Title
California's Evolving Water Management Institutions: Markets and Agricultural Water Districts

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Publication Date
1998

Peer reviewed

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DISSERTATION

Submitted in partial satisfaction of the requirement for the degree of

DOCTOR OF PHILOSOPHY

in

Agricultural and Resource Economics

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA, BERKELEY

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Spring 1998

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University of California, Berkeley

Spring 1998

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Abstract

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Professor W. Michael Hanemann, Chair

Water markets have been favorably compared to the status quo system. However, economists evaluating have erred in comparing "ideal" permit markets with "messy" existing regulatory structures. In fact, such markets are also likely to be "messy" with the existence of institutions and market imperfections. Some specific factors that influence permit markets in environmental commodities are identified and the potential magnitudes of these effects are discussed.

In California, special districts which provide agricultural customers with water supplies and service control the vast majority of water rights and contracts. The structure of these districts has been identified as an impediment to changing water management and distribution practices. Most districts use either of two electoral processes to elect board

members and to approve various tax and bond measures. Districts using land-owner enfranchised / assessed-value-weighted voting rules most closely mirror what would be used in an aggregate wealth-maximizing cooperative. Districts using universal suffrage / one-man, one vote rules distribute a greater amount of benefits to non-land-owners. This study explores how differences in the governance rules and political structures among these water-supply district "cooperatives" affect their management decisions.

A case study examines how California water markets have performed from 1977 to 1992, and what were the characteristics of the participants in inter-institutional short-term water trades.

Table of Contents

List of Tables

PREFACE

California, perhaps more than any other state, has wrestled with how to manage its water resources ever since gold was found in Sutters' Mill. At the sesquitennial of the state's admission to the Union, California is on the verge of another upheaval in water resource management. More than four-fifths of the state's diverted water is used for growing products in the nation's most diverse and valuable agricultural economy. Yet, rapid growth in the booming urban areas and degradation of the natural environment have put created a conundrum for policymakers: How can limited water resources be allocated to create the greatest statewide (and even national) social benefit while not meeting insurmountable resistance from powerful interest groups, such as farmers who now hold most existing water rights, or environmentalist who appeal to large segments of voters, or urban water agencies which have the ears of key state officials.

Two aspects of water-management policy development are sometimes misinterpreted. The first aspect is that a favored proposed policy solution is the encouragement of trading water for money, or "water markets." However, these types of "environmental commodity markets" can face "real world" problems that dissipate the apparent potential benefits and costs of implementing this policy. A second aspect is that the greatest resistance to this and other changes in the water management status quo is perceived to come from the agricultural community, and particularly the water districts that serve it. Yet, there is a distinction among the districts in how they approach the problem, and this distinction can be described in terms of the governance rules for those districts. This work focuses on how these two aspects can interplay, and on making policymakers aware of these pitfalls and distinctions as they wrestle with perhaps the most important issue for California's future.

The first chapter compares two applications of tradeable permits in managing water rights and air quality. The two streams of literature show that a common set of issues arise with respect to defining, monitoring and enforcing property rights, creating functional markets, and gaining sufficient political support. Without careful consideration of these issues, "market-based" solutions are unlikely to perform any better than the existing "command and control" regimes.

The second chapter examines how different governance rules affect water district management decisions. Districts relying on property ownership and valuation vote-weighing schemes appear to manage their resources in a more efficient manner from a strictly economic standpoint than popular-vote districts. The latter districts must appease voting members who are not agricultural owners, causing them to dissipate some benefits.

The third chapter ties together these two issues by looking at California water market activity from 1977 to 1992. Creation of the Drought Water Banks increased market activity beyond what had occurred in previous drought periods. The type of electoral system appears to have affected decisions by districts to participate in the short-term markets.

ACKNOWLEDGMENTS

I am thankful to many people, not all of whom possibly could be listed here, for both their support and contributions to this project. I thank my committee members, Michael Hanemann, David Zilberman, and Bart McGuire, as well as members of my oral examination committee, Gordon Rausser and Tony Fisher, for their invaluable comments. I am also thankful other University of California and Stanford faculty members John Dwyer, Dick Howitt, Jay Lund, John Dwyer, Bart Thompson, and Oliver Williamson for answering my questions and discussing particular issues at length. David Letson, Alison Del Rossi, Dallas Burtraw, and an anonymous referee provided invaluable insights in to my first chapter as it moved toward publication in *Contemporary Economic Policy*. Doug Parker, as an extension economist, helped gather the original water district data set used in the second chapter. Dan Osgood, a graduate student at UC Berkeley, was instrumental in putting the data set into a useful format. Rob Anex and Shi-Ling Hsu, graduate students at UC Davis, listened as I wrestled with developing the political-economy model. Dan Dudek at EDF was instrumental in starting the case study that evolved into the third chapter.

Funding for the first chapter came initially from the Southern California Gas Company, and was supplemented by the Environmental Defense Fund and the University of California's Water Resources Center. Most of the first chapter was published in *Contemporary Economic Policy* in July 1996. The second chapter was funded entirely by the UC WRC and was submitted as a Technical Completion Report for Project UCAL-

WRC-W-845 in July 1997. The third chapter was funded initially by the Environmental Defense Fund and supplemented through the UC WRC.

Throughout the project I received support from many individuals. My parents, John McCann and Helen Matekel, along with my stepmother, Diane McCann, always encouraged intellectual inquiry and questioning of the "common wisdom." My partners in M.Cubed, Dave Mitchell and Steve Moss, provide both important insights and understanding, including a short sabbatical. And finally my wife, Ellen Moratti, persevered throughout, and even gave me a couple well-deserved "shoves" along the way.

CHAPTER ONE

ENVIRONMENTAL COMMODITIES MARKETS: "MESSY" VERSUS "IDEAL" WORLDS[1]

Tradeable or marketable permits, quotas or licenses have become increasingly popular for addressing a wide range of policy problems. Economists have long argued that allowing decentralized individual choice should theoretically achieve the same environmental quality level as centralized-planning at less cost due to savings in information-acquisition costs and greater flexibility to exploit all beneficial opportunities. Current applications of tradeable permit markets (TPMs) include taxicab medallions in New York City (Roistacher 1988), fishery quotas in New Zealand (Pearse 1992), agricultural production quotas for dairy products and tobacco (Barichello 1996), water rights in the Western U.S., and air and water pollution permits in the U.S. and Europe.

Yet with all of this enthusiasm for permit trading, both by economists and regulators, we might ask: *Why have these programs not been as successful in environmental regulation as predicted by economists*? Perhaps the most important notion for analysts to consider in evaluating whether to "harness the marketplace" to solve environmental problems is that these programs will be implemented in a world which is just as "messy" as the one in which the current regulatory regimes operate. Firms and regulators will have insufficient information that leads to a degree of uncertainty; market

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[1]This chapter was previously published in *Contemporary Economic Policy*, July 1996.

participation or regulatory compliance will have additional administration costs; and compliance and enforcement of permits will be necessary. Nevertheless, many evaluations of permit markets compare an "ideal" market-based program to an implicitly "messy" existing command-and-control (CAC) or appropriative rights ("queuing") system. The result maybe an overestimate of the benefits attributable to a market-based approach (Hahn and Stavins 1992; Stavins 1995).

The traits that influence the workings of these markets can be delineated broadly into four areas. First, what are the physical and technological characteristics of the problem? How easily the commodity can be defined and segmented depends on these traits. Second, how will property rights be defined and enforced? While property rights—implicit and explicit—can and do exist without markets, markets require defined property rights to operate properly. A tension exists between defining immutable permit rights to assure tradeability, and achieving environmental quality or water supply reliability without a complete understanding by regulators of the influence by emissions or diversions. Third, how will transactions by consummated? The search, bargaining and transfer process can affect the efficiency of the chosen regulatory instrument, both through transaction costs and the resolution of trades. And finally, how committed are policymakers to the chosen policy approach? Success of any government program, not only the establishment of a market, depends on the level of commitment and resulting surety that participants expect. Without such certainty, potential participants may discount the value of holding permits or be reluctant to even enter the market.

This paper describes how "messy" environmental commodity markets can diverge from the "ideal" world often used by economists. To ground this discussion in real-world examples, the focus here is on markets for air pollution emission permits and water rights. Only by accurately capturing how similar imperfections and tradeoffs affect markets as well as other regulatory approaches can a proper comparison be made to the existing regulatory structure. However, one should keep in mind that many of the problems with environmental commodity markets identified here also occur in conventional regulatory approaches.

1.1 Providing an Analytic Framework

Economists tend to focus on a narrow set of issues surrounding economic activity, such as individual human behavior, technological aspects of the production process, and physical characteristics of resources traded and consumed. Yet the institutional details of how these resources are managed and exchanged intersect with the economic process at key points. Coase (1992) in his Nobel Lecture stated that the profession should focus more on the existing institutional structure in assessing the actual costs of participating in markets. Specifying a simple market exchange mechanism as is typically done is different from describing an allocation institution that addresses the resources characteristics and the impact of social and economic relationships (Chan 1989; Griffin 1991; Swaney 1988). As Young (1986) wrote, "(t)he choice of institutions to coordinate economic activity is among the most fundamental of social decisions."

Just as we observe in the ongoing transformation of centralized-management to market-driven economies, creating new market institutions can be a difficult process in which the final outcome is "path dependent" (i.e., how the market evolves in its initial stages affects the governing rules and conventions) which in turn dictates the effectiveness of achieving non-economic goals and efficiency of the market (North 1991). The "path" is influenced by such factors as initial allocation of property rights, uncertainty about market performance and surety, and adjustment costs during the requisite period of disequilibrium. This institutional evolution follows a process similar to technological innovation and adoption where the outcome may not be optimal due to the influence of other institutional and infrastructural choices (Arthur 1988).

Table 1-1 summarizes how the development process for these market types might be evaluated. *Market goals* represent what regulators, participants and interested third parties wish to achieve by adopting permit trading. *Measures of success* are the objectives an analyst can use to communicate to policymakers the goals attained by a market-based program. *Market proficiency* are the traits most likely to lead to a successful market program. This analytic framework can serve as a roadmap for an analyst in assessing these market proposals.

The Organization for Economic Cooperation and Development (1991) proposes one set of criteria for evaluating tradeable permit markets in that they should achieve economic efficiency, provide effective environmental protection, be politically acceptable and supportable, provide administrative ease for the regulatory agency, and achieve equity goals. The measures of a TPM's success depend on (1) the relationship of price to marginal value of product from the resource or environmental factor measured as an input being traded, (2) the amount of trading volume for permits, (3) the relative price stability and spread within the market, (4) the distributional impacts from markets' actions, and (5) whether the stated goals by the regulatory agency were achieved (Friedman 1993). An "efficient" market achieves all beneficial trades while reflecting all social values by internalizing the benefits and costs associated with using a resource.

Table 1-1 Evaluation Criteria for Market Development	
Issues	**Criteria**
Market Goals	Economic efficiency
	Effective environmental protection
	Politically acceptable and supportable
	Administrative ease
	Equitable
Measures of Success	Relationship of resource input prices to value of marginal product
	Trading volume and liquidity
	Relative market price stability and spread
	Distributional impacts
	Rate of technological innovation and adoption
	Achievement of stated goals
Market Proficiency	Degree of accessibility by potential participants
	Amount of information conveyed in the market
	Ease of identifying commodity
	Convenience of transactions
	Flexibility to accommodate supply and demand changes
	Ability to equilibrate between supply and demand
	Well-defined ownership of transferable property rights
	Many buyers and sellers to increase competition and liquidity
	Resource mobility and fungibility
	Reliability of continued availability
	Existence of exchange partners and control technologies
	Ease of entry and exit

To achieve efficiency, a market usually must have certain characteristics that encourage liquidity, certainty, and low transaction costs (Bromley 1993). One definition of "market proficiency" includes the degree of accessibility by potential participants, the amount of information the market conveys, the ability to accommodate adjustments in supply and demand changes, the degree to which the commodity can be easily identified, the convenience of transactions, and the ability to equilibrate between supply and demand (Brown et al. 1982). This list can be expanded to incorporate ways of achieving these goals, to include well-defined ownership of property rights that are transferable, many buyers and sellers to increase competition and liquidity, resource mobility—and implicitly—fungibility, and reliability of continuing availability of permits, and existence of partners and technology (Brajer et al. 1989; Saliba 1987).

1.1.1 Comparing Water Rights and Air Quality Permit Markets

Typically analyses of permit trading schemes, both theoretically and empirically, use a static setting with the assumption of "perfect" markets (Hahn and Stavins 1992; Tietenberg 1985). The resulting trading models assume that a market outcome will be equivalent to an omniscient central planner choosing the preferred mix of measures while achieving a static equilibrium.[2] These analyses might be better described as an assessment

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[2]See for example (Atkinson and Tietenberg 1982; Balleau 1988; Berck, Robinson, and Goldman 1991; Burness and Quirk 1979; Harrison, Nichols, and National Economic Research Assoc. 1990; Krupnick, Oates, and Verg 1983; McGartland and Oates 1985; O'Neill et al. 1983; Opaluch and Kashmanian 1985; South Coast Air Quality Management District 1993b; Tietenberg 1985; Vaux and Howitt 1984; Weinberg, Kling, and Wilson

of an improved command-and-control scheme because the analysis implicitly assumes a central-planning viewpoint rather than that of dispersed decision-makers at various firms. Firms and other institutions are "transparent" and inconsequential. If a control measure is economic to install from the central planner's viewpoint, a trade (internal or external to the relevant firms—commonly no distinction is made in the model) will occur to the benefit of all parties. These analyses usually differentiate markets only by focusing on the properties of the commodities themselves, such as difficulties in measurement, spillover effects on other users, the functional form for the production process, or perhaps potential market power (Griffin and Hsu 1993, for example). Such models often ignore important constraining institutional relationships, and an essentially *theoretical* rather than *applied* trading analysis is conducted.

Tradeable permit markets are influenced by both the physical and technological aspects of the resources being traded and the nature of the relevant institutions. The preexistence of institutions and their disparity nature from place to place lead to conditions that deviate significantly from the perfect market. These institutions constrain the design of TPMs through the structure and goals of the existing regulatory regime—whether command-and-control or "queuing"—the current allocation of permitted use among regulated firms, and the level of capital "fixity" within those firms (Tietenberg 1985). These factors will combine to induce significant adjustment costs for firms and regulators before reaching the prescribed equilibrium. Howitt (1995) mathematically describes the

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1993).

conditions under which the benefits of expanding water markets can overcome the inertia of the existing institutional setting.

Evaluating markets for environmental commodities can be structured to look at two aspects. The first is how do actual markets of any type differ from the theoretical market prescribed by economists. Actual markets operate in a dynamic environment where agents have limited information and other market distortions occur. Consequently, market participants must spend resources to acquire information, act on expectations about future conditions, and attempt to minimize their exposure to risk (Williamson 1983). The second concept is how might a tradeable permit market differ from the experience with other markets for commodities and services. Permit markets have not flourished previously because of difficulties in privately defining and enforcing property rights, high transaction costs that result from the nature of the resources and the market's novelty, and the political milieu in which the resources are regulated.

Water rights and pollution permit markets share several common characteristics. In both cases, the "flows"—emissions or diversions—are regulated to maintain a "stock" level in a common-property good—ambient environmental quality or streamflow. Demand for the "resource" can be cyclical with anticipated swings related to seasons and time of day; it can be randomly driven by natural events such as drought or atmospheric conditions; or it can be constant over time. The use of each has external effects that affect others downstream or -wind from the user, either by degrading the air or water quality or by reducing streamflows. The property rights in each case are technically difficult to define because of the interrelationship both among users, and between a user and the impact on the environment. In addition, these resources are claimed or awarded by a government entity, and they are direct inputs or by-products of output from another product. When trading rights, both markets have "transport" costs that create a "wedge" between buyers' and sellers' values. Typically permits specify not only quantity, but also temporal and spatial location, quality, transferability constraints and even type of use (Hahn and Noll 1982).

1.1.2 The Dimensions of Commodities and Markets

The many possible resource-use dimensions defined within the permit are key to identifying the physical and technological management issues. For pollution, economic analysis has focused on the physical aspects of the difference between issuing permits for emissions or impacts on ambient environmental quality, the relationship of controlling pollution to the production function, and multiple pollutant markets. For water rights, third-party impacts through return flows, linkage of the surface and groundwater systems, and conveyance limitations have been paramount. Also, permit trades between up and downstream (or wind) sites, and between certain regions, face various restrictions to assure no degradation in local water or air quality or water quantity. This approach is known in water law as the "no injury" rule (Sax, Abrams, and Thompson 1991, pp. 224-230). These limits, in turn, affect the reliability, fungibility and synergism with other resource use, adding to transaction costs.

Table 1-2 summarizes specific physical, technological and institutional factors that affect the development and operation of environmental commodity markets. Contrary to an archetypical "neo-classical" approach in which a "perfectly-competitive" market naturally and spontaneously develops, several factors can act to stymie effective market development. In particular, transaction costs and expectations (i.e., issues of risk and uncertainty) about future tradeable permit values will influence firm behavior. An important note here: many of these factors are characteristic of a world with command-and-control or appropriative rights regulation—they are not unique to market-based programs. However, these factors are not often captured in economic analyses that tend to sweep away such problems in pursuit of parsimony.

Table 1-2
Specific Factors in Environmental Resources that Influence Market Performance

Characteristics	Constraints
Physical	Diffuse nature makes definition of property rights difficult
	Significant measurement errors in availability and use
Technological	Capital intensity of control measures implies lumpiness and
	Irreversibility of investment decision increases risk
	TPM may require higher compliance and monitoring costs
Legal Institutions	Existing legal structures precede markets
	Markets depend on defined property rights
	Transferable property rights may not be recognized
	Difficulty in enforcing rights
	Uncertain government commitment to markets
	Usufructuary versus absolute property rights
	Differences in "effective" vs. transferable rights
	Declining permit baseline to achieve environmental standards
	Political oversight institutions
Management	Differing objectives among public, private and political
	Views of internal control vs. external opportunities
	Parallel market structures for other commodities
	Market power in input and output markets
	Information disclosure to competitors through permit trades
	Wariness by financial institutions
	Disparate treatment of new vs. existing firms
Exchange Institutions	Market search and matching process
	Exchange mechanism—brokered, merchant or centralized
	Price conveyance—negotiated, posted or auction
	Market depth and liquidity, influenced by "thinness."
	Contract terms—spot, lease, option, short-term or long-term

1.2 Legal and Rulemaking Institutions

Any incentive-based regulatory solution is likely to be superimposed on an *existing* legal structure that extends beyond the regulatory framework. Under most environmental regulatory regimes, ownership of the tradeable permit generally is not a true "property" right; rather it is a "license" or "permit" right, which do not have the same legal protection by the courts from being redefined or even revoked by the government (Hahn and Hester 1989).

A fundamental reason these markets have not evolved in the past is simply because defining and enforcing use rights by private parties can be difficult at best. The less well defined is the permit "right," then the less attractive the permit is as a trading commodity. As Bromley (1993, p. 7) writes, "(m)arkets can only exist within a legal system that has consciously set out to create ordered domains of exchange." Often a direct link exists between the use of a resource by one individual and the resulting damages to another. Also, the variations in flow over time and space make privately enforcing such rights more difficult than for other commodities. As these effects become more diffuse, the intervention of government agencies, rather than relying on the courts alone, to enforce permit or license rights and compliance becomes more attractive. How these rights are enforced through inspection and penalties will drive the level of compliance and success in market participation (Keeler 1991).

Defining the right associated with a tradeable permit is crucial. The right may be usufructuary or possessory, depending whether it is based on past consumption or permitted title (McCormick 1994). *Usufructuary rights* are based on the idea of "use it or lose it" in which the permit-holder must justify their consumption as "reasonable and beneficial," a common requirement with water rights. *Possessory rights* allow the holder to use the resource in any fashion after the initial claim is made. For example in emission markets, whether the tradeable permit represents either (a) a reduction in or (b) an allowance for existing usage is crucial to how firms view participation in the market. The first requires some commitment by management to a change of direction before the credit can be sold; the latter allows firms to sell tradeable permits as a course of business. "Banking" of credits or water storage can partially bridge the characteristics of these two types of rights by allowing deferment of use until the resources are more valuable. However, either regulatory or physical constraints limit the ability to convert such usufructuary rights fully into possessory.

The required level of enforcement affects the viability of markets in these permits. The less well defined is the permit "right," then the less attractive the permit is as a trading commodity. The enforcement of these rights vary because the impacts from usage vary in the scope of affected parties. As these impacts become more diffuse, the intervention of government agencies to enforce permit compliance is more attractive.

Transaction costs also rise with monitoring requirements. The uncertainty of whether (1) a penalty will be enforced inappropriately or (2) the underlying credit in the tradeable permit will be changed through mismeasurement adds to the risk that participants face (Russell, Harrington, and Vaughan 1986). The tendency to simultaneously move from a technology-driven standard-setting approach to a quantity-monitoring or "tailpipe" measurement method adds additional complexity (Cohen 1993).

The latter has higher costs due to greater administrative needs and is more likely to detect violations of permitted levels (Dwyer 1992). For example, continuous emission monitoring (CEM) under RECLAIM add significant paperwork and equipment costs beyond the usual technological certification and compliance process (South Coast Air Quality Management District 1993b). Measurement of consumptive use for transferring water rights has been a major barrier to increased use of markets (Sax, Abrams, and Thompson 1991). Increased monitoring is motivated by the increased value attached to emissions or diversions and distrust by environmentalist of "markets", but monitoring costs can be significant enough to substantially reduce the net benefits for even a well-functioning permit market (M.Cubed 1993).

Three different constituencies have to be satisfied to attain adequate political support to minimize risk to the property rights associated with government-established permit markets (Dwyer 1992). First, the regulated community must be willing to change their relationship to the regulatory institutional structure, and to treat the acquisition of the permits as another production input decision. Second, the agency personnel must be willing to step away from current management and decision processes to allow decentralized decision-making. And third, external interest groups, such as environmental activists, who probably help instigate the original regulatory structure, must accept that different means may achieve the same ends (Hahn 1990). This involves moving from a "presumption of prohibition" to that of "permission" (Bromley 1993). The emergence of environmentalists (Hahn and Hester 1989) and community preservationists (Brajer and Martin 1990; Metzger 1988) as a force in the creation of these markets has weakened the ownership concept further since they argue that these resources are a common good to which property rights can not be assigned. In addition, CAC schemes will tend to "overcontrol" due to the binding constraints on individual polluters, while incentive-compatible schemes attach no "shadow" value to such overcontrol (Oates, Portney, and McGartland 1989). Thus, incentive-based approaches may not be superior simply because they have lower costs if environmental quality also is degraded. The regulated community's view of the market will depend in part on the agency's role and its apparent level of commitment, and how well each group accepts the marketable permit approach.

The conflicting interests of these groups can create uncertainty for the participants about whether a government agency can adequately define the rights associated with a tradeable permit and commit to its interpretation for a sufficient period to allow the market to mature. For example, the SCAQMD has two specific backstop measures to end its RECLAIM program if the TPM does not provide sufficient emission reductions (South Coast Air Quality Management District 1993a, Rule 2015; South Coast Air Quality Management District 1994, Measure CTY-03). In addition, a suit by Citizens for a Better Environment challenging RECLAIM is still pending against the California Air Resources Board. Market participants will not only add a risk premium for this uncertainty, but could face significant transaction costs associated with legal requirements of defining the permit rights (Howe, Schurmeier, and Shaw 1986; Lund 1993)

1.3 Firms and Public Enterprise Management Institutions

Typically regulators will overlay a marketable permit system on existing markets that use the resource in question. These differences in market structure defined by the type of firms involved raise several questions that need to be addressed in the context of whom the participants are and what their motives may be. Resource management institutions often are created to reduce transaction costs and uncertainty associated with regular market exchanges that would otherwise require significant negotiation and contracting activities (Alston and Gillespie 1989; Williamson 1983). These institutions frequently have different measures of success, depending on their relationship to their constituencies, that lead to different weighting of institutional objectives than those ascribed to them by economists. The large water projects developed by the U.S. Bureau of Reclamation and California Department of Water Resources are prime examples of contractual institutions that fit this definition. While business managers may maximize profits for their shareholders, voting rules can influence how public enterprise district officials balance increasing wealth with distributing benefits or reducing risks (McDowell and Ugone 1982); and elected officials focus on creating certainty and equity rather than opportunity and efficiency (Willey 1992).

Businesses, governments and other types of organizations might ask these fundamental questions that affect the values that buyers and sellers will put on tradeable permits:

- "Should we purchase tradeable permits with their many uncertainties, or should we install our own abatement/conservation devices over which we have direct control?"
- "Should we sell tradeable permits with their many risks by installing additional abatement/conservation measures or closing some portion of the facility?"
- "Or should we only concern ourselves with achieving the reduction goals expected of us under the regulatory regime that represents the default outcome if the market-based approach fails?"

In other words, firms or other enterprise organizations view the availability of pollution reduction credits or regulated resource supplies from the perspective of whether these can be found *internally* or *externally* (Coase 1937). Reducing resources use *internally* can be done with the least transaction costs, with little uncertainty about legal claims, and with no value attached to future scarcity of permits. Turning to an *external market* requires that firms face these issues and also the uncertainty about the characteristics of the firms with which they must deal. The types of trades made under the U.S. EPA Emission Trading Program bear out this tendency (Hahn and Hester 1989). Even in what is considered the most successful TPM to date—the U.S. Lead Phasedown Program for Gasoline—70 percent of all trades occurred among refineries within the same company (Kerr and Mare 1995). While greater efficiencies induced by TPMs through *internal* trading are likely, most of the cost-savings that could be attributed to marketable permits by analysts are engendered by *external* trading (Atkinson and Tietenberg 1991; Hahn and Hester 1989; Hausker 1992).

The mix of industries might also affect the willingness of firms to trade among themselves. Instead of having an essentially vertical supplier-consumer relationship, firms frequently will be selling horizontally to competitors in other respects, especially in water rights. Because tradeable permits in many settings probably will require locational and temporal tagging, a firm may reveal private information about its production process through trading (Cohen 1993; Kerr and Mare 1995). This could lead to some reluctance to turn to outside sources for meeting regulatory requirements.

Other regulatory agencies may have a strong influence on the final form of the permit market. For example, local and state air and water pollution markets must gain U.S. EPA approval. For air or water pollution control regimes, the reductions from an economic incentive program must meet the test of being "permanent, real, enforceable, surplus and quantifiable" under EPA rules. These vague, conflicting criteria increase uncertainty about what "permit" rights will be in these cases (South Coast Air Quality Management District 1992; U.S. Environmental Protection Agency 1994). Other agencies may have parallel impacts on setting up the market. For example, state public utilities commission must approve electric and natural gas utility participation and actions in such markets (Bohi and Burtraw 1991). Tax-collection agencies (e.g., the Internal Revenue Service) must decide treatment of purchase, sale and ownership of tradeable permits (U.S. Internal Revenue Service 1992). Each of these factors impose an additional regulatory drag on a TPM (Cohen 1993).

In general, permits are made available for sale in several ways from installing new technologies to changing production processes to closing operations (Tietenberg 1985).

The capital intensity of most abatement and conservation technologies requires a stable rate of use to guarantee payback to the investment—a reflection of the economies of scale inherent in most control or conservation technologies (Dinar and Zilberman 1991; Tietenberg 1985). Control strategies are generally long-term decisions with which firms may be unwilling to rely on an untested supply source because of the inherent irreversibility of the decision. These large investments pose the risk of being irreversible sunk costs that may be unrecoverable if the nature of the market changes substantially. This will tend to cause underinvestment in such control technologies relative to case where costs are recoverable and outcomes more certain (Pindyck 1991). The market may drive permit prices to short-run marginal costs that lie below long-run costs, or demand may not appear at all (Tietenberg 1980). The risk posed by investment is compounded by the technologies' "lumpiness" (i.e., a device that is larger than the present needs must be installed in anticipation of future requirements) (Bohi and Burtraw 1991). Such investments create more uncertainty, and if relative risk is increasing with investment size, then investors will be even more averse.

As an added dimension, a firm's assumption about the speed of technological innovation and adoption may affect its behavior in the market. If the firm expects rapid innovation, it may either quickly sell its tradeable permits; if it expects little technologica improvement, it may wait to sell until prices rise sufficiently. Similarly, holding all else constant, since the pool of tradeable permits may decline over time, firms may have an incentive to delay investing in control technologies until tradeable permit prices have increased significantly.

These characteristics can both (1) lead to temporary overcontrol and (2) advance investment decision deadlines to well before actual operation. Overcontrol may provide a reservoir that smooths the availability of tradeable permits. On the other hand the extended lead-time may cause firms to be more cautious in relying on the market for providing tradeable permits forcing decisions to be made with less information and certainty. Using a dynamic analytic approach of how creation of the market might change the existing capital investment plans for the relevant industries could give a better picture of the opportunity costs that drive prices for a market credits.

Tradeable permits markets probably will evolve to have spot, short-term, seasonal, options, leases and long-term trading instruments (Shupe, Weatherford, and Checchio 1989). The long-term market segment is the one in which firms and other organizations will guarantee for long-term capital investments the rights to pollute or consume a resource. Such investments generally are not based on relying solely on a spot market unless that market is highly stable and well understood. Contingency option markets can backstop uncertainty about supply, but they can not provide the base supply for a capital-investment project. For these reasons, firms are likely to rely on diversified portfolios of permit rights when available.

The apparent uncertainties in a TPM versus command-and-control scheme could increase the entry barriers for new firms in the region by making credits less available (Dwyer 1992). Existing firms will have "license," "quota" or "permit" rights to either sell or use themselves to facilitate production. These are akin to quasi-property rights. New firms will have to buy tradeable permits to set up shop which is an additional cost that may represent a barrier to entry. Such property rights tend to maintain the status quo, particularly if permits are allocated at no cost and/or the sale of such permits have added transaction costs (DeAlessi 1983; Stavins 1995). Even in the case of moving from a less developed market, such as the New Source Review (NSR) Emission Trading Program (ETP), to a more refined market, such as RECLAIM, new firms may see increased barriers. With a larger market, the demand for credits expands while the supply of potential reductions remains the same. Only if transaction costs fall with the new market will new firms gain. On the other hand, a regulatory regime that simply requires of all emitters or users installation of a particular technology places all firms on equal footing.

Banks and other credit providers will discount the value of tradeable permits to account for market and policy uncertainties (Fitch 1993). Financial resources are not available unless critical components are bound with long-term contracts. Financial entities, such as banks or investing groups, require that the company secure sufficient environmental permits for at least the term of financing (typically 15 to 20 years) (Hausker 1992). This may lead to lenders being reluctant to provide capital for firms relying on unproven permit markets instead of providing their own traditional internal emission controls.

1.4 Search and Transaction Process in Market-exchange Institutions

The multi-dimensional aspects of an exchange institution are: (1) the relationship between agents and the market, (2) how prices are transmitted, (3) who initiates the offer-acceptance process, and (4) who administers the overarching mechanism. Market-exchange mechanisms can be characterized in two steps that describe the initiation of participation in the market, the negotiation of the terms and settlement, and exchange of the items that are the focus of the transaction:

(1) how are trading partners matched (i.e., the *search process*), and

(2) how are sales negotiated and consummated (i.e., the *transaction process*.)

The search process can range from limited individual effort to a complete exchange market. The transaction process can involve negotiation or bargaining, posted prices or dealer quotes, and auctions driven by purchasing orders or seller quotes. In addition, an intermediary, such as an agent, broker, merchant or market-maker, might be present.

While an extensive amount of research has been done in economics and finance on types of market exchange mechanisms, much less work has been done in environmental and resource economics on choosing an exchange institution.[3] Models assessing the efficiency, liquidity and transaction costs of market exchange mechanisms—different types of auctions (e.g., Dutch or English), bargaining or negotiated, and posted prices—are useful in assessing how the price is negotiated and settled (Smith and Williams 1992; Walls 1993). Theories on market exchanges highlight the importance of the offer-acceptance process—whether buyer-initiated, order-driven or seller-initiated, quote-driven—in affecting the efficiency of the final allocation (Saleth, Braden, and Erheart 1991). Finally, whether the market is administered by a regulating agency or a private entity such as an existing securities exchange influences the entire process, from how

[3]For some of the most complete analysis to date for establishing a permits market, see (Carlson et al. 1993a; Carlson et al. 1993b; Carlson and Scholtz 1994)

responsive and volatile prices may be to the transaction-clearance process (Friedman 1993; Huffman 1987).

While some centralized auction markets exist for permit markets, even these use intermediaries to facilitate search and exchange.[4] The two dominant forms of intermediaries are merchants and brokers (Hackett 1993). In markets with fairly stable demand and a strong response to marketing efforts, merchants tend to dominate. Dealers can gauge the amount of a commodity they will sell with some accuracy and can collect most of the returns from their own sales efforts. In markets with variable demand and low responsiveness to marketing efforts, brokers tend to dominate. Brokers do not need to hold stock and they will only be able to capture a portion of the returns from their sales efforts since they collect proportional commissions. Markets that rely on brokers will generate fewer sales because of the decreased marketing incentive for brokers and the need to spread merchants' fixed costs over larger sales. TPMs are more likely to have variable demand, thus relying more on brokers.

1.5 Empirical Evidence from Other Markets

Existing financial markets can provide useful analogies (e.g., housing, agricultural commodities, and financial instruments.) The real estate market is primarily brokered and matches individual buyers and sellers for trading heterogeneous, non-fungible goods.

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[4]Examples of central exchanges for permit markets include the RECLAIM Clean Air Auction operated by Cantor Fitzgerald, the Acid Rain Credit Exchange operated by the Chicago Board of Trade, and the periodic California Drought Water Bank operated by the Department of Water Resources.

However, housing is a stock resource that provides a flow of services. The new automobile market is an example of a hybrid between a direct sale and dealer-type market. Financial markets in stocks, bonds, commodities and derivative instruments represent both dealer and auction-driven structures. NASDAQ typifies a dealer market, while the New York Mercantile Exchange, Chicago Board of Trade and New York Stock Exchange are examples of auction markets.

While commodity markets work well with more reliance on the spot and short-term segments, these markets differ from tradeable permits in one significant respect: the sellers generally can not consume the product themselves. They are compelled to participate in the market to realize any economic gain. In contrast, most permit holders can use the resource internally to produce and sell another product. For permit holders, short-run participation is only compelled either by unanticipated regulatory action or natural catastrophe.

The most appropriate comparison might be made to the real estate market. Firms and individuals lease land or housing when they are transition or the scale of their needs is small compared with what is available in a locality. However, when a firm plans large-scale improvements at a particular site, it negotiates either a long-term lease or purchase. In these markets, participants enter infrequently, making a centralized exchange mechanism uneconomic due to the lack of scale derived from trading activity. Due to the many characteristics related to land, such as size, surrounding amenities and location, transaction prices do not always express the full value of a neighboring parcel.

Because demand for real estate is highly variable and marketing efforts are not highly effective, brokered-intermediation has evolved as the main exchange mode in this market. Sellers pass title directly to buyers while brokers collect commissions for bringing the parties together. Multiple listing services help facilitate the search process, but transactions are conducted one-on-one. Because each sale is unique, the transaction costs are significant, including a 5% to 10% brokerage fee. However, these costs are fairly fixed and decline in relative terms as the value of the transaction increases.

The most important and unique characteristic of permit markets is that the amount of the resource available simply can not be increased in the usual manner. Land in the real estate market has a similar characteristic, particularly for certain uses such as farming. If a resource-use cap declines over time or if economic activity increases, the value for a permit generally should increase at a premium above the general market interest rate or individual discount rate. This price behavior mimics that of an "exhaustible" resource. Technological innovation in real estate, such as building skyscrapers, can decrease the value of land even in the face of rising economic activity. But rapid price increases and sustained prices in the face of economic slumps in housing markets (e.g., San Francisco) reflect a scarcity value akin to that for environmental commodity permits.

1.6 The Evidence on "Messy" Tradeable Permit Markets

Transaction costs associated with market participation (e.g., brokers' fees, title searches, negotiating costs, financing delays) tend to increase as the market becomes decentralized. Various estimates have been made for the transaction costs associated with permit markets. For example, the SCAQMD analysis of the RECLAIM program estimates that the transaction costs for the NSR Emission Reduction Credits (ERC) program are about 35 percent of the contract price for the ERCs (South Coast Air Quality Management District 1993b, Appendix F). One broker stated these costs can range up to 50% of the final market price (Margolis 1995). A study of Rocky Mountain water markets found policy-induced transaction costs to average $91 on prices that ranged from $300 to $3,600 per acre-foot (Colby 1990; Saliba 1987). The transactions costs in the California Drought Water Bank, attributed to overhead costs, carriage water and carryover storage accounted for a 40% difference between the offer to sellers and price paid by buyers (California Department of Water Resources 1992; California Department of Water Resources 1993a; Lund, Israel, and Kanazawa 1992).

In addition, permit markets are often characterized by fixed or declining levels of resources, whether they are water rights or pollution credits.[5] Since these resources can not be produced freely, we would expect these markets to have the characteristics of nonrenewable-resource markets, leading to a time-dependent scarcity value being attached to the permits.[6] While such scarcity values are efficient, it raises the market price relative

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[5]The existence of the business insurance market demonstrates that even publicly-held corporations are risk averse to some degree.

[6]The Clean Air Act Amendments Acid Rain Reduction Program calls for declining amounts of oxides of sulfur (SO_x) emissions; the Central Valley Project Improvement Act reduces the amount of available water to project users over time while encouraging trading; and the SCAQMD's RECLAIM program has a declining cap over a nine-year period. In addition, economic growth with a fixed-resource cap produces the same effect

to the apparent accounting costs of internal measures in the critical early years of these markets.

On the other hand, anticipated rates of technological innovations may decrease the value of the permits. Unfortunately little work has been done to date showing how relative technological innovation rates are affected by general regulatory design. The one study available found in the most common and politically-acceptable form ("grandfathered" or free allocations), the incentive to innovate is actually *less* than under conventional regulation (Milliman and Prince 1989).

As shown by (Stavins 1995) transaction costs—created by market activity or risk premium—can prevent the tradeable permit market from achieving the cost-effective equilibrium assumed to occur by most analysts. These transaction costs also increase the importance of the initial allocation of permits. As the difference between the values held by buyers and sellers and the market-clearing price created by the transaction costs increase, the "inertia" of the initial allocation increases (DeAlessi 1983). The resulting market-instrument equilibrium may differ little from that of command-and-control (Stavins 1995). In addition, if the required control or conservation level is near the limits of technological feasibility, a permit market will not generate significant benefits because few

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as a declining cap with static or stable activity. Even if these resources are "banked" for future use, the overall amount of emission credit resources are capped as would be the case under nonrenewable resources. Banking can relieve some of the scarcity value by allowing intertemporal transfer, just as though when petroleum reserves are left in the ground rather than pumped.

trading opportunities will be available (Tietenberg 1985). The result could be that the transaction costs and adjustment costs over time may offset any net gains realized from improved allocative efficiency under a TPM (Zilberman, MacDougall, and Shah 1994).

Having a government regulator directly involved creates an additional form of risk in gaining approval for the trade itself, beyond the usual contractual and enforcement risks.(Lund 1993) Enforcement of transfer rights usually occurs through the regulatory, rather than judicial, system—a system that is more influenced by the vagaries of the political process. Contrary to the assumption that firms are "risk neutral" (i.e., that they choose between options based on single-point (myopic) expectations without regard to the range of uncertainties about each option), firms are more likely to be "risk averse" (i.e., they will choose the less risky of two options that have equivalent *expected* outcomes) (Sandmo 1971). These uncertainties may cause buyers to attach a *risk premium* to external exchanges compared to internal investments, and to cause sellers to accelerate their investment recovery period (Lund 1993). For example, the risk premia in well-established agricultural quota markets (e.g., tobacco and dairy products) have been estimated at 10% to 35% of quota values (Barichello 1996). Farmers participating in the California Drought Water Bank adjusted their sales for the perceived risks of losing their water rights (Howitt 1994).

In evaluating these markets, it can be difficult distinguishing whether differences in valuation occur due to transaction costs, risk premia or scarcity value. Each derives from different mechanisms within the market, but each mechanism may be difficult or impossible to observe directly. Accounting for market participation costs involves tracking expenses which may be undisclosed for proprietary reasons or even nonmonetary. A risk premium evolves from participants' expectations about the reliability of the market, which may be confused with participants' expectations about the future path of permit prices—the basis for scarcity value. Because all of these are only observable indirectly, creating useful distinctions involves a sophisticated analysis looking across many different types of markets—not an easy task when few such markets exist.

Clearly many factors exist that create a substantial difference between the values of external tradeable permits and internal abatement/conservation measures. Most analyses of TPM proposals fail to address a fundamental point: that firms face an important decision on whether to participate in an untested market, and that these decisions can inhibit participation in an emerging TPM by both buyers and sellers. Problems in administering the SCAQMD RECLAIM program, for example, have slowed participation (Johnston 1994; Margolis and Langdon 1995). Many firms may only enter a TPM once to make long-term purchases or sales and then withdraw. Because of the uncertainty surrounding these variables, it is difficult to predict whether a TPM will achieve sufficient trading volume to be efficient (Hyde 1994).

Low participation can lead to "thin" markets where bargaining power is important and the market-clearing prices can diverge sharply from the optimal equilibrium outcome (Saleth, Braden, and Erheart 1991). For example, a study on the U.S. EPA's sulfur dioxide market points out that most simulations for that market projected that at most 10% of the emission credits would be traded in any one year implying low market liquidity (Hausker 1992). RECLAIM after about one and a half years had traded about 2% of the

Reclaim Trading Credits (RTCs) available in the next nine years (Cantor Fitzgerald and Dames & Moore 1995; South Coast Air Quality Management District 1993a, p. 5-24). In contrast the Chicago Mercantile Exchange handled contracts worth $183 trillion in 1994, many times the total value of the commodities traded. In thin markets asset value volatility can increase (Allen and Gale 1994). This volatility makes more risk averse investors reluctant to enter the market in a process that becomes self-reinforcing.

Finally most permit trading schemes, particularly for water rights, do not provide for a central clearinghouse where all permits are auctioned simultaneously. Sequential bilateral bargaining or dealer-operated posted-price processes are more likely to exist and generally lead to suboptimal outcomes (Atkinson and Tietenberg 1991; Saleth, Braden, and Erheart 1991). For example, the 1991 California Drought Water Bank initially used a dealer-operated posted-price system before switching to a brokered approach in the 1992 Water Bank (California Department of Water Resources 1992; California Department of Water Resources 1993a). Existing Emission Trading Program offset credit markets under New Source Review in most regions rely on sequential bargaining processes, which may reduce net benefits of instituting a TPM by 50% or more (Atkinson and Tietenberg 1991).

1.7 Conclusion

Market performance can be evaluated in terms of its liquidity, ease of access and trading, the relationship of costs to prices, contract performance and enforcement, and distributional implications. Within each of these market institutions, issues of transaction costs, enforcement of property rights and contracts, and participants' characteristics affect performance. Search, negotiation and regulatory approval all add costs to participating in any market beyond producing the good or service itself. Uncertain property rights, created either through contractual limitations or government policy, can impede market development and participation. Potential participants may view market structures differently based on their perceptions of risks and future events. Addressing how firms make the decision to enter the market in the first place, what sort of premium that might be put on the value a permit depending on its source, and how regulations might affect the ability to use purchased credits versus those generated through internal management decisions

Table1-3 summarizes many of the impediments that occur in the development and operation of markets, particularly those that are just developing. Modelling a TPM is more involved than simply setting up the costs for technologies to reduce emissions or to conserve, and matching these to potential "buyers" of permits. Issues of market liquidity, transaction costs, market search and transaction negotiation are critical to the performance of any market. TPMs additionally face uncertainty about government policy and diffuse property rights not seen in many other types of markets. Understanding how markets behave with different sets of rules, mechanisms for interaction, and technological constraints requires disaggregating the marketplace and examining individual firm decisions, rather than simply summing total supply and demand and identifying the price where they equilibrate as the market-clearing one.

Table 1-3
Summary of Potential Impediments to Market Development and Operation

Categories	Issues
Market Distortions	Market-participation transaction costs driven by limited information
	Scarcity value driven by environmental goals
	Expectations and uncertainty about technological innovation and diffusion
	Risk premia from regulatory and contractual uncertainty
	Market exchange mechanisms
	Market "thinness" affecting liquidity
	Differentials in firms' internal and external valuation of permits
	Capital "fixity" and lumpiness
Regulatory Constraints	Existing command-and-control structure
	Current permit allocation
	Agency goals of environmental compliance and ease of administration
	Goals of political oversight institutions
	Political acceptance by agency, regulated community and third parties

To attain projected savings from TPMs, regulators must facilitate the evolution of an efficient, liquid market that is inexpensive to administer and encourages participants to reduce pollution and comply with environmental laws. Participants require an efficient, liquid market that does not face any major impediments, and has lower compliance costs than for existing agency rules before accepting the new regulatory strategy. Achieving the goals for permit trading of efficiency, liquidity, and broad information dissemination are

dependent on addressing the inherent uncertainties not only in marketable permits but any rapidly evolving market.

