WATER RESOURCES PLANNING TO WATER TRANSFERS TO MODERNIZATION OF AN IRRIGATION DISTRICT: OAKDALE IRRIGATION DISTRICT CASE STUDY

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ABSTRACT

Oakdale Irrigation District (OID) was formed in 1909 and provides pre-1914 water rights to over 55,000 acres of irrigated farmland located within the northern San Joaquin Valley of California. The district's situation is similar to many irrigation districts in the Central Valley; it has an aged and often failing infrastructure which has had little investment over the years; it has an intermixed customer base of both urbanizing ranchette lands, expanding dairies and a rapid conversion to high value permanent crops; it has a demand for more flexible water deliveries and services from its customers; and has limited financial resources to meet those demands.

With that backdrop, initiated in November 2004 and completed in June 2007, OID developed a Water Resources Plan (WRP) as a strategic roadmap for addressing those issues. Today the district is moving forward with the implementation of a $170 million capital improvement program to meet the multifaceted needs of the district. Those needs as outlined in the WRP include the protection of the District's water rights; an increase in agricultural water supply reliability during droughts; protection for the local areas surface and groundwater supplies; along with a roadmap to modernize and rebuild a century old system to meet the needs of its changing customer base. Regional water transfers are being used as the basic funding mechanism to make it all happen.

The paper will provide a background of the drivers that got the OID to begin the planning process; it will discuss how the planning process evolved; what the findings and recommendations were in the final Water Resources Plan (WRP); and finally, how those recommendations are being moved forward to implementation.

BACKGROUND

History of OID

In 1909 OID was organized under the California Irrigation District Act by a majority of landowners within the district in order to legally acquire and construct irrigation facilities and distribute irrigation water from the Stanislaus River (ref. Figure 1). In 1910 OID and the neighboring South San Joaquin Irrigation District (SSJID) purchased Stanislaus River water rights and some existing conveyance facilities from previous water companies. Both districts continued to expand their operations over the ensuing decades.

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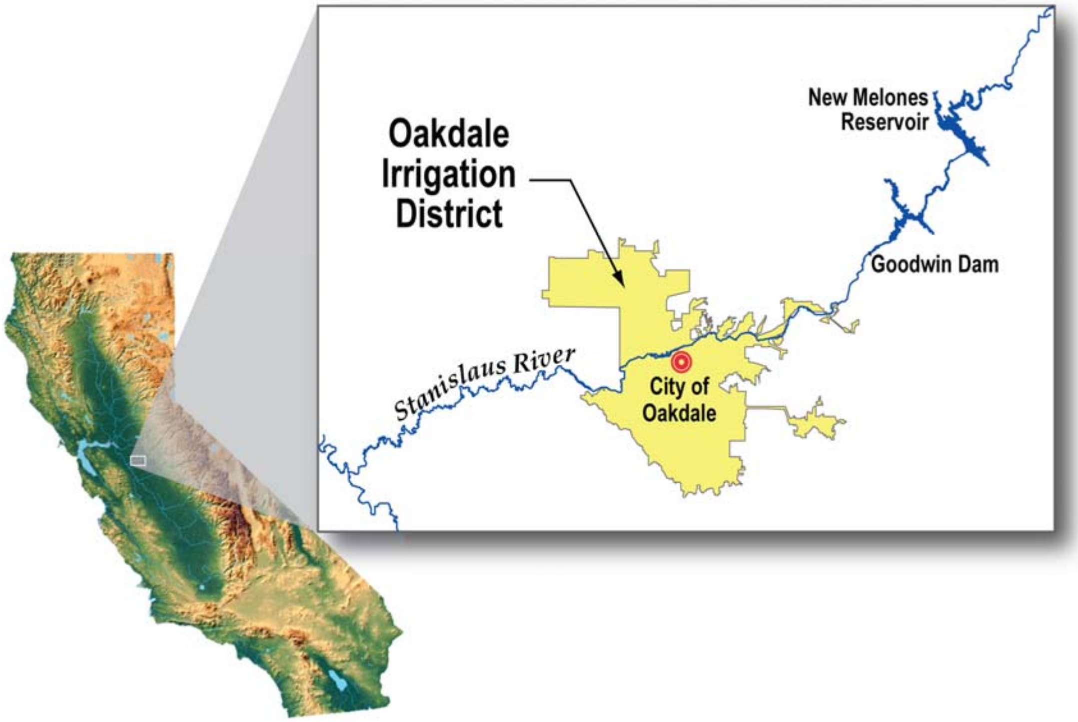

