conservation Agreement shall change the Seven Party Agreement dated August 18, 1931, which provides the schedule of priorities for use of the waters of the Colorado River within California as published in Section 6 of the General Regulations of the Secretary of the Interior (Secretary) dated September 28, 1931, and incorporated in the United States water delivery contracts with the Parties dated December 1, 1932 (IID), September 28, 1931 (MWD), February 7, 1933 (PVID), and October 15, 1934 (CVWD); (ii) IID'S, MWD's, PVID's, and CVWD's use of the Conserved Water shall be in accordance with the terms of the Conservation Agreement, as modified by this Approval Agreement; and (iii) all references in the Conservation Agreement to charging such water to the third priority under the Parties' water delivery contracts with the Secretary are nonoperating. Any Conserved Water used by MWD shall be charged to the fourth or fifth priority set forth in MWD's September 28, 1931 Supplementary Water Delivery Contract with the United States or to MWD's September 9, 1987 Surplus Water Delivery Contract with the United States, as appropriate under the operating conditions in existence at the time the use of Conserved Water by MWD is to be charged.

Article II

Verification of Water Conserved

Section 2.1: Water Conservation Measurement Committee. It is recognized and agreed that the estimates contained in the Conservation Agreement and this Approval Agreement of the amount of water to be conserved annually by the C&A Programs and the amount to be conserved by each project of the C&A Programs are based on information and data available to IID and MWD at this time, but that the initial and subsequent verification provided in Section 2.2 of this Approval Agreement may result in a determination of a different total amount of water conserved and different amounts conserved by the individual projects of the C&A Programs. In order to provide an orderly basis among the Parties for such verification, there shall be established a Water Conservation Measurement Committee (Measurement Committee) whose duties and responsibilities are limited solely to those specified in Section 2.2 of this Approval Agreement. To the extent the duties and responsibilities of the Measurement Committee with regard to the verification of the quantity of water conserved from the C&A Programs and the process of determining the amount of water conserved are duplicative or in conflict with the duties and responsibilities of the Program Coordinating Committee (as stated in the Conservation Agreement), the duties and responsibilities of the Measurement Committee with regard to the verification of the quantity of water conserved from the C&A

Programs and the process of determining the amount of water conserved as set forth in this Approval Agreement shall govern. The Measurement Committee shall be composed of all members of the Program Coordinating Committee, and one representative each from PVID and CVWD. The chairman of the Program Coordinating Committee shall also serve as the chairman of the Measurement Committee. The members of the Program Coordinating Committee shall be registered as professional engineers, including civil, agricultural, or other appropriate fields of engineering, and the chairman thereof shall be independent and have no past, present or pending relationship with the Parties, unless IID and MWD expressly consent thereto. Payment of the expenses of the Program Coordinating Committee members shall be governed by the provisions of the Conservation Agreement. Payment of the expenses of the other members of the Measurement Committee shall be borne by the Party they represent. Each member of the Measurement Committee shall have technical competence in the design, construction, or operation of major water supply facilities. PVID's and CVWD's members of the Measurement Committee shall be designated within 30 days after the effective date of the Conservation Agreement and may be replaced at the pleasure of their appointing agency. Following initial selection of the members, all changes in the membership shall be made promptly and in such fashion that it will not interfere with the duties and responsibilities of the Measurement Committee. By unanimous written agreement among all the

Parties, the duties and responsibilities of the Measurement Committee may be modified. The chairman of the Measurement Committee shall schedule meetings of the Measurement Committee upon request of any member of the Measurement Committee and shall provide each member of the Measurement Committee 15 days' notice of the time, place, and subject of the meeting. All decisions of the Measurement Committee shall be by a unanimous vote, recorded in writing, and consistent with the terms of this Approval Agreement. In the event that all Measurement Committee members are not present, a letter with the proposed action shall be sent to the absent member(s) by registered or certified mail, postage prepaid, return receipt requested. If no written protest from the absent member(s) is received by the Measurement Committee chairman within 30 days of the date of the receipt of the Measurement Committee letter, the decision shall be deemed unanimous and shall become final. Should the Measurement Committee not reach a decision by unanimous vote on any matter, that matter shall be resolved under Section 2.3 of this Approval Agreement. Notwithstanding the foregoing sentence, modification of the duties and responsibilities of the Measurement Committee may only be made by unanimous agreement among the Parties, and are not subject to change by Section 2.3 of this Approval Agreement.

Section 2.2: Duties and Responsibilities of the Measurement Committee. Within one year after the effective date of the Conservation Agreement, the Measurement Committee shall designate one or more consultants with recognized competence in water conservation and measurement activities. IID shall retain the consultant(s) on behalf of the Measurement Committee. Payment of the expenses of the consultant(s) shall be paid as a capital or annual direct cost by MWD under the Conservation Agreement. The consultant(s) shall serve at the pleasure of the Measurement Committee. During the construction period of the C&A Programs, the consultant(s) will be available to IID to advise IID of the measuring devices and techniques that should be used for the measurement of water conserved from the C&A Programs, and within six months after the appointment of the consultant(s), the consultant(s) shall recommend to the Measurement Committee the measures to be undertaken and facilities to be installed for verification of amounts of water conserved by the C&A Programs. To the extent such measures and facilities are approved by the Measurement Committee, IID shall implement the measures and construct the facilities in a timely manner to permit an accurate determination, by the end of calendar year 1994, of the quantity of water conserved from each project of the C&A Programs as well as the overall quantity of water conserved from the C&A Programs. Such measures and facilities for the verification of amounts of water conserved, and all related expenses, shall be paid by MWD in accordance with the provisions of the Conservation Agreement. Within 18 months from the effective date of the Conservation Agreement, the consultant(s) shall prepare a report(s) on the amount of water estimated to be conserved by the C&A Programs and each project thereof, and shall submit the report(s) to the Measurement Committee. Based on such report(s), the Measurement Committee shall make an estimate of the quantity of water to be conserved by the C&A Programs and each project thereof. Until actual data is available by the end of calendar year 1994 to verify or modify such estimate of water conserved, such estimate shall be used as the amount of the reduction of diversions by IID, and to thus determine the amount of Conserved Water which shall be available for use by MWD pursuant to the Conservation Agreement as augmented and modified by this Approval Agreement, except as provided in Article III of this Approval Agreement. Prior to the determination of the estimate by the Measurement Committee, the amounts shown in Section 3.2 and Appendices A and D of the Conservation Agreement and Exhibit A of this Approval Agreement shall govern. In order to assist in making an accurate determination of the quantity of water conserved from the C&A Programs by the end of calendar year 1994 and provide information to IID to assist it in making any modification or substitution of projects pursuant to Section 4.1 of this Approval Agreement, for each calendar year prior to calendar year 1994 the Measurement Committee shall endeavor to estimate the anticipated quantity of water to be conserved by the C&A Programs upon full implementation of projects, including any modifications or substitutions of projects made pursuant to the Conservation Agreement and this Approval Agreement. Commencing in calendar year 1994, and in each of the four successive years after 1994, the consultant(s) shall review the then available information and data and make a recommendation to the Measurement Committee on the amounts of water conserved by each individual project and by the C&A Programs. Based on such data, the Measurement Committee shall make a determination of the actual total amount of water conserved by the C&A Programs and shall correct the estimate and any prior determination to reflect the revised determination of the quantity of water conserved by the C&A Programs. Said determined amount shall, prospectively, constitute the amount of the reduced diversions by IID and the amount of Conserved Water which shall thus be available for use by MWD under the Conservation Agreement as augmented and modified by this Approval Agreement, subject to the limitations on MWD's use contained in the Conservation Agreement and this Approval Agreement. Following these initial five annual reviews, such reviews and reports to the Measurement Committee shall be made by the consultant(s) at five-year intervals for the balance of the term of the Conservation Agreement and at any other times or time requested by a member of the Measurement Committee; provided however, such reviews and reports shall not be made more frequently than once a year. The Measurement Committee shall have the right to decrease, or increase, the amount of water deemed to be conserved from a project of the C&A Programs in the event that an earthquake, binding administrative decision or court order, or other events cause the project to function differently than intended, designed, constructed or implemented. The Parties hereto mutually acknowledge that the C&A Programs are intended to conserve 106,110 acre-feet of water annually. In the event a determination is made by the Measurement Committee, or otherwise established pursuant to Section 2.3 of this Approval Agreement, that the total amount of water conserved from the C&A Programs is more than 106,110 acre-feet annually, the additional water, pursuant to the Conservation Agreement and as supplemented by this Approval Agreement, shall be available for MWD's use, subject to the limitations on MWD's use contained in the Conservation Agreement and this Approval Agreement. In the event a determination is made by the Measurement Committee, or otherwise established pursuant to Section 2.3 of this Approval Agreement, that the total amount of water conserved by the Conservation Program is less than 100,000 acre-feet annually, then IID shall proceed, but only at the expense of MWD, to implement additional conservation measures to the Conservation Program in accordance with the terms of the Conservation Agreement. However, in the absence of written approval from MWD to proceed with such additional conservation measures, IID shall not be obligated to construct or implement the additional conservation measures. The water conserved by such additional measures shall be subject to the provisions of the Conservation Agreement and this Approval Agreement. As more specifically set forth in Article IV of this Approval Agreement, within the constraints therein specified, IID has the necessary latitude and flexibility to modify or substitute projects such that the amount of water conserved by the Conservation Program will be between 100,000 and 110,000 acre-feet annually upon full implementation.

Section 2.3: Dispute Resolution. Any dispute among the Parties relating to the authority and actions of the Measurement Committee, or the Measurement Committee's inability to reach a unanimous decision, shall be resolved in the following manner. A Party requesting resolution of a dispute shall send written notice to all other members of the Measurement Committee and Parties which shall set forth in detail the position of the Party requesting resolution. Within 30 days of the notice being sent, the General Managers of MWD and IID, the Manager of PVID and the General Manager-Chief Engineer of CVWD or the respective authorized representatives of the Parties shall schedule a meeting, meet and attempt to resolve the dispute by a unanimous decision. In the event that all Parties' representatives are not present, a letter with the proposed action, signed by all the attending Parties representatives, shall be sent to the absent Party's (ies') representative by registered or certified mail, postage prepaid, return receipt requested. If no written protest from the absent Party's (ies') representative is received by the Parties within 30 days of the date of receipt of the letter with the proposed action, the decision shall be deemed unanimous and become final. Any written protest shall be mailed to each Party's representative, and to each of the Parties by registered or certified mail, postage prepaid, return receipt requested. Each Party shall bear its own expenses for the dispute resolution proceedings. Any resolution shall be in writing and be binding on the Measurement Committee and the Parties to this Approval Agreement. To the extent the dispute is not resolved by the Parties' representatives within 40 days of the conclusion of the dispute resolution meeting, the Parties shall endeavor to agree such that only two positions on each issue exist. The Parties shall endeavor to align themselves into two groups according to the positions taken on each issue. Each group shall select one arbitrator. If the Parties are unable to align themselves into two groups, the two arbitrators shall be selected pursuant to Commercial Arbitration Rules of the American Arbitration Association. On each issue to be resolved, each of the two groups of Parties shall, within 55 days from the date of the conclusion of the dispute resolution meeting, select one arbitrator and shall notify the other Parties in writing of their selection. The two arbitrators so selected shall select a third arbitrator. The third arbitrator shall be selected within 30 days following the selection of the last of the two arbitrators. In the event of a failure to name the third arbitrator, that arbitrator shall be selected as provided in the Commercial Arbitration Rules of the American Arbitration Association. All arbitrators shall have expertise in the field pertaining to the dispute. The third arbitrator shall act as chairperson of the arbitration panel and shall be independent from all the Parties, having no past, present or pending relationship with any of the Parties, members of the Measurement Committee, members of the Program Coordinating Committee or any of the consultants hired by the Measurement Committee or Program Coordinating Committee, unless unanimously consented thereto by all the Parties to the dispute. Except as otherwise provided herein, the arbitration shall be governed by the Commercial Arbitration Rules of the American Arbitration Association. The arbitration shall be limited to the consideration and resolution of the issue(s) submitted and shall be required to fall within the two extremes taken by the Parties. The panel of arbitrators shall not rewrite, change, or amend the Conservation Agreement as supplemented by this Approval Agreement. The panel of arbitrators shall render a final decision in this dispute within 120 days after the date of the selection of the third arbitrator. A majority decision by any two of the three arbitrators selected to the panel shall be final and binding on the actions of the Measurement Committee and the Parties. Each Party shall bear its own expenses of arbitration, with the costs of the arbitrators to be borne equally by all the involved Parties.

Section 2.4: Standard of Care. All members of the Measurement Committee, in carrying out their duties and responsibilities under this Approval Agreement, shall use sound, established engineering practices and procedures and shall endeavor to carry out their responsibilities, including the selection of the consultant(s) and of procedures and devices for measuring the quantity of water conserved, at the least possible cost consistent with accepted practices in the water utility industry.

Section 2.5: Third Party Challenges. In the event of a third party challenge by court or administrative action regarding the amount of water conserved, a determination by a final judgment of a court of competent jurisdiction, or a final binding administrative decision, that the amount of water conserved is different from the amount determined pursuant to this Approval Agreement, shall control. Costs incurred by IID and MWD in connection with any third party challenges relating to the amount of water conserved shall be paid by MWD as a capital or annual direct cost as provided in the Conservation Agreement.

Article III

Reduction in MWD's Use of Conserved Water

Section 3.1: Conditions for Reduction in MWD's Use of Conserved Water. In any calendar year following the effective date of the Conservation Agreement in which the agricultural agencies (PVID, Reservation Division of the Yuma Project, IID, and CVWD) net Colorado River diversions under the first three priorities of the Parties' water delivery contracts with the Secretary, together with the amount of Conserved Water used by

MWD, would exceed 3.85 million acre-feet and thereby the Secretary requires a reduction that year in diversions by the agricultural agencies; or in any calendar year that the Secretary requires the agricultural agencies to reduce their diversions because their prior calendar year's net diversions, together with the amount of Conserved Water used by MWD, exceeded 3.85 million acre-feet, MWD shall reduce its use of Conserved Water in accordance with the provisions of Section 3.2 of this Approval Agreement, subject to each and all of the following conditions:

(i) IID has elected not to reduce its use of water in accordance with the provisions of Section 3.4 of this Approval Agreement;

(ii) The water available to IID, CVWD, and PVID under the sixth priority of the Parties' water delivery contracts with the Secretary is not sufficient to meet the reduction that would be required by the Secretary; and

(iii) CVWD requests MWD, in accordance with this Article III, to reduce its use of Conserved Water.

Section 3.2: Reduction in MWD's Use of Conserved Water. If MWD is required to reduce its use of Conserved Water because the conditions enumerated in Section 3.1 of this Approval Agreement have occurred, MWD shall provide a portion of the first increment of an agricultural reduction required by the Secretary by reducing its use of Conserved Water in the calendar year of reduction. CVWD and PVID shall provide the remaining portions of the first increment of such a reduction by reducing their respective net Colorado River diversions in the calendar year of reduction. MWD's portion of the first increment is equal to the lesser of: (i) the agricultural reduction required by the Secretary less a quantity equal to the product of said agricultural reduction and the ratio of CVWD and PVID (for its third priority Mesa land) net Colorado River diversions to the amount of Conserved Water and the total net Colorado River diversions under the third priority of the Parties' water delivery contracts with the Secretary in the calendar year for which the 3.85 million acre-feet would be, or was, exceeded, whichever is appropriate, or (ii) 50,000 acre-feet. CVWD's portion of the first increment is equal to the product of: the ratio of CVWD's net Colorado River diversion to the amount of Conserved Water and the total net Colorado River diversions under the third priority of the Parties' water delivery contracts with the Secretary in the calendar year for which the 3.85 million acre-feet would be, or was, exceeded, whichever is appropriate, and the agricultural reduction required by the Secretary up to but not to exceed the amount of such reduction that causes MWD's portion of the first increment to equal 50,000 acre-feet. PVID's portion of the first increment is equal to the product of: the ratio of PVID's (for its third priority Mesa land) net Colorado River diversion to the amount of Conserved Water and the total net Colorado River diversions under the third priority of the Parties' water delivery contracts with the Secretary in the calendar year for which the 3.85 million acre-feet would be, or was, exceeded, whichever is appropriate, and the agricultural reduction required by the Secretary up to but not to exceed the amount of such reduction that causes MWD's portion of the first increment to equal 50,000 acre-feet. The amount of reduction that causes MWD's portion of the first increment to equal 50,000 acre-feet is: the quotient of 50,000 acre-feet divided by the ratio of the amount of Conserved Water and IID's net Colorado River diversion to the amount of Conserved Water and the total net Colorado River diversions under the third priority of the Parties' water delivery contracts with the Secretary in the calendar year for which the 3.85 million acre-feet would be, or was, exceeded, whichever is appropriate. To meet the second increment of such reduction required by the Secretary, if any, up to a maximum of the difference between (i) the amount of 106,110 acre-feet per year and (ii) the first increment provided above by MWD, PVID, and CVWD, shall be the responsibility of CVWD and PVID, through reduction in their respective net Colorado River diversions. PVID's portion of the second increment is equal to the product of: the ratio of PVID's (for its third priority Mesa land) net Colorado River diversion to the amount of Conserved Water and the total net Colorado River diversions under the third priority of the Parties' water delivery contracts with the Secretary in the calendar year for which the 3.85 million acre-feet would be, or was, exceeded whichever is appropriate, and the second increment of such reduction required by the Secretary. CVWD's portion of the second increment is equal to the difference between PVID's portion of the second increment and the second increment of such reduction required by the Secretary. To meet the third increment of such reduction required by the Secretary, if any, shall be the responsibility of MWD through reduction in its use of Conserved Water up to the amount, if any, that the actual Conserved Water exceeded the amount of 106,110 acre-feet per year. Any remaining reduction shall be the responsibility of the agricultural agencies in accordance with the various decrees, contracts, and regulations existing at the time of the reduction. If less than 106,110 acre-feet per year of water is conserved from the C&A Programs in the respective year for which the respective reduction is incurred, the values of 50,000 acre-feet set forth in the foregoing sentences of this Section 3.2 pertaining to the first increment of reduction, and the value of 106,110 acre-feet set forth in the foregoing sentence of this Section 3.2 pertaining to the second increment of reduction shall each be reduced to the respective amount determined by the product of said amount and the ratio of Conserved Water to 106,110 acre-feet. (Formulas and examples are shown in Exhibits B and C, respectively.)

MWD shall not be relieved of any payment obligations under the Conservation Agreement as modified by this Approval Agreement as a result of a reduction in its use of Conserved Water pursuant to this Section.

Section 3.3: Extension of Conservation Agreement. The term of the Conservation Agreement shall be extended beyond that stated in Section 7.1 of the Conservation Agreement for the number of years shown below if MWD reduces its use of Conserved Water under Section 3.2 of this Approval Agreement in the cumulative amount indicated below during the term of the Conservation Agreement:

Total Reduction in MWD Use (acre-feet)	Extension of Conservation Agreement Term (years)
26,000 to 75,000	1
75,001 to 125,000	2
125,001 to 175,000	3
175,001 to 225,000	4
225,001 or greater	5

Section 3.4: Reduction in IID's Use of Water. In lieu of MWD reducing its use of Conserved Water by the amounts specified in Section 3.2 of this Approval Agreement, IID may choose to reduce its net Colorado River diversions by an equal amount, and thus not extend the term of the Conservation Agreement for such reduction. IID shall make its choice and notify MWD within 14 days of notification by the Secretary of the pending reduction.

Article IV

Project Substitution and Augmentation

Section 4.1: In consideration of the mutual obligations and undertakings set forth herein including settlement of the pending litigation:

(i) IID will delete Project Number 1 (Trifolium Reservoir), Project Number 2 (South Alamo Canal Lining, Phase 1), and Project Number 13 (Tailwater Assessment) from the Appendices of the Conservation Agreement and substitute in their place the projects listed on Exhibit A attached hereto. Furthermore, IID shall reduce its annual diversions from the Colorado River below that which it would otherwise have been absent Project Number 1 and Project Number 2 (in an amount equal to the quantity of water conserved by these two projects, defined as the Augmentation Program, and estimated to be 6,110 acre-feet annually) so that the water from the Augmentation Program shall be available for MWD's use, subject to the limitations on MWD's use contained in the Conservation Agreement and this Approval Agreement. The amount of water conserved by these two projects will be determined by the Measurement Committee in accordance with Section 2.2 of this Approval Agreement. If the estimate is less than the Measurement Committee determines has been conserved, the additional water shall be available for use by MWD under the Conservation Agreement and this Approval Agreement, subject to the limitations on MWD's use contained in the Conservation Agreement and this Approval Agreement. If the estimate is more than the Measurement Committee establishes, there shall be no obligation on the part of IID, either at its own expense or at the expense of MWD, to provide the additional water. IID shall construct, operate, maintain, and replace such projects in the same manner as it would have constructed, operated, maintained, and replaced these projects had the projects remained an integral part of the Conservation Program and been paid for by MWD, and recognizing that 6,110 acre-feet annually was estimated to be conserved by the projects. IID shall pay the capital and annual direct costs of Project Number 1 and Project Number 2. Except for the provisions relating to the payment by MWD of the capital and annual direct costs for Projects 1 and 2, all other provisions set forth in the Conservation Agreement and this Approval Agreement shall be applicable to, and be binding upon, MWD and IID with respect to the use of water conserved by these two projects. All terms and conditions of the Conservation Agreement relating to Project Number 13 (Tailwater Assessment) shall be deleted, and such terms and conditions shall be applied to the substituted projects set forth in Exhibit A.

(ii) In addition to the modification and substitution of projects permitted by Section 1.3 of the Conservation Agreement, if a determination is made by the Measurement Committee that more than 100,000 acre-feet of water per year would be conserved by the Conservation Program, IID shall have the flexibility and latitude to modify the scope of projects or substitute projects so as to limit the reduction in IID's diversions required by the Conservation Agreement and this Approval Agreement relative to the Conservation Program to between 100,000 acre-feet per year and 110,000 acre-feet per year. Such substitutions or modifications shall be made in the most logical cost-effective manner to minimize the unit cost of water conserved by the Conservation Program while maintaining a well-balanced and viable Conservation Program, (considering, for example, interaction with other projects), all as determined by the Program Coordinating Committee using past actual costs, future estimated costs, and standard established engineering procedures and economic practices. In addition, such substitution or modification shall not cause MWD's total costs of the project in 1988 dollars under the Conservation Agreement and this Approval Agreement to exceed the total costs of the project absent such substitution or modification, all as determined by the Program Coordinating Committee using past actual costs, future estimated costs, and standard established engineering procedures and economic practices. In the event IID is unable to modify or substitute projects complying with the condition set forth in the preceding sentence, then this subsection shall be nonoperating.

Article V

East Mesa Groundwater Storage and Recovery Program

Section 5.1: The Parties shall support and cooperate in the development of the groundwater resources of the East Mesa, located in Imperial County, which have been recharged through the Coachella Canal or may in the future be recharged in the vicinity of the Coachella Canal. IID shall have a priority over MWD, CVWD and PVID to develop the resource. MWD shall have a priority over CVWD to develop the resource. The Party(ies) developing this resource ("Developing Party") shall have a priority to use it over any other Party(ies) not developing this resource. However, IID shall have the first right over all Parties hereto to the developed resource on a year-to-year basis by reimbursing the Developing Party an amount equal to the annualized cost of the development including capital. Such reimbursement shall be based on the costs the Developing Party incurs in funding the construction, debt service, operation, maintenance, power, replacement, and mitigation costs of development and the life of the development. Nothing in this article shall prevent CVWD from reducing or recovering current seepage from the Coachella Canal. Any program shall be undertaken in cooperation with, and in compliance with laws, ordinances, rules and regulations of, the County of Imperial, the State of California and the United States, to the extent applicable.

Article VI

Banking

Section 6.1: The Conservation Agreement as modified by this Approval Agreement shall not constitute express or implied consent, or be construed to grant any rights, by IID, PVID, or CVWD to MWD to withdraw and divert water from the Colorado River accumulated to its credit in a preceding year(s), other than MWD's rights under Sections 8 and 9 of Article 6 of its Supplementary Water Delivery Contract with the United States. Whenever MWD proposes to enter into any agreement to allow banking of any Colorado River water in Lake Mead or in any other reservoir on the Mainstream of the Colorado River, MWD shall notify all other Parties of such proposal and make available to the Parties pertinent documents prior to the execution of any such agreement. The Parties reserve any and all rights to challenge, by legal action or otherwise, any provision of any banking agreement proposed or executed.

