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FOREWORD

This report is the collaborative product of a group of researchers. Dr. Charles W. Howe provided the conceptual analysis relating to water bank design in chapter 4. Dr. Kathleen A. Miller, of the National Center for Atmospheric Research, contributed the California Water Bank analysis and most of the discussion related to third-party effects of water banking. Teresa A. Rice prepared the sections on water banks in Idaho and Texas, and the proposed Lower Colorado River Interstate Water Bank and she also contributed to the section on third-party effects. Sarah F. Bates, now with the Grand Canyon Trust, drafted most of the material related to groundwater recharge. The project benefitted greatly from the work of a number of students at the University of Colorado School of Law: Roberta Hoy, class of 1994; Ellen Cadette, class of 1996; Beth Doherty, class of 1996; Sharyl Kammerzell, class of 1996; Dan Reimer, class of 1996; and Mary Beth Searles, class of 1997.

We received the cooperation and assistance of water managers from around the West. At the outset we surveyed state water agencies and the Western States Water Council to determine the extent of water banking activity in the West. In connection with our detailed analysis of water banks in Idaho we were greatly aided by Ron Carlson, Phil Rassier, and Glen Saxton. Steve Macaulay provided substantial assistance regarding the California banks, as did Richard Howitt, Ray Hoagland, and Dave Marty. Daniel Beckett provided valuable assistance regarding the Texas bank. Gerry Zimmerman made important contributions to our discussion of the proposed Lower Colorado River bank as did Walt Muir and Bob Johnson. Professors Tom Rutherford and Mark Cronshaw commented on the analysis of water bank design, and Dr. Michael Walsh provided valuable insights based on his work for the Chicago Board of Trade. The authors, of course, remain responsible for any errors in the report itself.

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Larry MacDonnell

USING WATER BANKS TO PROMOTE MORE FLEXIBLE WATER USE

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Chapter 1

WATER BANKS: AN INTRODUCTION

A major challenge facing the western United States is the reallocation of a portion of its developed water supplies to new and changing uses. An elaborate and complex legal structure governs the entitlements to the use of the developed water, based largely on the timing by which the water uses were established. By far the largest portion of entitlements is dedicated to irrigation use—roughly 80 percent of all withdrawals and 90 percent of all consumptive uses. In many cases these irrigation uses also hold the highest priority rights to the use of available water.

Substantial additional development of the limited water supplies of the West seems unlikely. Instead existing uses are likely to become more efficient, and some water will shift to new uses. Reallocation of water to new uses most often occurs when the land on which water has been used changes its use—for example, from irrigation to residential. Less common but increasingly important are purchases of water rights for use in different locations. Such transactions generally involve total cessation of the original water-using activity so that as much water as possible can be transferred to the new use.

Economists long have noted the disparity of monetary value between water used in much of the irrigated agriculture of the West and the value of water in municipal and industrial uses. In a market system, resources are expected to move to uses in which they bring the highest economic return. Many explanations have been offered for the failure of water use to reflect this behavior—perhaps most commonly the existence of "legal impediments" to the marketability of water.

Consequently, much attention has focused on the legal structure by which water rights may be changed in use. Previous analysis by the Natural Resources Law Center suggests that while there is considerable inflexibility in the water allocation structure there are relatively few absolute legal barriers.[1] Removal of "legal impediments" will not by itself greatly change the process of water reallocation in the West.

Instead, attention now is turning to a more sophisticated evaluation of the nature of water use in the West and the factors that tend to keep water from changing use as readily as the relative value of water uses would suggest. One of these factors is the transaction costs, broadly defined, of making a water transfer.[2] There are substantial engineering, legal and other costs associated with locating purchasable water rights, determining their transferability, evaluating the amount of water that may be transferred, addressing issues of protection of other water rights and the public interest, and physically making the water available for use at the new location. These costs are, of course, in addition to the purchase price for the water right itself. Moreover, the state-level change-of-use processes tend to be slow moving and can be contentious.

A second factor is the growing concern with the so-called "third party" effects associated with transfers. Water flowing in a stream is not a resource readily susceptible to private ownership. It serves a multitude of benefits while in the stream. While portions of its flow periodically are dedicated to specific uses intended to benefit particular people it is often true that at least some of the water will subsequently be available for other uses. Because of the shared and interdependent nature of water the legal system recognizes and protects legal entitlements to the use of water but does not give title to the water itself. Legally speaking then, the marketable interest is the entitlement of use, not the water itself. A water use entitlement, whether expressed as an adjudicated water right, a share of a water right, a permit or license, a contract, or some other form, is inherently limited by the manner in which water is shared among a large number of uses. In a water rights context this relational dependency is recognized in the requirement that a change of use cannot occur if it will cause harm or injury to

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[1]Lawrence J. MacDonnell, F. Lee Brown, Charles W. Howe, Teresa A. Rice, The Water Transfer Process as a Management Option for Meeting Changing Water Demands, Natural Resources Law Center (1990).

[2]Charles W. Howe, Carolyn S. Boggs, and Peter Butler, "Transaction Costs as Determinants of Water Transfers," 61 U. Colo. L. Rev. 393 (1990).

other water rights. Increasingly there also are protections for other values of water, so-called third party interests, in the change of water right process.

Perhaps because quantities of water are not simply available for purchase at some known market at the time and place of need there is a tendency to hold onto water use entitlements (and to divert the water because of the "use it or lose it" aspect of prior appropriation law). Similarly, for those foreseeing increased water demands in the future there is a tendency to acquire water rights in advance of the need to assure the availability of the water. In an arid environment, water is opportunity: those who control the resource control the opportunities. In such a setting there is an understandable desire to obtain and hold onto that control.

Water marketing through the permanent transfer of water rights serves at least some of the need for more flexibility in the use of western water. But there are some serious limitations associated with this single approach. Given the transaction costs mentioned above, transfers of water rights for use in a different location often involve a large quantity of water. Typically this means that a major share of the water use entitlements to the water supply for an irrigation area are purchased, with the irrigated lands taken permanently out of production. The adverse local economic effects of such large-scale transfers can be substantial, prompting increased resistance to permanent water transfers in some instances. The choice facing the irrigator in a system from which water rights are being purchased is, in most cases, either to sell and go completely out of farming or not to sell and to attempt to stay in agriculture. There are no other real alternatives. The choice facing the water purchaser often is to purchase large blocks of water rights (perhaps including the lands on which they are used) to justify the transaction costs or to attempt to develop new supplies of either surface or ground water. More and better choices are needed, both for buyers and sellers.[3]

Water banks are emerging as one important way in which greater flexibility can be developed in the water allocation systems of the West. This general mechanism, which

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[3]This point is developed at greater length in Teresa A. Rice and Lawrence J. MacDonnell, "Agricultural to Urban Water Transfers: An Assessment of the Issues and Options," Natural Resources Law Center (1993).

we define broadly as an institutionalized mechanism specifically designed to facilitate the transfer of water use entitlements, is in use in a number of settings in the West. Our evaluation of water banking experience to date leads us to conclude that banks can provide an effective framework within which water transfers, particularly involving the temporary transfer of water, can occur.

A water bank is an intermediary. Like a broker it seeks to bring together buyers and sellers. Unlike a broker, however, it is an institutionalized process with known procedures and with some kind of public sanction for its activities. Conceptually, the process is straightforward: a valid water use entitlement is "deposited" with the bank and is available for withdrawal by others, subject to certain conditions—most importantly, paying some fee. One depositing the water use entitlement can withdraw the entitlement from the bank so long as it has not been rented to another. The depositor banks the entitlement hoping to earn more on its use by another. The renter goes to the bank hoping to find water at a lower cost than from other sources.

In its role as facilitator the bank has several key functions. It decides which water use entitlements may be banked and, probably, the quantity of bankable water associated with the entitlement. It decides who can rent water from the bank and sets the processes by which the terms of the rental are established.

There is nothing new about the basic purpose of a water bank: water districts and ditch companies long have facilitated "rotation" of water among users within their system. The important difference of modern water banks is that they act to facilitate transfers to uses outside of their original delivery system and for uses other than irrigation.

This report provides a detailed assessment of water banks.

Chapter Two of this report contains evaluations of the major water banks operating in the West today: the Idaho water banks and the California drought banks. It continues with descriptions of two newly proposed banks: the Texas Water Bank and the Lower Colorado River Interstate Water Bank. Finally it discusses other bank-like activities in several other states.

Chapter Three provides a thorough discussion of the use of groundwater recharge to bank water for future use. The chapter begins with a survey of state laws governing groundwater recharge. It then turns to an examination of several prominent examples of the use of recharge including the Kern Water Bank, the Orange County and Las Vegas Valley programs, and the Arizona-California Colorado River Water Storage Agreement.

Chapter Four contains a largely economic analysis of water bank design. It considers fundamental factors in developing a water allocation system and then turns to a focused consideration of water banks, referencing back to water bank features identified in the earlier chapters. Special attention is given to the issue of third party effects in water bank transfers. Finally a recommended general framework for designing and operating a water bank is proposed.

Chapter Five applies our recommended framework to an evaluation of three proposed water banks: the Lower Colorado River Interstate Water Bank, the Texas Water Bank, and the Fort Lyon Canal Water Bank. These examples were chosen for analysis because they are still under development and because they range broadly in scope from interstate, to state level, to local. We note points at which these banks differ in design from our recommended approach and offer alternative suggestions.

Chapter Six summarizes the findings from the study and restates the case for broader use of water banks in the West.

We turn first to an examination of water bank experience in the West.

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Chapter 2

WATER BANK EXPERIENCE IN THE WEST

This chapter examines the experience to date with the use of formal water banks in the West. We begin with the longest established water bank, the one in the Upper Snake Basin of Idaho, and its sister banks in that state. Then we turn to the recent experience with the state-level water bank in California that has been used to deal with drought-related water shortages in 1991, 1992, and 1994. Next we look at the newly-formed Texas Water Bank and the proposed Lower Colorado River Interstate Bank. Finally we look at bank-like activities in Kansas and at water district level banks in Colorado and Washington.

2.1 WATER BANKS IN IDAHO

Idaho has a statewide water supply bank administered by the Idaho Water Resource Board (Board) through the Idaho Department of Water Resources, and three storage rental pools managed by local committees. In addition, rules were adopted in 1994 governing the operation of a Tribal Water Supply Bank for the Shoshone-Bannock tribes.

The state's formal banking program dates back to 1979 when Idaho Legislators, following the recommendation of the Board, enacted a statutory scheme calling for the creation of a "water supply bank." The underlying policy, announced by the Board a few years earlier, called for the establishment of a water supply bank "for the purpose of acquiring water rights or water entitlements from willing sellers for reallocation by sale or lease to other new or existing uses."[1] A statewide banking program was subsequently established to "obtain the highest duty for beneficial use from water, provide a source of adequate water supplies to benefit new and supplemental water uses, and provide a

[1] See Leland L. Mink, "Water Banking in Idaho," paper presented at Riparian Management: Common Threads and Shared Interests, Feb. 4-6, 1993, and USDA Forest Service, General Technical Report RM-226 (1993).

source of funding for improving water user facilities and efficiencies."[2] In addition, the Board was given authority to appoint local committees to operate storage rentals at a local level.[3]

Short-term water rentals in Idaho have a much longer history, dating back more than 60 years to the water short years of the late 1920s and early 1930s. Annual water rentals with little state involvement became a common practice in the Upper Snake River Basin and continued until 1979 when a more formal procedure was adopted.

2.1.1 History of Water Rentals in the Upper Snake Basin

As early as 1928 water users in the Upper Snake River Basin looked at opportunities to rent water on an annual basis to meet periods of water shortage. One of the first years of rentals, 1932, witnessed a temporary transfer of 14,700 acre-feet of water at 17 cents per acre-foot. This practice continued with no formal rules or pricing mechanism in place until 1937, when the Upper Valley Storage Pool was formed to establish policies and rules governing water rentals in the upper basin, and a fixed rental price of 50 cents per acre-foot was established.[4]

Most storage space in the Upper Snake River Basin has been developed under Bureau of Reclamation projects. The issue of whether a storage space holder may profit from the rental of project water, debated today, was suggested even in these early days of water rental operations. Any amount collected for the rented water in excess of 12 cents per acre-foot had to be divided equally between the spaceholder and the Bureau of Reclamation, under the Bureau's interpretation of its repayment contract with the

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[2]Idaho Code § 42-1761 (1990).

[3]Stephen H. Riggin and H. Jerome Hansen, Idaho Dept. of Fish and Game, "Phase 1 Water Rental Pilot Project: Snake River Resident Fish and Wildlife Resources and Management Recommendations" (Oct. 1992), at 15 [hereinafter Water Rental Report].

[4]Ronald D. Carlson, Watermaster, Water District 1, Idaho Department of Water Resources, "The History of Water Banking in the Upper Snake River," (about 1988) [hereinafter Carlson History]; and telephone conversation with Ronald D. Carlson (Oct. 1, 1993).

American Falls Reservoir District.[5] Every year between 1937 and 1978 the price for water rentals was reviewed but fluctuated little from the 1937 price. In 1978, however, the rental price was raised to 75 cents per acre-foot. With this increase space holders began to receive 50 cents per acre-foot and the water district, not the Bureau, received the 25 cent balance.[6] The Bureau has not directly received any part of the rental fee since the 1978 change.[7]

The long history of renting water in the Upper Snake River Basin with little state involvement came to a close in 1979. With the enactment of the water banking statute, the Idaho Water Resource Board appointed a local committee to manage a rental pool in Water District 1 (Upper Snake River Basin), and a new pricing formula was set in place.[8]

2.1.2 Current Water Banking Program in Idaho

Idaho banks are governed by statutory provisions, rules, and local procedures. Water bank laws and rules govern the statewide bank, the three local rental pools, and the Shoshone-Bannock Tribal Water Supply Bank (tribal bank). In addition, each bank has adopted its own procedures which have been approved by the Idaho Water Resource Board. The statewide bank allows temporary or permanent transfers of entitlements under natural flow or storage water rights. Local rental pools have been established for Water District 1, as mentioned earlier, Water District 65 (Payette River Basin) and Water District 63 (Boise River Basin). Operating procedures were approved by the Board in 1994 for a tribal water bank, pursuant to the 1990 Fort Hall Indian Water

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[5] Carlson History at 3.

[6] Carlson History. Idaho is divided into water districts generally by major streams and tributaries. Water districts are delegated authority to distribute water among appropriators. See Idaho Code § 42-604 (Supp. 1993).

[7] Telephone conversation with Ronald D. Carlson (Oct. 1, 1993).

[8] The Bureau of Reclamation approved the new pricing structure, approval deemed necessary because of the Bureau's continuing restriction against unreasonable profits. See Carlson History.

Rights Agreement.[9] Following is a discussion of some important features of Idaho's water bank program with reference to the statewide bank and the three rental pools. A description of the new tribal water bank follows this discussion.

2.1.2.1 Local rental pools

The Idaho Water Resource Board (Board) is authorized to appoint local rental pool committees to operate storage rentals. These committees are required to develop procedures for, among other matters: (1) setting priorities among competing applicants for bank water; (2) managing rental pool funds; (3) setting annual rental price and administration fees; (4) preventing injury to other water rights and to the local public interest; (5) ensuring the conservation of water resources within the state of Idaho; and (6) notifying the department and the watermaster of rentals involving a change in place of use. An annual report of rental pool leases and rentals is submitted to the Board which must approve any fee increase. Table 2.1.1 shows rental pool activity from 1990 through 1993.[10]

2.1.2.2 Storage vs. natural flow water rights in Idaho

Under Idaho water rights administration, an irrigator can hold both natural flow and storage water rights to satisfy his irrigation needs.[11] A storage water right is the right to store water, when available, in a certain amount of reservoir space, for later specified beneficial use. If water is stored under a storage right and not needed in a given year it can be carried over if the holder of the right has available storage space. Carry over combined with the following year's supply cannot exceed the amount of

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[9]Pub. L. No. 101-602, 104 Stat. 3059 (1990).

