MANAGEMENT OF WATER CONSERVATION THROUGH IRRIGATION SYSTEM MODERNIZATION AND REHABILITATION

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ABSTRACT

A landmark water conservation agreement became effective in December 1989 between the Metropolitan Water District of Southern California and Imperial Irrigation District to conserve 106,110 acre-feet of water annually through the modernization and rehabilitation of Imperial Irrigation District's irrigation distribution system. The agreement provides for 17 projects (Program) to be planned, designed and implemented over a five year period, ending in 1995, plus verifying project accomplishments both from a cost and volume of water conserved standpoint. Management of the planning, design and implementation process, the process of verifying project accomplishments and three case studies demonstrating the various planning approaches used are presented.

INTRODUCTION

The Imperial Irrigation District (IID) distributes between 2.5 and 3 million acre-feet of Colorado River water annually through the All American Canal primarily for gravity irrigation of nearly 500,000 acres of farm land in the Imperial Valley in southeastern California. All agricultural drainage water flows northerly by gravity to the Salton Sea. During the mid-1980s, IID determined that up to 358,000 acre-feet of water could be conserved annually by the implementation of water conservation projects without negative impacts to agricultural production and that 250,000 acre-feet of this

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conserved water could be made available to lower priority users of Colorado River water in California. The Metropolitan Water District of Southern California (MWD) normally distributes over two million acre-feet of Colorado River water and State Water Project water annually to a service area of over 5,100 square miles in six Southern California counties in which over 15 million people reside. Faced with current and projected water supply shortages in its service area, MWD has been aggressively pursuing various programs aimed at improving the adequacy of its water supplies. One such program involves improving the efficiency of agricultural water use outside the MWD service area through economic incentives and making the conserved water available to MWD.

A landmark agreement (Agreement) became effective in December 1989 between MWD and IID which provides for the implementation by IID of 17 projects estimated to conserve 106,110 acre-feet of water annually by 1995. MWD is funding all the costs of 15 projects of the program and, in return will have available additional water from the Colorado River for diversion through its Colorado River Aqueduct. Figure 1 shows the service areas of IID and MWD, the Colorado River, and the MWD Colorado River Aqueduct.

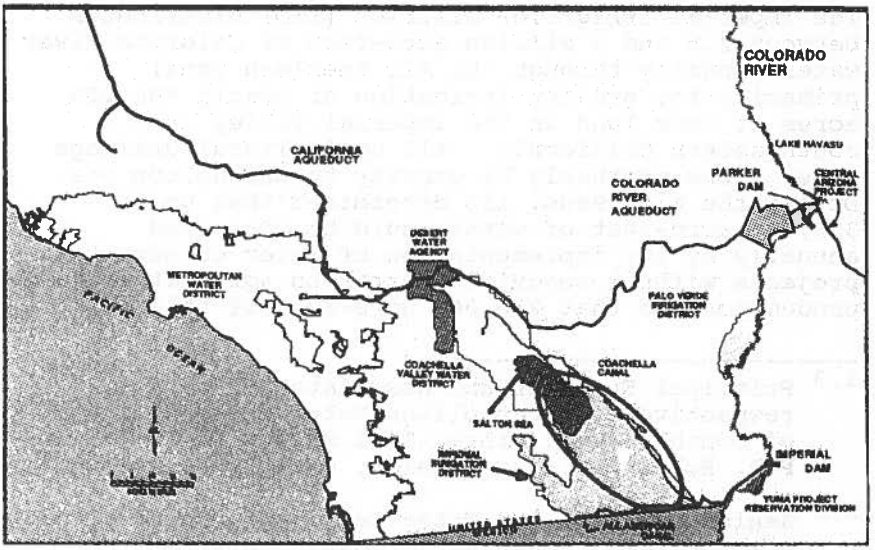

Figure 1: IID and MWD Service Areas.

ORGANIZATION FOR MANAGEMENT

As a means of managing the Program to provide prompt and orderly review and approval of planning activities as well as design and construction, a Program Coordinating Committee (PCC) consisting of three professional engineers competent and experienced in the agricultural and civil engineering fields was established. The PCC is composed of one representative from IID, one representative from MWD, and one representative selected by both parties to the Agreement.

Additionally, to oversee and direct the activities to verify the quantity of water conserved by the Program, a Water Conservation Measurement Committee (WCMC) was established. The WCMC is composed of the three PCC members plus one representative each from the Coachella Valley Water District (CVWD) and the Palo Verde Irrigation District (PVID). CVWD and PVID hold intervening rights to use of Colorado River water in California, hence their interest in verifying the amount of water conserved by the projects. The WCMC is assisted in carrying out its responsibilities by consultants specialized in water resources engineering.

The primary planning, design, and construction management activities are carried out by the IID staff supported, as required, by consultants. The Program, with estimated capital expenditures of $97.3 million and annual direct costs of $2.6 million (all in 1988 dollars), is a major effort requiring a substantial amount of planning, much of which is being conducted concurrently with design and construction activities in order to meet the schedule specified in the Agreement. As IID had only the necessary technical staff to carry out its normal water delivery operations, reorganization and additional staff were required to meet this challenge.