Article VII

Efficiency of Water Use

Section 7.1: IID, PVID, and CVWD agree that in any calendar year that the agricultural water use under the third priority of the Parties' water delivery contracts could cause MWD to reduce its use of Conserved Water in accordance with the provisions of Section 3.2 of this Approval Agreement, each will implement a reasonable public awareness agricultural conservation program.

Article VIII

Not to Impinge on Rights

Section 8.1: Subject to PVID and CVWD agreement not to divert the Conserved Water except as provided herein, and the other terms hereof as they may affect any of the Parties, this Approval Agreement, as a whole or any part thereof, shall not impinge upon, affect, or deprive any of the Parties hereto of any Colorado River water or of any rights thereto available to each of them in the absence of this Approval Agreement.

Article IX

Agreement Not to Use Water

Section 9.1: Subject to the terms and conditions of this Approval Agreement and except as provided herein, PVID and CVWD agree not to divert, pump, use or demand the Conserved Water. This PVID and CVWD expressly agree to do in order to permit such water to be made available to MWD in accordance with the Parties' water delivery contracts with the United States.

Article X

Effective Date and Term

Section 10.1: This Approval Agreement shall be effective on the date the Conservation Agreement becomes effective or the date on which the last Party to this Approval Agreement executes it, whichever is later. Thereafter, the term of this Approval Agreement shall be coextensive with the term of the Conservation Agreement. Upon termination of this Approval Agreement, no Party shall assert against any other Party any claim or right to Colorado River water based on the conduct of any Party pursuant to this Approval Agreement or the Conservation Agreement or based upon the reliance on the performance of any provision of this Approval Agreement or the Conservation Agreement.

Article XI

Approval Agreement to Govern

Section 11.1: Except as expressly provided for in this Approval Agreement, the Conservation Agreement shall govern the relationship between IID and MWD. With regard to the relationship among IID, MWD, CVWD, and PVID, to the extent the terms and conditions of this Approval Agreement conflict with, modify or alter the terms and conditions contained in the Conservation Agreement, this Approval Agreement shall govern.

Article XII

Dismissal of Action

Section 12.1: CVWD shall cause to be filed a request for dismissal with prejudice of the case entitled Coachella Valley Water District v. Imperial Irrigation District, et al. filed in the United States District Court for the Southern District of California, Case No. 890165B(IEG), within five days of the execution of this Approval Agreement.

Article XIII

Notices

Section 13.1: Provision of Notices. All notices, requests, demands and other communications required or permitted under this Approval Agreement shall be in writing and shall be deemed to have been received either when delivered or on the fifth business day following the mailing, by registered or certified mail, postage prepaid, return receipt requested, whichever is earlier, addressed as set forth below:

(i) If to IID:

General Manager
Imperial Irrigation District
Post Office Box 937
Imperial, California 92251

(ii) If to MWD:

General Manager
The Metropolitan Water District
of Southern California
Post Office Box 54153
Los Angeles, California 90054

(iii) If to PVID:

Manager
Palo Verde Irrigation District
180 West 14th Avenue
Blythe, California 92225

(iv) If to CVWD:

General Manager-Chief Engineer
Coachella Valley Water District
Post Office Box 1058
Coachella, California 92236

Section 13.2: Change of Addressee or Address. Any Party may change the addressee or address to which communications or copies are to be sent by giving notice of such change of addressee or address in conformity with the provision of this Article XIII for the giving of notice.

In witness whereof, the Parties hereto have executed this Approval Agreement the day and year first above written.

By: ______________________
President
Imperial Irrigation District

By: ______________________
General Manager
The Metropolitan Water District
of Southern California

By: ________________________
President
Palo Verde Irrigation District

By: ________________________
President
Coachella Valley Water District

Exhibit A

Project Substitution (Article IV)

17) Modified East Lowline Interceptor. Two separate collector canals, two regulating reservoirs, and two pump facilities located above the Alamo River for recovery of water that would have otherwise been discharged into the drain system.

18) Additional Irrigation Water Management. Water management practices in addition to those provided under project 14. This would include structural measures such as tailwater return systems and various types of on-farm irrigation system improvements, as well as non-structural measures involving adoption of best-management practices, such as improved irrigation scheduling practices.

Project	Estimated Annual Amounts of Water Conserved (Acre-feet)	Estimated Capital Costs (1988 Dollars)	Estimated Annual Costs (1988 Dollars)
17) Modified East Lowline Interceptor	7,390	5,297,000	12,200
18) Additional Irrigation Water Management	3,720	3,075,000	347,200
Total	11,110	8,372,000	359,400

Schedules of Estimated Cash Flow
for Substituted Projects (1988$)
and Amounts of Water Conserved

Project	1989	1990	1991	1992	1993	1994-2028
Modified East Lowline Interceptor						
Capital and Annual Expenditure	0	0	0	$2,648,500	$2,654,600	$12,200
New Water Available for Yr. (AF)	0	0	0	0	3,700	3,690
Total Water Available for Yr. (AF)	0	0	0	0	3,700	7,390
Additional Irrigation Water Management						
Capital and Annual Expenditure	0	$768,750	$855,550	$942,350	$1,029,150	$347,200
New Water Available for Yr. (AF)	0	0	930	930	930	930
Total Water Available for Yr. (AF)	0	0	930	1,860	2,790	3,720

Exhibit B

Nomenclature
(All Water Quantities are Respective Calendar Year Amounts in Acre-Feet)

IID	–	IID net Colorado River diversions.
PVID (M)	–	PVID (for its third priority Mesa land) net Colorado River diversions.
CVWD	–	CVWD net Colorado River diversions.
TP	–	Total net Colorado River diversions under the third priority of the Parties' water delivery contracts with the Secretary.
CW	–	An amount of water equal to the quantity of water conserved from the C&A Programs.
R	–	Reduction required by the Secretary of the Interior.
FI	–	First increment of R, lesser of: (i) R; or (ii) (50,000)* ÷ $\frac{CW+IID}{CW+TP}$
SI	–	Second increment of R, lesser of: (i) R-FI, but not < 0; or (ii) 106,110*-FI
TI	–	Third increment of R, lesser of: (i) CW-106,110, but not < 0; or (ii) R-FI-SI, but not < 0
RR	–	Remaining Reduction: R-FI-SI-TI, but not < 0
R_nMWD	–	In the respective increment, reduction in MWD's use of CW.

R_nPVID (M) - In the respective increment, reduction in PVID (for its third priority Mesa land) net Colorado River diversion.

R_nCVWD - In the respective increment, reduction in CVWD net Colorado River diversions.

Reductions*:

FI

R_1MWD = FI-(FI x [PVID (M)+CVWD]/(CW+TP))
R_1PVID (M) = (FI) x [PVID (M)/(CW+TP)]
R_1CVWD = (FI) x [CVWD/(CW+TP)]

SI

R_2PVID (M) = (SI) x [PVID (M)/(CW+TP)]
R_2CVWD = (SI)-R_2PVID (M)

TI

R_3MWD = TI

RR

Agricultural agencies in accordance with the various decrees, contracts, and regulations existing at the time of reduction.

*If less than 106,110 acre-feet of water is conserved from the C&A Programs in the respective year for which the reduction is incurred, then the 50,000 and 106,110 values set forth in the equations for the FI and SI shall each be reduced to the respective amount determined by the product of said amount and the ratio of CW to 106,110 AF.

Exhibit C

Examples of Reduction Under Section 3.2

Example A--50,000 Acre-foot Reduction (C&A Programs Completed)

Assumptions on Use Absent Reduction:

	Calendar Year Use (acre-feet)
PVID (Exclusive of its Third Priority Mesa Land) & Yuma Project, Reservation Division	450,000
IID	2,893,890
PVID for its Third Priority Mesa Land	20,000
CVWD	430,000
IID, PVID for its Third Priority Mesa Land, and CVWD Subtotal	3,343,890
Conserved Water (MWD)	106,110
Total	3,900,000
Limitation	- 3,850,000
Reduction Required	50,000

Allocation of Reduction Required:

	(acre-feet)
First Increment 50,000	
Conserved Water (MWD) 50,000 - [50,000 x (20,000 + 430,000) / (106,110 + 3,343,890)]	43,478
PVID for its Third Priority Mesa Land 50,000 x [20,000 / (106,110 + 3,343,890)]	290
CVWD 50,000 x [430,000 / (106,110 + 3,343,890)]	6,232
Total	50,000

Example B--100,000 Acre-foot Reduction
(C&A Programs Completed)

Assumptions on Use Absent Reduction:

	Calendar Year Use (acre-feet)
PVID (Exclusive of its Third Priority Mesa Land) & Yuma Project, Reservation Division	450,000
IID	2,943,890
PVID for its Third Priority Mesa Land	20,000
CVWD	430,000
IID, PVID for its Third Priority Mesa Land, and CVWD Subtotal	3,393,890
Conserved Water (MWD)	106,110
Total	3,950,000
Limitation	- 3,850,000
Reduction Required	100,000

Allocation of Reduction Required:

	(acre-feet)
First Increment	
50,000 / [(106,110 + 2,943,890) / (106,110 + 3,393,890)] = 57,377	
Conserved Water (MWD)	
57,377 - [57,377 x (20,000 + 430,000) / (106,110 + 3,393,890)]	50,000
PVID for its Third Priority Mesa Land	
57,377 x [20,000 / (106,110 + 3,393,890)]	328
CVWD	
57,377 x [430,000 / (106,110 + 3,393,890)]	7,049
Total	57,377
Remaining Reduction Required	42,623
Second Increment	
100,000 - 57,377 = 42,623	
PVID for its Third Priority Mesa Land	
42,623 x [20,000 / (106,110 + 3,393,890)]	244
CVWD	
42,623 - 244	42,379
Total	42,623

Total Reduction: First and Second Increments

MWD	50,000
PVID for its Third Priority Mesa Land	572
CVWD	49,428
Total	100,000

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

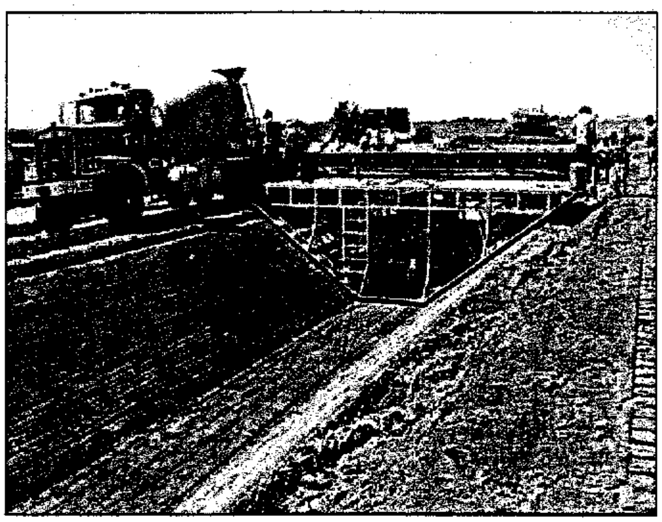
Imperial Irrigation District

and

Metropolitan Water District of Southern California

Water Conservation Program

Final Program Construction Report



IID Water Resources Unit

April 2000

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Figures

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Tables

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)

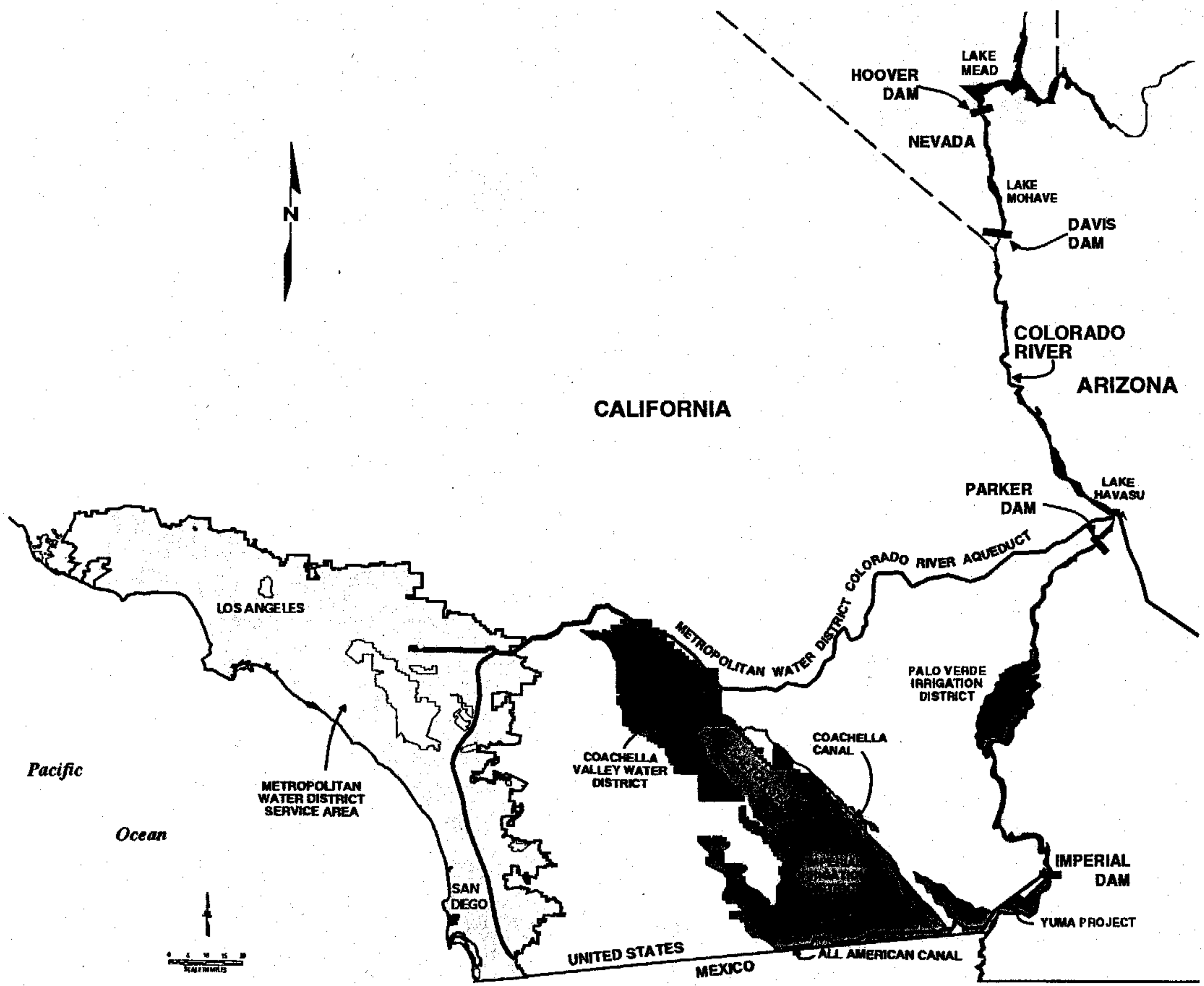

Figure 1.1 Location of IID and MWD Service Areas

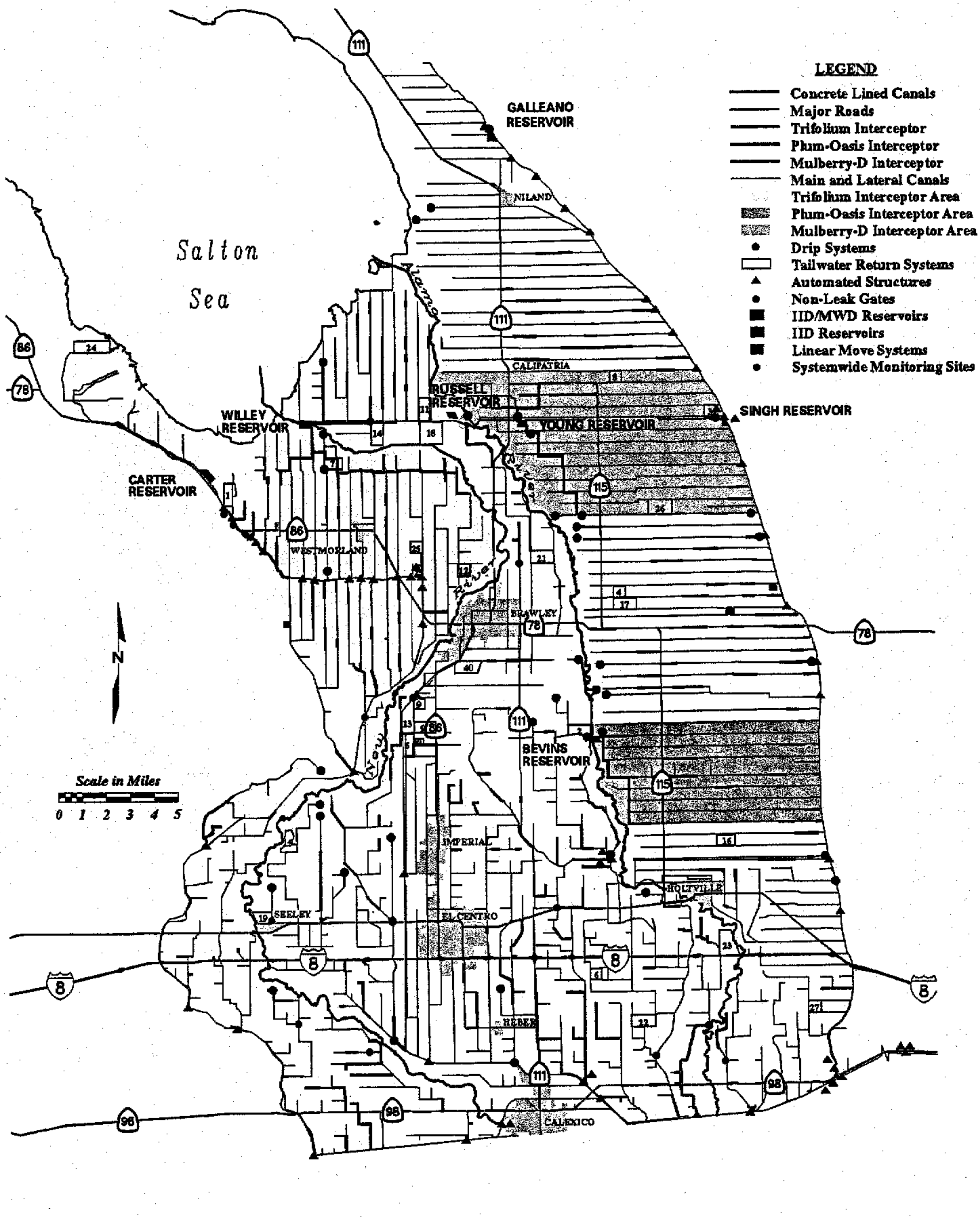

Figure 1.2 Location of IID/MWD Conservation Projects

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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]	1999 Water Conservation 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

[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

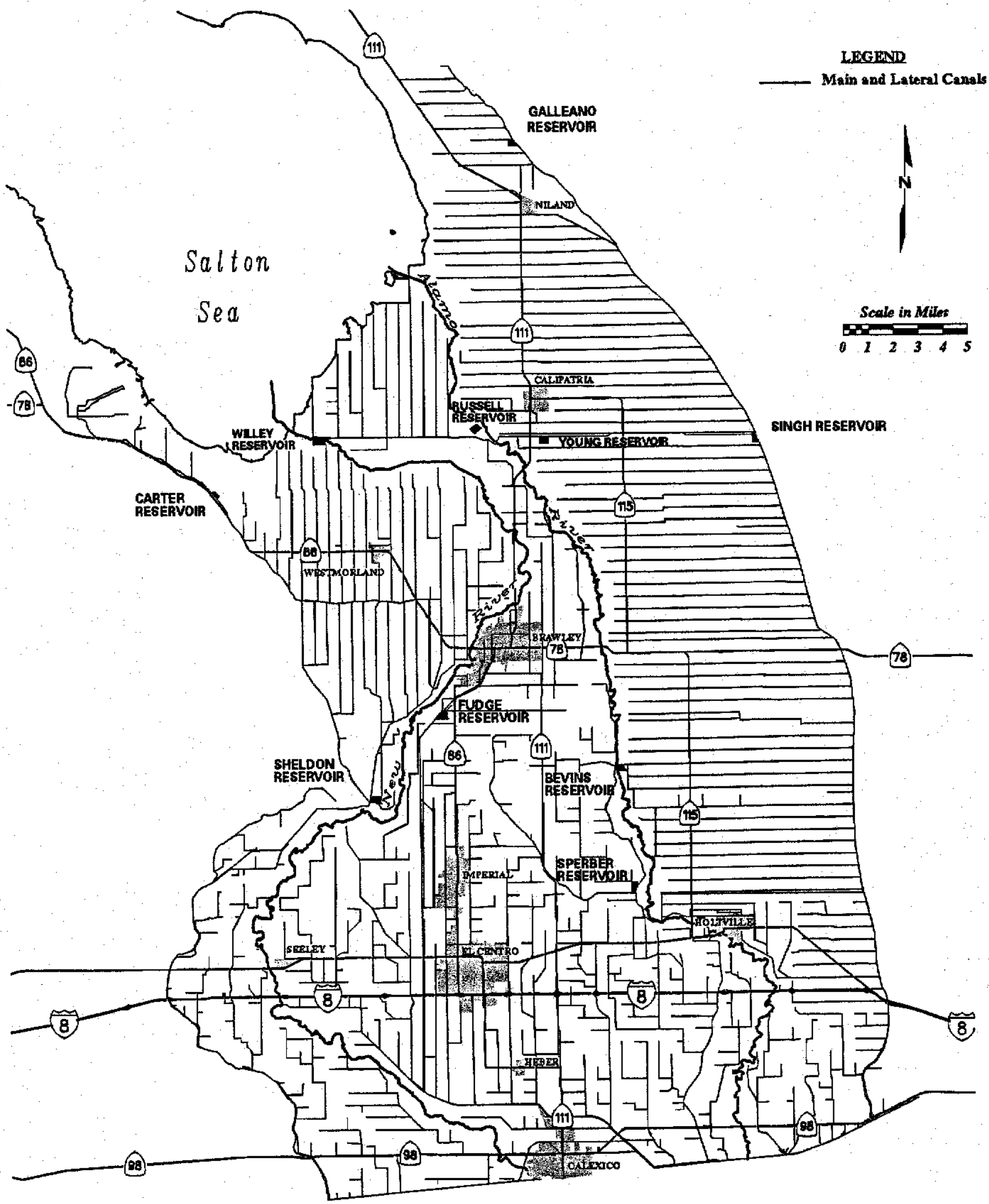

Figure 2.1 IID Main and Lateral Canals and Reservoirs

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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.