[10]In 1994, the Bureau of Reclamation assigned 371,480 acre-feet (AF) of space to the upper Snake River rental pool that yielded 277,305 AF of water. This water, along with 44,325 AF yielded from the City of Pocatello's assigned space, provided a combined 321,630 AF of water downstream for salmon recovery. Non-Bureau parties assigned an additional 74,732 AF that yielded 74,638 AF of water, all of which went to agricultural users in the district. These figures may be adjusted slightly in the final accounting for the season. Telephone conversation with Ronald D. Carlson (Aug. 15, 1994).

[11]See Rental Report, at 17.

storage space recognized under the right. Natural flow water rights, in contrast, must be diverted and used as the water becomes available. If not used, the water passes to the next appropriator in line.[12]

Idaho's bank program, as implemented by the local rental pools, limits the banking of natural flow rights. Only water available under storage rights may be transferred through the local rental pools and tribal bank.[13] In contrast, under the Board administered water bank, there is no such restriction. The Board has the authority to "purchase, lease, or otherwise obtain decreed, licensed or permitted water rights" for the water supply bank.[14] Though not expressly stated, the limitation of local pools and the tribal bank to storage water is meant to minimize questions of injury to other water rights in their operation.[15]

2.1.2.3 Special status of water assigned to the bank

Regardless of whether the water right assigned to the bank is for storage or natural flow, state water bank provisions shield the water right from challenges under the state water forfeiture law.[16] Under Idaho law, rights to the use of water can be lost by a

[12]Telephone conversations with Ronald D. Carlson (Oct. 1, 1993), and with Phillip J. Rassier, Deputy Attorney General, State of Idaho (Sept. 29, 1993). There is one recognized exception to this allocation principal under the temporary rules adopted this year for the Big Lost River basin, which allow rotation of certain natural flow rights in order to improve the efficiency of water use. See IDAPA 37.03.12040 (Rule 40).

[13]Idaho Code § 1765 (1990 and Supp. 1993). This provision does not expressly prohibit the banking of natural flow rights, but rather authorizes the Board to "appoint local committees to facilitate the rental of stored water." Local committee procedures, however, expressly limit banking to storage rights.

[14]Id. at § 42-1762.

[15]This was suggested by Phillip J. Rassier and by comments of Ronald D. Carlson, Watermaster, Water District 1 (April 29, 1994).

[16]Idaho Code § 42-1764 (1990); Water Supply Bank Rules, Idaho Water Resource Board, IDAPA 37.02.03.025.07(e).

Table 2.1.1

WATER SUPPLY BANK OVERVIEW OF LOCAL COMMITTEES

Upper Snake River			
Designated Committee:	Advisory Committee of Water District 1 (Committee of Nine)		
Reservoir Storage:	Approx. 4.1 million acre-feet (AF)		
Rental Activity:	1990	401,197	AF space assigned
		295,508	AF water yielded
		118,872	AF rented for irrigation
		63,000	AF rented for hydro and other uses
	1991	229,172	AF space assigned
		201,300	AF water yielded
		86,140	AF rented for irrigation
		99,000	AF rented for hydro and other uses
	1992	74,295	AF space assigned
		9,954	AF water yielded
		9,954	AF rented for irrigation
		0	AF rented for hydro and other uses
	1993	209,303	AF space assigned
		205,970	AF water yielded
		38,974	AF rented for irrigation
		65,000	AF rented for hydro and other uses
		206,647	AF Reclamation yield for salmon
Boise River			
Designated Committee:	Advisory Committee of Water District 63		
Reservoir Storage:	Approx. 1.0 million AF		
Rental Activity:	1990	11,182	AF space assigned/water yielded
		11,182	AF rented for irrigation
	1991	2,927	AF space assigned/water yielded
		2,758	AF rented for irrigation
	1992	1,832	AF space assigned/water yielded
		1,832	AF rented for irrigation
	1993	23,900	AF space assigned/water yielded
		23,000	AF rented for salmon recovery
Payette River			
Designated Committee:	Advisory Committee of Water District 65		
Reservoir Storage:	Approx. 815,000 AF		
Rental Activity:	1990	65,881	AF space assigned/water yielded
		0	AF rented for irrigation
		63,700	AF rented for hydropower
	1991	102,574	AF space assigned/water yielded
		2,000	AF rented for irrigation
		100,000	AF rented for salmon recovery
	1992	48,615	AF space assigned/water yielded
		48,615	AF rented for irrigation
	1993	35,000	AF space assigned/water yielded
		0	AF rented for irrigation
		35,000	AF rented for hydropower

Source: Idaho Department of Water Resources failure to use the water for the purpose appropriated for a period of 5 years.[17] Water rights accepted into any water bank in Idaho are protected from forfeiture from the date of acceptance into the bank until the right is removed from the bank by the owner. For water rights on which the five year period of nonuse began to accrue prior to placing the right into the bank, the type of protection depends on whether or not the water right is rented out during the time it is in the bank. If water under the right is rented and put to a beneficial use the owner begins a new five year period once the water right is removed from the bank. If the water right is not rented, the forfeiture period will continue to run when the water right is removed from the bank.[18]

2.1.2.4 Limitations on out-of-state or out-of-water district transfers

Idaho water law and the state water banking program place limitations on water bank transfers, although state law restrictions have been temporarily lifted as part of a regional coordinated effort to enhance salmon migration.[19] First, state law requires legislative approval for any changes of use (temporary or permanent) of more than 5,000 acre-feet of water for out-of-state use.[20] Second, the water bank law originally prohibited rentals for out-of-state use, but was amended in 1992 to provide standards for considering out-of-state use.[21] In reviewing applications to rent water from the water supply bank or for out-of-state uses, the Director of the Department of Water Resources

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[17]Id. at § 42-222(2). Under Idaho law, abandonment requires a finding of intent to permanently discontinue use of the water, regardless of the period of nonuse, while forfeiture can occur simply from nonuse for the 5 year statutory term, regardless of intent. See Gilbert v. Smith, 97 Idaho 735, 552 P.2d 1220 (1976).

[18]Idaho Code § 42-1764 (1990); and letter from Phillip J. Rassier, Deputy Attorney General, Idaho Department of Water Resources to Teresa Rice, regarding Water Banks in Idaho (July 8, 1994).

[19]The water must first be used for power production within the state of Idaho. See Idaho Code § 42-1763A (Supp. 1993); meeting with Frank Sherman, Idaho Department of Water Resources (July 28, 1993).

[20]Idaho Code § 42-108.

[21]1992 Idaho Sess. Laws, ch. 101.

(Director) is to consider Idaho's need for water and available water supply, among other factors.[22]

All three of the local rental pools have adopted what is known as the "last to fill" rule. Under this rule, space in reservoirs representing water rented from the pools for uses outside of the water district is the last space to refill.[23] The rule is intended to protect other water rights holders from being injured if the system does not fill the year following the rental.[24] The rental pools in Water Districts 1 and 65 require the express written consent of the lessor to rent water for out-of-district water use.[25]

In 1991, Idaho Power Company (IPC), acting as an agent for Bonneville Power Company, purchased water from the Upper Snake Bank and moved the water downstream and out of state to help meet target flows for salmon. Upon learning of this use, the Director contacted IPC and notified them that such use violated state water law.[26] As a result, in 1992, the Idaho Legislature provided interim authority (expiring January 1, 1996) for the rental of storage water to augment Lower Snake River flows

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[22]Idaho Code §§ 42-1763 and 42-401(3) (1990 and Supp. 1993). These standards also apply to the rental pools. Id. at § 42-1765.

[23]Water District 1 and 63 Rules, at rule 3.6; Water District 65 Rules, at rule 3.5.

[24]See Rental Report, at 17. The report suggests the rule is for the protection of senior water rights holders, but it would more clearly operate to protect juniors since senior space would be the first to fill.

[25]District 1 and 65 Rules, at rule 3.7. Hydrologic considerations dictate this distinction in Water District 1, for uses below Milner Dam. As a result of the history of irrigation development in the upper basin, the only significant flows of water below Milner Dam today typically occur during the non-irrigation season. During the summer (irrigation) months, the river is generally dried up at Milner and for about a mile below. Return flows from the upstream irrigation use contribute millions of acre feet of water to the Snake River Plain aquifer, significantly raising the groundwater table and increasing discharges into the Snake River below Milner Dam at Thousand Springs. As a result, the Snake River in Idaho has been viewed and managed as two separate river systems, one above Milner and the other below. See Jeffrey C. Fereday and Michael C. Creamer, "Swan Falls in 3-D: A New Look at the Historical, Legal and Practical Dimensions of Idaho's Biggest Water Rights Controversy," 28 Idaho L. Rev. 574, 582-83 (1992).

[26]See Stephen Steubner, "Idaho Water Chief's Statement Dampens Plan for Release," The Idaho Statesman (Sept. 13, 1991); and Rental Report, at 17, referring to a letter from Keith Higginson dated Sept. 5, 1991.

during the migration of Snake River salmon.[27] Releases for salmon migration must first be used in-state for power production purposes.[28]

2.1.2.5 Irrigation use preference

Local rental pool rules provide a preference to bank rentals for irrigation use. This preference reflects Idaho water transfer law, under which water rights may be changed so long as the change does not result in an enlargement of the right or injury to another right, and is found to be in the local public interest.[29] In general, rules state that irrigation or agricultural users should be the first and primary beneficiaries of bank operations.[30] For example, District 1 rules provide "[a] primary purpose in the operation of the rental pool will be to benefit the agricultural water users within Water District 1."[31] More specifically, all three rental pools give irrigators an exclusive right to rent bank water during the initial months of irrigation season.[32] Additionally, rental pool

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[27]1992 Idaho Sess. Laws, ch. 101, § 2; codified at Idaho Code § 42-1763A (Supp. 1993). This provision was extended until 1996 by House Bill 989, 1994 Idaho Sess. Laws, ch. 452, § 2.

[28]Under this interim measure, the Director is explicitly permitted to waive the analysis of the factors outlined previously. Where there is a local committee, any water intended to be used for this purpose must be rented through that committee. Those desiring to take advantage of this program must prepare an annual water flow augmentation plan that is approved by the Director. Approval is based on a determination that the water rented pursuant to this provision will be used as part of a regional coordinated effort to enhance salmon migration and that other parties are making a proportional contribution to solving the salmon migration problem. Idaho Code § 1763A(1) (Supp. 1993).

[29]See Idaho Code § 42-222 (1990).

[30]Rental Pool Procedures, rule 3.2.

[31]Water District 1, Rental Pool Procedures, Approved by the Committee of Nine May 29, 1991 [hereinafter District 1 Procedures]. District 63 procedures were first adopted in 1991 and state that the rental pool is operated "by and for the irrigators within the District through the Committee" with the objective of the rules to "assure that Stored Water is maintained and first made available for irrigation use." District 63 Rental Pool Procedures, rule 3.2 (amended June 24, 1993) [hereinafter District 63 Procedures]. District 65 rules have the same language. Water District 65, Rental Pool Procedures, rule 3.2 (July 31, 1992, as amended 1993) [hereinafter District 65 Procedures].

[32]See, e.g. District 1 Procedures, at rule 7.1. Priorities among potential renters of bank water are more fully discussed in section 2.1.2.7.

rules favoring in-district water use, discussed above, in effect operate as an irrigation preference.

Laws and rules pertaining to the statewide water supply bank have no express irrigation preference, but allow the administrator, in reviewing a proposed sale or lease to the bank or rental or purchase from the bank, to consider whether the proposed use would conflict with the local public interest.[33]

2.1.2.6 Deposits into the bank

Rules for assigning water rights or storage to a bank vary somewhat with each bank. For the statewide water supply bank, an owner of a water right wishing to assign the right to the bank must file a completed application with the Director that includes evidence of the entitlement such as a court decree, permit or license. Proof of current ownership as well as evidence that the right has not been lost through abandonment or forfeiture is also required. Finally, the applicant must demonstrate the "relative availability of water in the source to fill the water right." For a water right involving shares of stock in a canal company or in a system managed by an irrigation district, the written consent of such company or district is required.[34]

In considering whether to accept offered water into the water supply bank, the Board must consider, among other factors: (1) the reasonableness of the price or requested rental rate; (2) if acquisition of the right is consistent with the state water plan; (3) whether the application in the local public interest; and (4) the probability of selling or renting the water right.[35] A resolution accepting the application should include conditions describing the length of time the water right will be retained in the bank, and the terms of payment to the owner for the rental of the right, among other terms.[36]

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[33]Idaho Code § 42-1763 (Supp. 1993); and IDAPA 37.02.03.025.06 and 37.02.03.030.06.

[34]IDAPA 37.02.03.025.02.

[35]Id. at 37.02.03.025.06.

[36]Id. at 37.02.03.025.07.

Thirty days is given as a "grace period" within which the owner may withdraw the right if he chooses not to be subject to these conditions. Otherwise, the water right is deposited into the bank and the user is not authorized to make any use of the right during the period in which it is under the Board's control.[37]

Rental pool rules share common provisions, but are adapted to each basin's unique situation. In all three local rental pools, storage space is accepted into the bank on a contingency basis.[38] Only the actual yield of water to that space can be rented. Therefore, if the space does not fill or the storage is not rented the lessor receives no rental fee.[39]

In District 1, rental pool lessors must hold space or storage in a reservoir located in the district. While not expressly stated, this requirement is implied in the operations of the other rental pools in Idaho. The District 1 rental pool is unique from the other rental pools in that it allows the leasing of reservoir space as well as storage water.[40] The lessor must identify offered space or storage by reservoir. Otherwise bank administrators will assume, if the lessor holds space in more than one reservoir, that American Falls space is designated first, Jackson space second, and Palisade space third.[41]

District 1 rules also establish priorities among lessors for the purpose of renting bank and allocating rental proceeds. All lessors committing space or water prior to June 1 of each year (and all multi-year leases) are handled as one group. A second group comprises those who commit between June 1 and July 1. For a third group, those who

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[37]Id. at 37.02.03.025.08..

[38]Local Rental Pool Procedures, rule 3.4 (Districts 63, 65) and rule 3.5 (District 1).

[39]See Rental Pool Report, supra at 15; and District 1 Procedures, at rules 3.5, Districts 63 and 65 Procedures, at rules 3.4, 3.5. Evaporation losses are deducted from the water supply attributable to assigned space to determine an amount that can be rented from that space.

[40]District 1 Procedures, at rule 5.6. Space is defined as all or any portion of the active impoundment volume of a reservoir measured in acre feet. Id. at rule 2.21.

[41]Id. at rule 5.2.

submit lease applications after July 1, rentals and proceeds are handled on a first-committed, first-rented basis.[42]

In District 63, space in one of the three major reservoirs (Lucky Peak, Anderson Ranch, and Arrowrock/Lake Lowell) may be assigned or leased to the rental pool.[43] There are two priorities of lessors: those assigning storage space prior to July 1, and those assigning after July 1. Stored water attributable to space assigned before July 1 is rented before space assigned after July 1, and the earlier lessors share proportionately in the rental proceeds.[44] After July 1, lessors are treated on a first-committed, first-rented basis.[45] Rules are similar in the District 65 rental pool.[46]

2.1.2.7 Rentals from the bank

Under the Board's water supply bank, the Board can initiate the sale or rental of water rights from the bank[47] Requests or applications to purchase or rent are submitted to the Director who, in reviewing applications, is to consider several factors relevant to issues of injury, as discussed in section 2.1.2.10 of this report.

Local rental pools share some common rules on storage rental. Rental pool rules establish priorities among lessees or renters, as mentioned above under the discussion on the irrigation and in-district preferences. In District 1, first priority is given to renters who have acquired space in any of the Bureau's federal storage reservoirs in the district prior to 1979 for use on irrigated lands in the district. This same priority is shared by renters eligible for mitigation under the 1990 Fort Hall Indian Water Rights *Agreement* and to stockholders in the Mitigation Corporation that has been formed to contract with

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[42]District 1 Procedures, at rule 6.3.