Figure 1. Location of Oakdale Irrigation District

Since their creation, OID and SSJID have constructed dams and reservoirs to regulate surface water storage and deliveries. Most dams were constructed in the 1910s and 1920s, including Goodwin Dam (1913), Rodden Dam (1915), and Melones Dam (1926), which provided 112,500 acre-feet (ac-ft) of shared capacity. To provide supplemental water storage for OID and the SSJID, the Tri-Dam Project was created in the 1940s. Sites were approved in 1948 for Donnells Dam and Beardsley Dam on the Middle Fork of the Stanislaus River, and for Tulloch Dam above Goodwin. The two districts entered a joint agreement to carry out the proposed project and now jointly own and operate the three storage reservoirs for a combined storage capacity of 230,400 ac-ft.

In the early 1970s Reclamation replaced the Melones Dam with the larger New Melones Dam and Reservoir. The districts have an operations agreement with Reclamation to utilize the federally owned New Melones Reservoir.

Significant capital investment has led to a stable, plentiful water supply for the district. Over the last 50 years, the district has focused its financial resources principally on paying off these capital investments; as a result, the district has invested little in replacement, modernization, automation or rehabilitation of its existing system over the years.

Internal and External Drivers Necessitated a Change

Internal Issues: The position of the district in 2003 was not enviable. While water resources were plentiful to meet crop water needs for customers, the operational control of that water was lacking. Principally due to a lack of modern, and often failing, infrastructure that inhibited the district's ability to manage the system efficiently. System failures began dominating the annual workload and budget as years of non-investment in the delivery system began to show.

On-farm water use was equally deficient in terms of efficiency. Without a good system of controls in the canals of the district, farmers experienced significant canal fluctuations which impaired their ability to efficiently manage water on their side of the farm gate. Couple the above with foothill farming practices that had for years utilized wild flooding as its principle form of irrigation, and on-farm water use efficiency was not very high.

The district was also experiencing a change in its landscape and in the customer base it served. Pasture, which dominated the area's agriculture for years, was being converted to high value tree crops like almonds and walnuts. These changes were met with demands by farmers for a different service standard for their water deliveries. Similarly, a significant amount of pasture was being converted to feed crops such as corn and oats as dairies began buying and converting pasture for their expanding operations and to meet new regulations regarding nitrogen management within their operations.

External Issues: Water quantity issues in California have always been a subject of concern but in recent years, these shortages and their repetitiveness seemed to be on the increase. While the district has three (3) water transfers to its neighbors, one 15,000 acre foot transfer to the City of Stockton via the Stockton East Water District and two (2) transfers totaling 26,000 acre feet to the Bureau of Reclamation for environmental and water quality purposes, there was pressure to do more by the City of Stockton as the transfer term of the original contract was reaching its end. Similarly, the City and County of San Francisco has always expressed an interest in discussing the future status of OID's water supply.

The recent loss of the agricultural waiver for the discharge of surface water placed another problem both on the district and its agricultural customers. Farmers were looking towards the district to help with these changing regulations and the district, not being in a financial position to due otherwise, looked at these problems as on-farm issue, not one the district should be involved in.

Needless to say, the complexity of water issues, both locally and at the state level, necessitated a rethinking of OID's current practices and priorities in order to guarantee full protection of the district's and region's water supplies into the future. The District's Board of Directors and management, recognizing this challenge, commissioned CH2M HILL in the fall of 2004 to explore the issues facing OID and develop a comprehensive plan to respond to these issues. These were the principal objectives of the Water Resources Plan (WRP).

THE WATER RESOURCES PLAN

In the development of the WRP, the OID Board of Directors developed the following five goals that they agreed key to developing water management strategies and alternatives:

- Provide long-term protection to OID's water rights
- Address federal, state, and local challenges
- Rebuild and modernize an out-of-date system to meet changing customer needs
- Develop affordable ways to finance improvements
- Involve the public in the planning process

The WRP evaluated the district's water resources, delivery system, and operations, and examined land use trends to determine how future changes in these areas will impact water supply and demand during the next two decades. The plan also provided specific, prioritized recommendations for OID facility improvements that would comply with the California Environmental Quality Act (CEQA) and accommodate available financial resources.