The reorganization and additional staffing were accomplished through the hiring of professional and technical personnel, sometimes on a part-time basis, plus engaging consultants to provide specialized skills as required. In hiring consultants, the effort was focused on engaging specific professionals within firms who were known to have the expertise needed.

THREE PLANNING CASE STUDIES

Three case studies are presented to demonstrate the variety of management/planning approaches used. In addition to the basic planning documents, the development of implementation plans necessary to carry out verification activities including field monitoring sites, data gathering and analysis, and presentation of results and recommendations to the PCC and WCMC were required. The first case, canal concrete lining, had to begin quickly due to time constraints. IID staff had considerable experience in concrete lining, so construction began almost immediately after the Agreement became effective. On-Farm Water Management, the second example, was dependent on direct farmer involvement in the planning process. The third example, Plum-Oasis Lateral Interceptor, required extensive planning, part of which took place concurrently with design and construction.

Canal Concrete Lining Project

In January 1990, only three weeks after the first Program funds were deposited, construction began on lining existing earthen canals. The decision to proceed in this manner was based primarily on the initial estimate that 265 miles of lined canals were needed to conserve 29,150 acre-feet of water as specified by the Agreement. This would be a major effort, both from a cost and water conservation standpoint. Additionally, IID staff had considerable experience designing and constructing concrete lined canals; therefore, all the design/construction guidelines and criteria were available and were put immediately to the task at hand.

The verification process caught up with the design and construction effort about 18 months after project implementation began and approximately 110 miles of canals had been lined. Preliminary results indicated a potentially lower volume of conserved water per mile of canal than originally estimated, and the Agreement cost per acre-foot of water was now being exceeded. The PCC agreed to put this project on hold while IID staff developed preliminary procedures to evaluate the amount of water conserved. This planning was accomplished in a 45-day period resulting in a revised strategy to line an additional 26 miles of canals in 1992. A consultant was engaged

to continue this effort through a detailed evaluation of all operating considerations including flow management losses resulting from required daily changes in delivery locations and flow rates, seepage losses during and after the start-up of canal operations, losses during the canal operation shutdown period and evaporation losses. Taking into account these factors, a lateral conveyance loss computer simulation model, Lateral Probe, was developed and is being used to screen remaining earthen canals in IID for potential concrete lining under this project. Additionally, further refinement of the model for use in the verification process is underway.

On-Farm Water Management

The on-farm irrigation water management projects include implementation of tailwater pumpback systems, drip irrigation systems, level basin irrigation, and improving irrigation management skills of farmers. For planning purposes, some field data and information for on-farm projects were available from previous studies conducted by IID. However, successful implementation of the projects required farmers' direct involvement and cooperation. Farmers, through existing committees or newly established ones, were involved from the start. They have and will continue to play an active role in the decision making and formulation of the scope, magnitude and administration of this project.

Six tailwater pumpback systems were installed in 1991 and 12 will be installed in 1992. Implementation of four drip systems was completed and a field irrigation laboratory should be fully operational by late 1992. Plans to participate in three additional drip systems have been completed and one of these systems should be operational by October-November 1992. Field data, which will form the basis for future systems, is being collected for verification of water conservation as well as annual direct costs associated with each system. In order to address farmers' concerns regarding potential effects on crop yields, soil salinity monitoring is an integral part of the projects. This planning and implementation process for on-farm projects is proving to be an effective, dynamic process and has laid the groundwork for successfully completing the first Agreement projects as well as any possible future agreements.

Plum-Oasis Lateral Interceptor

The Plum-Oasis Lateral Interceptor (Interceptor), first of its kind for IID, consists of an open channel which will collect and transport operational discharge and returned farm delivery water from the ends of several laterals to a storage reservoir for use in another part of the distribution system (see Figure 2).

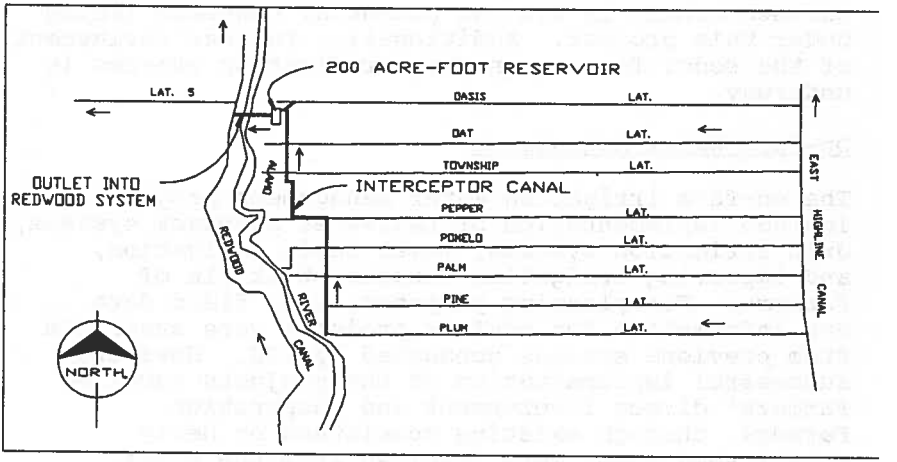

Figure 2. Plum-Oasis Lateral Interceptor.