[43]Id. at rule 5.

[44]District 63 Procedures, at rules 6.2, 6.3.

[45]Id. at rule 6.4.

[46]District 65 Procedures, at rules 6.2 - 6.4.

[47]IDAPA 37.02.03.030.

the Bureau for mitigation water. The second priority is given to renters for other irrigation uses above Milner Dam, with preference going to rentals for use on lands for which storage was rented prior to 1992. A third priority is given to other beneficial uses in the order in which their requests are received.[48] These priorities are determined within each time period—storage available before June 1, from June 1 to July 1, and after July 1.[49] Within each of these sub-groups, rentals are allocated in the order in which completed applications and money are received.[50]

In District 63, renter priorities are somewhat different. Prior to June 1, first priority is given to irrigation entities owning contracted space in one or more storage reservoirs.[51] After July 1 and until July 15, priority is given to this first group as well as other irrigation users within the district.[52] After July 15, rentals are opened up to all other users for any beneficial purpose.[53] Within these priority classes, preference is given in the order an application with payment is received.[54] Water must be used by the renter no later than March 1st of the year following the calendar year in which the storage occurs.[55] District 65 rules establish similar priorities among renters.[56]

2.1.2.8 Water bank pricing

The pricing of bank water is regulated by state law, and by state and local bank administrators. For the statewide water supply bank, rental or sale price is determined

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[48]District 1 Procedures, at rule 7.1(c).

[49]Id. at rule 7.1.

[50]Id. at rule 7.

[51]District 63 Procedures, at rule 7.2.

[52]Id. at rule 7.3.

[53]Id. at rule 7.4.

[54]Id. at rule 7.5.

[55]Id. at rule 7.

[56]District 65 Procedures, at rules 7.1 - 7.5.

on a case-by-case basis. Price is a factor in the decision whether to accept an offered water right into the water supply bank. The Board must consider "whether the offering price or requested rental rate is reasonable."[57] Once this criteria is met, the Board has discretion to set the price for water rights rented or sold from the water supply bank.[58]

The local committee for each local rental pool annually sets the fees for rental of bank water, subject to approval by the Board.[59] This amount may stay the same for several years (see Table 2.1.2). In District 1, the price in 1994 is $2.95 per acre-foot for uses above Milner Dam. The charge for water used below Milner Dam is $8.45. Of this higher amount, $2.00 per acre-foot is paid as additional compensation to the lessor if the space represented by the rented storage does not fill the following year. If the space fills, $2.00 will be returned to the renter.

District 65 rules have had a similar dual pricing method since 1992. The price for irrigation uses within the basin has been $2.70 since the rental pool began operating in 1990. Beginning in 1992, storage rented for uses below the mouth of the Payette is priced at $5.40 per acre-foot. If the space fills, $2.70 is returned to the renter. If the space does not fill, $2.00 is paid to the lessor the following year. In 1993, 35,000 acre-feet was rented at the higher price for uses outside of the basin. This space did not fill in 1994, so the renter received nothing back on the $5.40 payment, and the lessor (in this case irrigation supply companies) received $2.00 per acre-foot and accrued interest for the space that did not fill as a result of 1993 rentals.[60]

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[57]IDAPA 37.02.03.025.06.

[58]Id. at 37.02.03.030.

[59]Id. at 37.02.03.040.

[60]Telephone conversation with Helen Bivens, Watermaster, Water District 65, Idaho Department of Water Resources (June 15, 1994).

Table 2.1.2

PRICE OF STORAGE IN IDAHO LOCAL RENTAL POOLS, 1990-94

(INCLUDING ADMINISTRATIVE CHARGES)

	UPPER SNAKE RIVER	BOISE RIVER	PAYETTE RIVER
YEAR	Water District 1 Rental Pool [uses below Milner Dam] (per acre-foot)	Water District 63 Rental Pool [uses outside the water district] (per acre-foot)	Water District 65 Rental Pool [uses outside the water district] (per acre-foot)
1990		6.50	2.70
1991	2.95	6.50	2.70
1992	2.95 [no price set]	6.50	2.70
1993	2.95 [5.50]	6.50	2.70 [5.40]
1994	2.95 [8.45]	6.50	2.70 [5.40]
Local committee administrative fee 1994	.75	.32	.50

In District 1, lessors receive a percentage of bank revenues correlating to the amount of storage they make available, within the classes of lessors described earlier. As mentioned, the District 1 rental pool has rarely sold all storage offered, so the individual lessors will often not sell all storage made available. For example, if Company A assigns 50,000 acre-feet (AF) to the bank, and the bank rents 75,000 of a total of 100,000 AF of storage committed to the bank that year, then Company A will be paid for 25,000 AF of the water assigned and the remaining 25,000 AF will be carried over to the following year by Company A. In the past, this policy has caused some space holders to offer more storage to the bank than they really intend to rent, knowing that the full amount of storage made available will not be rented.[61]

All local rental pool prices include both a surcharge for the Water Resource Board and a local committee administrative fee. The Board surcharge is currently $.20 per acre-foot. Local committee fees range from $.32 per AF in District 63 to $.75 per AF in District 1.[62] District 1 also has a higher surcharge of $.50 per AF for water rented for uses below Milner Dam, and assesses an additional administrative fee on any lessor who subsequently withdraws all or part of the water from the rental pool.[63] Similarly, District 65 assesses an additional administrative fee on any lessor who subsequently (in the same year) rents replacement water from the bank.[64]

The use of funds collected by the Board or by the local rental pool committee as an administrative fee is subject to some broad statutory and regulatory limitations. Water supply bank funds are credited to a "water management account" and are to be used for improving water user facilities and efficiencies.[65] Administrative fees collected by the local committees must be used for public purposes set out in statutory provisions, including "expenses of the district," district improvement, educational projects, and other projects "designed to assist in the adjudication, conservation or more efficient distribution of water."[66]

Local rules may further limit or regulate the use of these funds. In District 1, the district may use all rental funds on an as needed basis so long as the accrual of interest

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[61]Telephone conversation with Ronald D. Carlson (Oct. 1, 1993). There is no penalty for committing storage subsequently withdrawn from the bank for use by the space holder.

[62]See District 63 and 65 Procedures, at rule 8.1; and District 1 Procedures, at rule 8.2.

[63]District 1 Procedures, at rule 8.2 (B) (surcharge) and 8.2 (C) (withdrawal fee).

[64]District 65 Procedures, at rule 8.1.

[65]See IDAPA 37.02.03.035. Allocations from the water management account are governed by Idaho Code § 42-1760 (1990).

[66]Idaho Code § 42-613A (Supp. 1993).

due suppliers (water bank lessors) is not affected.[67] District 65 rules allow the funds to be used "for other purposes that the Committee deems to be of benefit to Water District 65."[68] The difference between these two provisions seems to be whether the board of the local water district, or the local rental pool committee, has authority over the use of bank proceeds. State law provisions were amended in 1992 to clarify the authority of the water district advisory committee, when appointed by the Board to serve as a local rental committee, over the use of rental pool proceeds retained by the district.[69] The use of such proceeds must be consistent with the public purposes described above and with resolutions adopted by the water users of the district. Rental pool funds in District 1 have been used in part to pay attorney fees.[70]

2.1.2.9 Lease terms and carry over

Lease and rental terms for bank transactions are not dictated by state law, and vary among local committees. For the water supply bank, the term during which a water right can be retained in the water bank is open to specification in the purchase or lease agreement. Rentals from the bank can be approved by the Director for a period of up to to five years. Applications for longer periods require Board approval.

In District 1, leases of reservoir space to the rental pool may be made for periods up to 20 years and are to be negotiated on a case-by-case basis.[71] In Districts 63 and 65, bank rentals are limited to a term of one year. The District 1 rental pool, like Districts 63 and 65, require that rented water be used during the current water district year which ends on March 1 of the following year. Districts 63 and 65 have no provision for carry

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[67]District 1 Procedures, at rule 8.5.

[68]District 65 Procedures, at rule 8.3.

[69]See Idaho Code §§ 42-1765 and 42-605 (Supp. 1993).

[70]Monies have been set aside to cover future legal expenses. Comments of Ronald D. Carlson, Watermaster, July 1, 1994.

[71].District 1 Procedures, at rule 8.

over of rented water. In District 1, storage space rented and not used that year is returned to the lessor by crediting it to the lessor's carryover storage. The renter's rights are terminated at the end of the irrigation season. Leased storage may be carried over by the renter.[72] No water may be rented after November 1 without the lessor's approval.[73]

2.1.2.10 Addressing water rights and third party injury issues

The Idaho bank statute provides that approval of the rental of bank water operates as a substitution for complying with state water law transfer requirements.[74] Several provisions of the statutory scheme and bank rules are directed towards addressing potential injury from bank transactions. Limiting rental pool transactions to storage space is one such provision. Requiring use by March of the following year and limiting the ability to carry over rented water ensure that reservoir space will be available for storage rights holders the following season. In addition, as discussed below, bank administrators must consider factors relevant to the question of injury in deciding whether to accept water into the bank and whether to rent water from the bank.

The process for the statewide bank generally involves the publication of notice and a hearing before any water can be leased, with opportunity for anyone claiming injury to raise these concerns with the Department of Water Resources.[75] Under the water supply bank, the Director must evaluate lease applications to consider whether: (1) there will be injury to other water rights; (2) the proposal would constitute an enlargement of the water right; (3) the water will be put to a beneficial use; (4) the water

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[72]Rental Pool Procedures, rule 7.6 (District 1) and rule 7.7 (Districts 63 and 65). District 1 also provides for re-renting water not used for irrigation by the end of the summer. This water can be leased back to the rental pool, in which case proceeds from the re-rental will be paid to the original renter. District 1 Procedures, at rule 7.6.

[73]District 1 Procedures, at rule 7.6.

[74]Idaho Code § 42-1764 (1990).

[75]Many users are opting for the formal transfer process which may actually be faster than going through the bank.

supply available from applicable rights in the Board's water supply bank is sufficient for the use intended; and (5) the proposal is in the local public interest.[76] For applications to rent water for the benefit of salmon migration, the Director must consider only whether the use will injure other water rights.[77]

For the local rental pools, the Director is authorized to approve a general lease which the local committee can use to satisfy state (water transfer) approval requirements.[78] Rules for all three rental pools give administrators discretion to reject space offered to the bank if acceptance is not in the best interests of the rental pool or water district.[79] In lieu of rejection, the use, allocation or pricing of water rented from such space can be conditioned.[80]

2.1.2.11 Bank administration

As mentioned above, the Idaho Water Resource Board administers the statewide water supply bank, and is authorized to purchase, lease or otherwise obtain decreed, licensed or permitted water rights (both natural flow and stored water) to be credited to the water supply bank.[81] Rights may be divided or combined into more marketable blocks provided there is no injury to other water right holders, no enlargement of use, and the change is in the local public interest. The statewide bank has not had much

[76]Idaho Code § 42-1763 (Supp. 1993) The local public interest is defined as the affairs of the people in the area directly affected by the proposed use. Id. Any person aggrieved by a decision or action of the Director may request a hearing. Id. at § 42-1701(A)(3), and IDAPA 37.02.03.003.

[77]Id. at § 42-1763(A) (Supp. 1993). Aside from issues of injury to water rights, a determination must be made that the water rented "will be used as part of a coordinated effort to enhance salmon migration and that other parties are making a proportional contribution to solving the salmon migration problem." Id.

[78]Id. at § 42-1763 (Supp. 1993).

[79]Local Rental Pool Procedures, rule 5.4 (Districts 63, 65) and rule 5.3 (District 1).

[80]Id. There is only one case in Idaho dealing with the operation of a water bank, and specifically addressing the issue of injury to other water rights from the operation of the water supply bank. See Enterprise Canal Company v. Idaho Department of Water Resources, Case No. 96371 (4th Jud. Dist., Ada Co., Idaho 1993).

[81]Id. at § 42-1762, and IDAPA 37.02.03.025.

activity since established. One intended benefit of going through the state bank was that the bank administrator would act as a broker, connecting sellers and buyers. Since most temporary water use arrangements are made locally, the statewide bank has not functioned in this manner.[82]

For Water District 1, three members of the Committee of Nine (appointed by the Chairman), along with the superintendent of the Bureau of Reclamation's Minidoka Project and the District 1 watermaster, form the Rental Committee that assists the watermaster in making certain rental decisions. This committee has specific oversight responsibilities but meetings of this committee generally occur only when disputes arise. The watermaster acts as the manager of the rental pool.[83]

The Advisory Committee of Water District 63 has specified administrative responsibilities, including setting policies for the investment and disbursement of funds generated by the rental pool. The watermaster acts as the general manager of the rental pool.[84] Similarly, in Water District 65, the watermaster is designated as the manager of the rental pool, while the local Advisory Committee is delegated specific administrative tasks.[85]

2.1.3 Shoshone-Bannock Tribal Water Supply Bank

The 1990 Fort Hall Indian Water Rights Settlement Agreement, approved by Congress, authorized the creation of a fifth bank in Idaho—the Shoshone-Bannock Water Supply Bank.[86] The settlement also confirmed tribal water rights in the Upper Snake River Basin, including storage in American Falls Reservoir (46,931 acre-feet) and in Palisades Reservoir (83,900 acre-feet). Final rules governing operation of the bank were

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[82]Telephone conversation with Ronald D. Carlson (Oct. 1, 1993), and interview with Glenn Saxton, Idaho Department of Water Resources (April 27, 1993).

[83]District 1 Procedures, at rule 4.

[84]District 63 Procedures, at rule 4.

[85]District 65 Procedures, at rule 4.

[86]See Pub. L. No. 101-602, 104 Stat. 3061 (1990); 1991 Idaho Sess. Laws, ch. 228, at 547.

adopted in 1994 and, along with the terms of the underlying settlement agreement, establish the guidelines for bank operation.[87]

In several respects the tribal bank is not subject to limitations applicable to Idaho rental pools and the statewide water supply bank. For example, there are no constraints on the pricing of bank water or on the amount of profit accruing to the tribe from bank rentals.[88] In addition, bank rules expressly define beneficial use of bank water to include "fish propagation and instream flow uses as well as any other uses that provide a benefit to the user of the water."[89] Tribal space in American Falls may be rented below Milner Dam without being subject to last to fill provisions of other rental pools. Storage water accruing to the Tribe's American Falls space can be rented for use in the Snake River Basin anywhere within the state of Idaho.[90] Another difference in the tribal bank operation is the term of assignment of storage space to the bank. Assignments to the tribal bank can be for "any period of time."[91] Rentals from the bank are limited to a five- year term unless a longer term is negotiated between the Tribe and the Idaho Water Resources Board.[92]

The tribal bank is administered by a "Tribal Rental Pool Committee," comprised of the District 1 watermaster, the Fort Hall Indian Reservation watermaster, and three

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[87] See Administrative Rules of the Idaho Water Resource Board, Shoshone-Bannock Tribal Water Supply Bank Rules, IDAPA 37, Title 02, Chapter 04 (adopted July 8, 1994) [hereinafter Tribal Rules]. The Fort Hall Agreement also granted storage rights to water users potentially impacted by the terms of the settlement. The potentially affected water users were granted all uncontracted storage in Ririe Reservoir (80,500 acre feet) and uncontracted storage in Palisades Reservoir (18,980 acre feet) as compensation. These water users formed Mitigation, Inc., to hold and manage the mitigation storage on behalf of the users. Water accruing under storage controlled by Mitigation Inc. could be leased through the rental pool operating in Water District 1.

[88] See generally, "Director's Report for the 1990 Fort Hall Indian Water Rights Agreement (Reporting Area 25), prepared by the Director of the Idaho Department of Water Resources as part of the Snake River Basin Adjudication (1994).

[89] Tribal Rules, at rule 10.05.