CHAPTER TWO

GOVERNANCE RULES AND MANAGEMENT DECISIONS IN CALIFORNIA'S AGRICULTURAL WATER DISTRICTS

2.1 Introduction

Agricultural water districts are perhaps the most important players in efforts to reform water-resource management in California. According to several observers, a key impediment to the evolution of California water markets is the requirement in state law that water districts must approve any transfer of water rights outside of their borders (Holburt, Atwater, and Quinn 1988; Smith and Vaughan 1988; Thompson 1993a; Thompson 1993b). Agricultural irrigation districts have been particularly reluctant to participate in sales that would apparently transfer water from low-valued agricultural uses to higher-valued urban and industrial consumption. How these districts might distribute the costs and benefits associated with these trades has been the focal point of removing this particular barrier to developing viable water markets (Rosen 1992a; Smith 1989). In addition, the 1992 Central Valley Project Improvement Act focused on water districts as the agents for implementing water conservation and efficiency measures (U.S. Congress 1992). On the other hand, recent attempts to establish water market protocols in California that bypass district control have met stiff resistance to date from agricultural interests.[1]

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[1]See for examples of recent legislative reform attempts: Assembly Bill 2090 (Katz 1992) and Assembly Bill 97 (Cortese 1993).

Proposals by economists to reform water-resource management and to develop water markets generally have not considered the institutional context in which the targeted agricultural districts operate. Most analyses of water rights markets assume that the participants are attempting to gain the maximum net profits or monetary benefits. However, this presumption may be off target, particularly if public-enterprise agencies dominate the water management structure as is the case in California. Given that most future water transfers in California are likely to occur among public agencies, looking beyond typical neo-classical assumptions about the "theory of the firm" may be important to understanding how water markets might develop (Holburt, Atwater, and Quinn 1988 p. 45). Previous political economy studies of irrigation districts have looked at some of aspects of how district decision-making processes work(Bain, Caves, and Margolis 1966; Goodall, Sullivan, and DeYoung 1978; McDowell and Ugone 1982; Rosen and Sexton 1993), but none has examined California districts across political structures in an economic framework.

The emergence of two recent issues adds to the importance of better understanding the incentives embodied in various water-district institutional forms. The first is that use of any electoral system other than universally-enfranchised, popular-vote was challenged successfully in part in federal court (U.S. District Court 1995). The Association of California Water Agencies intervened with an *amicus curiae* brief to defend the voting system now in use in California water districts (Marchini et al. 1996). The second is the recent passage of Proposition 218 in November 1996. This new law requires in many instances that certain types of special-purpose taxes must be approved by a majority vote of the assessed-benefit, and fees and charges by a majority of "property owners" within the relevant jurisdiction (O'Malley 1996). Many of the dynamics that now affect water districts using assessed-value voting will come to bear in a larger context among many local governments.

The objective of water district management is not necessarily to maximize the district's net wealth; rather, it is more likely to please the maximum number of voting members of the district, depending on the institutional design of the district. Water districts in California generally select their board members using one of three methods—by popular "one-person/one-vote," by property-ownership-enfranchised size- or valuation-weighted vote, or by county-board appointment (Goodall, Sullivan, and DeYoung 1978). Yet, while the interaction between institutional structure and management decisions is evident, the relationship is not well understood in this setting.

Three key questions are assessed in this analysis:

- First, how do water districts differ in behavior from private firms in whether they maximize net revenues to their members and how they distribute those benefits?
- Second, do districts differ substantially in how they manage their resources and distribute benefits to their members based on their political structure and governance rules?
- And third, do the distributions of benefits within districts mirror the relative political "strength" of each member as measured by the formal voting rules?

This study represents just a first step formalizing the political-economic description of agricultural water districts in California. Most institutional work to date has been historical or anecdotal; little theoretical or empirical work has estimated parameters that might broadly describe the differences in behavior between districts. We build on motivational theories for public enterprises and cooperatives to create an objective function for water districts driven by institutional, physical and economic parameters. The analytic objective is to estimate the importance of these incentives in water pricing, use efficiency and trading.

2.1.1 A Review of Political-Economy Models of Agricultural Water Districts

At least six paradigms for the behavior of public enterprise agencies have been proposed in the political-economic literature:

(1) A political-participation model focused on the relationship between the electoral process of selecting managers and certain financial characteristics of these districts (Goodall, Sullivan, and DeYoung 1978). The study attempted to assess the level of participation by the local electorate based on the electoral rules for each type of district.

(2) Two political-sociological studies set forth the hypothesis that water districts may want to hold strong property rights in water as a means of exercising power in relations with other districts, even at the expense of lost profits for its members (Coontz 1989; Coontz 1991). This power is used in bargaining for larger shares of water-related infrastructure and better contractual terms, or in creating a sustainable cooperative management solution.

(3) The classical political-economy model assumes that the district maximizes net profits to members subject to a zero-profit constraint on its own operations. See for example, (Cave and Salant 1987; Moore 1986).

(4) Models using the median-voter concept set out the district managers' objective as a joint vote-benefit maximization problem where the manager balances votes with net profits to members, depending on the voting rules (Bain, Caves, and Margolis 1966; McDowell and Ugone 1982).

(5) A political-economic bargaining framework model assessed the collective-choice process (Rausser and Zusman 1991; Zusman and Rausser 1994). In this model, the manager is a the center of an influence process in which each member attempt to gain the most benefit from the district's policies in a non-cooperative game.

(6) A cooperative-game model of coalition building in a district viewed the decision-making process as directly reflective of the members' choice (Rosen and Sexton 1993). Benefits accrue in proportion to the voting power of each member.

The one example of a political-science study examined how the various electoral rules affected voter participation (Goodall, Sullivan, and DeYoung 1978). The authors, in a report done for the California Department of Water Resources, attempted to explain why property-based rules led to less "democratic" processes than the popular-based methods. Unfortunately, the predictive theory was unclear in the analysis, and the statistical analysis did not strongly support the thesis.

Two comparative studies used sociological methods. Coontz examined the historical development of the Kings River Water Association and maintains that districts single-mindedly pursued physical acquisition and control of water rights either through construction of diversion facilities or by appealing to outside government agencies for assistance in funding of upriver storage structures (Coontz 1991). Eventually, a strong contractual arrangement was structured, and the previously strife-torn parties successfully stood in concert against the U.S. Bureau of Reclamation during contract negotiations. In the Grasslands Area, Coontz found that the legacy of Miller-Lux had left control of the region's water rights and leadership role to the Central California Irrigation District (Coontz 1989). As part of the Miller-Lux operations, neighboring farmers were allocated water portions greater than they might have achieved in fighting Miller-Lux and losing. This cooperative arrangement among districts and farmers continues today.

Both of these situations represent bargaining solutions driven by the perceived disagreement outcomes by each party. In the first case, the upstream districts could physically control the flow of the Kings River, while the downstream Tulare Lake farmers could appeal to outside political power in the USBR and the city of Los Angeles. The result was a hard-driven bargain that required strictly defined behavior. In the second case, Miller-Lux, and later CCID, controlled the lion's share of local water rights. As a result, its neighbors were quite willing to accept a cooperative rather than confrontational solution since they could face substantial losses if they defected.

The classical paradigm in which the district maximizes the total net benefits of all members is the most frequently seen in the economic literature. In each case, the water district is entirely transparent to the motives of the farmers themselves. In other words, these models simply assume that district managers use maximizing aggregate net income as their objective function. The district managers have no individual motives themselves nor do they consider any other objectives than resource-use efficiency.

The three more recent political-economy models approach differently the question of how districts' policies are chosen (McDowell and Ugone 1982; Rosen and Sexton 1993; Zusman and Rausser 1994). The first two models treat the institutional management-selection rules as the focal point of policy decisions, while the latter one examines the importance of informal political influence. The first and third models put the districts' managers at the center of the decision-making process, while the second one implies that decisions directly reflect the wishes of the districts' members. The latter two models rely on information about individual members within each district, either about farming activities or relative political influence. None of the models assume that a district manager maximizes the total net benefits to member, but rather coalitions are built by targeting benefits to certain groups within a district.

In the first model, district managers attempt to maximize district profits while maintaining a sufficient level of voting support in a median-voter or "isoprofit/isovote" model (Bain, Caves, and Margolis 1966; McDowell and Ugone 1982). This model focuses on managers as the decision-making unit. Unfortunately, McDowell, did not adequately specify the empirical model to give meaningful empirical results.

In the second model, management policies are chosen based on which policy draws the greatest political support among the district's members, which is done by comparing the relative economic benefits that each would receive (Rosen and Sexton 1993). This approach views the members' operations as the units of analysis and aggregates to the district level. The model sees the managers as simply transparent to the decision-making process.

In the third model, the district managers attempt to maximize the benefits of the members subject to a distribution based on the relative political strengths of each member (Rausser and Zusman 1991; Zusman and Rausser 1994). This model examines the motives of both the managers and members and creates a two-stage optimization model.

McDowell, (M&U) examine whether government-enterprise managers respond to the sometimes divergent interests of "voter-consumers" in a manner different from those of private enterprises (McDowell and Ugone 1982). Public managers must balance maintaining political support that ensures their tenure with maximizing net benefits to consumers of the districts' services. The analytic framework uses the median-voter paradigm (Peltzman 1971). M&U hypothesize that if political support is not proportional to revenue responsibility, i.e., the district has many voters of whom few pay related fees or taxes, then interests diverge between the disparate groups within the district. They further ask whether cross-subsidies through pricing are more likely in the case of government enterprises.

M&U build on Peltzman's (1971) model in which the district manager attempts to maximize voter support subject to the constraint that total district benefits exceed a certain level (McDowell and Ugone 1982 p. 458). The dual of this problem is to minimize the economic benefits forgone to achieve a majority vote. The result is finding the tangency of the isovote and isoprofit curves in the multiple-group/price space. The isovote curve represents the combination of prices to the relevant groups within the district that maintain the same level of political support. The isoprofit curve represents the combination of prices to the relevant groups within the district that maintain the same level of total net benefits to the district. If the political process transmits voter support in proportion to the revenues generated by the consumers in each group, then the tangency should lie along the 45 degree line from the origin, i.e., the relative prices for each group should be the same. If the potential support is not proportional to revenues, then the tangency will deviate so that the group with more political clout receives lower prices. Both of these situations can deviate from the case of the discriminating monopolist which would charge prices based solely on the relative costs of providing service to each group.

The district manager, instead of equating marginal costs and marginal revenues, equates the ratio of marginal vote gains to marginal losses in profits among the various groups. M&U proposes to test their hypothesis by whether the price ratio of water for large farms to small farms is greater for districts using a popular vote method versus ones using an acreage-based method:

$$(P_L/P_S)_{pop} > (P_L/P_S)_{acre}$$

M&U do not directly test this hypothesis or the ones comparing public with private ownership. Instead, they estimate the parameters for three models across twenty-four special districts across seven states that examine the relationships of operational expenses, operational revenues and district rates of return to scale of water deliveries, proportion of agricultural service, board selection methods and whether electric utility service is also provided. They report results that they claim supports their hypothesis that acreage-based electoral systems provide more direct benefits to the consumers of district services.

However, the linkage does not appears evident for several reasons. The relative levels of district revenues and expenses are more likely to be influenced by other physical and institutional factors such as:

- the age of the district and its facilities,
- the sources of water supplies and whether these sources are federally-subsidized,
- the nature of the water rights that the district might hold and whether the district might be under or over investing based on the priority of those rights (Burness and Quirk 1979), and
- the general types of agricultural activity and their net returns per acre.

M&U also misspecify the measure of farm size in their models, instead measuring the intensity of water applied per acre of land in the district.

Rosen, (R&S) develop a cooperative game model that examines how coalitions might be built for water markets within a district (Rosen and Sexton 1993). This model uses an approach developed by Sexton to assess the voting patterns of agricultural production cooperatives (Sexton 1986). In this cooperative setting, R&S examine if a policy which maximizes the net benefits for a number of individuals that represents the majority in the district will be chosen over another which maximizes the *total* net monetary benefits to the members of the district. R&S assume that a single popular vote institution is used to transmit political influence to the district's board and managers.[2] The implicit assumption is that political power is in proportion to the institutional allocation of votes.

R&S examined the Imperial Irrigation District-Metropolitan Water District sales transactions and how IID farmers decided to accept or reject various sales terms and revenue allocations. R&S surveyed 31 farmers about their farm operations to estimate the net benefits from alternative trading scenarios. They then created a voter-decision model using a pair-wise voting procedure that simulated farmers' choices based on the expected net benefits to each individual. The result was that the policy which would have generated the greatest total benefits to district members—a *de facto* assignation of water rights to individual land owners before transfer—lost to a policy which gave the greatest net benefits to a majority of eligible voters—a combination of conservation measures to preserve water supplies to farms and a distribution of sales revenues after the conservation costs were covered. This conformed with the actual outcome of the transaction. R&S found that the

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[2]Rosen (1993, p. 40) states that most California irrigation districts use a one-person/one-vote mechanism. While this statement is true in the narrow context of state law as defined by the term "irrigation district," it is misleading about the more general nature of state's agricultural water-supply districts. In districts where a popular-vote method is used, voter qualification requirements vary regarding land ownership and residency. More importantly, electoral rules relying on eligibility and vote weighting by land ownership or value are equally prevalent, and representative of the most recently formed districts (Goodall, Sullivan, and DeYoung 1978). However, the results from R&S are generalizable to these other institutional structures with the proper adjustments.

interests of tenants and owners diverged between these policy options, with tenants prevailing because of the voting structure.

Zusman and Rausser (Z&R) create a non-cooperative bargaining model in which the managers are at the center of a institutional "wheel" with the district members as peripheral agents attempting to politically influence the managers' decisions (Zusman and Rausser 1994). Each member has a certain level of political strength that can be exerted at some cost. The member's objective function is to maximize the net economic benefits from the district's services. The center's objective function is to maximize the sum of the group's objective function plus the sum of the political support exerted to influence the center. Z&R show that using this model that any collective action to manage a resource will result in a socially-suboptimal outcome, defined as maximizing net wealth, unless none of the agents attempt to influence the center's decisions.

The solution concept to the bargaining problem is the product of the net benefits to each individual member, or the total benefits are maximized subject to minimizing the differences between members' benefits. To find the parameters of the model, the individual payoffs must be specified at the decision outcome and compared to the optimal district-wide solution if one assumes that the marginal cost of political influence is equated among members.

In a companion paper, Rausser and Zusman create a water-resource management model using these concepts (Rausser and Zusman 1991). They look at a situation similar to that described in Coontz (1991), where water districts try to influence the behavior of a central water-supply authority. The power relationship in this model is somewhat less formal than looking at the water districts themselves because the governance structure is not specified in a formal constitution. Nevertheless, the "hydrological-political-economic" equilibrium found in the model shows that a narrowly-rational districts will apply political pressure on the authority to lower water prices leading to increased water application.

2.1.2 How Might Differing Motives Affect Districts' Management Decisions

A useful institutional perspective is to compare how the operations and financing of water districts reflect the principles of cooperatives (Bain, Caves, and Margolis 1966; Rosen and Sexton 1993): these districts provide service "at cost" as non-profit organizations; benefits generally are distributed in proportion to use of the managed resource; returns to equity capital are limited and generally gained through directly-related activities, such as selling irrigated crops; and the district is controlled by the member-users, which meshes with the concept of vertical integration of the water supply with agricultural production.

Several advantages exist in the cooperative management of input resources (Sexton 1986). The joint allocation of resources avoids the transaction costs and risks associated with market-type exchange institution, e.g., post-contract opportunism by a party (Alston and Gillespie 1989; Williamson 1979; Williamson 1983). By extending or avoiding market power, it can encourage development of asset-specific relationships by removing risk of contract breach (Williamson 1983). And it provides a mechanism for avoiding, mitigating, spreading and sharing risk among members (Thompson and Wilson 1994). The internalization of allocation decisions can avoid government interference in the exchange institution, e.g., federal reclamation law acreage limitations (Wahl 1988).

The model presented here builds on the three political-economy models that explain district behavior from different perspectives, but rely on a common assumption. *The assumption is that members try to influence district managers to choose management policies that distribute benefits in proportion to political power while maximizing aggregate benefits subject to that constraint.* The district's objective, acting as a cooperative, is to maximize net benefits to all members, but the non-profit constraint means that the district's "rents" must be distributed among its members indirectly, perhaps through changes in water rates or allocations. This distribution is the function of political power within the district, measured in terms of voting share in this case.

Politically, water districts in California are marked by a variety of governance-selection schemes (Bain, Caves, and Margolis 1966; Goodall, Sullivan, and DeYoung 1978). Most of these are directed through state general district acts, of which there are 38 types; in addition, over one hundred special-district enabling acts were in place by 1994 (California Department of Water Resources 1994). Selection of the governing board may be through a vote of eligible persons or appointment by the county board of supervisors. Eligible voters may be residents of the district and/or property owners. Votes may be counted as one-person/one-vote (popular) or be weighted by property acreage or assessed value per acre. California law tends to favor landowners in governance procedures (Smith 1992). While the popular vote is predominate in older districts in the Sacramento and east San Joaquin Valleys, the property-weighted scheme has grown in use, especially in the west and south San Joaquin Valley served by the newer state and federal water projects where corporate farms, rather than family-owned farms, are more common (Goodall, Sullivan, and DeYoung 1978). Even older districts have switched to land-owner enfranchisement.[3]

Each of the districts' management-selection procedures give different incentives to district members and managers. Economic theory leads to an expectation that an assessed-property-value weighted voting scheme would most closely mimic that of a vertically-integrated firm. Agricultural property values reflect the net returns to crops, and to the degree that water application is correlated with land values, the votes would be allocated in proportion to implicit ownership and utilization of the water resource. However, because land values reflect other factors such as soil type and relative market location, value-based voting should not simply follow the same pattern as that for single-product firms. District "ownership" shares are not necessarily in direct proportion to the value-added from water application, as would be case in a private enterprise where ownership would be based on output value, not input quantities. Acreage-weighted schemes reflect a presumption that the amount of water applied per acre is roughly constant across farms and that marginal land values attributable to water use do not vary substantially across a district. This scheme is less likely to match the profit-maximizing interests of the landowners than value-based methods. A popular-vote method tends to divest the district from a solely profit-maximizing objective. Equitable distribution of benefits from district operations become more important. The interests of individual landowner farmers can diverge from that of the district, e.g. in the extra-district sale of water rights. Finally, board-appointed districts represent an interesting enigma. In theory, because the district board supposedly

[3]For example, Glenn-Colusa ID switched in 1992 and Richvale ID in 1996.

represents the interests of the entire county, the decision-making process for the district should be quite divergent from maximizing the profits of those receiving water supplies. However, these agencies are relatively obscure except to those directly impacted, and these boards more likely are "captured" by their customers and reflect their informally-transmitted desires. In summary, it is evident that the motives for the districts can be quite different than the classic assumption of "profit-maximization."

The various governance rules used by different types of districts, such as voting eligibility and weighting, can undermine some of the principles in cooperative management in achieving efficiency. Stating the hypothesis simply, *managers are likely to distribute benefits from operations of the district in proportion to the political strength of its members rather than to economic contribution*. Reliance on popular vote rather than property-weighted vote can create a wedge between those defined as members versus users, and benefits may be rebated on a basis different from use. These benefits might extend beyond simply delivering water to reassigning responsibility for water rights, deciding if water sales need approval to protect certain interests within the district, and setting district charges and taxes to achieve economic goals other than efficiency. In general, we might expect if the votes are distributed in proportion to the value of agricultural land, then the district will act to maximize the value to landowners. If on the other hand, the electoral selection process uses a one-person/one-vote rule, we might expect that the district will attempt to maximize the value of water-related economic activity regardless of its ties to the land. These action can include maintaining the water resource for tenant farmers who do not hold title to the land but may have significant fixed investments in their farm, and considering local farm-service businesses if they are eligible to vote. An assessed-value-weighted voting scheme appears more likely than a popular-vote system to mimic the prototypical "firm" in economic modeling due to the closer correlation between the governance process and the distribution of benefits from water use. Water sales tend to benefit landowners because the districts' rights are most frequently tied to the land. Thus, we expect property-weighted districts to be more receptive to selling into a water market than districts with other types of governance structures.

Using some assumptions about how the motives for various district members might differ, we can build a model that assesses how the various political structures might influence the districts' management decisions. In a property-based voting system, we can assume that the preferred policies will tend to lead to accrual of district benefits in land values. For the popular-vote structure, we must identify a proxy for those actions that target benefits towards water-related activities.

As the voting structure moves away from being directly proportional to the value of water use, we might find that the district's manager will pursue policies that benefit non-landowners. Landowners are more likely to be focused on the bottom line—for example, which generates more revenues per acre, growing crops or selling the water. On the other hand, tenant farmers require water to work their land—they are unlikely to receive payment for water sold by the landowner through a district. Local businesses also rely on farming activity, not just income flows to local landholders that might result from water sales. In a popular-vote system, the district may choose to both limit outside water sales so as to maintain farming activity, and to price water in a way that maximizes other related economic activity, e.g., fertilizer and equipment sales. Observing the former is difficult when water markets do not exist for many other reasons such as state policy. However, we may be able to find a suitable proxy for the latter.

In the case of tenant farmers, they may be reluctant to plant high-value, water-saving crops due to uncertainty about the their tenure on the land. Orchard crops require several years before they reach maturity and must produce for up to two decades to recover the initial investment. Tenants tend to show higher discount rates than owners, leading to less investment in resource-conserving technologies that are capital intensive (Hartman and Doane 1986). More efficient irrigation technologies generally require sunk investment that can be lost by a tenant if the landowner takes action to stop farming on the land. In response to these risks, tenant farmers would be more likely to grow water-intensive field crops with less-efficient irrigation technologies. To support these practices, the district would lower the per unit price of water so that higher application rates do not cause higher costs, and rely on other revenue sources such as per-acre fees or taxes and electricity sales. Higher property taxes have the added advantage for tenants that the elasticity of demand for land limits the incidence of the tax on rents, i.e., landlords must absorb part of the tax in their rents to stay competitive in the agricultural land market. The existence of sharecropping arrangements reinforces this tendency because landowners often must pay the delivered water charge, which comes out of their rent earnings.

Local businesses may prefer two types of outcomes.[4] The first is that crops be grown that require a high level of purchased inputs, e.g., fertilizer or equipment. Field crops generate less employment per acre-foot of water than other crops (Mitchell 1993, p. 5), which might imply that other local inputs such as farm equipment are utilized to a higher degree in production. The second is that business activity remain at a fairly constant or growing level, and that it be of the same nature year-to year (Pindyck 1991). This gives businesses a greater assurance that they will recover their investment in equipment, knowledge and good will. To serve both of these desires, the district will tend to establish pricing structures that do not penalize water use, particularly if the water is for long-established crops. Again, this perspective encourages support for a two-part pricing tariff in which the per water unit charge is relatively small compared to the fixed or property-based portion.

Confounding the analysis though is the inertia of the physical and institutional setting. Once built, a district's water storage and conveyance system is largely fixed. Also, project delivery contracts are largely chosen at a single point in time and have 30 to 40 year lifetimes. While shorter-term water markets are evolving, a district faces significant adjustment and transaction costs to sell or acquire water supplies that differ from those chosen initially. (See Chapter 3 for a discussion of this issue.) In addition, increasing

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[4]Because farm laborers in California frequently are foreign nationals, and are less likely to vote anyway due to having lower incomes, labor employment is not considered in this discussion, although it is relevant albeit to a lesser degree.

supply capacity, through contracts or concrete, is seriously constrained in the existing political milieu.

This analysis is a "snapshot" of a dynamic process which actually began with the formation of a particular district. The conditions at the outset affect the structure of the political institutions, and those institutions have shaped the districts' characteristics. An argument might be made that the variety of districts fits with Tiebout's model of local government competition (Kollman, Miller, and Page 1997). This analysis does not account for those initial conditions, but such a historical perspective, along with an examination of the fiscal policies over a period of time, could provide useful insights into how political institutions evolve from and with economic settings.

2.1.3 Analytic Approach

This study compares management decisions among various classes of water districts. This is done in a broad framework that encompasses a large number of districts. For this reason, the model developed here takes the perspective of a district as the decision-making unit. In this way, we can draw inferences about a broad range of districts while controlling for other factors that may influence their behavior, e.g., source of water, dominant crop type, the types of farming operations.

A modeling approach that relies on analyzing the individual farm operation as the unit of interest, as proposed in the types of models described in Rosen and Sexton, and Zusman and Rausser, has two problems. The first is that it misses the influence of non-farm voters on district decisions, particularly in popular-vote and board-appointed selection systems. The second is that the data requirements for a sufficiently broad empirical analysis quickly overwhelm the available resources for most studies of this type.

The model presented here specifies an objective function for the district managers in which they attempt to maximize their likelihood of being elected by adopting policies that maximize the welfare of certain voting interest groups. We examine theoretically how specific district policies would effect certain types of constituents rather than simulating how each farm operation might respond to different management schemes.

2.2 Defining The Political Structure of a District

This analysis addresses three questions as to how the institutional structures of California's agricultural water districts affect decisions by elected board members and farmer in these districts. The focus is on the governance rules and political structure of those institutions—voter eligibility and vote counting. These questions are:

- How do farmers' decision rules differ under different institutional structures, including an "optimal" cooperative,
- What are the decision rules for district board members under different rules for existing institutions; and
- How do the rules in the existing districts cause key management decisions to diverge from those in "optimal" or other types of districts.

We begin by comparing the "optimal" or efficient cooperative, as classically defined by economists, to the institutions which actually manage agricultural water resources at the retail level in California. We derive the decision rules for determining the levels of inputs—land, water and other types—under the theoretical structure versus the existing structures. We then turn to deriving decision rules for district managers under existing voting rules assuming that they are striving to maintain their political base. Finally, we compare how farmers' and other constituents' decisions vary among these various institutions and how managers might design their policies to cater to the key voter groups in their districts.

2.2.1 Farmers' Choices and Objectives

A farmer proceeds through several decision-making stages in deciding what to plant, production levels, investment and water use. The initial choice is the size of the operation. The decision as to how much land to put under cultivation and irrigation is dependent on many factors such as how it is acquired (e.g., purchased versus inherited), available financial resources, which crops are appropriate, past resource usage, variation in land quality, and distance to markets. Once this choice is made, a farmer chooses to plant and irrigate on their most "fixed" asset, land, to the maximum extent possible and selects that appropriate crops, water use and irrigation technologies on that basis.

Next the farmer selects the crops to be grown on this land. This choice drives other factor choices, particularly for water. Most crops require a fairly narrow range or "effective" water application as determined by local evapotranspiration requirements and land quality factors such as permeability, drainage and nutrient levels (Caswell and Zilberman 1986; Green et al. 1996). The amount of effective water, e, is a product of the amount applied, a, and the technical efficiency of the irrigation method, h. The farmer then adjusts either irrigation technology/source or amount of applied water to compensate for changes in the other factor. As a result, the farmer faces a two-stage problem—first choose either water applied *or* irrigation efficiency, then select the other given conditions that dictate effective water requirements (Caswell, Lichtenberg, and Zilberman 1990). Thus, the farmer first chooses optimal input levels for a particular mode and efficiency of irrigation, h_i, and selects the irrigation method that provides the largest net profits to the farm.

The decision on how much water to apply can be a long-term commitment. Historically, only a few opportunities have arisen to acquire surface water supplies with the initiation or expansion of water projects (e.g., the Central Valley Project in the 1940s and 1950s, and the State Water Project in the 1960s) (Bain, Caves, and Margolis 1966). These water "markets" only opened for short periods and only offered long-term contracts. Water diversion is capital intensive and can require commitments up to 40 years with payments relatively invariant with actual usage. While water market opportunities now are expanding and environmental regulations are constraining supplies, even in these cases farmers face long-term choices. Because of this time frame, the amount of water to apply from water district sources appears to be the dominant variable in choosing how to meet effective water requirements, and efficiency is a residual of these choices; thus we can leave a choice variable, h, to the second stage. The amount of effective water as a result is based on an expectation about the amount of land under cultivation, the price of water and of irrigation technologies, and the price and availability other inputs.

The water-use efficiency variable, h, can be interpreted in several ways, either as improved irrigation technologies or as greater reliance on water sources autonomous from district supplies, such as groundwater pumping. This decision of selecting the appropriate irrigation technology and/or water source has a long lead time as well (annual at minimum) and requires year-to-year planning to change. The expense of selecting a different technology is captured in the investment cost of the technology, $I(h,L)$, and the cost of pressurizing the irrigation system or for local groundwater pumping, $v(h)$. However since $h = A/E$, these costs are actually dependent only on the amount of water applied, a.[5] Thus v and I become functions of a as well.

Other inputs, x_p, are chosen in different time frames before and within each growing season. To simplify the problem, x represents a composite index of all other inputs. In fact, we would expect to see shifts among these inputs with changes in water usage and irrigation investment as well. This variable is included to measure the impact on non-farmer district members and residents from changes in district policies.

2.2.2 The Water Storage Infrastructure Investment Decision

Perhaps the most important reason for forming any water district is the provision of a *reliable* water supply. The issues of overall supply and service quality must be addressed collectively because they have clear "common property" traits. Adding capacity to a reservoir is likely to improve everyone's supply reliability within the district if the water rights are effectively "correlative" (Burness and Quirk 1980). Defining the property rights to this added capacity would undermine the cooperative nature of the district. The district

[5] To a certain extent, the quality of delivery service (e.g., scheduling and lead time on deliveries, amount of pressurized system, conveyance losses), also affects the efficiency of water application . However, we are ignoring this aspect in our current discussion.

is then searching for the "optimal" choice for these variables based on a set of rules. These rules begin with deriving the opportunity cost or "shadow value" of the water supply.

The choice of the supply capacity, S, directly influences reliability—the greater the storage capacity and transfer capability, the longer the district is able to carry over storage during drought periods. In other words, the probability that full water deliveries will be available, $F(S)$, increases with the size of storage capacity, S. The average supply availability below full deliveries is the sum of the probabilities of these lesser flows (Burness and Quirk 1979). However to simplify this problem, we can present it as a dichotomous probability case of either full deliveries or drought-constrained deliveries without any supply capacity, s_d, which equal approximately the average of the less-than-full delivery conditions. Thus we can estimate an expected level of delivery, $\bar{s}$, as a function of the supply capacity.

(1)
$$\begin{aligned} \bar{s}_i &= \int_0^{S_i} s_i(1 - f(s_i))ds_i + S_i \cdot F(S_i) \\ &\approx s_d \cdot (1 - F(S_i)) + S_i \cdot F(S_i) \\ &\approx s_d + (S_i - s_d) \cdot F(S_i) \end{aligned}$$

S_i =water delivery capacity per acre from district supplies, and district's delivery service quality to farm I measured by (1) relative miles of unlined/lined canals and pipelines, and (2) delivery conditions, requirements and lead time.

s_d = the minimum water delivery service and capacity which exists without district investment. For example, the minimum water delivery under drought conditions without storage facilities.

$\bar{s}_i$ = average water supplied to farmer during the year per acre.

$F(S_i)$ = cumulative probability density function of full water supply conditional on district supply capacity.

A district not only must supply water to its customers, but it also must deliver that water on schedule, without large conveyance losses, and of sufficient quality (e.g., low salinity). To this end, the district will have scheduling arrangements and constraints with customers, may line canals or install pipeline to reduce losses, and take measures to ensure that water quality is not degraded during transportation. All of these measures have costs beyond simply releasing stored water into district canals. Farmers' costs are affected by these quality factors, such as the use of laborers to irrigate fields at certain times, managing drainage, and losing yield to poorer quality water. A fully-cooperative district compares its marginal costs of improving quality to the marginal gains to farmers from such improvements.

2.2.3 Providing a Benchmark: A District as an Efficient Cooperative

Often the terms "efficient," "social-welfare maximizing" and "wealth maximizing" are often used interchangeably by economists as though they represent much the same measure. However, attaining the maximum wealth for a group may not be the most efficient outcome because two individuals still might want to trade among themselves. This results from their respective preferences changing at nonlinear rates. Perhaps even more confounding is that the distribution of wealth may also be important in attaining the preferred level of social welfare. Because individuals preferences are not linearly related to monetary returns, summing across individuals for two different choices might arrive at two different answers. One choice might generate the greatest monetary return, but all of that might go to a single individual—but that is not a likely policy choice by an elected board. Because the classical model often uses monetary measures of well-being, through profits, it reduces the definition of efficiency to maximizing total wealth. The problem with defining efficiency solely in terms of net monetary benefits is that the "cooperative" has key difference from the "firm" in the neoclassical sense—cooperative members maximize over their individual preferences which may include non-monetary outcomes, while a firm's shareholders only derive monetary returns. For comparative purposes though, we define our efficiency measure in this reduced simplistic form, which in turn may be somewhat misleading in a political-economic analysis.

If an agricultural water district was managed as a wealth-maximizing cooperative, it would choose the mixture of investment in water-supply capacity and agricultural production that would generate the greatest net benefits for its members. Water would be priced at its marginal cost internally to signal the most efficient uses to members, and any net profits or losses from water-supply operations would be returned to district members in a fashion which would not distort water-use decisions. In fact, this model is institutionally quite different from the way public-enterprise district operate.

Existing districts have several characteristics distinct from this model. The most important is the so-called "non-profit" requirement, i.e., that expenditures and revenues must be in approximate balance. Revenues are often limited to sources directly linked to water-use, e.g., prices, charges or property taxes, and thus pricing must approximate average, not marginal, costs. Water is not priced to signal the most-efficient uses these cases. The net benefits from the district also may be allocated in any number of ways, some of which distort water-use choices by farmers. Finally, water district board members tend to choose policies which allow them to continue to hold office. This means pleasing enough constituents to gain a majority of votes. Policies that increase total district wealth may benefit only a few district members and not generate sufficient political support.

Even though the "efficient cooperative" model may not be appropriate institutionally, it is useful as a benchmark to measure performance by other institutional forms. One can assess how a district's manager might choose to maximize total wealth if the manager could control all internal resource management decisions either through directives or complete internal pricing mechanisms. Thus, this is more appropriately called the "wealth-maximizing" model.[6] This model assumes that farmers see the full and direct costs for the water resources that they use and receive back the net profits from the

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[6]This model differs from a local monopoly water company where the manager maximizes profits to the water distribution entity at the expense of the farmers. Water districts are the dominant form in California due to several advantages including the ability to issue tax-free debt and to secure that debt with property tax assessments on all member of the district. The large fixed costs and economies of scale favor the public structure over a private one (Bain, 1966).

operations of the district. The institutions that manage and price such water resources are "transparent" in this case. The district does not face a non-profit constraint, nor must it decide how to return any excess profits to district members. Distribution of total benefits is not addressed in this model. However the model provides a useful measure for comparing the different institutional arrangements that water districts use in California.

In the efficient cooperative model, we assume that an "omniscient central planner" allocates all resources to produce the highest level of total district net wealth. Of course, in reality these functions are institutionally segregated between an elected or appointed governing board and the individual farmers. In the latter case, the issue becomes coordinating the actions between the farmers and board members through "signaling" such as pricing and voting. This is confounded by the effects on these signals of distribution of that wealth among district members—the "political economy" of the district.

2.2.3.1 The "Transparent" Efficient Cooperative Water District Model

In the "efficiently"-run cooperative, the objective for farmers and board members is to choose the total yield that maximizes net revenues after accounting for costs.[7] This a fully vertically-integrated system. Farmers see the direct or "transparent" cost of providing

[7]This is a static model representing one-year's decision rather than as a dynamic problem. We believe that we do not lose the important initial insights by assuming that the dynamic programming problem would not look substantially different from the static problem presented here.

water supplies, as represented by the investment in capacity, $K(S)$,[8] and the variable cost of supply, c. Because the cooperative reflects the singular preferences of the farmers/members to maximized total district wealth, the farmers also choose the level of supply capacity and delivery "quality"(i.e., timing, flexibility and conveyance losses), S, given the capital investment costs, K. In addition, the cooperative may buy or sell a portion of its supply in the water "market" at the going price, m. This can be thought of as the outside contract rate for project water acquired during the short "windows" that opened in the California water market (Bain, Caves, and Margolis 1966). These costs include the opportunity or "rental" cost, ry of land, L, for applied water, a, irrigation investment, $I(h,L)$ and pressurization costs associated with more efficient or alternative water irrigation systems, $v(h)$, and other input (e.g., labor, fertilizer, equipment) costs, b. The choice variables can be separated into two categories:

- those that affect district-wide capacity and operations and must be decided collectively—supply capacity, service and delivery quality, S, and
- those that affect the operations of individual farms and do not have direct impacts on other farmers in the district—acreage to be irrigated, L_i, applied water, a_i, and use of other inputs, x_{ij}, such as labor, fertilizer, and equipment.

The district's objective function becomes:

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[8]In addition, the cooperative may be supplying a joint product from hydropower generation, and it may be covering some of the system capacity costs through these revenues. However, the number of districts with this option are relatively small and we ignore them for this discussion.

$$\max_{L_i, a_i, x_i, S_i} \Pi_{coop} = \sum_{i=1}^{N} \left[p \cdot q(h_i \cdot a_i, x_i) \cdot L_i - I(h_i, L_i) - (v(h_i) \cdot a_i + bx_i + ry_i) \cdot L_i \right] \tag{2}$$
$$- \left[K(\sum_{i=1}^{N} S_i \cdot L_i) + \sum_{i=1}^{N} ca_i \cdot L_i \right] + \sum_{i=1}^{N} m \cdot (\bar{s}_i - a_i)$$

and the variables are defined as:

$L_i =$ acreage owned or rented by a farmer or business or resident within the district, enrolled in a district's assessments, but not necessarily irrigated.

$L_i =$ acreage irrigated by farmer I in acres

$S_i =$ water delivery capacity per acre from district supplies, and district's delivery service quality to farm *I* measured by (1) relative miles of unlined/lined canals and pipelines, and (2) delivery conditions, requirements and lead time.

$s_d =$ the minimum water delivery service and capacity which exists without district investment. For example, the minimum water delivery under drought conditions without storage facilities.

$\bar{s}_i =$ average water supplied to farmer during the year per acre.

$K =$ annual cost recovery for capital investment as a function of water supply capacity $(\sum S_i \cdot L_i)$.

$q =$ yield from an acre of crops on farm *I* as a function of effective water, land and other inputs.

$p =$ price per unit of output of crops, exogenously set in the agricultural marketplace.

$h_i =$ technical irrigation efficiency of applied to effective water

$a_i =$ delivered and applied water in acre-feet per acre

$e_i =$ "effective" water actually used by the crop or lost through evapotranspiration. Effective water is the product of applied water times the irrigation efficiency rate, $e_i = h_i \cdot a_i$

$m =$ "market" price for water supply either acquired from sources such as water projects (e.g., the State Water Project or the Central Valley Project) or sold outside of the district

$I =$ investment cost per acre of irrigation technology used by farmer as a function of land and efficiency.

$c =$ district-average variable or "volumetric" delivery costs per acre-foot per acre delivered to the main canal.

$v =$ On-farm groundwater and surface pumping and irrigation pressurization costs per acre-foot per acre as a function of use-efficiency as a function of efficiency.

$\rho =$ risk premium applied to fixed investments by tenant farmers relative to owner/operators due to the potential loss of tenancy through lease cancellation or sale of land or water rights by the landlord.

$x_i =$ composite index of other farm inputs (e.g., labor, fertilizer, energy, equipment)

$b =$ composite price of other farm inputs

$r =$ land "rental" or opportunity rate per acre

$y_i =$ assessed land value for property tax and district voting purposes

First Order Conditions:

$$\frac{\partial \Pi}{\partial L_i} = \sum_{i=1}^{N} \left(p \cdot q_i - \frac{\partial I}{\partial L_i} - (v_i + c) \cdot a_i - r \cdot y_i - bx_i - S_i \cdot \frac{\partial K}{\partial L_i} + m \cdot (\bar{s}_i - a_i) \right) = 0$$

$$\frac{\partial \Pi}{\partial a_i} = \sum_{i=1}^{N} L_i \cdot \left(p \cdot h_i \cdot \frac{\partial q_i}{\partial a_i} - (v_i + c + m) \right) = 0$$

$$\frac{\partial \Pi}{\partial x_i} = \sum_{i=1}^{N} L_i \cdot (p \cdot \frac{\partial q}{\partial x_i} - b) = 0$$

$$\frac{\partial \Pi}{\partial S_i} = \sum_{i=1}^{N} L_i \cdot \left(\frac{\partial K}{\partial S_i} - m \cdot \frac{\partial \bar{s}_i}{\partial S_i} \right) = 0$$

By assumption, the relevant functions have the following properties:

$$q_\iota \geq 0 \quad q_{\iota\iota} \leq 0; \text{ for } \iota = L_i, a_i, x_{ij}$$
$$q_h a = q_a h = q_e \text{ where } e = h \cdot a$$
$$I_h \geq 0 \; I_{hh} \geq 0; \; I_L \geq 0 \; I_{LL} \leq 0$$
$$v_h > 0 \quad v_{hh} > 0; \; v_h a = v_e$$
$$K_S > 0; \; K_L > 0$$
$$0 \leq F(S) \leq 1, \; F_S > 0, \; F_{SS} < 0$$

We assume the usual concavity and differentiability properties for the farm production functions, q (Berck and Helfand 1990). We also assume the usual properties for cross partials hold between applied water and irrigation efficiency so that we can find the derivative of effective water application on yield. Irrigation technology increases in cost with increased efficiency, a phenomenon commonly seen as farmers move from flood to furrow to sprinklers to drip systems (Caswell, Lichtenberg, and Zilberman 1990). The marginal investment costs are also increasing consistent with approaching an ultimate efficiency limit of 100%. Pressurization costs also increase, also at an increasing rate consistent with physics. In the case of land, total farm irrigation investment increases with size, but at a decreasing rate consistent with economies of scale.

2.2.3.2 Water "Market" Price and the Shadow Value of Water Supply

A useful benchmark is assessing the relationship between the value for *m* and the shadow value of adding supply capacity. The variable *m* has two interpretations. The first is as the "market price" for water, whether to acquire new resources beyond existing district capacity or to sell in a water market. In this case, *m* represents what the cooperative might pay or receive for the difference between its expected supply, $\bar{s}$, and applied water, *a*. The second interpretation is as the shadow value of water in the district's allocation of resources. It reflects the value of changing either the expected average water supplies from the district's system or the changing the amount of water allocated to district farmers for cultivation. Thus, *m* can be either imposed externally through markets or derived internally from the cost of changing resource management.

(5)
$$m = \frac{\partial K/\partial S_i}{\partial \bar{s}_i/\partial S_i} = \frac{\partial K}{\partial \bar{s}_i}$$

If *m* represents an external market price, it dictates the district's supply capacity decision, *S*. If *m* is interpreted as the shadow value of adding supply capacity (or reducing water allocated to district farms), then as shown in equation (5), the shadow value of water is dependent on the cost and effectiveness of expanding supply capacity. The shadow value equals the marginal capacity cost divided by the marginal increase in expected supplies from that added capacity (or the marginal capital cost for an increase in *expected* supply).

In other words, the district will choose to invest up to the point where the marginal cost per *expected or average* acre-foot equals the perceived water market price. This price might be the contract rate from the Bureau of Reclamation or Department of Water Resources (Bain, Caves, and Margolis 1966), or what the district believes is the going price for long-term water sales.

A second interpretation of *m* can be derived from the model. The value of marginal product of effective water equals the total of the on-farm pressurization costs plus district conveyance costs plus the "market price" or shadow value of expected system supplies per acre.

$$(6) \qquad p \cdot h_i \cdot \frac{\partial q_i}{\partial a_i} = p \cdot \frac{\partial q_i}{\partial e_i} = VMP_e = m + c + v = \frac{\partial K}{\partial \bar{s}_i} + c + v$$

As the value of marginal product increases, at least one of two things would likely occur: on-farm pressurization costs would increase, implying improved irrigation efficiency (or perhaps more or deeper groundwater pumping which is only indirectly addressed here); or the district would realize a higher value for *m* and either acquire new higher-cost supplies or increase investment in supply capacity to improve expected supplies.

2.2.3.3 *Value of Marginal Product of Land*

Rearranging terms from the first-order conditions and substituting for *m* from equations (5) and (6):

$$
\text{(7)} \quad \begin{aligned} p \cdot q_i = VMP_L &= \frac{\partial I}{\partial L_i} + (v + c + m) \cdot a_i + r \cdot y_i + b \cdot x_i + S_i \cdot \frac{\partial K}{\partial L_i} - m \cdot \bar{s}_i \\ &= S_i \cdot \frac{\partial K}{\partial L_i} + \frac{\partial I}{\partial L_i} + r \cdot y_i + b \cdot x_i + \left(VMP_e \cdot (a_i - \bar{s}_i) + \bar{s}_i \cdot (c + v) \right) \end{aligned}
$$

The value of marginal product for land equals the marginal investment cost for supply capacity per added acre, plus the marginal irrigation investment cost per acre plus the rent and added input costs per acre, plus the value of marginal product of effective water times the net applied water above district supplies, plus the conveyance and pressurization costs of the expected district supply per acre. The first two terms represent the additional investment, both by the district and the farmer, necessary to put an acre into production and under irrigation. The next two terms are usual costs of production. The last two terms represent the tradeoff in using more of the district's water supply—the net value of marginal product for water accrues to the added acre, but the district and farmer incur additional conveyance and pumping costs.

2.2.3.4 Other On-farm Inputs

The classical result that the value of marginal product equals the input price holds in this case.[9]

$$b = p \cdot \frac{\partial q}{\partial x_i} = VMP_x \tag{8}$$

2.2.4 The Efficient Cooperative Water District Model with A Non-Profit Constraint

Imposing a non-profit constraint on the optimal cooperative district implies that the difference between aggregate marginal costs and average costs accrue to the cooperative members directly through rates, rather than to the district itself. The process becomes a two-stage game, where the farmers first choose their optimal-output rules, and the district then establishes the optimal level of supply and electricity generation capacity. The water and land charges, *w*, *l* and *t*, then fall out of the results.