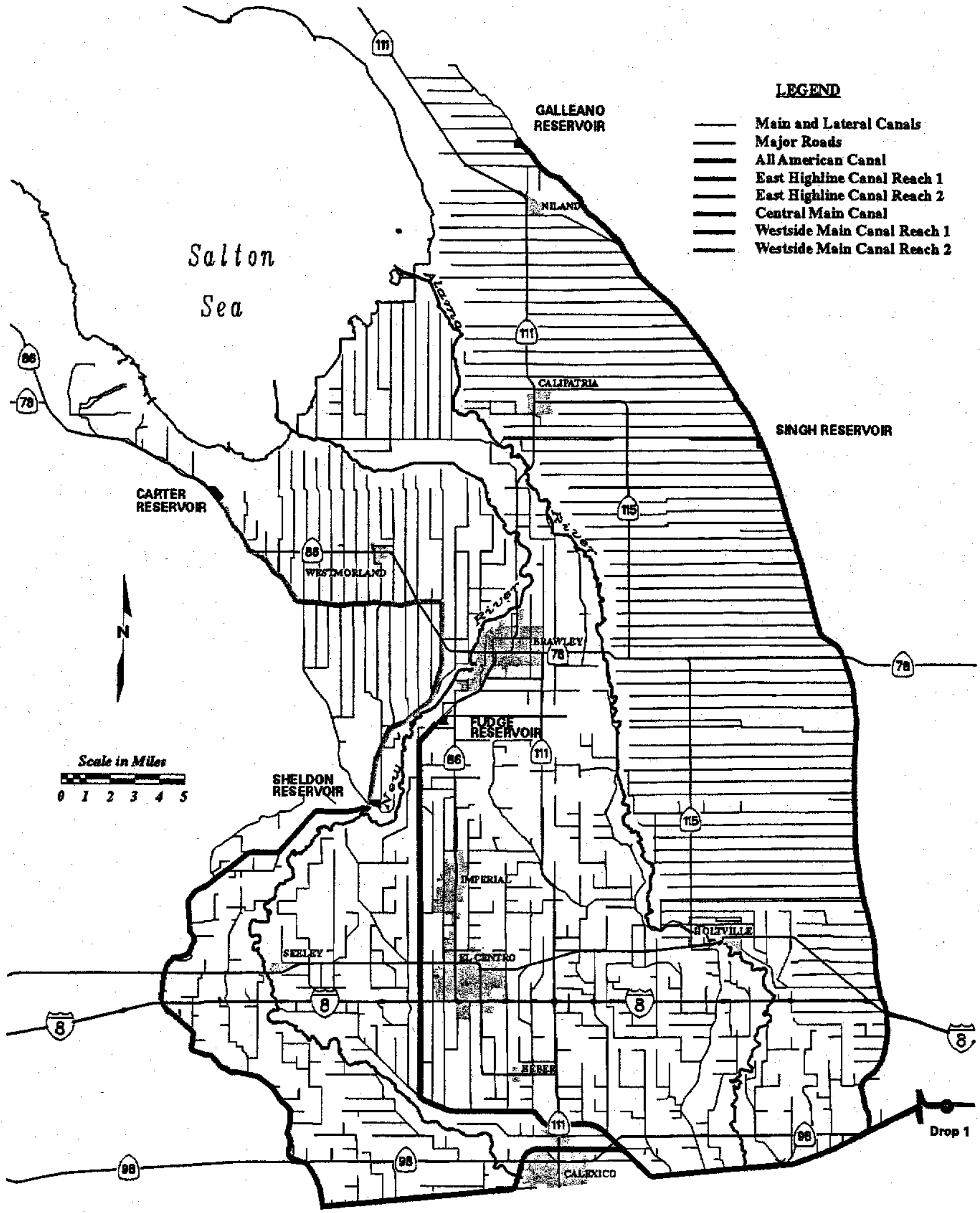

Figure 2.2 IID Main Canal Operating Reaches

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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.

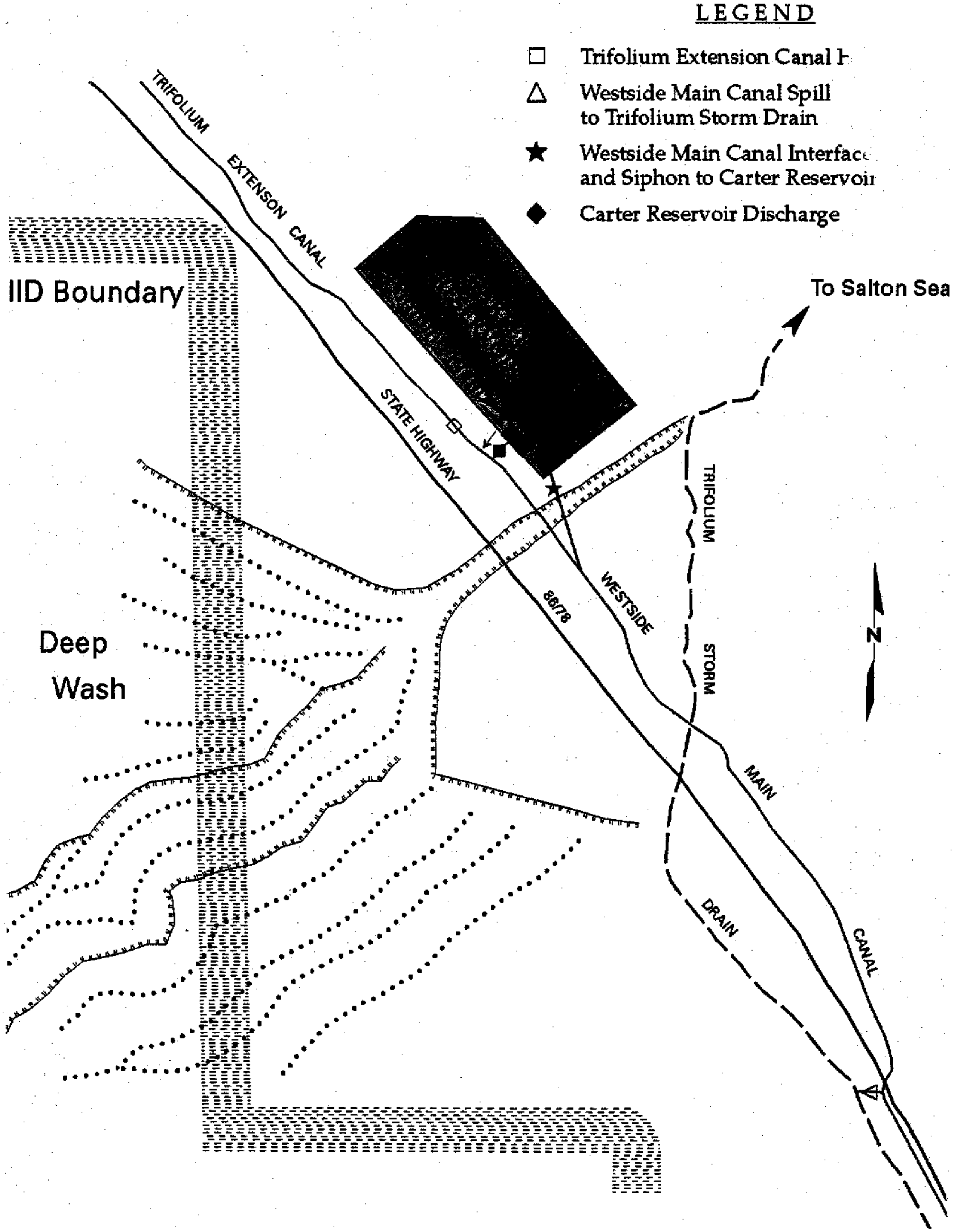

Figure 3.1 Carter Reservoir Project Site Map

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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.

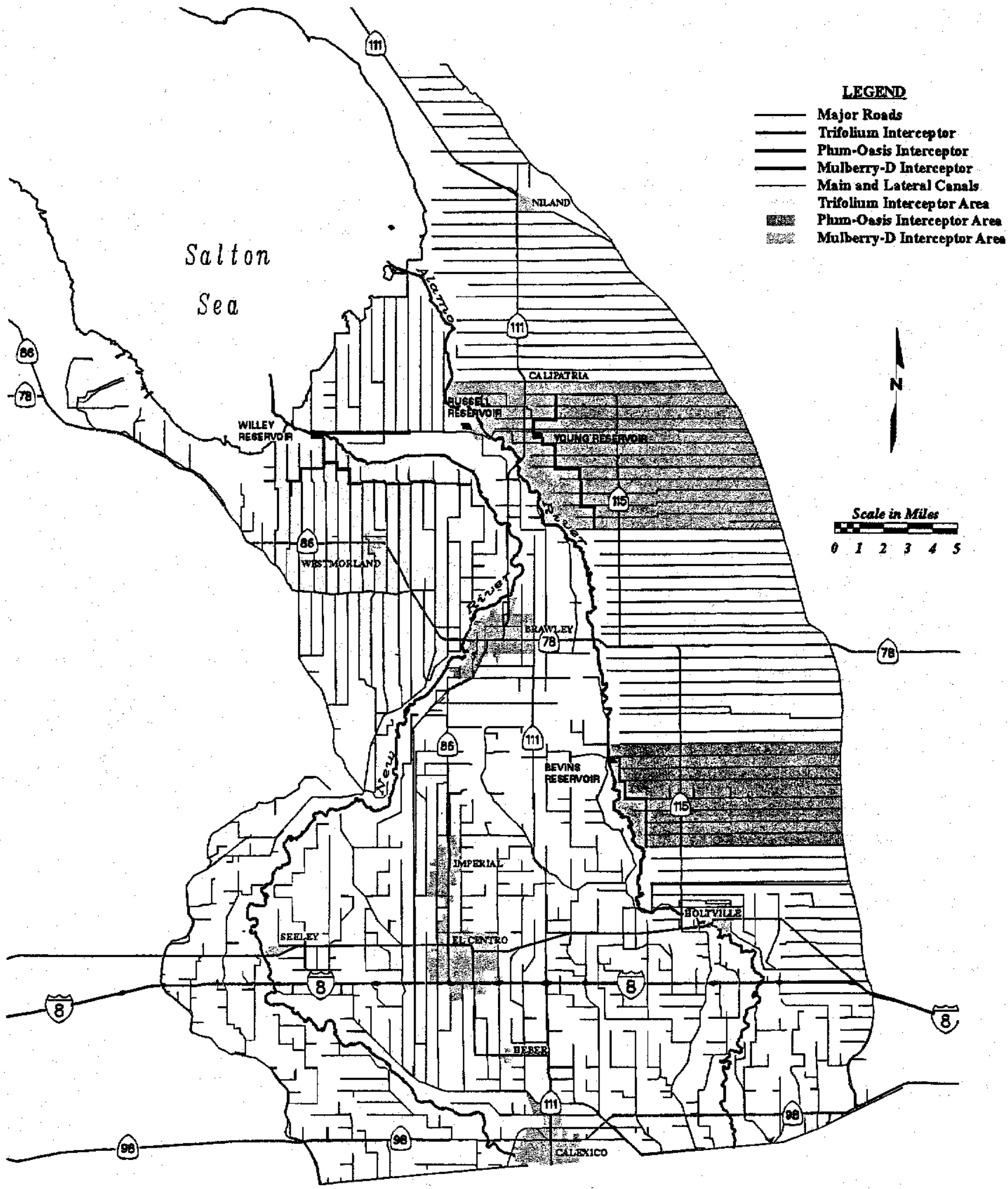

Figure 4.1 Location of IID/MWD Lateral Interceptor Projects

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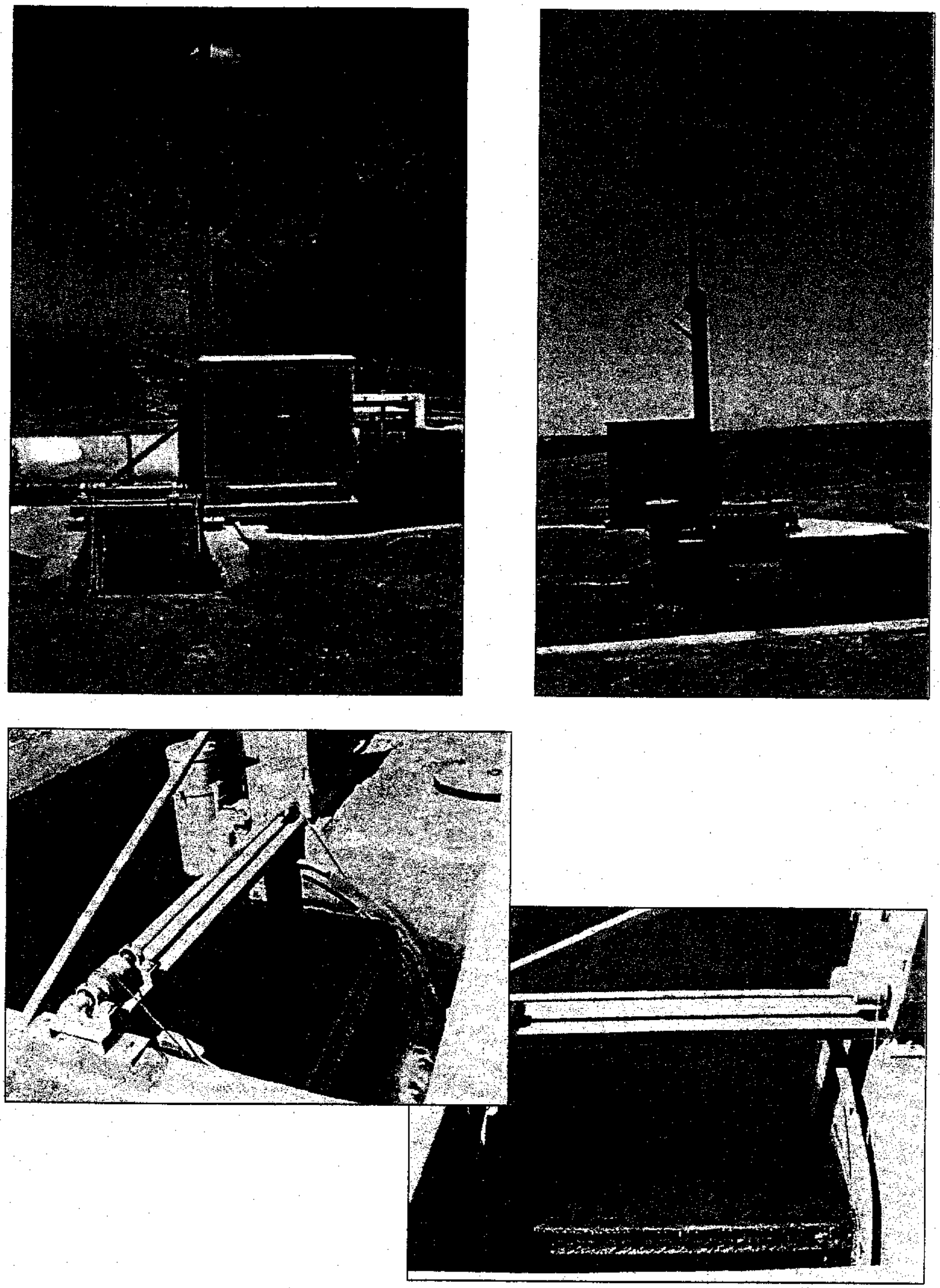

Figure 4.2 Automated Drop-Leaf Gate (ADLG) Sites

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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.

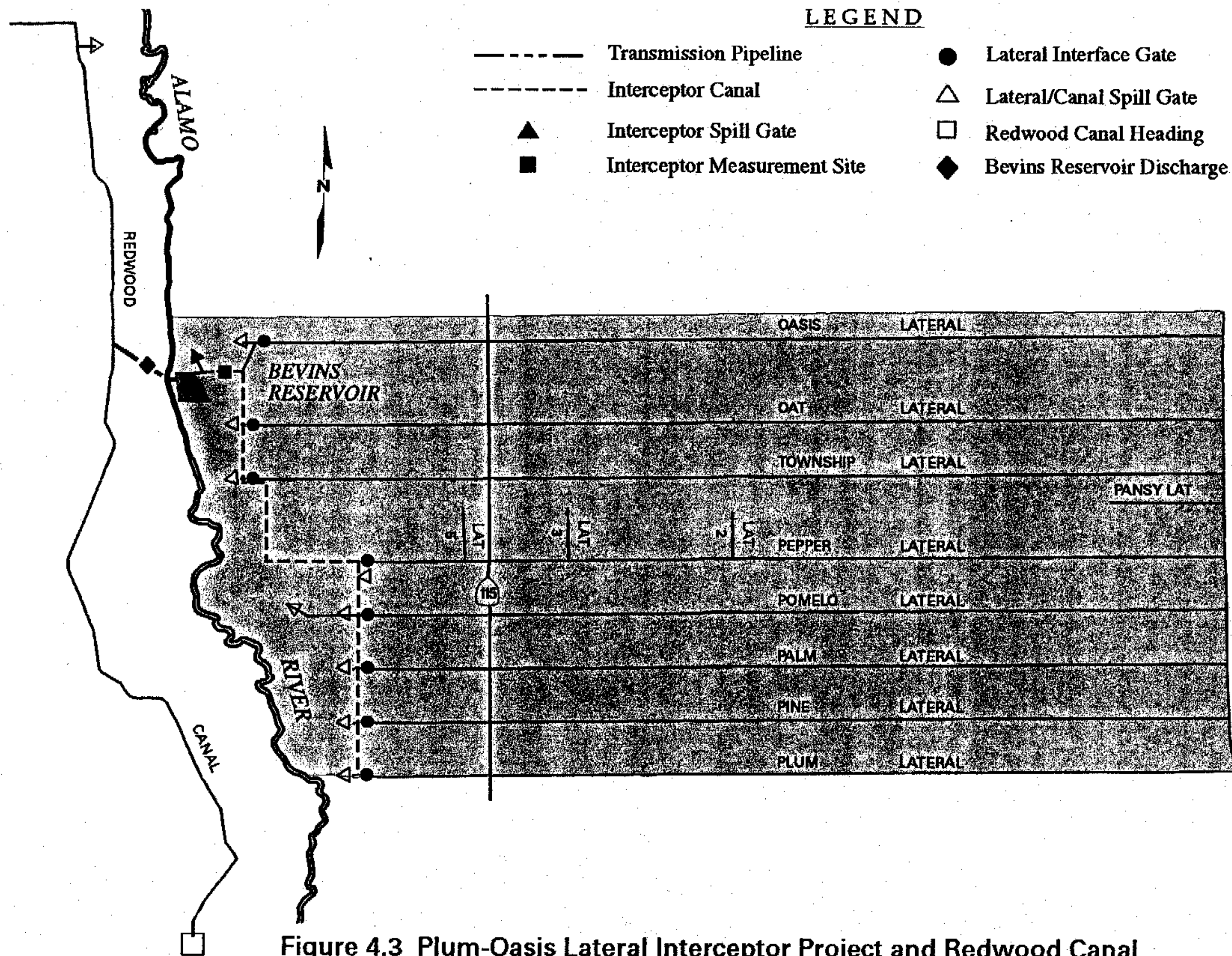

Figure 4.3 Plum-Oasis Lateral Interceptor Project and Redwood Canal

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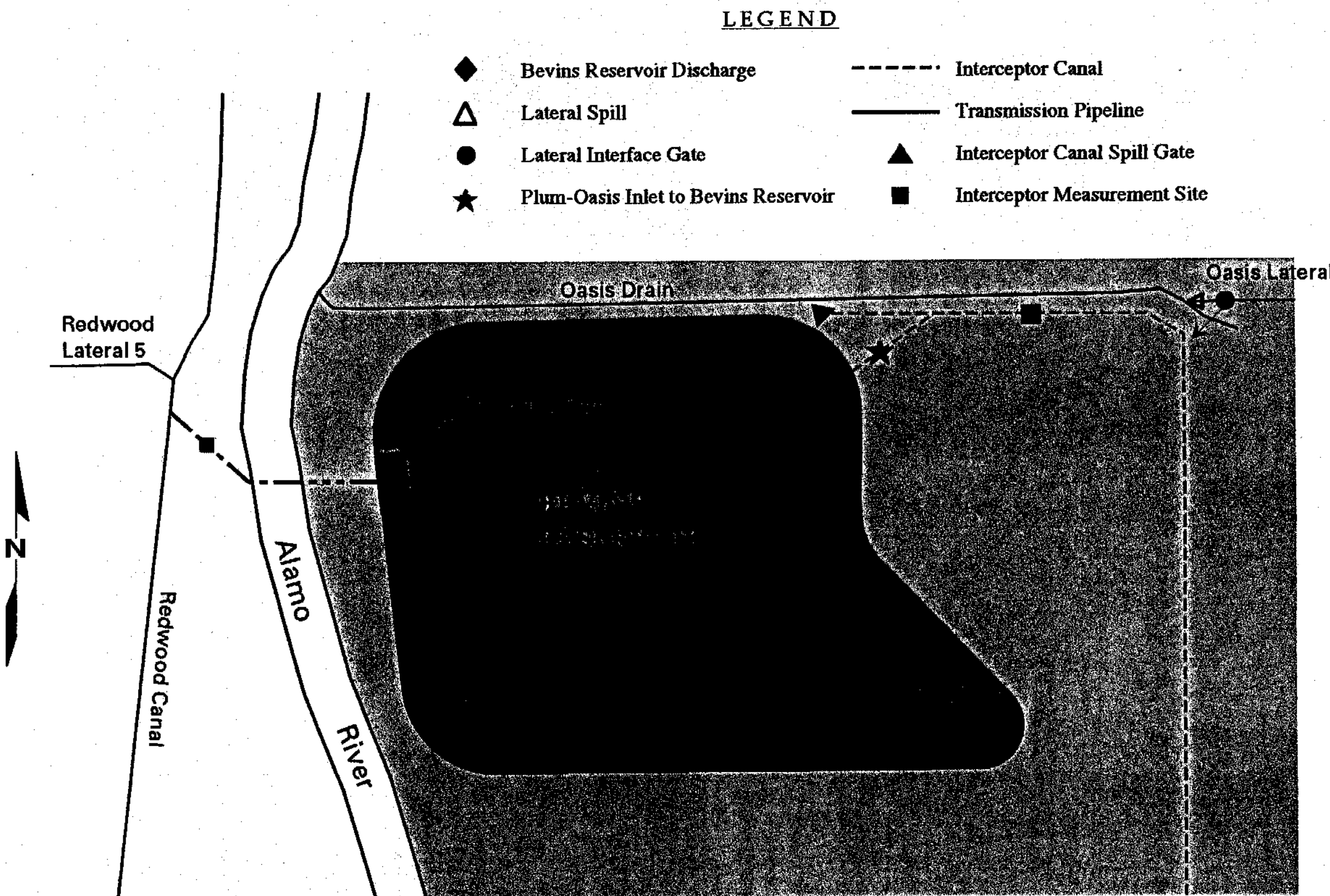

Figure 4.4 Plum-Oasis Lateral Interceptor Project, Bevins Reservoir Area

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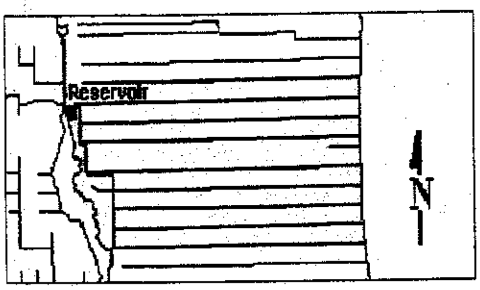
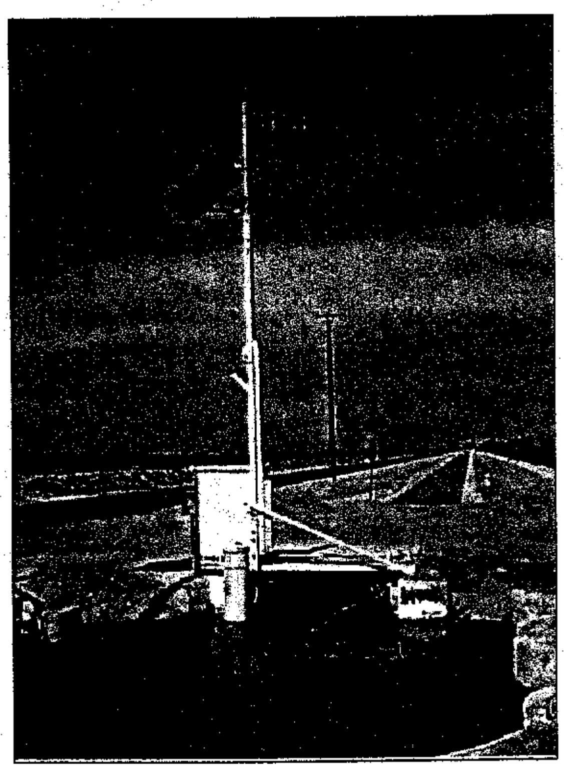
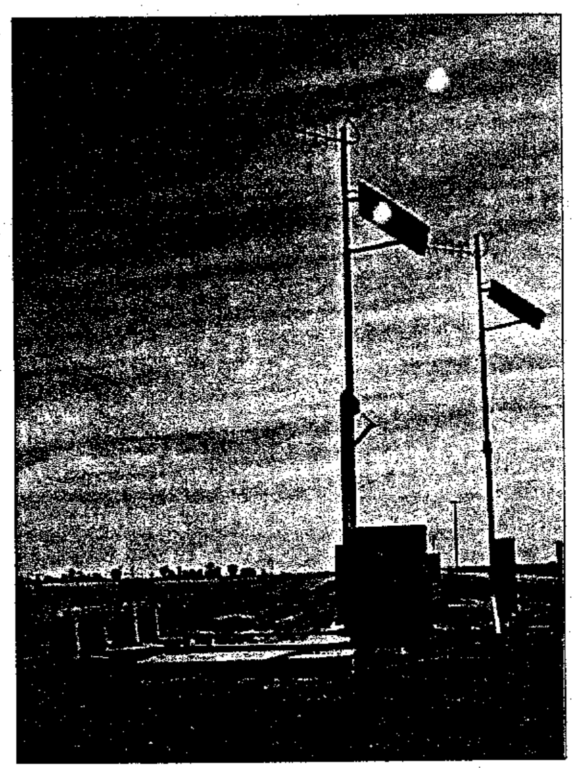