[90] Palisades storage water is limited to uses above Milner Dam. Tribal Rules, at rules 7.3.4 and 7.3.5.

[91] Tribal Rules, at rule 35.03.

[92] Id. at rule 50.055.

people designated by the Fort Hall Business Council.[93] Like other rental pools in Idaho, local water users are given a preference in renting from the tribal bank. Rules provide "the Fort Hall Indian Irrigation Project water users shall have a right of first refusal to rent any tribal stored water assigned to the bank."[94]

The Tribe is likely to need a significant portion of its storage water for historically irrigated lands within the Michaud Irrigation Project, so it is not clear how much of the Tribe's water will be available to lease to the bank. Additionally, the District 1 rental pool has not often rented all available storage. If tribal bank water is more expensive than District 1 rental pool water, there may be a limited market for water from the tribal bank unless other advantages, such as the ability to use the water below Milner Dam with no refill penalty, override the price difference.[95] In dry years, such as 1992, little or no water may be available from the District 1 Bank for uses below Milner if current pricing practices are continued. It remains to be seen whether the tribal bank will serve lower river demands in dry years by allowing the price to be set at a market-clearing level.

2.2 EMERGENCY DROUGHT WATER BANKS IN CALIFORNIA: 1991, 1992 AND 1994

2.2.1 Introduction

The state of California established emergency drought water banks in 1991, 1992 and 1994. These banks have represented an innovative use of public authority to assist the development of a water rental market. While public entities, including the State of California and the federal Bureau of Reclamation have long played a major role in the allocation and physical transfer of water in California, the reliance of the water banks on voluntary, mutually beneficial transfers of established water rights has been a radical

[93]Tribal Rules, at rule 30.02.

[94]Id. at rule 40.01.

[95]Telephone conversation with Ronald D. Carlson (Oct. 1, 1993).

departure from the previous functions of the State of California Department of Water Resources.

The impetus for this innovation arose in the crisis atmosphere prevailing at the beginning of 1991, as the state entered the fifth consecutive year of drought. Winter precipitation had been far below normal, reservoirs across the state were at or near their historic lows[96], and statewide streamflows were forecast to be approximately half of normal.[97] The expected impacts of the low-water conditions were very unevenly distributed. Rapidly growing urban centers, particularly in the southern portion of the state, as well as agricultural users served by the federal Central Valley Project (CVP) and the State Water Project (SWP) were anticipating severe cutbacks in supplies.[98] At the same time, other agricultural water users with riparian rights, senior appropriative rights or access to storage outside of the SWP or CVP had full or nearly full supplies at their disposal.

While it appeared obvious that substantial net benefits would arise from water transfers directed at reducing the unbalanced effects of the drought, it also appeared obvious that privately arranged transfers were unlikely to occur in sufficient volume to provide significant assistance to the cities and agricultural users most severely affected. Despite legislative attempts to promote water marketing,[99] privately arranged transfers

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[96]On December 31, statewide reservoir storage averaged 32 percent of capacity, 54 percent of the historical average. Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources. *California's Continuing Drought, 1987-1991: A Summary of Impacts and Conditions as of December 1, 1991.* Sacramento: State of California, Department of Water Resources.

[97]USDA, 1991. *Water Supply Outlook for the Western United States: January 1, 1991.* Portland: Soil Conservation Service.

[98]The SWP had announced complete suspension of deliveries to agricultural users and deliveries of only 10 percent of contractual entitlements to municipalities. The CVP had declared that supplies would be 50 percent of entitlements for urban users and 25 percent for agricultural customers, except for holders of Sacramento River water rights and San Joaquin exchange contractors, who would receive 75 percent. Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources.

[99]Gray, Brian E., 1989. "A Primer on California Water Transfer Law, *Arizona Law Review*. 31: 745-782.

remained rare outside of the confines of an irrigation district or project area.[100] Therefore, little market information as to relative marginal valuations or demand elasticities was available to potential participants in a statewide water market. In addition, California continued to have a reputation as a state in which the administrative requirements of the water transfer process were cumbersome and fraught with uncertainties.[101] Although the review process for temporary transfers had been streamlined in 1988,[102] it was still lengthy relative to the time-frame of a single-year transfer. Thus, potential delays, uncertainties about transferable quantities and lack of market information useful to private parties attempting to negotiate the price and other terms of a transfer agreement constituted significant barriers to the use of privately arranged transfers to mitigate the impacts of the drought.[103] In addition, riparian water rights were generally held to be non-transferable, and transfers from within an irrigation district to an outside party usually required that the water be declared surplus to the needs of the district. These facts further inhibited the spontaneous development of a private water-rental market.

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[100]Gray, Brian E., 1990. "Water Transfers in California: 1981-1989," in MacDonnell, Lawrence J. (Principal Investigator), *The Water Transfer Process as a Management Option for Meeting Changing Water Demands*, Volume II, USGS Grant Award No. 14-08-0001-G1538. Boulder: Natural Resources Law Center, University of Colorado.

[101]The California State Water Resources Control Board (SWRCB) has jurisdiction over transfers of water rights established after 1914 under the state's permit system. Earlier rights may be transferred without state review, although inadequate records may inhibit such transfers. National Research Council, 1992. *Water Transfers in the West: Efficiency, Equity and the Environment*, Washington, D. C.: National Academy Press. While the same non-injury standards apply for transfers of early rights as for those subject to SWRCB approval, aggrieved parties must seek remedy in the civil courts. Transfers of water within large irrigation projects such as the federal Central Valley Project (CVP) are also outside of the jurisdiction of the SWRCB. Gray, Brian E., 1990. "Water Transfers in California: 1981-1989," in MacDonnell, Lawrence J. (Principal Investigator), *The Water Transfer Process as a Management Option for Meeting Changing Water Demands*, Volume II, USGS Grant Award No. 14-08-0001-G1538. Boulder: Natural Resources Law Center, University of Colorado.

[102]California Water Code §§ 1725-1732 (West Supp. 1990).

[103]Macaulay, S., 1993. "Successes and Problems with Water Transfer and Marketing Programs," speech presented June 7, 1993 at meeting of Southern California Water Committee's Task Force on Water Transfers and Marketing.

2.2.2 The 1991 Bank

At the beginning of 1991, state policy makers viewed the situation as an emergency and began considering options for reallocating water to mitigate the impacts of the drought. At the end of January, the State Water Resources Control Board (SWRCB) held hearings on a variety of proposals to mandate reallocation of water through temporary regulatory modifications of existing water rights. This regulatory approach was not pursued. Instead, the Board accepted the recommendations of Governor Wilson's Drought Action Task Force. On February 15, the Governor announced a drought plan calling for the establishment of an Emergency Drought Water Bank to acquire water from willing sellers to meet the "critical water needs" of the purchasers as defined by the rules of the bank.

Responsibility for management of the bank was given to the DWR, which already possessed the considerable technical expertise needed to assure that the water purchased was both legally and physically available. As manager of the SWP, the DWR was also uniquely situated to make efficient use of SWP storage and conveyance facilities to move the water to buyers in the central and southern parts of the state. Since most of the water was sold from agricultural users in northern California to parties south of the Sacramento/ San Joaquin Delta, coordination of the timing of banked water availability, pumping operations and Delta outflow requirements were important concerns. DWR used storage facilities both north and south of the Delta to rearrange the timing of water availability to meet purchasers' requests while minimizing environmental damages at the Delta pumps. The availability of stored water in SWP northern California reservoirs allowed water bank deliveries to be made out of San Luis Reservoir (south of the Delta) during the early and mid summer. Water left in the Sacramento River during that period as a result of water bank purchases was used to meet both exports from the Delta and Delta outflow requirements. See Table 2.2.1 for information on the timing of water availability to the 1991 Bank, water use from the bank, and associated changes in storage in SWP and CVP reservoirs.

Table 2.2.1 **Water Distribution for the 1991 Drought Water Bank**

(in 1,000's of acre-feet)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Water Supply													
Delta Fallowing	0	0	0	29	42	55	82	55	15	7	0	0	285
Ground Water Exchange													
Sacramento River	0	0	0	7	15	17	26	17	18	4	0	0	104
Feather River	0	0	0	28	21	14	23	8	2	4	0	0	100
Yuba River	0	0	0	0	0	0	29	53	0	0	0	0	82
Non-Delta Fallowing													
Above Shasta Reservoir	0	0	0	0	2	1	2	2	0	0	0	0	7
Below Shasta Reservoir	0	0	0	1	11	9	10	7	-2	1	0	0	37
Storage Releases													
Yuba County Water Agency	0	0	0	0	0	0	0	0	84	15	0	0	99
Browns Valley I.D.	0	0	0	0	0	0	5	0	0	0	0	0	5
Oroville-Wyndotte I.D.	0	0	0	0	0	0	0	0	0	0	10	0	10
Little Holand	0	0	0	0	0	0	0	0	0	1	1	0	2
Wilson & McCall Inc.	0	0	0	0	1	0	0	0	0	0	0	0	1
Total Water Supply	0	0	0	65	92	96	172	147	117	32	11	0	732
Water Disposal													
Delta Exports													
H.O. Banks Pumping Plant	0	0	0	2	6	9	40	80	116	133	14	0	400
Carriage Water	0	0	0	0	1	1	7	13	19	22	2	0	65
Total Water Disposal	0	0	0	2	7	10	47	96	135	155	16	0	465
SWP/CVP Storage Change	0	0	0	63	85	86	125	54	-18	-123	-5	0	267

Source: DWR: Drought Water Bank Environmental Impact Report

DWR personnel negotiated the purchase contracts, monitored compliance with those contracts, obtained SWRCB approval where needed,[104] and coordinated deliveries of water to the purchasers. The DWR also committed SWP funds to cover purchases of water not sold to other entities, with that water to be held as carryover storage in SWP facilities to provide insurance against continuation of the drought.

Membership in the water bank as a prospective buyer was open to any corporation, mutual water company or public agency (other than DWR) that had responsibility to supply water for agricultural, municipal and industrial, fish and wildlife, or other uses in California.[105] Water purchased was to be allocated to the members on the basis of their estimated "critical needs". To qualify as having critical needs, municipal and industrial suppliers had to demonstrate full utilization of normal sources of supply (allowing for prudent carryover storage of surface water), maximum practical use of groundwater, reclaimed water and local water exchange opportunities and total water supplies less than 75 percent of normal water demand (equivalent to water use in 1986, adjusted for population growth). Estimated critical needs for agricultural use were to be based on water required for the survival of trees, vines and other high valued crops after full utilization of all other available supplies. The criteria for fish, wildlife and other critical needs were maximum use of all available supplies and case-by-case review by DWR.[106]

The rules of the bank specified that the available water was to be allocated first to "extreme critical needs" as determined by DWR (drinking water, health, sanitation and

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[104]In fact, of the 351 transfers to the 1991 Bank, the SWRCB asserted jurisdiction over only two. This may be partly accounted for by the fact that the majority of fallowing contracts involved riparian rights that do not fall under the Board's jurisdiction, but it also appears that the Board waived review of many transfers to the Bank over which it appeared to have statutory jurisdiction. This lack of review raised concerns about possible inadequate attention to impacts on affected interests. Gray, Brian E., 1994. "The Market and the Community: Lessons From California's Drought Water Bank," *West-Northwest Journal of Environmental Law, Policy, Thought.* 1, #1: 17-47.

[105]Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources.

[106]Id.

fire protection, and urgent agricultural critical needs). After these were met, water was to be allocated to meet remaining critical needs. Provisions also were made for purchases of water in excess of critical needs if surplus water was available. Specifically, it was provided that any water available in excess of the critical needs of the members could be purchased by the members first for "other high value uses" as determined by the DWR in consultation with the Water Purchase Committee and then according to the following provision: "Active members shall have a right of first refusal in amounts proportional to their purchases of water for Critical Needs to purchase at the final Melded Rate any unallocated water remaining in the bank after satisfying identified Critical Needs and other high value uses under Article 18 ... Any excess water remaining after the Active Members have exercised their right of first refusal shall be purchased by the Department for the State Water Project at the final melded rate paid by all Members."[107] It does not appear that any provision was made for sale of water to non-members.

While potentially an inefficient restriction on water transfers through the bank,[108] the critical needs criteria may have enhanced the political acceptability of the banking arrangement. In practice, such a large quantity of water was made available to the bank that the critical needs restrictions had little apparent effect—apart, perhaps, from reducing the number of bank members.

Membership in the bank gave the member representation on the "Water Purchase Committee" which established the price at which water was to be purchased. Each bank member had one vote on the committee and all decisions were to be approved both by a majority of bank members and by members that contributed more than 50 percent of the funds deposited into the bank.

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[107]Article 22 of the *Agreement Establishing a 1991 California Drought Emergency Water Bank*, quoted in Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources, p. 9.

[108]Wahl, Richard W., 1994. "Market Transfers of Water in California," *West-Northwest Journal of Environmental Law, Policy, Thought.* 1, #1: 49-69.

When formation of the water bank was announced, little information was available about what quantities of water might be offered for sale at various prices. A purchase price of $125 per acre-foot of consumptive use was selected on the basis of estimates that farmers of a variety of field crops could earn slightly more by fallowing their land and selling water at that price than they would earn on net by farming the land. It appears that the Committee could have voted to change the price later, but they did not do so.

During the first few weeks of the bank's operation, there was speculation that the purchase price would likely rise as the season progressed. This resulted in considerable reluctance among growers to sign contracts committing themselves to sale of their water. Rather than responding to this reluctance by immediately raising the offer price, a price escalation clause was added to the purchase contracts. This modification largely transferred the risk of price uncertainty from potential water sellers to purchasers and ultimately to the SWP. The price escalation clause guaranteed sellers that they would not receive a lower price than the price negotiated in their contracts and that if the average price paid to similarly-situated sellers in contracts executed by a particular date was higher by more than 10 percent, the seller would receive the higher price. Once that clause was introduced, sales to the water bank proceeded rapidly. Within approximately six weeks DWR personnel had negotiated over 300 purchase contracts for more than 800,000 acre-feet of water.[109] The purchases proceeded in advance of firm commitments from buyers, with the quantity purchased based on early estimates of critical needs.[110] Those estimates were obtained from eighteen suppliers who had expressed an interest in participating in the bank before it was known how much bank water would cost.[111]

The price to buyers from the water bank was to be set at a single "melded rate" reflecting all costs incurred to acquire water. The price was set at $175 per acre-foot at

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[109]Ultimately 351 contracts provided approximately 820,000 acre-feet to the 1991 Bank.

[110]DWR, 1992. *The 1991 Drought Water Bank.* Sacramento: State of California, Department of Water Resources.

[111]Howitt et al., 1992, supra

the Harvey O. Banks Delta Pumping Plant plus delivery charges from that point. The $175 figure was calculated to include payment to the sellers plus cost of administration and payment for carriage water required for conveyance through the Delta. Separate conveyance contracts were negotiated between DWR and the buyers, which included additional charges for conveyance from the Delta to the buyer. SWP contractors paid primarily for estimated conveyance losses and the energy required to pump the water to the point of delivery, and non-SWP contractor also paid a use-of-facilities fee which consisted of a proportional share of the capital and annual operation and maintenance costs associated with the SWP facilities used to make the transfer. Charges for conveyance, storage, and carriage water are reported to have raised the total cost of water transfers by several hundred dollars in some cases.[112]

Heavy rains in March, along with closer examination of demands in light of the relatively high cost of delivered water caused the prospective purchasers to revise their estimates of critical needs substantially downward. In addition, some entities that had initially expressed an interest in purchasing water from the water bank chose not to participate. When prospective buyers formally became members of the water bank they were required to quickly support their critical needs estimates with a substantial financial commitment. Within 7 days after joining the bank, members were required to deposit 50 percent of the estimated cost of the quantity of water necessary to meet their critical needs. Deposit of 75 percent of the estimated cost was to be made within 15 days of joining, with the balance to be paid prior to delivery.