A recap of the WRP findings and recommendations are provided in the following paragraphs.

General Background of OID

OID is located in the northeast portion of the San Joaquin Valley, about 30 miles southeast of Stockton and 12 miles northeast of Modesto. The OID service area consists of 72,500 acres between the Sierra Nevada and the Central Valley along the San Joaquin–Stanislaus County line, surrounding the city of Oakdale and bordering the cities of Riverbank and Modesto. The district's sphere of influence (SOI), land that the district is permitted by law to annex but to which it has not yet provided service, extends 86,290 acres farther to the north and east into Calaveras County. The Stanislaus River flows from the east through the center of the district service area and SOI.

Situated near the base of the Sierra Nevada foothills, OID's topography varies from gently rolling hills to the east and south of Oakdale to nearly flat around Riverbank. Approximately 75 percent of the land within the OID service area consists of irrigated agriculture. Native vegetation and rangeland dominates the land immediately outside the OID service area to the north, south, and east.

OID experiences mild, moderately wet winters and warm, dry summers typical of the Central Valley. Average temperatures range from the mid-forties in winter to the mid-nineties in summer. Precipitation averages about 12 inches annually, over 85 percent of which occurs between November and March. Average evapotranspiration (ET) is approximately 46 inches seasonally (April through October). Climate conditions are generally uniform throughout the district.

The District Today

Currently, the district maintains over 330 miles of laterals, pipelines, and tunnels, 29 production wells, and 43 reclamation pumps to serve local customers. In general, the district's facilities, system operations, political organization, and administration have not changed significantly over the last several decades. Nearly all water supply canals were constructed more than 90 years ago. In recent years, however, the district's customers, land use, and financial resources have developed in a direction that may influence the way OID provides services and conducts business in the future. The following sidebar highlights important background facts about the district.

OAKDALE IRRIGATION DISTRICT FACTS

Year OID was organized: 1909

Cost to OID and SSJID for existing irrigation system and water rights in 1910: $650,000

Total district acreage: 72,500

Total irrigated acres: 55,600

Annual diversion right: 300,000 acre feet

Diversion point: Goodwin Dam

Maximum diversion rate from Goodwin Dam: 910 cfs

Total distance of water delivery system: 330 miles of canals (open, lined, and buried pipelines)

Number of agricultural wells: 24

Number of agricultural and domestic water accounts: 3,500

Percent of OID agricultural customers who farm parcels of 10 acres or less: 60 percent, constituting 12 percent of OID land

Percent of OID agricultural customers who farm parcels of 40 acres or more: 4 percent, constituting 60 percent of OID land

Analyses and Findings

Analyses conducted for the WRP included detailed land use modeling, water balance modeling, on-farm surveys, a comprehensive infrastructure assessment, and the development of a phased infrastructure plan to rehabilitate and modernize an out-of-date system. The integrated approach also included water right evaluations, groundwater studies, development and evaluation of program alternatives, financial analyses, environmental compliance, and public outreach. The following discussion summarizes some of the key areas of evaluation that were conducted in the study.

Land Use

OID currently serves 2,800 agricultural customers on approximately 55,600 acres of serviceable land. The district also provides water to 700 domestic accounts primarily east of the City of Oakdale. Agriculture dominates the lands in and surrounding OID, as shown in Figure 2. Within the district service area, pasture makes up approximately half of the total land use, or about 32,000 acres. The other half of the district consists of orchards, corn and oat crops, and municipal land in relatively even proportions. Only a small percentage of the land in the district's service area consists of native vegetation. Outside the OID service area but inside the district's SOI, native vegetation dominates three-quarters of the land, or approximately 47,000 acres, as shown in Figure 3. Orchards and pasture crops make up 11 percent and 9 percent, respectively. Corn and oats make up 6 percent. Rice and urban/industrial areas make up 1 percent or less of the district SOI outside the service area.

