State Water Resources Control Board
Hearing Name IID Transfer - Phase 1
Exhibit: 4
For Ident: _____ In Evidence: _____

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STATE WATER RESOURCES CONTROL BOARD

STATE OF CALIFORNIA

IMPERIAL IRRIGATION DISTRICT and SAN DIEGO COUNTY WATER AUTHORITY, Petitioners.	**EXPERT QUALIFICATION AND WRITTEN TESTIMONY OF RODNEY T. SMITH IN SUPPORT OF IID-SDCWA JOINT LONG-TERM TRANSFER PETITION**

WRITTEN TESTIMONY OF RODNEY T. SMITH

1. My name is Rodney T. Smith, and I am the Senior Vice President of Stratecon Inc. My business address is 2335 West Foothill Blvd., Suite 11, Upland, California. The following testimony is provided under oath, as specified at the end of this document.

A. <u>Professional Background</u>

2. I am President and Managing Director of J&M Water Development LLC, a water supply development company and Senior Vice President of Stratecon Inc, an economics and strategic planning consulting firm specializing in the economics, finance, law, and politics of water resources. I am involved as a partner or advisor in the acquisition of water rights throughout the western United States and in the sale and leasing of water rights and water supplies to public and private sector water users. I also consult extensively for public and private sector clients on business and public policy issues concerning water resources, including California's Drought Water Bank, the government of New South Wales, Australia's effort to privatize irrigation organizations, and the economic, financial, legal, and political dimensions of water transactions in many western states. I also worked on the proposed IID/SDCWA transfer at issue here, and settlement of certain Colorado River disputes on behalf of the IID. I am routinely involved in economic valuation of water rights, water investments, and negotiation of water acquisition and transportation agreements. I also serve as an expert witness

in the economic valuation of groundwater resources and disputes over the economic interpretation of water contracts.

3. I have written extensively on the law, economics, and finance of water resources and water policy. In 1987, I created and became co-editor of Stratecon's two paid-circulation publications *Water Strategist: A Quarterly Analysis of Water Marketing, Finance, Legislation, and Litigation,* and *Water Intelligence Monthly*, a supplement reporting on recent developments in federal, state and local water policy. In January 1999, these publications were combined into a monthly web-based publication and information service, *Water Strategist*, which extended its coverage to include developments in the emerging private corporate participation in western water matters. The web address is *www.waterstrategist.com*. I wrote two books entitled, *Troubled Waters: Financing Water in the West*, and *Trading Water: A Legal Framework for Water Marketing*, sponsored by the Ford Foundation through grants to the Council of Governors' Policy Advisors. Former Secretary of the Interior Bruce Babbitt wrote the forwards for both books.

4. I received a Ph.D. in Economics from the University of Chicago and a Bachelor of Arts in Economics from the University of California at Los Angeles. Prior to making a full-time commitment to the private sector, I was a professor of economics at Claremont McKenna College for fifteen years. I also served as co-editor of *Economic Inquiry*, a professional economics journal of the Western Economics Association. In 1989, I was the John M. Olin Visiting Professor of Law and Economics at Columbia Law School. Before joining the faculty at Claremont McKenna College,

I was a research associate at the RAND Corporation from 1974 to 1978. From 1978 until 1983, I was initially a research fellow and then later Associate Director of the *Center for the Study of the Economy and the State* (founded by George Stigler, Nobel Laureate in Economics) at the Graduate School of Business, University of Chicago and later a visiting Assistant Professor of Business at the Graduate School of Business.

5. A true and accurate copy of my curriculum vitae is attached hereto as Exhibit "A," and is incorporated herein.

B. <u>IID Engagement</u>

6. The IID engaged me to study three topics for presentation to the State Water Resources Control Board: (1) Why does IID's water use fluctuate over time? (2) What costs would IID be facing if it had to undertake conservation on the scope of the proposed transfer with SDCWA, but without compensation from SDCWA? and (3) Is there a need in California for the IID and SDCWA water transfer?

7. I performed all three tasks for IID, and the results are contained in my three reports on the above topics, true and accurate copies of which are attached hereto as Exhibits "B," "C," and "D," respectively. My research and professional conclusions are stated in these reports. Each report was prepared after I performed reviews of detailed IID and Bureau of Reclamation records, spoke with IID personnel and farmers, consulted various reports and analyses on IID, and reviewed water transfer data which my company has gathered over years of consulting on water transfers and Colorado River water issues.

8. Though my three attached reports provide my testimony in detail, a summary of the conclusions reached in each report may be helpful to the SWRCB, and is thus provided here.

C. <u>IID's Water Use</u>

9. IID's annual use of Colorado River water has averaged 2,889,192 acre-feet ("AF") during the period 1964-2000 ("decree period"). However, annual use over the decree period has significantly fluctuated above and below this average. Though some have attempted to claim such fluctuation is not justified, in fact IID's differing Colorado River diversions are a completely warranted and understandable reaction to the needs of farmers based on a number of factors, such as local rainfall, cropping patterns, the economic conditions of farming, insect infestation, and the salinity of Colorado River water.

10. Through my analysis I developed what I believe is a fairly accurate predictive model for IID's water use, taking what I considered to be the major factors discussed above into consideration. It involved utilization of linear regression analysis, which is one of the most widely used methods of statistical techniques in the sciences and social sciences. Under this method, one specifies an equation relating the "dependent variable" (the behavior to be explained by the model) to the "explanatory variables" (the factors used to explain variations in the dependent variable). For this study, the dependent variable is IID's use of Colorado River water. The explanatory variables include annual rainfall, cropping patterns, economic conditions of farming, and salinity of Colorado River water. Though for a fuller explanation, the SWRCB should review

my attached Exhibit "B" report, the form of the equation is as follows:

$$\text{Use}_t = \alpha_0 + \alpha_1 \times \text{Rainfall}_t + \alpha_2 \times \text{Net Acres}_t + \alpha_3 \times \text{Double Cropping}_t + \alpha_4 \times \text{Sudan}_t + \alpha_5 \times \text{Price}_t + \alpha_6 \times \text{Cost}_t + \alpha_7 \times \text{Salinity}_t + \alpha_8 \times \text{Whitefly}_t + \varepsilon_t$$

where,

Use_t = IID's use of Colorado River water in year "t"

Rainfall_t = annual rainfall in Imperial Valley in year "t"

Net Acres_t = net acres in Imperial Valley in year "t"

Double Cropping_t = acres double-cropped in Imperial Valley in year "t"

Sudan_t = acreage in sudan in Imperial Valley in year "t"

Price_t = value of Imperial County price index in year "t"

Cost_t = value of cost of farming index in year "t"

Salinity_t = running average of salinity of Colorado River at Imperial Dam over previous five years

Whitefly_t = a variable signifying the presence of whitefly in the year 1992

ε_t = difference between the actual value and the model's predicted value of IID's annual use of Colorado River water in year "t" ("residual")

The values of the parameters (α_0, α_1, α_2, α_3, α_4, α_5, α_6, α_7) and the standard deviation of the residual ("σ") are estimated by the regression method commonly known as "linear regression" or "ordinary least squares".

11. By utilizing this formula, the factors included explain 90.9% of the fluctuations in IID's annual use of Colorado River water. The estimated standard deviation of the model's residual is 57,778 AF. Changes in rainfall, cropping patterns, economic conditions and salinity of Colorado River water explain (1) the period of increasing use of Colorado River water by IID from 1964 to 1974, (2) the period of declining use of Colorado River water by IID from 1975 through 1983, (3) the period of increasing use

of Colorado River water by IID from 1984 until the late 1990s, and (4) the recent decline in IID's use of Colorado River water in the past few years.

12. The above model has significant explanatory power but, like any statistical model, does have prediction errors (*i.e.*, residuals). These residuals are explained in my Exhibit "B" report. However, the distribution of the model's residuals is consistent with what would be expected under the assumption that the residuals follow a normal distribution.

13. Various factors can have a significant effect on water usage in IID. For example, consider the implications of variability in annual rainfall in Imperial Valley. Annual rainfall varying +/- 1.5 inches around the annual average of 2.91 inches translates into a range of variability of 155,738 AF of IID's annual use of Colorado River water around the level that would otherwise occur if all factors (including rainfall) were at their average levels. Similarly, swings of salinity equal to plus or minus one standard deviation of salinity during the decree period generate a range of variation of IID's annual use of almost 60,000 AF.

D. <u>IID Conservation Costs</u>

14. There are two types of potential agricultural water conservation opportunities in the Imperial Valley that do not entail a reduction in farming activity: (1) IID system improvements and (2) on-farm conservation. For each type of conservation opportunity, there are many dimensions to the economic costs of conservation. For system improvements, there are the costs of capital investment, operations and maintenance,

and replacement. For on-farm conservation, there are not only the costs of capital investment, operations and maintenance, and replacement, but also the costs associated with additional on-farm management, the assumption of additional risks, and the IID's cost of administration. Whatever the method of conservation, there is also the cost of environmental mitigation obligations related to the implementation of a conservation program, as well as the impact of conservation activity on other aspects of IID's operations. Some of these costs are more readily quantified than others. However, if one looks at the quantifiable costs, there is no doubt that large-scale conservation in the Imperial Valley is expensive, and would seriously impact the Valley's agricultural economy if no compensation were provided.

15. System Costs. Without even adding in the costs of systemwide improvements required to manage IID's system to assure capture of the estimated amount of conserved water, or costs related to any environmental mitigation obligations, it appears that IID's conservation potential from system improvements rapidly approaches annualized direct costs and exceeds $100/AF ('01$) for annual conservation at or above 40,000 AF per year. IID's conservation potential from system improvements reaches a practical maximum of 100,000 AF per year at annualized direct costs in excess of $150/AF ('01$). As stated, these numbers are lower than they should be, because certain fact-specific cost factors (such as environmental mitigation) are left out.

16. On-Farm. Numerous methods of on-farm water conservation have been proposed for potential implementation in

the Imperial Valley. Other than the tailwater recovery systems funded by the 1988 Agreement between IID and MWD, however, there is not enough field experience and data available to judge the efficacy and cost of on-farm conservation. For that reason, tailwater recovery systems have become the "benchmark technology" to illustrate the potential range of direct costs and yield of conserved water available by non-fallowing methods of on-farm conservation.

17. In my attached Exhibit "C" report I review the MWD program and other IID data and conclude that if a tailwater pumpback system conserves 0.65 AF/acre (the median yield), then a permanent 80-acre system conserves water at a direct annualized cost of $183/AF ('01$), a 120-acre permanent system conserves water at a direct annualized cost of $152/AF ('01$), and a portable system installed on 80 acres at a direct annualized cost of $189/AF ('01$). The direct annualized cost of conservation is lower for higher conservation yields, and higher for lower conservation yields. There is an important caveat to these figures, however -- they are again too low. They do not include legitimate cost factors such as compensation for additional management, compensation for assumed risks, compensation for the impact of on-farm conservation, operations, and incentive compensation. Thus, the real "cost" of such systems is higher than shown. Further, the amount of water that can be conserved would depend on: (1) the actual yield of conserved water that, based on the experience of the MWD program, can vary considerably; and (2) the amount of acreage suitable for water conservation activities.

18. Such conservation costs, even without considering the other noted factors, would have a significant impact on farmers in the Imperial Valley. An uncompensated conservation obligation requiring a $15/AF ('01$) increase in IID's water rate, which is at least what would be needed, would significantly reduce the economic viability of irrigated agriculture in Imperial Valley. When crop prices are low, such as they were in the year 2000, the impact of the water price increase would be greatest. In effect, with already thin economic margins, a water rate increase will push more acreage over into the realm of no longer being economically viable. Depending on market economics, such loss of irrigable acreage could reach 30%. Given the economic importance of agriculture to the Imperial economy, reduced agricultural activity will have a significant adverse impact on the local economy.

19. The costs of conservation imposed by such an obligation must be paid. IID must increase its water rate to fund any compelled activities. Given the competitive nature of agricultural markets, increased water rates would further erode the economic viability of agriculture in the Imperial Valley. The economic fall-out for Imperial County would be substantial. Land values and land rents would plummet. Marginal acreage would go out of production. The economic losses and reduced agricultural activity would have an adverse impact on the local economy; a county that already has the highest unemployment rate and lowest per capita income in the State would see this problem compounded.

20. Thus, after reviewing the applicable data, it is apparent that IID agriculture cannot sustain the costs of further large-scale conservation without compensation.

E. The Need For The IID/SDCWA Water Transfer

21. The State of California has pressing need for the proposed IID-SDCWA water transfer. The transfer, and the settlement with other agencies related to it, will (1) quantify the respective rights of IID and CVWD; (2) provide CVWD with additional Colorado River water supplies; (3) provide for the lining of the All American and Coachella Canals; (4) extend the term of the 1988 Agreement between IID and MWD; (5) resolve long-standing and pending legal disputes concerning the reasonableness of use of agricultural water agencies and the impact of Indian water rights and miscellaneous present perfected rights as to how much water is available to agricultural water users and Metropolitan; and (6) allow California to meet the requirements of federal policy to gain access to a significant quantity of surplus Colorado River water available under interim surplus criteria that will allow California to make the necessary transition to live within the state's basic 4.4 million acre foot ("AF") entitlement to Colorado River water.

22. Without these actions, California faces the prospect of a significant decline in the availability of Colorado River water supplies that would undermine the water supply of Southern California. Many of the legal disputes put aside by the parties to the QSA will erupt in the face of the immediate shortfalls in water supplies when federal policy must, on its own terms,

abandon the interim surplus criteria and return to normal operations of reservoirs on the Colorado River.

23. Currently, MWD firm supplies are its priority 4 right (550,000 AF) and the 1988 agreement with IID (110,000 AF). The addition of the water supplies from the IID-SDCWA agreement and the lining projects will reduce substantially MWD's dependence on surplus water. However, MWD needs about 5.9 million AF of surplus water through the year 2016 to meet its needs.

24. Surplus water made available by the interim surplus criteria will prove critical to meeting the water needs of Southern California. The Bureau of Reclamation anticipates that 600,000 AF of surplus water is firmly available this year (2002). The amount of firm surplus declines by about 50,000 AF until it reaches 400,000 AF in the year 2006. Thereafter, 400,000 AF per year of surplus water is predicted to be available under the interim surplus criteria through the year 2016, but it is not firm. A total of about 6.5 million AF of surplus water is predicted to be available through the year 2016, 2.8 million AF is firm, the remaining 3.7 million AF is non-firm.

25. If the IID/SDCWA proposed agreement, the QSA, and related agreements are not implemented, then the interim surplus policy will be suspended. In its place, a less generous strategy will be used to determine the availability of surplus water. Under that strategy, California can expect to have little surplus water available. As a result, California would lose virtually the entire remaining 5.9 million AF of surplus water that would otherwise have been available under the interim surplus criteria after this year.

26. Further, the loss of this surplus water represents a significant economic loss to MWD. From an economics perspective, a reasonable valuation of the surplus water would be at the cost of obtaining a replacement supply. Replacement cost is based on the price terms likely for the cost of obtaining a new supply, not the historical cost of existing supplies. Based on proposed and pending transactions in California, such as MWD's proposed agreement with the Cadiz Company, the cost of new water is approximately $350/AF ('02$). Using this value as a benchmark for the cost of replacement supplies, the economic value of the surplus water MWD is expected to receive from the interim surplus criteria is worth $1.8 billion.

27. In short, all of California will benefit from the proposed IID-SDCWA transfer. Without it, the QSA and related settlement documents will evaporate, and California will be without the water it needs for its present and for its future.

I declare under penalty of perjury under the laws of the state of California that the foregoing is true and correct. Executed on March 22, 2002, at Upland, California.

[signature]
RODNEY T. SMITH

RODNEY T. SMITH, Ph.D.

Curriculum Vitae

Education

Ph. D Economics, University of Chicago, 1976

B.A. Economics, University of California at Los Angeles, 1970

Work Experience

June 1998 to present, President and Managing Director, J&M Water Development LLC

July 1983 to present, Senior Vice President, Stratecon, Inc., Claremont, CA

July 1991 to June 1996, Professor of Economics, Claremont McKenna College

July 1985 to June 1991, Associate Professor of Economics, Claremont McKenna College

July 1989 to June 1990, Visiting Senior Scholar of Law and Economics, School of Law, Columbia University

July 1986 to June 1989, Director, Lowe Institute of Political Economy, Claremont McKenna College

January 1986 to July 1987, Director, Center for the Study of Law Structures, Claremont McKenna College

July 1984 to December 1985, Acting Director, Center for the Study of Law Structures, Claremont McKenna College

July 1983 to June 1985, Visiting Associate Professor of Economics, Claremont McKenna College

July 1983 to June 1984, Acting Associate Director, Center for the Study of Law Structures, Claremont McKenna College

September 1981 to June 1983, Visiting Assistant Professor of Economics, Graduate School of Business, University of Chicago

September 1980 to June 1983, Associate Director, Center for the Study of the Economy and the State, Graduate School of Business, University of Chicago

September 1978 to June 1983, Research Fellow, Center for the Study of the Economy and the State, University of Chicago

September 1977 to July 1978, Visiting Assistant Professor of Economics, Claremont McKenna College

September 1974 to August 1978, Research Economist, RAND Corporation, Santa Monica, CA

May 1973 to August 1973, Staff Economist, Presidential Commission on Housing Policy, Washington D.C.

EDITORSHIPS

July 1990 to present, Co-editor, *Economic Inquiry*

January 1990 to present, Co-editor, *Water Intelligence Monthly*

April 1987 to present, Founding Co-editor, *Water Strategist: Analysis of Water Marketing, Finance, Legislation, and Litigation*

July 1984 to June 1989, Associate Editor, *Economic Inquiry*

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

American Bar Association (associate member), American Economics Association, Western Economics Association, and the Western Tax Association (Vice President),Colorado River Water Users Association

TEACHING EXPERIENCE

Claremont McKenna College: economic regulation, antitrust, law and economics, introductory economics, intermediate micro-economic theory, and New Liberal Arts Clinic

Claremont Graduate School: advanced micro-economic theory, regulation, antitrust, law and economics

University of Chicago, Graduate School of Business: public finance, antitrust

University of Chicago, Executive Program of the Graduate School of Business: public regulation of business

BOOKS AND MONOGRAPHS

Trading Waters: An Economic and Legal Framework for Water Marketing (Washington D.C.: Council of State Policy and Planning Agencies, 1988)

An Open Access Rights System for Interstate Natural Gas Pipelines (Washington D.C.: Natural Gas Supply Association, 1988)(unpublished report) with A. DeVany and R. Michaels

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Vol. 3, No. 1 (April 1989)

"Leading Wall Street to Water: Pru-Bache Closes $20 MM Fund to Acquire Water"

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"Let's Make a Deal: The IID/MWD Conservation Agreement"

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"Red Tape Rising: Nebraska Proposes Water Transfer Permits"

"Anatomy of a Power Failure: The SEC Report to Congress on WPPSS"

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"Waste Water Finance after EPA"

"1987 Annual Litigation Review: The Growing Importance of Economic Principles in Western Water Law"

"New Use for California's Water Plan: Contingency Planning and Risk Assessment"

Vol. 2, No. 1 (April 1988)

"Having Water on Tap: Drought Insurance Through Water Trades"

"1987 Annual Bond Market Review: Rising Rates, Healthy Volume, an Changing Financial Markets"

Vol. 1, No. 4 (January 1988)

"Taking It to the Street: How Water Authorities Can Find Low-Cost Financing"

"Getting Credit Where Credit is Due: Reducing Borrowing Costs Through Credit Enhancement"

Vol. 1, No. 3 (October 1987)

"Irrigating the City: Emerging Markets for Water Transfers"

"Cashing-in on Conservation: The Emerging Doctrine of 'Save It and Sell It'"

"Avoiding Owns Valley Syndrome: Using Water Trades to Promote Rural Economic Development"

Vol. 1, No. 2 (July 1987)

"Just Rewards: Making Water Marketing Work for Local Interests"

"1986 Annual Litigation Review: Local Fees and Powers Upheld, Federal Reserve Rights Limited, and State Water Right Systems Reassessed"

Vol.1, No. 1 (April 1987)

"Water Policy in the Balance: Water Development and Environmental Interests in the Era of the Public Trust Doctrine"

"1986 Annual Bond Market Review: Higher Volume, Lower Costs, and Rejections of Common Perceptions"

SELECTED SPEAKING ENGAGEMENTS

"Shareholder Pressure and Board Opt Out Decisions from Pennsylvania's Anti-Takeover Law," presented at academic seminars at the University of California at Los Angeles, University of California at Santa Barbara, Claremont Graduate School, University of Chicago, University of Southern California, Southern Methodist University, University of Texas at Arlington.

"North American Free Trade Agreement and Water Resources," presented at the Eighth Annual Conference for Congressional Staffers, Sponsored by the Political Economy Research Center, Bozeman, Montana, December 5-7, 1992.

"Recent California Experience with Water Transfers," presented at *Buying and Selling Water in California: Issues, Experience, and Policy Options*, U.C.L.A. Public Policy Extension Program, Sacramento CA, November 12, 1992.

"Legal, Political and Economic Issues Concerning Colorado Interbasin Water Transfers," presented at *Moving Water in Colorado, the 1992 Annual Water Law and Policy Conference*, University of Denver, College of Law, October 30, 1992.

"Emerging Markets in Emission Reduction Credits: Potential Pitfalls in the South Coast Basin," presented at the Annual Meeting of the Association of Public Policy Administration and Management, Denver Colorado, October 29, 1992.

"The Economic Structure of Contracts for International Water Trades," presented at *Water Export Conference*, sponsored by the Canadian Water Resources Association, Vancouver, British Columbia, Canada, May 9, 1992 and at Claremont Graduate School, April 1992.

"The Case for Groundwater Adjudication," presented at the 19th Groundwater Conference, co-sponsored by the University of California, the State Water Resources Control Board, and the Department of Water Resources, September 1991.

"Emerging Water Markets in America: The Lessons for Australia," presented at the Third Annual Ministerial Forum, Sydney, Australia, August 1991.