Ultimately, approximately 390,000 acre-feet were delivered to 12 purchasers. The remainder of the water purchased went primarily to increased carryover storage of approximately 265,000 acre-feet, at a cost to the state of about $45 million[113] and carriage water requirements to maintain water quality standards in the Delta while the pumps were in operation for delivery of bank water. There were also substantial

[112]Lund, Jay R., Morris Israel and Richard Kanazawa, 1992. *Recent California Water Transfers: Emerging Options in Water Management*, Report No. 92-1. Davis: Department of Civil and Environmental Engineering, University of California.

[113]Id.

"technical adjustments," in the estimated quantity of water purchased, primarily because the March rains reduced the amount of irrigation water that would have been applied by wheat growers who had already signed agreements to dry crop their land.[114] (See Table 2.2.2 for the sources and disposition of water for the 1991 and 1992 Water Banks).

Three types of contracts were used to purchase water for the bank. Fallowing contracts required growers to fallow their land or withhold the application of any irrigation water to certain crops that are normally irrigated but that can be produced without supplemental irrigation. Fallowing accounted for approximately half of the water acquired by the 1991 Water Bank. Groundwater contracts accounted for one-third of the water purchased. These were primarily groundwater substitution contracts which allowed farmers to sell the surface water that would normally have been applied to their crops to the water bank and to continue irrigating with groundwater. In addition to the groundwater substitution contracts, the Rand report[115] also mentions contracts that involved direct pumping of groundwater into the surface system for sale to the bank, but that appears to have been only a minor source of supply. A total of 285,000 acre-feet were obtained from contracts involving groundwater substitution or direct provision of groundwater to the bank. Water stored in reservoirs accounted for the remaining 145,000 acre-feet purchased by the 1991 Water Bank.

The goal of the water bank was to introduce "new water" into the surface water system defined as: "water that would be developed by this program that otherwise would not be in the surface water system."[116] Parties selling water to the water bank were required to have a "provable firm water supply" and DWR staff made case-by-case determinations of the validity and ownership of the rights and entitlements involved in water bank transactions.

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[114]Personal communication, Steve Macaulay 7/19/93.

[115]Dixon, Lloyd S., Nancy Y. Moore and Susan W. Schechter, 1993. *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions*. Santa Monica: Rand.

[116]DWR, "General Negotiating Principles and Provisions" for the 1991 Water Bank, dated March 4, 1991.

Table 2.2.2	**Water Balance of 1991 and 1992 Drought Water Banks (numbers rounded)**	
	1991 WATER BANK AMOUNT	1992 WATER BANK AMOUNT
WATER SOURCE	(ACRE-FEET)	(ACRE-FEET)
Fallowing[1]	390,000	0
Ground water[1]	285,000	161,000
Surface water	145,000	32,000
Total	**820,000**	**193,000**
Delta Requirements[2]	- 165,000	- 34,000
Net available	655,000	159,000
Allocations		
Urban uses	307,000	39,000
Agricultural uses	83,000	95,000
Wildlife uses	0[3]	25,000
Carryover storage	265,000	0
Total allocated	655,000	159,000

[1]The amounts for fallowing and ground water shown in the table for 1991 are those used in the analysis in this report, and agreed to by the SWP and CVP as part of the Coordinated Operation Agreement. One large purchase, included entirely in the groundwater category, also included some fallowed acreage. If this had been accounted for in the fallowing category, the fallowing amount would be about 25,000 acre-feet greater and the ground-water amount would be about 25,000 acre-feet less. There would be no change in the availability of the water at the Delta, however, since this was a transfer from a water supply contractor of the federal CVP and was provided by the CVP in the Delta when it was needed.

[2]Water required to remain required to remain in Sacramento-San Joaquin Delta for water quality protection and miscellaneous technical corrections

[3]More than 40,000 acre-feet of water was provided in bank-related transactions

Source: DWR, 1993. *Program Environmental Impact Report: State Drought Water Bank.* Sacramento: State of California, Department of Water Resources.

There were a few disputes between landlords and tenants over who had the right to sell water. Many of the water sales involved fallowing or groundwater substitution on rented land. There were reports of tenants selling water without the landlord's knowledge and vice versa.[117] However, it appears that both the landlord and the tenant were included in most of the water bank contracts involving rented land. By 1992, such problems appear to have been contractually managed.

Owners of individually-held water rights as well as individuals entitled to allotments from an irrigation district were eligible to sell water to the water bank. In the latter case, approval of the district was required and in any case in which the water rights were owned by the district, it had to be a party to the contract. The district fallowing contract specified the quantity of water by which the district would reduce its planned surface diversions and required that the district would cooperate with the grower in documenting the reduced use. The contract also specified that DWR would make a payment of $3.00 per acre fallowed directly to the district. The contract did not appear to restrict the levy of further charges on the grower by the district.[118]

Payments for the fallowing contracts were based on the estimated consumptive water use of the crop planned for production in 1991. (See Table 2.2.3 for a listing of acreages in this program by crop and county). Since different crops entail different rates of consumptive use, the quantity of bankable water and thus payments per acre differed depending on the crop planned for production in 1991. For example, rice, pasture and alfalfa were each assumed to consume 3.5 acre-feet per acre while field corn was assumed to consume 2.5 acre-feet per acre and a crop of dry beans, 2.1 acre-feet per acre. Therefore, the payment was $450 per acre for rice, pasture or alfalfa but only $325 for field corn and $263 for dry beans.

[117]Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources; Dixon, Lloyd S., Nancy Y. Moore and Susan W. Schechter, 1993. *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions*. Santa Monica: Rand.

[118]DWR, 1991 District Fallowing Contract.

Table 2.2.3

The 1991 Drought Water Bank

Drought Water Bank Crop Summary by County (acres fallowed)

Crops	Butte County	Colusa County	Contra Costa County	Sacramento County	San Joaquin County	Shasta County	Solano County	Stanislaus County	Sutter County	Tehama County	Yolo County	Total
Alfalfa*			678.0	996.5	3,795.2	521.9	913.8				3,313.6	10,219.0
Asparagus					1,277.4							1,277.4
Barley*				175.6	412.6		79.2				53.9	721.3
Corn			6,500.0	9.014.3	24,958.3		5,471.7	136.0	1,589.4		11,606.6	59,276.3
Dichondra*											27.4	27.4
Dry Beans	458.5			243.9	959.1		387.5				1,187.1	3,236.1
Grapes*				198.0							56.2	254.2
Melons									167.0			167.0
Milo			40.0		188.9							228.9
Misc. Truck			18.0	58.9	462.7							539.6
Pasture*			1,482.0	1,783.9	591.7	3,258.1	3,208.5			390.0	5,473.3	16,187.5
Rice	1,158.0	2,231.0		798.0		577.6			2,557.8		857.8	8,180.2
Safflower				1,034.8	24.6		325.7				3,013.2	4,398.3
Seed Grass*							74.4				488.1	526.5
Sudan*				131.6								131.6
Sugar Beets		92.2		1,323.7	3,699.0		1,206.5		923.8		2,705.4	9,950.6
Sunflowers			518.0	862.1	383.7		572.4		166.1		267.1	2,769.4
Tomatoes				125.6	1,216.4		451.6				2,553.4	4,347.0
Turnips						35.4						35.4
Wheat*	1,455.7		1,344.2	11,927.1	14,288.5	50.5	5,859.9		55.0		8,602.9	43,583.8
Subtotal	3,072.2	2,232.2	10,580.2	28,674.0	52,258.1	4,443.5	18,551.2	136.0	5,459.1	390.0	40,206.0	166,093.5

*Several contracts were negotiated in which the method of conserving water was left to the discretion of the water district. These contracts may represent some additional fallowing; however, the amounts cannot be quantified. *Crops noted were planted but not irrigated, rather than fallowed.*

Source: DWR, 1992.

Evidence for cropping history and 1991 production plans was taken primarily from acreage reports filed with the federal Agricultural Stabilization and Conservation Service (ASCS). The fallowing contracts stipulated that documentation "satisfactory to the Department" would be provided showing that:

a. The areas withheld from surface irrigation were in agricultural production in 1990 or were used as set aside ground under the guidelines of the 1990 Federal farm program,

b. The areas were planned for agricultural production in 1991 as shown in a planting or operations plan for 1991 for the crops described in Paragraph 1, and

c. The information available at the time of execution of this contract shows that the area would have been irrigated with surface water in the absence of this contract.[119]

Given the short lead time for the 1991 Bank, and the required documentation of cropping plans, it does not appear that there was much strategic behavior in the form of "planning" to plant a water intensive crop in order to secure higher payments. However, DWR has identified such behavior as a concern for the operation of future water banks.[120]

In some cases payments were made for contracts that did not actually result in an increased availability of water in the Sacramento River. The fallowing contracts for pasture, alfalfa, wheat, barley and a few other crops allowed the crop to be grown as long as irrigation water was not applied. The bank absorbed the risk that rainfall occurring after the signing of a contract would cause the actual reduction in consumptive use from surface water to be smaller than was expected when the contract was signed. This was a concern for crops that may not require summer irrigation if sufficient moisture is available in the spring. For example, wheat contracts signed before the heavy March rains assumed that irrigation water would have been applied to the crop in the

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[119]DWR, "Sacramento Valley Grower Contract," 1991 Emergency Drought Water Bank.

[120]Macaulay, 1993, supra

absence of the contract. In actuality, the moisture supplied by the rain removed the need for the expected diversions so that the wheat contracts did not actually result in additional water available in the river. In an effort to avoid paying for such paper water, the DWR quickly adjusted payments made for new wheat contracts as moisture levels changed during the first two weeks of March. DWR eventually stopped signing contracts with wheat growers. No-irrigation contracts for Safflower were also abandoned after concerns were raised that the estimated reduction in consumptive use was over-stated.

Another problem reported with the 1991 fallowing contracts was that the short lead-time did not allow farmers to plan efficiently for their sales to the bank. Many complained that they had incurred unnecessary costs for pre-planting operations.

Payments under the groundwater substitution contracts were based on the estimated quantity of "new water" available in the surface water system as a result of the contract. If there was evidence of an immediate connection between a well and nearby streams, the well could not be used for a groundwater substitution contract. Well logs were used to determine the presence or absence of such immediate connections. However, with some lag, most of the groundwater in the Central Valley is tributary to surface streams. Thus, the groundwater substitution contracts generally involved tributary groundwater. According to Macaulay:[121]

> "In essence, ground water withdrawals are borrowed from future streamflow. From a system standpoint, new water results only to the extent that the borrowing can be repaid from future surplus flows. ...
>
> Most ground water transfers to date have been based on the implicit assumption that the induced future depletions of surface water will occur during times of surplus or that the risk of future impacts is low. In other words, the ground water withdrawn for transfer is assumed to refill largely from future flows that are in excess of all in-basin demands and Delta outflow requirements. In practice, the recharge process begins when the pumps are switched on; it doesn't wait for a period of surplus Delta outflow. As a result, ground water pumped in the Sacramento Valley is unlikely to be 100 percent new water. To the extent transfer activities deplete streamflow that would otherwise be used to meet in-basin demands

[121] Id.

or Delta outflow requirements, additional CVP and SWP storage releases will be required to make up the difference."

The DWR thus recognizes that surface rights could be adversely affected by the groundwater substitution contracts, particularly if drought conditions persist.

The program required pumping to be metered and the individual's water district was required to release an equivalent amount of surface water to the bank. Payments were based on actual quantities pumped up to a maximum specified in the individual contract.

Most of the groundwater substitution contracts were made directly with districts acting as agents for their members. The district then made arrangements with the members for the actual groundwater substitution. The Rand report[122] characterized some of the 1991 purchase contracts with water agencies as "black-box" contracts that only required reduced diversions by the district and left internal decisions regarding groundwater substitution and allocation of the reduction in surface supplies up to the district. The Rand report also states that tenant farmers, in particular, were sometimes unaware that their reduced surface supplies were the result of the district's sale of water to the water bank.

Concerns about possible subsidence as well as concerns about future groundwater tables led to the imposition of a 2 percent tax on groundwater contracts in Yolo and Butte Counties where the proceeds were used to fund county water planning. In Yuba County, the Yuba County Water Agency retained 20 percent of the proceeds from groundwater sales to the bank. In addition, the guidelines for groundwater substitution contracts provided that "Sellers may cancel pumping with cause on 5 days written notice" (e.g. adverse local groundwater impacts).

Table 2.2.4 gives the distribution of contract types by region for 1991 Water Bank acquisitions. It can be seen that the fallowing contracts were heavily concentrated in the region surrounding the Sacramento/San Joaquin Delta. Most of these involved owners of

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[122]Dixon, Lloyd S., Nancy Y. Moore and Susan W. Schechter, 1993. *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions*. Santa Monica: Rand.

Table 2.2.4	Drought Water Bank Purchase Summary		
Region	**Category**	**Acre-feet**	**Percent of Total**
Delta	Fallowing	333,723	40.7
	Groundwater	2,529	0.3
	Stored water	2,576	0.3
Sacramento River	Fallowing	34,463	4.5
	Ground water	27,308	5.7
Yolo	Fallowing	34,463	4.2
	Ground water	27,308	3.3
Yuba/Feather/Elsewhere	Fallowing	15,226	1.9
	Ground water	182,341	22.2
	Stored water	139,200	17.0
Statewide Totals	Fallowing	420,064	51.2
	Ground water	258.965	31.5
	Stored water	141,776	17.3
		820,805	100.0

Source: DWR, 1992

riparian rights. These rights are unquantified and unmetered, but the availability of credible evidence of cropping plans from the ASCS allowed reasonably accurate estimates of reductions in consumptive use. Howitt[123] has argued that the involvement of farmers in ASCS commodity set aside programs also provided a subsidy to their participation in the water bank since they could receive 92 percent of their base level of government support payments while using as little as 50 percent of their base acreage to grow crops.

Under most circumstances, riparian water rights are not transferable. The water can, however, be left in the stream for a limited period without loss of the right. This allowed the DWR to secure the participation of riparian right holders in the water bank by using the innovative argument that the water bank was not actually purchasing water from riparian owners, but rather was keeping the water instream to meet the Delta outflow and salinity control requirements applying to operation of the SWP. This, in turn, freed other SWP water to be transferred to the water bank.[124] The all-or-nothing nature of the fallowing contracts may have introduced some allocative inefficiencies (see appendix). However, fallowing contracts may have had a legal advantage, if the permissibility of partial water-sales contracts involving riparian rights was less certain.

In addition, fallowing contracts were far easier to monitor than would have been contracts based on small changes in consumptive use. The DWR used aerial surveys and a limited number of field visits to monitor fallowing contracts for the 1991 Water Bank. There was thus no need to check metering devices or monitor the length of time and rate at which water was applied and no need to perform additional computations to calculate changes in consumptive use arising from changes in water applications. Even if diversion rates are already carefully measured and logged by an entity other than the water bank

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[123]Howitt, Richard, 1993a. "Empirical Measures of Water Market Supply," Paper presented June 23, 1992 at the 69th Western Economic Association International Conference, Lake Tahoe.