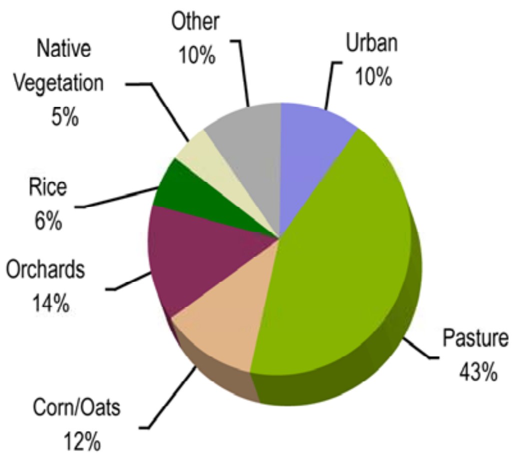

Figure 2. Land Use Distribution in OID

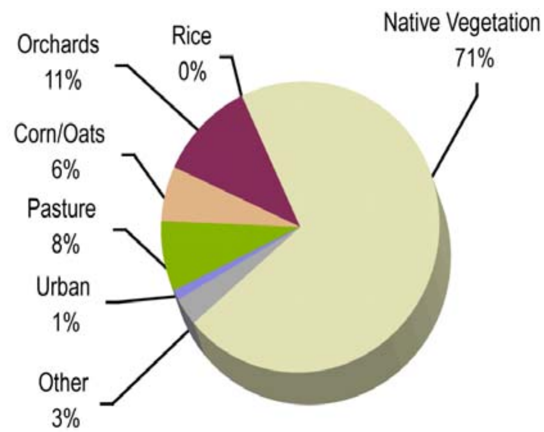

Figure 3. Land Use Distribution within OID Sphere of Influence

Land use within the OID service area has shifted in recent years, and these trends point to continued change in the future. Some agricultural land around the cities is urbanizing. The City of Oakdale is experiencing steady population growth. It is forecasted that over the next 20 years, 6,000 acres of agriculture in OID will be replaced by municipal land, resulting in fewer irrigated acres and a lower demand for OID water.

Many OID customers are also changing the types of crops they are growing. Across the region, higher-value tree crops are replacing pasture. Orchards use less water and require a more intensive, responsive level of irrigation service than is currently provided by the district. Land ownership is also changing as large parcels are subdivided, leading to increased ranchette-type development in some areas. All these factors may necessitate changes to the level of services the district can currently provide.

Of particular note is that orchard acreage outside OID's existing service boundaries has more than doubled in the past decade. This is the result of accelerated market conditions for nut crops. The irrigation water source for orchards outside OID is almost exclusively groundwater. The majority of orchard development has occurred immediately adjacent to OID's eastern boundary. This development offers significant opportunity for expansion of service by OID.

<u>Forecasted Trends</u> As shown in Figures 4 and 5, forecasted land use inside and adjacent to the current OID service area is expected to continue changing substantially. While pasture is generally projected to decrease within OID, orchards are expected to increase nearly 50 percent to approximately 15,000 acres in 2025. Nearly all these orchards are expected to implement fairly efficient irrigation systems (such as micro sprinklers), resulting in significant water savings. It is expected that most orchards (average applied water approximately 3 ac-ft per acre) will be planted on ground that was previously pasture (average applied water approximately 6 ac-ft per acre). This will result in the applied water demand being essentially cut in half. Also, the efficiency of the irrigation systems will result in other water savings, including reduced—and in many cases eliminated—tailwater production.