"Water Reallocation: Voluntary Transactions vs. Regulatory Fiat," presented at *Waterscapes '91*, sponsored by the Canadian National Ministry of Natural Resources, June 1991.

"The Canons of Reporting Economic Research," presented at the Annual Meeting of the *Western Economics Association, International* June 1991.

"The Proper Forum for the Evolution of the Electric Industry," comment on Charles Stalon, "The Significance of the FERC's Transmission Task Force Report in the Evolution of the Electric Industry," presented at the *Electric Policy Symposium*, School of Law, Columbia University, April 7, 1990

"Academic Research in the Courtroom: A Constitutional Challenge to the Legislative Implementation of Proposition 13," luncheon speech at the *12th Annual Research Conference of the Western Tax Association*, June 17, 1989, Lake Tahoe, California

"The Right-To-Know: Statute Law v. Common Law," presented at *Prior Restraint v. Free and Responsible Individuals*, sponsored by the Liberty Fund and the Political Economy Research Center, Bozeman, Montana, June 9, 1989

"The Changing Economic and Legal Environment" and "Evolving Water Rights and Administrative Regimes," presented at *Western Policy in Transition: Emerging Trends in Law, Economics, and Finance*, co-sponsored by the Lincoln Institute of Land Policy and *Water Strategist*. Santa Fe, New Mexico, June 8, 1989

"What We Have Learned about Leveraged Buyouts," presented at *The Leveraging Up of Corporate America: Prelude to Economic Growth or Financial Disaster?*, sponsored by the Lowe Institute of Political Economy, April 11, 1989, Los Angeles

"The Non-Shattering of Glass-Steagall." presented at *Shredding the Old Rules: The New Playing Field for Commercial and Investment Banking*, sponsored by the Lowe Institute of Political Economy and Inland Business Magazine, October 21, 1988 at Claremont McKenna College

"Strict Products Liability in Law and Economics," presented at the Annual Meetings of the Western Economics Association, International, July 1988

"An Open Access Rights Regime for Interstate Natural Gas Pipelines," presented at the Annual Meetings of the Western Economics Association, International, July 1988

"Local Fiscal Arrangements after Proposition 13," presented at the Tax Policy Roundtable of the Lincoln Institute of Land Policy, *Proposition 13: A Ten Year Retrospective*. Hotel Del Coronado, California, April 28-30, 1988.

"Protectionism and Competition," presented at the *California Conference on Trade: Focus on the Asian-Pacific Rim*, sponsored by the Asian Studies Center of the Claremont Institute, March 5, 1987

"A Comparative Study of State Taxation of Oil and Gas: The Lessons for Montana," presented at *Taxation in Montana" A Conference for Legislators and Legislative Candidates*, sponsored by the University of Montana and Montana State University, Helena, Montana, November 1986

"A Reconciliation of Water Marketing with Irrigation District Law in California," presented at the Eighth Annual Research Conference of the Association for Public

Policy Analysis and Management, LBJ School of Public Affairs, University of Texas at Austin, October 31, 1986

"Constitutional Constraints on the Allocation of California Property Taxes after Proposition 13," presented at the *Annual Conference of the Western Tax Association*, June 30, 1986

"Water Marketing: Institutional and Legal Issues," presented at *Buying and Selling Water in California: How Does it Fit Into the State's Water Policy Portfolio?*, sponsored by the Public Policy Program, UCLA Extension, February 27, 1986

"Financing Development of Indian Water Rights," presented at the *National Conference on Indian Water in the West*, sponsored by the American Indian Lawyer Training Program, Phoenix, Arizona, November 30, 1984

"Innovative Water Project Financing," presented at the *Missouri Basin State Water Resources Planning Seminar*, Denver, CO, June 7, 1984.

PERSONAL INFORMATION

Date and Place of Birth:	June 23, 1948, Fresno, CA
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IID's Use of Colorado River Water

By

Rodney T. Smith
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The use of Colorado River water in the Imperial Valley is almost exclusively for irrigated agriculture. As a result, the diversion of Colorado River water by the Imperial Irrigation District ("IID") depends on the water needs of irrigated agriculture in the Imperial Valley. As documented below, IID's use of Colorado River water reflects the variation in local rainfall, cropping patterns, the economic conditions of farming, and the salinity of Colorado River water. As reflected in the historical record since the U.S. Supreme Court issued its 1964 decree in *Arizona v. California*, these considerations explain the wide variations in IID's annual use of Colorado River water.

IID's Use of Colorado River Water

IID's annual use of Colorado River water has averaged 2,889,192 AF during the period 1964-2000 ("decree period").[1] However, annual use over the decree period has significantly fluctuated above and below this average (see Attachment 1). In the first calendar year of the decree period, 1964, IID's use of Colorado River water was 2,890,000 AF, or about the average use for the decree period. Over the next 10 years, IID's annual use trended upward, reaching its peak use of 3,171,977 AF in the year 1974. Thereafter, IID's annual use trended downward reaching its low of 2,555,617 AF in the year 1983. Over the next seven years, IID's annual use steadily increased until it reached 3,054,188 AF in the year 1990. IID's use of Colorado River plummeted to 2,572,659 AF in the year 1992, when a whitefly infestation required suspensions in the irrigation of alfalfa, the valley's largest crop. IID's use of Colorado River water recovered with the control of the whitefly. IID's use expanded above the previous peak reached in the year

[1] Calculated from historic record of IID's net use of Colorado River water as stated in the *Colorado River Use Database*, provided by the Lower Colorado Region, U.S. Bureau of Reclamation, based on the data provided in the annual "Compilation of Records in

1990, reaching 3,159,609 AF and 3,158,486 AF in the years 1996 and 1997, respectively. Since 1997, IID's annual use has trended downward so that by the year 2000, its use of Colorado River water was 2,931,251 AF.

Explaining the Annual Variation in IID's Use of Colorado River Water

Irrigation water needs in the Imperial Valley depend on many factors. The statistical study presented below considered the effect of rainfall, cropping patterns, economic conditions of farming, and the salinity of Colorado River water.

Rainfall. Local rainfall provides an alternative source of water for growing crops. For the decree period, annual rainfall in the Imperial Valley averaged 2.91 inches.[2] Like IID's annual use of Colorado River water, annual rainfall in the Imperial Valley has fluctuated substantially over the decree period (see Attachment 2). Annual rainfall reached its peak of 5.72 inches in the year 1983 and its low of 0.75 inches in the year 1989. During the decree period, there have been some sustained periods of either above-average or below-average rainfall. Annual rainfall was below-average for the six-year period 1970-1975 and the four-year period 1987-1990. IID's annual use of Colorado River water was rapidly rising during both of these periods of below-average rainfall. Annual rainfall was above-average in nine of the eleven years spanning 1976 to 1986. IID's annual use of Colorado River water was declining during this period of above-average rainfall.

Cropping Patterns. The acreage under irrigation also has a bearing on the amount of Colorado River water used in the Imperial Valley. Due to its favorable climate and the seniority of IID's water right, Imperial Valley agriculture is a year-round business. Generally speaking, irrigable acreage remains in production other than the time required for idling due to good farming practices. However, the intensity of farming varies annually in the Imperial Valley. A common measure of farming intensity in the Imperial Valley involves the amount of acreage "double cropped" (*i.e.*, a vegetable crop

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Accordance with Article V of the Supreme Court of the United States in *Arizona v. California*, dated March 9 1964.

2 Calculated from monthly rainfall data provided by staff of the Imperial Irrigation District.

grown in the fall or a field crop in the winter, and a different vegetable crop or sudan grown in the spring). Reflecting this practice, IID staff maintains records on the amount of acreage on which crops are harvested ("gross acres") and the acreage where more than one crop is grown in a year ("double cropping").[3] More intensive farming requires more water.

The amount of acreage involved in double cropping has varied considerably over the decree period (see Attachment 3). The amount of double-cropped acres has averaged 102,800 acres during the decree period.[4] The amount of double-cropped acres reached its peak of 170,083 acres in the year 1967, but then generally trended downward until it reached its low of 39,384 acres in the year 1988. Thereafter, the amount of acres double-cropped increased rapidly through the mid-to-late 1990s, when it reached 105,473 acres by the year 1998, or **2.6** times the amount of acres double-cropped 10 years earlier in 1988. IID's use of Colorado River water increased during periods of increasing amount of acreage double-cropped, especially since 1988.

In contrast, the amount of net acres irrigated in IID is relatively constant (see Attachment 4). Over the decree period, the amount of net acres in IID has averaged 450,925 acres.[5] Net acres reached a high of 467,791 acres in the year 1991. Its low of 422,501 acres was reached in the year 1964. Reflecting this small variability, the coefficient of variation for net acres is only 2.7%;[6] that is the standard deviation of the net acres is only 2.7% of its average. In comparison, the coefficient of variation for the acres double cropped is 32.1%. The acres double-cropped are almost 12 times as variable as the net acres under irrigation. As a consequence, there is a considerable variation in the intensity of agriculture in Imperial County that has a significant impact on IID's use of Colorado River water.

A final significant factor about cropping patterns in Imperial Valley involves the virtual explosion of acreage in sudan since the mid-1980s (see Attachment 5). Before the

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[3] Staff of Imperial Irrigation District.

[4] Calculated from acreage data provided by the staff of the Imperial Irrigation District.

[5] Calculated from acreage data provided by the staff of the Imperial Irrigation District.

[6] The coefficient of variation ("cv") is a common statistical measure of the variability of a data series. The formula is $cv = \mu/\sigma$, where μ= the mean and σ= the standard deviation.

mid-1980s, the annual acreage in sudan generally fluctuated between 10,000 acres and 20,000 acres. Starting in the year 1987, there was a sustained, 11-year increase in the amount of acreage in sudan. By 1997, there was 83,562 acres in sudan, or about **eight** times the amount of acreage in 1986. This increased acreage reflects the development of export markets for sudan, especially to Japan. IID's use of Colorado River water generally increased during this rapid expansion of sudan acreage (other than the period of the whitefly devastation).

Economic Conditions of Farming. Cropping patterns, including the intensity of agriculture as reflected in double-cropping, reflect planting decisions by farmers. These decisions, in turn, are undoubtedly affected by the economic conditions of agriculture. However, economic conditions are likely to influence water needs over and beyond their impact on cropping decisions. Higher crop prices create a higher economic return from increasing yields, which requires additional water. Conversely, higher production costs reduce the economic return from increasing yields, reducing the need for additional water.

Imperial Valley's crop prices and agriculture's cost of production has varied considerably over the decree period (see Attachment 6).[7] The index of Imperial Valley crop prices ('00$) rose rapidly relative to the cost of agricultural production in the early 1970s, late 1970s, mid-1980s, and late 1980s. These periods were generally times of increasing use of Colorado River water in IID. The gap narrowed between Imperial Valley crop prices and the cost of agricultural production (late 1970s, late 1980s, early 1990s and within the past two years). These periods were generally times of decreasing use of Colorado River water in IID.

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[7] Price Index calculated by deflating Weighted Average Per Acre Return by the GDP Implicit Price Deflator calculated by the U.S. Department of Commerce, Bureau of Economics. Weighted Average Per Acre Return provided by Dornbusch and Associates, whose calculation was based on the annual crop prices for representative crops in Imperial County (alfalfa hay, other hay, wheat, vegetables), weighted by the average crop yields over the decree period and acres growing crops in each year. GDP Implicit Price Deflator was restated in terms of year 2000 prices.

Cost Index calculated by deflating the Index for Prices Paid for Items Used in Production by the GDP Implicit Price Deflator. Index for Prices Paid for Items Used in Production is calculated by the U.S. Department of Agriculture.

Salinity. The salinity of Colorado River water at Imperial Dam has varied considerably (see Attachment 7).[8] Salinity was below 700 mg/L until the mid-1950s, when it spiked to almost 900 mg/L during periods of low flows in the Colorado River.[9] Salinity then fell considerably with the high river-flow years in the late 1950s. Salinity then marched upward until it reached its peak in the early 1970s (when numerical criteria for federal water quality standards were set). Salinity then began a sustained decline, rapidly plummeting during the 1983-86 period of historic flooding on the Colorado River, which purged significant amounts of salt from reservoirs and further reduced salinity through dilution. At the time, the Bureau of Reclamation anticipated that this improvement in salinity would persist for several years. However, this expectation was not fulfilled when flows on the Colorado River after 1986 proved to be below normal. Since the late 1980s, salinity was steadily on the rise until river flows increased in the late 1990s.

Salinity is an important factor in water use.[10] Leaching requirements depend on the amount of salt contained in irrigation water. Rising salinity means that a greater quantity of salts must be leached. Falling salinity means that a smaller quantity of salts must be leached. Since the salt loads to be managed by leaching reflects the accumulation of salts from applied water, Attachment 7 also shows the moving average of salinity for the 5 previous years to reflect the underlying trends in salt accumulation.

Generally speaking, there are three distinct periods of salinity trends during the decree period. Salinity was generally rising from 1964 to the mid-1970s. Thereafter, it was generally declining until 1990. For the decades of the 1990s, salinity started to rise again until its annual value peaked in 1995 and its 5-year moving average peaked in 1997. IID's use of Colorado River water was generally rising when salinity was rising and falling when salinity was falling.

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[8] Bureau of Reclamation, Upper Colorado Region Office. Historical data for 1940-1999 obtained from website www.uc.usbr.gov/progact/salinity;index.html. Data for the year 2000 obtained from Dave Trueman, Coordinator of the Salinity Control Program.

[9] See "Salinity of Colorado River Water: Causes, Consequences, and Remedies," ***Water Strategist*** (Spring 1996), p. 1.

[10] "Assessment of Imperial Irrigation District's Water Use," Natural Resources Consulting Engineers, IID Exh. 2, Chapter II-18 to II-22, and Chapter IV.

A Statistical Model of IID's Use of Colorado River Water

IID's annual use of Colorado River water depends on many factors—rainfall, cropping patterns, economic conditions of farming, and salinity of Colorado River water. While comparison of IID's annual use of Colorado River with individual trends in these factors may be informative in its own right, a statistical study relating IID's use of Colorado River water to these factors provides the best evidence of the extent to which IID's use of Colorado River water reflects these factors.

Linear regression analysis is one of the most widely used methods of statistical techniques in the sciences and social sciences.[11] Under this method, one specifies an equation relating the "dependent variable" (the behavior to be explained by the model) to the "explanatory variables" (the factors used to explain variations in the dependent variable). For this study, the dependent variable is IID's use of Colorado River water. The explanatory variables include annual rainfall, cropping patterns, economic conditions of farming, and salinity of Colorado River water. The form of the equation is as follows:[12]

$$\text{Use}_t = \alpha_0 + \alpha_1 \text{ x Rainfall}_t + \alpha_2 \text{ x Net Acres}_t + \alpha_3 \text{ x Double Cropping}_t +$$
$$\alpha_4 \text{ x Sudan}_t + \alpha_5 \text{ x Price}_t + \alpha_6 \text{ x Cost}_t + \alpha_7 \text{ x Salinity}_t + \alpha_8 \text{ x Whitefly}_t + \varepsilon_t$$

where,

Use_t = IID's use of Colorado River water in year "t"

Rainfall_t = annual rainfall in Imperial Valley in year "t"

Net Acres_t = net acres in Imperial Valley in year "t"

Double Cropping_t = acres double-cropped in Imperial Valley in year "t"

Sudan_t = acreage in sudan in Imperial Valley in year "t"

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[11] For discussion of the linear regression methods, see the following references:

Mood, A.F. *Introduction to the Theory of Statistics* (McGraw-Hill), 1950)

Scheffé, Henry *The Analysis of Variance* (Wiley, 1959, Chapter 10)

Draper and Smith *Applied Regression Analysis* (Wiley 1966, Chapter 6)

Rao, C.R. *Linear Statistical Inference and Its Applications* (Wiley 1973, Chapter 4)

Montgomery and Peck *Introduction to Linear Regression Analysis* (Wiley, 1982 Chapter 3).

[12] For data sources, see Attachments 1 through Attachment 7.

$Price_t$ = value of Imperial County price index in year "t"

$Cost_t$ = value of cost of farming index in year "t"

$Salinity_t$ = running average of salinity of Colorado River at Imperial Dam over previous five years

$Whitefly_t$ = a variable signifying the presence of whitefly in the year 1992[13]

ε_t = difference between the actual value and the model's predicted value of IID's annual use of Colorado River water in year "t" ("residual")

The values of the parameters (α_0, α_1, α_2, α_3, α_4, α_5, α_6, α_7) and the standard deviation of the residual ("σ") are estimated by the regression method commonly known as "linear regression" or "ordinary least squares".

The estimates of the statistical model are provided in the table below:[14]

Findings of Statistical Study

Variable (Parameter)	*Coefficient*	*Standard Deviation*	*T-Statistic*	*P-Value*
Constant ("α_0")	1,917,570	585,681	3.27	.003
Rainfall ("α_1")	-51,913	7,540	-6.88	.000
Net Acres (α_2")	1.63	1.35	1.20	.120
Double Cropping ("α_3")	2.82	0.56	5.06	.000
Sudan ("α_4")	3.80	0.63	6.08	.000
Price ("α_5")	349	63	5.51	.000
Cost ("α_6")	-628	157	-4.00	.000
Salinity ("α_7")	386	232	1.67	.054
Whitefly ("α_8")	-95,680	65,094	-1.47	.077
R^2=90.9%, σ=57,778 AF, DW=2.11				

"Coefficient" provides the estimated value for the respective parameter. "Standard Deviation" is a measure of the variability in the estimated value of a parameter. "T-

13 The "Whitefly" variable takes the form of a "dummy variable" that equals 1 in the year when the condition prevailed (year =1992) and 0 in years when the condition did not prevail (all other years).

14 Model estimated by the statistical package TSP Version 4.4, TSP International Palo Alto CA.

statistic" is a test statistic to determine whether the estimated value of a parameter is significantly different from zero. "P-Value" is the probability that a coefficient would equal its estimated value if it were truly zero.[15]

The statistical model confirms that IID's use of Colorado River water depends on rainfall, cropping patterns, economic conditions, and salinity of Colorado River water. Other than the net acreage variable (for which there is minor year-to-year variation during the decree period),[16] IID's use of Colorado River water is significantly related to the explanatory variables. Each one-inch increase in annual rainfall reduces IID's annual use of Colorado River water by 51,912/AF. Each additional acre double-cropped increases IID's annual use of Colorado River water by an estimated 2.82 AF. Each additional acre of sudan increases IID's annual use of Colorado River water by 3.80 AF. Each one dollar (year 2000 dollars) increase in Imperial County crop price index increases IID's annual use of Colorado River water by 349 AF. Each one-unit increase in the cost index for farming reduces IID's annual use of Colorado River water by 628 AF. Finally, the whitefly devastation experienced in the year 1992 reduced IID's use of Colorado River water by an estimated 95,680 AF.

The factors included in the statistical model explain 90.9% of the fluctuations in IID's annual use of Colorado River water.[17] The estimated standard deviation of the model's residual is 57,778 AF. The Durban-Watson statistic ("DW") measures the tendency for dependency in the time pattern of the model's residuals. One of the underlying statistical assumptions of the linear regression method is that the residuals are

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[15] For other than the constant term, the P-Values in the table are for what is known as a "one-sided" test. This test is relevant for the situation where there is a well-defined "alternative hypothesis" to the proposition that the dependent value is not affected by the independent variable. For example, consider the explanatory variable rainfall. As discussed above, one expects that the amount of rainfall in any year reduces IID's use of Colorado River water in that year. Therefore, the alternative hypothesis is that the coefficient for the rainfall variable (α_1) is negative rather than zero.

[16] The smaller the variation in an explanatory variable, the less likely a statistical model can detect the impact of the variable. As previously discussed, the annual variation in net acres during the decree period was quite small—1/12[th] the variation in acres double-cropped.

[17] The R^2 statistic measures the portion of the variation in the dependent variable explained by the variation in the explanatory variables.

independent of each other (*e.g.*, "serially uncorrelated"). The estimated DW statistic of 2.11 is statistically indistinguishable from its theoretical value of 2.00 if the statistical assumption about the residual were true.

The statistical model accurately tracks the variation in IID's annual use of Colorado River water (see Attachment 8).[18] Changes in rainfall, cropping patterns, economic conditions and salinity of Colorado River water explain (1) the period of increasing use of Colorado River water by IID from 1964 to 1974, (2) the period of declining use of Colorado River water by IID from 1975 through 1983, (3) the period of increasing use of Colorado River water by IID from 1984 until the late 1990s,[19] and (4) the recent decline in IID's use of Colorado River water in the past few years.

The model based on rainfall, cropping patterns, economic conditions and salinity has significant explanatory power but, like any statistical model, does have prediction errors (*i.e.*, residuals). A "positive residual" means that IID's actual use of Colorado River water in a year exceeded IID's predicted use. A "negative residual" means that IID's actual use of Colorado River water in a year was less than IID's predicted use. In the majority of the years, IID's actual use of Colorado River water is within +/- 50,000 AF of its predicted use (see Attachment 9).[20] For the decree period, the largest differences between IID's actual use and its predicted use occurred in three years (in 1974, the difference between IID's actual use and its predicted use was 135,443 AF; in 1984, the difference was -156,363 AF; in 1997, the difference was 90,458 AF). However, the discrepancies between IID's actual use and predicted use of Colorado River water were short-lived in each of these cases. From a statistical perspective, this lack of sustainability of the difference between IID's actual and predicted use of Colorado River

[18] The predicted value based on the estimated parameters reported in the table and the actual values of the explanatory variables.

[19] As previously discussed, the upward trend in IID's use was interrupted by the whitefly devastation in the year 1992.

[20] This is consistent with the finding that the standard deviation of the model's estimated residual is 57,778 AF. If the residuals are normally distributed, then about 2/3rds of the residuals would lie within the band defined by +/- 57,778 AF.

water reflects the fact that the model's residuals are serially uncorrelated.[21] That is, there is no tendency for either "high-use" or "low use" years to follow one another.