[124]Gray, Brian E., 1993. "Water Rights, Laws and Institutions," in Coppock, Raymond H.,and Marcia Kreith, eds., *California Water Transfers: Gainers and Losers in Two Northern Counties*, Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center, University of California. See also, Gray, Brian E., 1994. "The Market and the Community: Lessons From California's Drought Water Bank," *West-Northwest Journal of Environmental Law, Policy, Thought.* 1, #1: 17-47.

managers (e.g., by an irrigation district) it may be difficult to determine how much consumptive use would change if water applications are diminished since the relationship between water applications and consumptive use is likely to be nonlinear and the latter is not directly measurable as a practical matter.[125] While difficult, such estimates are not impossible. Under some circumstances, it may be preferable to incur the additional monitoring costs and allow partial water sales while crop production continues using the remaining portion of the water right. Contract types that have been suggested for future California water banks include crop switching agreements whereby the farmer agrees to grow a less water intensive crop and agreements to engage in "stress irrigation" or use other water saving techniques.[126]

Water acquisitions for the 1991 Water Bank were geographically concentrated, primarily in the Delta region and in areas drawing water from the Yuba and Feather Rivers. Howitt[127] argues that the disproportionate participation of Delta area riparians in the 1991 Water Bank might be explained by the fact that the relative security of those rights reduced the expected costs of participating in the bank. To the extent that riparian diversions are made by individuals rather than by irrigation districts, transaction costs may also have been lower than for individuals holding contract rights through an irrigation district. In addition, the fact that the rights of riparians along the lower Sacramento and in the Delta have priority over other rights on the river system may have made that water particularly valuable to the water bank. The geographical concentration of 1991 Water Bank purchases, and particularly of the fallowing contracts led to

[125]A water transfer can also have multi-year impacts on consumptive use. For example, the dry winter following the 1991 crop-season did not allow restoration of normal soil moisture on land that had been fallowed for the 1991 Water Bank. This may have led to an increased rate of consumptive water use on those lands in 1992 (Personal communication, Steve Macaulay, June 25, 1993).

[126]DWR, 1993. *Program Environmental Impact Report: State Drought Water Bank.* Sacramento: State of California, Department of Water Resources. Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources.

[127]Howitt, Richard, 1993a. "Empirical Measures of Water Market Supply," Paper presented June 23, 1992 at the 69th Western Economic Association International Conference, Lake Tahoe.

criticisms that the third-party effects of the bank fell disproportionately on a few counties.[128]

2.2.3 The 1992 Bank

Improved water supply conditions in the southern part of the state and the substantial costs that had been incurred by the SWP for the purchase and storage of water not sold to other entities during operation of the 1991 Water Bank led to a more cautious approach to acquisitions in 1992. An important policy change instituted in 1992 required that there be a signed contract with a buyer before the DWR would commit to purchase any water. In 1991, all members purchased water from a single "pool". In 1992, on the other hand, six separate pools were operated, each of which was to sell water at a single melded price to the members of the pool. Prices for the 1992 Water Bank could have varied from one pool to the next, but in practice, there was no change in the purchase or selling price as the season progressed. The purchase price was set at $50/ acre-foot and the selling price, net of delivery charges from the Delta at $72. If all critical needs from one pool had not been met, the members would automatically have become members of the next pool, but sufficient water was offered to the bank so that demands for each pool were met.

As part of this policy change, purchases for the 1992 Bank began somewhat later, when the water supply conditions for the year were better known than had been the case in 1991. In 1991, the DWR began buying water as soon as the formation of the water bank was announced in mid-February. In 1992, no agreements to buy water were concluded until the first pool was formed in mid-March.

[128]Coppock, Raymond H. and Marcia Kreith, eds., 1993. *California Water Transfers: Gainers and Losers in Two Northern Counties.* Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center. Davis: University of California.

Approximately 159,000 acre-feet were sold through the 1992 Water Bank[129] with 25,000 acre-feet purchased for fish and wildlife purposes and 60 percent of the sales going to agricultural uses as opposed to 20 percent in the previous year. Other changes in 1992 included elimination of fallowing contracts as a source of water, so that 161,000 acre-feet of the purchased water came from groundwater contracts and the remainder from storage releases.[130] As a result, 1992 purchases were geographically less concentrated than had been the case in the previous year. Figures 2.2.1 and 2.2.2 detail the distribution of purchases and allocations in the two years.

Another change instituted in 1992 allows the buyers greater flexibility in the use of bank water by allowing it to be held in storage for a longer period. The 1991 Bank was designed primarily to provide water for identified critical needs in 1991. Provision was also made for the purchase of water to meet such needs for the first 3 months of 1992, but at a lower priority. The 1992 Bank explicitly allowed longer carryover of purchased water, subject to the provision that delivery be taken prior to December 1995 and that "[c]arryover bank water can be lost by spillage if reservoir storage capacity is required for SWP purposes or other State needs."[131]

2.2.4 The 1994 Bank

After a single wet year in 1993, critically dry conditions again returned in 1994. As of May 1, flows for most of the state's major rivers were expected to be less than 50 percent of the long-term average.[132] As a result, another water bank has been formed, closely mimicking the 1992 Bank. Preliminary figures indicate that approximately 225,000 acre-feet will be acquired through groundwater substitution contracts and purchases of

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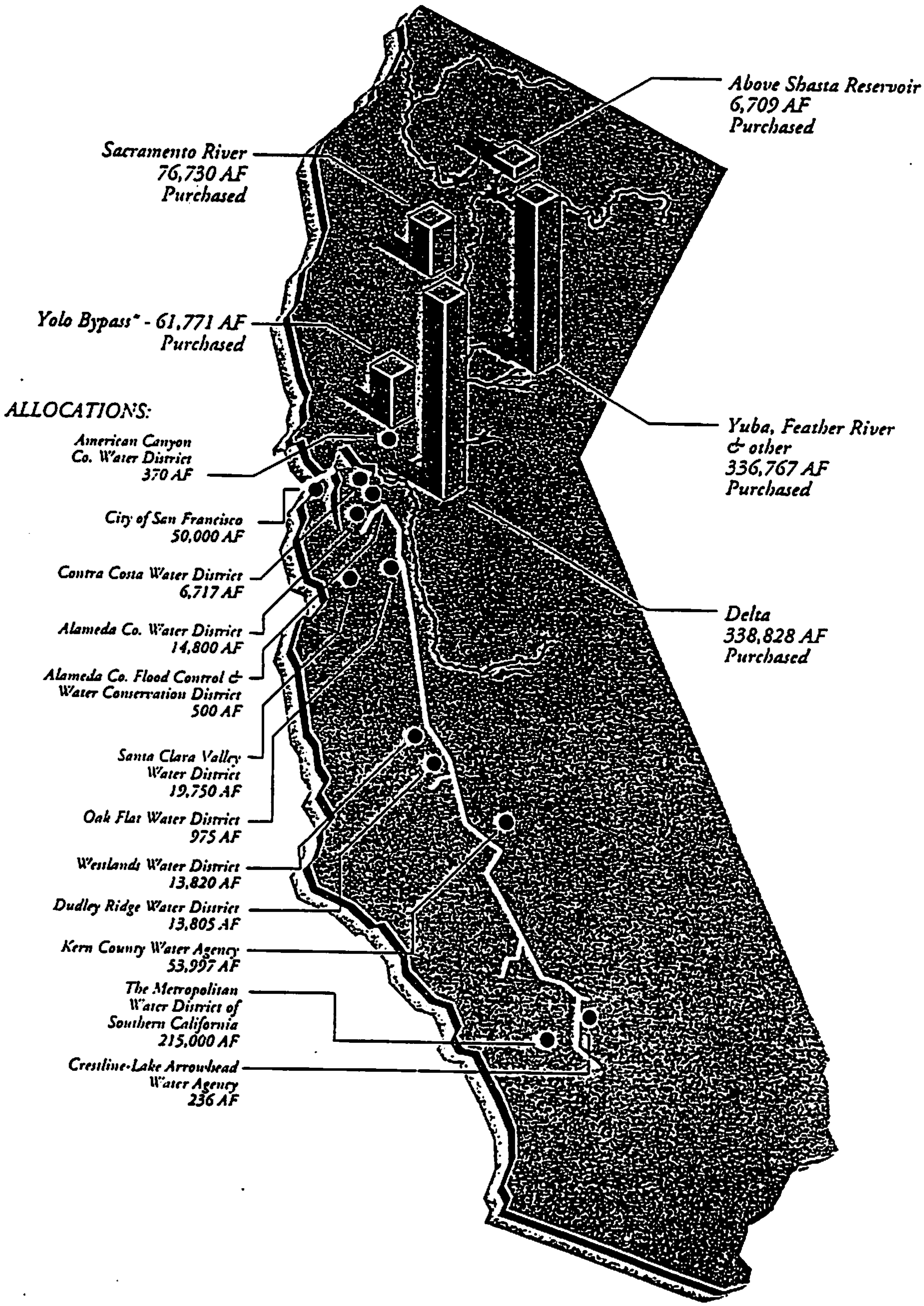
[129]Purchases to cover carriage water requirements accounted for another 34,000 acre-feet. DWR, 1993. *Program Environmental Impact Report: State Drought Water Bank.* Sacramento: State of California, Department of Water Resources.

[130]Id.

[131]Lund et al., 1992, supra

[132]USDA, 1994, supra

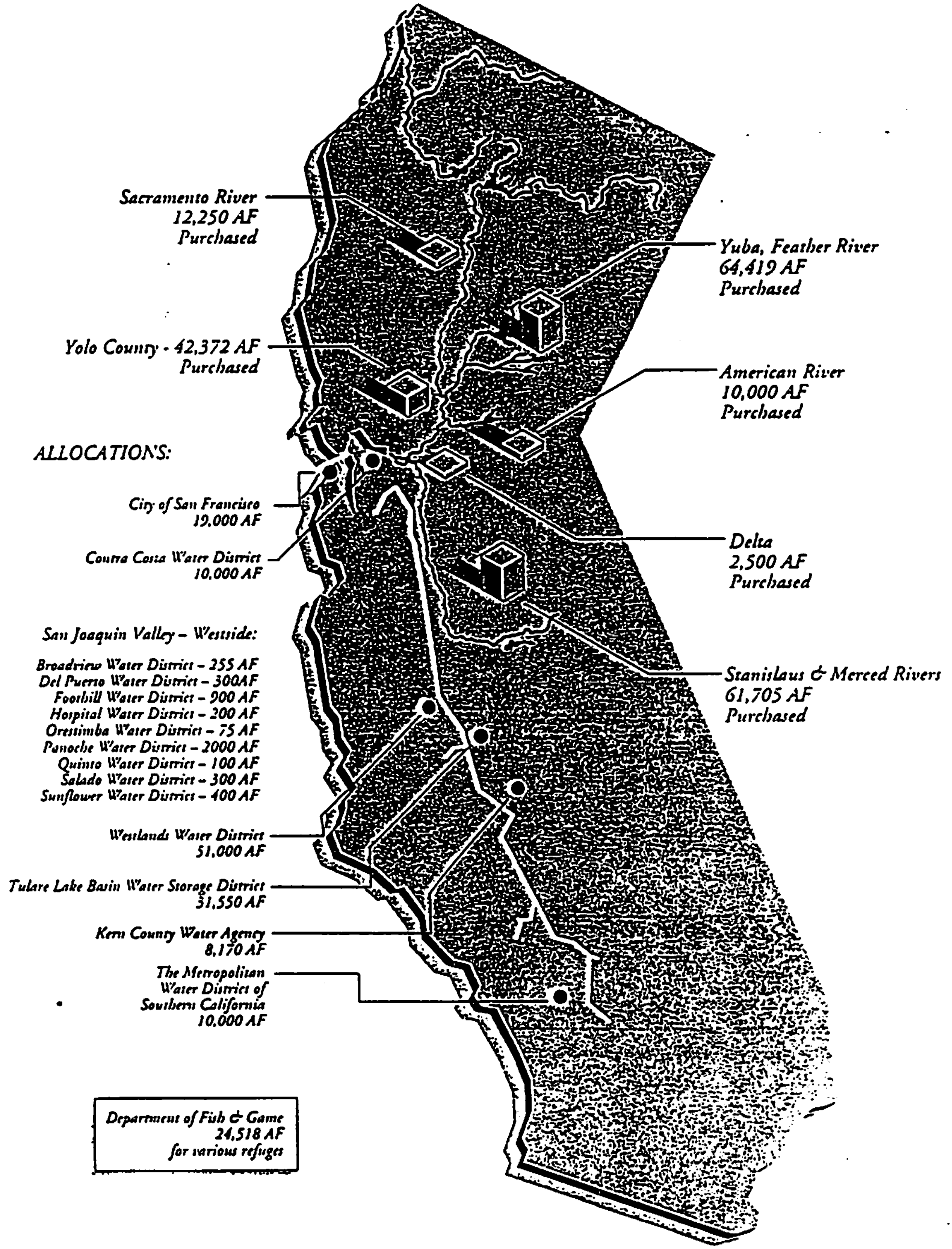
Figure 2.2.1. **The 1991 Drought Water Bank**



* excluding areas within the Delta

Source: DWR, 1993.

Figure 2.2.2. **The 1992 Drought Water Bank**



Source: DWR, 1993.

stored water in northern California. Twenty percent of that quantity will be used for Delta carriage water, leaving approximately 180,000 acre-feet to be delivered to purchasers south of the Sacramento/San Joaquin Delta.[133] The purchase price has been established at $50 per acre-foot and the melded price to buyers at the Delta pumps at $68 per acre-foot.

At present, it appears that almost all of the buyers from the 1994 Bank are agricultural water suppliers such as the Westlands District and the Kern County Water Agency. Central Valley Project contractors are among the major purchasers from the bank. Most CVP allotments have been cut to 35 percent of normal this year as a result of the drought. Urban suppliers, such as MWD, have purchased only small quantities from the 1994 Bank.

2.2.5 Assessment of the Emergency Drought Water Banks

Most observers view the 1991 and 1992 Emergency Drought Water Banks as a successful response to the imbalances between availability and demand created by the drought. It seems likely that the 1994 Bank will be similarly regarded. One study[134] conservatively estimated the net benefits of the 1991 Bank at $91 million, including net benefits of over $32 million to the agricultural sector. However, considerable concerns were raised, particularly in 1991, about the third party impacts of the Drought Water Banks, as well as about impacts on groundwater levels, and fish and wildlife habitats. A summary of these issues will be presented here. A more detailed description of environmental, socioeconomic and other third party impacts is presented in Section 4.5 of this report.

Discussion of third-party impacts centered primarily on the effects of fallowing contracts on agricultural sector employment and on the profitability of farm-related businesses. Given the rapid implementation of the 1991 Water Bank and the heavy concentration of fallowing contracts in a few localities, local business owners and

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[133]At present writing (July, 1994) only preliminary figures are available from DWR staff.

[134]Howitt, et al., 1992, <u>supra</u>

relatively immobile segments of the agricultural work force had little opportunity to protect themselves. Consequently, some of these parties experienced reduced incomes as a result of sales to the water bank. Efforts to quantify these third party impacts suggest that they were generally small relative to other fluctuations in agricultural sector income and employment and small relative to the statewide net benefits derived from the Emergency Water Banks, but they were unevenly distributed.[135]

Particular attention has been given to analyzing the third party impacts of 1991 fallowing contracts in Yolo and Solano Counties, both located in the Delta region. Together, these counties supplied 1/4 of the water purchased by the 1991 Water Bank.[136] Purchases were particularly heavily concentrated in Yolo County, from which 154,323 acre-feet were supplied to the bank, with approximately two-thirds of that coming from fallowing contracts. The 41,929 acre-feet supplied to the 1991 Water Bank from Solano County came entirely from fallowing contracts. In addition, Solano County set up its own Emergency Water Pool, through which 15,000 acre-feet were transferred from farmers in the central part of the county to local cities. After accounting for government set-aside programs, it has been estimated that water transfers accounted for the fallowing of 45,700 acres in Yolo County and 23,600 acres in Solano County. Over the decade of the 1980s, total crop acreage in Solano County had averaged around 200,000, while total acreage had fluctuated between 300,000 and 400,000 acres in Yolo Counties.[137] Given the normal year-to-year variability in cropped acreages, there was some room for the acreage declines arising from water bank transfers to be offset by increased utilization of other irrigable lands. In fact, compared to the previous four

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[135]See e.g., Coppock and Kreith, 1993, supra; DWR, 1993, supra; Holcomb, Valerie, 1992. *Buying and Selling Water in California: Issues, Experience and Policy Options,* Conference Summary Analysis, UCLA Extension Public Policy Program. Sacramento: Water Education Foundation.; Howitt, et al., 1992, supra; The Bay Area Economic Forum and Metropolitan Water District of Southern California, 1993. *Water Marketing in California: Resolving Third-Party Impact Issues.*

[136]Coppock and Kreith, 1993, supra

[137]Id.

years, the net decline in Yolo County irrigated acreage in 1991 was only 1,400 acres.[138] The net decline in Solano County, again compared to the previous four years was 15,900 acres. The difference in net declines between the two counties can be explained, in part, by the smaller normal interannual fluctuations in land use in Solano County, which may have resulted in a smaller inventory of idle, irrigable land. Another factor contributing to the large net decline in Solano County was the fact that the acreage idled by government set-aside programs doubled between 1990 and 1991 to 20,000 acres.