Plum-Oasis Lateral Interceptor Area Map

Bevins Reservoir

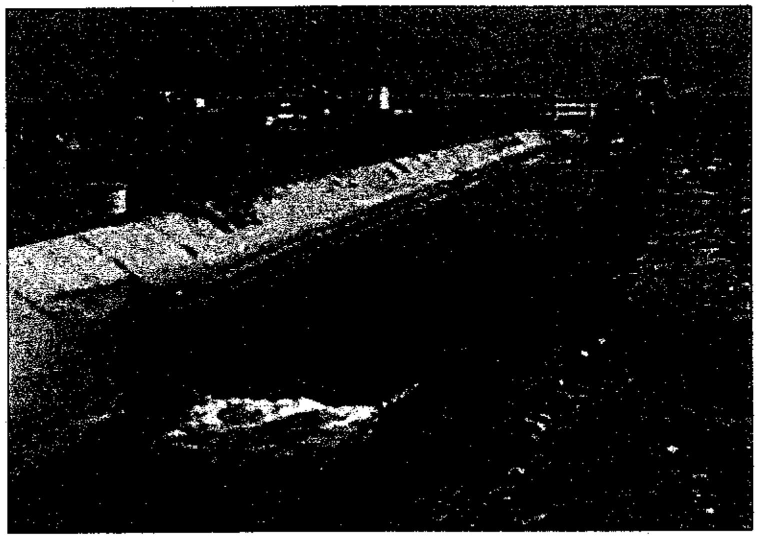


Pepper Interface Gate from Upstream

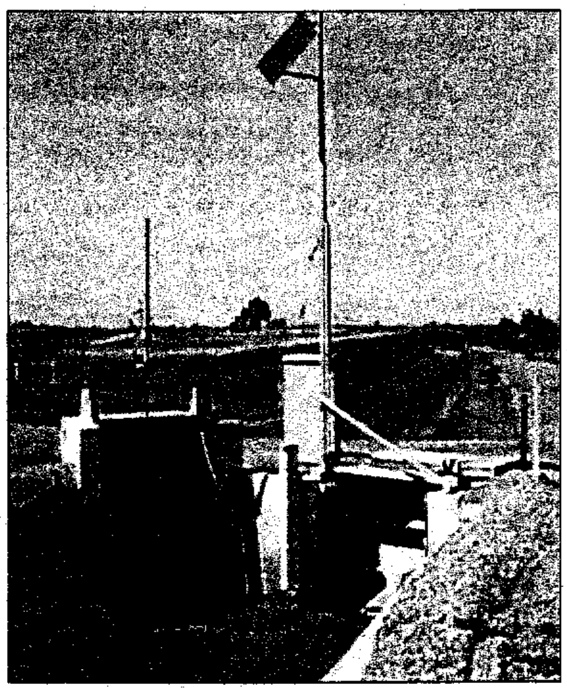


Pepper Interface Gate and Spill from Downstream

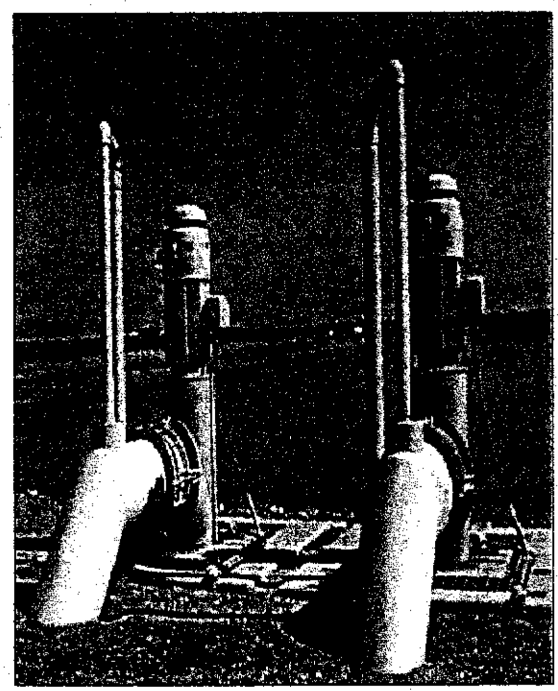
Figure 4.5 IID/MWD Project 3 Plum-Oasis Lateral Interceptor



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.

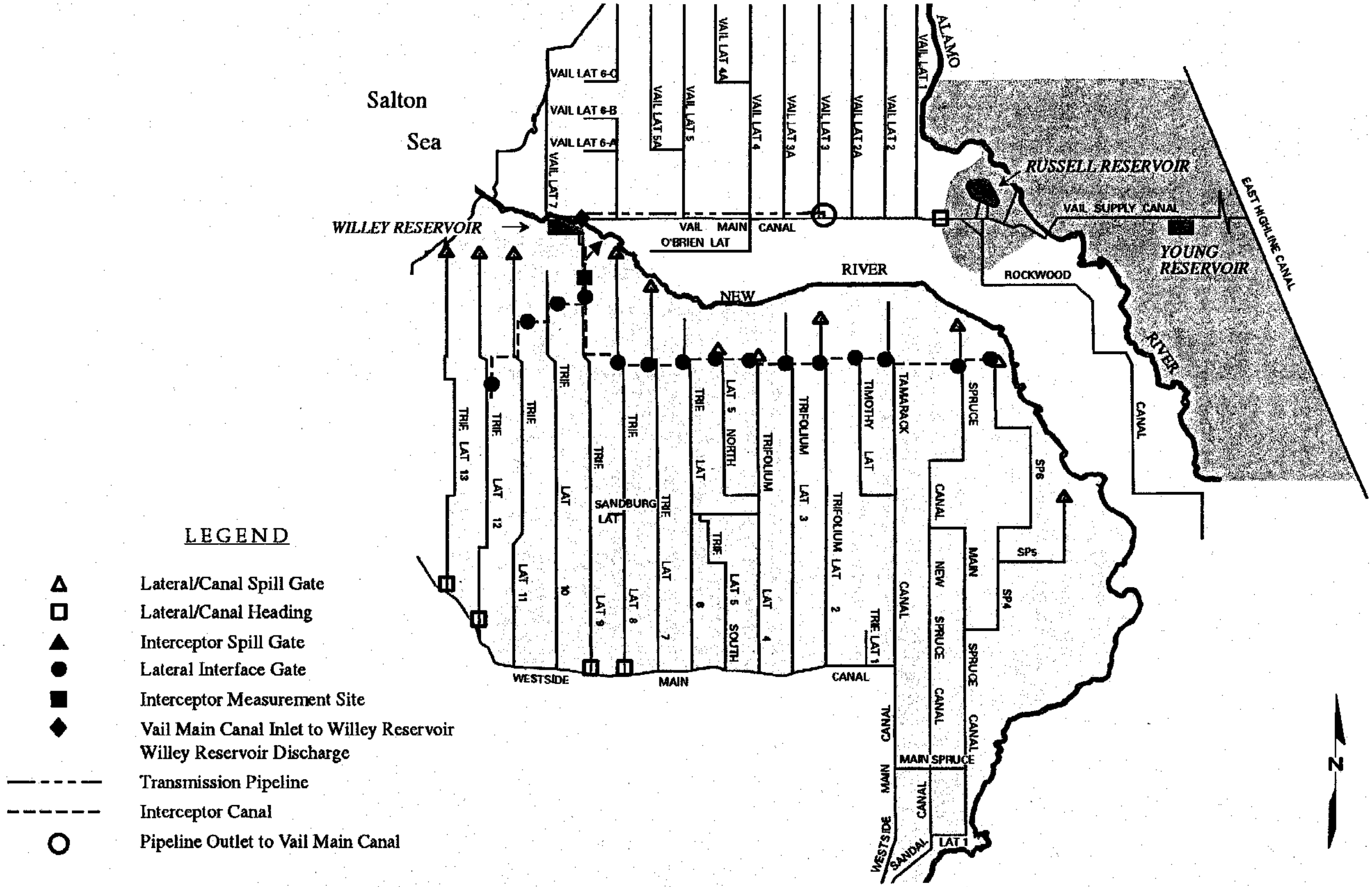

Figure 4.7 Trifolium Lateral Interceptor Project and Related Facilities

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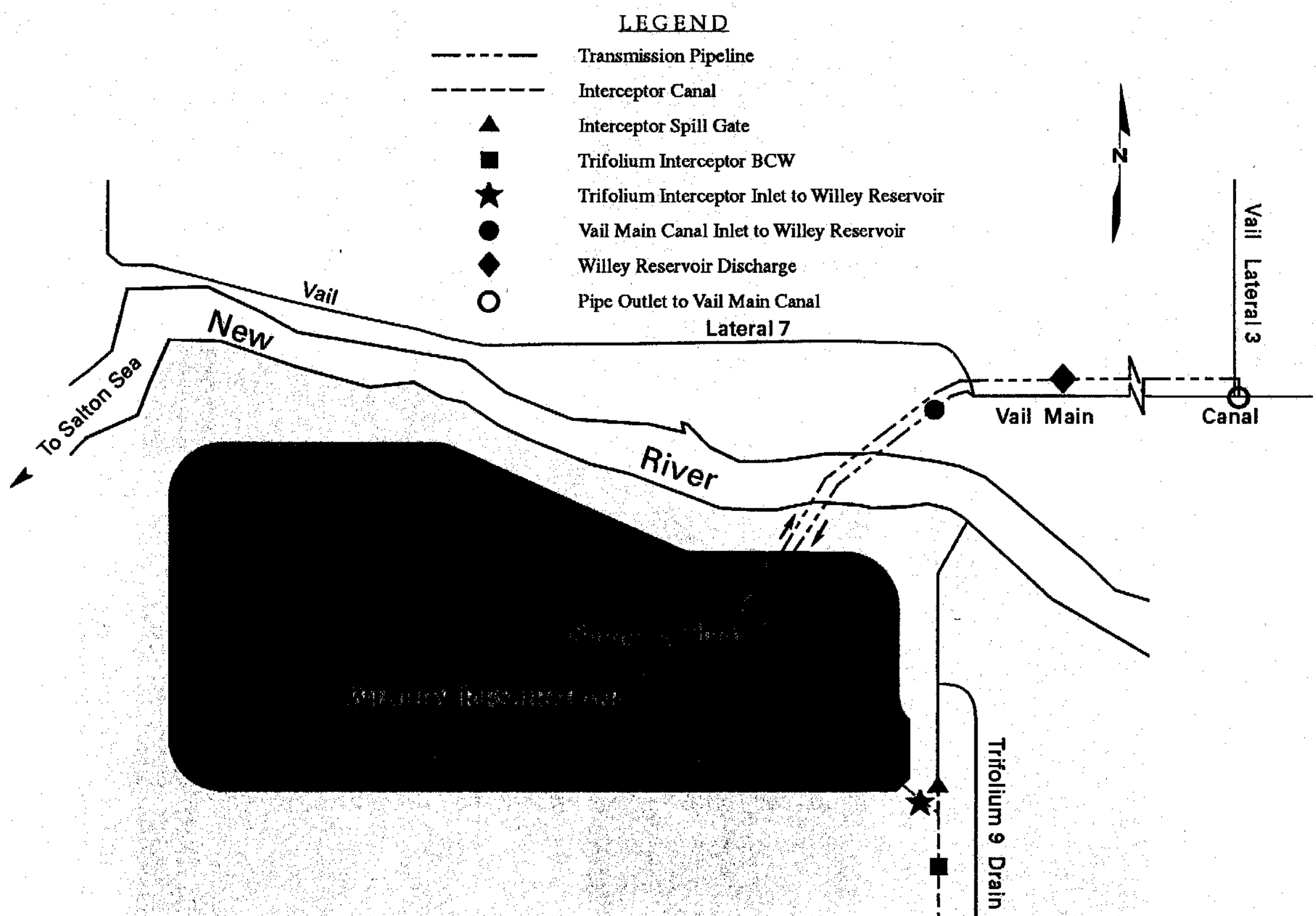

Figure 4.8 Trifolium Lateral Interceptor Project, Willey Reservoir Area

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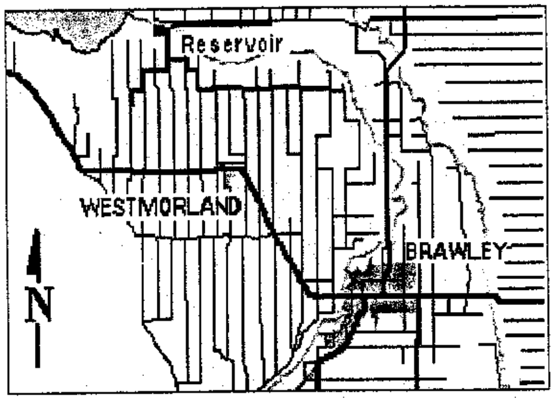
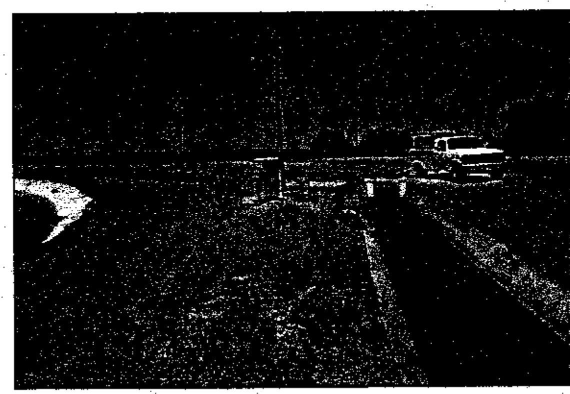


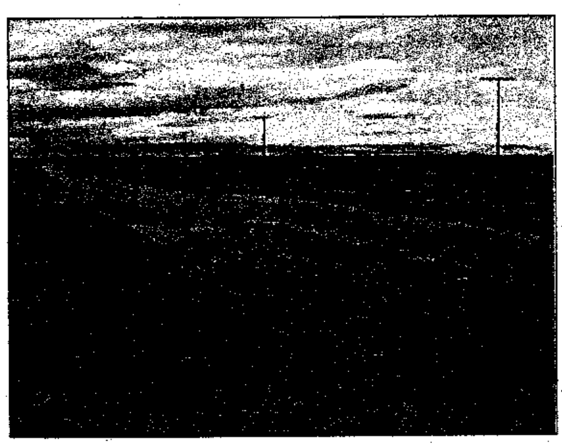
Trifolium Lateral Interceptor Project Area Map

Trifolium Lateral Interceptor Canal, downstream of Trifolium Lateral 4



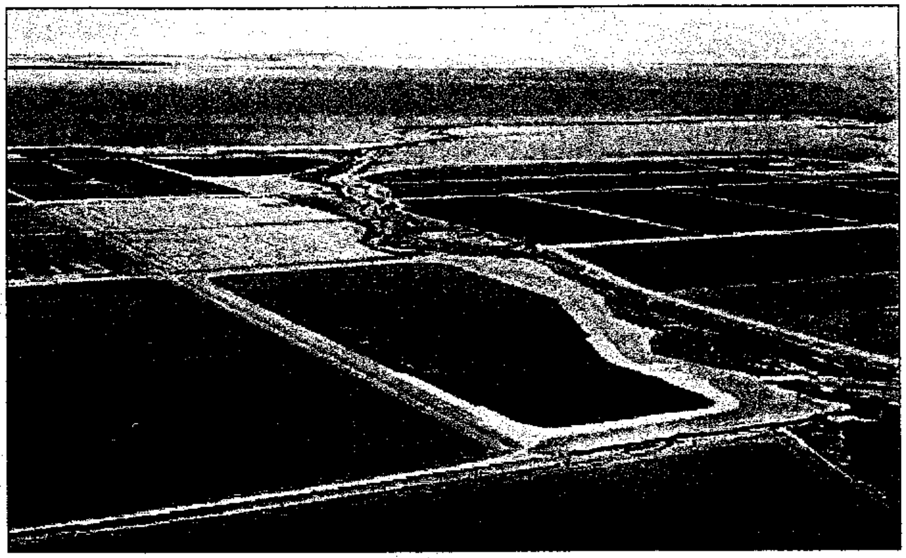
Trifolium Lateral 4 Interface to Trifolium Lateral Interceptor Canal

Trifolium Lateral Interceptor Canal Spill just downstream of the BCW

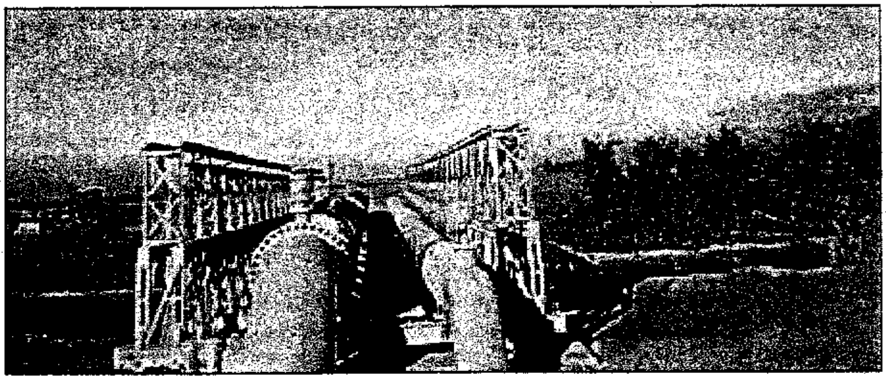


Trifolium Lateral Interceptor BCW just upstream of Willey Reservoir

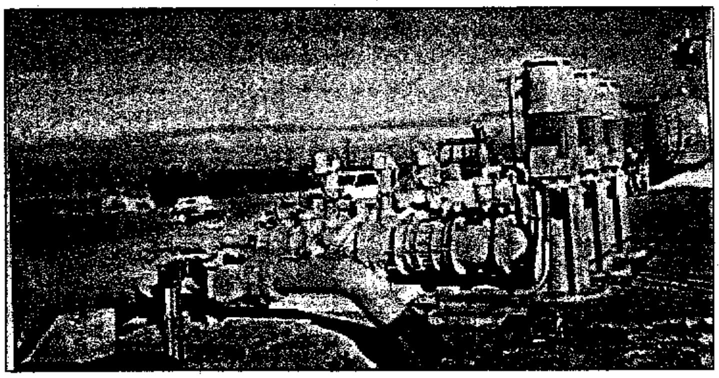
Figure 4.9 IID/MWD Project 8 Trifolium Lateral Interceptor



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.

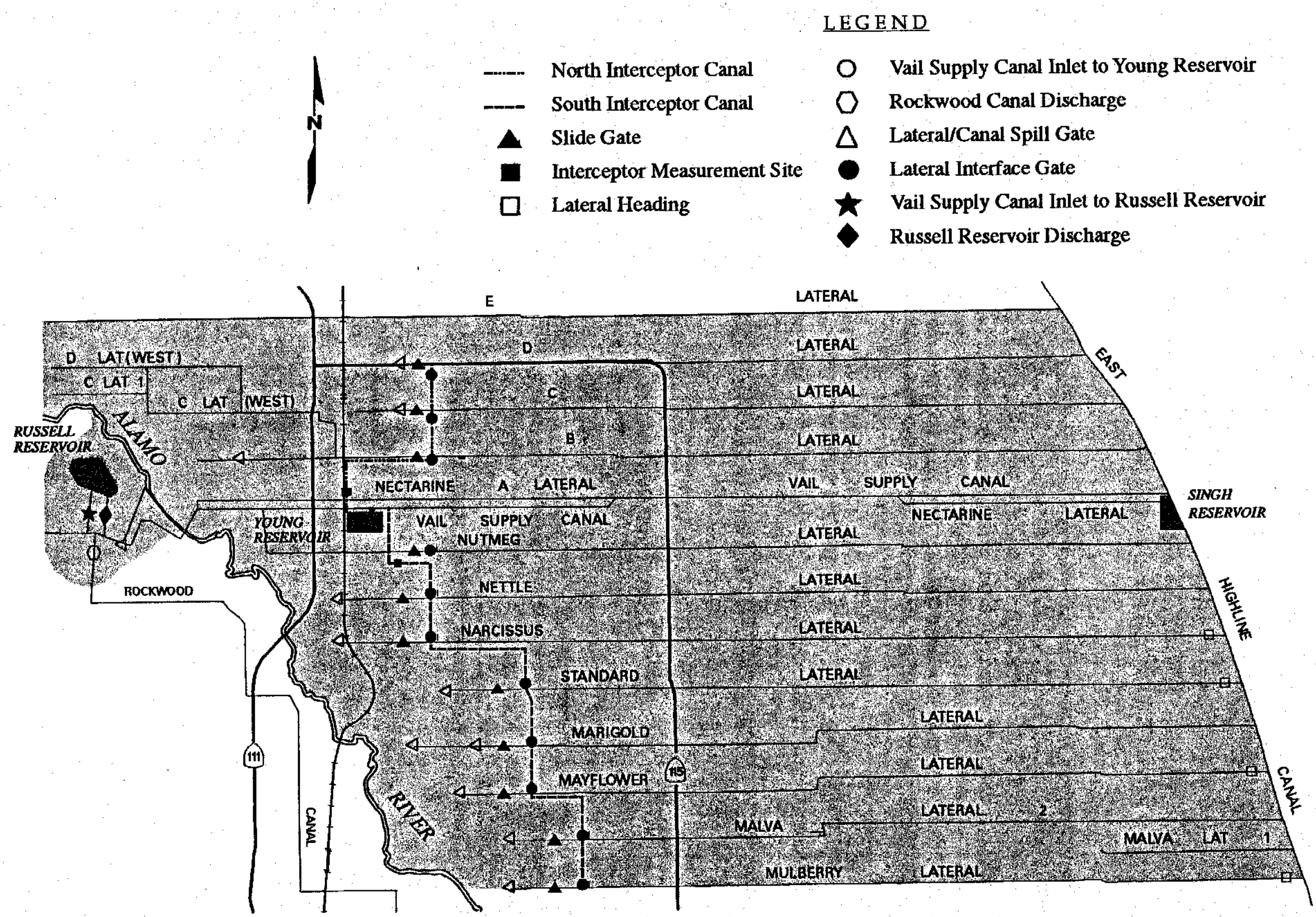

Figure 4.11 Mulberry-D Lateral Interceptor Project and Vail Supply Canal

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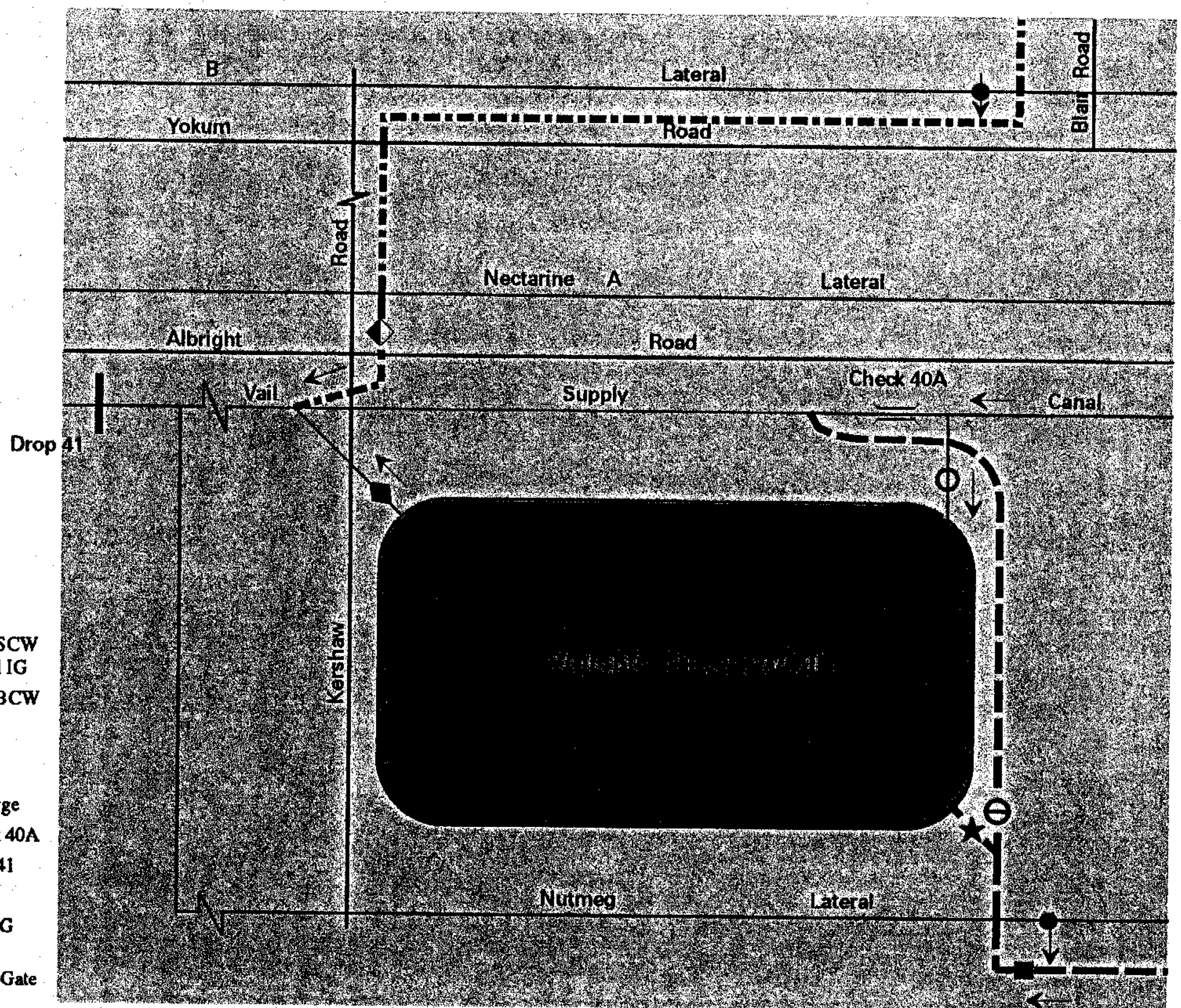