Finally, the distribution of the model's residuals is consistent with what would be expected under the assumption that the residuals follow a normal distribution (see table). The first column shows the range of values for a standardize residual.[22] The second column shows the theoretical frequency distribution of standardized residuals for a sample size of 37 (the number of years in the decree period). The third column shows the sample frequency of standardized residuals for the decree period.[23] The seemingly large residuals for the years 1974, 1984, and 1997 are consistent with what would be expected from random draws from the distribution of residuals for the estimated statistical model.

Comparison of Sample Frequency of Residuals With Theoretical Frequency under Normal Distribution

Range of Standardized Residual	*Theoretical Frequency*	*Sample Frequency*
<=-2.0	1	1
>-2.0 to -1.5	2	1
>-1.5 to -1.0	6	4
> -1.0 to -0.5	11	7
> -0.5 to 0.0	18	19
> 0.0 to 0.5	26	29
> 0.5 to 1.0	31	33
> 1.0 to 1.5	35	35
>1.5 to 2.0	36	36
>2	37	37

[21] The correlation between the residual for a current year and the prior year is -.058. Given the sample size of the decree period (37 years), the standard deviation of the estimated serial correlation is 0.164 under the hypothesis that the residuals are serially uncorrelated. Therefore, the estimated serial correlation of -.058 is both quantitatively small and statistically insignificant.

[22] Standardized residual = the value of a residual divided by the standard deviation of the distribution of residuals.

[23] Standardized residuals were calculated by dividing the value of the residuals shown in Attachment 9 by 57,778 AF (the estimated standard deviation of the residual of the regression model).

Implications

Given the size of the agricultural economy in Imperial County, IID's use of Colorado River water has become under increasing scrutiny in recent years. For example, the US Bureau of Reclamation commissioned several studies to review and evaluate water use within IID.[24] However, these studies concentrate on time periods with only a few years without consideration of the factors identified above that explain the substantial year-to-year changes in IID's annual use of Colorado River water.

Normal variations in rainfall, cropping patterns, economic conditions, and salinity have large impacts on the variability of IID's annual use of Colorado River water (see table).[25] Consider the implications of variability in annual rainfall in Imperial Valley. Annual rainfall varying +/- 1.5 inches around the annual average of 2.91 inches translates into a range of variability of 155,738 AF of IID's annual use of Colorado River water around the level that would otherwise occur if all factors (including rainfall) were at their average levels.

Range of Variability of IID's Annual Use of Colorado River Water Due to Variability in Factors

Factor	*Range of Variability*
Rainfall	155,738 AF
Net Acres	40,113 AF
Double Cropping	186,012 AF
Sudan	197,097 AF
Price	173,821 AF
Cost	148,223 AF
Salinity	57,973 AF

[24] Jensen, M.E. *Water Use Assessment of the Imperial Irrigation District Final Report* (1995), and Jensen, M.E and Walter, I.A, *Assessment of 1996-87 Water Use by the Imperial Irrigation District Using Water Balance and Cropping Data* (1997 draft).

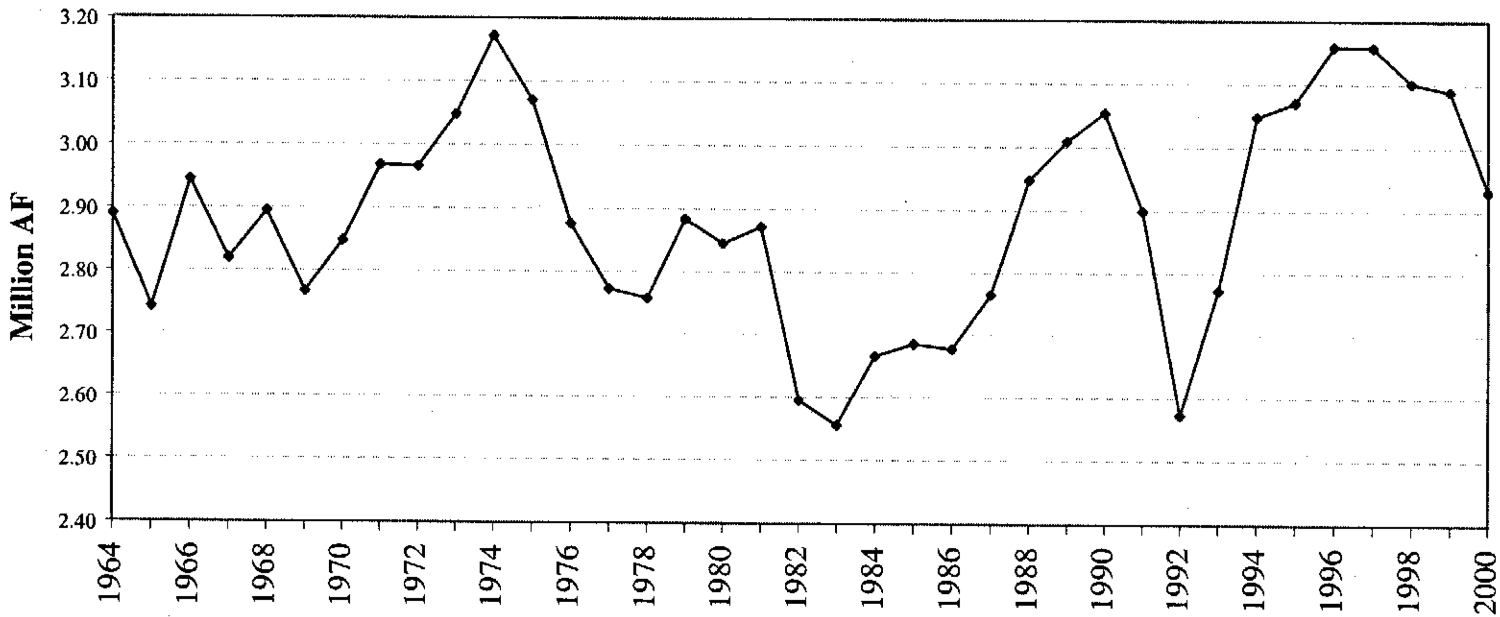
[25] Range of Variation = Estimated Coefficient • Range of Variation of Variable. The latter range was estimated as +/- one standard deviation of the variable. For a variable with a normal distribution, two-thirds of the values for the variable would lie within +/- one standard deviation. Actual variations will be greater because one-third of the values will be greater than +/- one standard deviation of the average value of a variable.

The variability in the other factors determining IID's water use of Colorado River water also create a wide range of variability in IID's annual use of Colorado River water. The variability in IID's annual use due to the fluctuations in double cropping acreage, sudan acreage, and crop prices in Imperial Valley are even greater than the variability due to fluctuations in annual rainfall. The variability in use due to fluctuations in farming costs are only slightly less than the variability in use due to fluctuations in annual rainfall. The variability in IID's use due to fluctuations in the salinity of Colorado River water is substantially less. However, swings of salinity equal to plus or minus one standard deviation of salinity during the decree period generate a range of variation of IID's annual use of almost 60,000 AF.

Conclusion

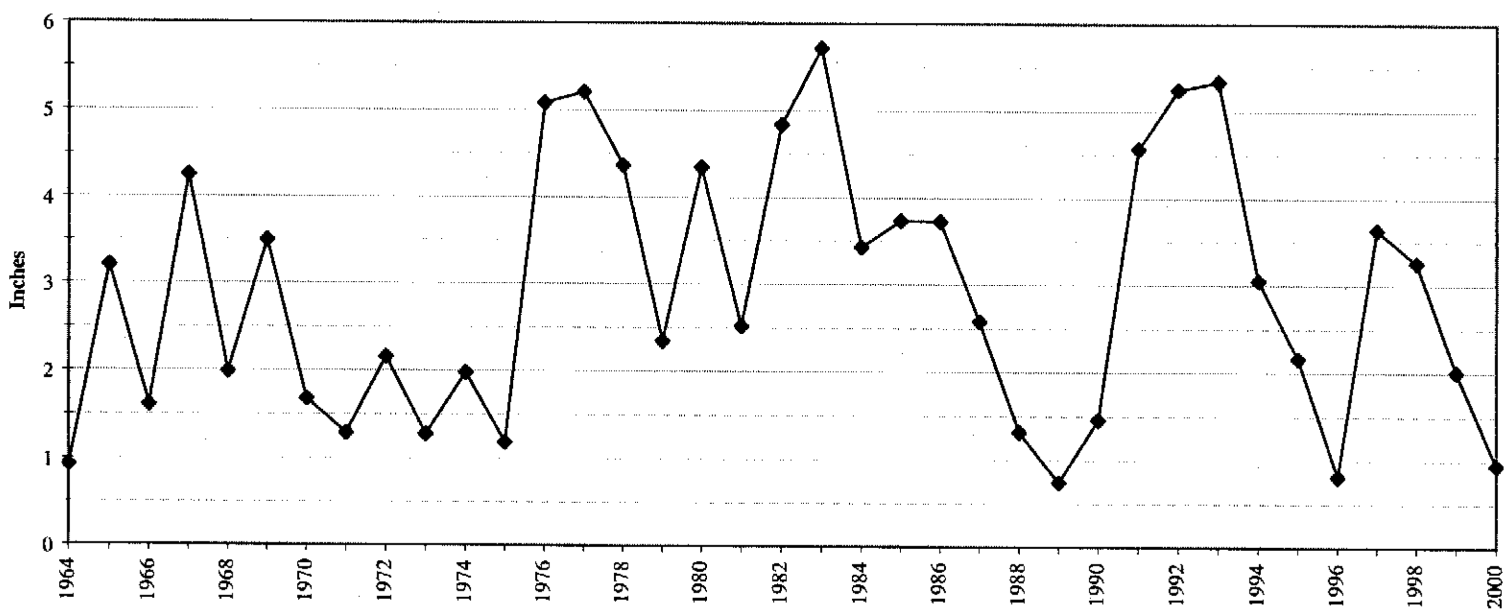
During the decree period, IID's annual use of Colorado River water has averaged 1,889,192 AF, ranging from a high of 3,171,977 AF in the year 1974 and a low of 2,555,617 AF in the year 1983. In the early 1990s, IID's annual use trended upward reaching another peak in 1997. This variability in IID's use reflects annual variations in local rainfall, cropping patterns, the economic conditions of farming, and the salinity of Colorado River water. The statistical model confirming these factors is robust and provides a satisfactory explanation of IID's water use over the decree period.

Attachment 1
IID's Use of Colorado River Water



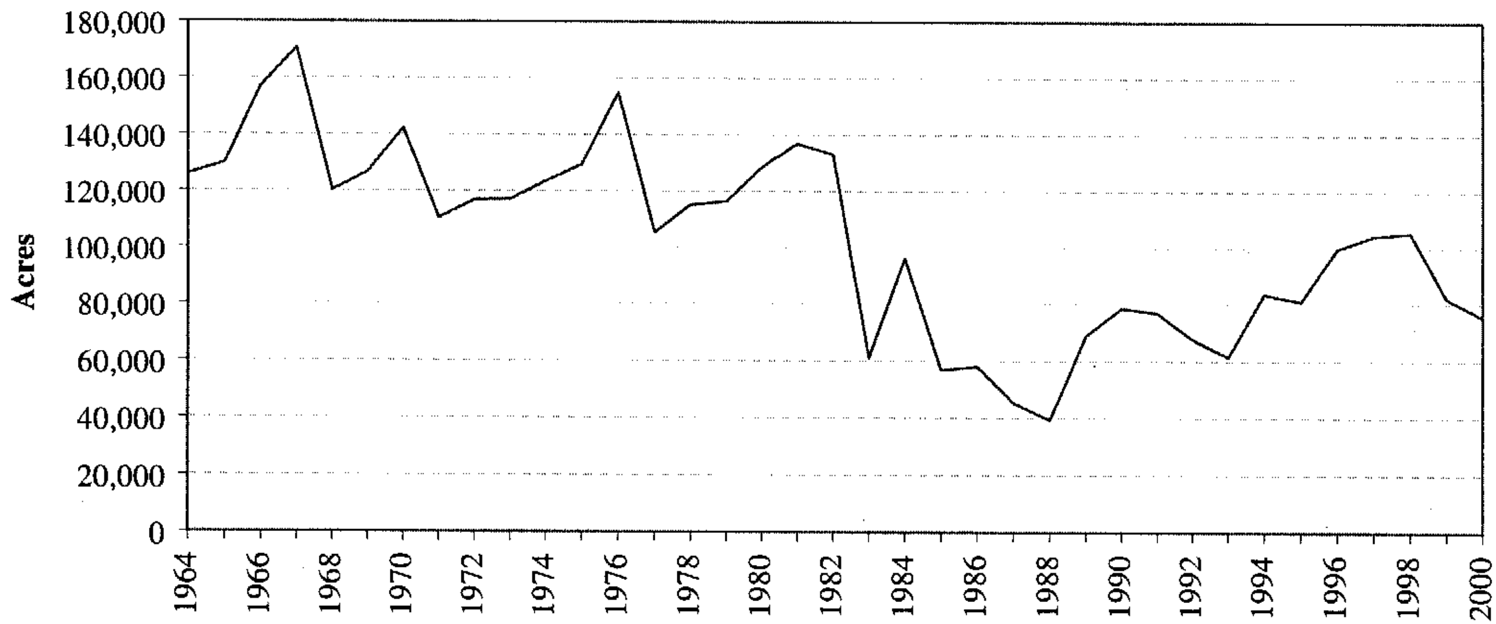
***Source*:** Colorado River Use Database, provided by the Lower Colorado Region, U.S. Bureau of Reclamation, based on the data provided in the annual "Compilation of Records in Accordance with Article V of the Supreme Court of the United States in *Arizona v. California*, dated March 9 1964.

Attachment 2
Annual Rainfall in Imperial Valley
(Average = 2.91")



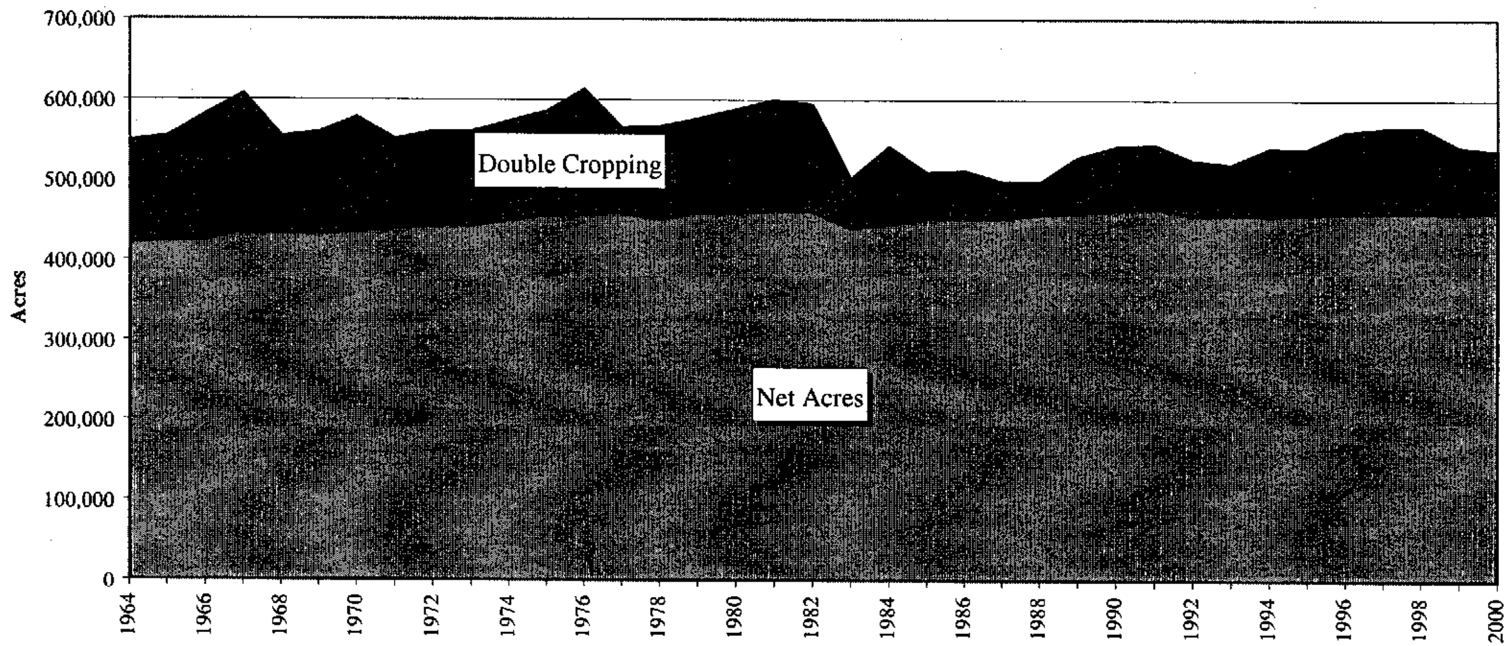
Source: Staff of Imperial Irrigation District

Attachment 3
Double Cropping in Imperial Valley



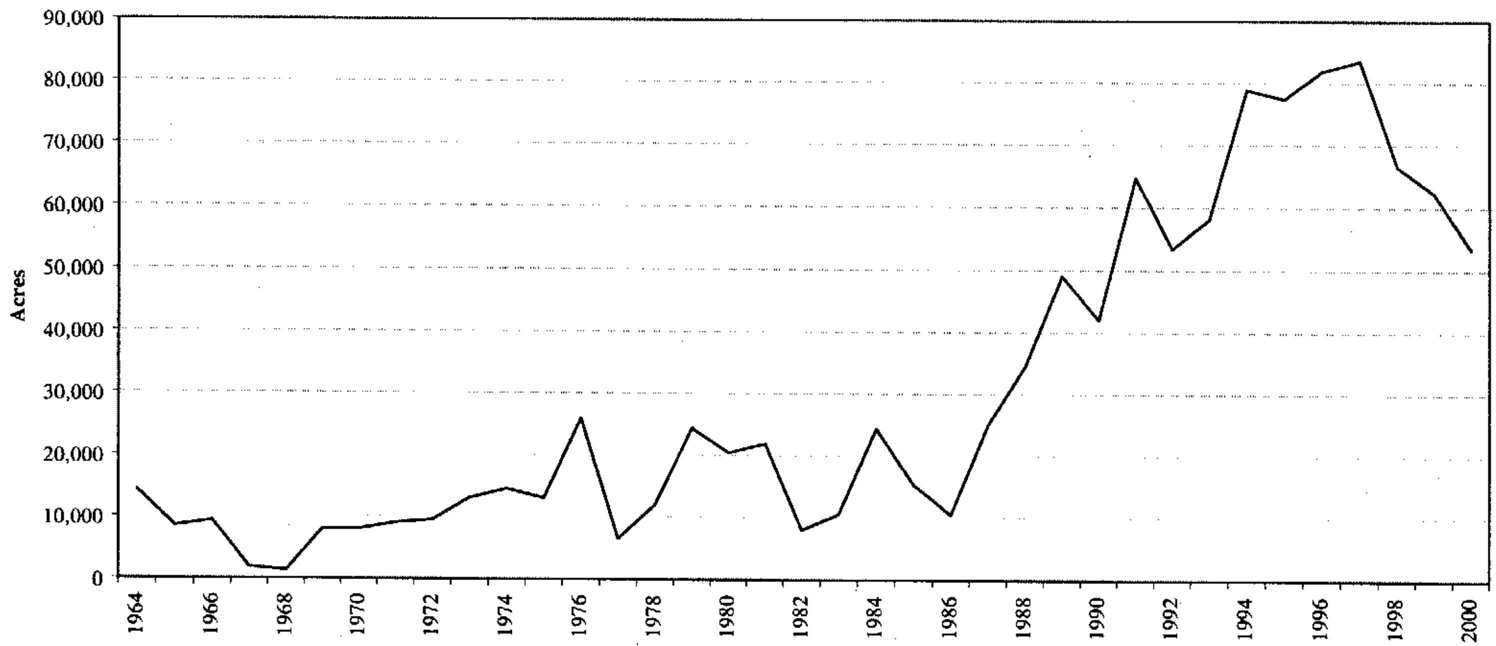
Source: Staff of Imperial Irrigation District.