Howitt[139] presents estimates of the magnitude of the third party impacts treating the increased utilization of other Yolo County lands as an independent change, that is, not affected by the release of resources or revenues obtained from sales to the water bank. Those results suggest that the sale of 154,323 acre-feet and fallowing of 45,700 acres resulted in the loss of 404 agricultural sector jobs in Yolo County and approximately a 5 percent decline in agricultural sector income. For Solano County, he estimates the loss of 191 agricultural sector jobs from the 1991 Water Bank, resulting in approximately a 3.5 percent decline in agricultural sector income. His model suggests that third-party impacts per thousand acre-feet sold are likely to be an increasing function of total sales. This implies that total adverse impacts can be reduced by spreading water purchases evenly over a large geographic area rather than allowing them to be concentrated in a few localities.[140]

Researchers at the Rand Corporation[141] followed a different approach in analyzing the impacts of the 1991 Water Bank on county level income. They surveyed farmers who sold water to the 1991 Bank and based their impacts estimates on changes

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[138]McBean, Ed, 1993. "Environmental Effects," in Coppock, Raymond H., and Marcia Kreith, eds., *California Water Transfers: Gainers and Losers in Two Northern Counties*, Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center. Davis: University of California.

[139]Howitt, Richard, 1993b. "Economic and Social Factors," in Coppock, Raymond H., and Marcia Kreith, eds., *California Water Transfers: Gainers and Losers in Two Northern Counties*, Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center, University of California.

[140]Howitt, 1993a,b, <u>supra</u>.

[141]Dixon et al., 1993, <u>supra</u>

in the entire farming operation, thus adjusting for increased utilization of other lands. Their results indicate that all impacts on county income were less than 1 percent.

The environmental effects of transfers through the water banks are difficult to separate from the effects of the drought itself. Three types of environmental impacts have been suggested: 1) damage to wild bird habitat and forage caused by the removal of grain crops from lands around the Sacramento Delta as a result of the fallowing contracts 2) reductions in groundwater levels and quality resulting from accelerated pumping and reduced aquifer recharge and possible acceleration of subsidence and 3) possible adverse impacts on endangered and threatened fishery resources in the Delta caused by increased operation of Delta pumping plants.

The first of these impacts may be manageable by increasing the geographical scope of water acquisition efforts for any future water banks and by limiting the percentage of land in sensitive areas that can participate in fallowing contracts. The DWR made efforts to ensure that there were no significant adverse impacts of increased groundwater withdrawals under groundwater substitution contracts by requiring that participating wells be metered and logged. Groundwater levels did decline in many areas that contributed water to the banks. However, only a portion of these declines can be attributed to the groundwater contracts.[142]

The Yolo County case is illustrative of the difficulty of assessing the impacts of water banking activities on groundwater levels in the presence of unregulated groundwater use.[143] The small net decline in irrigated acreage in that county occurred in conjunction with a substantial increase in groundwater withdrawals. McBean[144] estimates that total groundwater use in Yolo County increased between 1989 and 1990 by 97,400 acre-feet. The increased use, together with reduced recharge from both natural

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[142]McBean, 1993, <u>supra</u>.

[143]The SRWCB has no jurisdiction over groundwater, and its use in much of California remains unrestricted. There are, however, adjudicated basins in southern California where pumping rights have been quantified on the basis of the principle of mutual prescription. Tarlock, A. Dan, 1989. *Law of Water Rights and Resources*. New York: Clark Boardman.

[144]McBean 1993, <u>supra</u>

sources and irrigation seepage, caused groundwater depletion to increase by 139,700 acre-feet. McBean attributes only 20,000 acre-feet of increased groundwater use and 47,000 acre-feet of increased depletion to the activities of the water bank. This appears consistent with use allowable under the groundwater substitution contracts. It is unclear, however, if the managerial and other resources that would have been used on the lands idled by the fallowing contracts were used to increase the utilization of other Yolo County lands. If that was the case, the net impact of the 1991 Water Bank on groundwater withdrawals is likely to have been larger than suggested by McBean. It has not been possible to attribute any changes in subsidence to water sales to the banks.

The Sacramento/San Joaquin Delta is the achilles heel of the California Water distribution system. Both the SWP and the CVP are designed largely to transport water from the relatively water rich Sacramento Basin of northern California to the more arid southern portion of the state. These projects rely on pumping plants located in the Delta, the operation of which has proved harmful to fish populations resident in the Delta as well as to anadromous runs which must pass through the Delta to spawn. DWR officials argue that operation of the Drought Water Banks provided benefits to the endangered and threatened fish populations in the Delta by increasing Delta flows over levels that would have been attained in the absence of the transfers and by making use of SWP storage facilities on both sides of the Delta to allow pumping operations to be timed in such a way as to minimize adverse impacts on these populations.[145] On the other side of the coin is the argument that the SWP pumps were operated at a higher rate than they would have been in the absence of the water banks and that the increased pumping is likely to have increased fish mortality. Since the Delta is a slack-water estuary, the environmental damage caused by the pumping may not have been entirely offset by provision of carriage water as mandated under the regulations then controlling movement of water across the Delta. In a fast moving river, the environmental effects of adding a certain quantity of water at one point and withdrawing it downstream (after adjustment for channel losses) tend to be relatively small. Given the slow movement of

[145] Personal communication, Steve Macaulay, Manager, Drought Water Bank, DWR, May 10, 1993.

water and tidal influences in the Delta, however, introducing new water into the system does not ensure that a similar quantity can be pumped from the Delta without causing reverse flows in the vicinity of the pumps which may increase the entrainment of fish.

Reduced streamflows and associated changes in riverine and Delta conditions during the drought led to sharp reductions in populations of winter-run Chinook salmon and of Delta Smelt. Increasing concerns about the rapid decline of these populations has led to both federal and state efforts to impose stricter controls on Delta pumping operations. At the federal level, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service and the Environmental Protection Agency are each attempting to regulate water export operations through the Delta. In addition, the federal Central Valley Improvement Act of 1992[146] mandates that the CVP allocate 800,000 acre-feet of water annually for the purpose of restoring fish and wildlife habitat. This may require significant modification of CVP operations, particularly during dry years. At the state level, in December 1992, the SWRCB issued Draft Decision 1630, which proposed significant changes in Delta water quality and flow standards on an interim basis to respond to the biological emergency. Analyses performed by the SWRCB suggest that allowable export levels during a repeat of the recent drought would be significantly lower under both the original and revised versions of Draft Decision 1630 than under current regulation of the Delta and could be as much as 1.9 million acre-feet per year lower in certain critical periods.[147] This led agricultural interests south of the Delta to label the proposal a "regulatory drought" and under pressure from those interests, the governor issued a request to the SWRCB on April 1, 1993 to abandon further consideration of Draft Decision 1630 and to work instead on establishing permanent standards.[148]

[146](Title XXXIV of Public Law 102-575)

[147]SWRCB, 1993. *Revisions of Draft Interim Water Right Decision 1630*, Sacramento: State Water Resources Control Board. SWRCB, 1992. *Draft Water Right Decision 1630: San Francisco Bay/Sacramento-San Joaquin Delta Estuary*, Sacramento: State Water Resources Control Board.

[148]The Governor's letter to the Board cited preemption of regulatory authority by federal agencies as the reason for the request, but prominent environmentalists saw the governor's action as a betrayal and pulled out of the governor's Bay Delta Oversight Council; Mayer, Jim, 1993. "Governor backs off new rules for Delta," *The Sacramento Bee*, Sacramento, April 2, 1993; Olszewski, Lori and Vlas Kershner, 1993. "Gov. Wilson backs

Current regulations applying to Delta pumping operations are somewhat more restrictive than was the case in 1991 and 1992, but they have not proved to be an insurmountable barrier to the implementation of water banking in 1994. However, uncertainties about the availability of water transport capacity under proposed federal and state regulations resulted in no proposal for a State Water Bank in 1993 despite the fact that the Sacramento Basin had ample supplies while deliveries to CVP contractors south of the Delta were expected to be 40 percent below normal due to the Bureau of Reclamation's efforts to comply with the environmental mitigation requirements of the CVP Improvement Act. In an effort to address the potential adverse environmental effects of future water banks, the Department of Water Resources has prepared an Environmental Impact Report.[149] At present the department plans to limit its future involvement in water banking to occasional responses to emergency drought conditions, and acknowledges that until the condition of the Delta substantially improves, there will only be limited conveyance capacity available for north-to-south market transfers of water.[150]

Recent changes in state law will also affect future water banking operations. Section 1745.10 of the California Water Code, effective January 1, 1993 specifies that:

> A water user that transfers surface water pursuant to this article may not replace that water with ground water unless the ground water use is either of the following:
>
> (a) Consistent with a ground water management plan adopted pursuant to State law for the affected area.
>
> (b) Approved by the water supplier from whose service area the water is to be transferred and that water supplier, if a ground water management plan has not been adopted, determines that the transfer will not create, or contribute to, conditions of long-term overdraft in the affected ground water basin.

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off on water policy," *The San Francisco Chronicle*, San Francisco, April 2, 1993. Delta standards are currently regulated under Decision 1485. Draft Decision 1630 was meant to provide interim standards until a permanent replacement for Decision 1485 had been developed.

[149]DWR, 1993, supra.

[150]Macaulay, 1993, supra.

Another change in the Water Code, also effective January 1, 1993 is Section 1745.05. That section limits water sales from stored water or fallowing to:

> ... 20 percent of the water that would have been applied or stored by the water supplier in the absence of any contract entered into pursuant to this article in any given hydrological year, unless the agency approves, following reasonable notice and a public hearing, a larger percentage.

This provision leaves the decision to exceed the 20 percent limit up to the local water district.[151] Both of these amendments are designed to increase the degree of local control over sales of water to any future water banks, and they do not appear to have posed any significant problems for the acquisition of water for the 1994 Water Bank.

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[151]DWR, 1993, supra.

APPENDIX TO SECTION 2.2

FALLOWING CONTRACTS

Consider the case where the water demand functions of potential sellers are downward sloping rather than horizontal (or a series of discrete horizontal steps). In this case, all-or-nothing water sales are not a trivially natural result of the nature of the would-be sellers' production functions and resulting factor demands for the water input.

Figures 2.2A (A1 - A3) depict the value of marginal product and value of average product of water curves for the holder of a senior agricultural water right. The portion of the VMP curve lying to the right of Q* can be taken as equivalent to the short-run factor demand curve for water. An individual facing a water price of P* would not choose to produce this crop with the production techniques embodied in these curves knowing that less than Q* water would be available, since a negative profit would be earned if less than Q* water is applied. Since the value of the average product of water is at its maximum (P*) at that point, this individual would choose to sell the entire water supply and drycrop or fallow the land if offered any price for the water above P*, regardless if the price were offered on a per-unit or all or nothing basis.

<u>Potential welfare loss from all-or-nothing fallowing</u>

In Figures A2 and A3, the VAP of Q_s is P1, so P1 x Q_s is the total value to the individual of producing a crop with the full water right.

1) If offered a fallowing contract at any price above P1 (say P1 + $0.01), the individual would take the contract. If the same price were offered on a per unit basis, a crop would be grown with Q1 water and the quantity sold would be Q_s - Q1. Welfare losses resulting from the all-or-nothing deal are equal to the shaded area.

2) If the all-or-nothing price is below P1, no water will be sold, even though water would have been sold if the same price had been offered on a per unit basis. In Figure A3, at price P2, Q_s - Q2 would be sold on a per unit basis, so the shaded area is lost if a fallowing contract is offered instead.

With different production functions for different crops and different farms, both kinds of losses would be simultaneously incurred if water sales are constrained to be on an all or nothing basis.

<u>Potential Benefits of all-or-nothing sales</u>

Such arrangements would tend to minimize monitoring and enforcement costs. If the incremental monitoring costs of moving from fallowing to per-unit water sales contracts exceed the deadweight losses associated with fallowing contracts, then the all-or-nothing approach would be optimal.

FIGURES A1, A2, and A3

Definitions and Simplifying Assumptions:

* VMP = value of the marginal product of water to the senior user (e.g., an irrigator)—this is drawn for a particular crop, with price, technology and level of other factor inputs all fixed. It therefore corresponds to a short-run factor demand curve for water.

* VAP = value of the average product of that water.

* Q* = the minimum amount of water that an individual with access to a water market would choose (at the beginning of the season) to apply with the technology depicted in these curves, while still producing a crop.

* Q_s = the size of that individual's full water right.

For convenience, this is drawn so that VMP (or VMP net of marginal diversion cost if the curves have been drawn that way) is zero at that point. In practice, VMP at the actual Q_s will differ from zero since the positions of the VMP and VAP curves are not constant, but the right could not long be maintained outside of the range Q* - Q_s (as drawn) because water in excess of Q_s would likely be abandoned or sold and negative profits would be earned with less than Q*.

Figures 2.2A

Values of Marginal Product and Average Product of Water

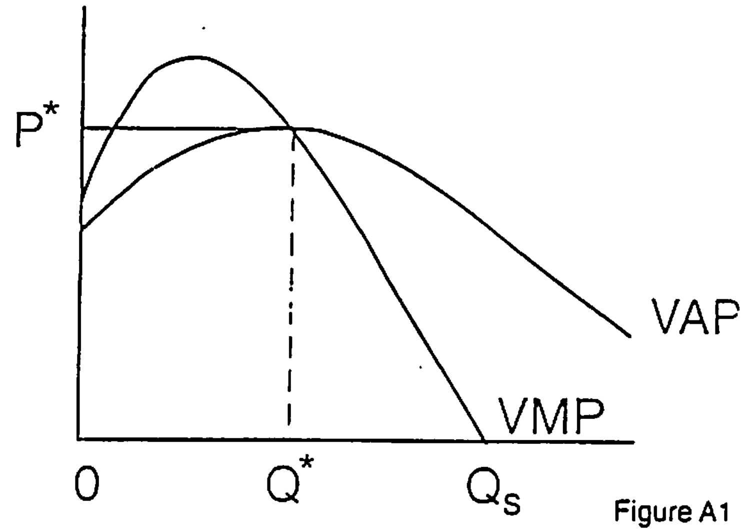

Figure A1

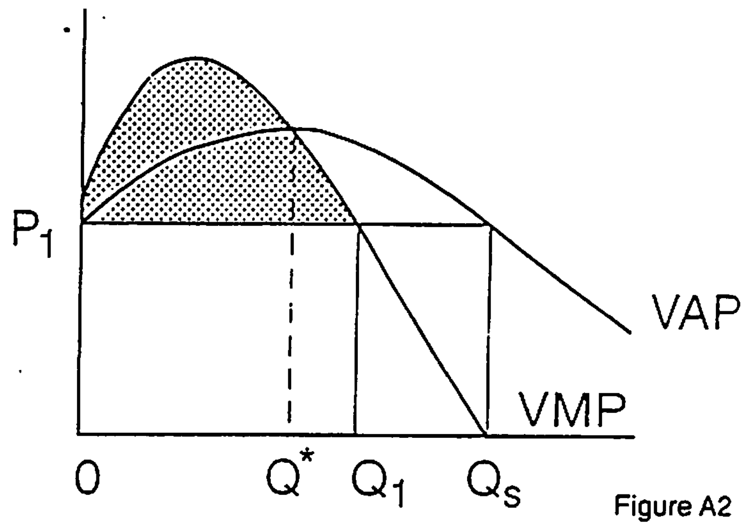

Figure A2

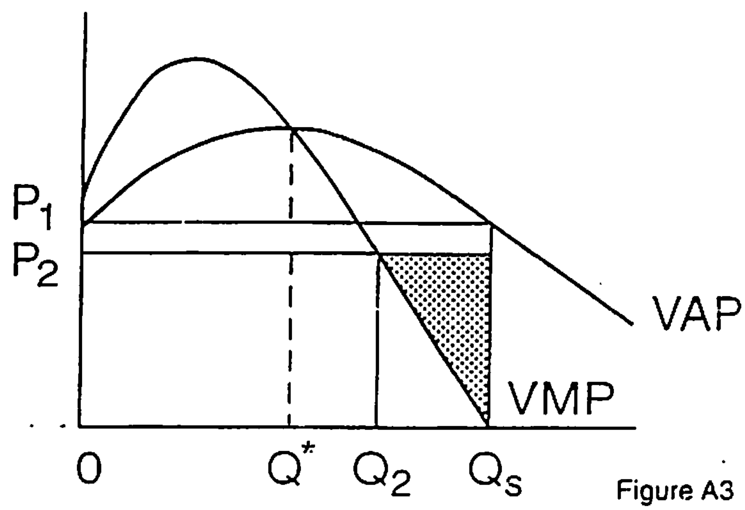

Figure A3

2.3 THE TEXAS WATER BANK

In 1993 the Texas Legislature adopted a water banking program to be established and administered by a state agency, the Texas Water Development Board (Board). The purpose of the bank is to "facilitate the transfer of water from all sources as necessary to provide sources of adequate water supplies for use within the State of Texas."[152] Thus the program may provide a vehicle for temporary and permanent transfers of water rights as well as the marketing of water conserved through public or private efforts. One of the co-sponsors of the bank legislation suggested that water banking may be a means of marketing water resources in some areas of the state where less than projected population growth has resulted in surplus water supplies.[153] Transfers outside of the bank program are permitted.[154]