N

NOT TO SCALE

LEGEND

- North Interceptor Canal
- South Interceptor Canal
- Mulberry-D Interceptor SCW downstream of B-Lateral IG
- Mulberry-D Interceptor BCW d/s Nutmeg Lateral IG
- Vail Supply Canal IG to Young Reservoir
- Young Reservoir Discharge
- Vail Supply Canal Check 40A
- Vail Supply Canal Drop 41
- Lateral IG
- Mulberry-D Interceptor IG to Young Reservoir
- Young Reservoir Bypass Gate

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

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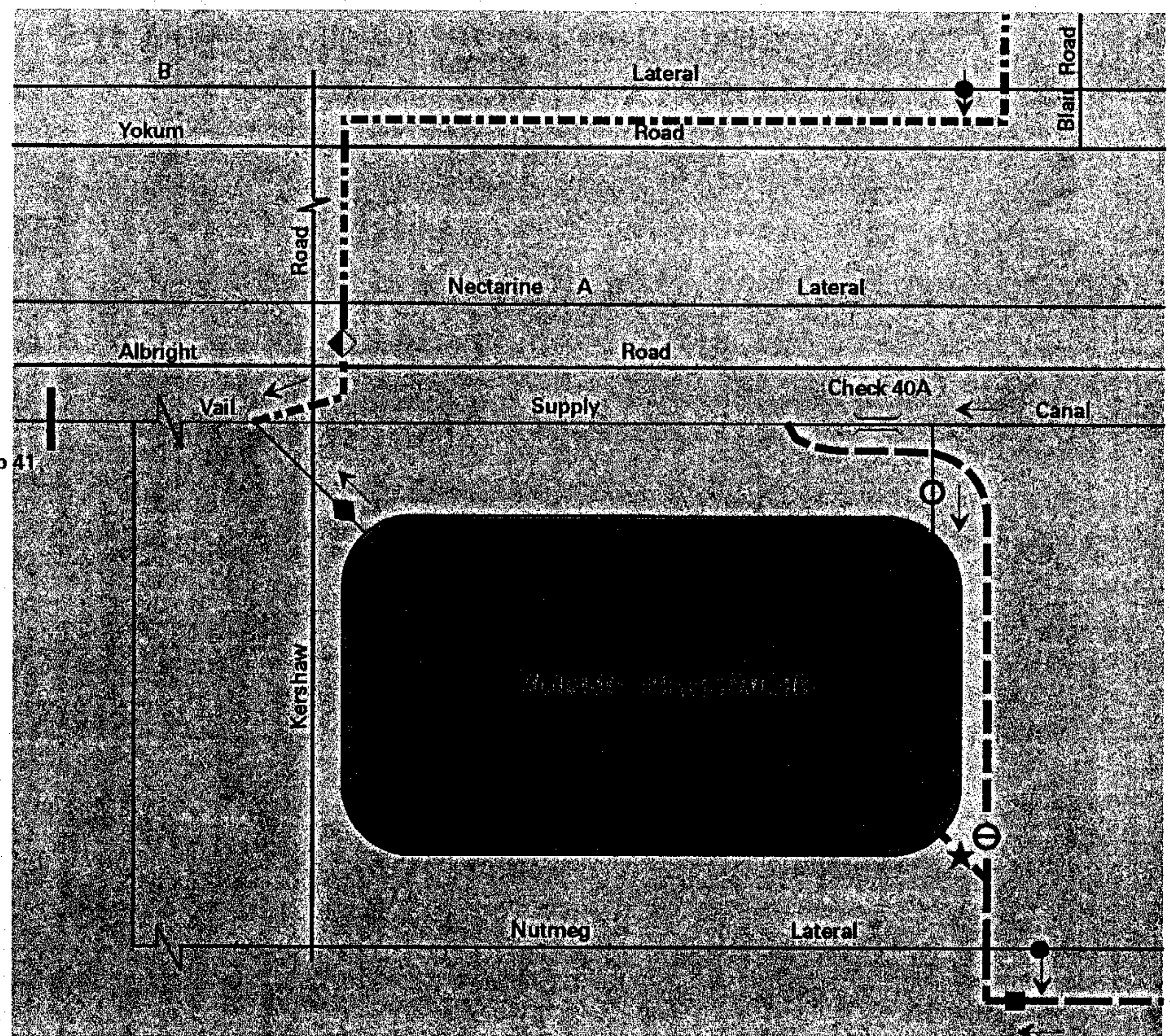

LEGEND

- North Interceptor Canal
- South Interceptor Canal
- Mulberry-D Interceptor SCW downstream of B-Lateral IG
- Mulberry-D Interceptor BCW d/s Nutmeg Lateral IG
- Vail Supply Canal IG to Young Reservoir
- Young Reservoir Discharge
- Vail Supply Canal Check 40A
- Vail Supply Canal Drop 41
- Lateral IG
- Mulberry-D Interceptor IG to Young Reservoir
- Young Reservoir Bypass Gate

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

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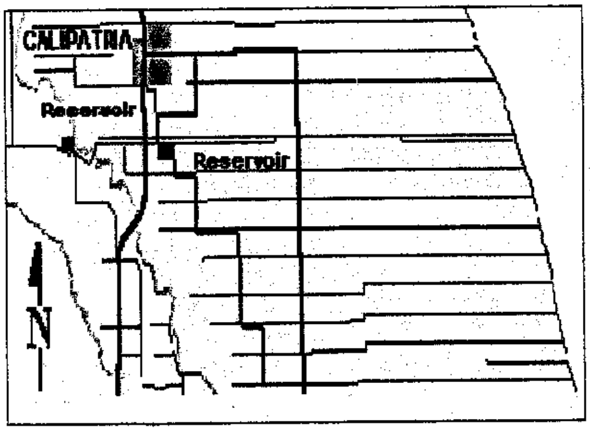
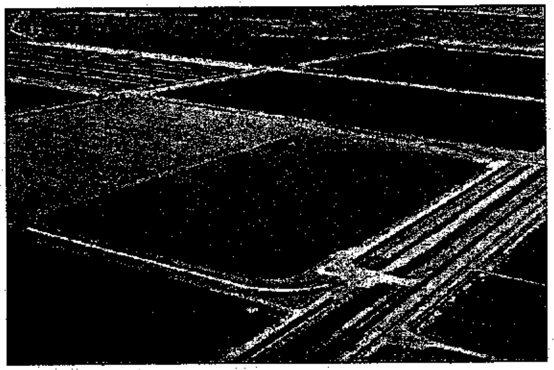
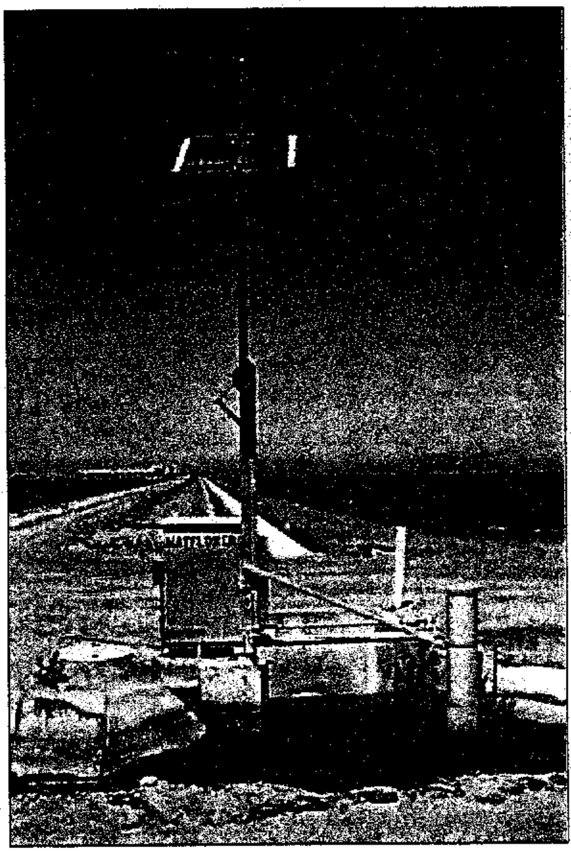


Mulberry-D Lateral Interceptor Project Area Map



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

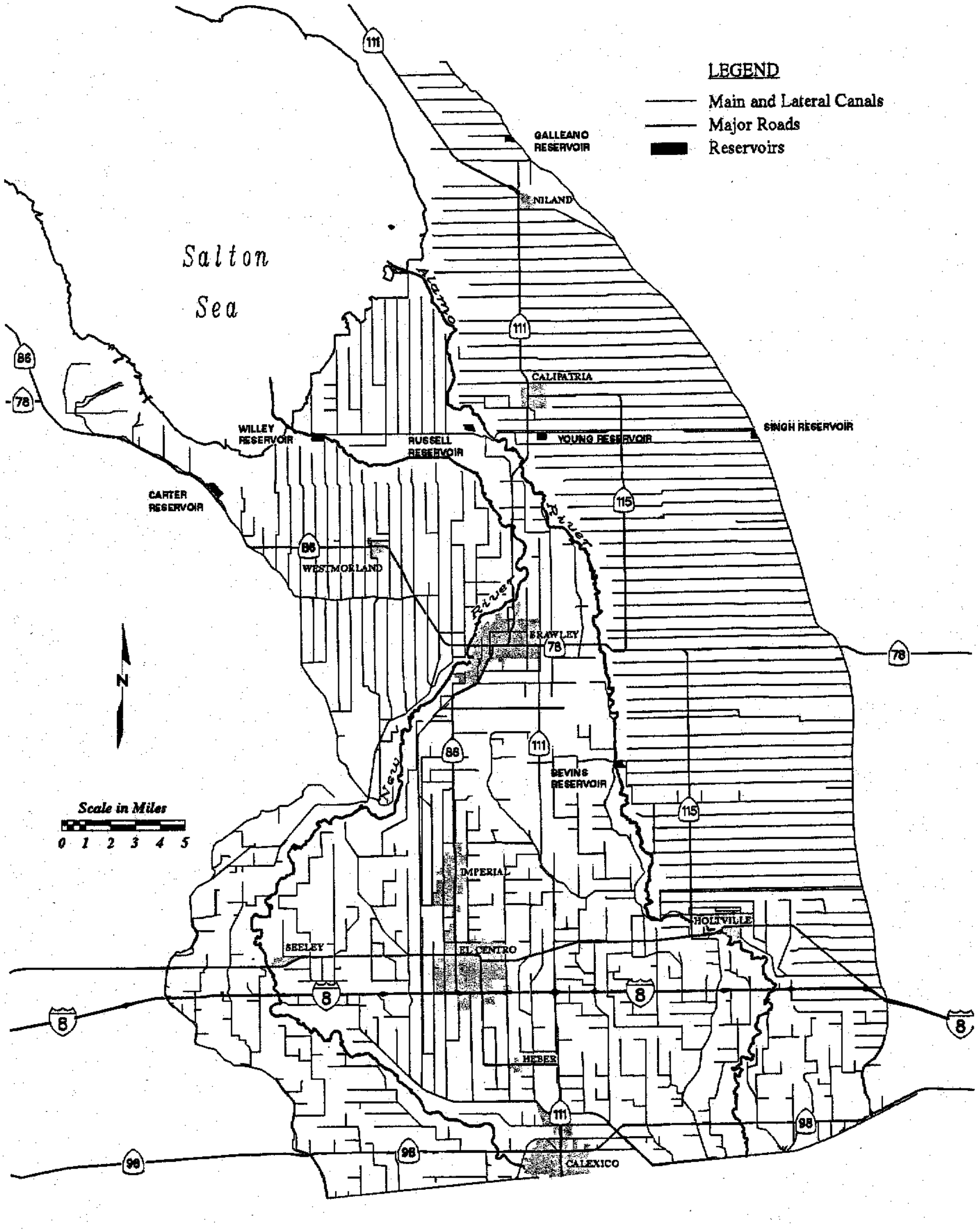

Figure 5.1 Location of IID/MWD Reservoirs

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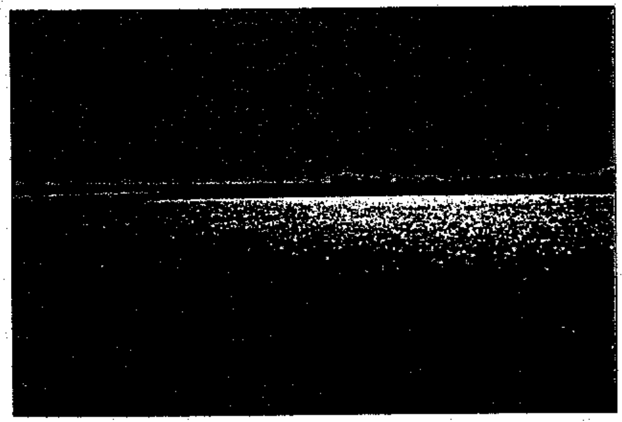
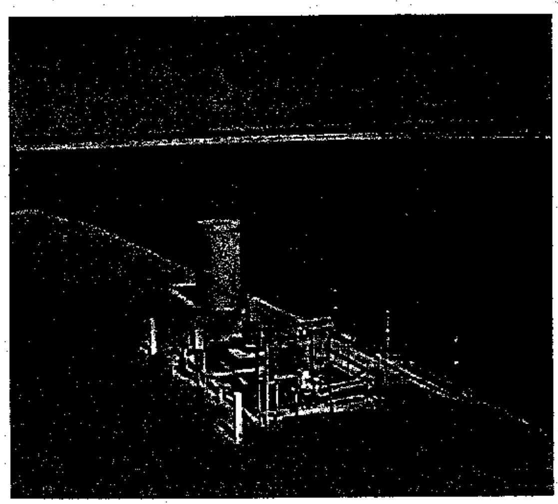
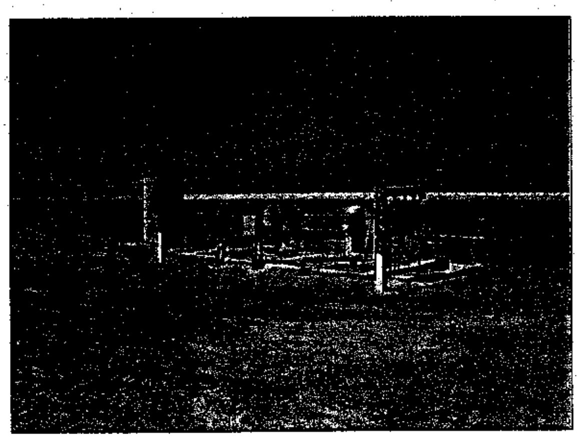


Carter Reservoir

Outlet Structure and Pumping Plant



Carter Reservoir Pumping Plant



Carter Reservoir Pumping Plant

Figure 5.2 IID/MWD Project 1 Carter Reservoir

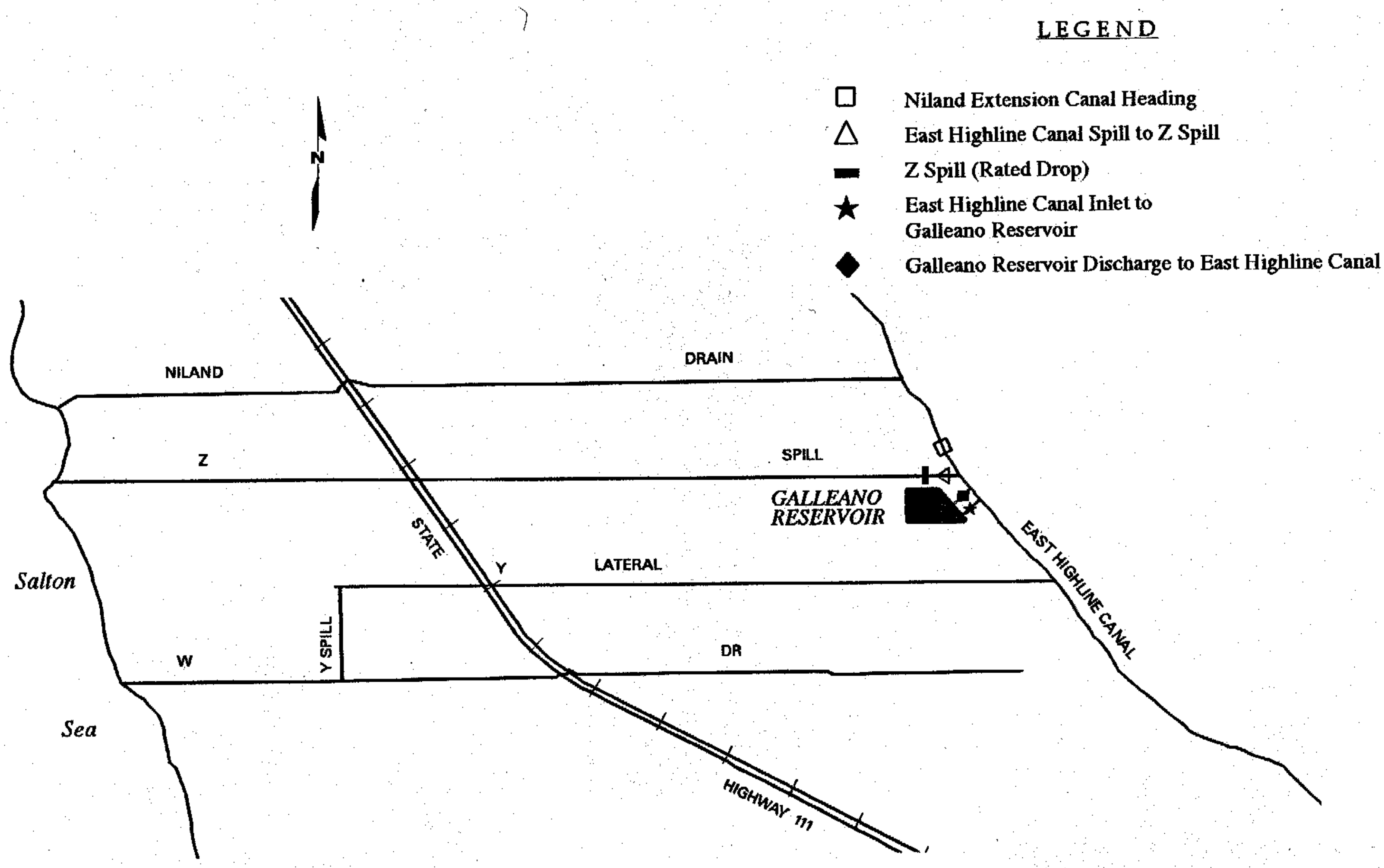


Figure 5.3 Galleano Reservoir Project Site Map

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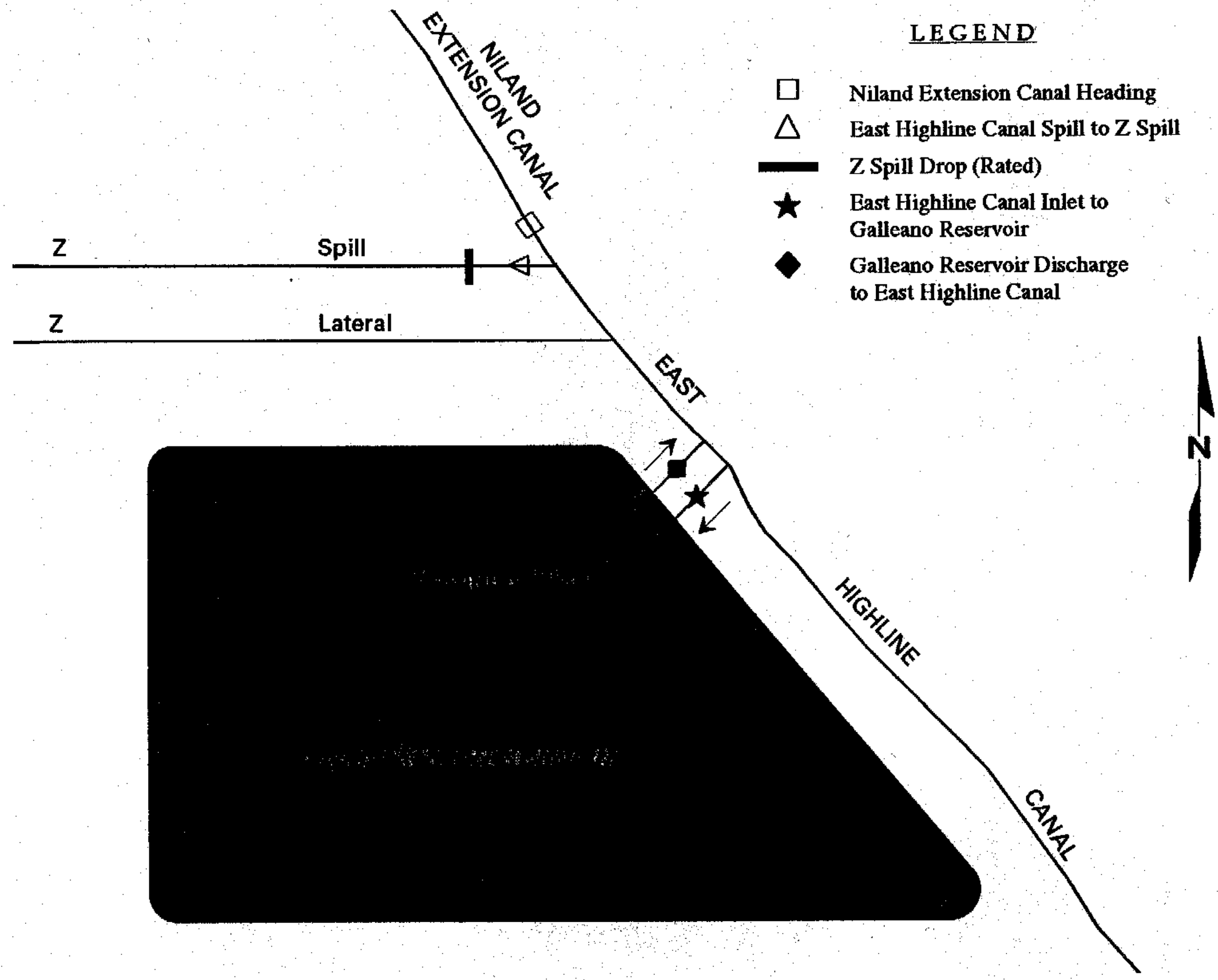