Attachment 4
Double Cropping and Net Acres in Imperial Valley



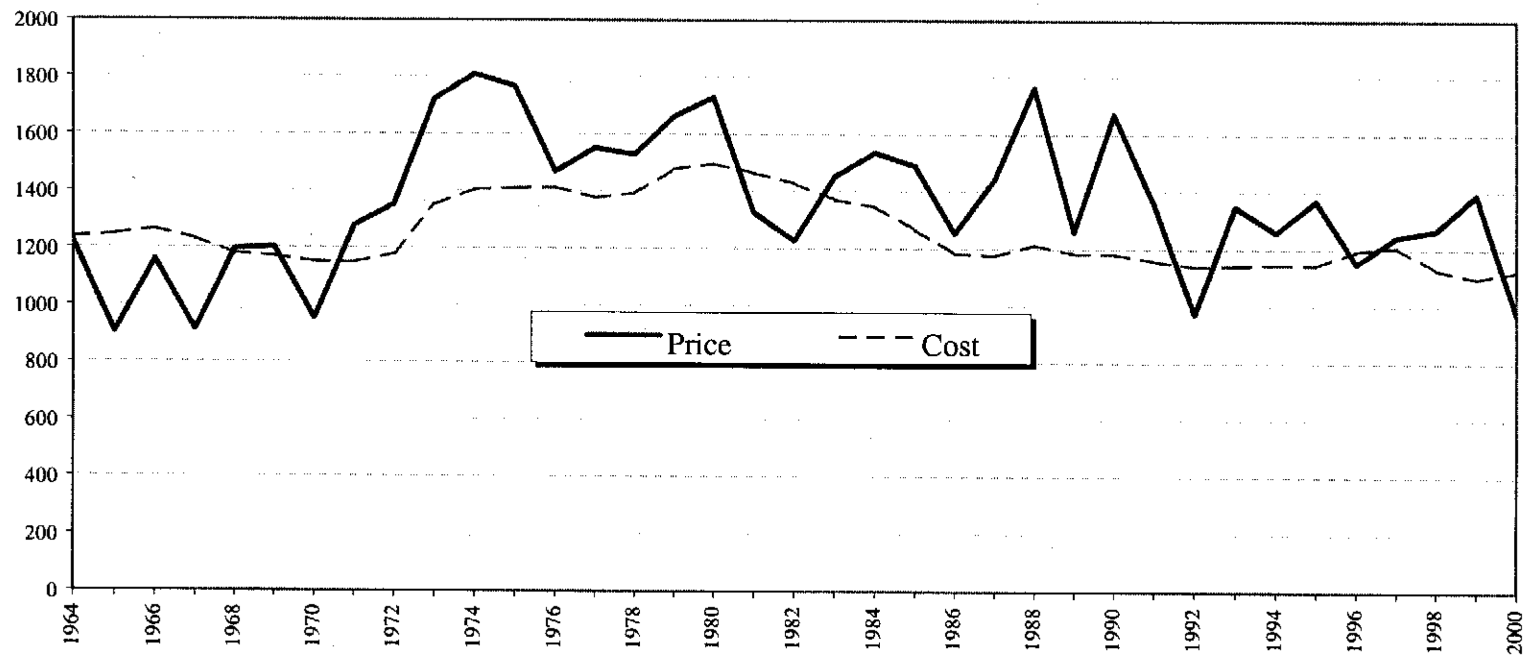
Source: Staff of Imperial Irrigation District (Net Acres = Gross Acres – Acreage Double Cropped)

Attachment 5
Sudan Acreage



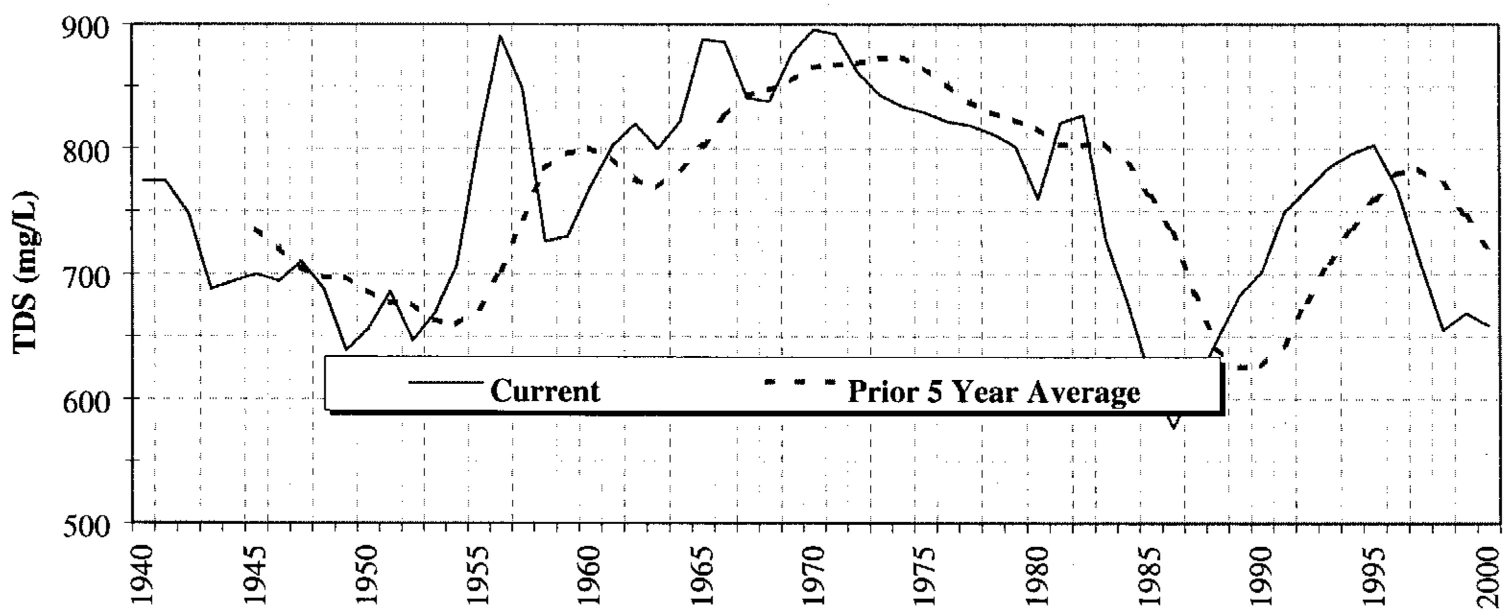
Source: Staff of Imperial Irrigation District

Attachment 6
Price and Cost Indices



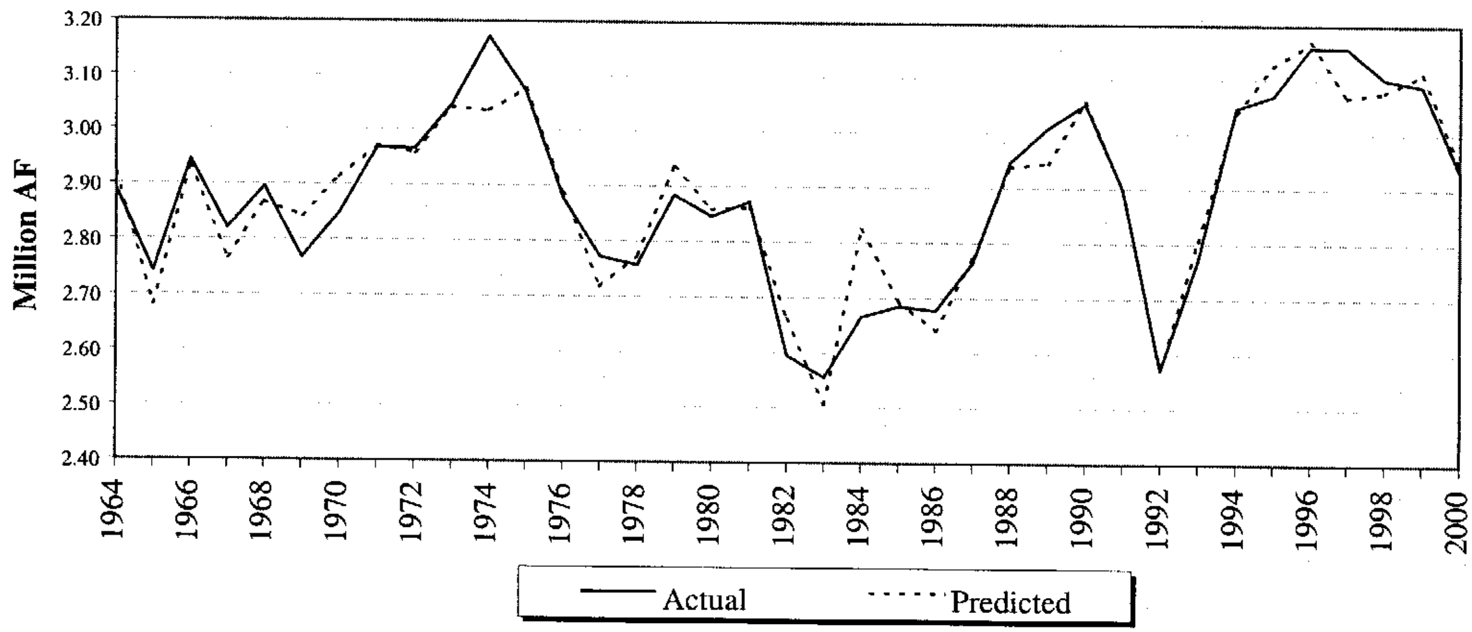
Source. Index of Imperial Valley Crop Prices: Dornbusch and Associates. Cost Index based on Index of Prices Paid for Items Used in Production, United States Department of Agriculture. See text for discussion of calculations.

Attachment 7
Salinity of Colorado River Water at Imperial Dam



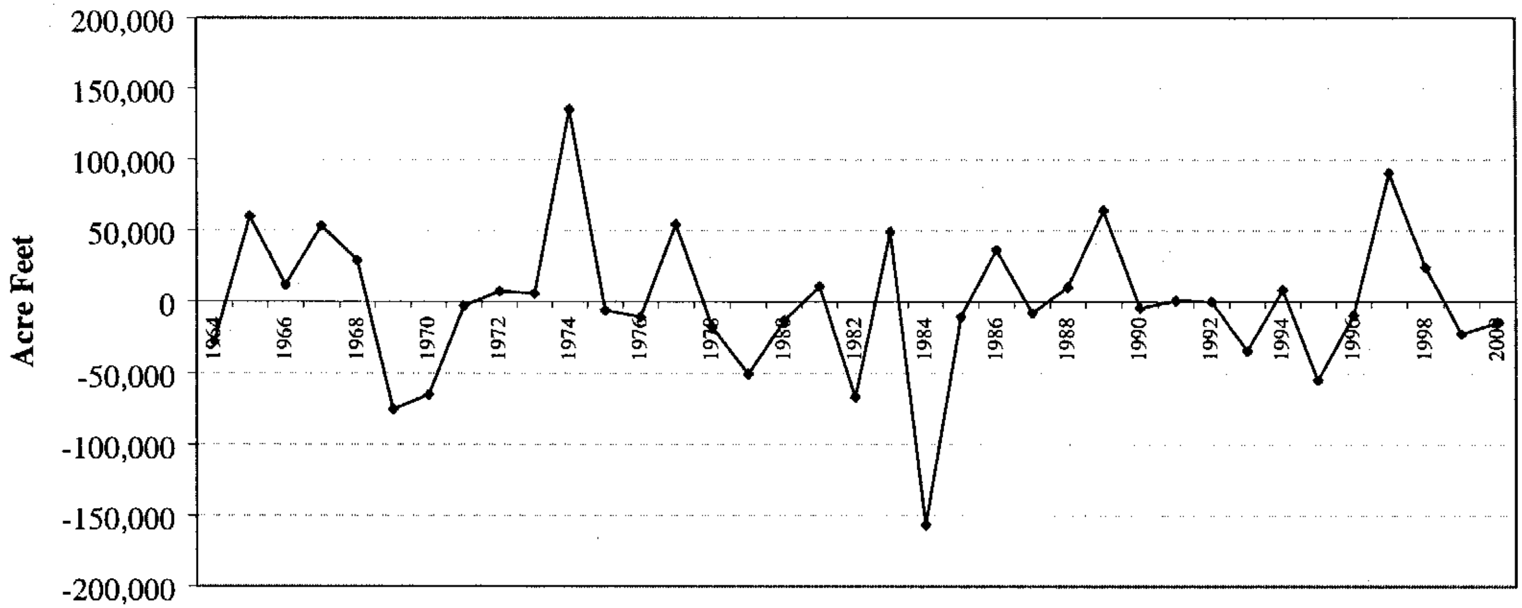
Source: Bureau of Reclamation, Upper Colorado Region Office

Attachment 8
Rainfall, Cropping Patterns, Economic Conditions and Salinity Explain IID's Use of Colorado River Water



Source: For actual IID's Use of Colorado River water, see Attachment 1. Predicted IID's use of Colorado River water based on statistical model presented in text.

Attachment 9
Difference Between IID's Actual and Predicted Use of Colorado River Water



Source For actual IID's Use of Colorado River water, see Attachment 1. Predicted IID's use of Colorado River water based on statistical model presented in text.

The Economic Costs of Water Conservation and the Impact of Uncompensated Conservation on the Economic Viability of Farming in the Imperial Valley

By

Rodney T. Smith
Senior Vice President
Stratecon Inc

The Imperial Irrigation District ("IID") has entered into a proposed long-term water conservation and transfer agreement with the San Diego County Water Authority ("SDCWA") and supplemental acquisition agreement with the Coachella Valley Water District ("CVWD") as part of the Quantification Settlement Agreement ("QSA"). The IID-SDCWA agreement contemplates the conservation and transfer of between 130,000 acre-feet ("AF") per year and 200,000 AF per year for a term up to 75 years. The supplemental agreement between IID and CVWD contemplates an eventual acquisition by Coachella of 50,000 AF per year for a term of up to 75 years and the acquisition of a second 50,000 AF per year for a term of up to 45 years. The conservation and transfer of 300,000 AF per year of Colorado River water represents about 10% of IID's average annual use of Colorado River water during the period from the date the U.S. Supreme Court issued its decree in 1964 in the case *Arizona v. California* to date.[1] The proposed IID-SDCWA and IID-CVWD agreement provides for IID to receive financial payments in return for IID making conserved water available to the SDCWA and CVWD.

A variety of issues have arisen in connection with IID's ability to conserve water, especially in the context of the IID-SDCWA agreement. For example, questions have been raised regarding the costs of water conservation in IID; should IID be obligated to undertake water conservation measures without compensation; and what impact, if any, would an obligation for IID to undertake conservation without compensation have on the

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1 IID's annual use of Colorado River water for the period 1964-2000 averaged 2,889,192 AF. Calculated from the historic record of IID's net use of Colorado River water as stated in the *Colorado River Use Database*, provided by the Lower Colorado Region, U.S. Bureau of Reclamation, based on data provided in the annual "Compilation of Records in Accordance with Article V of the Supreme Court of the United States in *Arizona v. California*, dated March 9, 1964. 300,000 AF/2,889,192/AF ≈ 10.4%.

economic viability of farming in Imperial County and the local economy in Imperial County? These questions have many dimensions—economic, public policy, political, and legal. This study addresses the economic dimensions of these issues:

- what are the economic costs of conservation?
- what are the economic implications of an obligation for the Imperial Valley to conserve water without any compensation?

The Economic Costs of Water Conservation

There are two types of potential agricultural water conservation opportunities in the Imperial Valley that do not entail a reduction in farming activity: (1) IID system improvements and (2) on-farm conservation. For each type of conservation opportunity, there are many dimensions to the economic cost of conservation. For system improvements, there are the costs of capital investment, operations and maintenance, and replacement. For on-farm conservation, there are not only the costs of capital investment, operations and maintenance, and replacement, but also the costs associated with additional on-farm management, the assumption of additional risks, and the IID's cost of administration. Whatever the method of conservation, there is also the cost of environmental mitigation obligations related to the implementation of a conservation program, as well as the impact of conservation activity on other aspects of IID's operations. Some of these costs are more readily quantified than others. I am unaware of any study of the costs of potential water conservation activities in the IID that takes into account all of the relevant dimensions of the economic costs of conservation. This study is no exception. Instead, this study focuses on the likely major considerations.

The Direct Cost of System Improvements

There are three main types of potential system improvements in the IID: seepage recovery, lateral inceptors, and the lining of the All American Canal.[2] Federal legislation

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[2] Staff of the IID.

governs the lining of the All American Canal.[3] Therefore, the discussion below considers the potential costs and potential yield of conserved water from seepage recovery and lateral interceptors.

IID staff have estimated the capital investment, operations and maintenance cost, and potential yield of conserved water for the East Highline seepage recovery project and fifteen mid-lateral inceptor projects (see Attachment 1). Assuming that the actual yield of conserved water equals the potential yield, up to 105,333 AF of water could be conserved from implementation of these system improvements. These system improvements would require a total capital investment of $148.8 million ('98$). Annual operations and maintenance costs total $4 million ('98$). If all the lateral interceptors were constructed, these system improvements would serve 365,810 acres, or about 80% of the irrigated acreage in the Imperial Valley.[4]

The annualized cost per AF in year 2001 dollars varies considerably among these projects.[5] The weighted average direct cost of conservation by these system improvements is $112/AF ('01$).[6] The East Highline Seepage Recovery Project is estimated to conserve 20,000 AF per year at an annualized cost of $20/AF ('01$).

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[3] Title II of Public Law §§ 100-675.

[4] For the period 1964-2000, an average of 450,925 acres were irrigated annually in Imperial Valley. Calculation based on acreage data provided by staff of the IID. Net acres equals the gross acres less acres double-cropped (acreage where more than one crop is grown in a year). 81.1% = 365,801/450,925.

[5] Calculation of annualized costs per AF in year 2001 dollars was as follows. First, escalate estimated cost of capital investment in year 1998$ to year 2001$ based on an annual escalation rate of 1.5% (IID staff estimate of cost escalation for the projects). Second, amortize the capital investment assuming a useful life of 50 years and a real interest rate of 2.9% (based on assumed IID cost of capital of 5.5% and an inflation rate of 2.5%). The use of the real interest rate provides an annualized capital cost in year 2001$ that, when growing at the rate of inflation, generates a payment stream with a present value over the useful life of the project equal to the initial capital investment. Third, estimate annual replacement costs (year 2001$) at 1% of initial capital investment. Fourth, escalate annual operations and maintenance costs in 1998$ to year 2001$ based on an annual escalation rate of 2.5% (general rate of inflation). Annualized costs/AF = (Annualized Capital Investment + Annual Replacement + Operations & Maintenance Cost)/Potential Yield of Conserved Water.

[6] Calculation weights each project's annualized cost by the project's potential annual yield of conserved water.

However, the direct cost of system conservation increases significantly with the total amount of water conserved (see Attachment 2).[7] After the amount of conserved water reaches 40,000 AF per year, the next block of conserved water costs more than $100/AF ('01$). After 60,000 AF per year are conserved, the next block of conserved water costs more than $125/AF ('01$). As IID conserves 100,000 AF per year by system improvements, the incremental direct annualized cost of system conservation approaches $150/AF ('01$). The cost of undertaking the last segment of conservation beyond 100,000 AF per year is literally "off the chart."

These estimates understate the actual cost of system conservation for two reasons. First, IID's staff cost estimates are exclusive of the costs of systemwide improvements required to manage IID's system to assure capture of the estimated amount of conserved water. Second, the estimated costs include only the direct cost of the system conservation projects; they do not include any costs related to any environmental mitigation obligations related to the implementation of the projects or the impact on IID's operations.

Keeping the above qualifications in mind, it appears that IID's conservation potential from system improvements rapidly approaches annualized direct costs and exceeds $100/AF ('01$) for annual conservation at or above 40,000 AF per year. IID's conservation potential from system improvements reaches a practical maximum of 100,000 AF per year at annualized direct costs in excess of $150/AF ('01$).

The Economic Cost of On-Farm Conservation

The IID/SDCWA and IID/CVWD agreements contemplate the conservation and transfer of up to 300,000 AF per year of. At the same time, IID's conservation potential from system improvements economically "caps out" at about 100,000 AF per year. Therefore, conserving water on farm will prove critical to generating the amount of water

[7] Attachment 2 assumes that the order IID would implement projects is based on the economic principle of undertaking the cheapest projects first. The "ranking" of the order of the projects according to this economic principle does not consider whether there are any interdependencies in the cost and/or yield of projects depending on the order the projects are implemented.

contemplated to achieve the objectives as expressed by the SDCWA and CVWD in their respective agreements with IID.

Numerous methods of on-farm water conservation have been proposed for potential implementation in the Imperial Valley.[8] Other than the tailwater recovery systems funded by the 1988 Agreement between IID and the Metropolitan Water District of Southern California ("MWD"), however, there is no field experience and data available to judge the efficacy and cost of on-farm conservation. For that reason, tailwater recovery systems have become the "benchmark technology" to illustrate the potential range of direct costs and yield of conserved water available by non-fallowing methods of on-farm conservation. For example, the pro forma costs of a tailwater recovery system were used in the negotiation of the IID/SDCWA agreement as a means to indicate the reasonableness of the pricing provisions included in that agreement.[9] Similarly, the socioeconomic analysis included in the draft environmental review of the proposed transfer agreements relied upon tailwater recovery systems to indicate the likely economic impacts of on-farm conservation by methods other than land fallowing.[10] The discussion below summarizes the data provided by MWD's funding of tailwater recovery systems, the cost pro formas developed during the negotiations of the IID/SDCWA agreement, and the implications for the economic cost of on-farm conservation.

Tailwater Recovery Systems Funded by MWD. MWD funded 23 permanent tailwater recovery systems under the 1988 IID/MWD Agreement (see Attachment 3 for summary data provided in 1996 by IID staff).[11] These 23 systems were involved in the

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[8] For a representative list, see §2.2.3.3 of the draft "Environmental Impact Report/Environmental Impact Statement for the IID Water Conservation and Transfer Project and Draft Habitat Conservation Plan" (State Clearinghouse No. 99091142, Reclamation Statement No. INT-DES-01-44), January 2002 at p. 2-9 to 2-12.

[9] Based on my personal experience from participating in the negotiation of the IID/SDCWA agreement.

[10] See Appendix G, *infra* note 8, especially at p. G-6.

[11] The accounting of the MWD program states capital investment costs in '88$. These costs were adjusted to '01$ by escalating the capital investment costs at an annual rate of 2.9% through the year 1999 and at an annual rate of 1.5% thereafter. (Assumptions about escalation rates reflect recommendations of IID staff concerning changes in costs of comparable projects over this time period.) The O&M costs were for the year 1996, the most then recent data available at the time that information from the MWD program was

irrigation of a total of 6,119 acres and conserved a total of 4,380.7 AF in 1996. The average size of system was 266 acres, ranging from a maximum of 574 acres to a minimum of 140 acres. Capital costs per acre averaged about $632/acre ('01$), ranging from a high of $963/acre to a low of $353/acre. Operations and maintenance ("O&M") costs averaged about $21/acre ('01$), ranging from a high of $52/acre to a low of $5/acre. The amount of water conserved averaged 0.75 AF/acre, ranging from a high of 1.75 AF/acre to a low of 0.16 AF/acre.

System size has a significant impact on the per acre capital investment, but not on the per acre O&M costs or the yield of conserved water per acre. The per acre capital investment cost of permanent tailwater recovery systems declines with the size of the system (see Attachment 4).[12] Based on the fitted trend line, the capital investment cost per acre declines at a rate of 53% of the rate of increase in the size of the system. In contrast, annual O&M costs are not related to size (see Attachment 5).[13] Similarly, the yield of conserved water per acre is also not related to size (see Attachment 6).[14]

A final lesson from the experience of the MWD agreement is that the costs and yield of conserved water vary considerably among systems. Even after controlling for the effect of system size, capital investment costs/acre vary significantly among the 23 systems; the actual costs deviate +/- $100/acre to $200/acre ('01$) from the fitted trend

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used in the negotiation of the IID/SDCWA agreement. These costs were adjusted to '01$ by escalating at an annual rate of 2.5% (general rate of inflation).