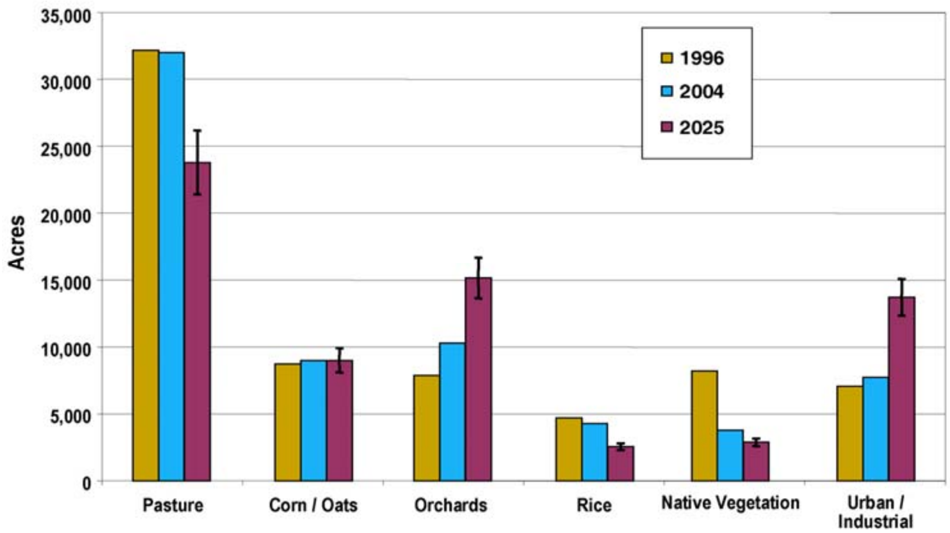

Figure 4. Historical and Forecasted Trends Inside OID Service Area

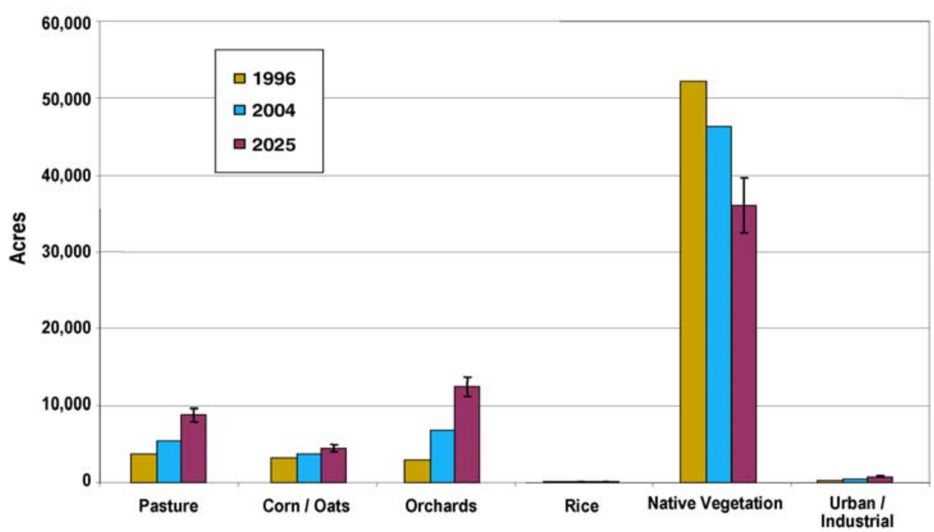

Figure 5. Historical and Forecasted Trends Outside OID Service Area

The forecasted 2015 City of Oakdale population is 29,000. Actual holding capacity of the 2015 boundary area, if completely built out, would be about 39,000. New residential growth through 2015 is forecasted to occur in all directions around the city, and will likely fill in four primary areas within the 2015 growth boundary. Accounting for additional urbanization between 2015 and 2025, 10 percent of total current OID lands, most of which is currently irrigated agriculture, will likely be lost to urbanization by 2025.

Land Use Conclusions Historical land use and forecasted changes will significantly influence the future of OID and service to its customers. Forecasted land use is a fundamental element of the WRP and has significant influence over the suggested recommendations for the future.

Infrastructure Assessment

As part of the WRP, a detailed infrastructure assessment was conducted. Those findings concluded that major vulnerabilities existed within the OID's primary water delivery system off the Stanislaus River and that a large proportion of the system had significantly deteriorated. Additionally, changing customer needs and service conditions necessitated that OID modernize its system to provide more responsive and reliable service. The assessment performed included the following areas of OID's water delivery system:

- Joint Main Canal, North Main Canal, and South Main Canal
- Regulating reservoirs
- Primary distribution system
- Groundwater wells
- Drainwater and reclamation facilities
- Supervisory Control and Data Acquisition System (SCADA)
- OID's standards for providing irrigation service to its customers

Water Balance Modeling

To facilitate this analysis, a systemwide operational water balance model (WBM) was developed. The WBM provided a flexible analytic tool for simulating a range of long-term operating scenarios and overall WRP alternatives.

The primary water balance unit of analysis was the Lateral Service Area (LSA). Each LSA represented the portion of the OID service area supplied by a specific distribution lateral. Water supply into the LSA is provided by a combination of surface water, groundwater from wells, and reclamation pumps (drainwater). Water leaves the LSA through ET, deep percolation, tailwater spills to drains, and operational spills to drains. The drainage basin is the object in the WBM for tracking the supply, reuse, and outflow of drainwater. Each LSA overlaps one or more drainage basins, into which its tailwater and operational spills flow.