This model is structured as a neo-classical central-planner model for both ease of exposition and to show that even in this framework, institutional characteristics can be incorporated to create political-economic effects. The model is informally akin to a Stackelberg-leader game where the district managers anticipate the actions by individual farmers in setting district policy and trying to assure the maximum probability that the managers will be re-elected.

---

[9]This result becomes more important when assessing how district managers respond to the non-farmer electorate under different governance rules however.

$$\text{(9)}\quad \max_{L_i,a_i,x_i,S_i} \Pi_{constraint} = \sum_{i=1}^{N} \pi_F$$

$$\text{subject to} \sum_{i=1}^{N} (w \cdot a_i + l + ty_i) \cdot L_i = K(\sum_{i=1}^{N} S_i \cdot L_i, E) + \sum_{i=1}^{N} ca_i \cdot L_i - \sum_{i=1}^{N} m \cdot (\bar{s}_i - a_i) \cdot L_i$$

where the owner/farmers' problem is represented as:

$$\max_{L_i,a_i,x_i} \pi_F = p \cdot q(h_i \cdot a_i, x_i) \cdot L_i - I(h_i, L_i) - ((v(h_i) + w) \cdot a_i + l + (r + t) \cdot y_i + bx_i) \cdot L_i$$

where:

$w =$ district's water charge per delivered acre-foot

$l =$ district's per acre land assessment for water delivery

$t =$ district's ad valorem property tax rate

The Lagrangian problem becomes:

$$\text{(10)}\quad = \sum_{i=1}^{N} \pi_F - \lambda \cdot \left[\sum_{i=1}^{N} (w \cdot a_i + l + ty_i) \cdot L_i - \left(K(\sum_{i=1}^{N} S_i \cdot L_i, E) + \sum_{i=1}^{N} ca_i \cdot L_i \right) + kE + \sum_{i=1}^{N} m \cdot (\bar{s}_i - a_i) \cdot \right.$$

First Order Conditions:

$$\sum_{i=1}^{N}\left(p\cdot q_i - \frac{\partial I}{\partial L_i} - (v_i + w)\cdot a_i - l - (r+t)\cdot y_i - bx_i\right) - \lambda\cdot\sum_{i=1}^{N}\left[wa_i + l + ty_i - S_i\cdot\frac{\partial K}{\partial L_i} - ca_i + m\cdot(\bar{s}_i - a\right.$$

$$\sum_{i=1}^{N} L_i\cdot\left(p\cdot h_i\cdot\frac{\partial q_i}{\partial a_i} - (v_i + w)\right) - \lambda\cdot\sum_{i=1}^{N} L_i\cdot(w - c - m) = 0$$

$$\sum_{i=1}^{N} L_i\cdot(p\cdot\frac{\partial q}{\partial x_i} - b) = 0$$

$$\sum_{i=1}^{N} \lambda\cdot L_i\cdot\left(\frac{\partial K}{\partial S_i} - m\cdot\frac{\partial \bar{s}_i}{\partial S_i}\right) = 0$$

2.2.4.1 Shadow Value of Expected Water Supplies

As with the unconstrained efficient cooperative, the market price for water equates to the marginal cost of increasing the district's average water supply. The non-profit constraint does not affect this result.

(11) $$m = \frac{\partial K/\partial S_i}{\partial \bar{s}_i/\partial S_i} = \frac{\partial K}{\partial \bar{s}_i}$$

2.2.4.2 Value of Other On-Farm Inputs

As with the unconstrained efficient cooperative, the value of marginal product for other inputs equals the price of those inputs. As with the shadow value of average supply, the non-profit constraint does not influence the result.

(12) $$b = p\cdot\frac{\partial q}{\partial x_i} = VMP_{x,\Pi}$$

2.2.4.3 The Effect of the Non-Profit Constraint on Revenue Sources

The non-profit constraint is a classic regulated monopoly problem (Carlton and Perloff 1990, p. 798.). Using the Lagrangian multiplier, λ, the resulting pricing rule is:

$$\frac{1}{1-\lambda} = \epsilon \cdot \frac{Revenues - Costs}{VMP_a}$$

where ϵ is the elasticity of demand for applied water by district customers and VMP_a is the value of marginal product for applied water. For the non-profit constraint to hold, λ equals one, since revenues must equal costs at the given level of input demand. We assume that this condition holds throughout this analysis, although in reality district managers may diverge from these pricing policies. Without the constraint, λ equals zero.

From the first-order conditions, we can derive two expressions for λ:

(13)
$$\lambda = \frac{\sum_{i=1}^{N} p \cdot q_i - \partial I/\partial L_i - (v_i + w)\cdot a_i - l - r_i - ty_i - bx_i}{\sum_{i=1}^{N} (w-c-m)\cdot a_i + l + ty_i - S_i \cdot \frac{\partial K}{\partial L_i} + \bar{s}_i \cdot m} = \frac{\sum_{i=1}^{N} \partial \pi_F / \partial L_i}{\sum_{i=1}^{N} (w-c-m)\cdot a_i + l + ty_i - S_i \cdot \partial K/\partial L_i + \bar{s}_i \cdot m}$$

$$\lambda = \frac{\sum_{i=1}^{N} L_i \cdot p \cdot h_i \cdot \partial q_i / \partial a_i - (v_i + w)}{\sum_{i=1}^{N} L_i \cdot (w - c - m)}$$

(14)

$$= \frac{\sum_{i=1}^{N} L_i \cdot \partial \pi_F / \partial a_i}{\sum_{i=1}^{N} L_i \cdot (w - c - m)}$$

The Lagrangian multiplier can be interpreted as the shadow value to the district of changing a district fee or charge.[10] In equation (14), increasing the per acre charge, l, will decrease λ through both the numerator and denominator. The water-sue charge, w, and the property tax rate, t, similar effects as l.

We can use these equations to find the preferred levels for the district charges, l, t and w. Setting equations (13) and (14) equal and rearranging the terms:

$$\text{(15)} \qquad \frac{\sum_{i=1}^{N} \partial \pi_F / \partial L_i}{\sum_{i=1}^{N} \partial \pi_F / \partial a_i \cdot L_i} = \frac{\sum_{i=1}^{N} a_i}{\sum_{i=1}^{N} L_i} + \frac{\sum_{i=1}^{N} (l + ty_i - S_i \cdot \partial K / \partial L_i + \bar{s}_i \cdot m)}{(w - c - m) \cdot \sum_{i=1}^{N} L_i}$$

Equation (15) shows the ratio between the land-based charges, l and t in the numerator, and the water charge, w, in the denominator, compared to the per-acre ratios of the marginal profits for land and applied water.

[10]A mechanism-design approach to optimal district pricing with a non-profit constraint can be found in (Brill, Hochman, and Zilberman 1995).

Proposition 1: *In the optimal cooperative with a non-profit constraint, the optimal per-acre charge* ($T^* + t^* y_i$) *equals marginal cost of storage capacity with respect to acreage times capacity per acre* ($S_i \cdot \partial K/\partial L_i$) *minus the marginal cost of storage with respect to changes in average water supply times the average water supply per acre* ($\bar{s}_i \cdot \partial K/\partial \bar{s}_i$).

At the optimal level of output for the cooperative, by using the envelope theorem, we can show that the aggregate effect from infinitesimal change in one input will equal the aggregate effect from an infinitesimal change in another input times the inverse ratio of the optimal levels of the inputs. If all of the individual farms were identical, by Chebyshev's inequality (Berck and Sydsaeter 1991), the ratio would be:

$$\frac{\partial \pi_F / \partial L_i^*}{\partial \pi_F / \partial a_i^* \cdot L_i^*} = \frac{a_i^*}{L_i^*}$$

However, the efficient cooperative is optimizing across the population of farms, and thus chooses policies across farms to derive maximum wealth without regard to distribution. The district then achieves this optimum at the ratio of the sum of applied water to the sum of irrigated land:

$$\frac{\sum_{i=1}^{N} \partial \pi_F / \partial L_i^*}{\sum_{i=1}^{N} \partial \pi_F / \partial a_i^* \cdot L_i^*} = \frac{\sum_{i=1}^{N} a_i^*}{\sum_{i=1}^{N} L_i^*} \tag{16}$$

which implies,

$$\frac{\sum_{i=1}^{N}(l+ty_i - S_i \cdot \partial K/\partial L_i + \bar{s}_i \cdot m)}{(w-c-m)\cdot \sum_{i=1}^{N} L_i} = 0$$

If we assume that each farm's acreage charge equals its net cost of providing supply per acre and substituting for *m*, then we arrive at

$$(17) \qquad \sum_{i=1}^{N} l^* + \sum_{i=1}^{N} t^* y_i = \sum_{i=1}^{N}\left(S_i \cdot \frac{\partial K}{\partial L_i} - \bar{s}_i \cdot \frac{\partial K}{\partial \bar{s}_i}\right)$$

Proposition 2: *In the constrained efficient cooperative, the per-acre-foot water charge,* w^**, equals the cost of conveying water to the district, c, plus the marginal cost of storage with respect to increased average supply,* $\partial K/\partial \bar{s}$*, times the average or expected supply per acre,* $\bar{s}$*.*

Inverting equations (13) and (14) which define λ, and equating,

$$\frac{\sum_{i=1}^{N} (w-c-m)\cdot a_i + l + ty_i - S_i\cdot \partial K/\partial L_i + \bar{s}_i\cdot m}{\sum_{i=1}^{N} \partial\pi_F/\partial L_i} = \frac{\sum_{i=1}^{N} L_i\cdot(w-c-m)}{\sum_{i=1}^{N} \partial\pi_F/\partial a_i\cdot L_i}$$

$$(w-c-m)\cdot\left[\frac{\sum_{i=1}^{N} L_i}{\sum_{i=1}^{N} \partial\pi_F/\partial a_i\cdot L_i} - \frac{\sum_{i=1}^{N} a_i}{\sum_{i=1}^{N} \partial\pi_F/\partial L_i}\right] = \frac{\sum_{i=1}^{N} l + ty_i - S_i\cdot \partial K/\partial L_i + \bar{s}_i\cdot m}{\sum_{i=1}^{N} \partial\pi_F/\partial L_i}$$

From Proposition 1, the right-hand side of this equation equals zero. Thus, after substituting for *m*,

(18) $$w^* = c + \bar{s}_i\cdot\frac{\partial K}{\partial \bar{s}_i}$$

Thus, the optimal water charge equals the conveyance cost plus the marginal investment cost per average acre-foot times the expected acre-feet of supply per acre irrigated.

These decision rules for the constrained wealth-maximizing cooperative now can be used as benchmarks for comparing other institutional district forms.

2.3 Examining Existing Institutions

The water supply and agricultural production institutions as they exist today are quite different from the efficient-cooperative model. The agencies that supply water and the farms which use the water for growing crops or raising livestock are not as fully vertically integrated as is implicitly assumed in the "wealth-maximizing" district model. No board centrally plans and allocates resource use and production levels. The institutional incentives differ from the theoretical model in two important ways:

(1) While the efficient cooperative managers are only concerned with generating the maximum net income for the district's members, the managers in existing districts are most concerned with maintaining their political power. This means that they must assemble a majority of votes through their policy choices.

(2) The efficient model assumes that land is used to the maximum benefit of the district's members regardless of ownership form and size. In fact many different forms of ownership exist, including different types of tenancy, and often non-farmers also have a stake in the electoral process. Individuals have different objective functions rather than the common one used in the theoretical model.

Fundamentally, the various district institutions are bifurcated between control of water rights and land rights. The district managers and voters control the water rights, and the farmers control the land property rights. The issue is how this bifurcation affects the efficiency of the use of these resources, and how the variations in institutional rules affect the different forms of the districts. As a cooperative, the district and the farms are partially integrated, but the exchange of information between the two levels—the district and the farmers—is externally manifested through prices and voting, and decision-making is decentralized. Farmers use water in amounts and in a manner that balance the benefits of revenues generated against the costs of this and other inputs. The district provides at least a price signal as to the "appropriate" use of the water. The district also responds to the wishes of the farmers through the electoral process. The responses to signals from both sides will be imperfect for a number of reasons, including transactions costs, the structure of the tariffs, externally-imposed legal requirements, and the voting rules for the cooperative. In addition, Arrow's "Impossibility Theorem" implies that any number of outcomes might occur, including non-transitive social preferences, or control of the decision process by a single key individual. For this reason, the procedural details of the decision making process can greatly influence the outcome (Ordeshook 1986,, p. 54).

2.3.1 Choices by District Board and Managers in Existing District Structures

District board members (by implication, the line managers) try to stay in office by pleasing a sufficient number of constituents through their policy choices. They attempt to win a majority of votes by addressing the issues that most affect district members. This is the basis of the median-voter model (Peltzman 1971). This idea can be extended to incorporate the "interest group" concept by assessing how voters grouped by key characteristics might respond to different policy choices, and determining whether board members can assemble a majority vote by appealing to these various groups (Olson 1965). The existence of different voting rules in California's agricultural water districts allows us to test this hypothesis.

Several different methods are specified in state law to identify qualified electors and how to weigh votes for electing governing boards. The two dominant methods are the property-qualification, assessed value-weighted method and the universal-franchise, popular vote method (California Department of Water Resources 1994).[11] The former allows only those who own property to vote, and each owner is given a vote in proportion to the assessed value of their land. This method might be interpreted as allocating votes in proportion to the value of net output from an agricultural district. The latter method enfranchises any registered voter and simply tallies one-person/one-vote. This is also the most common method for electing officials in other governmental jurisdictions.

While a board cannot guarantee that a particular voter will vote for them, they can affect the likelihood that they will receive a positive vote. The board has five variables to consider: who the eligible voters are in the district, the well-being of the district's individual voters, the cost of the district's water supply, the variability and reliability of the district's supply, and the mode of collecting the district's required revenues. We focus on the district board's objective function which is to maximize the number of voters subject to meeting a non-profit budget constraint.

The function γ specifies the relationship of individual net benefits for district voters and the likelihood of those voters voting for the incumbent board. γ can be interpreted as a single utility function in which the output is a "yea" or "nay" vote on the current district management. For purposes here, we need not specify the exact function, but only note that γ increases as net benefits increase for members within each interest group.

[11]In addition, property-qualification, popular vote, appointed boards and acreage-based voting systems are used but not nearly as common. These are not included in the further analysis for ease of exposition. The two dominant electoral methods discussed here largely represent the polar cases anyway.

In water districts, managers choose the levels of investment in water-supply infrastructure and face per-unit costs for transporting that water to members in the district. To meet these expenditures managers may choose from various instruments, including volumetric and per-acre water charges, property taxes, other enterprise activity sales (particularly electric power sales), or sales of water to other entities. These districts also face a non-profit constraint that revenues and expenditures must balance. Board members choose the level of supply capacity and the "quality" of delivery service, S, property tax, t, and water charges on volume ,w, and acreage, l, and the property tax rate, t.

2.3.2 Farmers' Choices under Existing District Institutions

Under the existing institutional structures farmers do not see the true marginal cost of their water supply captured in a single price or linked capacity/use tariff as derived in the "wealth-maximizing" cooperative model. The non-profit constraint and the ability to levy taxes unrelated to use leads a multi-part pricing system. To pay for water supplies from the district, a farmer may pay a volumetric charge, w, a per-acre charge, l, or ad valorem or benefit assessments, t. These district charges and policies are taken as given initially, but can be modified to attract votes for the district managers. The objective for farmers within a district is to choose the total yield that maximizes net revenues after accounting for costs. These costs include the opportunity cost, ry, of irrigated land, L, the cost of applied water, a, the investment, I, and pressurization, v, costs associated with more efficient or alternative water irrigation systems, h, and other input (e.g., labor, fertilizer, equipment), x, costs, b.

The objective function for a tenant farmer differs from an owner/operator in two ways from that of an owner. First, tenant farmers are more likely to incorporate a risk premium, ρ, on fixed irrigation technology investment due to the nature of tenancy versus ownership (Feder and Feeney 1993; Hartman and Doane 1986). Tenants risk not being able to fully recover investment costs since they do not control land use and cannot regain fixed investment in the land value. In other words, their risk of sunk costs in investment stand to be substantially higher. This effectively increases the apparent cost of upgrading irrigation efficiency if we assume improvements require higher fixed investment (Pindyck 1991). Second, a property tax has only a secondary effect through the rent on land costs to tenants. A portion of the property tax incidence is on landlords. Thus tenants do not fully realize the brunt or benefit from changes in this type of tax.

Models for two different types of water districts are evaluated in the next two sections. Each model is constructed in parallel to the constrained efficient cooperative to allow direct comparison. The first district model addresses the property-enfranchised, assessed-value governance rules that guide most "California water districts." Board members in these districts respond to political influence based on the assessed-value held by an elector in the district. The second model uses the universal-franchise, popular-vote governance rules that generally direct "irrigation districts." Board members receive direct political signals of equal weight from each farmer regardless of farm size or tenancy, plus each non-farmers has an equal vote. These differences governance rules lead to predictions about how district resources are managed.

2.3.3 Assessed-Value Weighted-Voting Water Districts

In California, a prevalent form of water-district organization is the "California water district" (Davis 1993). At the center of its governance rules is that only landowners are enfranchised and that one vote equals one dollar of assessed value (California Department of Water Resources 1994). By state law, this type of district is restricted to retail service for predominantly agricultural users; once districts reach a certain threshold of residential and commercial service, the district must modify it voting procedures to use a popular-vote system (Marchini et al. 1996). Given the linkage between agricultural land values, productivity and the value of marginal productivity from applied water within a specific region, we might expect that this voting structure most closely mirrors that of an efficient cooperative.

The objective function for managers in a district with landowner-enfranchised, assessed-value weighted voting, and a non-profit revenue constraint is:

(20)
$$\max_{L_i, a_i, x_i, S_i} \Gamma_{weighted} = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \gamma(\pi_F)$$

$$subject\ to\ \sum_{i=1}^{N} (w \cdot a_i + l + ty_i) \cdot L_i = K(\sum_{i=1}^{N} S_i \cdot L_i) + \sum_{i=1}^{N} ca_i \cdot L_i - \sum_{i=1}^{N} m \cdot (\bar{s}_i - a_i) \cdot L_i$$

$$\pi_F = (p \cdot q(h_i \cdot a_i, x_i) \cdot L_i - I(h_i, L_i) - ((v(h_i) + w) \cdot a_i + l + (r+t) \cdot y_i + bx_i) \cdot L_i)$$

where the enfranchised owner/farmer is represented as:

γ = a probability density function expressing the probability of voting for the current district board members based on economic benefits from district operations, and $0 \leq \gamma \leq 1$.

Γ = votes, if the district's voting rules are based on property value and ownership

The Lagrangian problem is represented as:

$$(21)\quad = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \gamma(\pi_F) \ - \lambda \cdot \left[\sum_{i=1}^{N} (w \cdot a_i + l + ty_i) \cdot L_i - \left(K(\sum_{i=1}^{N} S_i \cdot L_i) + \sum_{i=1}^{N} ca_i \cdot L_i \right) + \sum_{i=1}^{N} m \cdot (\bar{s}_i - a_i) \cdot \right.$$

First Order Conditions:

$$\frac{\partial \Gamma}{\partial L_i} = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot \left(p \cdot q_i - \frac{\partial I}{\partial L_i} - (v_i + w) \cdot a_i - l - (r+t) \cdot y_i - bx_i \right)$$

$$- \lambda \cdot \sum_{i=1}^{N} \left[wa_i + l + ty_i - S_i \cdot \frac{\partial K}{\partial L_i} - ca_i + m \cdot (\bar{s}_i - a_i) \right] = 0$$

$$\frac{\partial \Gamma}{\partial a_i} = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot L_i \cdot \left(p \cdot h_i \cdot \frac{\partial q_i}{\partial a_i} - (v_i + w) \right) - \lambda \cdot \sum_{i=1}^{N} L_i \cdot (w - c - m) = 0$$

$$\frac{\partial \Gamma}{\partial x_i} = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot L_i \cdot (p \cdot \frac{\partial q}{\partial x_i} - b) = 0$$

$$\frac{\partial \Gamma}{\partial S_i} = \sum_{i=1}^{N} \lambda \cdot L_i \cdot \left(\frac{\partial K}{\partial S_i} - m \cdot \frac{\partial \bar{s}_i}{\partial S_i} \right) = 0$$

2.3.3.1 Value of Other On-Farm Inputs

As with the unconstrained efficient cooperative, the value of marginal product for other inputs equals the price of those inputs. As with the shadow value of average supply, the non-profit constraint does not influence the result.

$$(22)\qquad b = p \cdot \frac{\partial q}{\partial x_i} = VMP_{x,\Gamma}$$

2.3.3.2 *Shadow Value of Expected Water Supplies*

We can derive the shadow value of additional water supply, as represented by ***m***:

$$m = \frac{\partial K / \partial S_i}{\partial \bar{s}_i / \partial S_i} = \frac{\partial K}{\partial \bar{s}_i} \qquad (23)$$

The important point here is that the rule for the shadow value is identical between the theoretical and existing district forms. As we show in the previous section on the wealth-maximizing cooperative, the optimal choice rule for district supply capacity can be derived from this equation. This implies that the choice of supply capacity is independent of the electoral rules of a district.

2.3.3.3 *Evaluating Changes in Revenue Sources and Other Policy Instruments*

In the efficient cooperative, λ represented the proportionate price adjustment to true marginal district supply costs required to balance revenues and expenditures. We assumed that λ was chosen in an efficient manner to create the least distortionary effects (Carlton and Perloff 1990, p. 798).

District boards must balance the relative effects from relying on available revenue sources to maintain political support. The shadow values, λ, describe how such support varies with changes in these revenue sources, and it may no longer be chosen simply to minimize price distortions. These shadow values can be used to evaluate the effect of changing revenue sources compared to the benchmark measure provided by the efficient cooperative.

(24)
$$\lambda = \frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot \left(p \cdot q_i - \frac{\partial I}{\partial L_i} - (v_i + w) \cdot a_i - l - r_i - ty_i - bx_i\right)}{\sum_{i=1}^{N} \left((w - c - m) \cdot a_i + l + ty_i - S_i \cdot \frac{\partial K}{\partial L_i} + \bar{s}_i \cdot m \right)} = \frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot \frac{\partial \pi_F}{\partial L_i}}{\sum_{i=1}^{N} \left((w - c - m) \cdot a_i + l + ty_i - S_i \cdot \frac{\partial K}{\partial L_i} + \bar{s}_i \cdot m \right)}$$

(25)
$$\lambda = \frac{\sum_{i=1}^{N} L_i \cdot \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot \left(p \cdot h_i \cdot \frac{\partial q_i}{\partial a_i} - (v_i + w)\right)}{\sum_{i=1}^{N} L_i \cdot (w - c - m)} = \frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_F} \cdot \frac{\partial \pi_F}{\partial a_i} \cdot L_i}{\sum_{i=1}^{N} L_i \cdot (w - c - m)}$$

and similarly to the optimal cooperative district:

(26)
$$\frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \partial \gamma / \partial \pi_F \cdot \partial \pi_F / \partial L_i}{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \partial \gamma / \partial \pi_F \cdot \partial \pi_F / \partial a_i \cdot L_i} = \frac{\sum_{i=1}^{N} a_i}{\sum_{i=1}^{N} L_i} + \frac{\sum_{i=1}^{N} (l + ty_i - S_i \cdot \partial K / \partial L_i + \bar{s}_i \cdot m)}{(w - c - m) \cdot \sum_{i=1}^{N} L_i}$$

***Proposition 3:** If the enrolled acreage, L_i, and the assessed value, y_i, for each farm are identical, then the optimal acreage-based charges, l and t, and per-acre-foot water charge, w, are the same as for both the constrained optimal cooperative district and the assessed-value-weighted-voting district.*

If we equate the "value" of marginal productivity ratios for the two types of districts,

$$\text{(27)} \qquad \frac{\sum_{i=1}^{N} \partial\pi_F/\partial L_i}{\sum_{i=1}^{N} \partial\pi_F/\partial a_i \cdot L_i} = \frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \partial\gamma/\partial L_i}{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \partial\gamma/\partial a_i \cdot L_i}$$

Assuming that the relative functional relationships of L_i and a_i to γ and π_F are the same, then the ratios of the terms should be equal. Expanding (27):

$$\frac{\sum_{i=1}^{N} \partial\pi_F/\partial L_i}{\sum_{i=1}^{N} \partial\pi_F/\partial a_i \cdot L_i} = \frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \partial\gamma/\partial\pi_i \cdot \partial\pi_F/\partial L_i}{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \partial\gamma/\partial\pi_i \cdot \partial\pi_F/\partial a_i \cdot L_i}$$

The relationships in equations (16) and (27) can only be true if:

$$\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_i} \cdot \sum_{i=1}^{N} \frac{\partial\pi_F}{\partial L_i} = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_i} \cdot \frac{\partial\pi_F}{\partial L_i} \quad \text{and}$$

$$\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_i} \cdot \sum_{i=1}^{N} \frac{\partial\pi_F}{\partial a_i} \cdot L_i = \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_i} \cdot \frac{\partial\pi_F}{\partial a_i} \cdot L_i$$

$$\bar{L}_i \cdot y_i \cdot \frac{\partial \gamma}{\partial \pi_i} = \bar{L}_j \cdot y_j \cdot \frac{\partial \gamma}{\partial \pi_j}$$

which only holds for Chebychev's inequality, (Berck and Sydsaeter 1991), if

.

***Proposition 4:** In an assessed-value weighted-vote district, if the district managers set rates optimally, the preferred land-based charge ($l^\Gamma + t^\Gamma y_i$) decreases as the amount of land irrigated on a farm (L_i) increases.*

Proposition 3 states that under certain conditions[12] the district will set its land-based charges as:

$$N \cdot l^\Gamma + t^\Gamma \sum_{i=1}^{N} y_i = \sum_{i=1}^{N} S_i \cdot \frac{\partial K}{\partial L_i} - \bar{s}_i \cdot \frac{\partial K}{\partial S_i}$$

Taking the total derivative of this equation with respect to l, t, and L_i:

$$\text{(29)} \qquad \frac{N \cdot dl^\Gamma + dt^\Gamma \sum_{i=1}^{N} y_i}{\sum_{i=1}^{N} dL_i} = \sum_{i=1}^{N} S_i \left(S_i \cdot \frac{\partial^2 K}{\partial L_i^2} - \bar{s}_i \cdot \frac{\partial^2 K}{\partial S_i \partial L_i} \right)$$

Storage and conveyance costs generally show economies of scale, at least with respect to the size of service territory (Bain, Caves, and Margolis 1966). This property implies $\partial^2 K/\partial L^2 \le 0$. Convexity requires that $|\partial^2 K/\partial L^2| \ge |\partial^2 K/\partial S \partial L|$. Also, by equation (2), $\bar{s} \le S$. Thus, we find

[12]Conditions which are likely to hold if California farmers generally irrigate their land as extensively as possible, and if assessed values are largely a function of agricultural productivity values.

$$\text{(30)} \qquad \frac{N \cdot dl^{\Gamma} + dt^{\Gamma} \sum y_i}{\sum dL_i} \leq 0$$

or that the preferred acreage assessment fees and/or the ad valorem tax rate decrease as the acreage per farm increases.

2.3.4 Popular-Vote Water District

Another common form of agricultural water-district organization in California is the "irrigation district" (Davis 1993). Irrigation districts were the first governmental entity formed to serve agricultural customers, with the formation of the Modesto and Turlock Irrigation Districts in 1887 under the Wright Act. Its governance rules rely on universal suffrage and one-person/one-vote or "popular" weighting (California Department of Water Resources 1994). These voting rules are modeled after those of general government agencies, and do not necessarily reflect the goals of economic efficiency.

The objective function for managers in a district with universal franchise, popular-weighted voting, and a non-profit revenue constraint is:

$$\text{(30)} \quad \underset{l_i, x_i, S_i}{\text{ax}} \Upsilon_{popular} = \sum_{i=1}^{N-T} \gamma(\pi_F) + \sum_{i=1}^{T} \gamma(\pi_T) + \sum_{j=1}^{B} \gamma(\pi_B)$$

$$\textit{subject to} \ \sum_{i=1}^{N} (w \cdot a_i + l + ty_i) \cdot L_i + \sum_{j=1}^{B} ty_j \cdot \bar{L}_i = K(\sum_{i=1}^{N} S_i \cdot L_i) + \sum_{i=1}^{N} ca_i \cdot L_i - \sum_{i=1}^{N} m \cdot (\bar{s}_i$$

where the profit functions for the owner-farmer (π_F), tenant-farmer (π_T), and input suppliers (i.e., laborers, stores, etc.) (π_B) are

$$\pi_F = (p\cdot q(h_i \cdot a_i, x_i)\cdot L_i - I(h_i, L_i) - ((v(h_i) + w)\cdot a_i + l + (r+t)\cdot y_i + bx_i)\cdot L_i)$$
$$\pi_T = (p\cdot q(h_i \cdot a_i, x_i)\cdot L_i - \rho\cdot I(h_i, L_i) - ((v(h_i) + w)\cdot a_i + l + r(t)\cdot y_i + bx_i)\cdot L_i)$$
$$\pi_B = \sum_{i=1}^{N} (b-z)\cdot \frac{x_i \cdot L_i}{B} - (r+t)\cdot \bar{L}_j$$

and an additional variable is:

Υ = vote if the district's voting rules are based on popular "one-person, one-vote"

The Lagrangian problem can be expressed as:

(31)
$$\mathfrak{L} = \sum_{i=1}^{N-T} \gamma(\pi_F) + \sum_{i=1}^{T} \gamma(\pi_T) + \sum_{j=1}^{B} \gamma(\pi_B)$$
$$-\lambda\cdot\left[\sum_{i=1}^{N} (w\cdot a_i + l + ty_i)\cdot L_i - \left(K(\sum_{i=1}^{N} S_i \cdot L_i) + \sum_{i=1}^{N} ca_i \cdot L_i\right) + \sum_{i=1}^{N} m\cdot(\bar{s}_i - a_i) + \sum_{j=1}^{B} ty_j \cdot \bar{L}_i\right]$$

First Order Conditions:

$$\frac{\partial\Upsilon}{\partial L_i} = \sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F}\cdot\frac{\partial\pi_F}{\partial L_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T}\cdot\frac{\partial\pi_T}{\partial L_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B}\cdot\frac{\partial\pi_B}{\partial L_i}$$
$$-\lambda\cdot\sum_{i=1}^{N}\left(wa_i + l + ty_i - S_i\cdot\frac{\partial K}{\partial L_i} - ca_i + m\cdot(\bar{s}_i - a_i)\right) = 0$$
$$\frac{\partial\Upsilon}{\partial a_i} = \sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F}\cdot\frac{\partial\pi_F}{\partial a_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T}\cdot\frac{\partial\pi_T}{\partial a_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B}\cdot\frac{\partial\pi_B}{\partial a_i} - \lambda\cdot\sum_{i=1}^{N} L_i\cdot(w - c - m) = 0$$
$$\frac{\partial\Upsilon}{\partial x_i} = \sum_{i=1}^{N-T} L_i\cdot(p\cdot\frac{\partial q}{\partial x_i} - b) + \sum_{i=1}^{T} L_i\cdot(p\cdot\frac{\partial q_i}{\partial x_i} - b) + \sum_{i=1}^{B}\sum_{i=1}^{N} L_i\cdot\frac{(b-z)}{B} = 0$$
$$\frac{\partial\Upsilon}{\partial S_i} = \sum_{i=1}^{N} \lambda\cdot L_i\cdot\left(\frac{\partial K}{\partial S_i} - m\cdot\frac{\partial\bar{s}_i}{\partial S_i}\right) = 0$$

2.3.4.1 Value of Other On-Farm Inputs

In both the "efficient cooperative" and assessed-value-weighted district, the value of marginal product for other inputs equals the price of those inputs, as shown in equation (22). However, in the case of popular-vote district, the rule used by the district managers equates the value of marginal product to z, the suppliers' opportunity cost, and not the farmers', in providing the other inputs, x.

(32) $$z = p\cdot\frac{\partial q}{\partial x_i} = VMP_{x,\Upsilon}$$

***Proposition 5:** In a popular-vote district, the district manager will set rates so that the use of other inputs, x_i, will be equal to or greater than in either the assessed-valuation weighted voting or optimal cooperative districts.*

Based on equation (22), the ratio of the value of marginal product for x_i for each of the district types is

(33) $$\frac{b}{z} = \frac{\partial q_i/\partial x_{i,\Pi}}{\partial q_i/\partial x_{i,\Upsilon}} \geq 1$$

since the factors used to produce x would be used elsewhere if they could not command at least their opportunity cost, z. With a convex production set with respect to its inputs, the marginal product declines as the use of the input increases. Thus,

(34) $$\frac{\partial q_i}{\partial x_{i,\Pi}} \geq \frac{\partial q_i}{\partial x_{i,\Upsilon}} \rightarrow x_{i,\Pi} \leq x_{i,\Upsilon}$$

and other inputs will used to a greater degree than in a similarly situated "efficient cooperative" or assessed-value weighted voting district.

2.3.4.2 Shadow Value of Expected Water Supplies

We can derive the shadow value of additional water supply, as represented by m:

(35) $$m = \frac{\partial K/\partial S_i}{\partial \bar{s}_i/\partial S_i} = \frac{\partial K}{\partial \bar{s}_i}$$

The important point here however is that the rule for the shadow value is identical between the assessed-value and popular-weight vote district forms. As we show in the previous discussion about the efficient-cooperative district, the choice rule for district supply capacity can be derived from this equation. This implies that the choice of supply capacity is independent of the electoral rules of a district.

2.3.4.3 Evaluating Changes in Revenue Sources and Other Policy Instruments

Again the district boards must balance the relative effects from relying on available revenue sources to maintain political support. The shadow values, λ, describe how such support varies with changes in these revenue sources. These shadow values can be used to evaluate the effect of changing revenue sources compared to the levels chosen by an efficient cooperative or assessed-value weighted-vote district. Solving from the first-order conditions,

(36)
$$\lambda = \frac{\sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F}\cdot\frac{\partial\pi_F}{\partial L_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T}\cdot\frac{\partial\pi_T}{\partial L_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B}\cdot\frac{\partial\pi_B}{\partial L_i}}{\sum_{i=1}^{N} ((w-c-m)\cdot a_i + l + ty_i - S_i\cdot\partial K/\partial L_i + \bar{s}_i\cdot m)}$$

(37)
$$\lambda = \frac{\sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F}\cdot\frac{\partial\pi_F}{\partial a_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T}\cdot\frac{\partial\pi_T}{\partial a_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B}\cdot\frac{\partial\pi_B}{\partial a_i}}{\sum_{i=1}^{N} L_i\cdot(w-c-m)}$$

We arrive at the expression comparable to equations (15) and (26):

(38)
$$\frac{\sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F}\cdot\frac{\partial\pi_F}{\partial L_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T}\cdot\frac{\partial\pi_T}{\partial L_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B}\cdot\frac{\partial\pi_B}{\partial L_i}}{\sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F}\cdot\frac{\partial\pi_F}{\partial a_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T}\cdot\frac{\partial\pi_T}{\partial a_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B}\cdot\frac{\partial\pi_B}{\partial a_i}} = \frac{\sum_{i=1}^{N} a_i}{\sum_{i=1}^{N} L_i} + \frac{\sum_{i=1}^{N} (l + ty_i - S_i\cdot\partial K/\partial L_i + \bar{s}_i\cdot m)}{(w-c-m)\cdot\sum_{i=1}^{N} L_i}$$

***Proposition 6:** In comparison to assessed-value voting districts, district managers in popular-vote districts will tend to set land-based charges (l^T + $t^T y$) higher and water charges (w^T) lower because of the electoral influence of tenant farmers and local businesses/suppliers.*

Note that the right-hand sides of equations (15), (26) and (38) are identical, and that Propositions 1 and 2 show that these expressions can be used to derive the land-based and water-based charges. Thus by comparing the left-hand sides of equations (26) and (38), we can determine the relative magnitudes of *(l + ty)* and *w* in each case. First, we can expand the left-hand sides of equations (26) and (38):

$$
\textbf{(39)} \quad \frac{\bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_F} \cdot \frac{\partial\pi_F}{\partial L_i}}{\bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_F} \cdot \frac{\partial\pi_F}{\partial a_i}} = \frac{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_F} \cdot (pq_i - (v_i + w) \cdot a - l - bx_i) - \sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_F} \cdot (\frac{\partial l}{\partial L_i} + (r+t)}{\sum_{i=1}^{N} \bar{L}_i \cdot y_i \cdot \frac{\partial\gamma}{\partial\pi_F} \cdot (ph\frac{\partial q_i}{\partial a_i} - (v+w))}
$$

$$
\textbf{(40)} \quad \frac{\frac{\partial\gamma}{\partial\pi_F} \cdot \frac{\partial\pi_F}{\partial L_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T} \cdot \frac{\partial\pi_T}{\partial L_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B} \cdot \frac{\partial\pi_B}{\partial L_i}}{\frac{\partial\gamma}{\partial\pi_F} \cdot \frac{\partial\pi_F}{\partial a_i} + \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T} \cdot \frac{\partial\pi_T}{\partial a_i} + \sum_{i=1}^{B} \frac{\partial\gamma}{\partial\pi_B} \cdot \frac{\partial\pi_B}{\partial a_i}} \quad \frac{\sum_{i=1}^{N} \frac{\partial\gamma}{\partial\pi_i} \cdot (pq_i - (v_i + w) \cdot a - l - bx_i) - \sum_{i=1}^{N-T} \frac{\partial\gamma}{\partial\pi_F} \cdot (\frac{\partial l}{\partial L_i} + (r+t) \cdot y_i) - \sum_{i=1}^{T} \frac{\partial\gamma}{\partial\pi_T} \cdot (\rho \cdot \frac{\partial l}{\partial L_i} + r(t) \cdot y_i) + \sum_{j=1}^{B} \sum_{i=1}^{N} \frac{\partial\gamma}{\partial\pi_B} \cdot \frac{b}{}}{\sum_{i=1}^{N} \frac{\partial\gamma}{\partial\pi_i} \cdot (ph\frac{\partial q_i}{\partial a_i} - (v+w))}
$$

Note that if we assume (i) each farm is of identical size and assessed value per acre and (ii) the probability of voting function, γ, is invariate across types of farms, that the denominators on the right-hand side of both equations are equivalent, and so are the first terms in the numerators. Thus we can determine the relative relationships of the two equations by focusing on the latter portions of the numerators. We first assume that the property tax incidence on rent, $r(t)$, must be one or less, i.e., that less than the whole amount of the property tax can be passed on to tenants. This implies $(r + t)y_i \geq r(t)y_i$. We also assume that tenants place a risk premium, ρ, on a fixed investment such as irrigation technology. This implies that $\partial I/\partial L \leq \rho\, \partial I/\partial L$. Using these parameters, we can relate the portions of the numerator attributable to farmers' objective functions:

(41)
$$\sum_{i=1}^{N} \frac{\partial I}{\partial L_i} + (r+t)\cdot y_i \gtrless \sum_{i=1}^{N-T}\left(\frac{\partial I}{\partial L_i} + (r+t)\cdot y_i\right) + \sum_{i=1}^{T}\left(\rho\cdot\frac{\partial I}{\partial L_i} + r(t)\cdot y_i\right)$$
$$\text{as } \sum_{i=1}^{N-T} \frac{\partial I}{\partial L_i} + \sum_{i=1}^{T} \rho\cdot\frac{\partial I}{\partial L_i} \lessgtr \sum_{i=1}^{N-T} (r+t)\cdot y_i + \sum_{i=1}^{T} r(t)\cdot y_i$$

However, this relationship is basically indeterminate because we can not adequately define this relationship between the magnitude of the risk premium and the property tax incidence. Each of these probably varies significantly and is empirically difficult to measure.

Turning to the businesses and suppliers portion of the numerator, this adds a strictly positive factor to the popular-vote district's numerator. Assuming that this factor outweighs the indeterminate relationship of the farmers' objective function in equation (30) (which is certainly true for districts with large non-farm electorates), then the numerator for the popular-vote districts is larger.

Returning to equations (26) and (38), the relative magnitudes of terms in equation (38) implies

$$(42)\quad \frac{a_i}{L_i} + \frac{\sum_{i=1}^{N}(l^{\Pi}+t^{\Pi}\cdot y_i - S_i\cdot\partial K^{\Pi}/\partial L_i + \bar{s}_i\cdot m^{\Pi})}{(w^{\Pi}-c^{\Pi}-m^{\Pi})\cdot\sum_{i=1}^{N}L_i} < \frac{\sum_{i=1}^{N}a_i}{\sum_{i=1}^{N}L_i} + \frac{\sum_{i=1}^{N}(l^{\Upsilon}+t^{\Upsilon}\cdot y_i - S_i\cdot\partial K^{\Upsilon}/\partial L_i + \bar{s}_i\cdot}{(w^{\Upsilon}-c^{\Upsilon}-m^{\Upsilon})\cdot\sum_{i=1}^{N}L_i}$$

which in turn leads to the conclusion that,

$$(43)\qquad (l^{\Pi}+t^{\Pi}\cdot y_i) < (l^{\Upsilon}+t^{\Upsilon}\cdot y_i)\ and\ w^{\Pi} > w^{\Upsilon}$$

The land-based charges, l and t, are higher and the water-use charge lower for the popular-vote districts than for the alternative district forms.

***Proposition 7:** As the per farm efficiency of irrigation technology increases in a popular-vote district and if the property-tax incidence in rents remains constant, then the tendency of district managers to rely on land-based charges increases.*

Taking the derivative of equation (41) with respect to irrigation efficiency, *h*,

$$\sum_{i=1}^{N}\frac{\partial^2 I}{\partial L_i\partial h_i} \le \sum_{i=1}^{N-T}\frac{\partial^2 I}{\partial L_i\partial h_i} + \sum_{i=1}^{T}\rho\cdot\frac{\partial^2 I}{\partial L_i\partial h_i}$$

with $\partial^2 I/\partial L\partial h > 0$, implies $\rho\,\partial^2 I/\partial L\partial h \ge \partial^2 I/\partial L\partial h$. This occurs because tenant farmers are more sensitive to the risk exposure of higher levels of irrigation investment than owner/operators. From equation (41), this implies that as the irrigation investment in a popular-vote district increases and if the property-tax incidence in rents remains constant, then the numerator on the right-hand side of equation (42), representing the popular-vote district, increases. This in turn implies that the tendency of popular-vote district managers to rely on land-based charges increases.

Proposition 8: (1) If the construction costs of storage and conveyance facilities exhibit "strong" intensive economies of scale (i.e., with increasing facilities per acre), a popular-vote district will construct smaller storage and conveyance facilities than an assessed -value-weighted voting district. (2) If storage and conveyance facilities do not exhibit strong economies of scale, then an assessed-value-weighted-voting district will construct smaller storage and conveyance facilities than a popular-vote district.

Economies of scale in developing and operating water supply storage and conveyance facilities is often cited as a primary reason for the creation of agricultural water-supply cooperatives, many of which evolved into or were created as governmental entities (Bain, Caves, and Margolis 1966). In the case of water districts, these economies of scale can be broken into two dimensions: "intensive" and "extensive." Intensive economy of scale relates to increased water usage relative to other inputs. This requires more storage and conveyance spread over the same land area, and the increased need for storage does not come with the acquisition new water sources. Extensive economy of scale occurs as water use increases in tandem with another input, e.g. land. As more land is irrigated, the need for more storage and conveyance facilities increases, but the costs and use are also spread over more acreage. Often new storage facilities and water sources become available with the added land as well. Because water use per acre is constant under extensive increases, and new water sources generally become available as land is annexed to a district, the extensive economy of scale for storage is more likely than intensive economy of scale. On the other hand, the cost of expanding a conveyance system over more acreage is likely to be more costly than increasing the volumetric capacity of the system without adding new acreage. Thus, the intensive economy of scale for conveyance is more likely than extensive economy of scale.

These economies of scale are affected by the changing probability of full water supply as reflected in the function $\bar{s}$. While the cost per added acre-foot of storage may fall as a reservoir increases in size, the marginal improvement in *expected* supply will eventually diminish as the reservoir approaches the expected runoff of the watershed.

One important note: Long-term economies of scale should not be confused with "lumpiness" of investment. Lumpiness reflects intensive economies of scale within a range of selected investment level due to high short-term fixed costs. This one-time economy of scale effect disappears when the district goes back to add additional storage or conveyance facilities, and the incremental costs are higher than the original investment per unit of water.