12 Each diamond in Attachment 4 corresponds to one of the 23 permanent tailwater recovery systems funded by MWD. The correlation between capital investment cost/acre and size is -.63. For a sample size of 23, the standard deviation of the estimated correlation coefficient is .20. Therefore, the estimated correlation coefficient is statistically significant from zero. The probability is .006 that the estimated correlation coefficient would have a value of -.63 if capital investment per acre were truly uncorrelated with size.

13 The correlation between annual O&M costs and size is -.14. The estimated correlation coefficient is not statistically significantly different from zero. For a sample size of 23, the probability is .50 that the estimated correlation coefficient would have a value of -.12 if annual O&M costs were truly uncorrelated with size.

14 The correlation between annual O&M costs and size is -.25. The estimated correlation coefficient is not statistically significantly different from zero. For a sample size of 23, the probability is .24 that the estimated correlation coefficient would have a value of -.25 if annual O&M costs were truly uncorrelated with size.

line (see Attachment 4). That is, the actual cost investment experience of systems installed under the MWD Program can vary by as much as +/- 15% to 30% of the average capital investment cost of $632/acre ('01$).[15]

Similarly, there is considerable dispersion among the systems in terms of both annual O&M Costs (see Attachment 5) and the yield of conserved water per acre (see Attachment 6). Comparing O&M costs across systems, the less costly systems (those with costs below the median) average O&M costs of $9.10/acre ('01$), while the more costly systems (those above the median) average O&M costs of $32.10/acre ('01$). Comparing the yield of conserved water across systems, the more productive systems (yields above the median) have an average yield of 1.06 AF/acre, while the less productive systems (yields below the median) have an average yield of 0.47 AF/acre. With O&M costs differing by a ratio of 3-to-1 and the yield of conserved water differing by a ratio of 2-to-1, there is considerable variability in the experience of different systems in their cost and yield of conserved water.[16]

The variability of costs and yield of conserved water reflects many factors: field size, slope, soil type, irrigation method, system layout and complexity, and cropping patterns.[17]

Cost Pro Forma. The experience of the 1988 MWD program provided a starting point for consideration of the use of tailwater recovery systems as a benchmark technology for costs. However, the average field size within IID is 75 acres, or about one-fourth the average size of systems installed under the 1988 agreement.[18] In light of

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[15] +/- $100/acre ('01$) ≈ +/-15% of $632/acre. +/-$200/acre ≈ +/- 30% of $632/acre.

[16] 3-to-1 ratio of variability for O&M costs based on the ratio of O&M costs of the most costly systems, $32.10/acre ('01$), to the O&M costs of the least costly systems, $9.10/acre ('01$). $32.10/$9.10 ≈ 3/1. 2-to-1 ratio of variability for the yield of conserved water based on the ratio of the conservation yield of the most productive systems, 1.06 AF/acre, to the conservation yield of the less productive systems, 0.47 AF/acre. 1.06/0.47 ≈ 2/1.

[17] Staff of IID.

[18] Average field size provided by staff of the IID. The average size system installed under the 1988 MWD/IID agreement was 266 acres (see Attachment 3). 75 acres/ 266 acres ≈ ¼.

the strong evidence that per acre capital investment costs depend on system size,[19] IID staff in consultation with SDCWA staff and consultants prepared cost pro forma for smaller-sized systems. The selection of field sizes was determined by the following considerations:

- In 1996,[20] IID had 5,192 gates serving 460,765 net-cropped acres.[21] The most common category of field size served by a delivery gate is 41 to 80 acres, with 2,243 of the total delivery gates (see Attachment 7). About half of the net-cropped acreage in 1996 was in field sizes below 120 acres. A total of 400,000 acres are in field sizes below 160 acres. Any significant on-farm conservation program must extend below the field sizes of the MWD program.
- Any broad-based on-farm program must target participation by parcels of 80 acres and 120 acres (see Attachment 8).[22] Otherwise, there is not sufficient acreage in fields to conserve a significant quantity of water. For example, programs targeted to include field size at or above 200 acres could not conserve 50,000 AF per year even if ALL fields of that size participated in an on-farm program. There are just too few fields of that size. A program targeted to include field sizes at or above 120 acres is needed to have at least the prospect of conserving 130,000 AF per year. However, unless the threshold for participation is extended down to 80 acres, high participation rates (in excess of 70%) would be required to conserve at least 130,000 AF per year.[23]

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[19] See Attachment 4 and text discussion, *supra*.

[20] The most recent data available at the time of the negotiations.

[21] Data provided by Staff of IID.

[22] Annual yield of conserved water assumed at 0.65 AF/acre, the median yield from the MWD program (see Attachment 3).

[23] In principle, a large system could be installed over many smaller fields and exploit the economies of scale in capital investment. However, the vast majority of fields in Imperial Valley are separated by physical obstructions (such as roads and concrete canals) with little common ownership of adjacent fields (based on an examination of plat maps of Imperial Valley). Therefore, any broad-based "consolidation" of operations would require further construction efforts to overcome the physical obstructions,

Based on the above information, cost pro formas were prepared for permanent tailwater recovery systems for 80 acres and 120 acres and a portable tailwater recovery system for 80 acres (see Attachment 9).[24] For permanent systems, an 80-acre system is estimated to require a capital investment of $970/acre ('01$) and a 120-acre system is estimated to require a capital investment of $784/acre ('01$). The relative capital investment of these systems is consistent with the experience of the MWD program where per acre capital investment fell at the rate of 53% of the rate of increase in the size of the system.[25] The level of capital investment in the cost pro forma exceed the $632/acre ('01$) average in the MWD program. However, recall that the size of systems installed in the MWD program was 266 acres.[26] After taking into account the differences in system size, the permanent tailwater recovery systems included in the cost pro forma are actually 20% cheaper than predicted by adjusting the $632/acre capital investment cost under the MWD program for the effect of system size (see Attachment 10).[27]

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assuming this was possible, and require either the reorganization of land ownership or creation of partnership entities. While neither is impossible, the former would require additional expenditures and the latter would involve transactions costs. In the end, the judgment was made that an on-farm program to conserve about 10% of water use should not be predicated on the assumption that there would be wide-spread efforts to overcome physical obstructions, a major reorganization of land ownership in the Imperial Valley, and creation of broad-based new partnership entities.

[24] The cost pro formas were based on diesel powered systems. The cost pro formas were prepared in the year 1997. Attachment 9 restates the costs in ('01$) by escalating the capital investment costs by 1.5% annually (IID staff's recommendation regarding escalation rates relevant for these projects) and the O&M costs by 2.5% annually (general rate of inflation).

[25] For estimate of the rate at which capital investment fell with the rate of increase of system size, see Attachment 4 and related text discussion. For the cost pro forma, the estimated rate implied by the cost estimates happens to be almost identical: ln($970/$$784)/ln(80/120) = -.5267.

[26] See Attachment 3.

[27] In Attachment 10, the estimate based on the MWD Program used the $632/acre ('01$) capital investment cost and adjusted for the size of system by the relationship found in Attachment 3—the rate of increase in capital investment per acre increases at a rate of 53% of the decrease in the size of the system.

In comparison to permanent systems, a portable system for 80 acres requires a smaller capital investment ($713/acre, '01$ versus $970/acre, '01$), but incurs a higher O&M cost ($78/acre, '01$ versus $46 per acre, '01$).

The annualized direct cost per acre for tailwater recovery systems ranges from $99/acre ('01$) for a permanent system installed on 120 acres, to $119/acre ('01$) for a permanent system installed on 80 acres, to $123/acre ('01$) for a portable system used on 80 acres (see Attachment 11).[28] For permanent systems installed on 80 acres, the annualized capital investment cost equals $58/acre ('01$). That is, an annual payment starting in the year 2001 of $58/acre escalating at the rate of inflation (2.5%) over the valuation horizon (45 years) discounted at an interest rate of 8% equals the initial $970/acre capital investment. Replacing the pumps over 10 years yields an annualized replacement cost obligation equal to $15/acre ('01$). Reflecting the per acre cost savings from larger systems, the annualized cost of capital investment and replacement for 120 acre systems are lower than for 80 acre systems by $16/acre ('01$).[29] The larger system also enjoys a cost advantage of $4/acre ('01$) in O&M costs. For permanent versus portable systems for 80-acre fields, the portable system's higher O&M costs more than offset its advantage of lower capital investment and replacement costs.

The direct cost of water conservation depends on the conservation yield (see Attachment 12).[30] If the systems conserve 0.65 AF/acre (the medium yield), then a permanent 80-acre system conserves water at a direct annualized cost of $183/AF ('01$),

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[28] Calculations based on cost pro forma data provided in Attachment 9. Replacement cost based on a 10-year useful life for pumps. The cost of pumps escalated annually at 1.5%. Financial calculations based on a 8% interest (250 basis points above interest rate on 10-year treasury note), an annual inflation rate of 2.5%, and valuation horizon of 45 years. Calculation of annualized cost per acre in '01$ for capital investment and replacement costs based on a real interest rate of 5.4% (reflecting the assumption that the interest rate is 8% and the annual inflation rate is 2.5%). For discussion of the role of the real interest rate in the calculation of annualized cost in '01$, see note 5, *supra*. O&M costs ('01$) provided in Attachment 9.

[29] $16/acre ('01$) = capital investment savings of $12/acre ('01$) + replacement cost savings of $4/acre ('01$).

[30] The medium yield equals the median conservation yield of the MWD program (see Attachment 3). The low and high yields were defined as +/- 0.15 AF/acre, a conservative range of yield in light of the experience with the MWD program. For the experience of the MWD program, see test discussion of Attachment 6, *supra*.

a 120-acre permanent system conserves water at a direct annualized cost of $152/AF ('01$), and a portable system installed on 80 acres at a direct annualized cost of $189/AF ('01$). The direct annualized cost of conservation is lower for higher conservation yields, and higher for lower conservation yields.

Economic Cost. The economic cost of on-farm conservation include more than the direct costs discussed above. A complete calculation would include the following:

1. direct costs
2. compensation for additional management
3. compensation for assumed risks
4. compensation for the impact of conservation on-farm operations
5. incentive

The estimated direct costs for tailwater recovery systems in Attachment 12 include only the first consideration. While an important component, it provides only a partial picture of the economic costs of on-farm conservation.

Water conservation activities require additional management. Water conservation activities are not self-operating. Instead, additional effort must be exerted to run the facilities, direct the labor, and coordinate/integrate conservation activities with farming operations. The additional management services have an economic value that should be added in the calculation of economic costs.

Water conservation activities face economic risk. The MWD program provides evidence of significant variation in actual costs and the yield of conserved water. There is no guarantee that actual performance of a tailwater system will reflect the assumptions used not only in the preparation of the cost pro forma considered here, but also the cost pro forma prepared by any other investigator. Risk bearing activities require compensation. The economic cost of risk bearing should be added to the calculation of economic costs.

Conservation activities can also impact farm operations. In the case of tailwater recovery systems, for example, the reuse of irrigation water offers potential additional costs and benefits. For example, the salinity of reused irrigation water will be higher than the salinity of water originally applied to the field. If unmitigated, the higher salinity may reduce crop yields or, potentially, require a switch to a more salt-tolerant crop. Such adjustments represent additional costs. Alternatively, blending fresh water with the reused water may mitigate the potential increase in salinity. The additional water used for blending, however, will reduce the yield of conserved water and, therefore, increase the cost of water conservation. The estimated direct cost of water conservation by tailwater recovery systems does not include any of these considerations.

Finally, at least for voluntary programs, there must be an economic incentive for water conservation activities to be adopted. Otherwise, there is no economic reason to undertake water conservation activities. Even non-voluntary programs need incentives. Otherwise, there will be significant problems with compliance. What constitutes a reasonable economic incentive? Until voluntary water markets develop in California, there is no factual basis to answer this question.

In sum, the economic costs of on-farm conservation exceed the direct costs discussed above. There is insufficient evidence to quantify the compensation for additional management, risk bearing, impact on farming operations, and economic incentive. The inability to quantify these considerations, however, does not mean that they are immaterial to a complete calculation of the economic costs of conservation.

Other Costs of Conservation

The complete cost of conservation must also take into account the impact of conservation activity on IID's operations and any environmental mitigation obligations required for a water conservation program. For example, if conserved water were transferred outside IID's service area, there would be a reduction in the generation of hydroelectric power produced from water flows through the IID delivery system. The cost of acquiring replacement power is properly included in the cost of water conservation. Similarly, if IID incurs additional costs in its systems operations or must investment in other system improvements to capture the water conserved by seepage recovery, lateral interceptors, or on-farm conservation, then these costs are properly included in the cost of water conservation. Finally, the impact of any water conservation activity on the Salton Sea, drain habitat, and other environmental resources must be considered. Until the environmental mitigation obligations are confirmed, there is no way to estimate the magnitude of these costs.

Conclusion Concerning the Range of IID's Cost of Conservation

Based on the foregoing, I conclude that IID's costs of conservation include the following:

1. Direct Cost of System Improvements: IID can conserve up to 40,000 AF per year at an annualized direct cost in excess of $100/AF ('01$) and additional conservation up to a total of 100,000 AF per year at an annualized cost in excess of $150/AF ('01$).
2. Other Costs of System Improvements: The estimates do not include the costs of systemwide improvements that would be required to capture the water actually conserved by seepage recovery, lateral interceptors, or on-farm conservation activity.
3. Direct Cost of On-Farm Conservation: IID can conserve water at a direct annualized cost between $120/AF ('01$) and $240/AF ('01$), depending on the field size, slope, soil type, irrigation method, system layout and complexity, and cropping patterns. The amount of water that can be conserved will depend on (1) the actual yield of conserved water that, based on the experience of the MWD program, can vary considerably; and (2) the amount of acreage suitable for water conservation activities.
4. Other On-Farm Costs: The estimates do not include the costs of additional management, risk bearing, impact on-farm operations, or economic incentive required for a successful implementation of an on-farm program.
5. Other Conservation Costs: The estimates above do not include the costs related to the impact of water conservation on IID operations, labor, management, power generation costs, water sale revenue loss, and improvements to capture the saved water, or any environmental mitigation obligations.

For the reasons stated in conclusions 2, 4, and 5, the cost estimates for system improvements stated in conclusion 1 and for on-farm conservation stated in conclusion 3 are minimum estimates of the IID's cost of conservation.

The Economic Impact of Uncompensated Conservation

Water use practices in the Imperial Valley reflect the economic circumstances of water users. Currently, the decisions governing water use and conservation are driven by the economics of irrigated agriculture. Will water conservation enhance revenues (through improved yields) and/or reduce costs (by saving expenditures on water and other factors of production) by enough to cover the cost of conservation. From an economics perspective, current water use practices reflect the fact that all economically viable water conservation practices on farm have been undertaken that, from the perspective of irrigated agriculture, pass this fundamental economic cost/benefit test. This economic calculus of water conservation can be fundamentally changed, of course, by offering economic incentives to conserve water.

Since at least the late 1990s, there has been some speculation that IID should conserve water without any economic incentive or, for that matter, any compensation for the costs incurred in conservation. Putting aside the legal and public policy issues raised by this question, the discussion here considers the economic impact of an uncompensated obligation of the Imperial Valley to conserve water. Under such an obligation, IID and its water customers would bear the cost of conservation presumably for the benefit of other parties who would receive the conserved water without any obligation to pay IID.

Defining the Scope of the Cost Burden

The discussion below considers the cost burden of four scenarios, again, without reference to legal or public policy considerations or constraints:

1. IID installs system improvements to conserve 50,000 AF per year
2. IID installs system improvements to conserve 100,000 AF per year
3. IID conserves 100,000 AF per year on farm
4. IID conserves 100,000 AF per year on farm and 100,000 AF per year by system improvements.

Based on the earlier discussion of the economic cost of conservation, the direct costs only of each scenario is as follows:[31]

1. $4,000,000 ('01$)
2. $10,000,000 ('01$)
3. $17,500,000 ('01$)
4. $27,500,000 ('01$)

As discussed previously, the economic costs of conservation will exceed the direct costs. If the additional costs were 50% of the direct costs, then the range of IID's costs of conservation would be 50% higher than estimated above.[32] Recall that these additional costs include excluded additional system improvements required for IID to capture the conserved water, the impact of conservation on IID operations, IID lost water and power revenues, IID administrative costs, and the cost of environmental mitigation obligations. For on-farm conservation, the additional costs also include compensation for additional management, risk bearing, impact on farm operations, and economic incentive.

Costs, whether incurred voluntarily or under an obligation must be paid. In the discussion below, I assume that IID recovers the costs of uncompensated conservation obligations through its rates and charges imposed on its customers. Traditionally, IID recovers the bulk of the costs of its water department through the water rate charged customers. Assuming that the water rate is levied on 2.75 million AF of annual IID water deliveries to the headgate (which is less system losses), then IID must increase its water rate by up to $15/AF ('01$).[33] In the discussion below, I consider the economic impact of a $15/AF ('01$) increase in IID's water rate.

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[31] Cost estimate for Scenario 1 based on the direct annualized cost of IID installing the "cheapest" system improvements found in Attachment 1 to conserve 50,000 AF per year (but see text discussion of Attachment 2). Cost estimate for Scenario 2 based on the direct annualized cost of installing the "cheapest" system improvements found in Attachment 1 to conserve 100,000 AF per year (but see text discussion, *ibid*). Cost estimate for Scenario 3 based on taking the mid-range of estimated direct annualized costs presented in Attachment 12—e.g., $175/AF ('01$). Cost estimate for Scenario 4 the sum of the cost estimates for scenarios 2 and 3.

[32] Due to the absence of experience discussed previously, the 50% assumption was arbitrary. The actual additional costs can vary substantially from the amount assumed here.

[33] $15/AF = 150%•$27,500,000/2,750,000 AF.

The Impact on the Economic Viability of Irrigated Agriculture

To assess the economic impact, it is necessary to compare the increase in water costs paid by farmers to the income earned from farming. For irrigated agriculture to be economically viable, the revenues earned from the sale of crops must equal or exceed the cost of production (including land rents), plus an economic return adequate to make it attractive for individuals to remain in farming.

Each year, the U.C. Cooperative Extension Service publishes guidelines for field and vegetable crops grown in Imperial County. The guidelines include "crop budgets" for the estimated costs for land preparation, planting, growing, harvesting, land rents, and assumed overhead costs for each crop. The crop budgets are developed to be "representative" of the costs actually incurred. Results on actual acreage will vary to the extent that the crops can be grown with different amounts of production inputs and/or inputs secured at prices different than assumed in the calculation of production costs reported in the guidelines. However, the crop budget data is commonly used as a barometer of the costs of crop production. When this information is combined with data reported annually by the Imperial County Agricultural Crop & Livestock Report on representative crop prices and crop yields, one can estimate the economic return earned by farmers of specific crops. The calculations below are based on the crop budgets prepared by the U.C. Cooperative Extension Service for the year 2000-2001.

Attachment 13 reports the Gross Return and Net Return from farming under three different conditions concerning crop prices and crop yields: (1) the year 2000; (2) the average of the period 1995-2000; and (3) a "reference price" reflecting improvements in the economic conditions of crop markets.[34] The "Gross Return" equals the cost of production (including rent) <u>before</u> any return attributed for farming. Only 5 of the 15 crops showed even a positive gross return in the year 2000. Overall, farmers lost an

[34] The "reference price" was defined by taking a weighted average of crop revenues per acre for the 1995-2000 period and the highest crop revenue per acre in any year of that period. A 75% weight is given to the average over the 1995-2000 period and a 25% weight given to the highest crop revenue per acre in any year during this period. This definition of the reference price defines a condition in crop markets that is "better" than the average of the 1995-2000 period, but "not as good" as the best year in the period.

estimated $131 per irrigated crop acre. The status of the Net Return from farming in the year 2000 is even worse. The Net Return from farming averaged a loss of $226/acre.[35]

Imposing a water rate increase on top of these economic conditions would increase the estimated loss from farming. IID farmers do not have the sufficient market power for increased water rates to result in higher crop prices.[36] Accordingly, any increased costs due to unilateral increases in IID's water rates will erode the income earned from farming.[37]

Farming income losses, of course, are not economically sustainable. Assuming that the economic conditions in the year 2000 were not representative of long-term market conditions, the analysis considered the gross and net returns from farming under the two alternative (more favorable) economic conditions. If economic conditions in crop markets were to return only to the average levels for the entire 1996-2000 period, the net returns to farming would become positive, averaging $72/acre. However, these crops account for only 166,605 acres of the 436,715 acres. If economic conditions were to further improve to the "reference price," then all but two crops become economically viable.

Examination of average per acre returns for a crop, of course, does not capture the fact that acreages planted in the same crop do not earn the same economic return. For example, crop yields vary significantly among parcels due to soil characteristics and farming skill. Therefore, at given crop prices, per acre returns are not identical. As a consequence, some acreage would earn more than the average return and, as a result, may remain economically viable despite the increased costs due to higher water rates. Alternatively, other acreage would earn less than the average return and, as a result, would not be economically viable even if the cost from an uncompensated conservation

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[35] The Net Return equals the Gross Return less an estimated per acre farming income necessary for farming to remain economically viable. The required per acre farming income was assumed to be a (conservative) 5% of the cost of establishing and growing crops plus land rent. This amount is less than the estimated overhead included in the U.C. Cooperative Extension crop budgets. If a higher percentage assumption were used, then the estimated losses from irrigated agriculture would be greater.

[36] See IID Exh. 6 report by Jason Bass and Jim Merchant, Dornbusch Associates.

[37] *Ibid.*

obligation required an increase in the IID water rate of less than $15/AF ('01$). Moreover, even if the average net return of a crop were positive, an increase in the water rate will make the marginal, low-earning acreage not economically viable.