Figure 5.4 Galleano Reservoir Project Area

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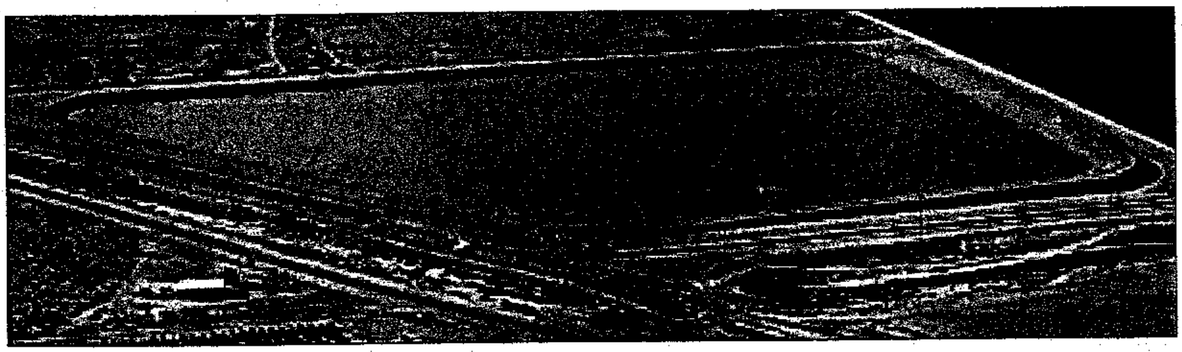
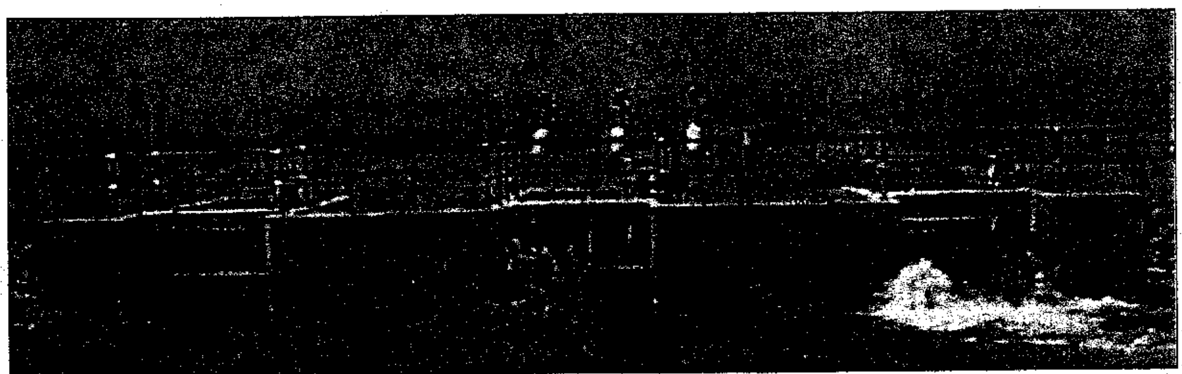
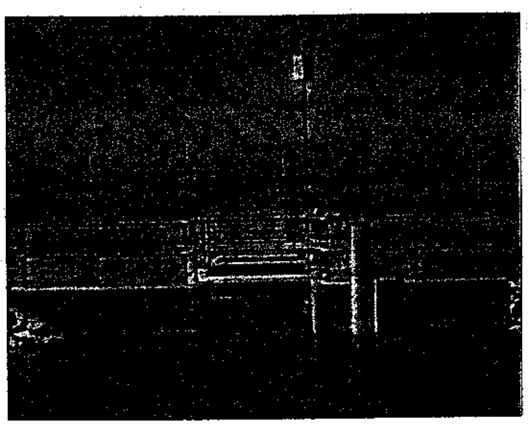


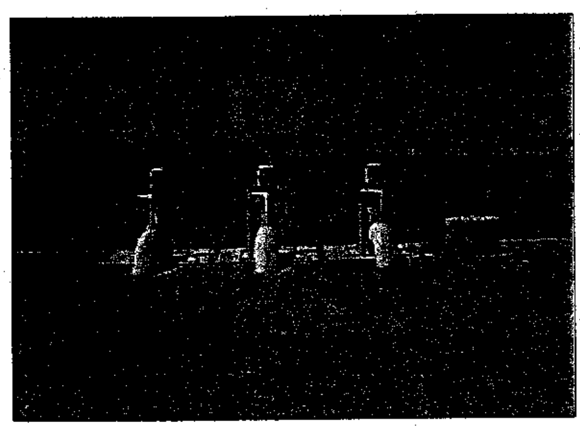
Galleano Reservoir



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%)

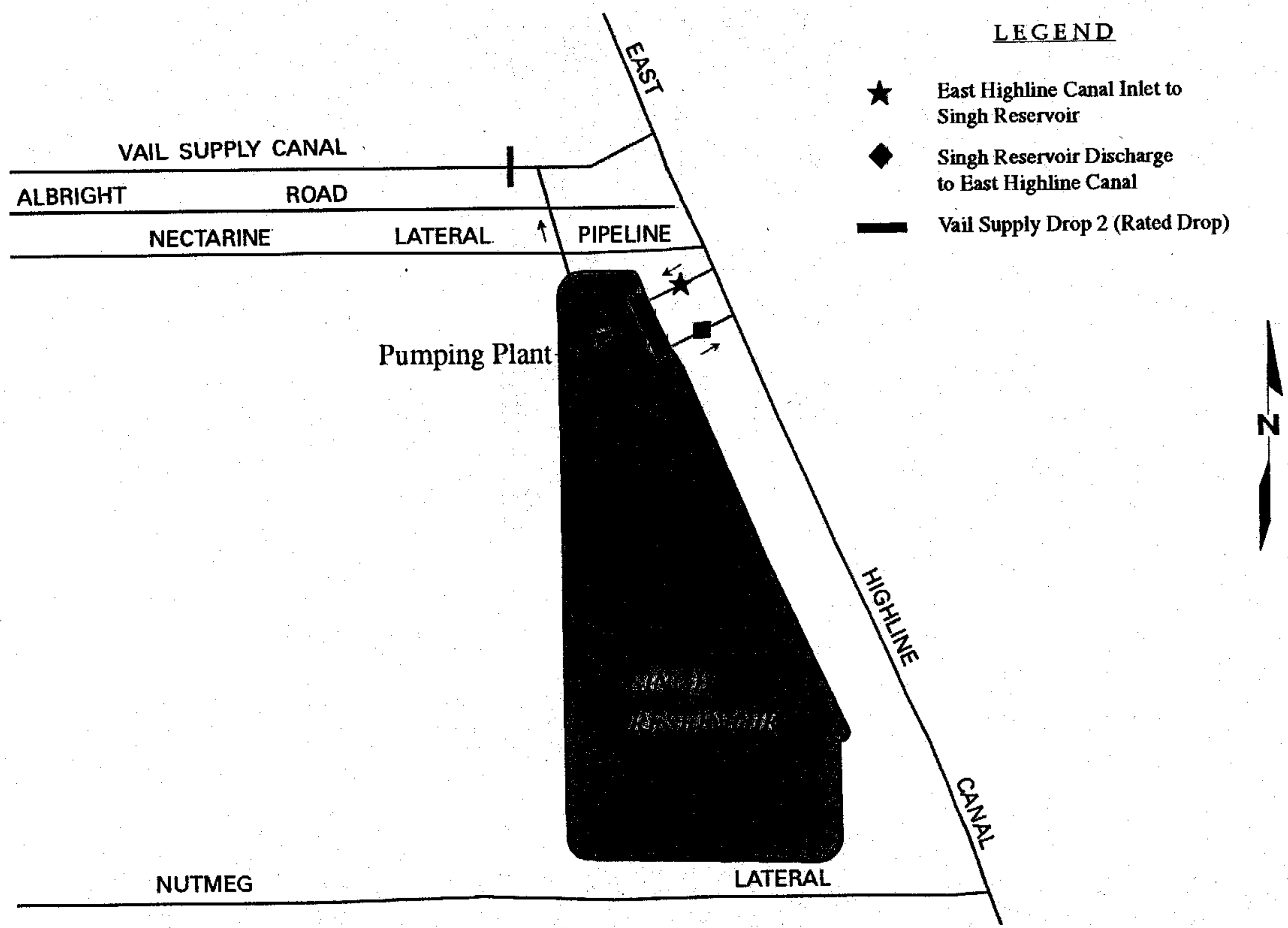


Figure 5.6 12-Hour Delivery Project, Singh Reservoir Pumping Plant

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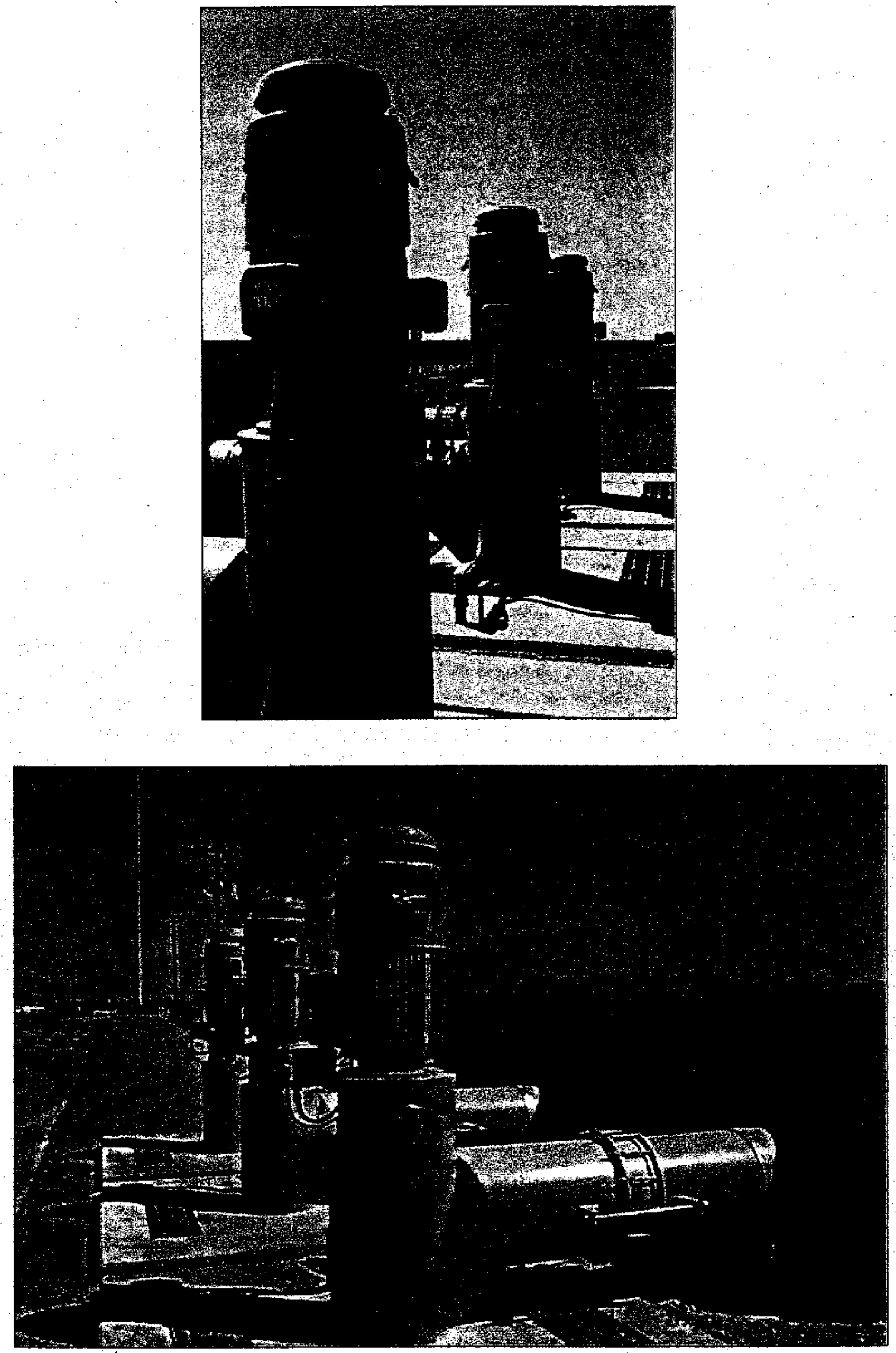

Pumping Plant at Singh Reservoir

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.

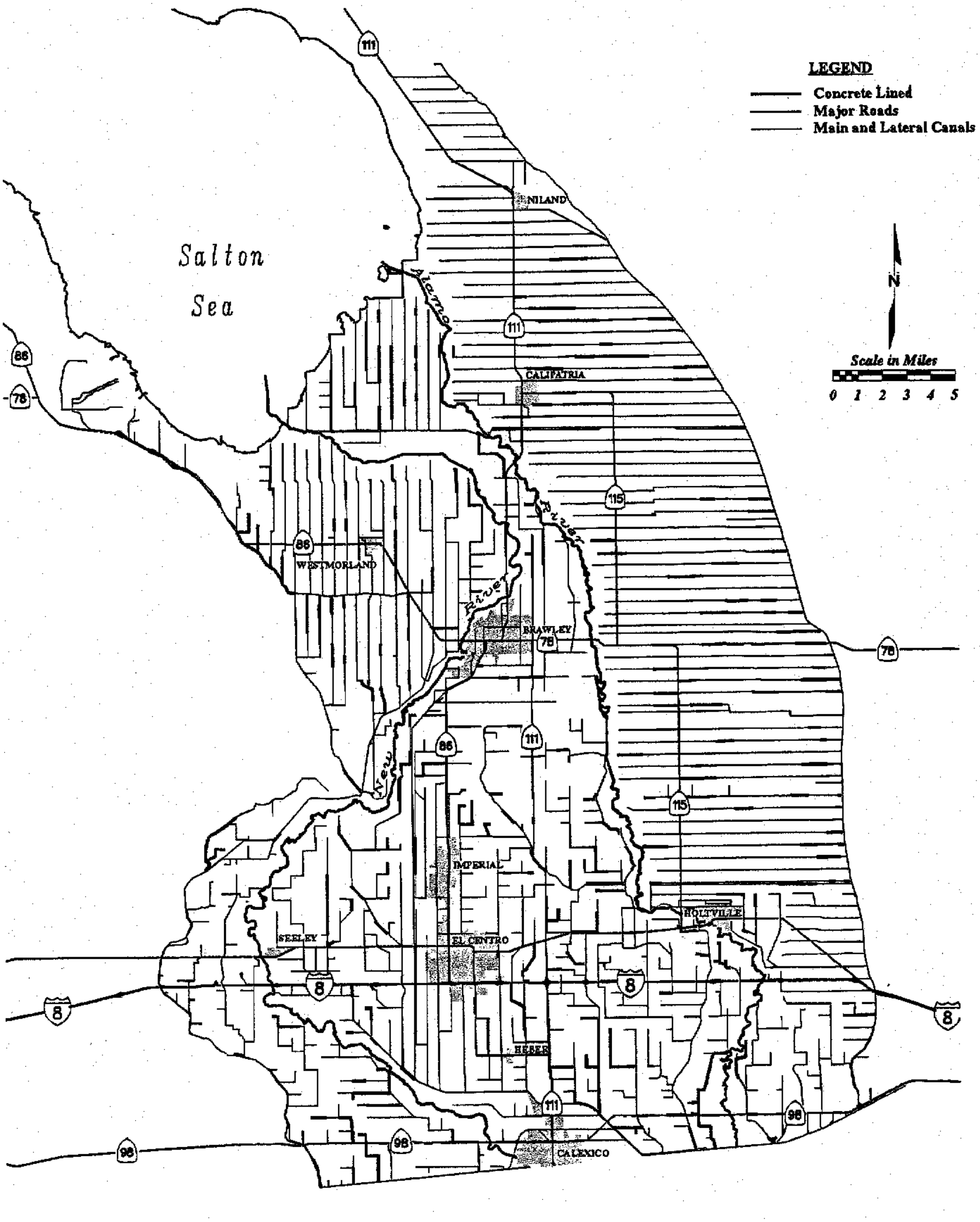

Figure 6.1 Location of IID/MWD Main and Lateral Canal Lining Projects

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Information Systems - GIS

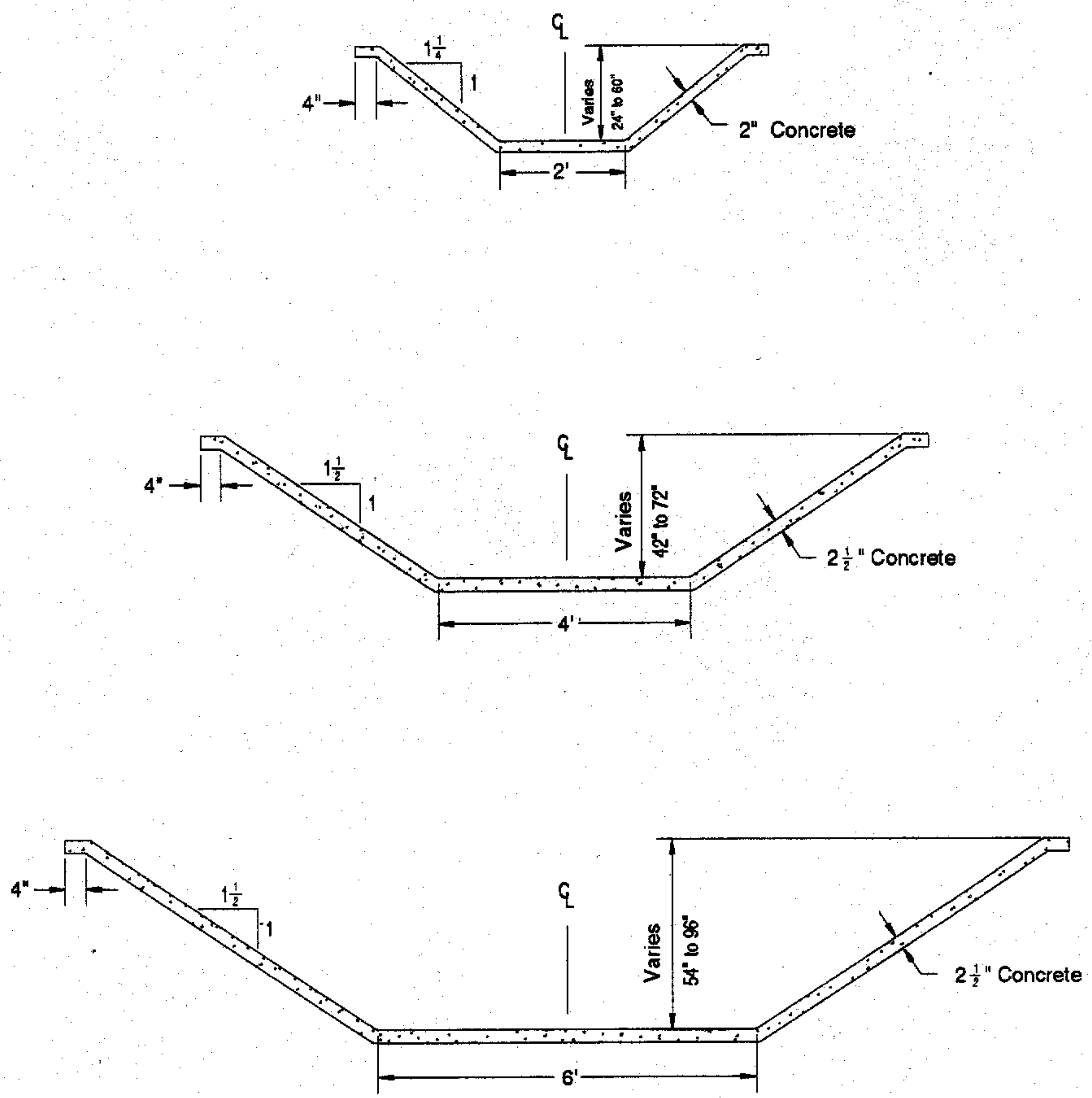
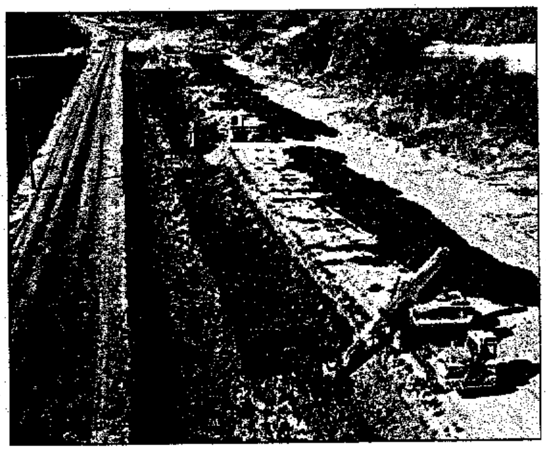
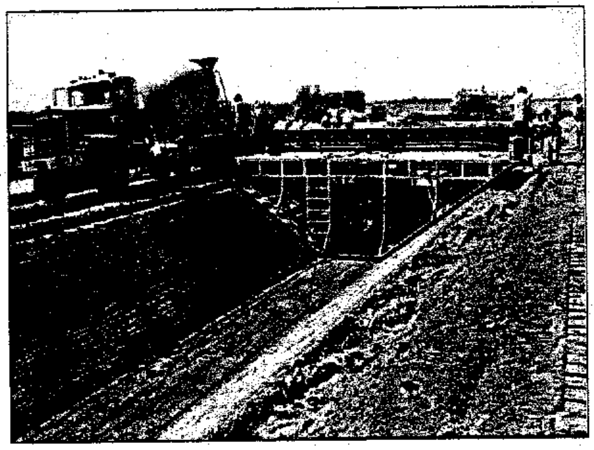


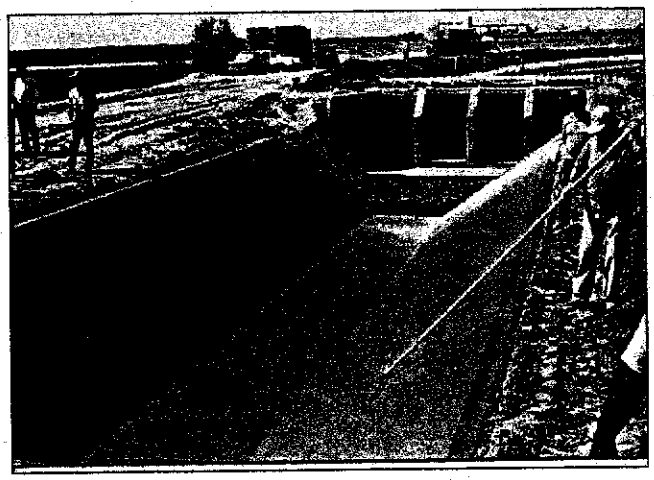
Figure 6.2 Typical Concrete Canal Sections



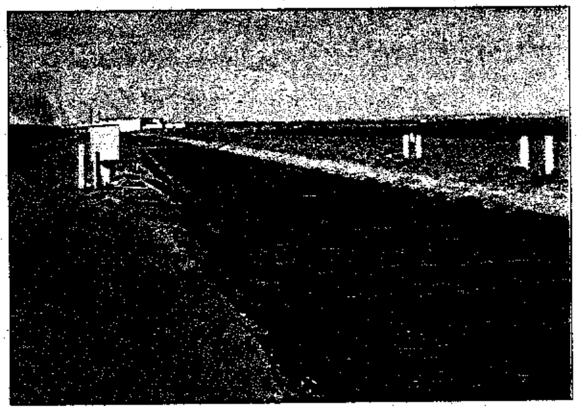
Main Canal Lining, South Alamo Canal



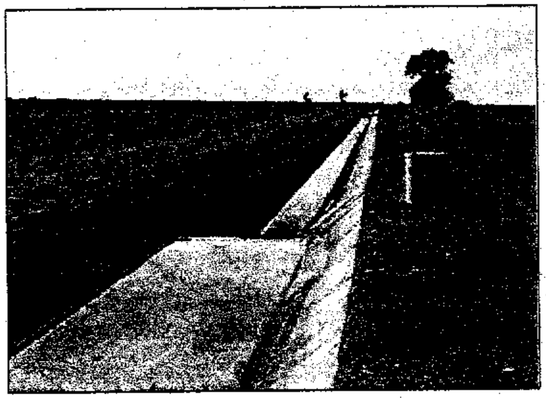
Main Canal Lining, South Alamo Canal



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]	1999 Water Conservation 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.