From equation (16), and substituting for $\bar{s}_i$,

$$(44) \qquad (w^* - c) = \bar{s}_i \cdot \frac{\partial K / \partial S_i}{\partial \bar{s}_i / \partial S_i} = \frac{\partial K}{\partial S_i} \cdot \frac{s_d + (S_i - s_d) \cdot F(S_i)}{F(S) + (S_i - s_d) \cdot f(S_i)}$$

Totally differentiating with respect to w and S and inverting,

(45)
$$\frac{dS_i}{dw^*} = \frac{-\left(2\cdot f(S_i) + (S_i - s_d)\cdot\frac{\partial^2 f(S_i)}{\partial S_i^2}\right)^2}{\frac{\partial^2 K}{\partial S_i^2}\cdot F(S) + (S_i - s_d)\cdot f(S_i)}$$

The terms $F(S_i)$, $f(S_i)$ and $(S_i - s_d)$ are positive, and the numerator is negative. To sign *dS/dw*, we must evaluate the conditions under which the denominator might be negative or positive, which depend solely on $\partial^2K/\partial S^2$, the rate of change in marginal capacity cost:

(46)
$$\textit{Condition 1: If } \frac{\partial^2 K}{\partial S_i^2} < 0 \textit{ and } \left|\frac{\partial^2 K}{\partial S_i^2}\right| > (S_i - s_d)\cdot\frac{f(S_i)}{F(S_i)} \textit{ then } \frac{dS_i}{dw^*} > 0$$
$$\textit{Condition 2: If } \frac{\partial^2 K}{\partial S_i^2} > 0 \textit{ and/or } \left|\frac{\partial^2 K}{\partial S_i^2}\right| < (S_i - s_d)\cdot\frac{f(S_i)}{F(S_i)} \textit{ then } \frac{dS_i}{dw^*} < 0$$

Condition 1 is the mathematical representation of "strong" intensive economies of scale. The marginal costs of adding storage and conveyance facilities are falling on a per acre basis, and the absolute value of the changes in marginal cost are greater than change in added expected water supply from the increase in capacity. Using equation (48), we can compare how popular-vote districts will invest in storage and conveyance facilities versus the assessed-value-weighted-voting districts. Since $w^T < w^{\Pi}$, then $S^T_i < S^{\Pi}_i$ if Condition 1 holds; otherwise, Condition 2 holds and $S^T_i > S^{\Pi}_r$. In other words, if the strong condition for economies of scale holds, then the popular-vote districts will invest less in storage and conveyance facilities than the other types of districts.

2.4 Empirical Analysis of District Managers' Behavior

To test the propositions put forward in the previous section of this study, a data set of agriculturally-oriented water districts located throughout California was compiled. An initial set of 128 districts were selected from a survey conducted on responses to the recent five-year drought (Zilberman et al. 1992; Zilberman, MacDougall, and Shah 1994). These districts were matched with additional information from the Association of California Water Agencies (ACWA) and financial data from the California State Controller (Davis 1993). In addition, the legal and financial requirements for each of these districts was drawn from a summary of the California Water Code produced by the California Department of Water Resources (California Department of Water Resources 1994). These data were summarized and analyzed using standard econometric techniques. The regression analysis found that the key proposition that electoral rules have a small but significant influence on whether district managers rely more on operating or non-operating revenue sources to finance district operations and capital expenditures. This study also indicates that further analysis might be fruitful in exploring how water pricing, debt financing and other factors varies by district and over time using and expanding the current data set.

2.4.1 Description of California's Agricultural Publicly-Owned Water Utilities

California has developed a wide variety of institutions to manage and deliver water supplies to agricultural customers. Several large water storage and conveyance projects have been developed by federal, state and consortiums of local agencies. For example, the Central Valley Project was built by the U.S. Bureau of Reclamation (USBR), the State

Water Project by the California Department of Water Resources (CDWR), and the Colorado Aqueduct by the Metropolitan Water District of Southern California (MWDSC). Other large local projects have been developed as well, such as Don Pedro Reservoir operated jointly by the Modesto and Turlock Irrigation Districts. Water from these projects is often delivered to wholesale agencies, such as the Kern County Water Agency (KCWA), which in turn sells the water to retail agencies.

California calls the local agencies that provide water delivery services "special districts." Such water districts are among a host of others that provide specialized government services beyond those that might be offered by counties or cities, such as flood control, mosquito abatement and waste collection. Special districts that provide services which are charged for directly, such as water utilities or waste collection, are called "enterprise districts."

The retail agencies, which are the focus of this study, are governed by a wide variety of state laws and regulations, contained mostly in the state Water Code. Many aspects of these districts have been described in several other publications (e.g., (Bain, Caves, and Margolis 1966; Chatterjee 1994; Goodall, Sullivan, and DeYoung 1978; Rosen 1992b). Table 2-1 compares the districts captured in the survey and reviewed in this analysis and several key characteristics (California Department of Water Resources 1994). These districts have a variety of functions and rules While community services districts are numerous, they are relatively small players in the agricultural water supply industry, and often do not even provide water service. County water and California water districts are the most numerous of the specialized water utilities, and the latter are designed specifically to provide agricultural water service. Reclamation districts, the next most prevalent group; however, the agencies are more often engaged in flood control than water service based on a review of the Controller's Annual Report. Irrigation districts are the next most numerous institutional form, and the second most numerous agricultural water provider. The remaining district forms are either few in number (e.g. water storage and water conservation districts) or more often dominated by municipal users (e.g. municipal water and public utility districts).

Table 2-1
Comparison of California's Water District Acts

District Type	Code #	Statute Date	Electoral Rules *Franchise; Weight*	Governing Board *Members; Decision Rules*	Bonding Requirements *Vote Approval; Debt Limits; Other Types*	Revenue Sources	Taxation Powers *Types, Limits & vote Approval*	Outside Water Sales
Community Services District	5	1951	Reg. voter	3-5, majority vote	GO: 2/3, Rev: ½; 5yr notes+GO<20% value	Rates/standby, leases, prop sale	AdVal* (land: irr.) <1%, special tax: 2/3	No provision
Antelope V.-E. Kern Water Agency	45.3	1959	Reg. voter	7; uncontested appt. by county	GO: 2/3, rev: ½; 5yr notes<$2m/2% value	Rates/standby, prop. lease/sales	AdVal, admin<0.1%, rev. capacity fees	Surplus
Placer County Water Agency	45.12	1957	Reg. voter	5, power sale by county	GO: 2/3 zone, rev: ½	Rates/standby, prop. lease/sales, power	AdVal*<0.1%, zone<0.5%	Surplus
San Diego County Water Authority	45.19	1943	County electors	1vote/$5m value	GO: 2/3, Rev: ½; <15% value; notes<1/4% value	Rates/standby, leases, prop sale, power	AdVal <0.5% excl. bonds	Member agencies pref., surplus w/ 1yr recapture
County Water District	42	1913	Reg. voter (some owners)	5, (some specific requirements)	GO: 2/3, Rev: 2/3 or ½; neg. notes	Rates, leases, prop. sale, power, other	AdVal* (land: US debt), special tax: 2/3, <$10/ac standby	Surplus
Irrigation District	52	1887, 1897	Reg. voter (some owners)	3-5, voter / freeholder	GO/Rev: 2/3 dir /1/2 vote; <4% value; notes/warrants	Rates, leases, prop. sale, power, other	AdVal*: land, special tax: 2/3	Surplus, limits w/acquired rights
Municipal Water District (1911)	44	1911	Reg. voter; imp. dist: 1/$1 value	5, dist residents	GO: 2/3, Imp: ½ value; 5yr notes<$5m/3% value, 10yr notes<$3m/1%	Rates/standby, leases, prop sale, power	AdVal*, spec. tax: 2/3, revenue in lieu, gw charge	Surplus
Public Utility District	40	1921	Reg. voter	3-5	GO/Rev: 2/3, <20% value	Rates/standby, leases, prop sale, power	AdVal except farm prod., spec. tax: 2/3	No limitation
Reclamation District	26	1867	1 vote/$1, proxy	3-7, owners	GO/Rev: ½; warrants	Rates/standby, leases, prop sale	Benefit/other basis	Contiguous land
Water Conservation District (1927)	46.3	1927	1 vote/acre, proxy	3-7	Rev: ½	Rates, approp. permit, prop. sales	AdVal <0.25%	Distribute to dist land, but not ratably
Water Conservation District (1931)	46.4	1931	Reg. voter	3-7, by div.	GO: 2/3, Rev: ½, 5yr notes<$5M/2% value; warrants: spec. assess.	Rates, water rights, prop. sale/lease, zonal ag/gw rates, electricity	AdVal: land<0.25%, benefit assmt: 51%/60% owners, gw charges	No provision
California Water District	41	1911, 1951	1 vote/$1; Reg. voter if muni>50%	<11, owners	GO: 2/3 or no ½ protest, Rev: ½; warrants<1/4% value w/4/5 board/1/2%	Rates, sales, prop. sale/lease, power	AdVal*: land w/ standby, specific tax / acre	Apportioned by acre., surplus. No water rights sales.
Water Storage District	48	1921	1 vote/<$100 assessed; proxy	5-11, owner	GO: ½ value or 2/3 board; warrants	Rates/sales, leases, prop. sale, power	Benefit assessments; interim project < $5/acre	Water & rights not necessary to district

* - Ad valorem taxes may be used to meet all deficits in these districts; otherwise may only be used for debt and fixed obligations.

Table 2-1 lists several aspects of the political structure, governance rules and financial considerations. Listed first are the *electoral rules*. Generally these types of special districts enfranchise either registered residents or landowners. Votes may be one-person/one-vote, one per landowner, per acre owned or per dollar assessed value. Next are the *governing board* requirements including membership and decision rules. *Bonding requirements* describe the vote thresholds necessary to approve general obligation (GO) and revenue (Rev) bonds, and the limitations on indebtness, usually relative to assessed value within the district's borders. *Revenue sources* generally describe the types of revenues that a district might raise from charges, fees and tariffs. *Taxation powers* describes the limits on ad valorem and benefit-assessment property taxes, and the voting requirements for imposing these types of taxes. Limitations on standby charges also are listed. Finally, availability and restrictions on *outside water sales* are shown. In most cases, only sales of water "surplus" to district customers' needs are allowed.

2.4.1.1 Electoral Rules

As with most general and special district governments in California, water districts generally rely on a universal-franchise, one-person/one-vote system or "residential voting."[13] Types of districts relying these rules (with some exceptions) include: community services, county water, irrigation, municipal water, public utility, and 1931 water

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[13]The passage of Proposition 218 in 1996 changes to voting rules on specific types of tax increases for many general and special district governments, including water and flood control districts, to account for either property ownership or expected service benefits.

conservation. In addition, specified water agencies[14], and California water districts which have a threshold where 50% of the assessable area is in non-agricultural use (California Water Code, Section 35041) also rely on this rule.[15] For some irrigation (California Water Code, Section 20527.1, *et seq*) and county water districts (California Water Code, Section 30700.5, *et seq*), the franchise may be limited to only those owning land within the district.[16] Another common method used by reclamation, water storage and agricultural-dominated California water districts enfranchises land owners, weights their votes by assessed value for the parcel (usually one vote per dollar value), and allows proxy voting in district elections. This type of voting is more reflective of that found in mutual water companies or corporations where voting rights and ownership in core assets are linked.

Only the 1927 water conservation districts limit voting to land owners and weight the votes on a per-acre basis. County water authorities, which are largely wholesale agencies, have appointed board members selected by the member agencies.[17]

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[14]Antelope Valley-East Kern and Placer County Water Agencies in the survey data set.

[15]Five California water districts in the data set rely on this type of voting.

[16]No districts of this type were included in the data set, however Glenn-Colusa Irrigation District switched to this system in 1992 after the data was collected.

[17]Only the San Diego County Water Authority is included in the data set with these characteristics.

2.4.1.2 *Governing Board Members and Decision Rules*

The number of board members ranges from three to eleven. Typically membership limitations mirror those of the voting requirements. In most cases, election may be at-large or by division, although the 1931 water conservation districts are restricted to election by division. Decisions generally can be made by majority vote.

2.4.1.3 *Requirements on Bond Approval and Debt Limitations*

In general these districts may issue either general obligation (GO) or revenue bonds. The former are financed from general tax revenues without linkage to any specific activity; revenue bonds are repaid from a specific revenue source such as water-use charges or property leases. Only the 1927 water conservation districts are restricted to issuing only revenue bonds. Other types of debt-financing instruments, such as short-term notes and warrants, are also specifically authorized for many of these districts.

GO bonds generally require a two-thirds majority from voters for approval. Districts which use assessed-value weighting (i.e., reclamation, and water storage districts) require only a 50% majority of voted assessments, and California water district boards may issue GO bonds if a majority of voters do not submit written protests.

Revenue bonds generally require only a majority vote for approval. In some cases, county water districts do require a two-thirds vote. Water storage districts are not specifically authorized to issue revenue bonds, although they are allowed to issue GO bonds, which are usually considered to be of superior investment-grade, with a majority vote in line with other districts' approval of revenue bonds.

Numerous limitations are placed on the districts' abilities to encumber assessed value, usually as a percentage or dollar-amount cap on total debt attributed to a specific type of instrument. For example long-term bond limits typically range from 3% to 20% of assessed value within a district. Limits may be higher for projects financed in a specific improvement district.

2.4.1.4 Revenue Sources

These are revenues sources available to a district beyond tax revenues, such as charges, fees, tolls and sales. All districts are authorized to collect rates for water service and sales, although some districts are not authorized to charge for "standby" service (i.e., water conservation, irrigation, county water, California water and water storage districts). Several districts may also lease or sell water (e.g. irrigation and California water districts). Property sales and leases also are generally allowed. Many districts may sell wholesale electric power (i.e., water agencies and authorities, municipal water, public utility, water conservation, California water and water storage districts), but only irrigation districts may make direct retail sales.

2.4.1.5 Taxation Power and Limits

Special districts rely almost solely on different types of property taxes. Ad valorem, which are based on a percentage of assessed value, and benefit-assessment, which allocates tax burdens based on projected benefits, taxes are the two most common. Ad valorem taxes, often with assessment limits ranging from 0.25% to 1%, are available to all but the reclamation and water storage districts. These two districts must rely on benefits-assessment taxes. 1931 water conservation districts also may use benefit-assessment taxes. Many districts also may raise special assessment taxes, often with a two-thirds vote.

Assessed valuation may be limited to land only without improvements, which is often the case in agriculturally-oriented districts such as irrigation, county water, California water, water conservation districts. Public utility and community service districts treat agricultural land in this manner as well. Other districts may include various amounts of improvements as well.

2.4.1.6 Outside Water Sales

Generally sales of water outside district boundaries are limited to "surplus" water. However, at least four types of districts may make outside sales. Public utility districts apparently have no limitations on sales and sales are specifically authorized. The 1927 water conservation districts may distribute water to the land within the district to be disposed of by the land owners. Water storage districts may sell water and rights not necessary for the uses and purposes of the district. And reclamation districts may sell to contiguous lands. On the other hand, irrigation and California water districts may only sell surplus water within the limits of acquired water rights. Community service and 1931 water conservation districts have no provisions for outside sales. The provisions for water sales appear to have little or no correlation with the district's electoral rules.

2.4.2 The District Data Set

The base data set for the empirical analysis is drawn from a survey conducted by the University of California at Berkeley, Department of Agricultural and Resources Policy and Economics. The survey covered 128 districts. The survey methodology and a partial summary of results is included in a department working paper (Zilberman et al. 1992), and an analysis of how the districts altered their behavior during the drought was later published (Zilberman, MacDougall, and Shah 1994).

The survey data set was supplemented with district-specific information from two other sources. The first was the ACWA membership list, which supplied further addresses and contacts, all activities undertaken by the districts, and information on agricultural and municipal customer usage and rates. One-hundred eight districts on the ACWA list were also included in the survey data set. The second was the State Controller data on special districts' financial transactions for the 1991-1992 fiscal year. One-hundred twenty-seven districts in the survey data set had supplied the State Controller with financial data. This source was also used to pinpoint the primary county and regional location

A third source was used to add data on electoral rules. Which voters are eligible in local elections, and how votes are weighted and counted was compiled by district type from the CDWR Bulletin 155-94 (California Department of Water Resources 1994). The data set was modified where the Water Code either had provisions specifically relating to a district or making exceptions dependent on the composition of the district (e.g., in Section 35041 for California Water Districts).

2.4.2.1 Geographical Distribution of Districts by County and Region

Table 2-2 shows how the districts in the data set are distributed among twenty-nine counties[18] and seven regions in California. The largest concentrations of districts are in San Diego (13), Tulare (12), Fresno (11) and Kern (11) counties. All other counties have six

[18]California has fifty-eight counties total.

or less. Most of the districts are located in four regions—the Sacramento and San Joaquin Valleys, the Tulare Lake Basin and Southern California, with 84% of respondents in these regions. Over 60% are located in the Central Valley. This distribution reflects the agricultural orientation of the initial survey since the majority of California's agricultural activity is located there.

Table 2-3 shows the distribution of land-owner-enfranchised districts in the data set. All but one of the forty-two districts of this type are located in the three Central Valley regions. The Sacramento Valley at the north end has almost the same number at the Tulare Lake Basin at the southern end. Kern county has the largest number, ten, which reflects the seven water storage districts located there. Tulare and Fresno county have five each. The concentration in the Central Valley of both types is apparent, along with the dominance by the region of land-owner-based electoral rules. Due to large and widespread urban activity in Southern California, land-owner-based electoral rules have difficulty surviving legal and political tests and none are shown in the data set despite the relatively high proportion of all districts located in the region.

Table 2-2
Survey Data by County

No. County	Data Set	All Districts: Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire
4 Butte	5	-	-	5	-	-	-	-
6 Colusa	4	-	-	4	-	-	-	-
7 Contra Costa	3	-	3	-	-	-	-	-
9 El Dorado	1	1	-	-	-	-	-	-
10 Fresno	11	-	-	-	11	-	-	-
11 Glenn	4	-	-	4	-	-	-	-
13 Imperial	2	-	-	-	-	-	-	2
15 Kern	12	-	-	-	-	11	1	-
16 Kings	4	-	-	-	-	4	-	-
19 Los Angeles	2	-	-	-	-	-	2	-
20 Madera	1	-	-	-	1	-	-	-
24 Merced	4	-	-	-	4	-	-	-
29 Nevada	1	1	-	-	-	-	-	-
30 Orange	5	-	-	1	-	-	4	-
31 Placer	1	1	-	-	-	-	-	-
33 Riverside	6	-	-	-	-	-	-	6
34 Sacramento	3	1	-	2	-	-	-	-
35 San Benito	1	-	1	-	-	-	-	-
37 San Diego	13	-	-	-	-	-	13	-
39 San Joaquin	6	-	-	-	6	-	-	-
42 Santa Barbara	6	-	-	-	-	-	6	-
45 Shasta	3	3	-	-	-	-	-	-
47 Siskiyou	2	2	-	-	-	-	-	-
48 Solano	2	-	-	2	-	-	-	-
50 Stanislaus	4	-	-	-	4	-	-	-
51 Sutter	2	-	-	2	-	-	-	-
54 Tulare	12	-	-	-	-	12	-	-
56 Ventura	3	-	-	-	-	-	3	-
57 Yolo	4	-	-	4	-	-	-	-
Regional Totals	127	9	4	24	26	27	29	8
		7.0%	3.1%	18.9%	20.5%	21.3%	22.8%	6.3%

Table 2-3
Survey Data by County

No. County	Data Set	Land Owner-Enfranchised Districts: Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire
4 Butte	3	-	-	3	-	-	-	-
6 Colusa	2	-	-	2	-	-	-	-
7 Contra Costa	-	-	-	-	-	-	-	-
9 El Dorado	-	-	-	-	-	-	-	-
10 Fresno	5	-	-	-	5	-	-	-
11 Glenn	3	-	-	3	-	-	-	-
13 Imperial	1	-	-	-	-	-	-	1
15 Kern	10	-	-	-	-	10	-	-
16 Kings	2	-	-	-	-	2	-	-
19 Los Angeles	-	-	-	-	-	-	-	-
20 Madera	-	-	-	-	-	-	-	-
24 Merced	2	-	-	-	2	-	-	-
29 Nevada	-	-	-	-	-	-	-	-
30 Orange	-	-	-	-	-	-	-	-
31 Placer	-	-	-	-	-	-	-	-
33 Riverside	-	-	-	-	-	-	-	-
34 Sacramento	1	-	-	1	-	-	-	-
35 San Benito	-	-	-	-	-	-	-	-
37 San Diego	-	-	-	-	-	-	-	-
39 San Joaquin	1	-	-	-	1	-	-	-
42 Santa Barbara	-	-	-	-	-	-	-	-
45 Shasta	-	-	-	-	-	-	-	-
47 Siskiyou	-	-	-	-	-	-	-	-
48 Solano	1	-	-	1	-	-	-	-
50 Stanislaus	-	-	-	-	-	-	-	-
51 Sutter	2	-	-	2	-	-	-	-
54 Tulare	5	-	-	-	-	5	-	-
56 Ventura	-	-	-	-	-	-	-	-
57 Yolo	4	-	-	4	-	-	-	-
Regional Totals	42	0	0	16	8	17	0	1
		0%	0%	38.1%	19.0%	40.5%	0%	2.4%

Table 2-4 shows the distribution by district type across the regions. The total population of districts, as of the 1991-1992 fiscal year, is shown next to the number in the sample data set. A high proportion of a district-type's population was captured in the case of the California water (21%) and irrigation (46%) districts.[19] The community services districts are all in the Mountain region of northern California, reclamation districts are all in the Sacramento Valley, and water storage districts are all in the Tulare Lake Basin. Municipal water districts are concentrated in the two most southern regions, reflecting a preponderance in San Diego county. 1931 water conservation districts are mostly in Southern California, as are the county water agencies. The three dominant types in the data set—California water, county water and irrigation districts—appear to be well distributed across the state. However, note that all but one of the California water districts located outside of the Central Valley rely on universal franchise or "residential voting" because the district's assessed area is more than 50% dedicated to non-agricultural uses.

[19]This high sample proportion leads to an adjustment in the sample variance for small populations.

Table 2-4
Survey Data by District

SC No.	District Type	Pop.	Smpl	All Districts: Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire
5	Community Services	305	2	2	-	-	-	-	-	-
26	Reclamation	156	6	-	-	6	-	-	-	-
40	Public Utility	54	1	-	-	-	-	-	1	-
41	California Water	157	33	1	-	10	8	9	3	2
42	County Water	189	14	-	2	2	1	1	7	1
44	Municipal Water (1911)	41	11	-	-	-	-	-	8	3
45	Water Agency	33	3	1	-	-	-	-	2	-
46.3	Water Conservation (1927)	14	1	-	-	-	-	1	-	-
46.4	Water Conservation (1931)	14	4	-	-	-	1	-	3	-
48	Water Storage	8	7	-	-	-	-	7	-	-
52	Irrigation	98	45	5	2	6	16	9	5	2

2.4.2.2 *State Controllers' Financial Transaction Data*

The basis of the subsequent analysis is financial data provided from the State Controller (Davis 1993). Most of the data on individual districts was drawn from Table 23 in the State Controllers' Report, "Water - Operating Statement and Changes in Fixed Assets." For districts which also act as electric utilities, data were taken from Table 19, "Electric - Operating Statement and Changes in Fixed Assets." Additional information on the number of districts, relevant statutory authorization, and primary county location was also used.

Table 23 in the Report separates revenues and expenditures into six general categories: (1) operating revenues; (2) operating expenses; (3) non-operating revenues; (4)

non-operating expenses; (5) fixed assets; and (6) accumulated depreciation. The first four categories were used in this analysis.

Operating revenues include water sales, categorized by end-user including "irrigation" and water services including fire prevention and groundwater replenishment. The "other" category often is the largest revenue source, however, rendering these revenue breakdowns imprecise.

Operating expenses include water supply purchases and pumping, treatment, distribution, and general expenses for customers and management. Districts appear not to follow a standard practice in assigning these costs to various categories, particularly between customer service and administrative.

The Controllers' Report also includes depreciation under this category. Because depreciation of a fixed-capital expenditure is an accounting convention which does not vary with operations, and since depreciation is representative of the principal included along with interest in debt repayment, this expense category was moved to non-operating expenses in later calculations.

Non-operating revenue includes outside income such as investment interest and leases as well as various tax revenue sources such as ad valorem and benefit assessment taxes, and specific debt repayment taxes.

One ambiguous category which is actually signficant is "other non-operating revenues." This source can be substantial: for example, Imperial Irrigation District received 58% of its total revenues in this category—$50 million out of $86.5 million.

Unfortunately, no notes are included on possible sources of these apparent windfalls. These revenues were excluded in the final calculation of total revenues.

Non-operating expenses include interest on short and long-term debt, judgements, and various taxes. The depreciation expenses were moved to this category for this study, as discussed above.

Net income equals total revenues might total expenses. In calculating total revenues in the analysis, net income was treated as a non-operating revenue source if net income was less than zero. This treatment reflects the fact that the district would have to draw from its financial assets to cover expenses in this situation. In the case where net income was positive, revenues were not adjusted.

2.4.2.3 Data Set Statistics

Table 2-5 summarizes several key statistics by district type from the Controller's Report. It also summarizes by electoral rules. The averages and standard deviations for the sample population is shown. After the type, code number and sample size, the ratios of operating revenues and expenditures to total expenditures, the amount of operating revenues recovered from irrigation, and the net income ratios are shown. Appendix A includes the data set sued in the empirical analysis presented here.

Table 2-5
Water District Survey Summary - Controllers' FY 1991-92 Financial Data

(1) By District Type	(2) Controller Dist Type	(3) Sample	(4) Oper. Rev / Expend.	(5) % Oper. Expend. / Total Exp	(6) %Ag. Rev / Oper Rev	(7) %Net Inc / Exp.	(8) % Adj Net Inc / Exp
			Averages				
Community Services	5.1	2	98.9%	76.0%	21.5%	11.2%	10.5%
Public Utility	40.1	1	105.1%	82.2%	42.3%	7.5%	-0.4%
California Water	41	33	110.0%	74.7%	69.1%	16.3%	8.6%
County Water	42	13	122.7%	77.8%	31.8%	34.3%	21.6%
Municipal Water	44	11	104.8%	80.6%	40.7%	46.9%	14.9%
Water Storage	48	7	90.0%	89.1%	71.1%	2.7%	0.5%
Irrigation	52	45	84.2%	82.2%	71.9%	6.5%	-3.1%
		Pop.	*Standard Deviation*				
Community Services	5.1	305	17.0%	0.2%	0.2%	18.8%	19.8%
Public Utility	40.1	54	0.0%	0.0%	0.0%	0.0%	0.0%
California Water	41	157	92.3%	5.2%	13.5%	74.5%	74.4%
County Water	42	189	14.3%	1.6%	16.0%	10.8%	6.0%
Municipal Water	44	41	2.8%	0.5%	5.8%	26.8%	3.2%
Water Storage	48	8	6.0%	0.1%	8.2%	2.4%	2.8%
Irrigation	52	98	10.3%	2.3%	10.4%	11.4%	7.9%
By Voting Franchise / Weight	**Franchise**	**Sample**	*Average*				
Land Ownership/Assessed Value	Land	39	101.3%	77.7%	76.6%	10.9%	2.8%
Registered / Popular	Reg.	84	94.9%	79.2%	52.4%	21.0%	6.9%
		Total	*Standard Deviation*				
Land Ownership/Assessed Value	Land	313	85.3%	5.2%	13.0%	68.7%	69.0%
Registered / Popular	Reg.	382	12.6%	2.6%	14.6%	16.8%	9.5%

Column (4) shows the ratio of operating revenues to total expenditures after the adjustments described above (Op Rev / Expend). These values are the dependent variable in the subsequent analysis because it measures the amount of sales-derived revenue that a district relies on to meet its total obligations. Note that this variable is not bounded by either zero or one. A district may provide refunds to its members from other revenues, thus producing negative operating revenues.[20] And as clearly shown by the averages for some districts, operating revenues can exceed expenditures. County water districts have the highest average operating revenue ratio, followed by California water districts. Irrigation districts show the lowest average ratio. The average for districts using land-owner-enfranchised electoral rules is higher than the popular-vote districts.

Column (5) shows the percentage of total expenditures accounted for by operating expenditures (Op Exp / Exp) as redefined above. The standard deviations within district types are remarkably small indicating that the relative costs among districts do vary substantially. Even the averages among districts and between electoral rules are spread over a relatively small range.

Column (6) shows the proportion of operating revenues collected from irrigation customers (Irrig Rev / Op Rev). This category reflects at least partially the relative dominance of agriculture within a district. Irrigation, water storage and California water districts show substantially higher irrigation revenue proportions than the remainder of the data set. This is also true for the land-owner-enfranchised districts, which by California law must be agriculturally dominated. For this reason, a separate econometric analysis was conducted for irrigation and California water districts, as discussed below, to distinguish the effects of agricultural-dominance on the dependent variable.

However, this measure is probably not fully reflective of the proportion of customers for two reasons. First, not all districts properly categorize their revenues, as evidenced by the number of responses showing "other sales." We have no way of knowing

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[20]In the Controller's Report, some districts show negative revenues in some categories.

if these districts have similar or different distributions of customers. Second, districts depend differentially on operating revenues, as this discussed in this study. The proportion of agricultural customers may be correlated with the relative dependence on operating revenues. Thus, this variable is not used as an independent variable in the econometric analysis.

Columns (7) and (8) show two measures of net income. The first is the net income as reported in the Controller's Report. The second is adjusted after subtracting the "other non-operating revenue" category which is undefined and often quite large for particular districts. This adjustment shows a rather large effect for California water, irrigation, county water and municipal water districts, and reduces the standard deviation substantially in the latter two cases.

2.4.3 Statistical Relationships Among Key Variables

The data set contains a number of variables that describe a range of activities and characteristics of the districts. The 1992 district survey gathered data on farm size, water supply sources and infrastructure development, water deliveries over the 1987 to 1991 period, irrigation methods, cropping patterns over the five-year period, and water charges. These data were manipulated and combined with the financial data from the State Controller to develop the final data set for the 127 districts.

2.4.3.1 Relationships Among Financial and Institutional Characteristics and Farm Size

Table 2-6 shows the correlation between key financial and institutional characteristics of the districts in the data set and the average size of the farms within each district. The institutional characteristics include dummy variables for whether a district relies land-owner franchise and whether it sells either wholesale or retail electricity. The next three variables are the total district expenditures on water utility services as a measure of district size, the ratio of operating revenues to total expenditures, and the percentage of total expenditures attributable operations. The last two variables show the average irrigated and total acreage per farm in each district

The correlation analysis indicates that popular-vote districts are more likely to provide electric sales and to be somewhat larger than land-owner-vote districts. Also larger districts also are more likely to sell electricity, which is consistent with need for water projects to be sufficiently large to generate hydropower economically, and the need for a larger administrative staff to manage an electric utility. The next two variables measure financial performance ratios are largely uncorrelated with most other district characteristics, although the percentage operating expenditures is negatively related to district size. This is probably reflective to district scale—as infrastructure investment increases, operational costs increase at less than a proportional rate. In contrast though, operating revenues are slightly negatively correlated with operating expenses, indicating that districts do not necessarily link revenues and expenses in establishing rates and charges.

Table 2-6 Correlation Coefficients Among District Financial Measures and Average Farm Size									
Variables	*N*	*Mean*	*S.D.*	**Land-Own. Vote**	Electric Utility	Expend.	**Op Rev / Exp**	Op Exp / Exp	Irr Acres / Farm
Land-Own. Vote	105	35.2%	NA	1					
Electric Utility	105	13.3%	NA	*-.172*	1				
Expenditures	105	$0.99M	$2.34M	*-.187*	*.392*	1			
Op Rev/Exp	105	95.2%	66.4%	.056	-.091	-.013	1		
Op Exp/Exp	105	79.1%	18.4%	.015	.014	*-.204*	-.088	1	
Irr. Ac./Farm	105	539.9	1462.1	*.376*	-.103	-.004	-.076	*.189*	1
Acres/Farm	105	815.5	2101.1	*.304*	-.107	.074	-.064	.114	*.932*

Average size farm and the acreage irrigated per farm is strongly correlated. Because data on irrigated acreage is probably better than on actual farm size, the irrigated acreage is used the proxy for farm size.

Farm size tends to be large in districts with land-owner franchise. This relationship may reflect one of several possibilities. The first could be the desire of larger land owners to better influence district policies. However, the second one is that the more urbanized districts, which tend to have smaller farm operations, are required to use popular-vote electoral rules. Thus, the districts which can use land-owner enfranchisement will tend to have larger farms. Or the relationship may be simply geographical, reflecting the tendency of larger farms to be located in the Central Valley where almost all of the land-owner-enfranchised districts are located.

One way to assess the possible source of this relationship is to isolate the analysis to the most agriculturally-dominated districts, irrigation and California water districts, and those located in the three Central Valley regions and the Inland Empire (i.e., Imperial and eastern Riverside counties). Table 2-7 compares the means and correlation coefficients from all districts in the data set to those for irrigation and California water districts located in the Central Valley and Inland Empire. The results differ only slightly with the narrowing of the analysis, indicating the relationship between electoral rules and average farm size appear to be invariant with urbanization or location. This relationship appears to be most consistent with the first proposition that large land owners prefer an electoral system in which they can wield greater direct political influence.

Table 2-7
Correlation Coefficients Between Electoral Rules and Average Farm Size for All Districts vs. Central Valley and Inland Empire Irrigation and California Water Districts

Variables	*Mean*		**Land-Owner Vote**		Irrigated Acres/ Farm	
	All	*CV & IE*	*All*	*CV & IE*	*All*	*CV & IE*
N	105	58	105	58	105	58
Irrigated Acres/Farm	539.9	668.0	.376	.330	1	1
Acres/Farm	815.5	778.1	.304	.325	.932	.995

2.4.3.2 Relationship Among Institutional Characteristics and Water Supply Sources and Infrastructure

Table 2-8 shows the correlation coefficients among district characteristics such as voting rules, size and farm size, and storage and delivery infrastructure and surface water sources. Popular-vote districts tend to have a higher level of investment in storage, pipeline and lined canals. These districts also tend to rely more on appropriative rights for their water sources. Reliance on stream diversion naturally leads to the conclusion that storage facilities would be larger in these districts. However, the amount of pipeline is also strongly correlated with storage as well. On the other hand, while lined canal systems are relatively larger in popular-vote districts, the levels are uncorrelated with either of the other infrastructure measures. The tendency toward lined canals by popular-vote districts indicates that "strong" intensive economies of scale may not exist in conveyance facilities, consistent with the second condition in Proposition 8.

Table 2-8
Correlation Coefficients Among District Characteristics and Water Supply Infrastructure and Sources

Variables	*N*	*Mean*	*S.D.*	**Land-Own. Vote**	**Expend.**	**Irr. Ac. / Farm**	**Storage**	**Pipe line**	**Lined Canal**
Land-Owner Vote	69	39.1%	NA	1					
Expenditures	69	$0.862	$2.17M	-.137	1				
Irrigated Acres/Farm	69	517.9	1333.1	.339	-.077	1			
Storage AF/Acre	69	1.37	8.24	*-.115*	-.024	-.062	1		
Pipeline Mile /100 Acres	69	0.027	0.110	*-.182*	-.003	-.090	*.949*	1	
Lined Canal Mile /100 Acres	69	0.068	0.188	*-.147*	.048	.021	-.013	.093	1
CVP Class 1	69	38.1%	45.0%	.109	-.122	*-.198*	-.131	-.121	-.216
CVP Class 2	69	7.6%	21.6%	-.160	-.088	-.103	-.059	-.057	.107
CVP Exchange	69	2.8%	14.3%	-.091	-.047	-.041	-.033	-.047	-.031
SWP	69	14.5%	34.1%	.118	.068	*.570*	-.051	-.068	-.035
Appropriative Rights	69	29.3%	44.1%	*-.226*	*.172*	*-.144*	*.242*	*.261*	*.230*

The relationship of popular-vote districts and appropriative rights probably is indicative of the fact that these districts were formed before land-owner enfranchised districts since these districts would be better able to access appropriative rights. That Central Valley Project Exchange contractors, who relinquished their appropriative and pre-1914 rights to the U.S. Bureau of Reclamation in exchange for favorable water supply contracts, also slightly tend to be popular-vote districts is consistent with this observation.

Receiving water project supplies, either from the CVP or SWP is negatively correlated with infrastructure size. This might reflect the fact that much of the delivery infrastructure for these contractors is paid for through project charges rather than by direct district investment.

An interesting relationship is irrigated acreage to CVP Class 1 and SWP water deliveries. The negative relationship in the first case is consistent with CVP "hammer clause" rules requiring that farm "units" be less than 960 acres to be eligible for these contracts (Wahl 1988). This limitation does not hold for either the Exchange contracts or more expensive Class 2 deliveries. However, these districts tend slightly to use the land-owner franchise, contrary to the overall tendency of districts with larger farms to rely on this electoral rule. In contrast, districts with SWP contracts strongly tend to have larger farms. This reflects the lack of rules on individual farm operation size and eligibility in this water project. However, these districts are not any more likely to use land-owner franchise rules than the districts with CVP Class 1 deliveries.

2.4.3.3 *Relationship of Institutional Characteristics to Irrigation Efficiency and Cropping Patterns*

Table 2-9 shows the correlation coefficients among the three institutional characteristics shown in Table 2-8, irrigation efficiency, and the proportions of crops planted in each district. Efficiency is the weighted average for each of four methods—drip, sprinkler, furrow and burrow (Caswell, Lichtenberg, and Zilberman 1990). The five crop types are classified from the individual crops identified in the survey responses.

Table 2-9
Correlation Coefficients Among District Characteristics, Irrigation Efficiency and Crop Patterns

Variables	*N*	*Mean*	*S.D.*	**Land-Owner Vote**	Expend.	Irrig Acres. / Farm.	Irrig. Efficiency
Land Vote	90	34.4%	NA	1			
Expenditures	90	$1.09M	$2.51M	-.194	1		
Irrig. Acres/Farm	90	474.0	1258.2	.375	.014	1	
Irrig. Efficiency	53	69.4%	12.6%	*-.290*	.063	-.021	1
Orchards	90	45.6%	39.5%	*-.365*	.040	-.069	*.756*
Field Crops	90	28.3%	32.2%	*.505*	*-.194*	*.222*	*-.588*
Pasture	90	14.8%	20.8%	.063	*.184*	-.093	*-.647*
Produce	90	6.1%	11.8%	-.037	.120	-.082	*-.052*
Nursery	90	3.2%	11.0%	-.142	-.010	-.078	*.322*

Irrigation efficiency generally has the expected strong positive correlations with orchard and nursery crops, which have the highest product value per acre (Mitchell 1993), and negative with field and pasture crops. Produce crops, such as vegetables, berries and melons, show no relationship with irrigation efficiency, which is somewhat surprising given the relative output value per acre.

The relationship of crop patterns and irrigation efficiencies to electoral rules also is interesting. Orchard crops tend to be located in districts using popular-vote rules while field crops tend to be in land-owner enfranchised districts. In addition, larger farms tend to grow more field crops, consistent with the fundamental economics of these various crops. As a result of these two relationships, irrigation efficiency is positively correlated with popular-vote rules. At first glance, this would seem to be inconsistent with Proposition 6 which states that popular-vote districts will tend to set lower water-use charges, which in turn should encourage lower, not higher, efficiencies. However, Green, *et al* (1996), found that water pricing had a relatively small effect on irrigation choices. According to Proposition 5, if orchard farming requires the use of more local inputs such as equipment, fertilizer and labor relative to field crops, then district managers will tend to set rates which encourage this crop choice. This is consistent with past findings that orchard crops have substantially higher employment rates per acre-foot of water applied (Mitchell 1993) and a regional economic analysis of the Sacramento Valley found a higher ratio of in-region purchases for the "fruit and nuts" subsector than for "feed grains" (Moss et al. 1993, Appendix C). The improvement in irrigation efficiency would simply be a byproduct of this tendency toward local-input-intensive crops in popular-vote districts.

2.4.4 Testing A Political-Economy Model of District Management Decisions.

From analyzing the theoretical model presented above, a set of eight propositions were developed on how district managers might respond under different governance rules.

Propositions 1 and 2 define decisions rules for a theoretical constrained optimal cooperative. Proposition 3 compares the conditions under which an assessed-value-weighted voting district will arrive at the same decision rules as constrained optimal cooperative. The subsequent five propositions present hypotheses which could be tested with empirical data and analysis. However, the presently-available data is only sufficient to test Propositions 5 and 6. Some preliminary inferences can be drawn for Propositions 4 and 8, but the data is sufficiently confounding to preclude any assessment of Proposition 7.

2.4.4.1 Proposition 6: Relative Reliance on Water Sales Revenues

The first proposition to be tested is Proposition 6 as to whether universal franchise/popular-vote (PV) districts are less likely to rely on water-use charges than land-owner-franchised/assessed-value-weighted (AVV) districts. Another way to state this proposition is: PV districts meet a lower proportion of their total expenditures with operating revenues than AVV districts. This assumes a close link between the use of water charges and operating revenues, and between fixed charges and taxes and non-operating revenues. Proposition 6 presents a simple test comparing the ratio of water-use and acreage-based charges, i.e., the ratio of water-use to acreage-based revenues should be greater for AVV districts compared to PV districts. The hypothesis can be stated mathematically as:

$$H_0: \frac{w^{\Gamma}}{l^{\Gamma}+t^{\Gamma}\cdot y_i} = \frac{w^{\Upsilon}}{l^{\Upsilon}+t^{\Upsilon}\cdot y_i}$$

$$H_1: \frac{w^{\Gamma}}{l^{\Gamma}+t^{\Gamma}\cdot y_i} > \frac{w^{\Upsilon}}{l^{\Upsilon}+t^{\Upsilon}\cdot y_i}$$

We have assumed in this analysis that "water-use charges" are equivalent to "water sales" and "water service" as defined in the State Controller's Report. We can then test equivalently what proportion of total district revenues are derived from "operating revenues" as shown in the State Controllers' Report. As discussed above, we have included negative net income as a fixed revenue source equivalent to draws on "non-operating income." The resulting dependent variable is the ratio of operating revenues to total expenditures (OR_i/Exp_i).

Note that this dependent variable is independent of regional variations in water pricing. A high-cost district can have the same ratio as a low-cost district. This avoids the problem of having to trace the numerous local and institutional factors which create pricing differentials. McDowell and Ugone (1982) developed a similar model but assessed the absolute dollar spending on operating expenses, and thus had to account for regional disparities across the Southwest U.S.

Nevertheless, both economic theory and an analysis of the correlation coefficients leads to the conclusion that several other key variables may affect this ratio. The first is whether the district also delivers wholesale or retail electricity service. These districts may be able to cross subsidize between electric and water utility service (Chatterjee 1994), and these districts are likely to be larger than comparable non-electric districts. Whether a district is also an electric utility (E_i) is represented as a (0,1) intercept dummy variable and added as a slope dummy to the parameter (Judge et al. 1988, p. 429) on district size to account for economy of scope. The second factor is the economy of scale inherent in district operations (Bain, Caves, and Margolis 1966). Larger districts are likely to have a lower costs per acre-foot delivered. However, we do not expect a linear relationship due to the law of diminishing returns; rather, we expect the magnitude of the effect to diminish with increasing district size. In this case, the natural log of total expenditures (*Log(Size$_i$)*) is used to represent economy of district scale. The third is the relative size of farms in the district. Proposition 4 hypothesizes that larger farm operations will prefer a greater reliance on water-use charges. Again, we do not expect the effect to be linear, and the natural log of average irrigated acreage per farm is used (*Log(AIAF$_i$)*). Based on Proposition 4, a slope dummy is added to assess the effect of larger farm size within land-owner-franchised / assessed-value-weighted voting districts. Finally, a (0,1) dummy variable is added to distinguish districts using a land-owner-franchised / assessed-value-weighted voting scheme (AVV_i) from those using a universal-franchise / popular-vote system. The model used to test Proposition 6 is:

$$\text{(47)} \qquad \frac{OR_i}{Exp_i} = \beta_1 + \beta_2 * AVV_i + \beta_3 * Log(Size_i) + \beta_4 * (E_i * Log(Size_i)) + \beta_5 * (AVV_i * Log(AIAF_i)) + e_i$$

Table 2-10 shows the results for two models, along with the test statistic probability values.[21] The first model evaluates Proposition 6 for most districts with usable data in the sample.[22] A second model isolates the effect for two different district forms, irrigation and

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[21]The models were estimated using the SHAZAM Econometrics Computer Program, Version 7.0.

[22]Certain district types were removed from the regression model data set. Community service (two) and public utility (one) districts were removed due to the multitude of functions they

California water districts. While both types are districts are generally dominated by agricultural activities, California water districts use assessed-value voting and irrigation districts use the popular vote method.[23]

Table 2-10
Operating Revenue Ratio Models

Model	*Constant*	*AVV*	*L(Size)*	*E*L(Size)*	*AVV *L(AIAF)*	DF	R^2	F-stat.
Model (1) Parameters	*-0.080*	*1.218*	*0.072*	*-0.018*	*-0.176*	*106*	0.1029	3.04
t-stat. p-value	0.438	0.002	0.020	0.066	0.003			
F-stat. p-value		0.003	0.040	0.131	0.006			0.028
Model (2) Parameters	*-0.447*	*2.028*	*.0941*	*-0.021*	*-0.283*	*73*	0.1465	3.13
t-stat. p-value	0.265	0.001	0.030	0.081	0.003			
F-stat. p-value		0.001	0.060	0.162	0.005			0.027

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perform and their small number in the data set. Reclamation districts (six) were removed due to their apparent focus on flood control and the lack of financial data in Table 23 of the Controller's Report in many instances. Water agencies (three) were removed due to small numbers in the data set and their nature as a wholesaler overlaid on other retail districts.

[23]The second model also eliminates those California water districts now using popular-voting rules because their proportion of agricultural water service has at least fallen below the 50% threshhold.

Except for the intercept parameter, β_1, all of the model parameters exhibit relative high probabilities of being different from zero. The intercept is probably collinear with the district size because the size is relatively large and constant value relative to the other variables in the model. As a result, the t-statistic on β_3 understates the probability that this parameter differs from zero. The R^2 and F-statistics indicate that each model is statistically significant at the 5% level.