The $15/AF ('01$) increase in IID's water rate would reduce the economic viability of farming in the Imperial Valley. The final three columns in Attachment 13 estimate the impact of the increase in the IID water rate on the economic viability of farming under the three different economic conditions in crop markets.[38] Under the economic conditions of the year 2000, the increased water rate would reduce the portion of acreage that is economically viable by 30% of the acres farmed. Even if crop prices return to their averages of the 1995-2000 period, the increased water rate would reduce the acreage that is economically viable also by 30% of the acreage. Only if economic conditions return to the more favorable conditions represented by the reference price, will the adverse impact from an increased water rate be limited to 15% of the acres farmed.

In sum, an uncompensated conservation obligation requiring a $15/AF ('01$) increase in IID's water rate will significantly reduce the economic viability of irrigated agriculture in Imperial Valley. The size of the impact depends on the economic conditions in crop markets. When crop prices are low, such as they were in the year 2000, the impact of the price increase would be greatest (see Attachment 14). In effect, with already thin economic margins, a water rate increase will push more acreage over into the realm of no longer being economically viable. If crop market conditions improve to the average price levels experienced during 1995 through 2000, almost all of the irrigated acreage in the Imperial Valley will be economically viable. However, a $15/AF

[38] The calculations are based on assuming that per acre crop yields are distributed lognormally, with the range in the per acre yields within a band of +/- 25% of average crop yields. For example, the average per acre yield for alfalfa in the year 2000 was 8.1 tons/acre. Therefore, the range of yields for this period would be between 6.1 tons/acre and 10.1 tons/acre. Given crop prices and the cost of production, one calculates the minimum crop yield for the net return from farming to be zero ("breakeven crop yield"). In the calculation, I assume that the land rent of marginal land is 50% of the average rent reported in the crop budgets. The portion of the acreage that is economically viable equals the portion of the distribution of crop yields that exceeds the breakeven crop yield. The columns "Reduced Economic Viability" in Attachment 13 equals the difference between the portion of the acreage that is economically viable with and without the $15/AF ('01$) increase in IID's water rate.

('01$) increase in IID's water price will cut the economic viability of irrigated acreage on the order of 15% to 30%.

Sustained reductions in the economic viability of irrigated agriculture will place downward pressure on land values and land rents. Unless land values fall by the full amount of the cost burden of an uncompensated conservation obligation, reduced economic viability will ultimately translate into potential reductions in irrigated acreage. Given the economic importance of agriculture to the Imperial economy, reduced agricultural activity will have an important adverse impact on the local economy.

Conclusion

Water use practices in the Imperial Valley reflect the economic circumstances of water users. Nevertheless, there are potential opportunities to conserve water in the Imperial Valley through system improvements and on-farm conservation. Pursuing these opportunities, however, requires a substantial commitment of economic resources.

The direct costs of system improvements would reach $150/AF ('01$) if IID were to fully pursue opportunities for system improvements by seepage recovery and lateral interceptors. However, the actual costs will exceed these estimates, because the estimates do not include the costs of other system improvements required to capture and manage the conserved water. IID's conservation potential through system improvements is capped at about 100,000 AF per year.

Given the scale of conservation contemplated under the transactions envisioned in the QSA, conserving water on farm will become an important part of meeting the objectives expressed in the proposed conservation agreements with IID. Many water conservation opportunities on farm have been proposed. For the Imperial Valley, the best-documented and known on-farm conservation method involves tailwater recovery systems. The experience under the 1988 IID/MWD Agreement provides valuable data on the costs and yields of conserved water. However, that experience illustrates that there would be a diversity of circumstances affecting the cost and yield of conserved water.

The costs of conservation will grow with the scale of water conserved on-farm. Given the distribution of field sizes in the Imperial Valley, any program seeking more than 50,000 AF per year of conserved water on farm must extend its reach to field sizes substantially below the sizes funded under the MWD program. As is generally true in economics, the more of an activity undertaken, the greater the incremental costs.

Based on updated cost pro formas prepared as part of the negotiations of the IID/SDCWA agreement, the direct annualized cost of conserved water with tailwater recovery systems would average about $175/AF ('01$). At the same time, actual direct costs and yield of conserved water will vary considerably around this estimate.

Like the cost estimate for system conservation, the full economic costs of conservation on-farm will be greater than the direct costs of conservation. Additional consideration must be given to the need for compensation for additional management, assumption of risks related to the variability of costs and yields of conserved water, impact of conservation on farming operations, and economic incentives. Economic incentives will prove critical for securing participation in voluntary programs and for securing compliance with non-voluntary programs.

The cost of water conservation includes more than the considerations outlined above. Water conservation will have other impacts on IID operations, such as lost hydroelectric power and water sales. Furthermore, conservation activity may create environmental mitigation obligations. Both the costs of other impacts on IID operations and the cost of environmental mitigation obligations are properly included in a complete assessment of the cost of conservation.

In sum, the economic cost of conservation exceeds the estimates provided above. Imposing an uncompensated conservation obligation on the IID would create a significant economic burden for farming in the Imperial Valley. The costs of conservation imposed by such an obligation must be paid. In the end, IID must increase its water rate to fund any compelled activities. Given the competitive nature of agricultural markets, increased water rates will further erode the economic viability of agriculture in the Imperial Valley. An increase in the water rate of $15/AF ('01$), for example, would significantly reduce the economic viability of agriculture. Depending on the conditions in crop markets, a sustained increase in the water rate of this amount could make as much as 15% to 30% of the acreage currently farmed not economically viable. The economic fall-out for Imperial County would be substantial. Land values and land rents will plummet. Significant acreage would go out of production. The economic losses and reduced agricultural activity would have an adverse impact on the local economy, a county that already has the highest unemployment rate and lowest per capita income, would see this problem compounded. In the end, an uncompensated obligation to conserve water for the benefit of third parties would be an assault on the economic value of both irrigated agriculture and the local community in Imperial County.

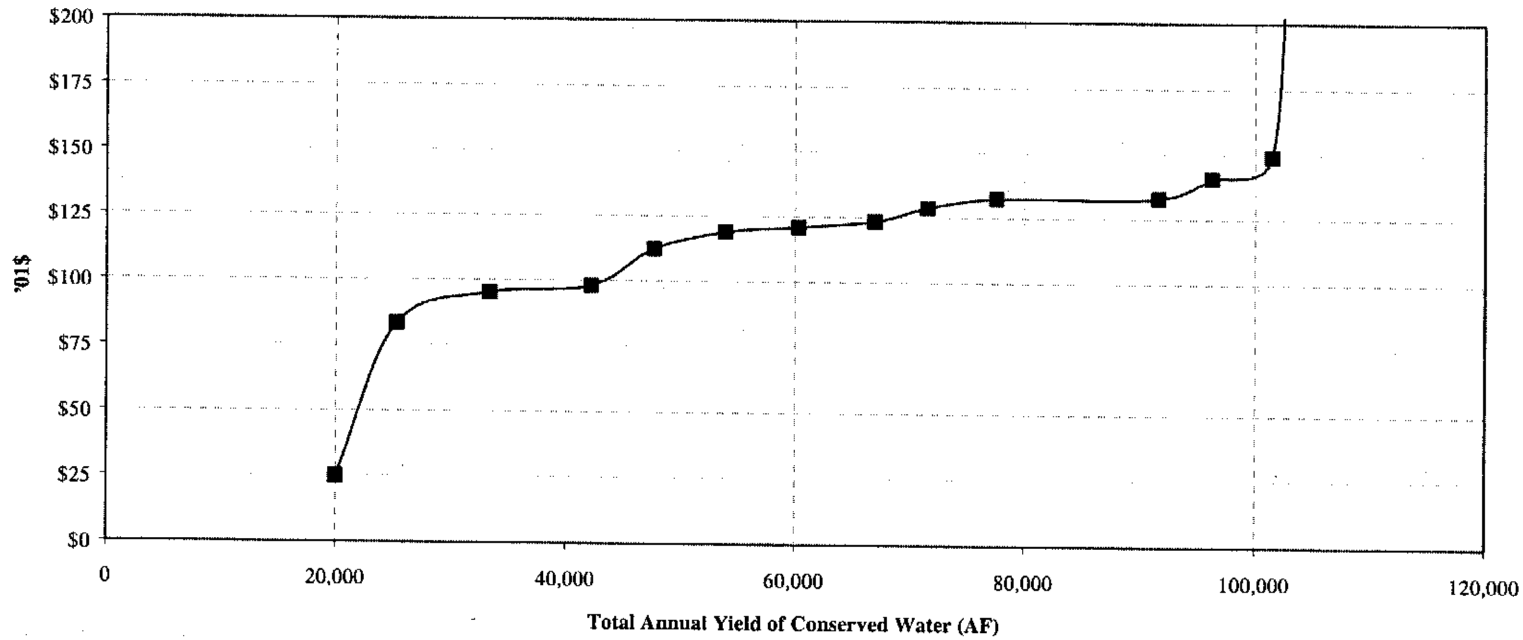
Attachment 1
Estimated Direct Costs and Potential Yield of System Improvements

Project	*Irrigated Acres*	*Estimated Capital Cost (1998$)*	*Estimated Annual O&M (1998$)*	*Estimated Yield of Conserved Water (AF/yr)*	*Annualized Direct Cost/AF ('01$)*
Seepage Recovery					
East Highline		$3,900,000	$278,000	20,000	$25
Lateral Interceptors					
Acacia	24,963	$11,154,600	$229,829	6,572	$123
Ash	22,631	$10,039,048	$229,578	1,970	$383
Elder	30,553	$9,939,000	$244,782	8,043	$95
Fern	20,059	$5,458,200	$152,329	5,281	$83
Holt	17,555	$7,808,594	$186,230	4,621	$129
Niland	53,663	$23,394,000	$644,693	14,127	$133
Orient-Oleander	23,751	$8,998,091	$267,703	6,252	$119
Orita-Munyon	22,939	$10,477,126	$250,927	6,039	$132
Peach	17,650	$9,201,754	$175,421	4,646	$141
Redwood	24,011	$9,304,800	$273,005	6,321	$121
Rockwood	15,255	$5,653,075	$129,007	1,600	$265
Thistle	18,473	$5,565,960	$148,233	300	$1,470
Tri-City	33,847	$11,407,920	$277,256	8,910	$98
Vail	19,546	$8,638,939	$307,326	5,145	$149
Wisteria	20,914	$7,849,800	$205,713	5,506	$112
Total/Wtd Ave	365,810	$148,790,907	$4,000,031	105,333	$112

Source: Staff of the Imperial Irrigation District

See text for description of the calculation of annualized cost/AF ('01$)

Attachment 2
Incremental Annualized Direct Costs of System Conservation

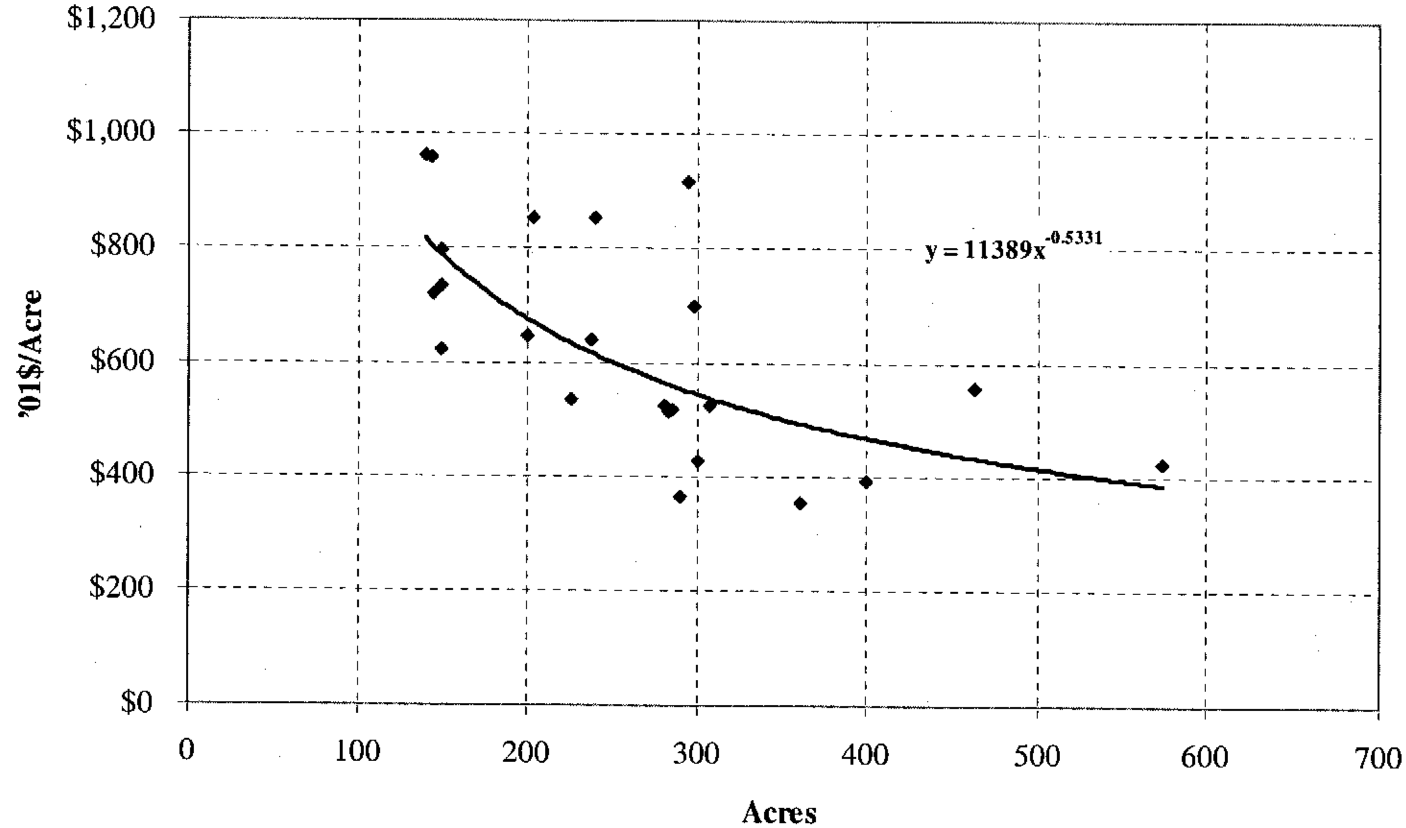


Attachment 3
Permanent Tailwater Return Systems Funded by IID/MWD 1988 Agreement

System	*Acres*	*Capital Cost/Acre('01$)*	*O&M Costs/Acre('01$)*	*Amount Conserved Water (AF)*	*Conserved Water (AF/Acre)*
1	140	$962.94	$38.46	183.6	1.31
2	144	$959.98	$51.93	252.7	1.75
3	145	$721.03	$36.76	117.4	0.81
4	149	$797.25	$9.16	51.7	0.35
5	150	$621.93	$8.41	71.3	0.48
6	150	$733.41	$23.60	148.5	0.99
7	200	$646.90	$5.68	129.9	0.65
8	203	$852.05	$5.57	84.9	0.42
9	225	$533.60	$15.88	117.4	0.52
10	237	$639.43	$29.76	117.7	0.50
11	239	$853.90	$22.31	278.8	1.17
12	281	$524.81	$9.88	294.7	1.05
13	283	$515.16	$14.06	164.7	0.58
14	285	$518.12	$14.64	199.6	0.70
15	290	$363.50	$32.44	134.4	0.46
16	295	$916.51	$26.01	179.7	0.61
17	298	$700.86	$47.67	270.9	0.91
18	300	$427.84	$8.41	136.5	0.46
19	307	$524.63	$5.33	430.9	1.40
20	361	$353.40	$12.83	56.2	0.16
21	400	$393.52	$15.19	362.8	0.91
22	463	$556.55	$44.60	324.9	0.70
23	574	$423.57	$6.39	271.5	0.47
Acreage Wtd Ave. or Total	6,119	$584.82	$20.26	4,380.7	0.72
Simple Average	266	$632.21	$21.09	190.5	0.75
Median	281	$621.93	$15.19	164.7	0.65
Maximum	574	$962.94	$51.93	430.9	1.75
Minimum	140	$353.21	$5.33	51.7	0.16

Source: Staff of Imperial Irrigation District

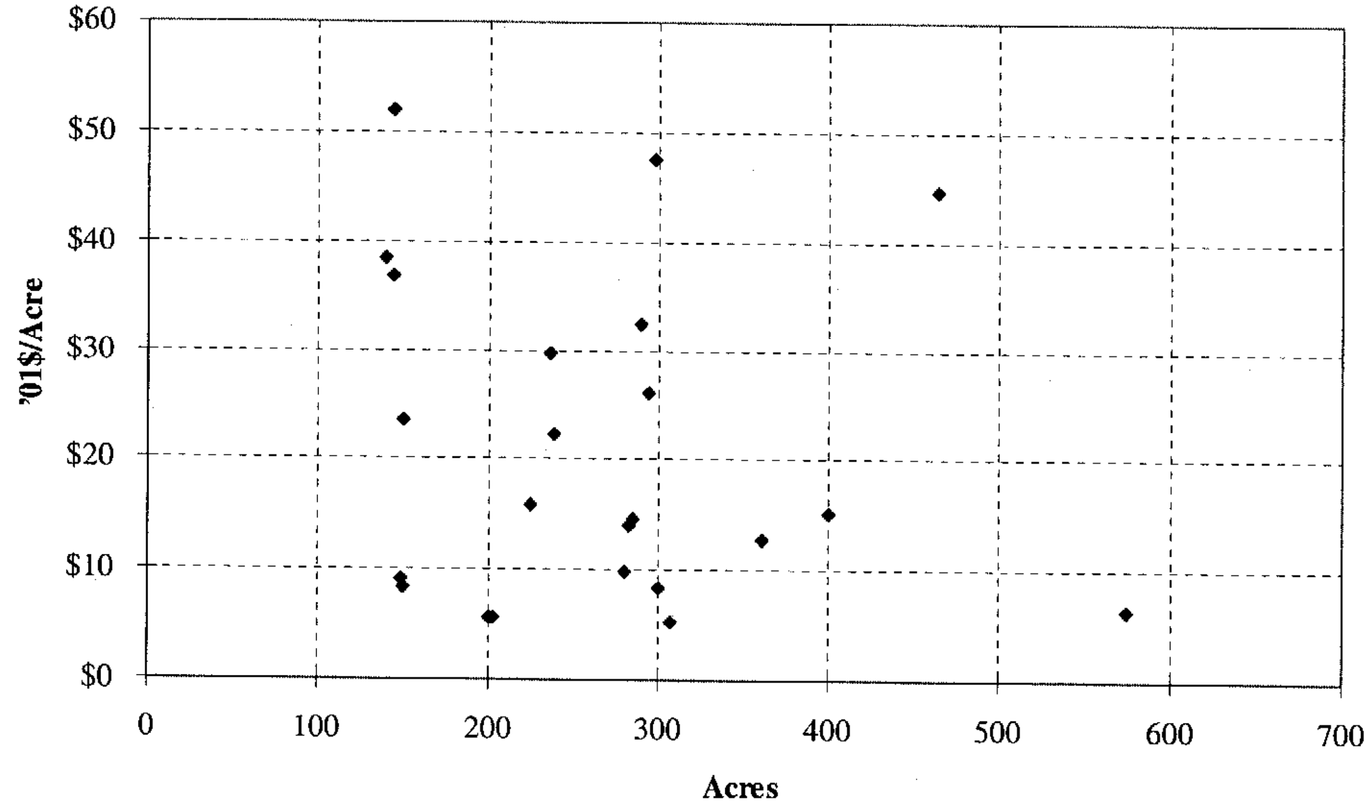
Attachment 4
Per Acre Capital Costs of Permanent Tailwater Recovery Systems vs. Size



Source: Staff of Imperial Irrigation District for Capital Investment Costs in '88$. See text for discussion of adjustment to '01$

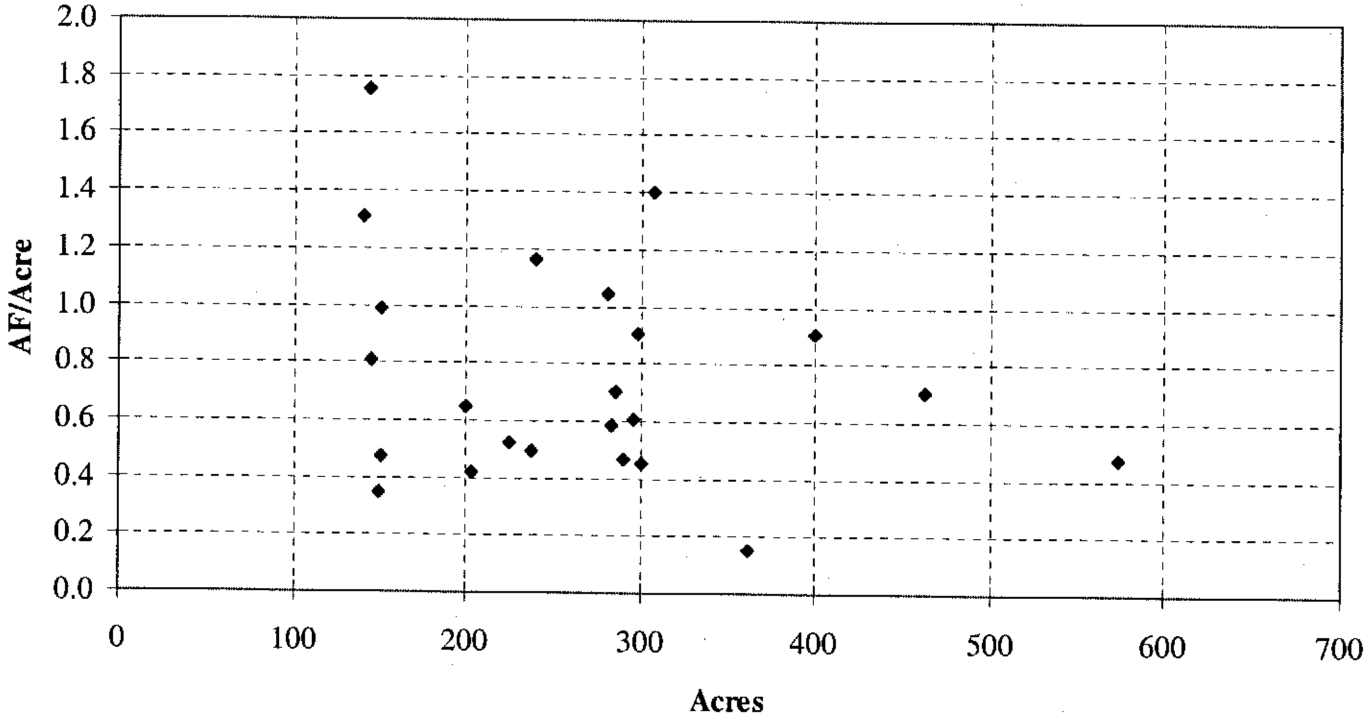
Fitted trend line shows the statistically significant relation between capital investment cost/acre and acres