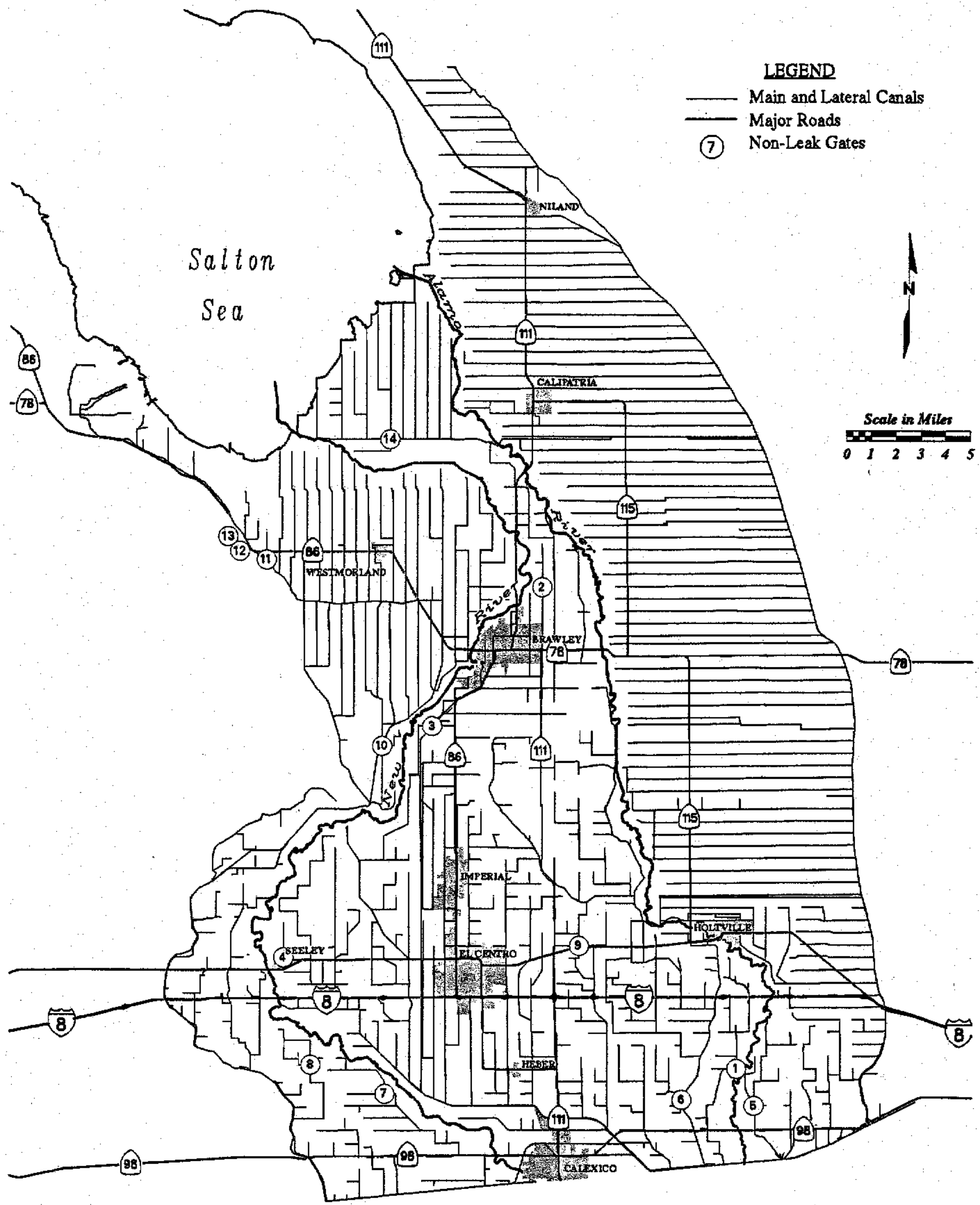


Figure 8.1 Location of IID/MWD Non-Leak Gate Sites

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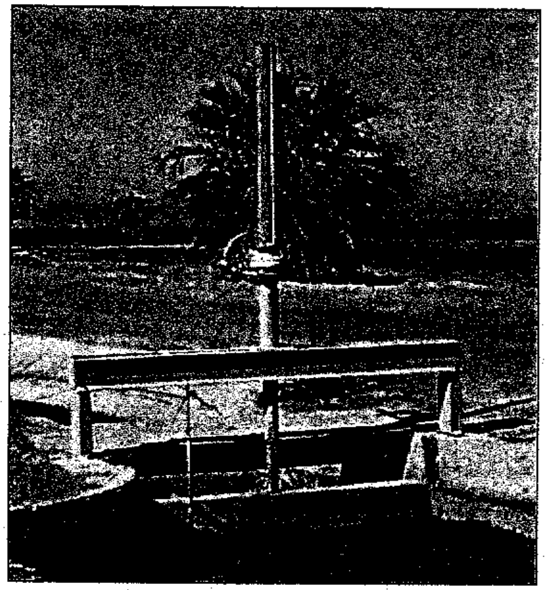
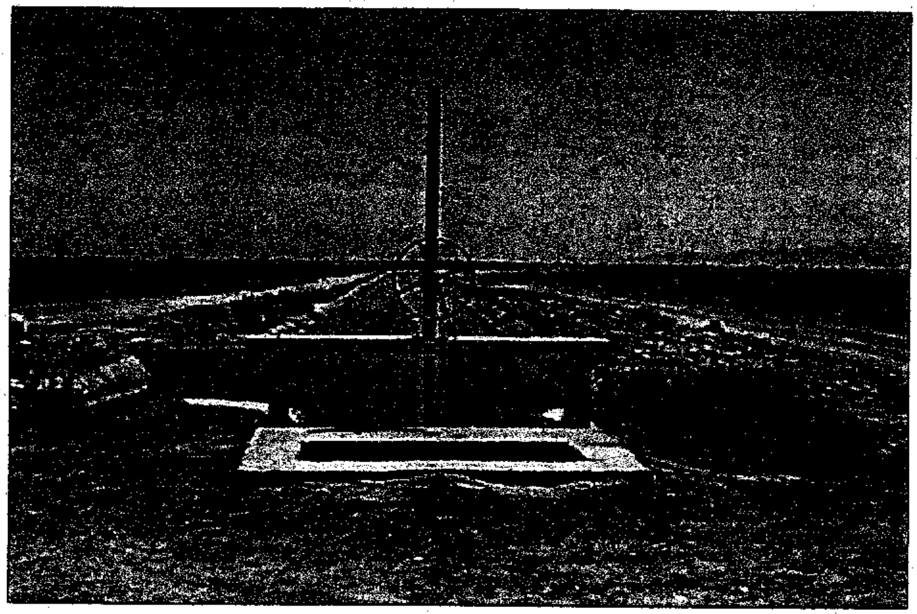
Information Systems - GIS



Typical Non-Leak Gate

Wisteria Lateral 7 Heading 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.

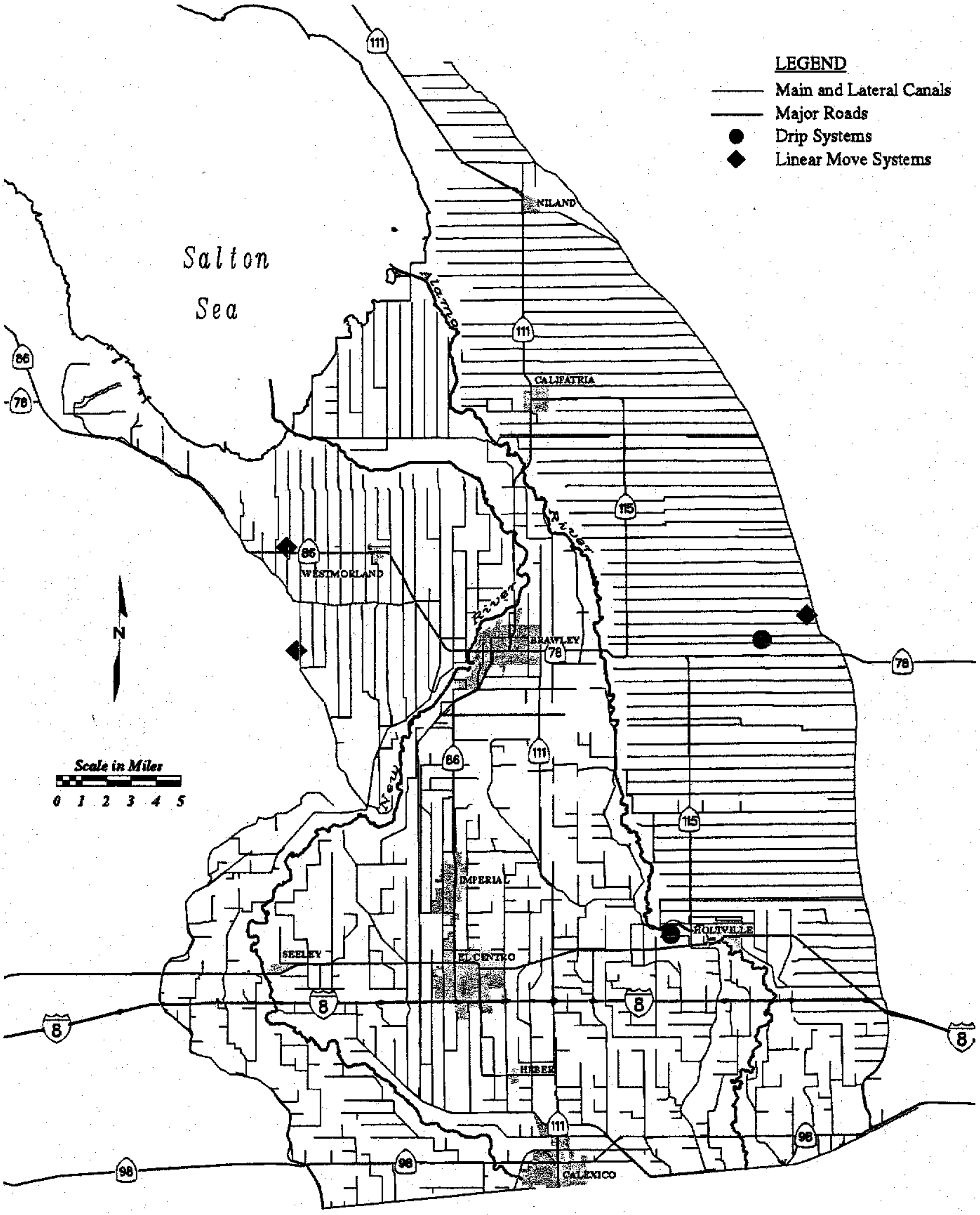


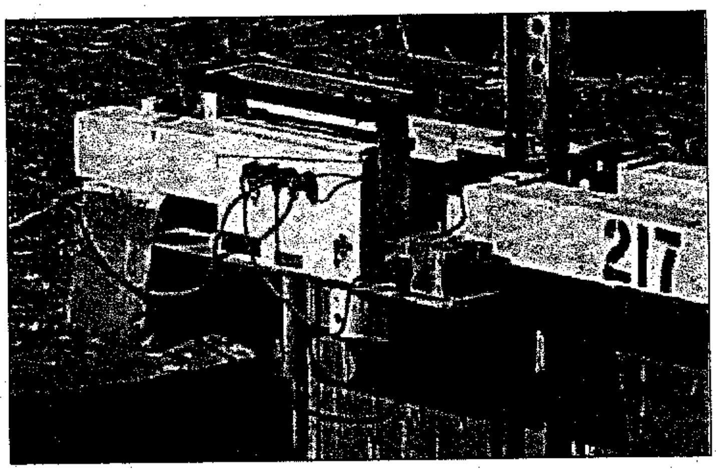
Figure 9.1 Location of IID/MWD Irrigation Water Management Projects

Information Systems - GIS

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.

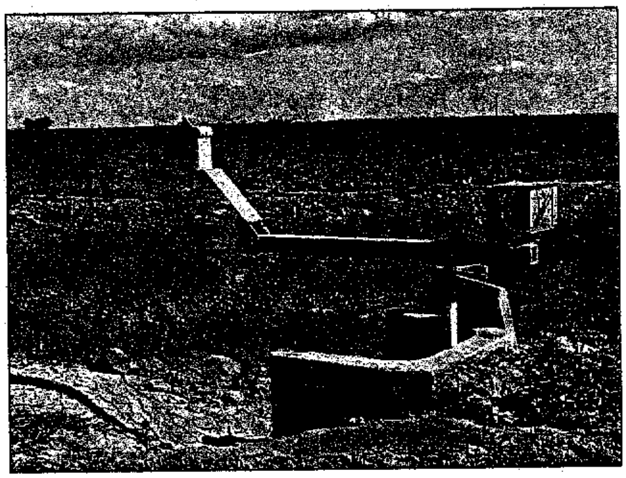
Photos of irrigation training and evaluation equipment and of a linear move and drip system are provided in Figures 9.2 and 9.3. Irrigation Water Management Cost Summary details are provided in Table 9.1.

Zanjero and Hydrographer Training



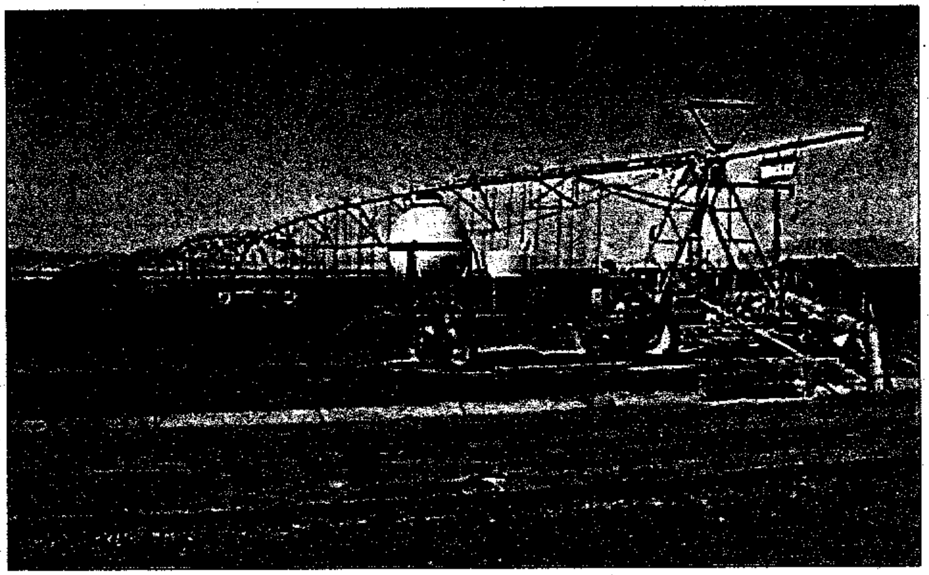
Close-up of Delivery Meter

Delivery Meter

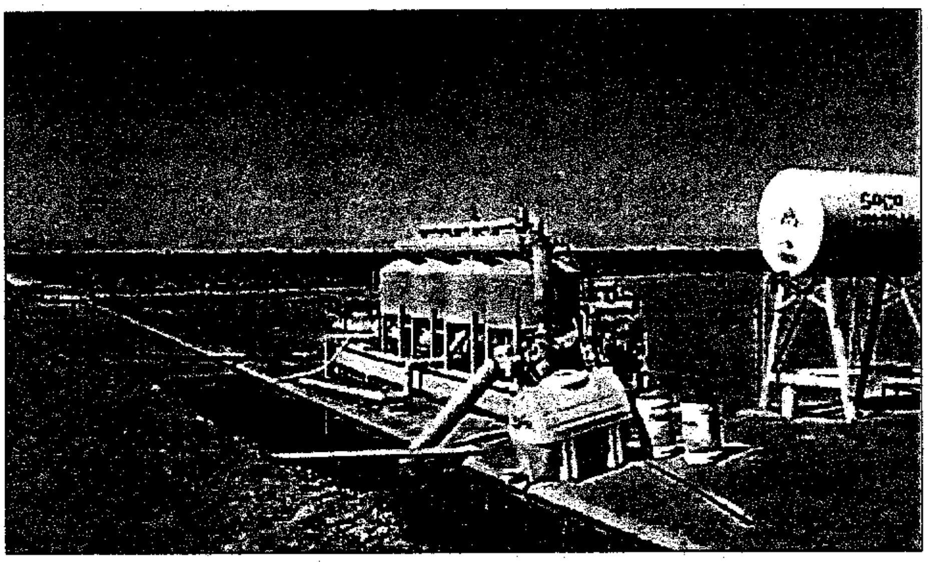


Tailwater Meter

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]	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

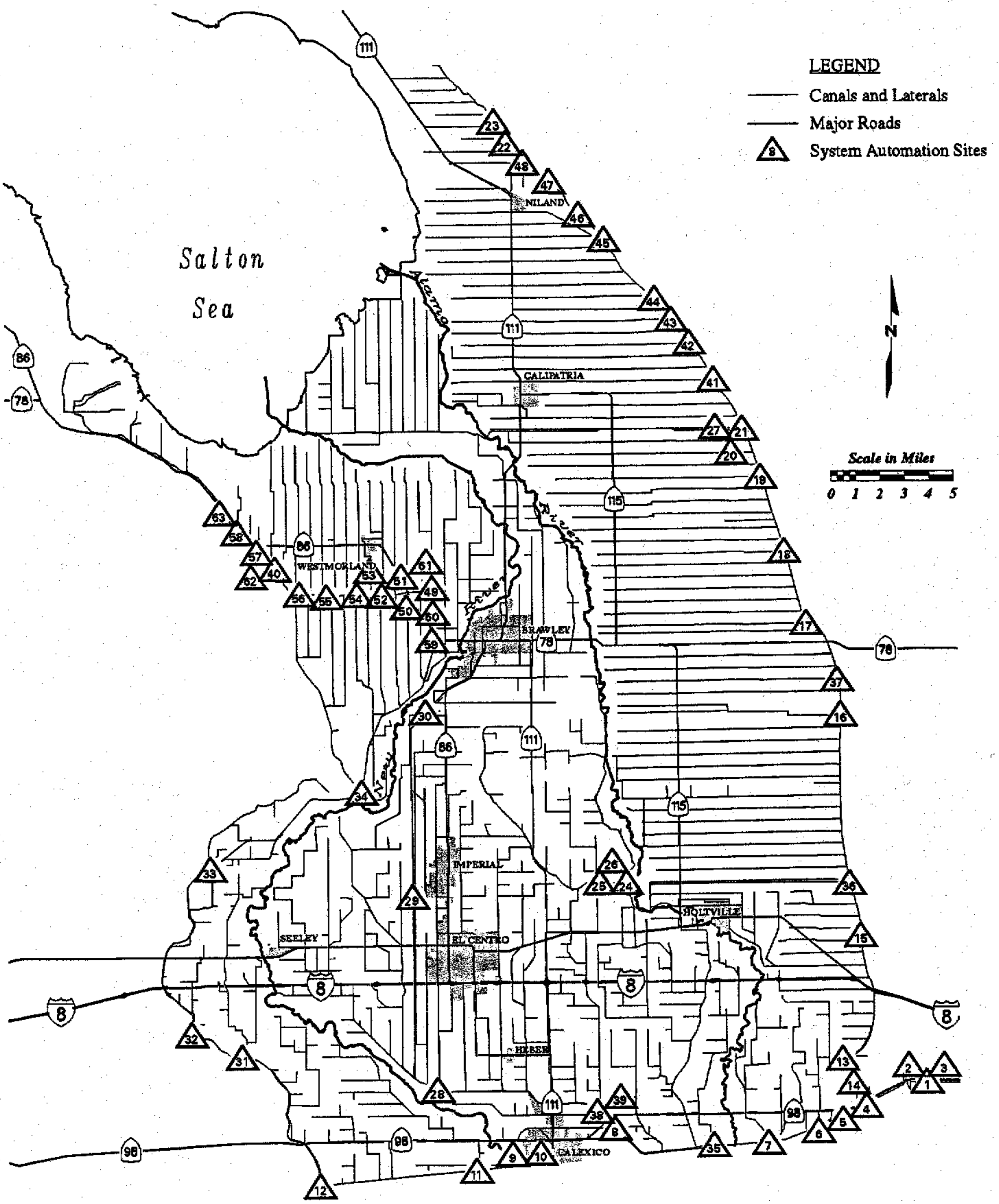


Figure 10.1 Location of IID/MWD System Automation Sites

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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.

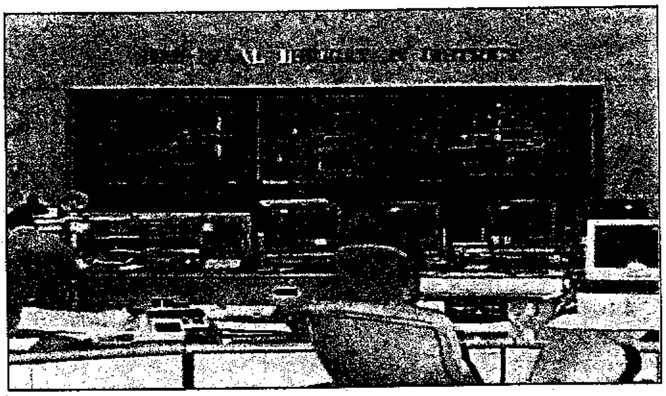
Communications Improvements

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.

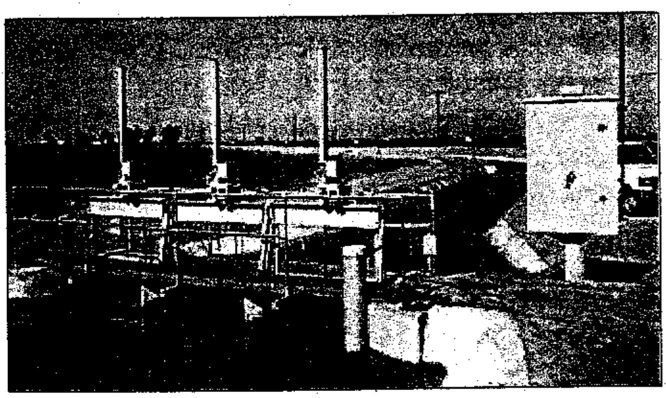
Field communication is accomplished using digital radios connected to the control room via an existing microwave system. Thus, local site information is monitored on a real-time basis throughout the system. Open-channel flow was recognized as a process that could benefit from standard industrial control 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.