In addition, a joint null hypothesis is tested for each model that the slope parameters $\beta_4 = \beta_5 = 0$ (Judge et al. 1988, p. 434; White 1992, p. 91). For Model (1) with 5 parameters and 106 degrees of freedom, the F-statistic probability value equals 0.0097. For Model (2) with 5 parameters and 96 degrees of freedom, the F-statistic probability value equals 0.012. These probability values indicate a strong probability that both of these parameters are significantly different from zero in both models.

Both Models (1) and (2) support Proposition 6 that electoral rules do affect district decisions on how to collect revenues. The direction of β_2 is consistent with the hypothesis that land-owner-enfranchised districts will tend to rely more on water sales revenues to meet total expenditures. Model (2) indicates that the electoral effect may be stronger in agriculturally-dominated districts such as irrigation and California water districts.

In both models, larger districts tend to rely more on operating revenues. As previously mentioned the operating revenues and operating expenditures are somewhat negatively correlated. The theory presented in this analysis makes no conclusions about how district size should affect the balance between water-use rates and land-based charges and taxes.

On the other hand, economies of scope that allow cross subsidies from electricity operations to water service are evident. The addition of electricity sales reduces the size effect and is consistent with other previous analyses (Chatterjee 1994).

Finally, increasing farm size in land-owner-enfranchised districts exerts a depressing effect on the use of water sales revenues in a district. This is inconsistent with Proposition 4. However, this may be in part an artifact of the data set being dominated by CVP-contractor districts. Table 2-7 shows that CVP Class 1 contracts tend to reduce the size of farms in a district, consistent with USBR rules, but that these districts also tend to use land-owner-enfranchisement rules. Another possibility is that the economies of scale in the conveyance system are sufficient that the costs typically allocated to an individual customer are decreasing faster than the desire for large land-owners to pay more through water sales than in land-based charges. These latter charges may be allocated in greater proportion to centralized district facilities and operations.

2.4.4.2 Proposition 5: District Manager Biases Toward Crop Choices

Proposition 5 states that managers of popular-vote districts will tend to set water rates that encourage the use of local resources in farming activity. An indicator of these policies would be a greater preponderance of local-input-intensive crops in these districts. A previous regional economic analysis indicated that orchard crops generate substantially more direct spending on agricultural support services than field crops (Moss et al. 1993). The resulting hypothesis is:

$$H_0: \frac{Orchard^{\Gamma}}{Field^{\Gamma}} \geq \frac{Orchard^{\Upsilon}}{Field^{\Upsilon}}$$
$$H_1: \frac{Orchard^{\Gamma}}{Field^{\Gamma}} < \frac{Orchard^{\Upsilon}}{Field^{\Upsilon}}$$

Two sets of models were developed to test Proposition 5. The models are again distinguished between assessing the entire data set and two district forms dominated by agricultural, irrigation and California water districts. The first set of models evaluates whether electoral rules influence the proportion of orchard crops within a district.. The second set evaluates whether electoral rules influence the proportion of field crops within a district. The sample sizes are reduced substantially due to the lack of data on cropping patterns in the data set.

According to Table 2-9, orchard crops are strongly associated with irrigation efficiency. The only potentially exogenous variable in the data set positively correlated with efficiency is the proportion of surface water supplies received from the State Water Project (*SWP*). The resulting model also includes an intercept dummy for whether the district uses a land-owner-enfranchisement rule (*AVV*).

(48) $$Orchard_i = \beta_1 + \beta_2 * AVV_i + \beta_3 * SWP_i + e_i$$

Table 2-11 shows the parameters and test statistics for Models (3), all districts, and (4), irrigation versus California water districts:

Table 2-11 **Orchard Crop Influence Models**						
Model	*Constant*	*AVV*	*SWP*	**DF**	R^2	**F-stat.**
Model (3) Parameters	*0.588*	*-0.308*	*0.000*	*47*	0.161	4.51
t-stat. p-value	0.0	0.004	0.362			
F-stat. p-value		0.008	0.724			0.023
Model (4) Parameters	*0.414*	*-0.144*	*0.000*	*34*	0.045	0.80
t-stat. p-value	0.001	0.151	0.339			
F-stat. p-value		0.302	0.678			0.353

Model (3) appears to be significant at the 2.5% probability level, but Model (4) which focuses on just the two district forms does not appear to give significant results. The parameter estimate for the influence of electoral rules in Model (3) is consistent with Proposition 5 and statistically significant at the 1% level. Whether the district is a SWP contractor appears to have little influence over whether farmers in the district choose orchard crops.

The second set of models assesses the influence on the choice to grow field crops. Table 2-9 indicates a positive relationship between average farm size and the share of field crops. Given the relatively low revenue and value per acre, this is relationship is consistent with economic theory that economies of scale would prevail in these operations. As with the models of district revenue sources, we expect that this scale effect diminishes with the size of the farm, so the natural logarithm of average irrigated acreage (*L(AIAF)*) is used.

The resulting model also includes an intercept dummy for whether the district uses a land-owner-enfranchisement rule (*AVV*).

(49) $$Field_i = \beta_1 + \beta_2 * AVV_i + \beta_3 * L(AIAF_i) + e_i$$

Table 2-12 shows the parameters and test statistics for Models (5), all districts, and (6), irrigation versus California water districts:

Table 2-12
Field Crop Influence Models

Model	*Constant*	*AVV*	*L(AIAF)*	DF	R^2	F-stat.
Model (5) Parameters	*-0.162*	*0.147*	*0.083*	*51*	0.385	15.96
t-stat. p-value	0.070	0.061	0.001			
F-stat. p-value		0.122	0.002			0.000
Model (6) Parameters	*-0.113*	*0.119*	*0.084*	*37*	0.324	8.87
t-stat. p-value	0.205	0.146	0.004			
F-stat. p-value		0.292	0.008			0.000

Both models appears to be significant at the 0.01% probability level, which probably reflects the inclusion of more than just a dummy variable as a significant explanatory variable. As in Model (3), the parameter estimates for the influence of electoral rules are consistent with Proposition 5 and statistically significant at the 10% level in Model (5) and 15% level for Model (6). As expected, farm size positively influences the proportion of district acreage devoted to field crops.

2.5 Conclusions And Discussion

2.5.1 Findings

This study sets out a series of propositions about how governance rules affect the management incentives and decisions in special districts that supply water to agricultural customers. The first two propositions set out decision criteria that a aggregate net-wealth maximizing cooperative facing a non-profit budget constraint would use to determine the optimal level of water -use charges and property-based taxes and assessments. A third proposition says that a water district which uses land-owner-franchise / assessed-value-weighted voting (AVV) rules, under conditions consistent with empirical economic data, will also tend to use these rules because this voting scheme is consistent with incentives and benefit distribution in the constrained cooperative.

A fourth proposition states that larger landholders will tend to prefer relatively higher water-use charges than smaller landowners. The empirical analysis contradicted this statement, but this may have resulted from one of two causes. The data set was disproportionately drawn from districts which contract with the CVP for water supplies. USBR rules require that "farms" be smaller than 960 acres to receive the lowest-prices supplies, so these districts show smaller farms, which in fact may be managed jointly in larger "management units." A second cause might be from an economy of scale for conveyance to larger farms. This scale economy may be decreasing per farm delivery costs faster than the desire of larger landowners to see water-use rates rather than property taxes.

The next two propositions compare incentives for managers between AVV and universal-franchise / popular-vote (PV) rule districts. The fifth proposition says that managers in PV districts will tend to set water rates to encourage greater use of local inputs for farming, and as a result foster the growth of local-resource-intensive crops, such as fruit and nut trees. Econometric analysis supports this proposition. The sixth proposition makes a fundamental comparison of how much district managers rely on water sales to cover district expenditures. Empirical analysis of the hypothesized model supports the proposition that PV districts will tend to rely less on water sales than AVV districts.

The seventh proposition states that as irrigation efficiency increases in a PV district, managers will tend to rely more on property taxes and assessments. The complicated relationship of irrigation choice and institutional structure could not be disentangled using the data available here.

In the last proposition, two conditions were set out for when a PV district might have more or less investment in water-supply infrastructure than an AVV district. The nature of the scale economies for such infrastructure establishes the decision rules. While not analyzed empirically, the data could be supplemented to assess the likely type of scale economies that these decision rules imply.

2.5.2 Conclusions and Policy Recommendations

In general the empirical analyses support the propositions that the rules governing district elections influence the decisions that district board members and managers make. These differences in institutionally-derived incentives have several important policy implications.

First, AVV districts are more likely to rely on water sales and water-use charges. Given that the recent trend to encourage agricultural water conservation through increased water rates, (e.g., the USBR Best Management Practice Guidelines), this means that AVV districts will be more likely to adopt these types of measures. That Westlands and Broadview Water Districts, which are AVV districts, are at the forefront in adopting agricultural BMPs is consistent with this finding. Conversely, PV districts, such as irrigation districts, are likely to be more resistant to adopting BMPs, particularly ones that shift district revenues toward water sales.

Another implication is that AVV districts are likely to be willing to participate in water transfers outside of the district boundaries. These districts' members view water sales revenues, no matter the source, as beneficial.

PV districts are more likely to encourage input-intensive orchard crops. This means that local communities are more dependent on agricultural activity for their livelihood. These crops also tend to use more efficient irrigation technologies. These two effects tend to amplify the local influences from water transfers out of the district. These operations cannot easily reduce their water use due to the already high levels of efficiency without either fallowing or turning to groundwater. If either the land is fallowed or water costs increase, use of local resources is likely to decrease. Because of the tighter local linkage, this reduction will be felt more severely in these PV district communities.

2.5.3 Recommendations for Further Analyses

The empirical analysis presented here is somewhat limited in scope. It assesses only one of the propositions developed in this study and it looks at data from only one year, the 1991-1992 fiscal year. The survey data set provides data over a five-year period from 1987 to 1991, and State Controller financial data is available over this same time period. A pooled-time series analysis would likely provide a richer view of how districts manage their finances over a longer period, particularly given the apparent large fluctuations in net income and availability of "other non-operating income." Changes in cropping patterns, water use and water rates over this period also is available in the survey data set.

The State Controller data set also contains information on district debt loads and infrastructure investment, and financial data on other district activities such as flood control and electricity production. How electoral rules might influence these decisions might affect at least indirectly the differential reliance on operating versus non-operating revenues. In particular, differences how districts decide to incur additional debt obligations (i.e., general obligation and revenue bonds) might be important.

The data set could be supplemented with at least three more pieces of information. The first set is the year in which the district was founded, and the dates that the district began receiving water service from either of the large water projects, i.e., the Central Valley Project or the State Water Project. These date could be useful in sorting out whether the differences seen between districts is more reflective of electoral rules or of the contractual arrangements offered by the project managers, i.e., the U.S. Bureau of Reclamation and the California Department of Water Resources. In addition, the choice of district form might have reflected the composition of farmers locally, or simply been the "fad" of the moment. The question is whether a particular political form conforms best with the needs of constructing infrastructure and signing delivery contracts, or that a contractual and investment arrangement dominates whatever electoral form was chosen. The problem is likely to be endogenous and require a more sophisticated econometric analysis than presented here.

The second set would come from overlaying locally-specific groundwater usage and depth data available from the CDWR's CVPM mathematical-programming model. Data on "discrete analytic units" (DAUs) shows estimated groundwater usage rates and depth by local regions that usually encompass several districts in the Central Valley (Dale 1994; Hatchett 1994). Combined with the surface-water source data, the total water usage within a district could be estimated and compared. A closer review of CVP and SWP deliveries to these specific districts also would be useful to derive a more accurate estimate of water consumption.

A third set would incorporate the soil type information also included in the CVPM model (Hatchett, Horner, and Howitt 1991; Howitt and Horner 1993) and shown to have a significant effect on the choice of irrigation technology and water application rates (Green et al. 1996). This information would help further distinguish between district characteristics.

Further analysis could look at how district types might be clustered regionally or by time of formation, although isolating these factors might be difficult. The date of formation and location are likely to be correlated. Distribution among water projects and sources also might be more important than found in this study if better data is gathered on the districts' water supplies. In addition, the relationships among local districts might actually dominate their behavior, in the fashion described by Coontz (1991). The ultimate study would be to examine historical records on district formation, and test whether the explanatory variables tested on contemporary districts tell a similar story in the past.

CHAPTER THREE

CASE STUDY: CALIFORNIA WATER MARKETS FROM 1977 TO 1992

Several market-based programs have been implemented in California and other western states to reallocate water supplies and provide environmental restoration to waterways. These programs have taken many forms, including user fees and taxes, orchestrated markets, and barter exchanges. Trading activity has generally been greatest in the Rocky Mountain states of Colorado, New Mexico, Utah, Nevada and Arizona (Colby 1990). The trend towards water markets in California gained additional momentum with two events. First was the creation of the State Drought Water Bank in 1991, and repeated operation in 1992 and 1994. These markets generated significant activity to mitigate effects of a long-term drought. Second was the passage of the Central Valley Project Improvement Act (CVPIA) in 1992, as well as the ensuing "Bay-Delta Agreement" consummated in December 1994 among the state and federal agencies, collectively called "CALFED." The CVPIA for the first time legislatively authorized market-based transfers of Central Valley Project (CVP) water to entities other than project contractors, and instituted a restoration fund whereby water could be purchased for instream uses and other environmental restoration efforts. Using water markets in other Western U.S. federal water projects is being considered as well.

Howitt (1995) develops an institutional economic model that explains when markets might evolve quickly due to changes in economic conditions. In a setting where the expected benefits of defining and enforcing tradeable property rights outweigh the institutional inertia and transaction costs of developing the property rights system, then a market is much more likely to evolve to a greater level of activity. Such a condition occurred in California with the 1976-78 and 1987-92 droughts. Spot market activity increased dramatically after 1980, and the Water Banks were instituted in 1991. The CVPIA at least in part was a result of institutional pressure created by then-existing drought conditions. The evolution of these market institutions can be analyzed further in the context of the paradigms discussed in Chapters One and Two.

3.1 Advantages and Disadvantages of Water Rights Markets

The advantages of market-based water exchanges are the same as those for marketable permit programs designed to lower the cost of pollution control. Markets create greater opportunities for individuals to seek out least-cost solutions. Market-based policies that encourage water users to jointly pursue conservation investments and other efficiency-improving programs or transfers from one region to another can increase the availability of water in an economically and environmentally non-disruptive way.

However, market-based solutions to water-supply problems must address several important issues before they can become successful. Institutional and political issues barriers can be significant, and the physical relationship of surface and groundwater should be considered in designing such a market. These issues can be separated into three categories.

First, potential gains from trades may be offset to a large extent by high transaction costs. Poorly defined water rights, environmental documentation requirements, and legal challenges can make perfecting a trade difficult and costly. For example, the Metropolitan

Water District-Imperial Irrigation District joint-implementation water conservation exchange took five years to negotiate. Yet it is reasonable to expect that some types of transaction costs will decline over time, as participants become more experienced, and as institutions and procedures evolve to streamline transactions. Nevertheless, one should expect that water markets, particularly for any transaction beyond spot sales, will look more like housing markets than stock exchanges in terms of liquidity, transaction costs and other measures of market proficiency, as discussed in Chapter One..

Second, market-based strategies to reallocate surface water or to provide for additional instream flows, unless carefully designed, pose the risk of trading one problem for another. For example, while surface water allocation may improve, groundwater overdraft may worsen. Because the two resources are physically and economically linked, market-based policies that directly impact one but not the other may yield unexpected and deleterious results. This is similar to the problem of a market-based air-quality management program that creates an incentive to substitute for volatile organic compounds (VOC or ROG) or chlorinated flurocarbons (CFC) with other, potentially more toxic substances.

Third, market-based water transfers have met with considerable resistance from communities in selling regions. Concern over "third-party" impacts–the economic impacts to individuals or businesses not directly party to the exchange–have become a focal point of debate over market-based programs to reallocate water. The idea that water can or should be bought and sold like any other good in the economy is both alien and frightening to many. Pecuniary externalities from market transactions—the financial gains and losses incurred by those not directly party to a transaction[1]—while accepted as an everyday fact of life of the private sector economy, are frequently contested when they result from market-based regulatory action. This is similar to the pollutant "hot spot" controversy that arises with trading of air pollution rights. The issue can be cast in terms of equity—are improvements in overall economic efficiency and environmental quality being achieved at the expense of less politically and economically powerful groups? These groups generally perceive that they are. Whether this is true, however, is an empirical question that depends on the situation at hand. Recent studies measuring third-party impacts from the Drought Water Bank and other transfers, for example, found relatively small impacts on a regional economic scale (Dixon, Moore, and Schechter 1993; Mitchell 1993 #83). However, those impacts could be concentrated in certain communities (Lee, Sumner, and Howitt 1997; Mitchell 1995).

In addition, contesting parties may have different perceptions about how water rights should be defined and allocated (Colby 1995). Current diverters may perceive any change from the status quo as threatening to their existing investments and livelihood. Environmentalists may contend that the original allocations failed to consider the commensurate benefits to society from natural amenities. These arguments often reflect a

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[1]The loss of sales for a hardware store due to a new hardware store locating around the block is an example of a pecuniary externality. Pecuniary externalities differ importantly from physical externalities in that they are an essential by-product of a market-based economy that relies on relative prices to guide investment, production, and consumption choices.

difference in the premises more than in facts or expectations, and such differences are difficult to overcome in the political process.

3.2 A Brief Comparison of California and Rocky Mountain Water Markets

In California, the right to allocate, use or transfer a surface water right is generally held by a government entity (e.g., water districts or federal and state water agencies) rather than by individual farmers or businesses, as is more common in the Rocky Mountain states. These institutions commonly respond to political rather than direct monetary incentives in choosing how to manage their resources, as demonstrated in Chapter Two and generally found in the literature (McDowell and Ugone 1982; Rosen and Sexton 1993; Smith and Williams 1992; Thompson 1993). In addition, a variety of types of rights have evolved from the California legal system based on vintage, development and location. Two forms of appropriative rights, riparian rights and project contracts may all coexist within the same surface-water basin (Sax, Abrams, and Thompson 1991). In addition, few groundwater aquifers are adjudicated and most users simply follow the "rule of capture." In contrast in the Rocky Mountain states, usually only one or two types of rights are recognized and most groundwater basins are regulated in some form. California's convoluted legal institutions have tended to delay the development of water rights markets relative to those in the Rocky Mountain states.

3.3 A Short History of California Water Markets

The common wisdom is that California water markets did not exist in a viable form until quite recently. In fact, such markets have existed for most of this century, although not necessarily in the forms that exist elsewhere in the West. In addition the market has been incomplete, often missing the "spot" market component which is key to creating liquidity and conveying price information to market players. The California market has been dominated by the long-term contract market as manifested in the Central Valley and State Water Projects (SWP). In addition, various pool exchanges have existed within these projects. The evolution of the Water Banks during recent droughts have been accompanied by the development of other types of non-project long-term contracts. Each of these markets interact with each other in providing supply, encouraging demand and reflecting water's value of productivity.

3.3.1 Long-term Water Transfers and Contracts

As Bain, *et al* (1966) pointed out, long-term contract markets have existed in California at least since the development of the Colorado River Project with the Imperial Irrigation District early in the twentieth century. The development and expansion of the CVP by the U.S. Bureau of Reclamation (USBR) and the SWP by the California Department of Water Resources (CDWR) were characterized by short periods when contracts were made available to local water supply agencies by the federal or state governments. The contracts had 30 to 40-year terms, bound both resource acquisition and delivery into a single product, and had little allowance or incentive for trading among contractors. The CVP contracts amount to at least 5.8 million acre-feet (MAF) annually (U.S. Bureau of Reclamation 1994), and SWP contracts to 4.2 MAF (California Department of Water Resources 1994b). Other long-term project contracts around the state include those between the City and County of San Francisco and various Bay Area cities and water agencies for Hetch Hetchy project supplies, and the agreements between the Metropolitan Water District of Southern California (MWDSC) and local water agencies in Los Angeles which led to the construction of the Colorado River Aqueduct.

Similar long-term markets also developed in other utilities, such as natural gas and electricity, over the same period. Contracts for both acquisition and transportation of the resource were common in these industries. However, these other industries are now evolving to provide disaggregated products. With natural gas, the 1978 Natural Gas Policy Act decontrolled natural gas production prices, and the collapse of the Organization of Petroleum Exporting Countries (OPEC) cartel in 1986 put further pressure on interstate pipelines to separate the commodity and transportation charges. The Federal Energy Regulatory Commission (FERC) formally disconnected the commodity and transportation markets with Order 436 and now a wide range of markets exist for natural gas. Electricity is now going through a similar transformation with the passage of the 1992 National Energy Policy Act and California's Assembly Bill 1890 in 1996, and the issuance of FERC Orders 888 and 889. California water markets may now be going through a similar transformation as state and federal agencies reexamine resource allocations and uses.

As originally designed, the CVP and SWP contract entitlements were intended to by minimum allocations from the projects, but recent political and physical constraints have transformed the contract entitlements into proportional allocations of year-to-year yields. Within these projects certain contractors have higher priorities to the projects' yield based on various criteria including contract vintage, whether the contractor relinquished a previous right to the project, and what the ultimate use is for the water supply.

As a result of excess supplies or demands created by the difference between the contract entitlements and actual agencies' needs, and from the difference in supply priority, internal markets have arisen in both the CVP and SWP. Within the CVP, contractors may buy or sell allocations with other contractors through the USBR in the San Joaquin Valley or various contractor associations in the Sacramento Valley (Gray 1990). The USBR limits the sales price to the appropriate contract rate plus a cost-based fee. The price only coincidentally reflects the true economic value of the water to the buyer or seller. In the SWP, when water supplies are available in excess of the firm project yield, contractors may exchange current supplies for future deliveries (California Department of Water Resources 1994b). The MWDSC, which holds the largest contract in the SWP, often allows the Kern County Water Agency (KCWA) to use the MWDSC excess in those years. Of course, these trades occur in years when the water is least valuable–during wet or above-normal runoff.

The MWDSC has been in the forefront of pursuing other long-term contractual arrangements which do not involve "laying concrete," but rather using existing project facilities to allow purchases from the Central Valley or the Colorado River. Perhaps the most widely-known is the purchase of conserved water from the Imperial Irrigation District (Rosen and Sexton 1993). MWDSC agreed in 1988 to invest $113 million in conservation projects, and an additional $4 million per year over a 35-year period to receive an estimated 106,100 acre-feet (AF) per year (Metropolitan Water District of Southern California 1997c). MWDSC also has two ongoing groundwater banking agreements with two SWP contractors, the Desert Water Agency and the Coachella

Valley Water District (Metropolitan Water District of Southern California 1997a). MWDSC delivers Colorado River Aqueduct water in exchange for SWP. A third Colorado River transfer was at test fallowing program with the Palo Verde Irrigation District, which lasted two years from 1992 to 1994 (Metropolitan Water District of Southern California 1997b). The program yielded 185,798 AF which was stored on the Colorado River for future use by MWDSC. The program cost $67.40 per AF.

MWDSC has tried to sign several long-term contracts in the Central Valley, but have only consummated a groundwater banking agreement with Arvin-Edison Water Storage District. The contract was approved after eight years by the State Water Resources Control Board in 1996 (Daily Republican Staff 1996). The contracts calls for up to 135,000 AF per year to be banked beneath AEWSD by MWDSC, and for MWDSC to be able to extract up to 128,500 AF per year during dry years (Israel and Lund 1995). MWDSC also has a short-term banking arrangement with Semitropic WSD in Kern County, with MWDSC storing 45,000 AF in 1992 for later use (California Department of Water Resources 1994a).

3.3.2 Short-term Water Transfers

Table 3-1 shows the pattern of short-term interagency water sales and exchanges in the Central Valley from 1977 to 1992, and the Sacramento River Index (SRI) of annual flows in MAF.[2] The 1991 purchases include the entire Water Bank purchase of 732,000 AF, although only about 400,000 AF was actually sold for use in 1991, with 266,000 AF

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[2]Appendix B contains the transaction detail for spot and bank market activities during this period.

retained by CDWR as carryover in the State Water Project (SWP) to 1992, and 66,000 AF spent in carriage losses (California Department of Water Resources 1993b). The 1992 activity shows only Water Bank purchases of 193,000 AF with 33,000 AF in carriage losses and 15,000 AF of carryover (California Department of Water Resources 1993b).

Table 3-1
Summary of Water Market Activity

	Spot Market		*Banks & Pools*		*Totals*			SRI
Year	Applied	Actual	Sold	Bought	Offered	Bought	*YCWA Sales*	MAF
1977	17,000	17,000	46,438	42,544	63,438	59,544		5.1
1978	-	-	-	-	-	-		23.9
1979	-	-	-	-	-	-		12.4
1980	-	-	-	-	-	-		22.3
1981	-	-	27,328	25,366	27,328	25,366		11.1
1982	5,000	5,000	106,738	106,738	111,738	111,738	*5,000*	33.3
1983	-	-	110,401	62,896	110,401	62,896	-	37.7
1984	2,366	2,366	62,839	42,304	65,205	44,670	*2,266*	22.4
1985	241,668	43,768	70,692	36,515	312,360	80,283	*750*	11.0
1986	108,900	12,500	133,945	92,495	242,845	104,995	-	25.7
1987	260,919	60,219	82,234	39,405	343,153	99,624	*37,000*	9.2
1988	697,571	628,471	104,549	60,889	802,120	689,360	*128,000*	9.2
1989	415,950	273,700	NA	NA	415,950	273,700	*144,000*	14.8
1990	452,091	468,632	NA	NA	452,091	468,632	*57,669*	9.2
1991	320,046	127,046	745,707	670,370	1,065,753	797,416	*266,256*	8.4
1992	25,000	25,000	199,595	169,200	224,595	194,200	-	8.9
Totals	**2,546,511**	**1,663,702**	**1,690,466**	**1,348,722**	**4,236,977**	**3,012,424**		**16.5**

Sources: (California Department of Water Resources 1994a; Gray 1990; Israel and Lund 1995; Jones and Stokes Associates 1991; Lund, Israel, and Kanazawa 1992)

The amount of sales increased in general over the period. In part, this was due to the extended dry period that began in 1985, with respites only in 1986 and 1993, and extending through 1994. However, the increase in trading activity was large in 1991, as the Water Bank alone did as much business as the entire water market had in any previous year. Whether this was due to the change in political and legal institutions or the creation of a centralized market mechanism is not discernable. Whichever is the case, the influence of institutions on market performance is evident.

At least 110 short-term interagency water transfers occurred between 1977 and 1992 outside any formal pools or banks organized by the USBR or CDWR (California Department of Water Resources 1994a; Gray 1990; Israel and Lund 1995; Jones and Stokes Associates 1991; Lund, Israel, and Kanazawa 1992).[3] These trades often were instigated by direct agency contacts or with some assistance from private brokers. The trades either fell under one of three sections of the state Water Code, or were used to meet public trust considerations (Gray 1990). Little activity occurred before 1985, but the activity level appears to have quickly peaked in 1988, just before the USBR and CDWR stepped in to facilitate further trading through other market mechanisms. Trading reached over 600,000 AF in that year, and tailed off to about 400,000 AF in the subsequent three years. Of the amount proposed for transfer over that period, about 65% was actually sold. Much of the remainder failed to pass regulatory review, either from the SWRCB or by the lead agencies for the environmental impact reviews (Gray 1990).

The other market forum for short-term transfers are formal pools and banks. The USBR established a water bank in 1977 to buy from Sacramento River rights holders and to sell to CVP contractors (Gray 1990). The 1977 bank bought about 46,000 AF and sold 42,000 AF at about $61 per AF. Transaction costs amounted to about 20% of the selling

[3]Little data exists on intra-agency activity, due in part to the informality of these types of trades. The Westlands Water District has been one agency with many such trades (Olmstead et al. 1997).

price. The USBR also facilitated ongoing trades within and among its five larger CVP divisions (Gray 1990). The USBR only acted as a broker or intermediary by bringing together willing participants and reviewing the transfers for appropriate sales conditions. In addition, two contractor associations would acquire water from CVP contractors and then sell it to other contractors, acting as dealers in the market (Gray 1990; Lund, Israel, and Kanazawa 1992). These associations however avoided "stock carrying costs" by only paying selling contractors after the sales of the excess water supplies. Over the 1981-88 period, the trading activity was fairly stable across these markets.

The CDWR introduced the State Drought Water Bank in 1991, and operated the Bank in a similar fashion in 1992 and 1994. The 1991 Bank purchased as much water as had been transferred in any single year up to that point, and as a result almost 800,000 AF was transferred. However, it is important to note that this was still less than 20% of the amount actually delivered by the CVP and SWP even in that drought year.

An interesting participant in the nascent water market was the Yuba County Water Agency (YCWA). Table 3-1 also shows the annual sales by YCWA (shown in *italics*). The YCWA had excess storage capacity that it aggressively marketed. In some years it sold up to 35% of the water offered. However in 1992, the SWRCB decided to review YCWA's rights to this water, thus putting a damper on further sales by YCWA (Lund, Israel, and Kanazawa 1992). YCWA was the major participant in the 1991 Water Bank, but did not make any sales to the 1992 Bank.

3.4 The Effect of the Drought Water Bank on Market Institution Development

Establishment of the Drought Water Banks brought about institutional changes that affected the workings of the California water market. Legal, political and market exchange institutions were modified and even created that facilitated water trades. Even within the Water Bank itself the rules for trading changed with resulting impacts on water market activity.

The creation of the 1991 Drought Water Bank lead to two dramatic shifts in California water management. The first was the diminished resistance to water transfers by the California Department of Water Resources (CDWR) and one of its main patrons, the agricultural community. While leery of losing long-term water rights, rural communities became comfortable with short-term drought relief (Coppock and Kreith 1992). The CDWR began to realize that despite the pressures of a five-year drought, they still had little support for constructing more dams. The best alternative for acquiring large-scale supplies was transferring water rights.

The second was the creation of a centralized market to facilitate trades. Previously, buyers or sellers had to seek out prospective partners and to commence bilateral negotiations that could consume time and money. Larger transfers were also subject to significant environmental review as well. Water transfers had to be approved by the State Water Resources Control Board (SWRCB) under one of at least four different Water Code sections (Gray 1990). The Water Bank placed the CDWR as the chief agent that seeked and accepted offers of sale and collected purchase requests. Because of the CDWR's position as both resource manager and state agency, it could more easily surmount legal requirements. The transaction process was further assisted by drawing up a standard sales contract.

3.4.1 The State Drought Water Banks' Performance

The CDWR established the first Emergency Drought Water Bank late in the winter of 1991 as California was on the verge of its driest year in at least a century (California Department of Water Resources 1992). Entering March, the CDWR had requests for nearly one MAF of water to meet coming summer demand. In response the CDWR launched an aggressive purchase program acting as a "merchant" or "dealer." A merchant takes title to a commodity before reselling it at a price that covers the merchant's transaction and holding costs (Hackett 1993). The merchant must act on expectations about the market, including price and quantity demanded, and thus works best when demand is stable. However in the case of the Water Bank, a second "March Miracle" (the first occurred in 1989) partially relieved this demand by doubling the state's snowpack. In addition, the CDWR overestimated the price that water districts, particularly those that are agriculturally-dominated, would be willing to pay for Water Bank supplies. The asking price by the Water Bank was $175 per acre-foot, which contrasted recent short-ter transfer prices ranging from $30 to $50 per acre-foot (Lund, Israel, and Kanazawa 1992). Generally only urban water districts were willing to pay these higher prices. The CDWR believed that it was committed to the higher price offer although it soon realized its mistake (California Department of Water Resources 1993a). These two factors eventually lead to an oversupply of water, with 732,000 AF being bought and 266,000 AF being held for year-to-year carryover. The 1977 Drought Water Bank set up by the USBR relied on a similar "merchant" mechanism, although it did not offer a single price to all sellers and to all buyers.

The drought continued into 1992 and the CDWR established a second Drought Water Bank, but with two key changes in operations (California Department of Water Resources 1993a). In response to the oversupply of water due to overestimating the market price, the CDWR moved to a "brokered" system. A broker brings together willing sellers and buyers, but does not take title to the commodity before the transaction is consummated as is the case with a merchant (Hackett 1993). Brokered systems match supply and demand as market conditions change, but market activity is typically less than under a merchant system because there are costs associated with searching for individual suppliers and delays in consummating transactions. Water districts interested in purchasing through the Water Bank first had to provide the CDWR with funds and commitments. The CDWR then arranged and monitored the trades. As a result, the offer price fell from $125 to $50 per acre-foot. The number of parties offering water also decreased from 348 to 14 (Lund, Israel, and Kanazawa 1992). Much of this decrease, though, was in new rules with limited how water could be supplied to the Water Bank.

This change in eligibility was made in response to complaints that the 1991 Water Bank had created significant local third-party impacts (California Department of Water Resources 1993a; Coppock and Kreith 1992; Dixon, Moore, and Schechter 1993; Howitt 1994; Lund, Israel, and Kanazawa 1992; Mitchell 1993; Thompson 1993). The 1992 Water Bank did not purchase surplus water created by land fallowing; it limited sales to trading groundwater for surface water rights and to excess storage releases. Land fallowing had provided 51.2% of the water sales to the 1991 Water Bank (California Department of Water Resources 1993a). Fallowing was dropped in response to complaints from local communities, most notably Yolo County which had been a primary source of water to the Bank. Total purchased water amounted to 193,246 AF in 1992, compared to 405,921 AF from similar groundwater exchanges and excess storage releases in 1991.

Table 3-2 compares the quantities, prices and transaction costs between the two Water Banks. The decrease in purchases is largely attributable to the fall in urban agency purchases and storage carryover reflecting overpurchasing in 1991. Agricultural districts increased purchases, in large part because the Bank's asking price fell 60%. Most of these 1992 agricultural customers were CVP contractors. A case in point was the purchase pattern by the Westlands Water District (WWD). In 1991, Westlands bought 12,000 AF at the $175 plus transport costs per AF rate. In 1992, it bought 51,000 AF at $72.50 plus transport costs.

Table 3-2
Comparison of 1991 and 1992 California Drought Water Banks

	1991 Water Bank	1992 Water Bank	*Differences*
Quantity Purchased	732,000	193,246	*(627,418)*
Excluding Fallowing	405,921	193,246	*(212,675)*
To Urban	307,373	39,000	*(268,373)*
To Agriculture	82,597	95,250	*12,653*
To Environment	50,000	24,518	*25,482*
Carryover	265,558	15,000	*(250,558)*
Purchase Price ($/af)	$125	$50	*($75)*
Admin. Costs ($/af)	$6.25	$5.00	*($1.25)*
Carriage Losses (%)	16%	19%	*3%*
Conveyance Charge	$43.75	$17.50	*($26.00)*
% Direct Admin. Cost	29%	31%	*2%*
Sale Price ($/af)	$175.00	$72.50	*($102.50)*

Sources: (California Department of Water Resources 1993a; Israel and Lund 1995).

At least six types of transaction costs existed with the two Water Banks; these are listed in Table 3-3. Within the Water Banks, the CDWR charged an administrative fee to cover search and negotiation costs in purchasing the water and monitoring costs to enforce the purchase contracts. Also, the transport of the water suffered carriage losses, mostly attributable to Sacramento-San Joaquin River Delta outflow requirements. These carriage losses were substantial, averaging 16% to 19%. For pricing purposes, carriage losses were estimated to be up to 35%. A third internal cost, not captured in the Water

Bank price, was the cost of holding excess supply–carryover– by the CDWR acting as a merchant. This excess inventory cost effectively added 32% to the cost of the 1991 Water Bank, but this was spread over all State Water Project contractors who paid for it in 1992, rather than solely to market participants. Another cost not reflected in directly in the Water Bank price was conveyance costs down either the SWP or federal CVP. The San Francisco Water District, as a non-member of the SWP, was charged $200 per acre-foot to move water to its system (Lund, Israel, and Kanazawa 1992). For farmers selling to the Water Bank, uncertainty over the security of their water rights after a temporary transfer lead to their adding of a risk premium in deciding whether to participate. Farmers who held riparian rights–the most secure under California law–were much more willing to participate in the 1991 Water Bank than those that held appropriative rights or project contracts, who in turn were more willing than those holding groundwater rights (Howitt 1994). In addition, farmers and agencies that sold water from Yolo and Butte counties in the Sacramento Valley reimbursed the counties 2% of the purchase price, or about $2.50 per acre-foot in 1991 and $1 per acre-foot in 1992 and 1994 (California Department of Water Resources 1993a).

Table 3-3 Summary of California Water Bank Transaction Costs	
Type	*Cost or Effect*
CDWR Administrative Charge	$5 to $22.50 per acre-foot
Carriage Losses	Add 16% to 19% to purchase price
Excess Carryover	Add 32% to 1991 Water Bank costs
Conveyance Charges	$20 to $200 per AF depending on whether buyer was SWP, CVP or outside contractor
Uncertainty over Water Rights after Transfer	Reduces willingness to sell to Water Bank
Local County Area-of-Origin Charge	2% of purchase price

Another State Water Bank was established in 1994 which was the fourth-driest year on record after a wet year in 1993. The 1994 Water Bank worked with the same rules at for 1992. About 200,000 AF was purchased again at about $50 per AF (Hansen 1995). Preparations were under way for a 1995 Water Bank, with projected offer prices at $40 per AF. A new innovation was the offer to purchase an option at $3.50 per AF to be exercised in March if necessary (Jercich 1995). However, 1995 turned out to be an above-average year in runoff, and the Water Bank was never implemented. The CDWR has initiated an environmental review in preparation for establishing a permanent bank market structure (California Department of Water Resources 1996).

3.4.2 The Solano County Drought Water Bank

As a comparative measure of transaction costs, the Solano County Water Agency instituted a similar water bank in 1991 to transfer water from agriculture to urban districts (Lund 1993). Three cities bought 13,400 AF at a cost of $200 per acre-foot. Due to starting later than the State Water Bank, the SCWA had to pay a higher price to farmers of $170 per acre-foot. The SCWA kept $30 per acre-foot to cover its administrative costs, an amount in excess of four times the rate charged by the CDWR.

3.5 The Characteristics of Water Market Participants

California's water resource management agencies and entities can be categorized in several ways. In relationship to the water resource itself, the entities can be classified by private individuals and companies, private mutual companies and utilities, retail special districts, wholesale special districts, water project managers, and environmental monitoring and enforcement agencies. These entities can be placed in a generally hierarchical structure relative to the source and uses of water. Individuals of course consume water, but they also may divert or pump directly. Private utilities and special districts sell water directly to individuals and may have their own supplies. Wholesale and project management agencies exist to develop a resource and convey water to retailers. Environmental agencies oversee all of these activities to protect common non-water resources.

A second classification system, based on the discussion in Chapter Two, distinguish among the management decision processes. Individuals need only consult themselves. Managers of private companies, including mutual water companies and utilities, generally must only make decisions that maximize company profits and shareholder returns. Individuals outside the company have little influence, except perhaps through the regulatory process. Special districts which rely on the property-ownership franchise and assessed-value-weighted voting (AVV) are more akin to the mutual water companies, except that the district managers do not get direct any feedback from maximizing district profits–the legal non-profit limit eliminates this motive.[4] These managers must be more attune to how water management decisions, such as water transfers, affect each farmer's individual profitability and well-being. Most retail special districts use the universal franchise, popular vote (PV). In these districts, the managers must consider not only the effects on their direct customers, but also on other voters who may be indirectly affected by changes in water-use patterns, such as agricultural services businesses. Wholesale and project management agencies most often are governed either by appointed boards or by departments several layers below politically-elected officials. The objectives of these agencies are more likely to reflect the complexity of the political dynamics driven by their member agencies as well as the overall project goals (Zusman and Rausser 1994).

Table 3-4 shows the annual pattern of California water transfer sales classified by decision-making process. Private individuals and companies did not participate in the water market–at least not at a formal level that required SWRCB approval–until 1990 when the recent drought worsened. The establishment of the Drought Water Bank apparently added legitimacy to private-public transfers. It also reduced the risk to water-rights holders of losing those rights when making short-term transfers. Howitt (1994) found that farmers' willingness to participate depended on how those farmers felt about the security of their water rights. The popular-vote districts, which include cities and urban water utilities, participated at a relatively steady rate throughout the period. In part

[4]The specifics of special district governance rules are discussed in Chapter Two.

this reflects the activity within the Friant Division of the CVP, which is dominated by irrigation districts that have among the oldest water service contracts, which in turn are less likely to suffer reduced deliveries during drier years. However, in 1991, irrigation districts located in Northern California were among the largest sellers to the Water Bank. Assessed-value voting districts had a lower level of activity until the establishment of the Water Bank, at which point these districts made sales at similar levels to popular-vote districts. The wholesale agency sales were almost entirely from the YCWA, whose circumstance was discussed above. Most California and federal agency sales were among each other, in large part to meet public trust commitments.

Table 3-4
Water Transfer Sales by Decision-Making Entity

Year	Private	Retail Agencies: Popular Vote	Retail Agencies: Assessed-Value Vote	Retail Agencies: Sacramento River*	Wholesale Agencies	California Agencies	US Agencies
1977 ...	27,456	17,000	5,000	5,797	-	8,185	-
1981	-	23,775	2,553	1,000	-	-	-
1982	-	88,747	10,133	7,858	5,000	-	-
1983	-	58,333	718	51,350	-	-	-
1984	-	23,969	7,300	31,570	2,266	-	100
1985	18	18,889	16,928	39,875	750	-	38,000
1986	-	52,481	42,449	47,515	-	-	4,000
1987	75	26,804	17,004	46,170	37,000	-	15,400
1988	1,950	39,031	25,198	51,070	218,771	-	397,000
1989	600	39,000	6,600	NA	189,300	-	38,200
1990	99,450	31,765	9,500	NA	100,869	226,866	182
1991	203,928	144,511	160,467	37,000	303,647	17,000	6,200
1992	43,995	114,100	56,500	-	10,000	-	-
Totals	377,472	678,405	360,350	319,205	867,603	252,051	499,082

* - These transfers occurred within and from the Sacramento River CVP Division and could not be classified due to lack of data on individual participants from 1981-1988.

Table 3-5 shows the annual patterns of water transfer purchases, again classified by decision-making process. Private rights holders generally did not make large purchases which needed formal SWRCB review. Popular-vote and assessed-value voting districts have similar totals sales levels over the period, but apparently the PV districts purchased more water supplies earlier in the drought. The Westlands WD was the dominant buyer among AVV districts. The PV purchases reflect urban water utility transfers. The water service contractors on the Sacramento River were strong net sellers throughout the period.[5] Wholesale agencies began to make large purchases in 1990 as SWP supplies began to dwindle. California agency purchases include CDWR purchases made acting as the intermediary in the State Water Bank in both 1991 and 1992, as well as large purchases made by the California Department of Fish and Game for wildlife refuges and salmon spawning.

[5]Post-1990 data allowed for greater distinction among transfer participants in this region.

Table 3-5
Water Transfer Purchases by Decision-Making Entity

Year	Private	Retail Agencies: Popular Vote	Retail Agencies: Assessed-Value Vote	Retail Agencies: Sacramento River*	Wholesale Agencies	California Agencies	US Agencies
1977	-	-	17,000	-	-	-	42,544
...							
1981	-	24,165	201	1,000	-	-	-
1982	5,000	88,574	10,306	7,858	-	-	-
1983	-	58,692	359	3,845	-	-	-
1984	2,366	28,180	3,089	11,035	-	-	-
1985	868	22,562	13,255	5,698	-	37,900	-
1986	-	74,124	17,306	6,065	3,500	4,000	-
1987	-	25,010	11,173	3,341	7,700	46,300	6,100
1988	1,950	141,797	35,432	7,410	7,771	493,500	1,500
1989	1,700	39,600	104,200	NA	21,000	99,000	8,200
1990	9,450	19,890	50,075	NA	316,977	72,058	182
1991	1,391	123,722	38,500	NA	308,083	318,078	6,200
1992	-	29,000	87,030	NA	18,170	60,000	-
Totals	22,725	675,316	387,926	46,252	683,201	1,130,836	64,726

* - These transfers occurred within and from the Sacramento River CVP Division and could not be classified due to lack of data on individual participants from 1981-1988.

Table 3-6 shows the transfer activity for two major types of retail agricultural water districts, irrigation districts which use popular voting, and California water districts which use assessed-value voting. Before 1990, irrigation districts as a whole tended to buy more than they sold. The opposite was true for California water districts over the same period. Then the extended drought switched this trend. The Westlands WD entered the water market in 1988 to make a series of large purchases, sometimes up to 50,000 AF in a single year. The irrigation districts in Northern California made large sales to the Water Banks. In part this shift reflects the fact that irrigation districts tend to hold older water service contracts with the CVP, and thus receive reduced delivery cutbacks during extended droughts. The passage of the CVPIA in 1992 and the signing of the Bay-Delta

Agreement in 1994 will tend to exacerbate this situation until final resolution of the "CALFED" policy-making process.