Attachment 5
Annual O&M Costs of Permanent Tailwater Recovery Systems vs. Size



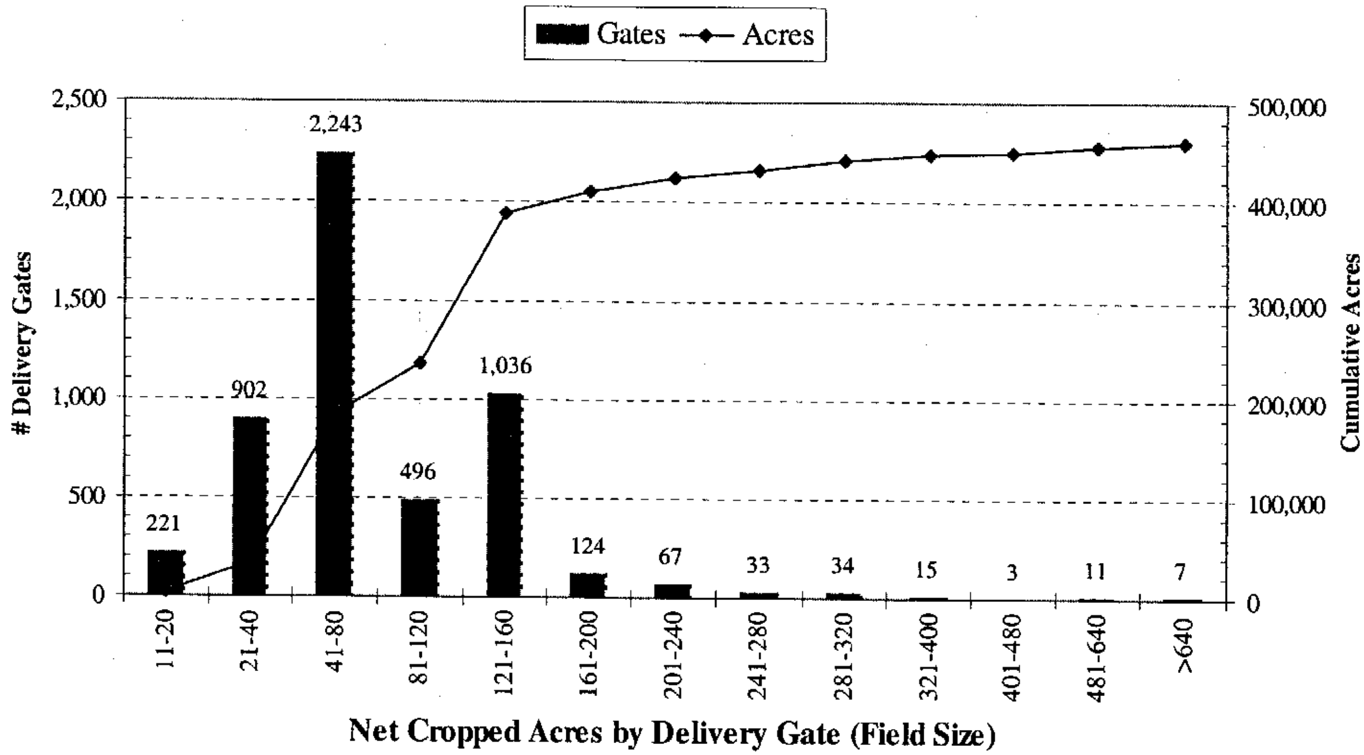
Source: Staff of Imperial Irrigation District for O&M Costs in '96$. See text for discussion of adjustment to '01$

Attachment 6
Yield of Conserved Water from Permanent Tailwater Recovery Systems vs. Size



Source: Staff of Imperial Irrigation District

Attachment 7
Number of Fields and Cumulative Acres by Estimated Field Size (1996)



Source: Staff of Imperial Irrigation District

Attachment 8
Minimum Participation Rate in On-Farm Conservation Program by Acreage Threshold and Amount of Annual On—Farm Conservation

Acreage Threshold	*Maximum Yield*	*Amount of On-Farm Conservation*						
	277,570 AF	50,000 AF	75,000 AF	100,000 AF	125,000 AF	150,000 AF	175,000 AF	200,000 AF
40	297,222 AF	17%	25%	34%	42%	50%	59%	67%
80	277,570 AF	18%	27%	36%	45%	54%	63%	72%
120	177,762 AF	28%	42%	56%	70%	84%	98%	**na**
160	145,478 AF	34%	52%	69%	86%	**na**	**na**	**na**
200	47,944 AF	**na**	**na**	**na**	**na**	**na**	**na**	**na**
240	33,491 AF	**na**	**na**	**na**	**na**	**na**	**na**	**na**
300	18,296 AF	**na**	**na**	**na**	**na**	**na**	**na**	**na**

Calculated from data on the distribution of acreage by field size in Attachment 7

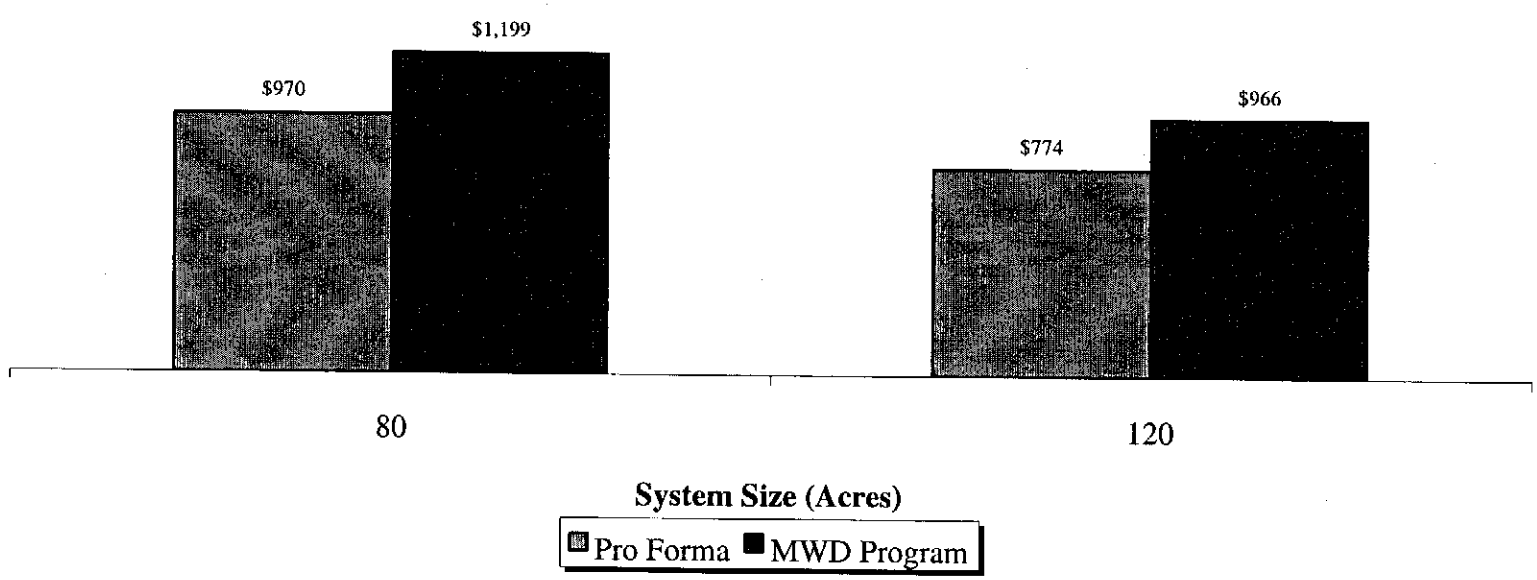
Notes

- Acreage Threshold: Field size must exceed threshold for targeted inclusion in on-farm program
- Maximum Yield = 0.65 AF/acre • number of acres in fields with sizes above acreage threshold
- Participation Rate = amount of on-farm conservation ÷ Maximum Yield
- **na** means that there are not enough acres in field sizes above the acreage threshold to conserve the targeted amount of water

Attachment 9
Pro Forma Direct Cost of Tailwater Recovery Systems

Initial Investment	*Permanent 80 Acres*	*Permanent 120 acres*	*Portable 80 Acres*
Pumps	$20,697	$21,227	$2,653
Pipes	$35,110	$46,318	$35,110
Reservoir	$16,080	$19,556	$15,016
8% Contingency	$5,750	$6,968	$4,222
Total	$77,637	$94,069	$57,002
Per Acre	$970	$784	$713
Initial O&M/Acre	$46	$42	$78

Attachment 10
Capital Investment Cost for Permanent Tailwater Recovery Systems
('01$/acre)



Source: Pro Forma costs (see Attachment 9 and related text discussion). MWD Program based on adjustment of average capital investment of systems installed under the MWD program for the relation between per acre capital investment and system size (see test discussion of this attachment)

Attachment 11

Annualized Direct Cost per Acre for Tailwater Recovery Systems ('01$)

	Permanent 80 Acres	*Permanent 120 acres*	*Portable 80 Acres*
Capital Investment	$58	$46	$42
O&M Costs	$46	$42	$78
Replacement Costs	$15	$11	$2
Total	$119	$99	$123

Attachment 12

Annualized Direct Cost per AF Conserved Water ('01$) by Range of Annual Conservation Yield

System	Conservation Yield		
	Low (0.50 AF/Acre)	Medium (0.65 AF/Acre)	High (0.80 AF/Acre)
Permanent			
80 Acres	$239	$183	$149
120 Acres	$198	$152	$124
Portable 80	$245	$189	$153

Attachment 13

Impact of $15/AF ('01$) Increase in Water Rate on Economics of Irrigated Agriculture in Imperial Valley under Various Crop Market Conditions

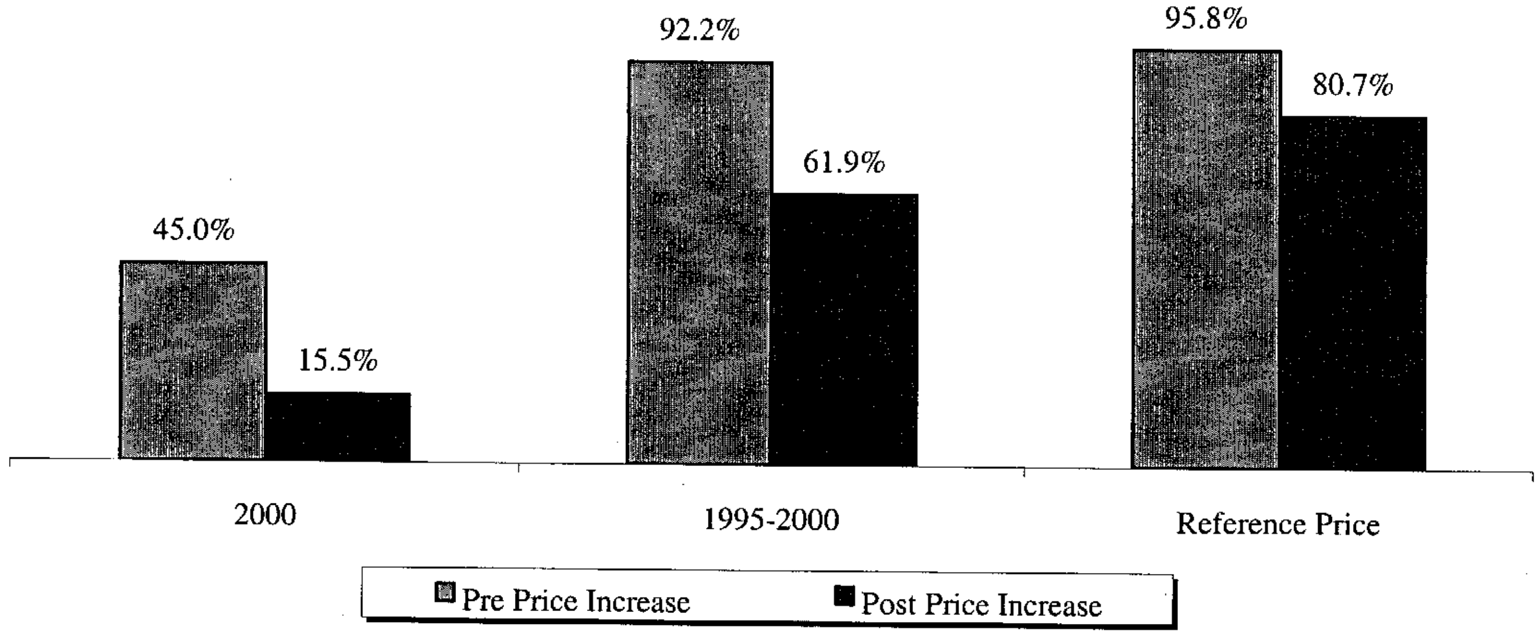
		Gross Return By Economic Conditions			Net Return By Economic Conditions			Reduced Economic Viability		
Crop	Acres ('95-'00)	2000	95-2000	Reference Price	2000	95-2000	Reference Price	2000	95-2000	Reference Price
Alfalfa	172,415	-$73	$31	$72	-$202	$0	$41	39.8%	50.4%	23.1%
Cotton	8,555	-$75	$109	$228	-$193	$59	$178	18.5%	17.6%	1.0%
Sudan	73,620	-$55	$15	$35	-$127	-$5	$15	23.5%	48.4%	29.8%
Sugar Beets	33,740	$190	$298	$366	$52	$243	$311	5.0%	0.3%	1.0%
Wheat	75,735	-$31	$39	$60	-$89	$18	$39	50.9%	6.0%	1.5%
Asparagus	4,865	-$2,067	$119	$561	-$2,250	$56	$498	0.0%	14.0%	3.9%
Broccoli	9,195	-$896	$324	$675	-$1,041	$246	$597	0.0%	7.6%	0.4%
Cantaloupe	14,065	-$698	-$219	-$122	-$842	-$291	-$194	0.0%	7.4%	10.6%
Carrot	8,170	-$643	$1,440	$1,904	-$805	$1,364	$1,828	0.6%	0.0%	0.0%
Cauliflower	3,670	$336	$920	$1,286	$188	$847	$1,213	5.8%	0.0%	0.0%
Lettuce (Wrapped)	9,131	$422	$422	$602	$272	$332	$512	4.1%	4.1%	1.6%
Lettuce (Leaf)	7,959	$461	$1,338	$2,137	$306	$1,243	$2,042	3.2%	0.0%	0.0%
Onions (Market)	5,045	-$1,087	$482	$1,191	-$1,245	$407	$1,115	0.0%	7.6%	0.0%
Sweet Corn	5,275	-$1,347	-$396	-$276	-$1,485	-$459	-$339	0.0%	0.6%	4.2%
Watermelon	5,275	$196	-$529	$191	-$34	-$699	$22	6.9%	1.5%	6.9%
Average	436,715*	-$113	$110	$205	-$226	$72	$166	30%	30%	15%

* total

Notes

- Gross Return = estimated crop revenues – costs (including land rent)
- Net Return = Gross Return – estimated per acre farming income that must be earned for farming to be economically viable
- Reduced Economic Viability: reduction in the calculated percentage of acreage in a crop that is economically viable due to the $15/AF ('01$) increase in IID's water rate

Attachment 14
Economic Viability of Crop Acreage by Economic Condition



The Public Policy Interests Served by the Implementation of the IID-SDCWA Transfer and the Quantification Settlement Agreement

by

Rodney T. Smith
Senior Vice President
Stratecon Inc.

Implementation of the proposed long-term water conservation and transfer agreement between the Imperial Irrigation District ("IID") and the San Diego County Water Authority ("SDCWA") and the proposed Quantification Settlement Agreement ("QSA") are vital to addressing the emerging water challenges facing California. The IID/SDCWA agreement will provide a new source of reliable Colorado River water supply to meet Southern California's water needs. The QSA would (1) quantify the respective rights of IID and the Coachella Valley Water District ("CVWD"); (2) provide CVWD with additional Colorado River water supplies; (3) provide for the lining of the All American and Coachella Canals; (4) extend the term of the 1988 Agreement between IID and the Metropolitan Water District of Southern California ("MWD"); (5) resolve long-standing and pending legal disputes concerning the reasonableness of use of water by the agricultural districts and the impact of Indian water rights and miscellaneous present perfected rights on the water available to agricultural water users and MWD; and (6) allow California to meet the requirements of federal policy to gain access to a significant quantity of surplus Colorado River water available under interim surplus criteria that will allow California to make the necessary transition to live within the state's basic 4.4 million acre foot ("AF") entitlement to Colorado River water.

Without these actions, California faces the prospect of a significant decline in the availability of Colorado River water supplies that would undermine the quantity and reliability of the water supply of Southern California. Many of the legal disputes put aside by the parties to the QSA will immediately erupt in the event of substantial shortfalls in water supplies caused by the federal policy that must, on its own terms, abandon the interim surplus criteria and return to normal operations of reservoirs on the Colorado River.

The End of the Era of Expanding Use of Colorado River Water

The annual consumptive uses of Colorado River water have grown by 4 million acre-feet ("AF") since the U.S. Supreme Court entered its decree in 1964 in the case *Arizona v. California* (see Attachment 1). In 1964, the consumptive uses of the Upper Basin, the Lower Basin, and Mexico were about 10 million AF. By the year 2000, consumptive uses approached 14 million AF. During the 20th century, the natural flow of the Colorado River has averaged 15 million AF.[1] Therefore, the cushion between the demands for Colorado River water and the average supply has almost disappeared.[2] As a result, in the future, smaller deviations from the average flow of the Colorado River will result in the need to withdraw water from storage to avoid shortages of Colorado River water.

The increased pressure on the availability of Colorado River water supplies is the most intense in the Lower Basin. Except in conditions of surplus, the Lower Basin must limit its use of Colorado River water to 7.5 million AF, apportioned among the Lower Basin states as follows: Arizona, 2.8 million AF; California, 4.4 million AF; and Nevada, 300,000 AF. If one state does not fully utilize its entitlement, the "unused entitlement water" is available for use by the other states in the Lower Basin. Any available "surplus" water (the amount of water available in excess of 7.5 million AF) is apportioned as follows: Arizona (46%), California (50%), and Nevada (4%).

Use of Colorado River water in the Lower Basin remained below 7.5 million AF per year until the late 1980s when the Central Arizona Project ("CAP") commenced

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1 Calculated from data on natural flow of the Colorado River available on website of the Lower Colorado Region, U.S. Bureau of Reclamation.

2 In fact, the cushion between the demand for Colorado River water and average supply is even narrower than indicated in the text. In the U.S. Bureau of Reclamation's CRESSez model, annual evaporation and system losses are set at 2.6 million AF. Fortunately, the amount of available water on the Colorado River includes its natural flow plus Gains Above and Below Hoover Dam, which average 1.3 million AF per year. *Ibid.* Therefore, annual evaporation and system losses net of gains above and below Hoover Dam are 1.3 million AF. If this 1.3 million AF per year is added to current consumptive uses, then total uses of Colorado River water (consumptive uses plus evaporation and system losses in excess of gains above and below Hoover Dam) equal the average natural flow of the River today.

operations (see Attachment 2). California has exceeded its basic annual entitlement of 4.4 million AF in all but two years (1982 and 1983). Until the mid-1990s, California was able to use more than its basic entitlement due to the availability of unused entitlement water from Arizona and Nevada; these states used less than their respective annual entitlements of 2.8 million AF and 300,000 AF respectively. Until 1996, the amount of unused entitlement water was sufficient for California to use more than its basic entitlement with total annual uses in the Lower Basin remaining below 7.5 million AF. Since 1996, the use of Colorado River water in the Lower Basin has routinely exceeded 7.5 million AF.

Arizona and Nevada now almost, if not fully use their basic apportionments. In the case of Arizona, it initiated a water banking program in 1996. With the most junior priority in the Lower Basin, Arizona faces a long-term water reliability problem. To address this problem, Arizona established a state authority to bank unused Arizona entitlement water in Arizona to both address its chronic groundwater overdraft problem and to have water available when the inevitable shortages occur for the CAP. Since the initiation of the banking program, Arizona's use jumped and now approaches the state's basic annual entitlement. The notorious growth in Southern Nevada explains the disappearance of unused entitlement water in Nevada.

The Policy Background Leading to the QSA

The IID/SDCWA Agreement, the QSA, and related agreements are the outcome of multi-year negotiations within the setting of a clear federal policy requiring California to develop a credible plan to limit its use of Colorado River water to its basic entitlement. California can not rely upon surplus water in lieu of making the necessary adjustments in its use. Instead, the prospect of additional surplus water during a "transitional" period is offered, provided that California undertakes the necessary investments and activities to assure that it will be able to live within its basic entitlement by the year 2016.