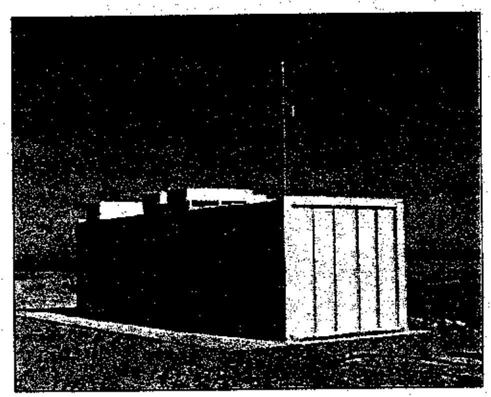


Water Control Center Panel

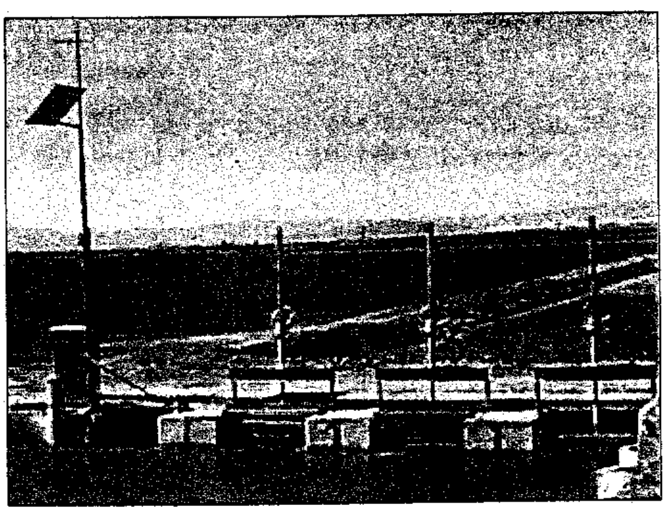
Water Control Center Entrance



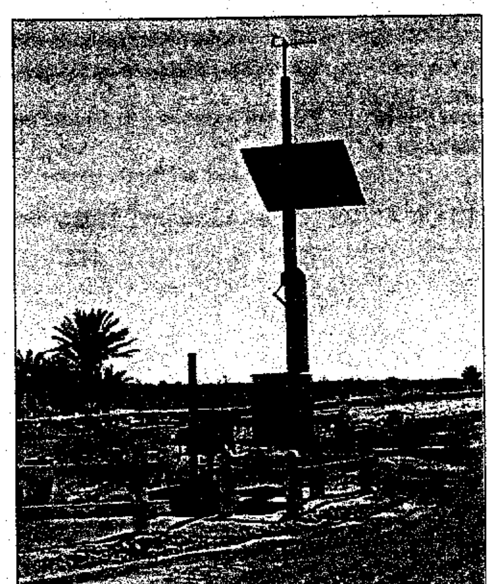
Automated Gates



Typical Control Building

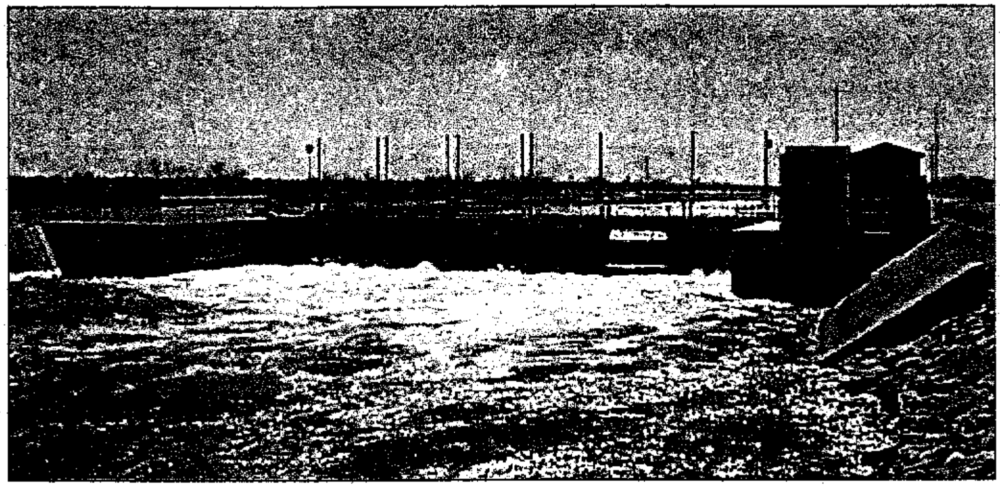


Solar Powered Gates



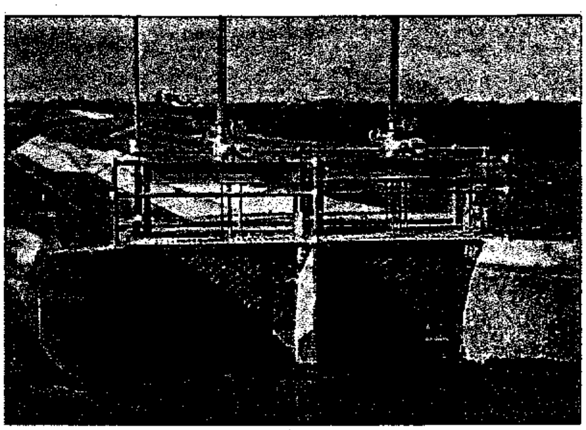
Solar Powered SCADA System

Figure 10.2 IID/MWD Project 15 System Automation

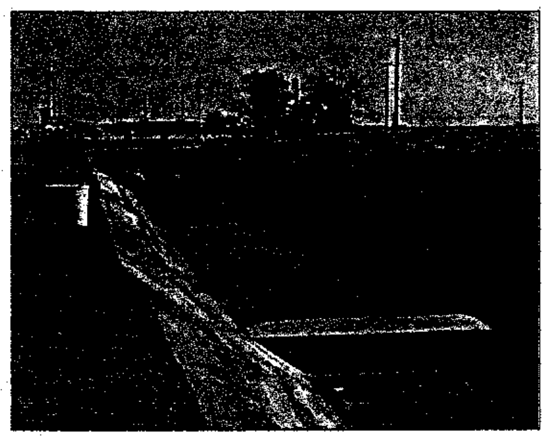


Automated Gates , East Highline Canal

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]	1999 Water Conservation 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.

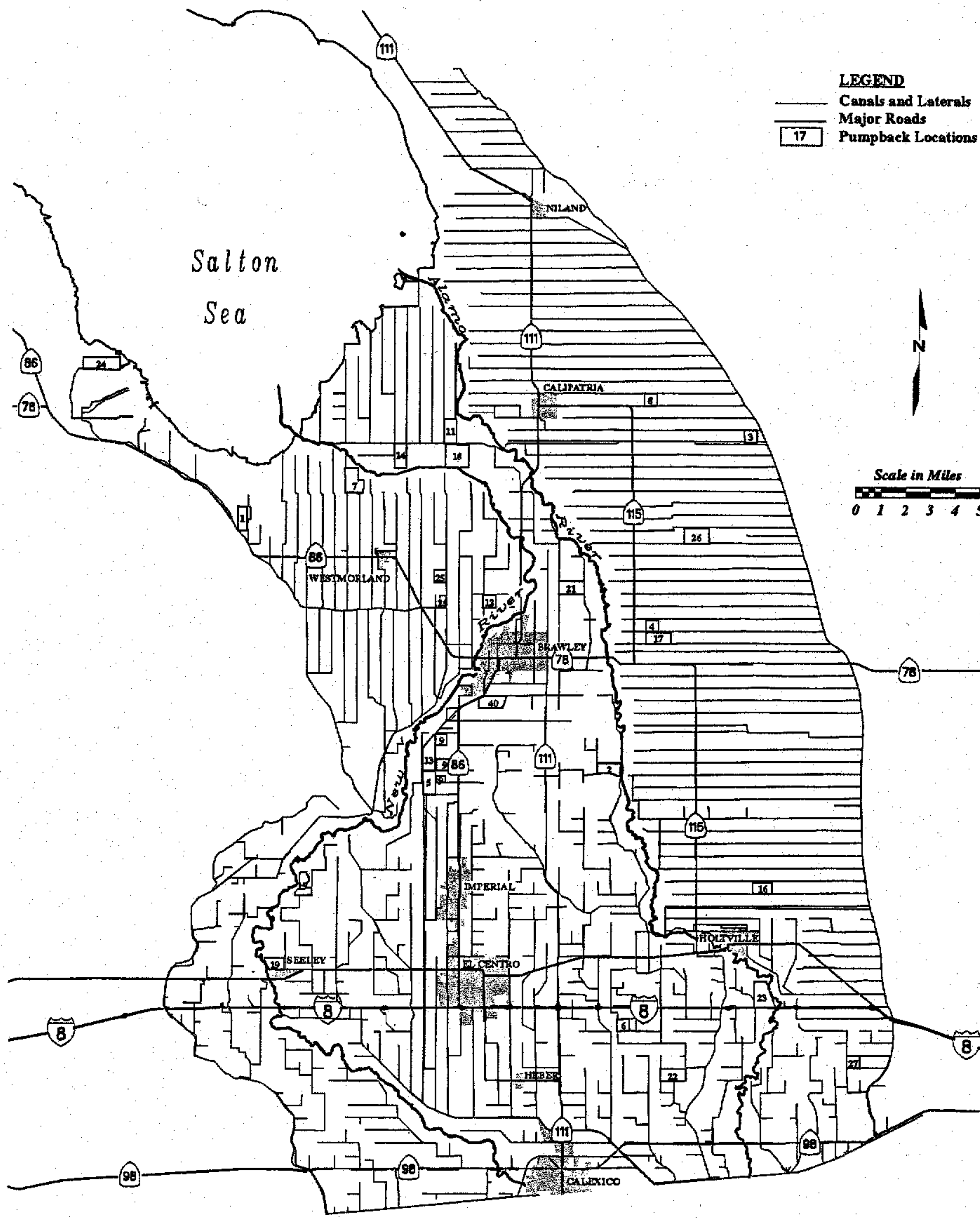


Figure 11.1 Location of IID/MWD Additional Irrigation Water Management Projects

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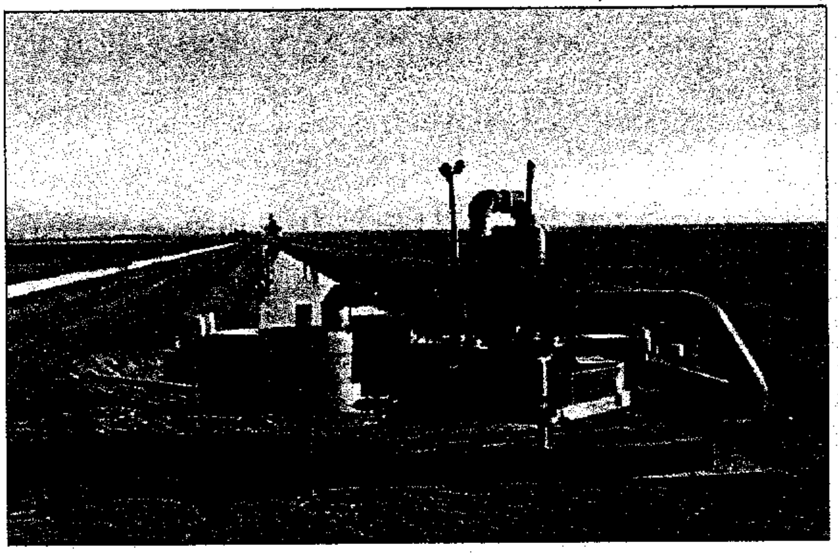
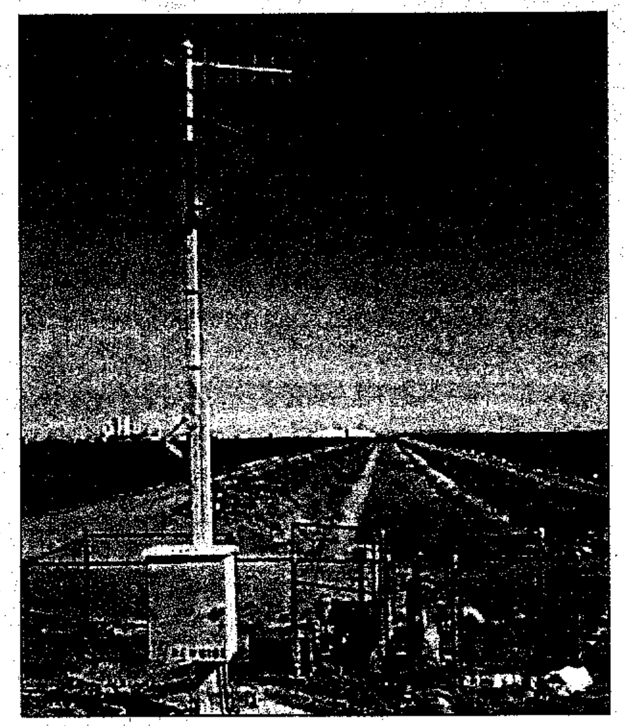
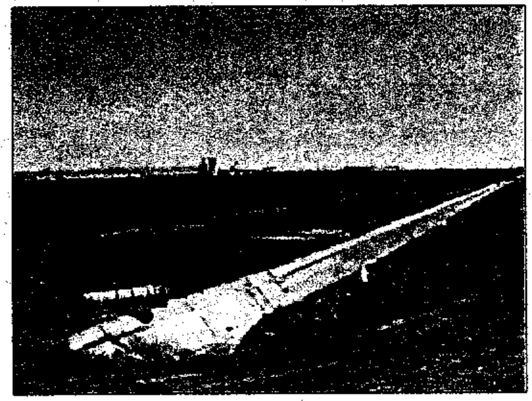


Permanent Tailwater Return System and Pond

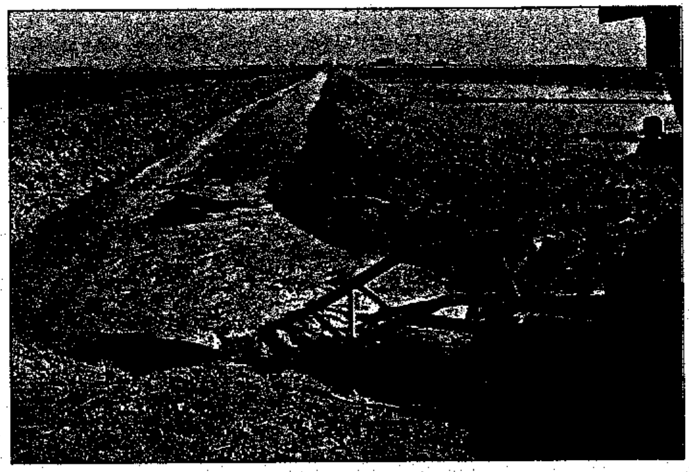


Permanent Tailwater Return System and Pond

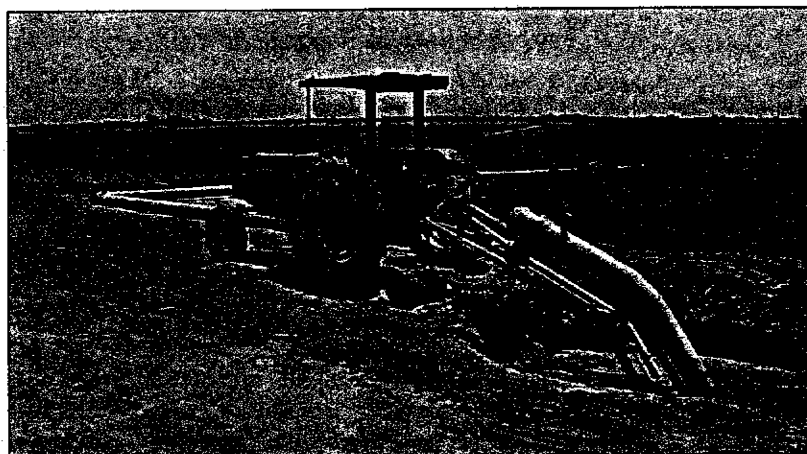


Tailwater Return System Outlet to Field Head Ditch

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.

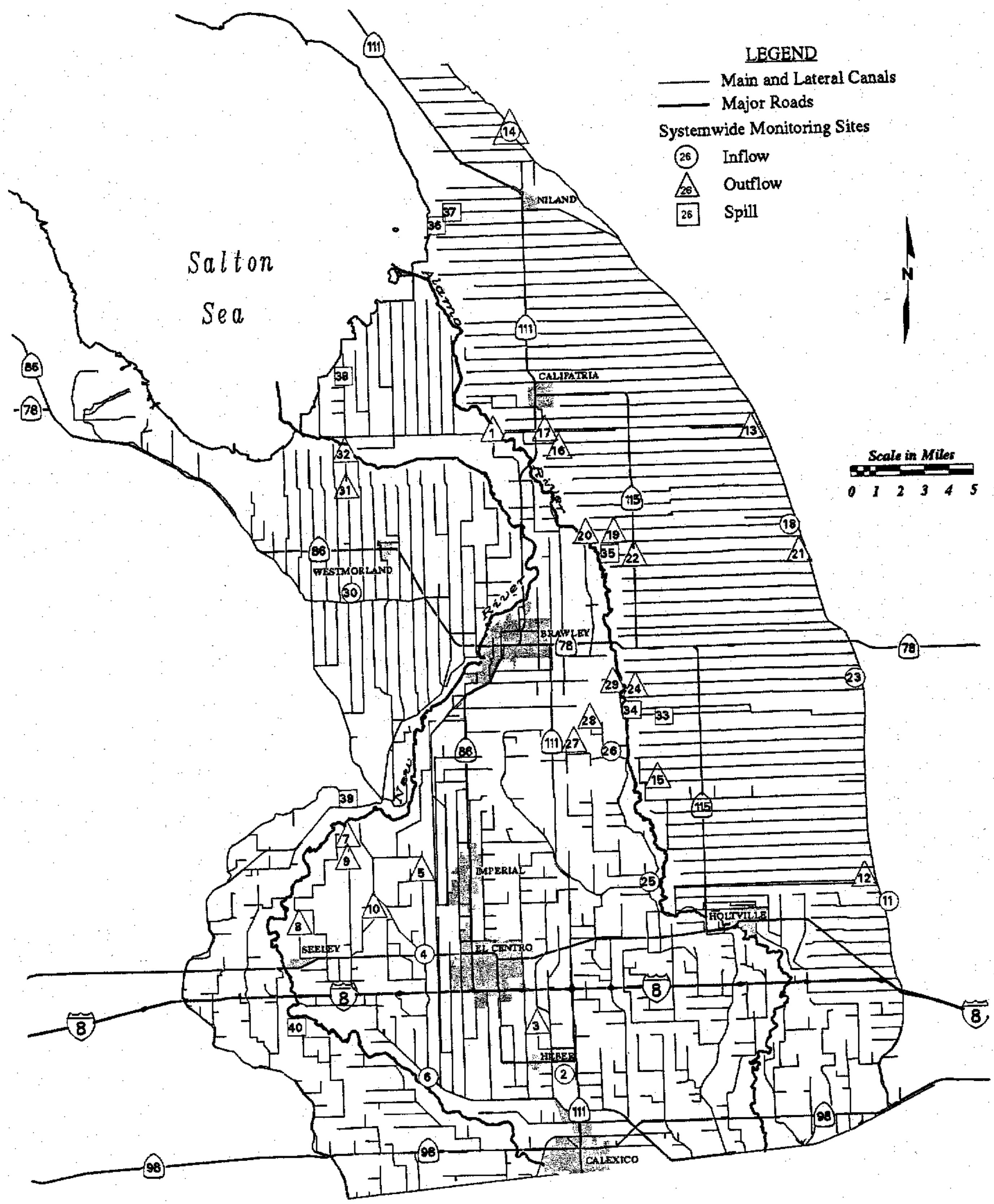

Figure 12.1 Location of IID/MWD Systemwide Monitoring Sites

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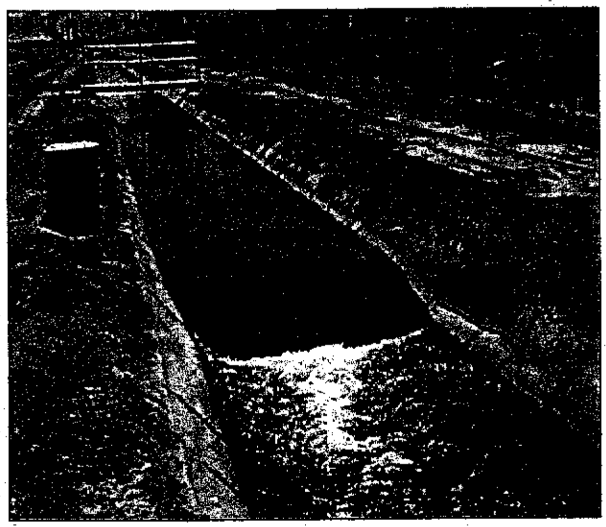
Table 12.1 IID/MWD Systemwide Monitoring (SWM) Site Summary Table

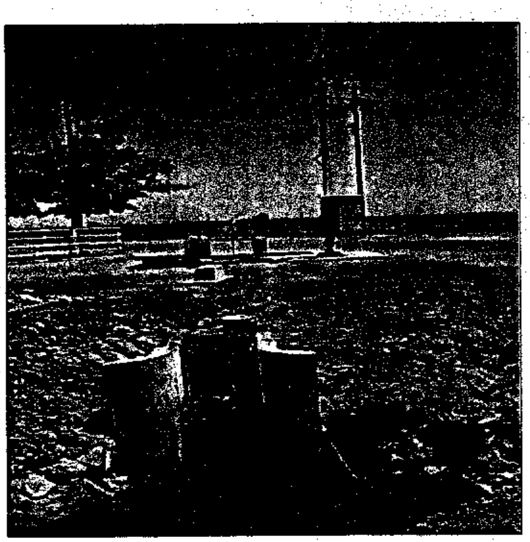
Site No.	Site Name	Flow Measurement Structure	Flow Measurement Recorder	SWM Area	Site Type	IID Division
1	Alamo River Drop 3	Drop	RTU	Alamo River	Outflow	Northend
2	Daffodil Canal Heading BCW	BCW	RTU	Daffodil	Inflow	Southwest
3	Daffodil Canal Spill	SCW	RTU	Daffodil	Outflow	Southwest
4	Ebony Canal Heading 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

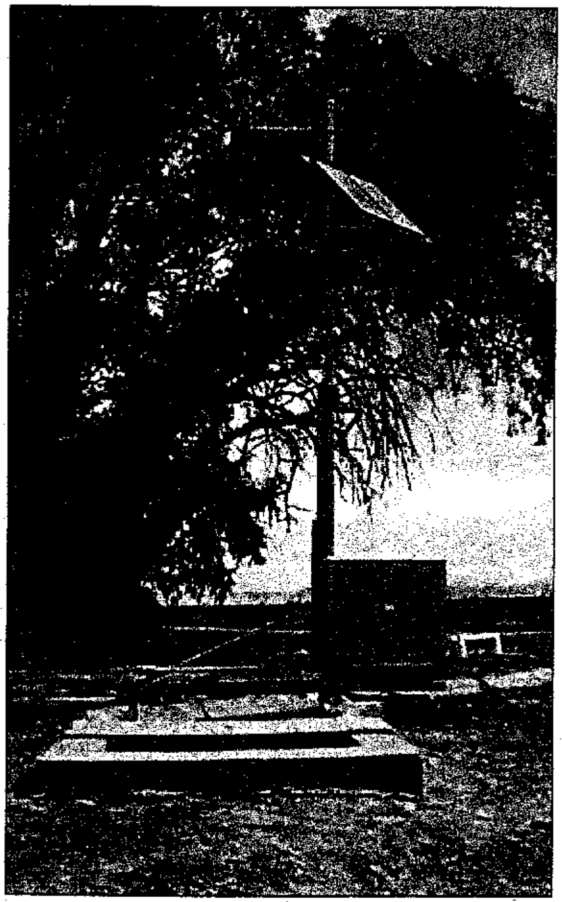


Daffodil Canal Heading, SWM Site

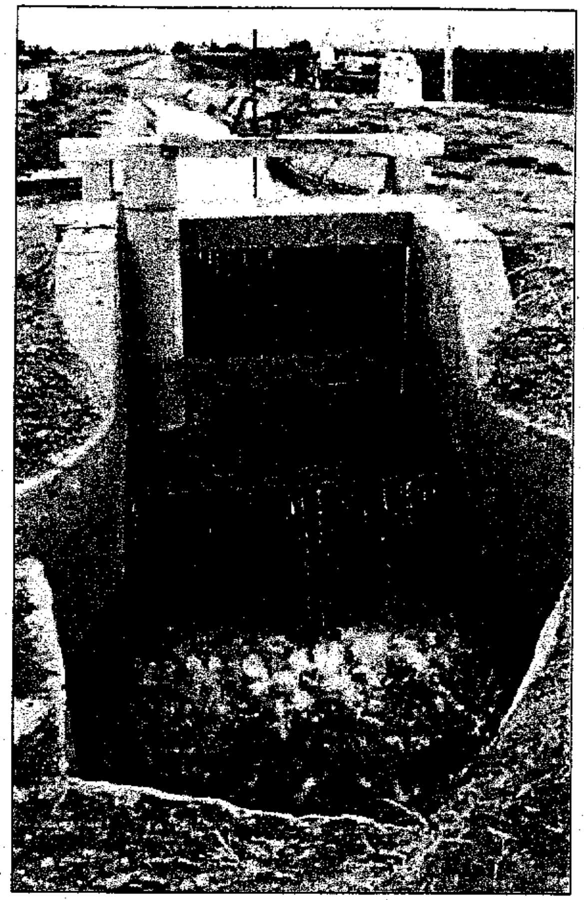


Daffodil Canal Spill, SWM Site

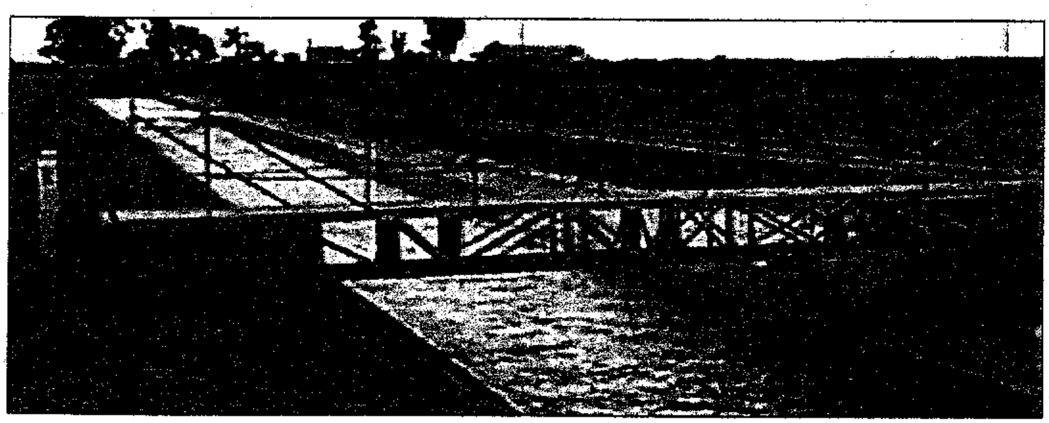
Figure 12.2 IID/MWD Systemwide Monitoring (SWM)



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