Table 3-6
Water Transfer Activity for Two Types of Agricultural Water Districts

	Irrigation Districts			California Water Districts		
Year	Sold	Bought	Net Sales	Sold	Bought	Net Sales
1977	17,000	-	17,000	-	-	-
1981	23,775	24,165	(390)	2,553	201	2,352
1982	88,690	88,517	173	10,133	10,306	(173)
1983	58,211	58,570	(359)	718	359	359
1984	22,187	26,398	(4,211)	7,300	3,089	4,211
1985	13,571	17,244	(3,673)	16,928	13,255	3,673
1986	46,697	68,340	(21,643)	42,449	17,306	25,143
1987	26,606	24,737	1,869	17,004	11,173	5,831
1988	39,031	131,797	(92,766)	15,298	34,982	(19,684)
1989	-	600	(600)	6,600	47,800	(41,200)
1990	31,765	-	31,765	8,000	50,075	(42,075)
1991	127,864	-	127,864	100,000	38,500	61,500
1992	114,100	-	114,100	55,000	55,530	(530)

The initial net-sales trend tends to support the thesis in Chapter Two that popular-vote district managers will act to protect more water-intensive agricultural activity, while assessed-value-voting district managers will recognize that water sales revenues can be distributed to voters in proportion to the economic benefits and costs of the water transfers. On the other hand, the shift after 1989 appears at first impression to run counter to this thesis. However, it is more likely that the "bite" of the extended drought had started to affect the more highly-valued crops grown in the westside San Joaquin Valley districts, while the northern irrigation districts recognized that the rising water market prices brought substantially more economic benefits versus continued cultivation of low-valued crops such as rice, alfalfa and corn. In this case the economic situation may have shifted the political weights in the decision process beyond the inflection point from retaining water supplies to benefit the community toward the benefits from water sales that accrue to individual farmers through reduced water rates.

It is interesting to note that two irrigation districts which were significant participants in the 1991 (Glenn-Colusa) and 1994 (Richvale) Water Banks changed their voting franchise rules through state legislation from universal to land-ownership shortly after participating in the Water Banks. Such a change would remove formal resistance to water sales by non-farmers within the district. In fact this was the reason expressed in a Sacramento Bee article by a GCID director in 1994 (Mayer and Vogle 1994). If the holdings within these district are about equally sized, then the benefits accruing to voters would approximate those of the assessed-value-voting districts such as the California water districts.

3.6 Discussion

California's water markets began with long-term contracting used to facilitate project development. Just as with natural gas and electric utility markets, other types of market forums have evolved to allow more short-term trading. The extended drought from 1987 to 1992 pushed the development of these market institutions, including the formal institution of a centralized marketplace in the Water Banks. The two Water Banks provide an interesting comparison of the benefits and risks associated with a merchant-run (1991) or broker-facilitated (1992) market structure. How each market structure addresses the risks from uncertainty created by natural events (e.g., the "March Miracles" in 1989 and 1991) is important in deciding which type is preferable. The State Water

Project paid for an inflexible merchant approach in 1991, and in response shifted all of the risk to market purchasers in 1992 and 1994. The option pricing system proposed for the never-instituted 1995 Bank would have been an intermediate step.

Market transaction costs are significant relative to the economic value placed on water. In the case of the water projects, some commentators have argued that the costs are greater than the value achieved from water application (Wahl 1988). For short-term trades, the transaction costs can exceed 50% of the water sale price when including non-monetary factors such as carriage losses, environmental requirements, and storage carryover.

The water market activity patterns for different agencies and entities are not clear, but the patterns are consistent with the hypotheses discussed in Chapter Two. Private companies and individuals apparently were ready to sell large amounts once a forum was established that protected their water rights. Wholesale agencies largely relied on long-term project contracts until the drought forced them into the market. Popular-vote retail agricultural districts, such as irrigation districts, were generally net buyers until the drought increased market prices substantially. Assessed-value-voting districts, such as California water districts, were net sellers until the drought cut deeply into their own supplies. A more detailed analysis of the economics within the agricultural districts that participated in the markets during this period could reveal the economic and political tradeoffs made by district managers under different governance rules.

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Appendix A

California Agricultural Water Districts

Fiscal, Political and Economic Data

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Table A-1
Agricultural Water District Fiscal, Political and Economic Data

	Water District	Data Code	County	Controller Dist Type	Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire	%Op/Rev	Op Rev / Exp.
	Variable Name	*Code*	*Co*	*Type*	*Mtn*	*CC*	*SV*	*SJV*	*TLB*	*SC*	*IE*	*OpRvRv*	*OpRvEx*
1	San Juan Suburban Water District	345001	34	5	1	0	0	0	0	0	0	0.506	0.697
2	Clear Creek Community Services District	455001	45	5	1	0	0	0	0	0	0	0.718	1.281
3	San Benito County Water District	358001	35	8	0	1	0	0	0	0	0	0.229	0.495
4	Reclamation District 108	626001	6	26	0	0	1	0	0	0	0	0.358	0.479
5	Reclamation District 744	3426002	34	26	0	0	1	0	0	0	0	.	.
6	Reclamation District 2068	4826001	48	26	0	0	1	0	0	0	0	0.319	0.454
7	Reclamation District 307	5726001	57	26	0	0	1	0	0	0	0	.	.
8	Reclamation District 900	5727002	57	27	0	0	1	0	0	0	0	0.194	0.194
9	Reclamation District 999	5727003	57	27	0	0	1	0	0	0	0	.	.
10	Fallbrook Public Utilities District	3740001	37	40	0	0	0	0	0	1	0	0.863	1.051
11	Biggs-West Gridley Water District	441001	4	41	0	0	1	0	0	0	0	0.893	0.965
12	Butte Water District	441002	4	41	0	0	1	0	0	0	0	0.893	3.799
13	Western Canal Water District	441003	4	41	0	0	1	0	0	0	0	0.970	1.232
14	Westside Water District	641002	6	41	0	0	1	0	0	0	0	0.645	1.237
15	Broadview Water District	1041001	10	41	0	0	0	1	0	0	0	0.709	0.876
16	International Water District	1041002	10	41	0	0	0	1	0	0	0	0.401	0.401
17	Panoche Water District	1041003	10	41	0	0	0	1	0	0	0	0.792	1.104
18	Pleasant Valley Water District	1041004	10	41	0	0	0	1	0	0	0	0.000	0.000
19	Westlands Water District	1041005	10	41	0	0	0	1	0	0	0	0.631	0.747
20	Glide Water District	1141001	11	41	0	0	1	0	0	0	0	0.652	2.516
21	Kanawha Water District	1141002	11	41	0	0	1	0	0	0	0	0.464	1.065
22	Orland-Artois Water District	1141003	11	41	0	0	1	0	0	0	0	0.369	0.681
23	Bard Water District	1341001	13	41	0	0	0	0	0	0	1	0.808	1.091
24	Berrenda Mesa Water District	1541001	15	41	0	0	0	0	1	0	0	0.931	1.008
25	Kern Delta Water District	1541002	15	41	0	0	0	0	1	0	0	0.487	0.551
26	Lost Hills Water District	1541003	15	41	0	0	0	0	1	0	0	0.404	0.461
27	Dudley Ridge Water District	1641001	16	41	0	0	0	0	1	0	0	0.705	0.741
28	Lakeside Irrigation Water District	1641002	16	41	0	0	0	0	1	0	0	0.331	0.755
29	Le Grand-Athlone Water District	2441001	24	41	0	0	0	1	0	0	0	0.000	0.000
30	Pacheco Water District	2441002	24	41	0	0	0	1	0	0	0	0.801	0.864
31	Irvine Ranch Water District	3041001	30	41	0	0	0	0	0	1	0	0.258	1.143
32	Los Alios Water District	3041002	30	41	0	0	0	0	0	1	0	0.640	0.826
33	Rancho California Water District	3341001	33	41	0	0	0	0	0	0	1	0.269	1.155
34	Riverview Water District	3741002	37	41	0	0	0	0	0	1	0	0.908	1.068
35	Plain View Water District	3941001	39	41	0	0	0	1	0	0	0	0.304	0.670
36	Bella Vista Water District	4541002	45	41	1	0	0	0	0	0	0	0.693	1.061
37	South Sutter Water District	5141001	51	41	0	0	1	0	0	0	0	0.444	1.235

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	% Net Inc / Exp	% Op Exp / Exp	LN(Total Expenses)	Voting	Electric Sales	Ac/ Farm	IrrAc/ Farm	Avg AF / Ac	%Ag AF	% Surface Water-91	CVP class 1	CVP class 2
Variable Name	*NetInc*	*OpExEx*	*LSize*	*Vote*	*Electric*	*AcFarm*	*IAcFarm*	*AFAc*	*PAgAF*	*SW91*	*CVP1*	*CVP2*
San Juan Suburban Water District	-0.210	0.725	15.820	0	0	.	.	.	1.00	1.00	0.20	0.00
Clear Creek Community Services District	0.419	0.795	13.395	0	0	9	5	0.28	1.00	1.00	1.00	0.00
San Benito County Water District	0.742	0.804	14.667	0	0	102	45	0.55	0.99	1.00	1.00	0.00
Reclamation District 108	-0.422	0.748	14.718	1	0	580	477	4.91	1.00	0.98	0.14	0.00
Reclamation District 744	.	.	0.000	1	0	.	.	.	0.00	.	.	.
Reclamation District 2068	-0.069	0.703	13.345	1	0	377	347	3.51	1.00	1.00	.	.
Reclamation District 307	.	.	0.000	1	0	256	243	.	0.00	.	.	.
Reclamation District 900	-0.712	1.000	9.635	1	0	1833	417	.	0.00	.	.	.
Reclamation District 999	.	.	0.000	1	0	744	744	2.69	1.00	1.00	0.00	0.00
Fallbrook Public Utilities District	-0.004	0.822	15.905	0	0	42	15	0.78	0.49	1.00	0.00	0.00
Biggs-West Gridley Water District	-0.012	0.926	13.003	1	0	353	160	6.28	1.00	1.00	.	.
Butte Water District	2.889	0.914	13.028	1	0	38	38	3.82	1.00	1.00	0.00	0.00
Western Canal Water District	0.241	0.977	15.502	1	0	500	467	4.09	1.00	1.00	0.00	0.00
Westside Water District	-0.295	0.522	13.542	1	0	397	397	2.94	1.00	1.00	1.00	0.00
Broadview Water District	-0.256	0.810	13.616	1	0	501	474	2.21	1.00	0.98	1.00	0.00
International Water District	-0.536	1.000	10.815	1	0	104	89	0.64	1.00	1.00	1.00	0.00
Panoche Water District	0.222	0.877	14.615	1	0	585	554	0.29	1.00	1.00	1.00	0.00
Pleasant Valley Water District	0.347	1.000	9.418	1	0	5714	4571	.	0.00	.	.	.
Westlands Water District	-0.205	0.845	16.983	1	0	1007	947	1.75	0.99	1.00	1.00	0.00
Glide Water District	-0.235	0.259	12.711	1	0	426	426	1.31	1.00	1.00	1.00	0.00
Kanawha Water District	0.072	0.458	13.293	1	0	357	357	1.99	1.00	1.00	1.00	0.00
Orland-Artois Water District	-0.470	0.541	14.021	1	0	158	153	0.64	1.00	1.00	1.00	0.00
Bard Water District	0.046	0.872	13.582	1	1	340	300	5.73	1.00	1.00	.	.
Berrenda Mesa Water District	-0.038	0.924	16.852	1	0	5500	4900	2.12	1.00	0.95	0.00	0.00
Kern Delta Water District	-0.011	0.885	15.077	1	0	313	280	1.14	1.00	1.00	0.00	0.00
Lost Hills Water District	-0.266	0.876	16.225	1	0	2880	1994	0.95	1.00	1.00	.	.
Dudley Ridge Water District	-0.157	0.951	15.343	1	0	6000	5484	1.44	1.00	1.00	0.00	0.00
Lakeside Irrigation Water District	-0.473	0.438	13.884	1	0	360	303	0.65	1.00	1.00	0.00	0.00
Le Grand-Athlone Water District	-0.531	0.428	9.711	1	0	375	375	.	1.00	.	0.00	0.00
Pacheco Water District	-0.199	0.927	13.593	1	0	367	358	2.92	1.00	0.83	0.69	0.00
Irvine Ranch Water District	0.244	0.281	17.749	0	0	5869	708	0.24	0.39	1.00	.	.
Los Alios Water District	0.017	0.785	15.623	0	0	1793	900	3.27	1.00	0.99	.	.
Rancho California Water District	-0.375	0.250	17.879	0	0	78	9	3.26	0.53	0.66	0.00	0.00
Riverview Water District	0.079	0.916	13.756	0	0	667	.	.	0.00	.	.	.
Plain View Water District	-0.463	0.454	12.721	1	0	150	145	2.43	0.96	1.00	1.00	0.00
Bella Vista Water District	0.209	0.790	14.691	0	0	34	7	1.18	0.58	0.67	1.00	0.00
South Sutter Water District	0.230	0.677	14.623	1	1	373	293	2.00	1.00	1.00	0.00	0.00

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	CVP exchange	SWP contract	Riparian rights	Approp. rights	91 Avg Ag $/AF	91 $/Acre	91 $/AF Cntrct	91 $/AF Divrd	ACWA - MI Price/AF	Storage AF/Ac	Tile Drain Ac/Ac	Unlined Canal Mi/Ac	Lined Canal Mi/Ac
Variable Name	*CVPX*	*SWP*	*Rip*	*App*	*AgPAF*	*AgPAc*	*AgCPAF*	*AgDPAF*	*MIPAF*	*StoreAc*	*TileAc*	*UninAc*	*LineAc*
San Juan Suburban Water District	0.00	0.00	0.60	0.20	.	.	.	.	.	.	.	.	.
Clear Creek Community Services District	0.00	0.00	0.00	0.00	.	.	.	.	.	0.00	0.000	0.0000	0.0000
San Benito County Water District	0.00	0.00	0.00	0.00	77.61	.	.	.	168.92	1.45	0.000	0.0002	0.0000
Reclamation District 108	0.00	0.00	0.86	0.00	5.00	.	.	.	.	0.00	0.000	0.0042	0.0007
Reclamation District 744	.	.	.	.	.	.	.	.	.	.	.	.	.
Reclamation District 2068	.	.	.	.	15.90	.	.	.	5.50	0.00	0.000	0.0068	0.0000
Reclamation District 307	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0063	0.0000
Reclamation District 900	.	.	.	.	.	15.00	0.00	0.00	.	0.00	0.000	0.0140	0.0000
Reclamation District 999	0.00	0.00	0.00	1.00	11.00	.	.	.	.	0.00	0.000	0.0100	0.0000
Fallbrook Public Utilities District	0.00	0.00	0.00	1.00	382.00	.	.	.	584.00	0.15	0.000	0.0000	0.0000
Biggs-West Gridley Water District	.	.	.	.	3.90	.	.	.	3.90	0.00	0.000	0.0017	0.0000
Butte Water District	0.00	0.00	0.00	1.00	.	.	.	.	.	0.00	0.000	0.0011	0.0000
Western Canal Water District	0.00	0.00	0.00	0.00	4.22	5.00	0.00	3.00	.	0.00	0.000	0.0011	0.0000
Westside Water District	0.00	0.00	0.00	0.00	22.50	.	.	.	.	0.00	0.000	0.0000	0.0000
Broadview Water District	0.00	0.00	0.00	0.00	18.00	.	.	.	25.00	0.00	0.722	0.0039	0.0000
International Water District	0.00	0.00	0.00	0.00	.	.	.	.	.	0.11	0.000	0.0000	0.0000
Panoche Water District	0.00	0.00	0.00	0.00	56.72	.	.	.	44.51	0.00	0.611	0.0003	0.0004
Pleasant Valley Water District	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0000	0.0000
Westlands Water District	0.00	0.00	0.00	0.00	47.04	5.76	0.00	43.75	95.00	0.00	0.000	0.0000	0.0000
Glide Water District	0.00	0.00	0.00	0.00	23.00	0.00	12.00	23.00	.	0.00	0.000	0.0000	0.0000
Kanawha Water District	0.00	0.00	0.00	0.00	23.71	0.00	12.00	23.71	.	0.00	0.000	0.0000	0.0000
Orland-Artois Water District	0.00	0.00	0.00	0.00	.	.	.	.	.	0.00	0.000	0.0000	0.0000
Bard Water District	.	.	.	.	.	.	.	.	.	0.00	0.013	0.0040	0.0005
Berrenda Mesa Water District	0.00	1.00	0.00	0.00	125.00	.	.	.	1500.00	0.00	0.000	0.0000	0.0030
Kern Delta Water District	0.00	0.11	0.00	0.89	20.68	7.30	30.17	0.00	.	0.00	0.004	0.0011	0.0000
Lost Hills Water District	.	.	.	.	80.00	.	.	.	.	0.00	0.120	0.0011	0.0002
Dudley Ridge Water District	0.00	1.00	0.00	0.00	235.00	66.50	0.00	194.10	.	0.00	0.000	0.0000	0.0004
Lakeside Irrigation Water District	0.00	0.00	0.00	0.00	30.00	.	.	.	.	0.00	0.000	0.0020	0.0000
Le Grand-Athlone Water District	0.00	0.00	0.00	0.00	35.00	.	.	.	.	0.00	0.000	0.0004	0.0000
Pacheco Water District	0.31	0.00	0.00	0.00	57.00	0.00	0.00	57.00	.	0.00	0.581	0.0040	0.0014
Irvine Ranch Water District	.	.	.	.	225.00	0.00	0.00	225.00	265.72	2.35	0.000	0.0000	0.0007
Los Alios Water District	.	.	.	.	.	.	.	.	.	0.09	0.000	0.0000	0.0000
Rancho California Water District	0.00	0.00	0.00	1.00	326.63	0.00	0.00	326.63	315.00	4.17	0.000	0.0000	0.0000
Riverview Water District	.	.	.	.	.	.	.	.	640.33	.	.	.	.
Plain View Water District	0.00	0.00	0.00	0.00	21.50	.	.	.	62.40	0.00	0.000	0.0000	0.0000
Bella Vista Water District	0.00	0.00	0.00	0.00	9.18	4.91	5.03	0.00	149.41	0.00	0.000	0.0000	0.0000
South Sutter Water District	0.00	0.00	0.00	1.00	7.15	.	.	.	.	2.37	0.000	0.0009	0.0000

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	Pipeline Mi/Ac	Orchard	Field	Produce	Nursery	Pasture	Misc	Drip	Sprinkler	Furrow	Border
Variable Name	*PipeAc*	*Orchard*	*Field*	*Produce*	*Nursery*	*Pasture*	*Misc*	*Drip*	*Sprinkler*	*Furrow*	*Border*
San Juan Suburban Water District	.	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Clear Creek Community Services District	0.0364	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
San Benito County Water District	0.0045	.	.	.	.	.	.	.	.	.	.
Reclamation District 108	0.0000	0.02	0.91	0.02	0.00	0.05	0.00	0.00	0.21	0.27	0.52
Reclamation District 744	.	.	.	.	.	.	.	.	.	.	.
Reclamation District 2068	0.0000	0.00	0.40	0.20	0.00	0.40	0.00	0.00	0.02	0.59	0.39
Reclamation District 307	0.0000	0.00	0.80	0.00	0.00	0.20	0.00	.	.	.	.
Reclamation District 900	0.0000	0.00	0.33	0.00	0.00	0.66	0.00	0.00	0.05	0.55	0.40
Reclamation District 999	0.0001	0.00	0.75	0.00	0.00	0.25	0.00	0.00	0.75	0.20	0.05
Fallbrook Public Utilities District	0.0250	0.40	0.20	0.20	0.20	0.00	0.00	0.25	0.75	0.00	0.00
Biggs-West Gridley Water District	0.0000	0.00	0.50	0.00	0.00	0.50	0.00	.	.	.	.
Butte Water District	0.0000	0.60	0.20	0.00	0.00	0.20	0.00	.	.	.	.
Western Canal Water District	0.0000	0.00	0.67	0.00	0.33	0.00	0.00	.	.	.	.
Westside Water District	0.0000	0.67	0.33	0.00	0.00	0.00	0.00	.	.	.	.
Broadview Water District	0.0000	0.00	0.67	0.33	0.00	0.00	0.00	.	.	.	.
International Water District	0.0161	1.00	0.00	0.00	0.00	0.00	0.00	0.20	0.80	0.00	0.00
Panoche Water District	0.0001	.	.	.	.	.	.	0.07	0.00	0.93	0.00
Pleasant Valley Water District	0.0000	0.00	1.00	0.00	0.00	0.00	0.00	.	.	.	.
Westlands Water District	0.0018	0.00	0.84	0.11	0.00	0.05	0.00	0.03	0.16	0.76	0.05
Glide Water District	0.0026	0.00	0.71	0.00	0.00	0.29	0.00	0.02	0.00	0.33	0.62
Kanawha Water District	0.0060	0.00	0.62	0.00	0.00	0.38	0.00	0.00	0.06	0.43	0.51
Orland-Artois Water District	0.0034	.	.	.	.	.	.	.	.	.	.
Bard Water District	0.0000	.	.	.	.	.	.	.	.	.	.
Berrenda Mesa Water District	0.0016	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Kern Delta Water District	0.0000	0.05	0.58	0.02	0.00	0.26	0.09	0.01	0.04	0.57	0.13
Lost Hills Water District	0.0009	.	.	.	.	.	.	.	.	.	.
Dudley Ridge Water District	0.0003	0.82	0.16	0.03	0.00	0.00	0.00	0.00	0.96	0.04	0.00
Lakeside Irrigation Water District	0.0000	0.03	0.75	0.02	0.00	0.20	0.00	.	.	.	.
Le Grand-Athlone Water District	0.0000	.	.	.	.	.	.	.	.	.	.
Pacheco Water District	0.0000	0.00	0.94	0.06	0.00	0.00	0.00	0.00	0.31	0.69	0.00
Irvine Ranch Water District	0.0682	0.63	0.00	0.15	0.22	0.00	0.00	0.80	0.20	0.00	0.00
Los Alios Water District	0.0370	.	.	.	.	.	.	.	.	.	.
Rancho California Water District	0.0406	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Riverview Water District	.	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Plain View Water District	0.0018	0.25	0.00	0.25	0.00	0.50	0.00	0.00	0.10	0.80	0.10
Bella Vista Water District	0.0129	0.33	0.00	0.33	0.00	0.33	0.00	.	.	.	.
South Sutter Water District	0.0001	0.08	0.83	0.00	0.00	0.08	0.00	0.01	0.04	0.00	0.95

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

	Water District	Data Code	County	Controller Dist Type	Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire	%Op/Rev	Op Rev / Exp.
	Variable Name	*Code*	*Co*	*Type*	*Mtn*	*CC*	*SV*	*SJV*	*TLB*	*SC*	*IE*	*OpRvRv*	*OpRvEx*
38	Sutter Extension Water District	5141002	51	41	0	0	1	0	0	0	0	0.961	5.361
39	Angiola Water District	5441001	54	41	0	0	0	0	1	0	0	0.905	0.940
40	Atwell Island Water District	5441002	54	41	0	0	0	0	1	0	0	0.149	0.175
41	St. Johns Water District	5441003	54	41	0	0	0	0	1	0	0	0.618	0.778
42	Tea Pot Dome Water District	5441004	54	41	0	0	0	0	1	0	0	0.755	0.895
43	Dunnigan Water District	5741004	57	41	0	0	1	0	0	0	0	0.423	0.887
44	Colusa County Water District	642003	6	42	0	0	1	0	0	0	0	0.320	0.610
45	Contra Costa Water District	742001	7	42	0	1	0	0	0	0	0	0.845	2.221
46	Free Water County Water District	1042006	10	42	0	0	0	1	0	0	0	0.962	1.029
47	Kings County Water District	1642003	16	42	0	0	0	0	1	0	0	0.469	0.791
48	La Habra Heights County Water District	1942001	19	42	0	0	0	0	0	1	0	0.597	1.134
49	Mesa Consolidated Water District	3042003	30	42	0	0	1	0	0	0	0	0.915	1.415
50	Coachella Valley County Water District	3342002	33	42	0	0	0	0	0	0	1	0.731	1.271
51	Vallecitos Water District	3742003	37	42	0	0	0	0	0	1	0	0.820	1.293
52	Carpenteria County Water District	4242001	42	42	0	0	0	0	0	1	0	0.927	1.241
53	Goleta Water District	4242002	42	42	0	0	0	0	0	1	0	0.906	1.434
54	Montecito Water District	4242003	42	42	0	0	0	0	0	1	0	0.933	1.363
55	Summerland County Water District	4242004	42	42	0	0	0	0	0	1	0	0.930	1.146
56	Camrosa County Water District	5642001	56	42	0	0	0	0	0	1	0	0.752	0.999
57	Elsinore Valley Municipal Water District	3344003	33	44	0	0	0	0	0	0	1	0.640	1.179
58	Lake Hemet Municipal Water District	3344004	33	44	0	0	0	0	0	0	1	0.844	1.078
59	Western Municipal Water District	3344005	33	44	0	0	0	0	0	0	1	0.729	0.803
60	Olivenhain Municipal Water District	3744004	37	44	0	0	0	0	0	1	0	0.826	1.213
61	Otay Water District	3744005	37	44	0	0	0	0	0	1	0	0.674	1.246
62	Rainbow Municipal Water District	3744006	37	44	0	0	0	0	0	1	0	0.770	0.997
63	Ramona Municipal Water District	3744007	37	44	0	0	0	0	0	1	0	0.739	1.195
64	Rincon del Diablo Municipal Water District	3744008	37	44	0	0	0	0	0	1	0	0.821	1.115
65	Valley Center Municipal Water District	3744009	37	44	0	0	0	0	0	1	0	0.836	1.020
66	Yuima Municipal Water District	3744010	37	44	0	0	0	0	0	1	0	0.766	1.015
67	Casitas Municipal Water District	5644002	56	44	0	0	0	0	0	1	0	0.402	0.668
68	Placer County Water Agency	3145001	31	45	1	0	0	0	0	0	0	0.753	1.669
69	San Diego County Water Authority	3745011	37	45	0	0	0	0	0	1	0	0.839	1.173
70	Antelope Valley-East Kern Water Agency	1545004	15	45	0	0	0	0	0	1	0	0.228	0.763
71	Kaweah Delta Water Conservation District	5446005	54	46.3	0	0	0	0	1	0	0	0.000	.
72	North San Joaquin Water Conservation Distri	3946002	39	46.4	0	0	0	1	0	0	0	0.075	0.095
73	Santa Maria Valley Water Conservation Distri	4246005	42	46.4	0	0	0	0	0	1	0	.	.
74	Santa Ynez River Water Conservation Distric	4246006	42	46.4	0	0	0	0	0	1	0	0.541	0.900

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	% Net Inc / Exp	% Op Exp / Exp	LN(Total Expenses)	Voting	Electric Sales	Ac/ Farm	IrrAc/ Farm	Avg AF / Ac	%Ag AF	% Surface Water-91	CVP class 1	CVP class 2
Variable Name	*NetInc*	*OpExEx*	*LSize*	*Vote*	*Electric*	*AcFarm*	*IAcFarm*	*AFAc*	*PAgAF*	*SW91*	*CVP1*	*CVP2*
Sutter Extension Water District	3.929	0.902	12.981	1	0	200	198	4.75	1.00	1.00	.	.
Angiola Water District	-0.092	0.963	14.665	1	0	10065	9333	0.96	1.00	0.00	.	.
Atwell Island Water District	-0.825	0.852	10.629	1	0	583	498	.	0.00	.	.	.
St. Johns Water District	0.210	0.962	11.520	1	0	583	563	.	0.00	.	.	.
Tea Pot Dome Water District	0.073	0.906	13.097	1	0	30	30	1.73	1.00	1.00	1.00	0.00
Dunnigan Water District	-0.519	0.476	12.708	1	0	211	211	1.11	1.00	1.00	1.00	0.00
Colusa County Water District	-0.093	0.524	14.064	0	0	148	146	1.31	1.00	1.00	1.00	0.00
Contra Costa Water District	0.654	0.629	17.514	0	0	252	18	0.83	0.01	1.00	1.00	0.00
Free Water County Water District	-0.008	0.954	10.020	0	0	30	27	0.72	1.00	1.00	0.00	0.00
Kings County Water District	0.652	0.980	13.356	0	0	.	.	.	1.00	.	0.00	0.00
La Habra Heights County Water District	0.216	0.640	14.611	0	0	42	39	0.62	1.00	1.00	0.00	0.00
Mesa Consolidated Water District	0.096	0.709	16.225	0	0	384	384	0.08	0.00	0.40	.	.
Coachella Valley County Water District	0.440	0.828	17.344	0	0	534	65	2.84	0.78	1.00	0.00	0.00
Vallecitos Water District	0.352	0.858	15.770	0	0	182	45	0.34	0.19	1.00	.	.
Carpenteria County Water District	-0.040	0.747	14.647	0	0	21	8	1.52	1.00	0.35	0.00	0.00
Goleta Water District	0.283	0.812	15.943	0	0	162	20	.	0.21	.	.	.
Montecito Water District	0.161	0.795	15.085	0	0	183	18	0.76	0.13	0.89	0.00	0.00
Summerland County Water District	0.040	0.844	12.782	0	0	.	.	.	1.00	1.00	.	.
Camrosa County Water District	0.057	0.798	15.508	0	0	.	.	.	0.00	.	.	.
Elsinore Valley Municipal Water District	0.465	0.795	16.333	0	0	59	25	1.55	0.40	1.00	.	.
Lake Hemet Municipal Water District	-0.010	0.783	15.462	0	0	330	50	0.98	0.40	1.00	.	.
Western Municipal Water District	0.022	0.927	17.063	0	0	1883	35	0.42	0.42	1.00	.	.
Olivenhain Municipal Water District	0.112	0.757	16.102	0	1	78	50	0.09	0.14	1.00	.	.
Otay Water District	0.423	0.769	16.629	0	0	410	10	2.93	0.03	1.00	.	.
Rainbow Municipal Water District	-0.159	0.772	16.418	0	0	.	.	0.96	0.85	1.00	.	.
Ramona Municipal Water District	0.075	0.665	16.119	0	0	.	118	0.00	0.53	0.00	.	.
Rincon del Diablo Municipal Water District	0.077	0.793	15.269	0	0	83	7	1.60	0.15	1.00	.	.
Valley Center Municipal Water District	0.100	0.902	16.764	0	0	40	6	3.92	0.76	1.00	.	.
Yuima Municipal Water District	0.175	0.886	14.398	0	0	.	13	0.95	0.97	1.00	.	.
Casitas Municipal Water District	0.357	0.816	15.324	0	0	349	20	1.82	0.47	1.00	.	.
Placer County Water Agency	-0.111	0.451	16.626	0	0	.	.	1.11	0.88	1.00	0.49	0.00
San Diego County Water Authority	0.234	0.882	18.715	0	1	.	.	0.28	0.18	1.00	.	.
Antelope Valley-East Kern Water Agency	1.209	0.642	16.231	0	0	.	1111	0.13	0.18	0.05	0.00	0.00
Kaweah Delta Water Conservation District	-0.419	0.000	14.174	1	0	.	.	.	0.00	.	.	.
North San Joaquin Water Conservation Distri	0.090	0.854	11.778	0	0	502	427	0.16	1.00	1.00	.	.
Santa Maria Valley Water Conservation Distri	.	.	0.000	0	0	450	400	0.15	1.00	1.00	0.00	0.00
Santa Ynez River Water Conservation Distric	0.098	0.661	14.612	0	0	.	.	.	0.00	.	.	.

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	CVP exchange	SWP contract	Riparian rights	Approp. rights	91 Avg Ag $/AF	91 $/Acre	91 $/AF Cntrct	91 $/AF Divrd	ACWA - MI Price/AF	Storage AF/Ac	Tile Drain Ac/Ac	Unlined Canal Mi/Ac	Lined Canal Mi/Ac
Variable Name	*CVPX*	*SWP*	*Rip*	*App*	*AgPAF*	*AgPAc*	*AgCPAF*	*AgDPAF*	*MIPAF*	*StoreAc*	*TileAc*	*UnlnAc*	*LineAc*
Sutter Extension Water District	.	.	.	.	4.94	23.50	0.00	0.00	.	0.00	0.000	0.0019	0.0000
Angiola Water District	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0059	0.0000
Atwell Island Water District	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0000	0.0000
St. Johns Water District	.	.	.	.	.	5.00	0.00	0.00	.	0.00	0.000	0.0022	0.0000
Tea Pot Dome Water District	0.00	0.00	0.00	0.00	74.69	27.50	13.11	58.75	.	0.00	0.000	0.0000	0.0000
Dunnigan Water District	0.00	0.00	0.00	0.00	20.00	20.00	7.35	12.65	73.95	0.00	0.000	0.0000	0.0000
Colusa County Water District	0.00	0.00	0.00	0.00	31.14	16.00	8.16	12.00	.	0.00	0.000	0.0000	0.0000
Contra Costa Water District	0.00	0.00	0.00	0.00	85.00	0.00	0.00	1068.00	1290.00	0.00	0.003	0.0378	0.0000
Free Water County Water District	0.00	0.00	0.00	1.00	.	.	.	.	.	0.00	0.000	0.0017	0.0000
Kings County Water District	0.00	0.00	0.00	0.00	5.00	.	.	.	.	0.00	0.000	0.0015	0.0000
La Habra Heights County Water District	0.00	0.00	0.00	1.00	431.24	.	.	.	.	0.01	0.000	0.0000	0.0000
Mesa Consolidated Water District	.	.	.	.	.	.	.	.	579.35	3.53	0.000	0.0000	0.0000
Coachella Valley County Water District	0.00	1.00	0.00	0.00	13.25	0.00	13.25	13.25	.	0.02	0.484	0.0005	0.0010
Vallecitos Water District	.	.	.	.	425.00	0.00	0.00	425.00	653.00	0.41	0.000	0.0000	0.0000
Carpenteria County Water District	0.00	1.00	0.00	0.00	435.00	1.00	25.00	1.00	.	0.00	0.000	0.0000	0.0000
Goleta Water District	.	.	.	.	392.00	.	.	.	1315.00	0.01	0.000	0.0000	0.0000
Montecito Water District	0.00	0.57	0.00	0.43	893.39	356.53	22.48	1130.12	1130.12	4.71	0.000	0.0000	0.0000
Summerland County Water District	.	.	.	.	.	.	.	.	.	.	.	.	.
Camrosa County Water District	.	.	.	.	.	.	.	.	.	.	.	.	.
Elsinore Valley Municipal Water District	.	.	.	.	292.00	.	.	.	357.00	2.55	11.640	0.0004	0.0004
Lake Hemet Municipal Water District	.	.	.	.	325.00	.	.	.	752.00	5.24	0.000	0.0000	0.0080
Western Municipal Water District	.	.	.	.	0.00	0.00	241.50	0.00	470.00	0.03	0.000	0.0000	0.0000
Olivenhain Municipal Water District	.	.	.	.	616.98	0.00	616.98	0.00	757.00	0.01	0.000	0.0000	0.0000
Otay Water District	.	.	.	.	.	.	.	.	621.00	2.05	0.000	0.0000	0.0000
Rainbow Municipal Water District	.	.	.	.	392.04	0.00	0.00	392.04	622.90	0.09	0.000	0.0000	0.0000
Ramona Municipal Water District	.	.	.	.	650.00	.	.	.	696.00	0.08	0.000	0.0000	0.0000
Rincon del Diablo Municipal Water District	.	.	.	.	475.81	.	.	.	567.07	0.00	0.000	0.0000	0.0000
Valley Center Municipal Water District	.	.	.	.	446.00	0.00	0.00	446.00	601.00	0.21	0.000	0.0000	0.0000
Yuima Municipal Water District	.	.	.	.	457.31	.	.	.	512.12	0.01	0.000	0.0000	0.0000
Casitas Municipal Water District	.	.	.	.	313.63	.	.	.	407.83	0.01	0.000	0.0000	0.0000
Placer County Water Agency	0.00	0.00	0.00	0.51	51.97	.	.	.	375.41	5.32	0.000	0.0006	0.0018
San Diego County Water Authority	.	.	.	.	141.50	.	.	.	482.00	0.00	0.000	0.0000	0.0000
Antelope Valley-East Kern Water Agency	0.00	1.00	0.00	0.00	75.00	.	.	.	170.00	0.00	0.000	0.0000	0.0000
Kaweah Delta Water Conservation District	.	.	.	.	.	.	.	.	.	0.07	0.000	0.0007	0.0000
North San Joaquin Water Conservation Distri	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0000	0.0000
Santa Maria Valley Water Conservation Distri	0.00	0.00	0.00	1.00	.	.	.	.	.	3.75	0.000	0.0000	0.0000
Santa Ynez River Water Conservation Distric	.	.	.	.	.	.	.	.	.	0.01	0.000	0.0000	0.0000

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	Pipeline Mi/Ac	Orchard	Field	Produce	Nursery	Pasture	Misc	Drip	Sprinkler	Furrow	Border
Variable Name	*PipeAc*	*Orchard*	*Field*	*Produce*	*Nursery*	*Pasture*	*Misc*	*Drip*	*Sprinkler*	*Furrow*	*Border*
Sutter Extension Water District	0.0000	0.04	0.96	0.00	0.00	0.00	0.00	.	.	.	.
Angiola Water District	0.0000	.	.	.	.	.	.	.	.	.	.
Atwell Island Water District	0.0000	0.00	0.50	0.00	0.00	0.50	0.00	.	.	.	.
St. Johns Water District	0.0000	0.50	0.33	0.00	0.00	0.17	0.00	0.01	0.00	0.69	0.30
Tea Pot Dome Water District	0.0052	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.07	0.00
Dunnigan Water District	0.0025	0.20	0.51	0.02	0.00	0.27	0.00	0.10	0.85	0.75	0.74
Colusa County Water District	0.0027	0.85	0.09	0.00	0.00	0.06	0.00	0.24	0.50	0.26	0.00
Contra Costa Water District	0.0000	0.90	0.00	0.00	0.00	0.10	0.00	.	.	.	.
Free Water County Water District	0.0006	1.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.84	0.00
Kings County Water District	0.0000	.	.	.	.	.	.	.	.	.	.
La Habra Heights County Water District	0.0385	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Mesa Consolidated Water District	29.8464	.	.	.	.	.	.	.	.	.	.
Coachella Valley County Water District	0.0057	0.81	0.13	0.00	0.00	0.06	0.00	0.46	0.06	0.30	0.12
Vallecitos Water District	0.0343	0.81	0.00	0.00	0.00	0.00	0.19	0.50	0.50	0.00	0.00
Carpenteria County Water District	0.0207	0.68	0.00	0.00	0.27	0.02	0.04	0.51	0.43	0.06	0.00
Goleta Water District	0.0500	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Montecito Water District	0.1016	0.67	0.00	0.00	0.00	0.00	0.33	0.70	0.30	0.00	0.00
Summerland County Water District	.	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Camrosa County Water District	.	.	.	.	.	.	.	.	.	.	.
Elsinore Valley Municipal Water District	0.0182	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Lake Hemet Municipal Water District	0.1000	.	.	.	.	.	.	.	.	.	.
Western Municipal Water District	0.0287	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Olivenhain Municipal Water District	0.0175	0.71	0.00	0.00	0.29	0.00	0.00	0.44	0.56	0.00	0.00
Otay Water District	1.7000	.	.	.	.	.	.	.	.	.	.
Rainbow Municipal Water District	0.0222	0.67	0.00	0.00	0.33	0.00	0.00	.	.	.	.
Ramona Municipal Water District	0.0045	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Rincon del Diablo Municipal Water District	0.1581	1.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Valley Center Municipal Water District	0.0297	0.67	0.00	0.00	0.33	0.00	0.00	0.40	0.60	0.00	0.00
Yuima Municipal Water District	0.0068	1.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00
Casitas Municipal Water District	0.0189	1.00	0.00	0.00	0.00	0.00	0.00	0.95	0.05	0.00	0.00
Placer County Water Agency	0.0050	0.50	0.00	0.00	0.50	0.00	0.00	.	.	.	.
San Diego County Water Authority	0.0033	0.75	0.00	0.14	0.11	0.00	0.00	.	.	.	.
Antelope Valley-East Kern Water Agency	0.0010	0.50	0.00	0.00	0.00	0.50	0.00	.	.	.	.
Kaweah Delta Water Conservation District	0.0001	.	.	.	.	.	.	.	.	.	.
North San Joaquin Water Conservation Distri	0.0003	.	.	.	.	.	.	.	.	.	.
Santa Maria Valley Water Conservation Distri	0.0000	0.00	0.20	0.80	0.00	0.00	0.00	.	.	.	.
Santa Ynez River Water Conservation Distric	0.0165	0.50	0.25	0.00	0.00	0.25	0.00	.	.	.	.