A baseline operations water balance was created to simulate the primary water components of OID's overall system under existing land use and varying hydrologic and climatic conditions. The baseline model was developed using 2004 land use information (which represents the most recent land use survey data available), irrigation efficiencies developed from an on-farm survey at OID, available outflow data from OID's boundary outflow program, and average- and drought-period climatic (ET and precipitation) records. Land use was developed using geographic information system coverage for OID's assessed parcels combined with California Department of Water Resources land use survey data. By starting with a baseline model that reasonably represents existing conditions, the model can then be used to evaluate the net impacts of key factors influencing OID's long-term water demand and supply through the 2025 planning period, such as crop shifting and changes in farm efficiency levels, annexation of new service areas, varying levels of drainwater reclamation, groundwater pumping, and distribution system improvements.

Alternative Development and Evaluation

The WRP evaluated the district's water resources, delivery system, and operations. It surveyed on-farm water use and practices and evaluated the infrastructure and modernization needs of the OID. In conjunction with this comprehensive assessment, the WRP examined land use trends to project how future land uses will impact water supply and demand over the next two decades. Lastly, the water balance efforts provided insight on projected water use and various means by which the OID may put to beneficial use water that would be generated through implementation of the WRP.

To address the expected changes in future OID customers' needs and to reasonably and beneficially use the district's water supplies, four distinct programmatic alternatives were developed and evaluated. These alternatives encompassed a range of reasonable options available to the district in response to the land use, regulatory, resources, and customer-driven issues presented in the WRP. The term *programmatic* is used to emphasize that the alternatives evaluated in the WRP are broad-based and strategic, and represent policy-level options for OID's consideration.

Evaluation Methodology Applying some key common assumptions to all alternatives, a detailed methodology was employed to determine key water balance components for projected 2025 conditions for each programmatic alternative. Next, decisions regarding the provision of service to customers outside OID but inside the SOI (annexation) and water transfers were made for each alternative. Lastly, a Financial Model was used to analyze various strategies for viably supporting each alternative.

The four alternatives, combined with the viable financial strategies for implementation, results in a set of 13 distinct options, all of which are financially and technically feasible. Following the evaluation, a matrix summarizing each alternative was then compared to the WRP goals. From this comparison emerged the Best Apparent Alternative. The results of the water balance analysis for each programmatic alternative are summarized in Table 1.

In multiple programmatic alternatives, an initial and final level of firm and variable water transfers are identified. A firm water transfer is defined as the quantity of water provided in every year, including droughts. Variable transfers are reduced during dry years as Stanislaus River supplies to OID are curtailed. OID currently transfers water to a neighboring special district and to the federal Bureau of Reclamation. These existing transfers total 41,000 ac-ft. Of that volume, 30,000 ac-ft are firm and 11,000 ac-ft are variable. Over the course of WRP implementation, the quantities of firm and variable supplies available for transfer were forecast to increase to 50,000 ac-ft and 17,000 ac-ft, respectively. In Alternative 2, these supplies are assumed to be transferred. Alternative 4 assumes that these supplies support expansion of service into the SOI. Alternative 3 assumes that the firm quantity is transferred, and the variable quantity supports expansion of service into the SOI.

Table 1. Summary of Programmatic Alternatives and Associated need to change the format of the table for ease of reading

Alternative	Description	Key Components
1	Continue Present Practices	The "do nothing" alternative Limited investing in service improvements Continues same level of replacement and rehabilitation No annexations Continue minimum transfers of 30,000 ac-ft up to a maximum of 41,000 ac-ft.
2	Maximize Service Improvements within District Boundaries	Improve service standards Rehabilitate and modernize system Provide drought protection measures with added deep wells and reclamation facilities No annexations Finance all costs through transfer of 50,000 ac-ft and additional variable transfers of 17,000 ac-ft.
3	Maximize Service Improvements within District Boundaries and Moderate Expansion of Service within OID's SOI	All elements of Alternative 2 except allows annexation of 4,250 acres of expanded service in SOI to utilize 17,000 ac-ft Finance all costs through transfer of 50,000 ac-ft
4	Maximize Expansion of Service within OID's SOI	Annexation of 16,750 acres of expanded service in SOI to utilize 67,000 ac-ft of available supplies Annexations would consume available water allowing for no water transfers

<u>Evaluation Results</u> The Financial Model analyzed various strategies for viably supporting each programmatic alternative. This analysis led to the selection of Alternative 3 as the Best Apparent Alternative. This alternative maximized improvements in the district, provided for moderate expansion into the SOI, most strongly supported all the WRP's

goals, and kept water rates at a favorable level. Following Board endorsement, Alternative 3 was termed the Proposed Program.