With uses in the Lower Basin exceeding 7.5 million AF in 1996, the other Colorado River Basin States started a campaign for California to acknowledge that the days of California using more than its basic 4.4 million AF entitlement were limited.[3] Secretary of the Interior Bruce Babbitt declared an annual surplus for 1996, to allow uses in the Lower Basin to exceed 7.5 million AF. If a surplus had not been declared then, California would have had to reduce its use of Colorado River water by 624,704 AF.[4]

In December 1996 at the annual meeting of the Colorado River Water Users Association, Secretary of the Interior Bruce Babbitt put California on notice that it must develop an enforceable plan to limit its use of Colorado River water.[5] He said, "it is a matter of special sensitivity that the concerns of other Basin states with the long term future of California's demands on the Colorado River have not been addressed." As a means to address the situation, Mr. Babbitt stated his belief "that water marketing is an important tool that can help us to use the water in the Colorado River more effectively, and in particular that it can be important in meeting California's long term need to bring its demand in line with available supply."[6]

Secretary Babbitt also outlined the basic principles that ultimately governed federal policy for the remainder of the 1990s and provided the background for the QSA. He said, "it is clear that surplus water will not be available indefinitely to meet demands beyond the 4.4 million acre foot entitlement of California. The prospect of long-term reliance on such water by users in California is a matter of great concern to other states in both basins. The effective implementation of surplus criteria depends on the presence of a well-conceived strategy within California designed to cope with its long term demands on the River."[7] Rather than acceding to California's request to put in surplus guidelines to assure California the continued availability of surplus water (that would avoid annual shortages over 600,000 AF in California), Secretary Babbitt said that he "shall temporarily defer making any such guidelines final in order to give California an

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3 "Colorado River Basin States Tell CA to Live Within 4.4 MAF Entitlement," *Water Intelligence Monthly*, December 1996.

4 624,704 = 7,500,000 AF –2,714,755 AF (Arizona's Use in 1996) – 249,249 AF (Nevada's Use in 1996) – 161,955 AF (Arizona's unmeasured return flows in 1996).

5 "Secretary Babbitt Announces Steps to Have California Live Within Its 4.4 MAF Entitlement with Water Marketing," *Water Intelligence Monthly*, January 1997.

6 *Ibid.*

7 *Ibid*

opportunity to put in place a realistic strategy to assure that it will be able to reduce its use when necessary, or to meet its needs from sources that do not jeopardize the entitlement of others."[8]

In December 1997 at the annual meeting of the Colorado River Water Users Association, Secretary Babbitt increased the pressure on California to develop a credible 4.4 Plan.[9] He stated that he would not consider changing the criteria for surplus declarations until California has firm commitments in place to live within its basic 4.4 million AF entitlement. While noting progress the California parties had made (such as the then recent announcement of the IID/SDCWA Agreement), he observed that "a number of very important problems remain to be resolved, not the least among them a resolution of beneficial use and quantification issues within the agricultural districts so that transfers can go forward, and arrangements for transportation of transferred water through Met(ropolitan)'s and San Diego's aqueduct."[10] "When further steps are taken so that firm commitments are in place . . . including the execution of binding contracts, agreed-on arrangements for transportation, and resolution of quantification and beneficial use issues, I will adopt surplus criteria that will permit California to continue to meet its beneficial use needs from the Colorado River. I anticipate that these criteria will be effective for a specified number of years, at which time they will expire on their own terms, and will be reviewed before they are renewed, in order to ensure that California continues to make reasonable forward progress in implementation of its strategic plan."

Over the next three years, the California parties negotiated the various agreements needed to meet the Secretary's conditions. With the negotiation of the QSA and related agreements, Secretary Babbitt on the last day of the Clinton Administration adopted interim surplus guidelines for the Colorado River.[11] The guidelines provide California with a greater quantity of surplus water than would be available if the reservoir were

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8 *Ibid*

9 "Babbitt Increases Pressure on California for Credible 4.4 Plan," *Water Intelligence Monthly*, January 1998.

10 *Ibid.*

11 "Babbitt Adopts Interim Surplus Guidelines for Colorado River," ***Water Strategist***, January 2001.

operated under existing policy. However, these guidelines will be suspended unless the California parties execute all the agreements contemplated by the QSA by the end of the year 2002 and the California agricultural agencies conserve a significant additional amount of water starting in the year 2003, with additional amounts to be conserved to reach specified targets every three years thereafter. If the agreements are not executed or the benchmarks not met, then the new guidelines are suspended under their own terms until the situation is remedied. The guidelines will remain in effect for surplus determinations made through the year 2015 regarding the availability of surplus water through the calendar year 2016.

Despite the change in administration, the federal policy remains to keep California on track with the implementation of the QSA agreements.[12] Speaking on behalf of Secretary of the Interior Gale Norton at the annual meeting of the Colorado River Water Users Association in December 2001, Assistant Secretary of the Interior for Water and Science, Mr. Bennett Raley noted that California's commitment to limit its use of Colorado River water to 4.4 million AF dates back to the 1922 Compact. He also expressed the administration's concern about California completing its plans. "I must say that with every passing day the Secretary and I grow more concerned about the ability of entities in California to comply with the commitments in the California 4.4 Plan. *Time is of the essence* (emphasis added), and it is vital that we together complete each of the required elements of the 4.4 Plan implementation—and complete them on schedule (emphasis in original)."[13]

Mr. Raley indicated that California would face consequences for any failure in adhering to its plan. "The interim surplus guidelines depend on attaining benchmarks—i.e., specific reductions of Colorado River water use in California. If California is not successful in implementing the 4.4 Plan, the results could be grave for California. . . . **If we experience several more dry years like 2001, and if the required benchmarks are not met, California would have to reduce its usage in a much shorter time frame than currently planned under interim surplus guidelines.** (emphasis added). While

12 "Bush Administration Resolute to Follow Rule of Law on Colorado River," ***Water Strategist***, December 2001.

13 *Ibid.*

such an eventuality would immediately impact urban water users in Southern California, they would not be the only ones harmed."

Mr. Raley foresaw significant collateral damage from the failure of the California 4.4 Plan. He noted, "The risk of loss of surplus water for urban users in California would undoubtedly provoke renewed demands to investigate beneficial use by agricultural users in California, a longstanding source of conflict within the state. This would certainly be an extremely divisive matter that could undo much of the progress we have collectively been making on river management in the basin."

The scope of damage would extend outside the basin. According to Mr. Raley, "Any inability to meet Southern California's water needs from existing sources tends to set off controversy that reverberates up through the Central Valley and the Sacramento River basin. We do not want anything to ignite North-South conflicts in the Golden State."

Other basin states will not be immune. As Mr. Raley explained, "If California's performance benchmarks for implementing the interim surplus guidelines are not met, and if we experience several dry years, water availability will be determined by enforcement of the Supreme Court Decree, and we could find California and the other basin states in contention over the criteria that should be applied to define surplus and shortage. In short, trouble in California growing out of controversy on the Colorado River is adverse to the interests of all of the basin states and their citizens."

The Rewards of Success

Implementation of the IID/SDCWA Agreement, the QSA and related agreements will help California adjust to the new era of restricted availability of Colorado River water supplies. The water conservation contemplated under the various agreements provides a new reliable source of Colorado River water to meet the needs of the South Coast Plain and the needs of CVWD. By maintaining the interim surplus policy, the South Coast Plain will also have access to a significant quantity of surplus water. The setting of the respective quantities and priorities of the rights between IID and CVWD will enhance the quantity and reliability of CVWD's water supplies.

Water users in the South Coast Plain will find a significant increase in the quantity of their available supplies (see Attachment 3).[14] Currently, MWD's firm supplies are its priority 4 right (550,000 AF) and the 1988 agreement with IID (110,000 AF). The addition of the water supplies from the IID/SDCWA agreement and the lining projects will reduce substantially MWD's dependence on surplus water. However, MWD needs about 5.9 million AF of surplus water through the year 2016 to meet its needs.

Surplus water made available by the interim surplus criteria will prove critical to meeting the water needs of Southern California (see Attachment 4).[15] The Bureau of Reclamation anticipates that 600,000 AF of surplus water is firmly available this year (2002). The amount of firm surplus declines by about 50,000 AF until it reaches 400,000 AF in the year 2006. Thereafter, 400,000 AF per year of surplus water is predicted to be available under the interim surplus criteria through the year 2016, but it is not firm. A total of about 6.5 million AF of surplus water is predicted to be available through the year 2016, 2.8 million AF is firm, the remaining 3.7 million AF is non-firm.

The proposed quantification of IID's and CVWD's water rights will also provide a significant benefits. For IID, it will enable it to implement its agreement with the SDCWA.[16] For CVWD, they have a quantified priority 3 right of 330,000 AF, rather

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[14] Chart assumes that (1) IID/SDCWA agreement ("IID/SD") starts in the year 2002 at 20,000 AF per year and ramps up to 200,000 AF per year by the year 2012; (2) the lining projects for the All American and Coachella canals ("AAC/CC") are completed by the year 2006. The 1988 Agreement between IID and MWD is already in place. The "surplus" shown in the figure is the difference between MWD's needs for 1.25 million AF of Colorado River water and the water available from MWD's priority 4 entitlement, the 1988 agreement, the IID/SDCWA agreement, and the lining projects.

[15] Chart based on the data published in the Final Environmental Impact Statement, Colorado River Interim Surplus Criteria, U.S. Department of the Interior, Bureau of Reclamation, December 2000, Figure 3.4-12, p. 3.4-32. "Firm Surplus" based on the amount California's use is predicted to exceed 4.4 million AF at the 10th percentile (*e.g.*, 90% of the time the amount of available water will exceed that amount). Total surplus based on the amount California's use is predicted to exceed 4.4 million AF at the 50th percentile (*e.g.*, 50% of the time; I use this median as an estimate of the mean). Non-firm surplus is the difference between the total surplus and firm surplus.

[16] The quantification of IID's right was one of the conditions Secretary Babbitt indicated would be required for federal approval of the IID/SDCWA Agreement.

than an unquantified right to the amount of water remaining under the 3.85 million AF agricultural entitlement after uses by Priority 1, 2, and IID.

The Consequences of Failure

If the IID/SDCWA agreement, the QSA and related agreements are not implemented, then the interim surplus policy will be suspended. In its place, a less generous strategy will be used to determine the availability of surplus water. [17] Under that strategy, California can expect to have little surplus water available.[18] As a result, California would lose virtually the entire remaining 5.9 million AF of surplus water that would otherwise have been available under the interim surplus criteria after this year.[19]

The loss of this surplus water represents a significant economic loss. From an economics perspective, a reasonable valuation of the surplus water would come at the cost of obtaining a replacement supply. Replacement cost is based on the price terms likely for the cost of obtaining a new supply, not the historical cost of existing supplies. Based on proposed and pending transactions in California, such as MWD's proposed agreement with the Cadiz Company, the cost of new water is approximately $350/AF ('02$). Using this value as a benchmark for the cost of replacement supplies, the economic value of the surplus water MWD is expected to receive from the interim surplus criteria is worth $1.8 billion.[20]

Without surplus water, MWD's available water supplies would be limited to its priority 4 right (550,000 AF) and the water available under its 1988 agreement with IID (110,000 AF). Moreover, under an agreement it entered into with the State of Arizona in the year 2001, MWD would be obligated to limit its orders of Colorado River water so that California's use does not exceed 4.4 million AF plus any surplus available to California under the 70R strategy, independent of any Secretarial action to suspend the

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[17] The criteria used will be the "70R strategy".

[18] Figure 3.4-12, p. 3.4-32, *supra* note 15.

[19] 5.9 million AF = 6.5 million AF (total amount available through the year 2016) less 600,000 AF received this year.

[20] Calculation based on the present value of the value of the amount of water available under the interim surplus criteria. The $350/AF ('02$) value escalated at an annual rate of 2.5% (general inflation). Calculation used an interest rate of 5.5%.

interim surplus guidelines.[21] Southern California faces an immediate annual shortage of 600,000 AF of Colorado River water.

With the unraveling of the QSA and large shortages imminent if not already occurring, California economy, law, and politics will become a victim of the law of unintended consequences. The legal disputes set aside by the QSA would probably move to front and center stage. The State Water Resources Control Board will probably review many of the same issues of this proceeding, but within the context of a proceeding contested among the settlement parties. Resources will be allocated towards the court room, the hearing room, the Governor's office, and the halls of the legislature. What will be sacrificed is the allocation of resources that would have been marshaled if the agreements and the QSA had proceeded that would have conserved the water and put off the disputes so that California can indeed enjoy a peaceful transition to living within its basic Colorado River entitlement. The economic cost of such shortages in terms of job losses and reduced economic activity would be substantial.

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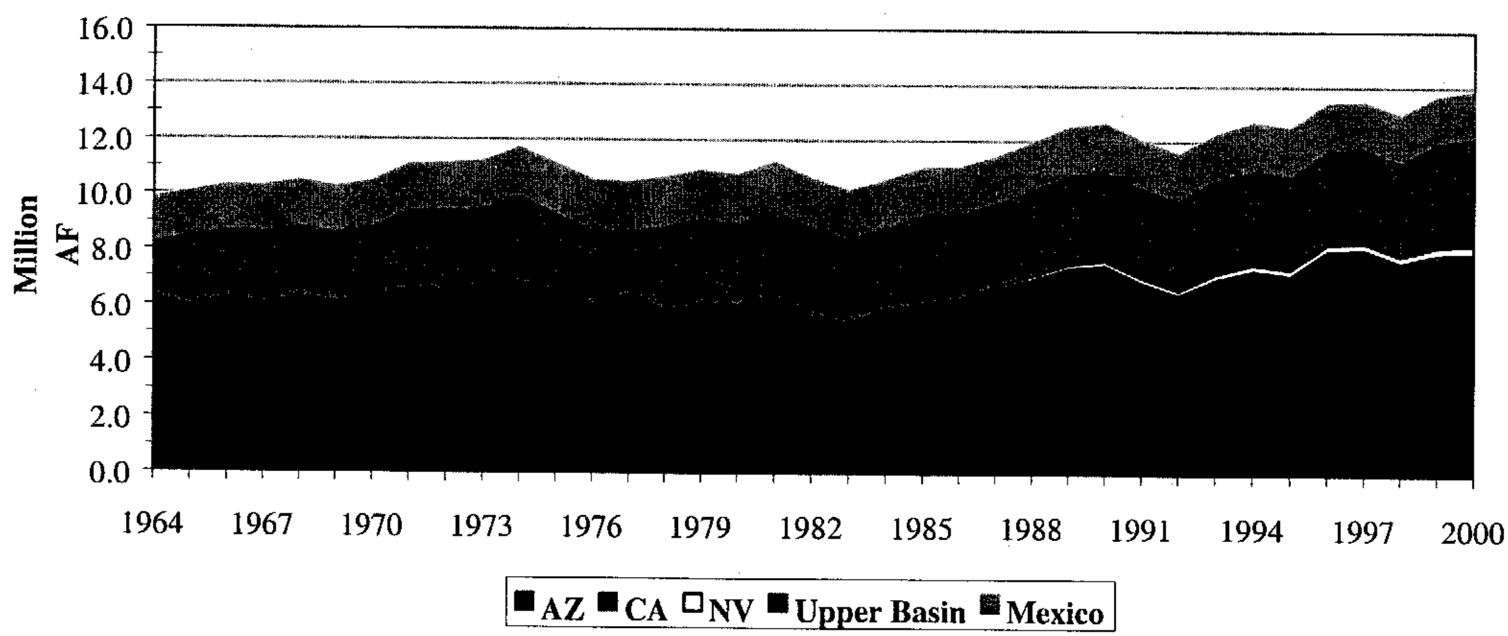
[21] See "Arizona Governor Signs Joint Resolution on Colorado River Agreement," ***Water Strategist*** , July/August 2001. MWD entered into this agreement with the State of Arizona because Secretary Babbitt required it to enter this agreement as a condition of implementing the interim surplus criteria.

Attachment 1
Consumptive Uses of Colorado River Water



Source: Lower Colorado Region, U.S. Bureau of Reclamation

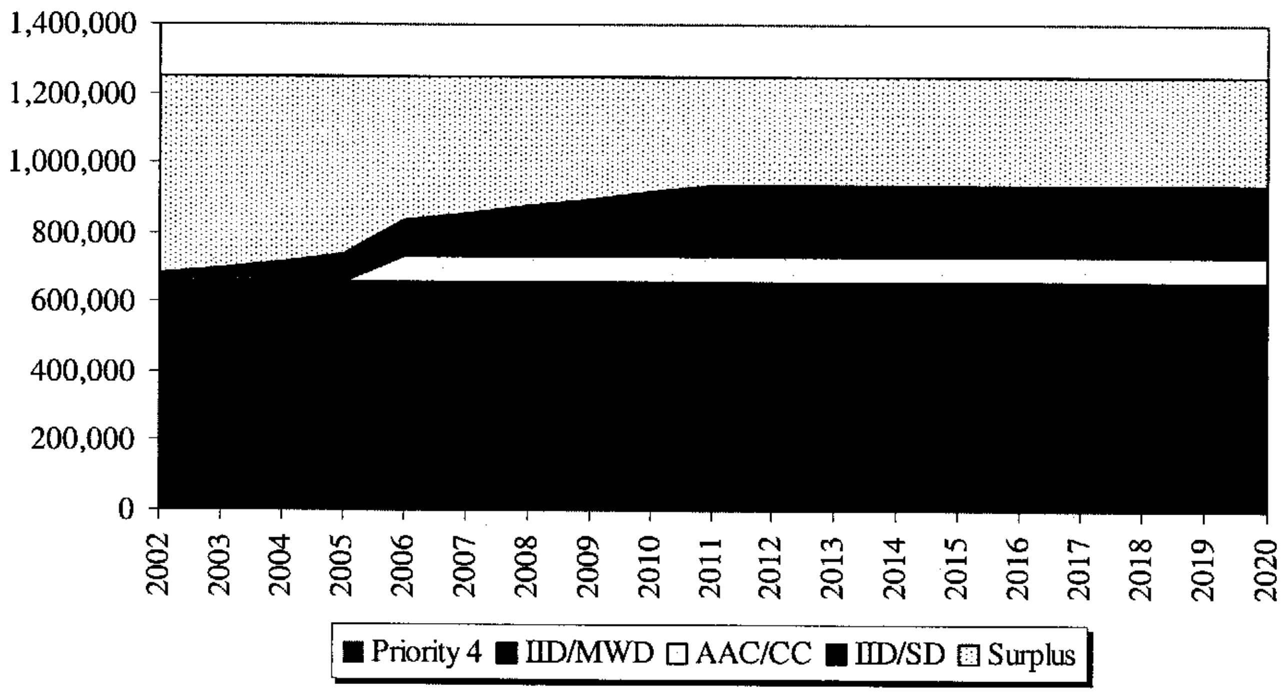
Attachment 2
Consumptive Use of Colorado River Water in the Lower Basin
Since U.S. Supreme Court Decree in *Arizona v. California*

Year	*Arizona*	*California*	*Nevada*	*Lower Basin Total*	*Unmeasured Return Flows*	*Adjusted Total*
1964	1,127,176	5,064,733	25,297	6,217,206	0	6,217,206
1965	1,008,531	4,899,987	22,716	5,931,234	0	5,931,234
1966	1,072,744	5,096,907	26,656	6,196,307	0	6,196,307
1967	1,107,927	4,886,715	27,190	6,021,832	0	6,021,832
1968	1,170,005	5,072,514	33,614	6,276,133	0	6,276,133
1969	1,139,671	4,896,527	37,392	6,073,590	0	6,073,590
1970	1,201,441	5,015,018	38,308	6,254,767	0	6,254,767
1971	1,296,930	5,216,192	50,586	6,563,708	0	6,563,708
1972	1,203,043	5,230,635	81,051	6,514,729	0	6,514,729
1973	1,268,744	5,317,547	92,649	6,678,940	0	6,678,940
1974	1,325,631	5,414,040	94,889	6,834,560	0	6,834,560
1975	1,358,003	4,983,705	72,062	6,413,770	0	6,413,770
1976	1,248,020	4,706,594	73,192	6,027,806	0	6,027,806
1977	1,231,275	5,097,343	73,174	6,401,792	0	6,401,792
1978	1,234,942	4,503,340	71,293	5,809,575	0	5,809,575
1979	1,150,854	4,788,423	88,830	6,028,107	0	6,028,107
1980	1,221,226	4,732,879	92,362	6,046,467	0	6,046,467
1981	1,415,830	4,788,470	109,945	6,314,245	0	6,314,245
1982	1,240,384	4,299,799	102,253	5,642,436	0	5,642,436

Year	*Arizona*	*California*	*Nevada*	*Lower Basin Total*	*Unmeasured Return Flows*	*Adjusted Total*
1983	1,062,169	4,245,082	86,526	5,393,777	0	5,393,777
1984	1,116,116	4,671,080	101,357	5,888,553	0	5,888,553
1985	1,194,208	4,778,748	101,640	6,074,596	0	6,074,596
1986	1,356,930	4,804,802	112,144	6,273,876	0	6,273,876
1987	1,734,172	4,891,961	108,863	6,734,996	0	6,734,996
1988	1,922,737	5,039,679	129,420	7,091,836	0	7,091,836
1989	2,229,697	5,144,417	156,213	7,530,327	0	7,530,327
1990	2,260,271	5,217,626	178,111	7,656,008	0	7,656,008
1991	1,864,359	5,003,784	180,224	7,048,367	0	7,048,367
1992	1,906,070	4,515,767	177,551	6,599,388	0	6,599,388
1993	2,246,696	4,742,029	207,944	7,196,669	0	7,196,669
1994	2,152,410	5,169,401	227,542	7,549,353	253,798	7,295,555
1995	2,221,346	4,925,480	217,439	7,364,265	282,937	7,081,328
1996	2,714,755	5,322,655	249,249	8,286,659	259,188	8,027,471
1997	2,853,886	5,250,120	242,777	8,346,783	245,871	8,100,912
1998	2,566,707	5,045,230	245,303	7,857,240	236,632	7,620,608
1999	2,727,960	5,194,380	291,135	8,213,475	237,076	7,976,399
2000	2,802,758	5,162,211	321,983	8,286,952	271,902	8,015,050

Source Lower Colorado Region, U.S. Bureau of Reclamation.

Attachment 3
MWD Colorado River Supplies and Surplus Water Requirements



Attachment 4
Surplus Water Available under Interim Criteria