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

	Water District	Data Code	County	Controller Dist Type	Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire	%Op/Rev	Op Rev / Exp.
	Variable Name	*Code*	*Co*	*Type*	*Mtn*	*CC*	*SV*	*SJV*	*TLB*	*SC*	*IE*	*OpRvRv*	*OpRvEx*
75	United Water Conservation District	5648003	56	46.4	0	0	0	0	0	1	0	0.803	0.976
76	Arvin-Edison Water Storage District	1548005	15	48	0	0	0	0	1	0	0	0.808	0.915
77	Belridge Water Storage District	1548006	15	48	0	0	0	0	1	0	0	0.824	0.895
78	Buena Vista Water Storage District	1548007	15	48	0	0	0	0	1	0	0	0.715	0.839
79	North Kern Water Storage District	1548008	15	48	0	0	0	0	1	0	0	0.879	0.922
80	Rosedale-Rio Bravo Water Storage District	1548009	15	48	0	0	0	0	1	0	0	0.844	1.380
81	Semitropic Water Storage District	1548010	15	48	0	0	0	0	1	0	0	0.099	0.121
82	Wheeler Ridge-Maricopa Water Storage Dist	1548011	15	48	0	0	0	0	1	0	0	0.893	1.227
83	Oroville-Wyandotte Irrigation District	452004	4	52	0	0	1	0	0	0	0	1.010	1.710
84	Paradise Irrigation District	452005	4	52	0	0	1	0	0	0	0	0.734	1.250
85	Maxwell Irrigation District	652004	6	52	0	0	1	0	0	0	0	0.937	0.998
86	Byron Bethany Irrigation District	752002	7	52	0	1	0	0	0	0	0	0.627	0.713
87	East Contra Costa Irrigation District	752003	7	52	0	1	0	0	0	0	0	0.816	1.130
88	El Dorado Irrigation District	952001	9	52	1	0	0	0	0	0	0	0.177	1.423
89	Consolidated Irrigation District	1052007	10	52	0	0	0	1	0	0	0	0.833	0.984
90	James Irrigation District	1052008	10	52	0	0	0	1	0	0	0	0.828	1.122
91	Laguna Irrigation District	1052009	10	52	0	0	0	1	0	0	0	0.000	0.000
92	Orange Cove Irrigation District	1052010	10	52	0	0	0	1	0	0	0	0.922	0.968
93	Tranquility Irrigation District	1052011	10	52	0	0	0	1	0	0	0	0.853	0.947
94	Glenn-Colusa Irrigation District	1152004	11	52	0	0	1	0	0	0	0	0.735	0.979
95	Imperial Irrigation District	1352002	13	52	0	0	0	0	0	0	1	0.495	1.243
96	Shafter-Wasco Irrigation District	1552012	15	52	0	0	0	0	1	0	0	0.804	1.283
97	Empire West Side Irrigation District	1652004	16	52	0	0	0	0	1	0	0	0.682	0.807
98	Littlerock Creek Irrigation District	1952002	19	52	0	0	0	0	0	1	0	0.420	0.598
99	Madera Irrigation District	2052001	20	52	0	0	0	1	0	0	0	0.468	0.515
100	Central California Irrigation District	2452003	24	52	0	0	0	1	0	0	0	0.816	0.888
101	Merced Irrigation District	2452004	24	52	0	0	0	1	0	0	0	0.699	0.896
102	Nevada Irrigation District	2952001	29	52	1	0	0	0	0	0	0	0.495	1.192
103	Carpenter Irrigation District	3052004	30	52	0	0	0	0	0	1	0	0.015	0.019
104	Serrano Irrigation District	3052005	30	52	0	0	0	0	0	1	0	0.705	0.997
105	Palo Verde Irrigation District	3352006	33	52	0	0	0	0	0	0	1	0.806	0.989
106	Galt Irrigation District	3452003	34	52	0	0	1	0	0	0	0	0.709	0.856
107	San Dieguito Water District	3752012	37	52	0	0	0	0	0	1	0	0.824	1.382
108	Santa Fe Irrigation District	3752013	37	52	0	0	0	0	0	1	0	0.819	1.121
109	Banta Carbona Irrigation District	3952003	39	52	0	0	0	1	0	0	0	0.649	0.690
110	South San Joaquin Irrigation District	3952004	39	52	0	0	0	1	0	0	0	0.145	0.285
111	West Side Irrigation District	3952005	39	52	0	0	0	1	0	0	0	0.574	0.617

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	% Net Inc / Exp	% Op Exp / Exp	LN(Total Expenses)	Voting	Electric Sales	Ac/ Farm	IrrAc/ Farm	Avg AF / Ac	%Ag AF	% Surface Water-91	CVP class 1	CVP class 2
Variable Name	*NetInc*	*OpExEx*	*LSize*	*Vote*	*Electric*	*AcFarm*	*IAcFarm*	*AFAc*	*PAgAF*	*SW91*	*CVP1*	*CVP2*
United Water Conservation District	0.076	0.890	15.442	0	1	208	183	0.12	0.55	0.20	0.00	0.00
Arvin-Edison Water Storage District	-0.088	0.883	16.226	1	0	440	170	2.67	0.99	0.29	0.11	0.89
Belridge Water Storage District	-0.135	0.921	16.368	1	0	16000	8667	1.75	0.92	1.00	0.00	0.00
Buena Vista Water Storage District	0.061	0.905	14.873	1	0	500	400	1.38	1.00	1.00	0.00	0.00
North Kern Water Storage District	-0.090	0.954	15.829	1	0	1000	938	1.66	1.00	0.15	0.00	0.00
Rosedale-Rio Bravo Water Storage District	0.496	0.915	14.431	1	0	.	.	0.24	1.00	1.00	0.00	0.00
Semitropic Water Storage District	-0.363	0.818	15.991	1	0	1692	1049	1.11	1.00	0.19	0.00	0.00
Wheeler Ridge-Maricopa Water Storage Dist	0.158	0.842	16.717	1	0	1125	1088	1.66	1.00	1.00	0.00	0.00
Oroville-Wyandotte Irrigation District	0.378	0.745	16.134	0	1	.	.	.	0.00	1.00	.	.
Paradise Irrigation District	0.165	0.684	14.755	0	0	288	5	1.49	0.05	1.00	0.00	0.00
Maxwell Irrigation District	-0.026	0.940	12.682	0	0	.	.	.	1.00	1.00	0.33	0.00
Byron Bethany Irrigation District	-0.109	0.879	13.933	0	0	159	118	2.95	1.00	1.00	.	.
East Contra Costa Irrigation District	0.240	0.895	14.369	0	0	112	76	2.68	1.00	0.94	0.00	0.00
El Dorado Irrigation District	-0.716	0.124	17.790	0	0	583	22	0.46	0.29	1.00	1.00	0.00
Consolidated Irrigation District	0.075	0.909	14.563	0	0	27	27	0.90	1.00	1.00	.	.
James Irrigation District	0.259	0.930	14.663	0	0	578	511	3.43	1.00	0.19	1.00	0.00
Laguna Irrigation District	0.103	0.874	13.122	0	0	47	45	0.00	1.00	1.00	1.00	0.00
Orange Cove Irrigation District	-0.016	0.952	14.430	0	0	59	56	1.27	1.00	1.00	1.00	0.00
Tranquility Irrigation District	-0.044	0.901	13.724	0	0	307	285	2.95	1.00	0.84	0.41	0.00
Glenn-Colusa Irrigation District	-0.090	0.749	15.474	0	1	206	165	5.65	1.00	1.00	0.13	0.00
Imperial Irrigation District	0.069	0.802	18.887	0	1	1712	788	5.24	1.00	1.00	0.00	0.00
Shafter-Wasco Irrigation District	0.364	0.855	14.034	0	0	165	139	1.38	1.00	1.00	0.56	0.44
Empire West Side Irrigation District	-0.049	0.845	11.534	0	0	1071	1000	0.76	1.00	1.00	0.00	0.00
Littlerock Creek Irrigation District	-0.225	0.703	13.744	0	0	250	9	.	0.37	.	0.00	0.00
Madera Irrigation District	0.091	0.975	15.236	0	1	160	133	0.57	1.00	1.00	0.31	0.69
Central California Irrigation District	-0.093	0.918	15.536	0	0	192	180	4.04	1.00	0.87	0.00	0.00
Merced Irrigation District	0.170	0.924	16.137	0	1	18	33	.	1.00	.	0.00	0.00
Nevada Irrigation District	0.437	0.691	16.581	0	1	40	13	1.25	0.92	1.00	0.00	0.00
Carpenter Irrigation District	0.158	0.898	11.631	0	0	6	6	14.48	1.00	1.00	.	.
Serrano Irrigation District	-0.228	0.708	14.173	0	0	64	6	6.37	1.00	0.49	.	.
Palo Verde Irrigation District	-0.001	0.815	15.298	0	0	400	310	9.61	1.00	1.00	.	.
Galt Irrigation District	0.206	0.999	10.400	0	0	.	.	15.17	1.00	1.00	.	.
San Dieguito Water District	0.211	0.722	15.447	0	0	28	6	0.18	0.17	1.00	0.00	0.00
Santa Fe Irrigation District	0.243	0.906	15.746	0	0	42	42	0.07	0.06	1.00	.	.
Banta Carbona Irrigation District	-0.031	0.940	14.254	0	0	176	142	3.47	1.00	0.99	0.11	0.00
South San Joaquin Irrigation District	-0.426	0.683	15.809	0	1	20	17	1.50	1.00	1.00	0.00	0.00
West Side Irrigation District	-0.286	0.931	13.403	0	0	60	60	0.09	1.00	1.00	1.00	0.00

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	CVP exchange	SWP contract	Riperian rights	Approp. rights	91 Avg Ag $/AF	91 $/Acre	91 $/AF Cntrct	91 $/AF Divrd	ACWA - MI Price/AF	Storage AF/Ac	Tile Drain Ac/Ac	Unlined Canal Mi/Ac	Lined Canal Mi/Ac
Variable Name	*CVPX*	*SWP*	*Rip*	*App*	*AgPAF*	*AgPAc*	*AgCPAF*	*AgDPAF*	*MIPAF*	*StoreAc*	*TileAc*	*UninAc*	*LineAc*
United Water Conservation District	0.00	1.00	0.00	0.00	54.00	.	.	.	192.00	0.81	0.000	0.0000	0.0000
Arvin-Edison Water Storage District	0.00	0.00	0.00	0.00	71.22	6.65	29.00	40.00	38.00	0.00	0.000	0.0000	0.0009
Belridge Water Storage District	0.00	1.00	0.00	0.00	90.00	0.00	25.00	300.00	65.00	0.00	0.000	0.0002	0.0005
Buena Vista Water Storage District	0.00	0.16	0.00	0.84	23.87	32.99	0.00	0.00	.	2.98	0.000	0.0031	0.0013
North Kern Water Storage District	0.00	0.00	0.00	1.00	68.02	5.00	0.00	65.00	.	0.00	0.000	0.0013	0.0004
Rosedale-Rio Bravo Water Storage District	0.00	1.00	0.00	0.00	.	.	.	.	.	0.00	0.000	0.0000	0.0000
Semitropic Water Storage District	0.00	1.00	0.00	0.00	46.50	.	.	.	.	0.00	0.000	0.0002	0.0001
Wheeler Ridge-Maricopa Water Storage Dist	0.00	1.00	0.00	0.00	565.22	211.00	0.00	453.00	.	0.00	0.000	0.0000	0.0001
Oroville-Wyandotte Irrigation District	.	.	.	.	.	.	.	.	474.63	.	.	.	.
Paradise Irrigation District	0.00	0.00	0.00	1.00	65.34	.	.	.	.	68.31	0.000	0.0000	0.0000
Maxwell Irrigation District	0.00	0.00	0.00	0.67	.	.	.	.	.	.	.	.	.
Byron Bethany Irrigation District	.	.	.	.	19.50	.	.	.	.	0.00	0.846	0.0015	0.0019
East Contra Costa Irrigation District	0.00	0.00	0.00	1.00	28.50	.	.	.	.	0.00	0.320	0.0002	0.0080
El Dorado Irrigation District	0.00	0.00	0.00	0.00	30.57	.	.	.	362.32	0.00	0.000	0.0000	0.0000
Consolidated Irrigation District	.	.	.	.	15.58	14.00	0.00	0.00	.	0.00	0.000	0.0023	0.0003
James Irrigation District	0.00	0.00	0.00	0.00	46.00	.	.	.	.	0.00	0.000	0.0039	0.0000
Laguna Irrigation District	0.00	0.00	0.00	0.00	.	.	.	.	.	1.52	0.091	0.0015	0.0000
Orange Cove Irrigation District	0.00	0.00	0.00	0.00	50.00	.	.	.	.	0.00	0.000	0.0000	0.0000
Tranquility Irrigation District	0.59	0.00	0.00	0.00	33.75	14.00	0.00	29.00	.	0.00	0.000	0.0027	0.0000
Glenn-Colusa Irrigation District	0.00	0.00	0.00	0.87	4.23	23.88	0.00	0.00	.	0.00	0.000	0.0029	0.0000
Imperial Irrigation District	0.00	0.00	0.00	1.00	11.50	.	.	.	.	0.01	0.819	0.0014	0.0020
Shafter-Wasco Irrigation District	0.00	0.00	0.00	0.00	27.35	4.00	9.92	25.00	.	0.00	0.000	0.0000	0.0023
Empire West Side Irrigation District	0.00	0.19	0.00	0.81	.	.	.	.	.	0.21	0.000	0.0021	0.0000
Littlerock Creek Irrigation District	0.00	0.00	0.00	1.00	80.00	.	.	.	290.00	3.74	0.000	0.0000	0.0114
Madera Irrigation District	0.00	0.00	0.00	0.00	20.00	0.00	20.00	0.00	.	0.02	0.000	0.1635	0.0068
Central California Irrigation District	1.00	0.00	0.00	0.00	5.50	.	.	.	.	0.00	0.026	0.0019	0.0003
Merced Irrigation District	0.00	0.00	0.00	0.00	22.00	.	.	.	.	0.00	0.000	0.0077	0.0008
Nevada Irrigation District	0.00	0.00	0.00	1.00	18.47	.	.	.	420.88	3.11	0.000	0.0033	0.0011
Carpenter Irrigation District	.	.	.	.	26.00	56.00	0.00	0.00	.	0.00	0.000	0.0000	0.0000
Serrano Irrigation District	.	.	.	.	.	.	.	.	.	78.13	0.000	0.0000	0.0000
Palo Verde Irrigation District	.	.	.	.	4.27	41.00	0.00	0.00	.	0.00	0.000	0.0023	0.0004
Galt Irrigation District	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0000	0.0000
San Dieguito Water District	0.00	0.00	0.00	1.00	588.00	.	.	.	627.40	0.37	0.000	0.0000	0.0000
Santa Fe Irrigation District	.	.	.	.	469.80	.	.	.	601.12	0.04	0.000	0.0000	0.0004
Banta Carbona Irrigation District	0.00	0.00	0.42	0.46	21.00	0.00	9.71	21.00	.	0.00	0.448	0.0052	0.0019
South San Joaquin Irrigation District	0.00	0.00	0.00	1.00	6.00	20.00	0.00	0.00	32.60	0.80	0.000	0.0039	0.0008
West Side Irrigation District	0.00	0.00	0.00	0.00	.	.	.	.	.	0.00	0.333	0.0013	0.0003

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	Pipeline Mi/Ac	Orchard	Field	Produce	Nursery	Pasture	Misc	Drip	Sprinkler	Furrow	Border
Variable Name	*PipeAc*	*Orchard*	*Field*	*Produce*	*Nursery*	*Pasture*	*Misc*	*Drip*	*Sprinkler*	*Furrow*	*Border*
United Water Conservation District	0.0005	0.43	0.00	0.43	0.14	0.00	0.00	.	.	.	.
Arvin-Edison Water Storage District	0.0034	0.42	0.14	0.41	0.00	0.04	0.00	0.23	0.52	0.24	0.00
Belridge Water Storage District	0.0013	0.27	0.73	0.00	0.00	0.00	0.00	.	.	.	.
Buena Vista Water Storage District	0.0013	0.00	0.91	0.00	0.00	0.09	0.00	0.00	0.00	0.90	0.10
North Kern Water Storage District	0.0000	0.40	0.40	0.00	0.00	0.20	0.00	0.20	0.30	0.30	0.20
Rosedale-Rio Bravo Water Storage District	0.0000	0.00	0.50	0.25	0.00	0.25	0.00	.	.	.	.
Semitropic Water Storage District	0.0010	0.12	0.57	0.00	0.00	0.31	0.00	.	.	.	.
Wheeler Ridge-Maricopa Water Storage Dist	0.0040	0.53	0.23	0.23	0.00	0.00	0.00	.	.	.	.
Oroville-Wyandotte Irrigation District	.	.	.	.	.	.	.	.	.	.	.
Paradise Irrigation District	0.8738	0.99	0.00	0.00	0.00	0.00	0.01	.	.	.	.
Maxwell Irrigation District	.	.	.	.	.	.	.	.	.	.	.
Byron Bethany Irrigation District	0.0017	0.20	0.60	0.00	0.00	0.20	0.00	0.07	0.07	0.23	0.63
East Contra Costa Irrigation District	0.0024	0.00	0.50	0.00	0.00	0.50	0.00	.	.	.	.
El Dorado Irrigation District	0.1569	0.33	0.00	0.33	0.00	0.33	0.00	.	.	.	.
Consolidated Irrigation District	0.0007	0.50	0.00	0.50	0.00	0.00	0.00	0.15	0.00	0.85	0.00
James Irrigation District	0.0001	.	.	.	.	.	.	.	.	.	.
Laguna Irrigation District	0.0012	.	.	.	.	.	.	.	.	.	.
Orange Cove Irrigation District	0.0042	0.67	0.33	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00
Tranquility Irrigation District	0.0005	0.00	0.74	0.04	0.00	0.23	0.00	0.00	0.05	0.95	0.00
Glenn-Colusa Irrigation District	0.0000	0.02	0.90	0.00	0.00	0.07	0.00	0.15	0.32	0.39	0.91
Imperial Irrigation District	0.0000	0.00	0.00	0.28	0.00	0.72	0.00	.	.	.	.
Shafter-Wasco Irrigation District	0.0034	0.35	0.37	0.10	0.00	0.18	0.00	0.02	0.41	0.11	0.46
Empire West Side Irrigation District	0.0000	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.10	0.70	0.20
Littlerock Creek Irrigation District	0.2143	.	.	.	.	.	.	.	.	.	.
Madera Irrigation District	0.0115	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Central California Irrigation District	0.0000	0.06	0.51	0.13	0.00	0.30	0.00	0.00	0.05	0.65	0.30
Merced Irrigation District	0.0008	.	.	.	.	.	.	.	.	.	.
Nevada Irrigation District	0.0033	0.00	0.22	0.00	0.00	0.78	0.00	.	.	.	.
Carpenter Irrigation District	0.3333	0.60	0.00	0.00	0.00	0.00	0.40	0.00	0.03	0.12	0.00
Serrano Irrigation District	0.0000	1.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.
Palo Verde Irrigation District	0.0000	0.00	0.23	0.08	0.00	0.63	0.06	0.00	0.00	0.50	0.50
Galt Irrigation District	0.0000	.	.	.	.	.	.	.	.	.	.
San Dieguito Water District	0.1542	0.00	0.00	0.25	0.75	0.00	0.00	.	.	.	.
Santa Fe Irrigation District	0.0139	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
Banta Carbona Irrigation District	0.0032	0.38	0.15	0.37	0.00	0.10	0.00	0.00	0.09	0.68	0.15
South San Joaquin Irrigation District	0.0052	0.43	0.14	0.00	0.00	0.29	0.14	0.10	0.20	0.70	0.00
West Side Irrigation District	0.0017	0.00	0.67	0.00	0.00	0.33	0.00	.	.	.	.

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

	Water District	Data Code	County	Controller Dist Type	Mountain	Central Coast	Sacramento Valley	San Joaquin Valley	Tulare Lake Basin	Southern California	Inland Empire	%Op/Rev	Op Rev / Exp.
	Variable Name	*Code*	*Co*	*Type*	*Mtn*	*CC*	*SV*	*SJV*	*TLB*	*SC*	*IE*	*OpRvRv*	*OpRvEx*
112	Woodbridge Irrigation District	3952006	39	52	0	0	0	1	0	0	0	0.542	0.560
113	Anderson-Cottonwood Irrigation District	4552003	45	52	1	0	0	0	0	0	0	0.722	1.345
114	Scott Valley Irrigation District	4752001	47	52	1	0	0	0	0	0	0	0.139	0.705
115	Tulelake Irrigation District	4752002	47	52	1	0	0	0	0	0	0	0.849	0.978
116	Solano Irrigation District	4852002	48	52	0	0	1	0	0	0	0	0.702	0.590
117	Modesto Irrigation District	5052001	50	52	0	0	0	1	0	0	0	0.050	0.182
118	Oakdale Irrigation District	5052002	50	52	0	0	0	1	0	0	0	0.325	0.660
119	Turlock Irrigation District	5052003	50	52	0	0	0	1	0	0	0	0.064	0.128
120	West Stanislaus Irrigation District	5052004	50	52	0	0	0	1	0	0	0	0.804	0.841
121	Alta Irrigation District	5452006	54	52	0	0	0	0	1	0	0	0.839	0.916
122	Exeter Irrigation District	5452007	54	52	0	0	0	0	1	0	0	0.615	0.906
123	Ivanhoe Irrigation District	5452008	54	52	0	0	0	0	1	0	0	0.250	0.280
124	Lindsay-Strathmore Irrigation District	5452009	54	52	0	0	0	0	1	0	0	0.826	0.891
125	Porterville Irrigation District	5452010	54	52	0	0	0	0	1	0	0	0.479	0.920
126	Saucelito Irrigation District	5452011	54	52	0	0	0	0	1	0	0	0.595	0.642
127	Tulare Irrigation District	5452012	54	52	0	0	0	0	1	0	0	0.554	0.737

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	% Net Inc / Exp	% Op Exp / Exp	LN(Total Expenses)	Voting	Electric Sales	Ac/ Farm	IrrAc/ Farm	Avg AF / Ac	%Ag AF	% Surface Water-91	CVP class 1	CVP class 2
Variable Name	*NetInc*	*OpExEx*	*LSize*	*Vote*	*Electric*	*AcFarm*	*IAcFarm*	*AFAc*	*PAgAF*	*SW91*	*CVP1*	*CVP2*
Woodbridge Irrigation District	-0.133	0.968	13.527	0	0	117	117	1.58	1.00	1.00	0.00	0.00
Anderson-Cottonwood Irrigation District	0.736	0.932	13.411	0	0	1700	600	12.30	1.00	1.00	0.06	0.00
Scott Valley Irrigation District	-0.789	0.197	11.582	0	0	128	121	1.96	1.00	1.00	.	.
Tulelake Irrigation District	-0.103	0.867	14.144	0	0	105	105	4.53	1.00	1.00	.	.
Solano Irrigation District	-0.209	0.889	16.391	0	1	200	171	2.02	0.91	0.93	.	.
Modesto Irrigation District	-0.892	0.567	18.694	0	1	40	26	2.40	0.84	0.90	.	.
Oakdale Irrigation District	-0.297	0.740	16.102	0	1	17	12	5.77	1.00	1.00	.	.
Turlock Irrigation District	-0.801	0.946	18.317	0	1	36	29	3.41	1.00	0.77	.	.
West Stanislaus Irrigation District	-0.066	0.956	14.494	0	0	.	.	0.22	1.00	1.00	1.00	0.00
Alta Irrigation District	-0.044	0.916	14.319	0	0	33	25	0.87	1.00	1.00	.	.
Exeter Irrigation District	0.289	0.874	13.449	0	0	40	34	0.79	1.00	1.00	0.38	0.62
Ivanhoe Irrigation District	-0.018	0.892	13.331	0	0	63	61	0.68	1.00	1.00	0.49	0.51
Lindsay-Strathmore Irrigation District	-0.112	0.927	14.718	0	0	31	28	1.69	0.96	0.96	1.00	0.00
Porterville Irrigation District	0.294	0.673	12.926	0	0	148	130	0.93	1.00	1.00	0.35	0.65
Saucelito Irrigation District	-0.125	0.927	13.655	0	0	130	127	1.05	1.00	1.00	0.39	0.60
Tulare Irrigation District	0.058	0.796	14.730	0	0	240	207	0.06	1.00	1.00	0.18	0.82

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	CVP exchange	SWP contract	Riparian rights	Approp. rights	91 Avg Ag $/AF	91 $/Acre	91 $/AF Cntrct	91 $/AF Divrd	ACWA - MI Price/AF	Storage AF/Ac	Tile Drain Ac/Ac	Unlined Canal Mi/Ac	Lined Canal Mi/Ac
Variable Name	*CVPX*	*SWP*	*Rip*	*App*	*AgPAF*	*AgPAc*	*AgCPAF*	*AgDPAF*	*MIPAF*	*StoreAc*	*TileAc*	*UnlnAc*	*LineAc*
Woodbridge Irrigation District	0.00	0.00	0.00	1.00	13.65	0.00	0.00	13.65	.	0.00	0.000	0.0024	0.0004
Anderson-Cottonwood Irrigation District	0.00	0.00	0.00	0.94	9.69	38.75	0.00	9.69	.	0.00	0.000	0.0200	0.0006
Scott Valley Irrigation District	.	.	.	.	4.00	.	.	.	.	0.00	0.000	0.0049	0.0000
Tulelake Irrigation District	.	.	.	.	21.00	21.00	0.00	0.00	.	0.00	0.000	0.0063	0.0000
Solano Irrigation District	.	.	.	.	11.55	0.00	0.00	11.55	75.00	0.00	0.063	0.0017	0.0002
Modesto Irrigation District	.	.	.	.	7.50	7.50	0.00	0.00	125.00	0.44	0.000	0.0002	0.0023
Oakdale Irrigation District	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0058	0.0002
Turlock Irrigation District	.	.	.	.	3.00	.	.	.	20.17	5.91	0.008	0.0002	0.0014
West Stanislaus Irrigation District	0.00	0.00	0.00	0.00	.	.	.	.	.	0.00	0.000	0.0007	0.0021
Alta Irrigation District	.	.	.	.	.	.	.	.	.	0.00	0.000	0.0028	0.0010
Exeter Irrigation District	0.00	0.00	0.00	0.00	44.50	0.00	16.89	44.50	.	0.00	0.000	0.0000	0.0000
Ivanhoe Irrigation District	0.00	0.00	0.00	0.00	12.50	.	.	.	.	0.00	0.000	0.0000	0.0000
Lindsay-Strathmore Irrigation District	0.00	0.00	0.00	0.00	101.00	.	.	.	175.00	0.01	0.000	0.0000	0.0000
Porterville Irrigation District	0.00	0.00	0.00	0.00	35.00	.	.	.	.	0.00	0.000	0.0011	0.0000
Saucelito Irrigation District	0.00	0.00	0.01	0.00	25.66	5.00	23.29	25.66	.	0.00	0.000	0.0000	0.0000
Tulare Irrigation District	0.00	0.00	0.00	0.00	.	.	.	.	.	0.01	0.000	0.0045	0.0000

Table A-1
Agricultural Water District Fiscal, Political and Economic Data

Water District	Pipeline Mi/Ac	Orchard	Field	Produce	Nursery	Pasture	Misc	Drip	Sprinkler	Furrow	Border
Variable Name	*PipeAc*	*Orchard*	*Field*	*Produce*	*Nursery*	*Pasture*	*Misc*	*Drip*	*Sprinkler*	*Furrow*	*Border*
Woodbridge Irrigation District	0.0000	0.50	0.00	0.11	0.37	0.02	0.00	0.00	0.00	1.00	0.00
Anderson-Cottonwood Irrigation District	0.0000	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.90
Scott Valley Irrigation District	0.0000	0.00	0.20	0.00	0.00	0.80	0.00	0.00	0.00	0.00	1.00
Tulelake Irrigation District	0.0000	0.00	0.60	0.21	0.00	0.18	0.00	0.00	0.60	0.05	0.35
Solano Irrigation District	0.0030	0.00	0.33	0.00	0.00	0.16	0.50	0.02	0.18	0.80	0.00
Modesto Irrigation District	0.0000	0.60	0.14	0.00	0.00	0.27	0.00	0.05	0.15	0.08	0.72
Oakdale Irrigation District	0.0014	.	.	.	.	.	.	.	.	.	.
Turlock Irrigation District	0.0100	0.49	0.33	0.00	0.00	0.19	0.00	.	.	.	.
West Stanislaus Irrigation District	0.0010	0.33	0.00	0.67	0.00	0.00	0.00	.	.	.	.
Alta Irrigation District	0.0002	0.80	0.20	0.00	0.00	0.00	0.00	.	.	.	.
Exeter Irrigation District	0.0464	1.00	0.00	0.00	0.00	0.00	0.00	0.10	0.70	0.14	0.06
Ivanhoe Irrigation District	0.0043	1.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.10	0.00
Lindsay-Strathmore Irrigation District	0.0062	0.80	0.00	0.20	0.00	0.00	0.00	0.00	0.99	0.01	0.00
Porterville Irrigation District	0.0044	.	.	.	.	.	.	0.00	0.00	0.38	0.60
Saucelito Irrigation District	0.0027	0.39	0.54	0.07	0.00	0.00	0.00	0.09	0.06	0.85	0.00
Tulare Irrigation District	0.0003	0.00	0.67	0.00	0.00	0.33	0.00	.	.	.	.

Appendix B

California Water Market Activity

1977 - 1992

Table B-1
California Water Market Short-TermTransfers 1977-1992

					AF Transferred			Purchase	Wheeling	Water	Area of	Water	Facilities	
Year	Seller	TypeS	Buyer	TypeB	Applied	Approved	Actual	$/af-yr	$/af-yr	Code #	Origin	Source	Storage	Wheeling
1977	CID	52	Alta ID	48	17,000	17,000	17,000				Kings R			None
1982	YCWA	45.1	Newhall	100	5,000	5,000	5,000	$3.50		1725	Yuba R	Storage	Bullards Bar	None
1984	USBR	US	Musco Olive	100	100	100	100			1725	CVP	Storage	CVP	SWP
1984	YCWA	45.1	Newhall	100	2,266	2,266	2,266	$3.50		1725	Yuba R	Storage	Bullards Bar	None
1985	Barry Hill	100	Skylark	100	18	18	18			1735	Sta.Rosa Cr.	Storage	local	None
1985	EBMUD	39	CCWD	42	5,000	5,000	5,000			1725	Mokelumne	Storage	Comanche	None
1985	USBR	US	CDFG	CA	195,000	195,000	3,100			1435	CVP	Storage	CVP	SWP
1985	USBR	US	Musco Olive	100	100	100	100			1725	CVP	Storage	CVP	SWP
1985	USBR	US	CDWR	CA	12,800	12,800	12,800			1435	CVP	Storage	CVP	SWP
1985	USBR	US	CDFG	CA	28,000	28,000	22,000			1435	CVP	Storage	CVP	SWP
1985	YCWA	45.1	Newhall	100	750	750	750			1725	Yuba R	Storage	Bullards Bar	None
1986	EBMUD	39	CCWD	42	5,000	5,000	5,000			1725	Mokelumne	Storage	Comanche	None
1986	Solano ID	52	NCFCWCD	8	3,500	3,500	3,500				Solano	Storage	Solano	SWP
1986	USBR	US	CDFG	CA	100,000	100,000	4,000			1435	CVP	Storage	CVP	SWP
1986	YCWA	45.1	Newhall	100	400	0	0			1725	Yuba R.	Storage	Bullards Bar	None
1987	BSA	100	Willits	60	75	75	75			1435	Finney V. Crk	Diversion	None	None
1987	EBMUD	39	CCWD	42	44	44	44			1725	Mokelumne	Storage	Comanche	None
1987	Solano ID	52	NCFCWCD	8	7,700	7,700	7,700				Putah Creek	Storage	Solano	SWP
1987	USBR	US	USFWS	US	10,000	10,000	6,100			1435	CVP	Storage	CVP	SWP
1987	USBR	US	CDFG	CA	80,000	10,000	9,300			1435	CVP	Storage	New Melones	SWP
1987	USBR	US	DRWD	41	80,000	0	0			1735	CVP	Storage	CVP	SWP
1987	YCWA	45.1	CDWR	CA	83,100	83,100	37,000	$21.00		1725	Yuba R.	Storage	Bullards Bar	None
1988	AEWSD	48	DEID	52	8,000	8,000	8,000				Tulare Basin	GW	None	None
1988	EWSID	52	TLBWSD	48	450	450	450				Kings R.			None
1988	KCWA	45	misc. Kern	52	83,100	83,000	83,000				SWP	Storage		SWP
1988	KTWD	41	OCID	52	400	400	400				CVP		CVP	SWP
1988	McArthur	100	Malacha	100	500	500	500			1725	Juniper Crk.	Storage	Iverson Res.	None
1988	MWDSC	43	KCWA	45	6,171	6,171	6,171				SWP	Storage	SWP	SWP
1988	Payne	100	Heidrick	100	1,450	1,450	1,450			1725	Yolo	Stream	None	None
1988	SCWA	45	NCFCWCD	8	1,600	1,600	1,600				Solano	Storage	Solano	SWP
1988	TLBWSD	48	WWD	41	1,600	1,600	1,600				SWP			SWP
1988	TLBWSD	48	EWSID	52	300	300	300				Kings R.			
1988	USBR	US	CWD	41	10,000	10,000	10,000				CVP	Storage	CVP	CVP
1988	USBR	US	LWD	41	10,000	10,000	10,000				CVP	Storage	CVP	SWP
1988	USBR	US	KCWD	42	10,000	10,000	10,000				CVP	Storage	CVP	SWP
1988	USBR	US	CDWR	CA	100,000	100,000	100,000			1435	CVP	Storage	CVP	SWP
1988	USBR	US	EBMUD	39	75,000	0	0			1435	CVP	Storage	Folsom	Folsom S.

Table B-1
California Water Market Short-TermTransfers 1977-1992

Year	Seller	TypeS	Buyer	TypeB	Transfer Type	Carriage Water	Period	Notes	J&S #	Gray #	Lund #	DWR #
1977	CID	52	Alta ID	48	Sale				1			
1982	YCWA	45.1	Newhall	100	Exchange		7/1/82-8/31/82		2	2-1		
1984	USBR	US	Musco Olive	100	Sale		8/1/84-7/31/85		4			
1984	YCWA	45.1	Newhall	100	Exchange		7/1/84-8/31/84		3	2-2		
1985	Barry Hill	100	Skylark	100	Sale		11/15/85-11/1/86		11	2-5		
1985	EBMUD	39	CCWD	42	Sale		9/25/85-12/31/85		9	2-4		
1985	USBR	US	CDFG	CA	Public Trust		3/1/85-6/30/85	Kern NWR	5			11-3
1985	USBR	US	Musco Olive	100	Sale		8/1/85-7/31/86		7			
1985	USBR	US	CDWR	CA	Exchange		9/19/85-10/15/85		8	7-1		
1985	USBR	US	CDFG	CA	Public Trust		11/15/85-3/1/86	Grasslands Refuge	10			11-3
1985	YCWA	45.1	Newhall	100	Sale		7/1/85-8/31/85		6	2-3		
1986	EBMUD	39	CCWD	42	Sale		1/1/86-4/30/86		12	2-6		
1986	Solano ID	52	NCFCWCD	8	Sale						86-1	
1986	USBR	US	CDFG	CA	Public Trust		2/24/86-4/7/86	Kern NWR	13			11-3
1986	YCWA	45.1	Newhall	100	Sale		7/1/86-9/30/86			2-7		
1987	BSA	100	Willits	60	Sale		11/20/87-5/19/88			2-11		
1987	EBMUD	39	CCWD	42	Public Trust		11/1/87-12/31/87		17	2-10		
1987	Solano ID	52	NCFCWCD	8	Sale						87-2	
1987	USBR	US	USFWS	US	Public Trust		9/1/87-4/30/88	Kern NWR	15	7-2		11-3
1987	USBR	US	CDFG	CA	Public Trust		12/1/87-2/28/87	WR Salmon	16	7-3		11-3
1987	USBR	US	DRWD	41	Sale					2-8		
1987	YCWA	45.1	CDWR	CA	Storage		7/17/87-9/30/87		14	2-9	87-1	
1988	AEWSD	48	DEID	52	Sale				18			
1988	EWSID	52	TLBWSD	48	Exchange				22			
1988	KCWA	45	misc. Kern	52	Sale				23			
1988	KTWD	41	OCID	52	Sale				24			
1988	McArthur	100	Malacha	100	Sale		11/1/88-12/31/88		31	2-16		
1988	MWDSC	43	KCWA	45	Sale							
1988	Payne	100	Heidrick	100	Exchange		6/15/88-8/30/88		29	2-14		
1988	SCWA	45	NCFCWCD	8	Sale						88-2	
1988	TLBWSD	48	WWD	41	Sale				25			
1988	TLBWSD	48	EWSID	52	Sale				26			
1988	USBR	US	CWD	41	Sale				19			
1988	USBR	US	LIWD	41	Sale				20			
1988	USBR	US	KCWD	42	Sale				21			
1988	USBR	US	CDWR	CA	Public Trust		3/14/88-4/10/88		27			
1988	USBR	US	EBMUD	39	Exchange		7/1/88-6/30/89			2-23		

Table B-1
California Water Market Short-TermTransfers 1977-1992

					AF Transferred			Purchase	Wheeling	Water	Area of	Water	Facilities	
Year	Seller	TypeS	Buyer	TypeB	Applied	Approved	Actual	$/af-yr	$/af-yr	Code #	Origin	Source	Storage	Wheeling
1988	USBR	US	CDWR	CA	85,500	85,500	85,500			1435	CVP	Storage	San Luis	SWP
1988	USBR	US	USFWS	US	1,500	1,500	1,500			1435	CVP	Storage	San Luis	SWP
1988	USBR	US	CDFG	CA	125,000	125,000	125,000			1435	CVP	Storage	San Luis	SWP
1988	USBR	US	CDFG	CA	45,000	45,000	45,000			1435	CVP	Storage	San Luis	SWP
1988	USBR	US	CDWR	CA	10,000	10,000	10,000			1435	CVP	Storage	San Luis	SWP
1988	YCWA	45.1	CDWR	CA	110,000	110,000	116,000	$12.00		1735	Yuba R.	Storage	Bullards Bar	None
1988	YCWA	45.1	CDWR	CA	12,000	12,000	12,000			1435	Yuba R.	Storage	Bullards Bar	None
1989	DRWD	41	TLBWSD	48	2,400	2,400	2,400				SWP	Storage	SWP	SWP
1989	DRWD	41	SLWD	41	1,600	1,600	1,600				SWP	Storage	SWP	SWP
1989	DRWD	41	WWD	41	900	900	900				SWP	Storage	SWP	SWP
1989	DRWD	41	Munco	100	1,700	1,700	1,700			1725	Fresno			
1989	EBMUD	39	CDFG	CA	0	0	39,000	$5.00	$8.75	1435	Yuba R.	Storage	Bullards Bar	SWP
1989	KCWA	45	OFWD	41	300	300	300				Yuba R.	Storage	Bullards Bar	SWP
1989	KCWA	45	WWD	41	55,000	55,000	45,000	$37.00	$12.00	1435	Kern	Fallow	SWP	SWP
1989	Payne	100	Calif. V. Land Co.	41	1,450	0	0			1725	Yolo Bypass	Diversion	groundwater	None
1989	PG&E	100	EID	52	600	600	600			1435	American	Storage	Caples L.	None
1989	SCWD	42	MMWD	44	10,800	10,800	?					Storage		None
1989	USBR	US	CDFG	CA	30,000	30,000	30,000			1435	CVP	Storage	CVP	SWP
1989	USBR	US	USFWS	US	8,200	8,200	8,200			1435	CVP	Storage	CVP	SWP
1989	YCWA	45.1	CDFG	CA	30,000	30,000	30,000			1725	Yuba R.	Storage	Bullards Bar	None
1989	YCWA	45.1	EBMUD	39	66,000	66,000	39,000	$45.00		1725	Yuba R.	Storage	Bullards Bar	None
1989	YCWA	45.1	NCFCWCD	8	7,000	7,000	4,000	$45.00		1725	Yuba R.	Storage	Bullards Bar	SWP
1989	YCWA	45.1	SCVWD	45	90,000	17,000	17,000	$45.00		1725	Yuba R.	Storage	Bullards Bar	SWP
1989	YCWA	45.1	TLBWSD	48	110,000	54,000	54,000	$11.00	$19.00	1725	Yuba R.	Storage	Bullards Bar	SWP
1990	BBID	52	CDWR	CA	8,000	8,000	8,000				SWP		None	SWP
1990	BVID	52	WWD	41	375	375	375				Yuba R.	Storage	Bullards Bar	CVP
1990	CDWR	CA	SBCWA	45	400	400	400				SWP	Storage	SWP	SBCWA
1990	CDWR	CA	SCVWD/TLBWSD	45	62,204	62,204	62,204			1725	Yuba R.	Storage	Bullards Bar	SWP
1990	CDWR	CA	Salyer	100	8,500	5,000	5,000			1725	Tulare	Storage	San Luis	SWP
1990	CDWR	CA	KCWA	45		150,000	150,000				SWP	Storage	SWP	SWP
1990	CDWR	CA	CDFG	CA	9,262	9,262	9,262				SWP	Storage	SWP	SWP
1990	ECCID	52	WWD	41	3,500	3,500	3,500				Delta		None	SWP
1990	JWDB	41	CDWR	CA	3,000	3,000	3,000				Feather R.	Conserve	Oroville	None
1990	LaHacienda	100	KCWA	45	98,000	98,000	98,000				LaHacienda	GW	SWP	KCWA
1990	MID	52	SFWD	60	12,000	12,000	4,890	$45.00	$350.00		Tuolumne	GW	San Antonio	SBay Aq.
1990	OWID	52	WWD	41	15,000	15,000	15,000			1725	Feather R.	Storage	OWID Res.	SWP
1990	Payne	100	Heidrick	100	1,450	1,450	1,450			1725	Liberty Cut	Storage	None	None
1990	PCWA	45	WWD/SLWD	41	40,500	40,500	28,000			1725	American	Storage	Folsom	CVP

Table B-1
California Water Market Short-TermTransfers 1977-1992

					Transfer	Carriage			J&S	Gray	Lund	DWR
Year	Seller	TypeS	Buyer	TypeB	Type	Water	Period	Notes	#	#	#	#
1988	USBR	US	CDWR	CA	Public Trust		7/1/88-2/28/89		30	2-15		
1988	USBR	US	USFWS	US	Public Trust		10/1/88-3/31/89		33	7-6		
1988	USBR	US	CDFG	CA	Exchange		10/1/88-3/31/89		33	7-6		
1988	USBR	US	CDFG	CA	Public Trust		10/7/88-3/31/89	Stanislaus R	34	7-7		
1988	USBR	US	CDWR	CA	Public Trust		1/1/89-3/31/89		35	7-8		
1988	YCWA	45.1	CDWR	CA	Sale		7/1/88-9/30/88		28		88-1	
1988	YCWA	45.1	CDWR	CA	Exchange		8/18/88-9/15/88		32	2-15		
1989	DRWD	41	TLBWSD	48	Sale				36			
1989	DRWD	41	SLWD	41	Sale				37			
1989	DRWD	41	WWD	41	Sale				38			
1989	DRWD	41	Munco	100	Sale				50			
1989	EBMUD	39	CDFG	CA	Public Trust		8/23/89-11/30/89		47	2-22	89-4	
1989	KCWA	45	OFWD	41	Sale			from YCWA	39			
1989	KCWA	45	WWD	41	Exchange		9/21/89-12/31/89		48	2-23		
1989	Payne	100	Calif. V. Land Co.	41	Sale		6/15/89-8/30/89			2-21		
1989	PG&E	100	EID	52	Exchange		3/1/89-3/10/89		43	2-19		
1989	SCWD	42	MMWD	44	Sale				40			
1989	USBR	US	CDFG	CA	Public Trust		5/10/89-8/20-89	Kern NWR	45	7-9		11-3
1989	USBR	US	USFWS	US	Public Trust		9/15/89-12/31/89	Grasslands Refuge	46	7-10		11-3
1989	YCWA	45.1	CDFG	CA	Public Trust			Salmon	41	2-17		11-3
1989	YCWA	45.1	EBMUD	39	Option		3/1/89-2/28/90		41	2-17		
1989	YCWA	45.1	NCFCWCD	8	Sale		4/1/89-9/30/89		42	2-18	89-1	
1989	YCWA	45.1	SCVWD	45	Sale	12%	5/1/89-9/30/89	thru DWR	44	2-20	89-2	
1989	YCWA	45.1	TLBWSD	48	Sale	12%	5/1/89-9/30/89	thru DWR	44	2-20	89-3	
1990	BBID	52	CDWR	CA	Sale				64			
1990	BVID	52	WWD	41	Sale	30%			51			
1990	CDWR	CA	SBCWA	45	Sale				54			
1990	CDWR	CA	SCVWD/TLBWSD	45	Sale		5/1/90-12/31/90		57		90-2	
1990	CDWR	CA	Salyer	100	Sale		6/22/90-12/31/90		58			
1990	CDWR	CA	KCWA	45	Kern Water Bank						90-3	
1990	CDWR	CA	CDFG	CA	Public Trust						90-4	
1990	ECCID	52	WWD	41	Sale				63			
1990	JWDB	41	CDWR	CA	Sale				67			
1990	LaHacienda	100	KCWA	45	Sale				52			
1990	MID	52	SFWD	60	Sale	59%			72		A108	
1990	OWID	52	WWD	41	Sale	30%	9/19/90-3/31/90		59			
1990	Payne	100	Heidrick	100	Sale		6/15/90-8/30/90		55			
1990	PCWA	45	WWD/SLWD	41	Sale		10/23/90-3/31/91		61			

Table B-1
California Water Market Short-TermTransfers 1977-1992

					AF Transferred			Purchase	Wheeling	Water	Area of	Water	Facilities	
Year	Seller	TypeS	Buyer	TypeB	Applied	Approved	Actual	$/af-yr	$/af-yr	Code #	Origin	Source	Storage	Wheeling
1990	PCWA	45	SFWD	60	15,000	15,000	15,000	$45.00	$250.00		American	Storage	PCWA	SWP
1990	SCVWD	45	OFWD	41	200	200	200					Storage		SWP
1990	TLBWSD	48	WWD	41	1,500	1,500	1,500				SWP	Storage	None	SWP
1990	TTCo	100	WWD	41	1,000	1,000	?					Storage		CVP
1990	USBR	US	USFWS	US	6,200	6,200	182				CVP	Storage	CVP	SWP
1990	WCWD	41	CDWR	CA	3,500	3,500	3,500				Oroville	Storage	Oroville	None
1990	WCWD	41	CDWR	CA	1,500	1,500	1,500				Oroville	Storage	Oroville	None
1990	YCWA	45.1	NCFCWCD	8	7,000	6,373	6,373			1725	Yuba R.	Storage	Bullards Bar	SWP
1990	YCWA	45.1	CDWR	CA	146,000	83,796	46,796			1725	Yuba R.	Storage	Bullards Bar	SWP
1990	YCWA	45.1	TMWCo	101	6,500	3,000	3,000			1435	Yuba R.	Storage	Bullards Bar	None
1990	YCWA	45.1	FWD	41	1,500	1,500	1,500				Yuba R.	Storage	Bullards Bar	None
1991	AVEKWA	100	KCWA	45	1,000	1,000	1,000				SWP	Storage	SWP	SWP
1991	CCWD	42	MWWD	41	75,000	75,000	?				CVP			CVP
1991	CDWR	CA	SBCWA	45	3,600	3,600	3,600				SWP	Storage	Castaic	CC
1991	LaHacienda	100	KCWA	45	100,000	100,000	?						Oroville	SWP
1991	MWA	45	AVEKWA	100	1,391	1,391	1,391				SWP	Storage	SWP	SWP
1991	MID	52	SFWD	60	4,808	4,808	4,808				Tuolumne	Storage	Hetch Hetchy	HHP
1991	OWID	52	WWD	41	8,500	8,500	8,500				Feather R.	Storage	SWP	CVP
1991	PCWA	45	CDFG	CA	0	5,200	5,200				American	Storage	PCWA	SWP
1991	PCWA	45	SCVWD	45	14,000	14,000	14,000				American	Storage	PCWA	SWP
1991	PCWA	45	SFWD	60	40,000	16,800	16,800	$45.00	$250.00		American	Storage	PCWA	SWP
1991	NMCWD	42	MMWD	44	2,500	2,500	2,500				North Coast	Storage	None	None
1991	Redding	60	BVWD	41	1,400	1,400	1,400				Trinity R.	Storage	Shasta	CVP
1991	CDWR	CA	CDFG	CA	13,400	13,400	13,400				SWP	Storage	SWP	SWP
1991	SFWD	60	CDFG	CA	5,920	5,920	5,920				Tuolumne	Storage	Hetch Hetchy	SWP/CVP
1991	USBR	US	USFWS	US	6,200	6,200	6,200				CVP	Storage	CVP	SWP
1991	Vallejo	60	Benicia	60	627	627	627	1:2 exchange			Sacramento	Storage	None	SWP
1991	Vallejo	60	Benicia	60	2,500	2,500	2,500	1:2 exchange			Sacramento	Storage	None	SWP
1991	Vallejo	60	Fairfield	60	3,100	3,100	3,100	1:2 exchange			Sacramento	Storage	None	SWP
1991	Vallejo	60	ACCWD	42	600	600	600	1:2 exchange			Sacramento	Storage	None	SWP
1991	YCWA	45.1	Napa	60	7,500	7,500	7,500				Yuba R.	Storage	Bullards Bar	SWP
1991	YCWA	45.1	CDFG	CA	28,000	28,000	28,000	$50.00			Yuba R.	Storage	Bullards Bar	None
1992	MID	52	CDFG	CA	15,000	15,000	15,000				Tuolumne	Storage	Don Pedro	None
1992	BVID	52	CDFG	CA	5,000	5,000	5,000				Yuba	Storage	Bullards Bar	SWP
1992	BWD	41	CDFG	CA	5,000	5,000	5,000				Feather R.	Storage	Oroville	SWP