THE PROPOSED PROGRAM

To comply with the California Environmental Quality Act (CEQA), OID prepared a Programmatic Environmental Impact Report (PEIR) to address the potential environmental impacts resulting from the implementation of the Proposed Program. That document was concluded and certified in June 2007.

The resultant Proposed Program adopted by the OID for implementation is currently in the Implementation Phase. The major components of the adopted Proposed Program consist of the following projects and programs:

- Flow control and measurement projects
- Canal Reshaping and Rehabilitation Program
- Groundwater Well Program
- Main Canal and Tunnel Improvement Program
- Pipeline Replacement Program
- Regulating Reservoir and Woodward Reservoir Intertie
- Turnout Replacement Program
- Drainwater Reclamation Program
- Surface water outflow management projects (Reclamation Program)
- Water transfers
- Expansion into the SOI

In all, the Program components in the WRP total $169 million in modernization, rehabilitation and replacement projects to be implemented over the next 20 year period. The principle method of funding this cost will be from revenues generated through water transfers.

FINANCING THE IMPLEMENTATION OF THE WRP

The financial support for the implementation of the WRP programs will come from water transfers. Currently the OID has 41,000 acre feet in existing transfers and will produce another 10,000 acre feet of transferable water with full implementation of the WRP over the next 20 years. With projected implementation costs for the WRP at $169 million, and assuming 20 year financing, and 50,000 acre feet of transferred water, the return cost on transferred water is $200 to $250 per acre foot depending on finance terms.

Placing this on an annual basis, OID would need an average revenue stream of $12.5 million per year for its 50,000 acre feet of transferred water to fund the rebuilding, and modernization of OID without unreasonable and preferably no water rate increases to its customers. To meet that need, the following range of transfer terms would make that possible;

- OID could find a buyer of 50,000 acre feet at $250 per acre foot,
- OID could find a buyer of 25,000 acre feet at $500 per acre foot,
- OID could find a buyer of 12,500 acre feet at $1,000 per acre foot,

Water Markets

There are three water markets available to the OID in which to evaluate transfer opportunities. Each market has a different ability to pay and comes with a different set of politics.

High End Metropolitan Areas. These market areas come with a capacity to pay but the local politics of completing such transactions can be difficult for small rural irrigation districts. Water kept locally serving local needs is a mantra of concern and is not without some merit. However, the benefit in marketing in these areas is the ability to receive high returns with less water in transfer thereby, in the long run, meeting both the financial needs of the irrigation district and the needs of the local community in keeping as much water locally as is financially possible.

Local and Regional Areas. These markets are only now being exposed to the true value of water. For many years, the local and regional areas have relied on a seemingly abundant groundwater supply that is now become less than usable in the San Joaquin Valley. With the implementation of the new arsenic rule, nitrate contamination issues, salt water intrusion from years of overdraft, etc. cities in the local and regional markets are only now beginning to face avoided cost issues for their future water supplies.

Agriculture Markets. This market's capacity to pay is simple to define. Their avoided cost for water is equivalent to that which they would pay to pump groundwater. In the area east of Oakdale, where agricultural is expanding on groundwater, that current cost is approximately $80-$100 per acre foot of pumped water, depending on depth to water. While the market is easy to define, there is difficulty in educating locals that these markets, with a limited ability to pay, could require water rate increases to offset the lack of revenues if oversold to this market.

The End Game. The end game is to provide the maximum protection to the district's water rights. Meeting that goal may be best met by having equal participation of transferred water into each market area. Politically, this strategy may provide the broadest base support to any challenge of OID's water in the future.

OID is currently in negotiations and discussions with multiple parties regarding its marketing strategies going forward.

CONCLUSIONS

The true benefit of the WRP is that it has set a course of action for the OID. It has brought focus to an irrigation district and laid a path to meet the needs of a changing agricultural industry. If implemented as planned, the WRP will have provided the following regional benefits;

- Protected the OID’s water rights
- Provided enhanced customer service opportunities to constituents
- Rebuild, modernize, and expand OID’s water delivery infrastructure
- Protect the future water supply needs of the local urban areas
- Keep water rates affordable through a balanced effort of water transfers (50,000 acre feet) and allowing for agricultural expansion into OID’s SOI (17,000 acre feet)
- Enhances local water supplies by 30,000 ac-ft
- Substantially increases water supply reliability and meets OID service needs in a worst-case drought