Planning for the Interceptor was performed by IID staff and began in January 1990. The basic goals of the planning effort were to determine the specific location of the channel and storage reservoir, and to develop criteria for interceptor channel and reservoir sizing. The primary criteria for locating the Interceptor included: 1) locating the system as close as possible to a portion of the distribution system where the collected water could be used, and 2) water demand in the receiving portion of the distribution system had to equal or exceed the anticipated quantity of water to be captured. Developing criteria for interceptor channel and reservoir sizing was based on estimating inflow to the Interceptor. The inflow estimate would also be used to determine whether an area met the supply versus demand criteria previously mentioned.

Inflow to the Interceptor will be composed of two components: 1) operational discharge (incidental flow fluctuations and carriage water which is required to fill ponds and insure that enough water reaches every delivery in IID's gravity system), and 2) water generated by providing greater water delivery shutoff flexibility to farmers. At present, water is ordered for 24-hour or 12-hour time periods. A farmer may request that an order be terminated early; however, this can be done only if IID personnel are available to close the delivery gate and adjust the canal heading so that the water does not continue to flow down the lateral and result in spill. With the Interceptor in place, farmers may be given the freedom to terminate deliveries ahead of schedule without having to notify IID in advance.

Estimating the quantity of operational discharge was relatively straightforward because operational discharge data collection began on the Plum through Oasis Laterals in June 1988. Thus, about 1.5 years of operational discharge flow records were available for project planning. However, the quantity of water that would be produced by allowing farmers to terminate their deliveries early had to be estimated using actual delivery records combined with assumptions as to how many deliveries would be terminated early and how far in advance termination would take place. Liberal sizing criteria were recommended because the Interceptor will be used to determine the potential for water conservation by allowing unrestricted, early termination of deliveries. Further restriction on the size of the Interceptor would necessitate lesser operational flexibility which could reduce the effectiveness of the project.

Providing additional flexibility will also require replacing the regularly operated check gates in the laterals with control structures which will allow flow changes to pass downstream with minimal impact to deliveries in progress. Determining the type of structure to be used became a study in itself, which took place after the planning for the interceptor channel and storage reservoir were complete. Thus, design of the interceptor channel and reservoir was started while planning for the new gate structures was in progress.

A total of three lateral interceptor systems, including the Plum-Oasis Lateral Interceptor, are included in the Agreement. Construction of the Plum-Oasis Lateral Interceptor began in March 1992. As part of this effort an Operations Study is being planned to evaluate the various potential operating scenarios such as: 1) Entire lateral automated; 2) Lateral heading and connection to interceptor canal automated but not canal checks; and 3) Lateral automated with exception of the heading. To facilitate this Study only three of the eight laterals had all the drop-leaf gates installed, at the check structures, during this phase of project construction. The Study is expected to provide practical, field results for finalizing the Plum-Oasis Lateral Interceptor configuration. Experience gained from this project will be used for planning and design of the remaining two interceptor projects to be constructed in 1993 and 1994.

SUMMARY

A landmark agreement became effective in December 1989 between MWD and IID which provides for the implementation by IID of 17 projects which will conserve an estimated 106,110 acre-feet annually by 1995. MWD is funding all the costs of 15 projects of the program and, in return will have available additional water from the Colorado River for diversion through its aqueduct. The primary planning activities are carried out by the IID staff supported, as required, by consultants. A Program Coordinating Committee was established to provide review and approval of planning, design, and construction activities. A Water Conservation Measurement Committee was established to oversee and direct activities to verify the quantity of water conserved by the program.

Three case studies demonstrate the variety of management/planning approaches used. Construction of concrete lined canals began almost immediately after the Agreement became effective. However, 18 months after project implementation, new information from water conservation verification activities caused a temporary slowdown while the strategy for selecting canal sections for lining was revised. On-farm irrigation water management projects required farmers' direct involvement and cooperation through

existing committees or newly established ones. They played an active role in the decision making and formulation of the scope, magnitude and administration of this project. Planning for the Plum-Oasis Lateral Interceptor was conducted by IID staff. Once the size and location of the new interceptor channel and reservoir were completed, design began progressing concurrently with planning to determine the type of control structure to be used in the existing canals which would discharge into the Interceptor.

Managing the Program through the PCC concept has been working extremely well in providing planning and technical reviews and approvals in an expeditious manner with recommendations for studies required to resolve outstanding questions prior to initiating final plans and designs. Additionally, the requirement for the PCC to review and approve all project costs plus monitoring actual costs on a monthly basis provides a regular fiscal accountability to both MWD and IID.

While additional costs have been incurred due to the "fast track" nature of the Program, fortunately problems have been identified in time due to the close management of all Program elements by the PCC and IID staff. Through the substitution of alternative projects for those found not meeting the Program's cost versus volume of water conserved criteria, it is believed that the Program will meet its cost and conserved water objectives.

Appendix I - SI unit conversions

1 acre	=	0.40486 ha
1 mile	=	1.6093 km
1 acre-foot	=	1233.4 m^3