Table B-1
California Water Market Short-TermTransfers 1977-1992

					Transfer	Carriage			J&S	Gray	Lund	DWR
Year	Seller	TypeS	Buyer	TypeB	Type	Water	Period	Notes	#	#	#	#
1990	PCWA	45	SFWD	60	Sale	49%			69			
1990	SCVWD	45	OFWD	41	Sale				70			
1990	TLBWSD	48	WWD	41	Sale				62			
1990	TTCo	100	WWD	41	Sale	30%			71			
1990	USBR	US	USFWS	US	Public Trust			Kern NWR			90-4	11-3
1990	WCWD	41	CDWR	CA	Public Trust			SJ NWR	65			11-3
1990	WCWD	41	CDWR	CA	Sale				66			
1990	YCWA	45.1	NCFCWCD	8	Sale		4/1/90-10/15/90		56		90-2	
1990	YCWA	45.1	CDWR	CA	Public Trust		5/1/90-12/31/90		57			
1990	YCWA	45.1	TMWCo	101	Sale		8/28-90-10/15/90		60			
1990	YCWA	45.1	FWD	41	Sale				68			
1991	AVEKWA	100	KCWA	45	Sale							11-2
1991	CCWD	42	MVWD	41	Sale				74			
1991	CDWR	CA	SBCWA	45	Sale						91-77	
1991	LaHacienda	100	KCWA	45	Option				75			
1991	MWA	45	AVEKWA	100	Sale							11-2
1991	MID	52	SFWD	60	Sale							11-2
1991	OWID	52	WWD	41	Sale							11-2
1991	PCWA	45	CDFG	CA	Sale	39%		thru SFWD			A107	
1991	PCWA	45	SCVWD	45	Sale							11-2
1991	PCWA	45	SFWD	60	Sale	39%					A107	
1991	NMCWD	42	MMWD	44	Sale							11-2
1991	Redding	60	BVWD	41	Sale							11-2
1991	CDWR	CA	CDFG	CA	Public Trust			Wildlife Refuges				11-3
1991	SFWD	60	CDFG	CA	Public Trust			American R				11-3
1991	USBR	US	USFWS	US	Public Trust			Kern NWR				11-3
1991	Vallejo	60	Benicia	60	Exchange		1991				A113	
1991	Vallejo	60	Benicia	60	Exchange		1991-1992				A113	
1991	Vallejo	60	Fairfield	60	Exchange		1991-1993				A113	
1991	Vallejo	60	ACCWD	42	Exchange		1991				A113	
1991	YCWA	45.1	Napa	60	Sale		4/1/91-10/15/91		73			
1991	YCWA	45.1	CDFG	CA	Public Trust						91-77	
1992	MID	52	CDFG	CA	Public Trust							
1992	BVID	52	CDFG	CA	Public Trust			Gray Lodge Refuge				
1992	BWD	41	CDFG	CA	Public Trust			Gray Lodge Refuge				

Table B-2
California Water Market Bank Transfers 1977-1992

					AF Transferred			Purchase	Wheeling	Sale	Pool/	Area of	Water	Facilities
Year	Seller	TypeS	Buyer	TypeB	Applied	Sold	Bought	$/af-yr	$/af-yr	$/af-yr	Bank	Origin	Source	Storage
1977	NCMWCo	101	USBR	US		6,000		$15.00			BRWB	Sacramento		
1977	SRWCA	CVP	USBR	US		5,797		$15.00			BRWB	Sacramento		
1977	PMWCo	101	USBR	US		4,425		$25.00			BRWB			
1977	RD 108	26	USBR	US		5,000		$25.00			BRWB	Sacramento		
1977	Chaplin-Lewis	100	USBR	US		1,279		$35.00			BRWB			
1977	PG-VMWCo	101	USBR	US		15,752		$70.00			BRWB			
1977	CDWR	CA	USBR	US		8,185		$84.51			BRWB	SWP		SWP
1977	USBR	US	CVP 27 agencies	US			42,544		$12.51	$48.49	BRWB	CVP	CVP	CVP
1981	Friant Div.	52	Friant Div.	52		23,775	23,775	Cost			CVP Ex.	CVP	CVP	CVP
1981	Sacramento R Div	CVP	Sacramento R Div	CVP		1,000	1,000	Cost			CVP Ex.	Sacramento	CVP	Shasta
1981	TCCA	41	TCCA Pool	41		2,053	91	Cost			TCCA	Sacramento	CVP	Shasta
1981	W San Joaquin Div.	41	Friant Div.	52		390	390	Cost			CVP Ex.	CVP	CVP	CVP
1981	W San Joaquin Div.	41	W San Joaquin Div.	41		110	110	Cost			CVP Ex.	CVP	CVP	CVP
1982	American R Div.	39	American R Div.	39		57	57	Cost			CVP Ex.	American	CVP	Folsom
1982	Friant Div.	52	Friant Div.	52		88,517	88,517	Cost			CVP Ex.	CVP	CVP	CVP
1982	Friant Div.	52	W San Joaquin Div.	41		173	173	Cost			CVP Ex.	CVP	CVP	CVP
1982	Sacramento R Div	CVP	Sacramento R Div	CVP		7,858	7,858	Cost			CVP Ex.	Sacramento	CVP	Shasta
1982	TCCA	41	TCCA Pool	41		4,565	4,565	Cost			TCCA	Sacramento	CVP	Shasta
1982	W San Joaquin Div.	41	W San Joaquin Div.	41		5,568	5,568	Cost			CVP Ex.	CVP	CVP	CVP
1983	American R Div.	39	American R Div.	39		122	122	Cost			CVP Ex.	American	CVP	Folsom
1983	Friant Div.	52	Friant Div.	52		58,211	58,211	Cost			CVP Ex.	CVP	CVP	CVP
1983	SRWCA	CVP	SRWCA Pool	CVP		51,350	3,845	Cost			SRWCA	Sacramento	CVP	Shasta
1983	W San Joaquin Div.	41	Friant Div.	52		359	359	Cost			CVP Ex.	CVP	CVP	CVP
1983	W San Joaquin Div.	41	W San Joaquin Div.	41		359	359	Cost			CVP Ex.	CVP	CVP	CVP
1984	American R Div.	39	American R Div.	39		1,782	1,782	Cost			CVP Ex.	American	CVP	Folsom
1984	Friant Div.	52	Friant Div.	52		22,187	22,187	Cost			CVP Ex.	CVP	CVP	CVP
1984	Sacramento R Div	CVP	Sacramento R Div	CVP		2,500	2,500	Cost			CVP Ex.	Sacramento	CVP	Shasta
1984	SRWCA	CVP	SRWCA Pool	CVP		29,070	8,535	Cost			SRWCA	Sacramento	CVP	Shasta
1984	TCCA	41	TCCA Pool	41		2,500	2,500	Cost			TCCA	Sacramento	CVP	Shasta
1984	W San Joaquin Div.	41	Friant Div.	52		4,211	4,211	Cost			CVP Ex.	CVP	CVP	CVP
1984	W San Joaquin Div.	41	W San Joaquin Div.	41		589	589	Cost			CVP Ex.	CVP	CVP	CVP
1985	American R Div.	39	American R Div.	39		318	318	Cost			CVP Ex.	American	CVP	Folsom
1985	Friant Div.	52	Friant Div.	52		13,571	13,571	Cost			CVP Ex.	CVP	CVP	CVP
1985	Sacramento R Div	CVP	Sacramento R Div	CVP		4,625	4,625	Cost			CVP Ex.	Sacramento	CVP	Shasta
1985	SRWCA	CVP	SRWCA Pool	CVP		35,250	1,073	Cost			SRWCA	Sacramento	CVP	Shasta
1985	TCCA	41	TCCA Pool	41		3,000	3,000	Cost			TCCA	Sacramento	CVP	Shasta
1985	W San Joaquin Div.	41	Friant Div.	52		3,673	3,673	Cost			CVP Ex.	CVP	CVP	CVP

Table B-2

California Water Market Bank Transfers 1977-1992

						Transfer	Carriage		J&S	Gray	Lund	DWR
Year	Seller	TypeS	Buyer	TypeB	Wheeling	Type	Water	Period	#	#	#	#
1977	NCMWCo	101	USBR	US	CVP	Bank					6-6	
1977	SRWCA	CVP	USBR	US	CVP	Bank					6-4	
1977	PMWCo	101	USBR	US	CVP	Bank					6-7	
1977	RD 108	26	USBR	US	CVP	Bank					6-1	
1977	Chaplin-Lewis	100	USBR	US	CVP	Bank					6-3	
1977	PG-VMWCo	101	USBR	US	CVP	Bank					6-2	
1977	CDWR	CA	USBR	US	CVP	Bank					6-5	
1977	USBR	US	CVP 27 agencies	US	CVP	Bank	8%				77-71	
1981	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1981	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1981	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1981	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				4-1		
1981	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1982	American R Div.	39	American R Div.	39	CVP	Sale				4-1		
1982	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1982	Friant Div.	52	W San Joaquin Div.	41	CVP	Sale				4-1		
1982	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1982	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1982	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1983	American R Div.	39	American R Div.	39	CVP	Sale				4-1		
1983	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1983	SRWCA	CVP	SRWCA Pool	CVP	None	Bank				4-1		
1983	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				4-1		
1983	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				5-1		
1984	American R Div.	39	American R Div.	39	CVP	Sale				4-1		
1984	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1984	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1984	SRWCA	CVP	SRWCA Pool	CVP	None	Bank				4-1		
1984	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1984	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				5-1		
1984	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1985	American R Div.	39	American R Div.	39	CVP	Sale				4-1		
1985	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1985	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1985	SRWCA	CVP	SRWCA Pool	CVP	None	Bank				4-1		
1985	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1985	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				5-1		

Table B-2
California Water Market Bank Transfers 1977-1992

					AF Transferred			Purchase	Wheeling	Sale	Pool/	Area of	Water	Facilities
Year	Seller	TypeS	Buyer	TypeB	Applied	Sold	Bought	$/af-yr	$/af-yr	$/af-yr	Bank	Origin	Source	Storage
1985	W San Joaquin Div.	41	W San Joaquin Div.	41		10,255	10,255	Cost			CVP Ex.	CVP	CVP	CVP
1986	American R Div.	39	American R Div.	39		784	784	Cost			CVP Ex.	American	CVP	Folsom
1986	Friant Div.	52	Friant Div.	52		43,197	43,197	Cost			CVP Ex.	CVP	CVP	CVP
1986	Sacramento R Div	CVP	Sacramento R Div	CVP		5,535	5,535	Cost			CVP Ex.	Sacramento	CVP	Shasta
1986	SRWCA	CVP	SRWCA Pool	CVP		41,980	530	Cost			SRWCA	Sacramento	CVP	Shasta
1986	TCCA	41	TCCA Pool	41		13,763	13,763	Cost			TCCA	Sacramento	CVP	Shasta
1986	W San Joaquin Div.	41	Friant Div.	52		25,143	25,143	Cost			CVP Ex.	CVP	CVP	CVP
1986	W San Joaquin Div.	41	W San Joaquin Div.	41		3,543	3,543	Cost			CVP Ex.	CVP	CVP	CVP
1987	American R Div.	39	American R Div.	39		154	154	Cost			CVP Ex.	American	CVP	Folsom
1987	Friant Div.	52	Friant Div.	52		18,906	18,906	Cost			CVP Ex.	CVP	CVP	CVP
1987	Sacramento R Div	CVP	Sacramento R Div	CVP		3,050	3,050	Cost			CVP Ex.	Sacramento	CVP	Shasta
1987	SRWCA	CVP	SRWCA Pool	CVP		43,120	291	Cost			SRWCA	Sacramento	CVP	Shasta
1987	TCCA	41	TCCA Pool	41		10,350	10,350	Cost			TCCA	Sacramento	CVP	Shasta
1987	W San Joaquin Div.	41	Friant Div.	52		5,831	5,831	Cost			CVP Ex.	CVP	CVP	CVP
1987	W San Joaquin Div.	41	W San Joaquin Div.	41		823	823	Cost			CVP Ex.	CVP	CVP	CVP
1988	Friant Div.	52	Friant Div.	52		38,581	38,581	Cost			CVP Ex.	CVP	CVP	CVP
1988	Sacramento R Div	CVP	Sacramento R Div	CVP		2,350	2,350	Cost			CVP Ex.	Sacramento	CVP	Shasta
1988	Sacramento R Div	CVP	Sacramento R Div	CVP		2,350	2,350	Cost			CVP Ex.	Sacramento	CVP	Shasta
1988	SRWCA	CVP	SRWCA Pool	CVP		46,370	2,710	Cost			SRWCA	Sacramento	CVP	Shasta
1988	TCCA	41	TCCA Pool	41		9,656	9,656	Cost			TCCA	Sacramento	CVP	Shasta
1988	W San Joaquin Div.	41	Friant Div.	52		1,516	1,516	Cost			CVP Ex.	CVP	CVP	CVP
1988	W San Joaquin Div.	41	W San Joaquin Div.	41		3,726	3,726	Cost			CVP Ex.	CVP	CVP	CVP
1989		#N/A		#N/A										
1990		#N/A		#N/A										
1991	BVID	52	CDWR	CA		23,800		$125.00			SDWB	Yuba	GW	aquifer
1991	BVID	52	CDWR	CA		5,000		$125.00			SDWB	Yuba	Storage	Bullards Bar
1991	BVID/SWP?	52	CDWR	CA		16,106		$125.00			SDWB	Yuba	Fallow	none
1991	Conaway, others	100	CDWR	CA		52,000		$125.00			SDWB	Sacramento	GW	aquifer
1991	ECCID	52	CDWR	CA		4,000		$125.00			SDWB	Sacramento	GW	aquifer
1991	Falls R. V. (14)	100	CDWR	CA		6,734		$125.00			SDWB	Sacramento	Fallow	none
1991	JWDB/WCWD	41	CDWR	CA		100,000		$125.00			SDWB	Feather	GW	aquifer
1991	Little Holland	100	CDWR	CA		2,000		$125.00			SDWB	Sacramento	Storage	none
1991	OWID	52	CDWR	CA		10,000		$125.00			SDWB	Feather	Storage	Oroville
1991	Private farmers	101	CDWR	CA		141,194		$125.00			SDWB	Delta	Fallow	none
1991	RD 108/1004	26	CDWR	CA		60,467		$125.00			SDWB	Sacramento	GW	aquifer
1991	Solano ID	52	CDWR	CA		42,250		$125.00			SDWB	Delta	Fallow	none
1991	SRWCA (14)	CVP	CDWR	CA		37,000		$125.00			SDWB	Sacramento	Fallow	Shasta
1991	Wilson&McCall	100	CDWR	CA		1,000		$125.00			SDWB	Sacramento	Storage	none

Table B-2
California Water Market Bank Transfers 1977-1992

						Transfer	Carriage		J&S	Gray	Lund	DWR
Year	Seller	TypeS	Buyer	TypeB	Wheeling	Type	Water	Period	#	#	#	#
1985	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1986	American R Div.	39	American R Div.	39	CVP	Sale				4-1		
1986	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1986	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1986	SRWCA	CVP	SRWCA Pool	CVP	None	Bank				4-1		
1986	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1986	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				5-1		
1986	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1987	American R Div.	39	American R Div.	39	CVP	Sale				4-1		
1987	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1987	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1987	SRWCA	CVP	SRWCA Pool	CVP	None	Bank				4-1		
1987	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1987	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				5-1		
1987	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1988	Friant Div.	52	Friant Div.	52	CVP	Sale				4-1		
1988	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1988	Sacramento R Div	CVP	Sacramento R Div	CVP	CVP	Sale				4-1		
1988	SRWCA	CVP	SRWCA Pool	CVP	None	Bank				4-1		
1988	TCCA	41	TCCA Pool	41	CVP	Bank				4-1		
1988	W San Joaquin Div.	41	Friant Div.	52	CVP	Sale				5-1		
1988	W San Joaquin Div.	41	W San Joaquin Div.	41	CVP	Sale				6-1		
1989		#N/A		#N/A								
1990		#N/A		#N/A								
1991	BVID	52	CDWR	CA	SWP	Bank					A112	
1991	BVID	52	CDWR	CA	SWP	Lank					A112	
1991	BVID/SWP?	52	CDWR	CA	SWP	Bank					A112	
1991	Conaway, others	100	CDWR	CA	SWP	Bank					A112	
1991	ECCID	52	CDWR	CA	SWP	Bank			76			
1991	Falls R. V. (14)	100	CDWR	CA	SWP	Bank			76,80,81		91-49	3-1
1991	JWDB/WCWD	41	CDWR	CA	SWP	Bank					A111	3-1
1991	Little Holland	100	CDWR	CA	SWP	Bank			83			3-1
1991	OWID	52	CDWR	CA	SWP	Bank						3-1
1991	Private farmers	101	CDWR	CA	SWP	Bank			77			
1991	RD 108/1004	26	CDWR	CA	SWP	Bank			79			3-1
1991	Solano ID	52	CDWR	CA	SWP	Bank			81			3-1
1991	SRWCA (14)	CVP	CDWR	CA	SWP	Bank			78			3-1
1991	Wilson&McCall	100	CDWR	CA	SWP	Bank			85			3-1

Table B-2
California Water Market Bank Transfers 1977-1992

					AF Transferred			Purchase	Wheeling	Sale	Pool/	Area of	Water	Facilities
Year	Seller	TypeS	Buyer	TypeB	Applied	Sold	Bought	$/af-yr	$/af-yr	$/af-yr	Bank	Origin	Source	Storage
1991	YCWA	45.1	CDWR	CA		30,200		$125.00			SDWB	Yuba	GW	aquifer
1991	YCWA	45.1	CDWR	CA		99,000		$125.00			SDWB	Yuba	Storage	Bullards Bar
1991	Yolo Co. farmers	45.1	CDWR	CA		101,556		$125.00			SDWB	Delta	Fallow	none
1991	Solano ID	52	SCWA	45		13,400		$170.00			EDWP	Solano	Fallow	Berryessa
1991	SCWA	45	Benicia	60			9,000		$30.00	$200.00	EDWP	Solano	Fallow	Berryessa
1991	SCWA	45	Fairfield	60			2,000		$30.00	$200.00	EDWP	Solano	Fallow	Berryessa
1991	SCWA	45	Vacaville	60			2,400		$30.00	$200.00	EDWP	Solano	Fallow	Berryessa
1991	SDWB	CA	ACCWD	42	270		370		$219.00	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	ACFCCWD	8			500		$57.11	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	ACWD	42	14,800		14,800		$48.48	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	CCWD	42			6,717		$20.36	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	CLAWA	45			236		$224.64	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	DRWD	41	17,205		13,805		$29.03	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	KCWA	45	52,997		53,997		$40.64	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	MWDSC	43	215,000		215,000		$162.60	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	OFWD	41	600		975		$22.40	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	SCWWD	45	39,500		19,750		$37.78	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	SFWD	60	50,000		50,000		$200.00	$175.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	SWP-Carryover	CA			265,558			$125.00	SDWB	SWP	Storage	SWP
1991	SDWB	CA	WWD	41	12,820		13,820		$20.36	$175.00	SDWB	SWP	Storage	SWP
1992	APJV	100	CDWR	CA		5,000		$50.00			SDWB		GW	aquifer
1992	BVID	52	CDWR	CA		4,600		$50.00			SDWB	Yuba	Storage	Bullards Bar
1992	Conaway	100	CDWR	CA		17,500		$50.00			SDWB	Sacramento	GW	aquifer
1992	Davis Ranches	100	CDWR	CA		4,000		$50.00			SDWB	Sacramento	GW	aquifer
1992	ECCID	52	CDWR	CA		2,500		$50.00			SDWB	Sacramento	GW	aquifer
1992	Los Rios Farms	100	CDWR	CA		15,000		$50.00			SDWB	Sacramento	GW	aquifer
1992	Merced ID	52	CDWR	CA		12,000		$50.00			SDWB	Merced	Storage	
1992	Oakdale ID	52	CDWR	CA		25,000		$50.00			SDWB	Tuolumne	Storage	Don Pedro
1992	OWID	52	CDWR	CA		25,000		$50.00			SDWB	Sacramento	Storage	Oroville
1992	PCWA	45	CDWR	CA		10,000		$50.00			SDWB	American	Storage	Placer Co.
1992	Pelger MWCo	101	CDWR	CA		1,500		$50.00			SDWB			
1992	RD 900	26	CDWR	CA		1,500		$50.00			SDWB	Sacramento		
1992	S San Joaquin ID	52	CDWR	CA		25,000		$50.00			SDWB	Mokelumne	Storage	Melones
1992	Upper Swanston	100	CDWR	CA		995		$50.00			SDWB			
1992	WCWD	41	CDWR	CA		50,000		$50.00			SDWB	Feather	GW	aquifer
1992	SDWB	CA	BWD	41			255		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	CCWD	42			10,000		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	CDFG	CA			20,000		$0.00	$72.00	SDWB	SWP	Storage	SWP

Table B-2
California Water Market Bank Transfers 1977-1992

						Transfer	Carriage		J&S	Gray	Lund	DWR
Year	Seller	TypeS	Buyer	TypeB	Wheeling	Type	Water	Period	#	#	#	#
1991	YCWA	45.1	CDWR	CA	SWP	Bank					91-74	3-1
1991	YCWA	45.1	CDWR	CA	SWP	Bank			84			3-1
1991	Yolo Co. farmers	45.1	CDWR	CA	SWP	Bank			84			3-1
1991	Solano ID	52	SCWA	45	None	Sale						3-1
1991	SCWA	45	Benicia	60	None	Sale			82			3-1
1991	SCWA	45	Fairfield	60	None	Sale						3-1
1991	SCWA	45	Vacaville	60	None	Sale						3-1
1991	SDWB	CA	ACCWD	42	SWP	Bank	16%				5-4	
1991	SDWB	CA	ACFCCWD	8	SWP	Bank	16%		88		5-4	
1991	SDWB	CA	ACWD	42	SWP	Bank	16%		89		5-4	
1991	SDWB	CA	CCWD	42	SWP	Bank	16%		90		5-4	
1991	SDWB	CA	CLAWA	45	SWP	Bank	16%				5-4	
1991	SDWB	CA	DRWD	41	SWP	Bank	16%				5-4	
1991	SDWB	CA	KCWA	45	SWP	Bank	16%		92		5-4	
1991	SDWB	CA	MWDSC	43	SWP	Bank	16%		91		5-4	
1991	SDWB	CA	OFWD	41	SWP	Bank	16%		93		5-4	
1991	SDWB	CA	SCVWD	45	SWP	Bank	16%		87		5-4	
1991	SDWB	CA	SFWD	60	SWP	Bank	16%		86		5-4	
1991	SDWB	CA	SWP-Carryover	CA	SWP	Bank	16%		94		5-4	
1991	SDWB	CA	WWD	41	SWP	Bank	16%					3-1
1992	APJV	100	CDWR	CA	SWP	Bank					5-6	
1992	BVID	52	CDWR	CA	SWP	Bank					5-6	3-2
1992	Conaway	100	CDWR	CA	SWP	Bank					5-6	
1992	Davis Ranches	100	CDWR	CA	SWP	Bank					5-6	
1992	ECCID	52	CDWR	CA	SWP	Bank					5-6	3-2
1992	Los Rios Farms	100	CDWR	CA	SWP	Bank					5-6	
1992	Merced ID	52	CDWR	CA	SWP	Bank					5-6	3-2
1992	Oakdale ID	52	CDWR	CA	SWP	Bank					5-6	3-2
1992	OWID	52	CDWR	CA	SWP	Bank					5-6	3-2
1992	PCWA	45	CDWR	CA	SWP	Bank					5-6	3-2
1992	Pelger MWCo	101	CDWR	CA	SWP	Bank					5-6	
1992	RD 900	26	CDWR	CA	SWP	Bank					5-6	
1992	S San Joaquin ID	52	CDWR	CA	SWP	Bank					5-6	
1992	Upper Swanston	100	CDWR	CA	SWP	Bank					5-6	
1992	WCWD	41	CDWR	CA	SWP	Bank						3-2
1992	SDWB	CA	BWD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	CCWD	42	SWP	Bank	19%				5-5	
1992	SDWB	CA	CDFG	CA	SWP	Public Trust	19%				5-5	

Table B-2
California Water Market Bank Transfers 1977-1992

					AF Transferred			Purchase	Wheeling	Sale	Pool/	Area of	Water	Facilities
Year	Seller	TypeS	Buyer	TypeB	Applied	Sold	Bought	$/af-yr	$/af-yr	$/af-yr	Bank	Origin	Source	Storage
1992	SDWB	CA	DPWD	41			300		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	Foothill WD	41			900		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	HWD	41			200		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	KCWA	45			8,170		$40.64	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	MWDSC	43			10,000		$162.60	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	OWD	41			75		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	PWD	41			2,000		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	QWD	41			100		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	SFWD	60			19,000		$200.00	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	Solado WD	41			300		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	Sunflower WD	41			400		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	TLBWSD	48			31,500		$30.14	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	WWD	41			51,000		$20.36	$72.00	SDWB	SWP	Storage	SWP
1992	SDWB	CA	SWP-Carryover	CA			15,000			$50.00	SDWB	SWP	Storage	SWP

Table B-2
California Water Market Bank Transfers 1977-1992

						Transfer	Carriage		J&S	Gray	Lund	DWR
Year	Seller	TypeS	Buyer	TypeB	Wheeling	Type	Water	Period	#	#	#	#
1992	SDWB	CA	DPWD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	Foothill WD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	HWD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	KCWA	45	SWP	Bank	19%				5-5	
1992	SDWB	CA	MWDSC	43	SWP	Bank	19%				5-5	
1992	SDWB	CA	OWD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	PWD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	QWD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	SFWD	60	SWP	Bank	19%				5-5	
1992	SDWB	CA	Solado WD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	Sunflower WD	41	CVP	Bank	19%				5-5	
1992	SDWB	CA	TLBWSD	48	SWP	Bank	19%				5-5	
1992	SDWB	CA	WWD	41	SWP	Bank	19%				5-5	
1992	SDWB	CA	SWP-Carryover	CA	SWP	Bank	19%					

Table B-3
California Water Market Participans 1977-1992

Agency	Name	Type	WRC Code	County	Controller Dist Type	Ag owners	No. Farms	CVP class 1	CVP class 2	CVP exchange contract
ACCWD	American Canyon Co. Water District	Retail-M&I		7	42					
ACFCCWD	Alameda Co. Flood Control & Water Conservation Dist.	Retail-M&I		1	8					
ACWD	Alameda Co Water District	Retail-M&I		1	42					
AEWSD	Arvin-Edison Water Storage District	Wholesale	1548005	15	48	310	300	40,000	311,675	
AVEKWA	Antelope Valley-East Kern Water Agency	Wholesale		15	45					
Alta ID	Alta Irrigation District	Retail-Ag.	5452006	54	52	4,000				
American R Div.	American River Division-CVP (MUD & ID)	Project			39					
APJV	Alhambra Pacific Joint Venture	Private			100					
Barry Hill	Barry Hill, farmer	Private			100	1	1			
BBID	Byron-Bethany Irrigation District	Retail-Ag.	752002	7	52	250	110			
Benecia	City of Benecia	Retail-M&I			60					
BSA	Boy Scouts of America	Private		23	100					
BVID	Browns Valley Irrigation District	Retail-Ag.		58	52					
BVWD	Bella Vista Water District	Retail-Ag.	4541002	45	41	700	1,000	24,000		
BWD	Broadview Water District	Retail-Ag.	1041001	10	41	28	19	27,000		
CCWD	Contra Costa Water District	Retail-M&I	742001	7	42	65		195,000		
CDFG	California Department of Fish and Game	Agency			CA					
CDWR	California Department of Water Resources	Project			CA					
Chaplin-Lewis	Chaplin-Lewis-Lewis Farms	Private			100					
CID	Consolidated Irrigation District	Retail-Ag.	1052007	10	52		5,500			
CLAWA	Crestline-Lake Arrowhead Water Agency	Wholesale		36	45					
Conaway	Conaway Conservancy/PG&E	Private		57	100					672
CVP	Central Valley Project	Project			US					
CWD	Cawelo Water District	Retail-Ag.		15	41					
Davis Ranches	Davis Ranches	Private			100					9,800
DEID	Delano-Earlimart Irrigation District	Retail-Ag.		15,54	52			108,800	74,500	
DPWD	Del Puerto Water District#	Retail-Ag.		50	41			12,080		
DRWD	Dudley Ridge Water District	Retail-Ag.	1641001	16	41	62	5			
EBMUD	East Bay Municipal Water District	Retail-M&I		1	39			150,000		
ECCID	East Contra Costa Irrigation District	Retail-Ag.	752003	7	52	465	165			
EID	El Dorado Irrigation District	Retail-M&I	952001	9	52		228	34,850		
EWSID	Empire Water Storage & Irrigation District	Retail-Ag.	1652004	16	52	7	7			
Fairfield	City of Fairfield	Retail-M&I			60					
Falls R. V.	Falls River Valley - 14 sellers	Private			100					
Foothill WD	Foothill Water District#	Retail-Ag.		24,50	41			10,840		
Friant Div.	Friant Divison-CVP (Most ID)	Project			52					
FWD	Feather Water District	Retail-Ag.		51	41					20,000
GCID	Glenn-Colusa Irrigation District	Retail-Ag.	1152004	11	52	1,200	850			105,000
Grasslands	Grasslands Water District	Retail-Ag.		24	41					

Table B-3
California Water Market Participans 1977-1992

Agency	Name	SWP contract	Riparian rights	Appropriative rights	1991 Total entitlement	Avg AF Delivered
ACCWD	American Canyon Co. Water District					
ACFCCWD	Alameda Co. Flood Control & Water Conservation Dist.	34,000			34,000	
ACWD	Alameda Co Water District	38,400			38,400	
AEWSD	Arvin-Edison Water Storage District			8,821	360,496	1,382,512
AVEKWA	Antelope Valley-East Kern Water Agency	138,400			138,400	
Alta ID	Alta Irrigation District					867,678
American R Div.	American River Division-CVP (MUD & ID)					
APJV	Alhambra Pacific Joint Venture					
Barry Hill	Barry Hill, farmer					
BBID	Byron-Bethany Irrigation District					38,376
Benecia	City of Benecia					
BSA	Boy Scouts of America					
BVID	Browns Valley Irrigation District			Yes		
BVWD	Bella Vista Water District				24,000	144,422
BWD	Broadview Water District				27,000	198,744
CCWD	Contra Costa Water District			Yes	195,000	1,195,856
CDFG	California Department of Fish and Game					
CDWR	California Department of Water Resources					
Chaplin-Lewis	Chaplin-Lewis-Lewis Farms					
CID	Consolidated Irrigation District					1,347,932
CLAWA	Crestline-Lake Arrowhead Water Agency	5,800			5,800	
Conaway	Conaway Conservancy/PG&E			17,500	18,172	
CVP	Central Valley Project					
CWD	Cawelo Water District	38,200		73,033	111,233	
Davis Ranches	Davis Ranches				9,800	
DEID	Delano-Earlimart Irrigation District				183,300	
DPWD	Del Puerto Water District#				12,060	
DRWD	Dudley Ridge Water District	57,700			57,700	395,848
EBMUD	East Bay Municipal Water District				150,000	
ECCID	East Contra Costa Irrigation District			50,000	50,000	33,488
EID	El Dorado Irrigation District				34,850	23,382
EWSID	Empire Water Storage & Irrigation District	3,000		13,000	16,000	53,196
Fairfield	City of Fairfield					
Falls R. V.	Falls River Valley - 14 sellers					
Foothill WD	Foothill Water District#				10,840	
Friant Div.	Friant Divison-CVP (Most ID)					
FWD	Feather Water District			Yes	20,000	
GCID	Glenn-Colusa Irrigation District			720,000	825,000	790,456
Grasslands	Grasslands Water District					

Table B-3
California Water Market Participans 1977-1992

Agency	Name	Type	WRC Code	County	Controller Dist Type	Ag owners	No. Farms	CVP class 1	CVP class 2	CVP exchange contract
Heidrick	Heidrick Farms	Private		57	100	1	1			
HWD	Hospital Water District#	Retail-Ag.		50,39	41			34,105		
JWDB	(Biggs-W. Gridley, Butte WD, Richvale ID, Sutter ExWD)	JPA	composite	4,51	41	1,194	1,044			
	Biggs-West Gridley Water District		441001	4	41	300	150			
	Butte Water District		441002	4	41	754	754			
	Richvale Irrigation District			4	52					
	Sutter Extension Water District		5141002	51	41	140	140			
KCWA	Kern County Water Agency	Wholesale		15	45					
KCWD	Kings County Water District	Retail-Ag.	1642003	16	42					
Kern misc.	Miscellaneous Kern districts	JPA		15	60					
KTWD	Kern-Tulare Water District	Retail-Ag.		15,54	41				40,000	
LaHacienda	La Hacienda Ranch, et al	Private		15	100	1	1			
Little Holland	Little Holland	Private			100					
LIWD	Lakeside Irrigation Water District	Retail Ag.	1641002	16	41	148	89			
Los Rios Farms	Los Rios Farms	Private			100					
Malacha	Malacha Hydroelectric Co.	Hydro			100					
McArthur	McArthur, et al	Private			100	1	1			
Merced ID	Merced Irrigation District	Retail-Ag.	2452004	24	52	3,000				
MID	Modesto Irrigation District	Retail-Ag.		50,55	52					
MMWD	Marin Municipal Water District	Retail-M&I		21	44					
Munco	Munco Farms	Private			100	1	1			
Musco Olive	Musco Olive Co., Tracy	Private		39	100	1	1			
MVWD	Mid-Valley Water District	Retail-Ag.		10	41					
MWA	Mojave Water Agency	Wholesale		36	45					
MWDSC	Metropolitan Water District of Southern California	Wholesale		19	43					
Napa	City of Napa	Retail-M&I			60					
NCFCWCD	Napa Co. Flood Control and Water Conservation District	Retail-M&I		28	8			7,500		
NCMWCo	Natomas Central Mutual Water Co.	Retail-Ag.		34	101					22,000
Newhall	Newhall Land & Farming Co.	Private		58	100	1	1			700
NMCWD	North Marin County Water District	Retail-M&I		21	42					
Oakdale ID	Oakdale Irrigation District	Retail-Ag.	5052002	50	52	6,500	4,400			
OCID	Orange Cove Irrigation District	Retail-Ag.	1052010	10	52	600	475	39,200		
OFWD	Oak Flat Water District	Retail-Ag.		50	41					
OWD	Orestimba Water District#	Retail-Ag.		50	41			15,860		
OWID	Oroville-Wyandotte Irrigation District	Retail-Ag.	452004	4	52					
Payne	Payne	Private		57	100	1	1			
PCWA	Placer County Water Agency	Wholesale	3145001	31	45			117,000		
Pelger MWCo	Pelger Mutual Water Co.	Retail-Ag.			101					1,750
PG&E	Pacific Gas and Electric Co.	Hydro		CA	100					

Table B-3
California Water Market Participans 1977-1992

Agency	Name	SWP contract	Riparian rights	Appropriative rights	1991 Total entitlement	Avg AF Delivered
Heidrick	Heidrick Farms					
HWD	Hospital Water District#				34,105	
JWDB	(Biggs-W. Gridley, Butte WD, Richvale ID, Sutter ExWD)			Yes		
	Biggs-West Gridley Water District					
	Butte Water District			134,400	134,400	110,897
	Richvale Irrigation District					
	Sutter Extension Water District					1,304,106
KCWA	Kern County Water Agency	1,153,400		1,886	1,155,286	
KCWD	Kings County Water District					
Kern misc.	Miscellaneous Kern districts					
KTWD	Kern-Tulare Water District	27,582			67,582	
LaHacienda	La Hacienda Ranch, et al			93	93	
Little Holland	Little Holland					
LIWD	Lakeside Irrigation Water District					175,854
Los Rios Farms	Los Rios Farms					
Malacha	Malacha Hydroelectric Co.					
McArthur	McArthur, et al					
Merced ID	Merced Irrigation District			Yes		
MID	Modesto Irrigation District			Yes		
MMWD	Marin Municipal Water District					
Munco	Munco Farms					
Musco Olive	Musco Olive Co., Tracy					
MVWD	Mid-Valley Water District					
MWA	Mojave Water Agency	50,800			50,800	
MWDSC	Metropolitan Water District of Southern California	2,011,500		400,000	2,411,500	
Napa	City of Napa					
NCFCWCD	Napa Co. Flood Control and Water Conservation District	7,290			14,790	
NCMWCo	Natomas Central Mutual Water Co.			Yes	22,000	
Newhall	Newhall Land & Farming Co.				700	
NMCWD	North Marin County Water District					
Oakdale ID	Oakdale Irrigation District			Yes		
OCID	Orange Cove Irrigation District				39,200	33,663
OFWD	Oak Flat Water District	5,700			5,700	
OWD	Orestimba Water District#				15,860	
OWID	Oroville-Wyandotte Irrigation District			Yes		
Payne	Payne					
PCWA	Placer County Water Agency			120,000	237,000	82,168
Pelger MWCo	Pelger Mutual Water Co.			Yes	1,750	
PG&E	Pacific Gas and Electric Co.			Yes		

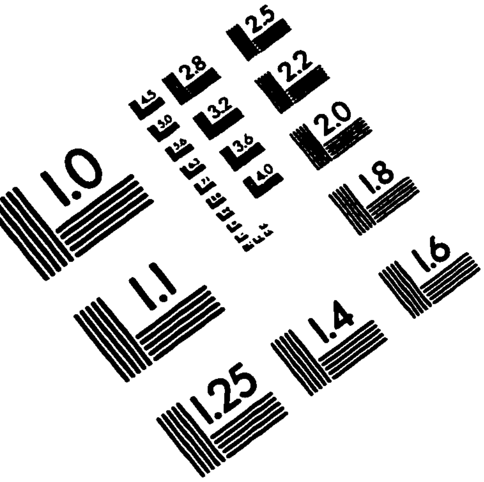
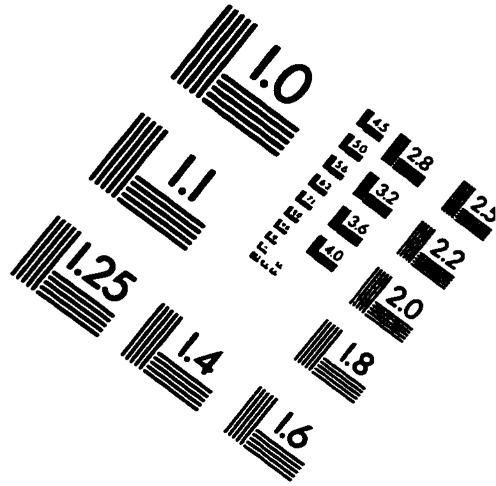
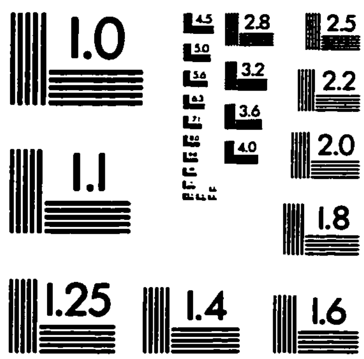
Table B-3
California Water Market Participans 1977-1992

Agency	Name	Type	WRC Code	County	Controller Dist Type	Ag owners	No. Farms	CVP class 1	CVP class 2	CVP exchange contract
PG-VMWCo	Pleasant Grove-Verona Mutual Water Co.	Retail-Ag.		51	101					2,500
PWD	Panoche Water District	Retail-Ag.	1041003	10	41	150	65	94,000		
QWD	Quinto Water District#	Retail-Ag.		24	41			8,620		
RD 108	Reclamation District No. 108	Retail-Ag.	626001	6	26	80	100			33,000
RD 900	Reclamation District No. 900	Retail-Ag.	5727002	57	26	45	6			9,680
Redding	City of Redding	Retail-M&I		45	60			6,140		
S San Joaquin ID	South San Joaquin Irrigation District	Retail-Ag.	3952004	39	52	3,633				
Sacramento R Div	Sacramento River Division-CVP (ID, MWC & private)	Project			CVP					
Salyer	Salyer American Co.	Private		16	100	1	1			
SBCWA	Santa Barbara County Water Agency	Wholesale		42	45			65,060	60,000	
SCVWD	Santa Clara Valley Water District	Retail-M&I		43	45			152,500		
SCWA	Solano Co. Water Agency	Wholesale		48	45			199,500		
SCWD	South Coast Water District	Retail-M&I/Ag		30	42					
SDWB	State Drought Water Bank	Project		CA	CA					
SFWD	San Francisco Water Department (HHW&P)	Retail-M&I		38	60					
Skylark	Skylark Nursery	Private			100	1	1			
SLWD	San Luis Water District	Retail-Ag.		24,10	41					
Solado WD	Solado Water District#	Retail-Ag.		50	41			9,130		
Solano ID	Solano Irrigation District	Retail-Ag.	4852002	48	52	850	350	159,600		
SRWCA	Sacramento River Water Contractors Association	JPA		4,6,11,52,51	CVP					
Sunflower WD	Sunflower Water District#	Retail-Ag.		50	41			16,625		
SWP	State Water Project	SWP		CA	CA					
TCCA	Tehama-Colusa Canal Association (All CaWD)	JPA		52,6	41					
TLBWSD	Tulare Lake Basin Water Storage District	Wholesale		16,54	48					
TMWCo	Tudor Mutual Water Co	Retail-Ag.		51	101					
TTCo	Thousand Trails Co.	Private			100					
Upper Swanston	Upper Swanston Ranch Inc.	Private			100					
USBR	US Bureau of Reclamation	Agency		CA	US					
USFWS	US Fish and Wildlife Service	Agency		CA	US					
Vacaville	City of Vacaville	Retail-M&I			60					
Vallejo	City of Vallejo	Retail-M&I			60					
W San Joaquin Div.	W San Joaquin Division-CVP (All CaWD)	Project			41					
WCWD	Western Canal Water District	Retail-Ag.	441003	4	41	120	120			
Willits	City of Willits	Retail-M&I			60					
Wilson&McCall	Wilson & McCall, Inc.	Private			100					
WWD	Westlands Water District	Retail-Ag.	1041005	10	41	2,500	600	900,000	250,000	
YCWA	Yuba County Water Agency	Wholesale		58	45.1					

Table B-3
California Water Market Participans 1977-1992

Agency	Name	SWP contract	Riparian rights	Appropriative rights	1991 Total entitlement	Avg AF Delivered
PG-VMWCo	Pleasant Grove-Verona Mutual Water Co.				2,500	
PWD	Panoche Water District				94,000	103,764
QWD	Quinto Water District#				8,620	
RD 108	Reclamation District No. 108		199,000		232,000	234,000
RD 900	Reclamation District No. 900				9,680	
Redding	City of Redding				6,140	
S San Joaquin ID	South San Joaquin Irrigation District			300,000	300,000	90,000
Sacramento R Div	Sacramento River Division-CVP (ID, MWC & private)					
Salyer	Salyer American Co.					
SBCWA	Santa Barbara County Water Agency				125,060	
SCVWD	Santa Clara Valley Water District	94,000			246,500	
SCWA	Solano Co. Water Agency	22,300			221,800	
SCWD	South Coast Water District					
SDWB	State Drought Water Bank					
SFWD	San Francisco Water Department (HHW&P)			300,000	300,000	
Skylark	Skylark Nursery					
SLWD	San Luis Water District					
Solado WD	Solado Water District#				9,130	
Solano ID	Solano Irrigation District				159,600	133,497
SRWCA	Sacramento River Water Contractors Association					
Sunflower WD	Sunflower Water District#				16,625	
SWP	State Water Project					
TCCA	Tehama-Colusa Canal Association (All CaWD)					
TLBWSD	Tulare Lake Basin Water Storage District	118,500			118,500	
TMWCo	Tudor Mutual Water Co			Yes		
TTCo	Thousand Trails Co.					
Upper Swanston	Upper Swanston Ranch Inc.			Yes		
USBR	US Bureau of Reclamation			Yes		
USFWS	US Fish and Wildlife Service			Yes		
Vacaville	City of Vacaville					
Vallejo	City of Vallejo			Yes		
W San Joaquin Div.	W San Joaquin Division-CVP (All CaWD)					
WCWD	Western Canal Water District			295,000	295,000	229,140
Willits	City of Willits					
Wilson&McCall	Wilson & McCall, Inc.					
WWD	Westlands Water District				1,150,000	990,108
YCWA	Yuba County Water Agency			300,000	300,000	

IMAGE EVALUATION TEST TARGET (QA-3)

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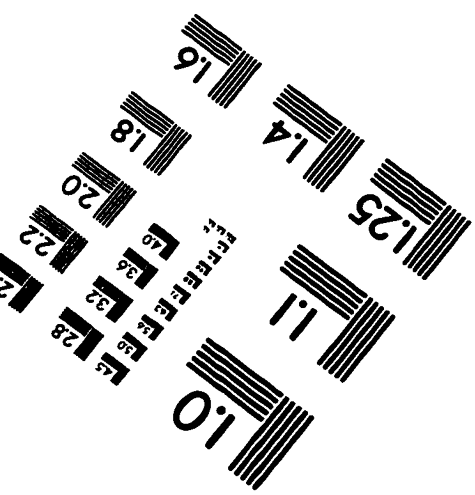
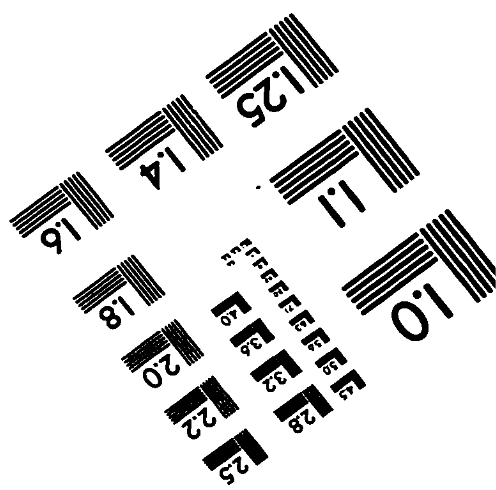

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