The first order of business under the new program was the development of rules. During the summer of 1993, public meetings were held throughout the state with potential buyers and sellers of bank water to elicit recommendations and concerns with implementation of the program. Following these meetings, bank rules were drafted, and published for public comment in early 1994. The draft rules, as modified, were adopted by the Board in April, 1994. The following sections describe the bank program, as set out in the laws and rules. It also draws on comments of the bank manager and a few other individuals regarding how the bank is expected to operate, and potential difficulties in implementing the program.

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[152]Tex. Water Code Ann. §15.702 (West Supp. 1994) and Water Bank Rules, Texas Water Development Board, adopted May 13, 1994, at 31 Texas Administrative Code § 359.1 [hereinafter Water Bank Rules].

[153]This was suggested by Representative David Counts, Chairman of the House Natural Resources Committee, and a public meeting in Lubbock, Texas on August 11, 1993. See Carmon McCain, "Comments Offered on Texas Water Bank Operation," The Cross Section, a newsletter published by High Plains Underground Water Conservation Dist. No. 1, Vol. 39, No. 9.

[154]Water Bank Rules, at § 359.1. Texas law recognized a limited type of water bank prior to the enactment of the water bank law. River authorities, given broad authority to deliver water to all or part of a water basin, have been regularly purchasing water rights to ensure future water supplies. Because the water may not be currently needed, these authorities frequently lease their excess water to urban water suppliers under long-term contracts. See Jean A. Bowman, "Reallocating Texas' Water: Slicing up the Leftover Pie," Tex. Water Resources Inst., Vol. 19, No. 4 (Winter 1993), at 3.

2.3.1 Bank Administrator

Under the 1992 law, the authority of the Board is broadly defined. The Board may take "all actions necessary to operate the bank and to facilitate the transfer of water rights from the bank for future beneficial use."[155] More specifically, the Board may negotiate the sales price and terms between depositor and buyer, inform water users of water or water rights available through the bank, and maintain a registry of potential bank buyers and sellers.[156] Potential buyers of bank water can submit a request on a form provided by the bank administrator.[157] The seller registry is not for bank depositors, but for those who do not want to deposit a water right with the bank, yet wish to advertise the availability of the right for transfer.[158] The Board may also acquire water or water rights as necessary to operate the bank.[159]

Actual brokering, where bank administrators assist in the negotiation of transfer terms, can only be done at the request of both the depositor and the interested buyer.[160] The bank can play a role as intermediary and facilitator, provide state agency expertise and input, and hopefully assist the transaction through the necessary state approval process. This type of transaction need not go through the bank but, by doing so, may be more likely to reduce opposition from third parties and gain state approval during the

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[155]Tex. Water Code Ann. § 15.703 (West Supp. 1994).

[156]Id., at § 15.703(1), (2), and (3); and Water Bank Rules, at § 359.9 and 359.10.

[157]Water Bank Rules, at § 359.9.

[158]Id., at § 359.10.

[159]Id., at § 359.3.

[160]Id., at § 359.12. One of the first potential transactions through the bank would involve the Board in this type of role. A seller is interested in permanently transferring (Texas) Colorado River water rights to a private party. Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (May 24, 1994).

administrative transfer procedure.[161] The idea of using a water bank to facilitate permanent water transfers appears to be unique to the Texas bank program.[162]

Under the rules, a statewide bank is administered by the Board and regional banks may be established by the Board upon petition. State agencies, political subdivisions or other entities may be designated by the Board as Regional Bank Administrators. In considering the need for and designation of a regional bank, the Board may consider the manner in which proposed rules and procedures of the regional bank address the following:

- allocating water leases or purchases among competing buyers;
- allocating reimbursement funds (not defined or described) among depositors;
- establishing bank transaction fees and their allotment;
- notice to the Board and other state agencies of regional bank activities.[163]

It is anticipated that a regional bank will eventually operate in the Lower Rio Grande Valley.[164]

2.3.2 Bank Deposits

There are few guidelines on depositing water into the bank although the statute contemplates that the Board will develop more specific regulations.[165] The amount of a water right transferable to the bank can be no more than 50 percent of the right.[166] The term of deposit is limited to ten years and, during the time the water is in the bank,

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[161]See discussion infra at section 2.3.4 regarding the need to comply with Texas water rights transfer requirements.

[162]The bank administrator is specifically authorized to "take any appropriate action to facilitate water transfers *both within and external to the operations of the water bank.*" Water Bank Rules, at § 359.8 (b)(emphasis added).

[163]Water Bank Rules, at § 359.13.

[164]Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18, 1994).

[165]Tex. Water Code Ann. § 15.703(8)(b) (West Supp. 1994).

[166]Water Bank Rules, at § 359.6(a).

the water right is protected from cancellation whether or not it is used (Texas equivalent to forfeiture).[167]

The rules define the type of water or water right that may be deposited in the bank. "Water right" is defined as "a right acquired or authorized under the laws of this state to impound, divert, or use state water, underground water, or water from any source to the extent authorized by law."[168] Deposits of water rights representing conserved water may also be accepted into the bank.[169] Conserved water is defined in the rules as it is in the Texas Water Code:

> The development of water resources, and those practices, techniques and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.[170]

The water bank statute specifically authorizes the Board to encourage water rights holders to implement water conservation practices and deposit the right to use the conserved water into the bank. The Board will not accept water rights if any portion of the right is, at the time of the application for deposit, involved in a cancellation or forfeiture proceeding.[171] Deposits to water banks under the Texas program are

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[167] Id. at §15.704. Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (July 19, 1994).

[168] Id., at § 359.2. Based on prior court decisions, bank administrators will interpret this as 50 percent of the paper right rather than 50 percent of historic diversions. Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (June 2, 1994).

[169] Id., at § 359.7(b); Tex. Water Code Ann. § 11.002(8) (West 1988).

[170] Tex. Water Code Ann. § 15.703(4) (West Supp. 1994). Even before the enactment of this law, Texas recognized the right to sell or lease appropriated water saved under a documented conservation plan. See Bowman, at 2.

[171] Water Bank Rules, at § 359.6(b).

expected to take two forms: (1) deposits for lease for a specified period of time and quantity of water; and (2) permanent transfers of water rights.[172]

The 50 percent limitation has raised some questions that may require clarifying legislation.[173] One issue is whether the cap applies to permanent transfers of a water right, or only short term leasing arrangements. Another issue is conserved water. It is anticipated that the conservation of water and related bank deposit could result in more than 50 percent of a water right being available for deposit in the bank.[174] A third issue is how the rule is to be applied to groundwater. In the case of surface water, it has been interpreted as 50 percent of the amount that can be diverted rather than 50 percent of the consumptive use amount. With groundwater rights, which in general are not quantified, and which may be described as a "right of capture," it will be difficult to determine a precise quantity of water associated with the right.[175] Bank rules do not resolve these issues, and additional legislation may be proposed in early 1995 to do so.[176]

2.3.3 Withdrawal and Use of Bank Water

Bank withdrawals can be made at the request of the purchaser or original depositor, or by the bank administrator. As discussed above, most surface water transfers will need to obtain regulatory approval from the Texas Natural Resource and Conservation Commission (TNRCC) prior to withdrawal. Whether or not regulatory approval is required, the applicant for withdrawal will need to show compliance with

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[172] See Bowman, at 2.

[173] Tex. Water Code Ann. §15.704 (West Supp. 1994).

[174] See "Meeting Summary: Texas Water Bank, Informal Draft Rules Discussion, Jan. 27, 1994, Austin, Texas," prepared by Dan Beckett, Manager, Texas Water Bank, Jan. 28, 1994.

[175] See Bowman, at 3; Tex. Water Code Ann. § 52.002 (West 1988); and Houston & Texas Central Railway Co. v. East, 98 Tex, 146, 81 S.W. 279 (Tex. 1904) (property owner may pump water from a well on his land regardless of any effect it may have on adjacent lands).

[176] Telephone conversations with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18 and May 24, 1994).

bank contract terms and conditions.[177] A bank deposit (water or water rights) may be assigned to another party without removal of the water or water right from the bank.[178]

A depositor may also withdraw his water right by submitting a "withdrawal form" to the bank administrator.[179] Depositors who do this will likely forfeit any transaction fees paid earlier.[180] Withdrawal will not negate any contractual responsibilities associated with the right.[181]

Finally, the bank administrator may, under the rules, independently decide to withdraw the water right from the bank if the administrator determines the water or water right deposited is non-quantifiable (e.g., groundwater rights) or involved in a pending administrative proceeding for cancellation or forfeiture (initiated prior to the deposit), or that the deposit is contrary to the purposes of the Texas Water Code, Water Bank Rules, or other applicable law.[182]

2.3.4 Consideration of Impacts

Will bank administrators or another state agency consider questions of third party impacts of proposed bank transactions? Under the rules, transfers through the bank do not eliminate the need to comply with Texas water transfer laws.[183] For other water rights transfers, except surface transfers permitted under a "watermaster program" for

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[177]Water Bank Rules, at § 359.8(d)(2).

[178]Id., at § 359.8 (g).

[179]Id., at § 359.7(e). It may take up to 30 days following submission of the withdrawal form for the withdrawal to become effective.

[180]Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18, 1994). This provision would seem to protect depositors in the event circumstances change and they need to use the water previously deposited in the bank.

[181]Comment of Daniel E. Beckett, Manager, Texas Water Bank, received by facsimile transmission June 16, 1994.

[182]Id., at § 359.6.

[183]Water Bank Rules, at § 359.4.

process includes consideration of the proposed transfer's third party impacts, including impacts on other water rights and on the public welfare. In addition to the no-injury rule and public welfare considerations, the TNRCC must also find that the new use will be a beneficial use, and that water will be physically available for the new use.[185] Groundwater in most of Texas is not subject to regulation, so, unless the law changes, transfers of groundwater through the bank would not be subject to this type of formal review.[186]

The water rights transfer review is not expected to occur when a water right is deposited into the bank but, rather, when a transfer or sale from the bank is proposed. The primary emphasis at the front end of the bank transaction will be in assessing the nature of the water right being offered, the availability (both location and season) of water under that right, and the percentage of the water right being offered. In the second half of the bank transaction, transfers will be subject to the transfer procedure and criteria described above. Transfers from one watershed (defined as a named river basin or coastal basin) to another may require a permit, and may trigger other review standards, further lengthening the transaction time.[187] Groundwater transfers are expected to be difficult to evaluate in terms of potential impacts, in part because of the difficulty in quantifying such rights. Administrators are concerned about addressing questions of injury to other water rights.[188]

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[185]Id.; and Tex. Water Code Ann. § 11.134(b)(3)(B) (West 1988); Clark v. Briscoe, 200 S.W. 2d 674 (Tex. Civ. App. 1942).

[186]See Bowman, at 3.

[187]Under Texas law inter-watershed transfers require a permit from the state following notice and a hearing. See Texas Water Code Ann. § 11.085(b) (West 1988).

[188]Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18, 1994). Determining non-injury is expected to be easier within areas designated as "Underground Water Conservation Districts," where standards may have been developed.

Bowman, at 5, discusses the preliminary results of a current research project indicating that the water bank's role as a clearinghouse will stimulate the development of water markets in Texas, but that legal barriers under the no-injury rule present a potential limitation. The TNRCC is working on modifications to the no-injury rule that may require mitigation or provide compensation in the event of third party injuries.

The Texas program also provides a potential vehicle for considering ways in which water from water bank operations could provide environmental benefits. Beginning in 1994, regular reporting to the Governor and the Legislature on water bank implementation is required under the Act. The Texas Water Development Board (Board) must coordinate with the State Parks and Wildlife Department and the Texas Water Commission in preparing these reports, which are to include changes needed to provide flows "to meet instream, water quality, fish and wildlife habitat, and bay and estuary inflow needs through the water rights marketing and transfer process."[189]

2.3.5 Bank Finances

The Texas Water Bank is not expected to be economically self-sustaining, and the budget, at least initially, may be lean. In connection with the development of program rules, the Texas State Director of Finance estimated the annual cost to the state for the first five years of operation at $62,500.[190]

The water bank statute allows the Board to assess a transaction fee against the depositor of up to $500.[191] Bank rules provide for a $10 fee for transfers of 10 acre-feet per year or less, increasing by $1 for each additional acre-foot up to a maximum of $500.[192] Political subdivisions are exempt from the transaction fee, and this exemption is expected to apply to a significant number of depositors.[193] Regional bank rules could provide for both regional and state-level administration fees, if the local bank operator is

[189]This provision is section 2 of the 1993 law, 73rd Leg., ch. 647 (1993), and appears in the Texas Water Code in the Historical and Statutory Note to § 15.701 (West Supp. 1994).

[190]See Preamble to Draft Rules, Texas Water Bank, published in the *Texas Register* on Mar. 18, 1994.

[191]Tex. Water Code Ann. § 15.705 (West Supp. 1994).

[192]Water Bank Rules, at § 359.14.

[193]Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18, 1994).

otherwise authorized to levy assessments and has entered an agreement with the Board.[194]

2.3.6 Public Concerns

Public meetings held around the state while rules were being developed revealed several concerns of the water community. Many expressed concern that the bank not function to protect unused water rights that should be permanently reallocated. The ten year ceiling on placing water in the bank should limit this practice. Additionally, administrators will be carefully considering the percentage of a water right that is being deposited, to avoid deposits of a small percentage of a water right for the purpose of protecting the entire right.[195] This concern has been addressed by the rules, which interpret the statute to mean that only that portion of the water right deposited into the bank will be protected.[196]

Municipalities are expected to be significant depositors into the bank.[197] However, they are concerned that, under existing law, they may have difficulty terminating, at the end of a contract term, a commitment to supply water.[198]

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[194]Id. The new law establishes a "water bank account" that is to be used only for administration and operation of the bank, to be comprised of legislative appropriations; grants, contracts, or gifts the Board may receive under the program; and interest earned on the investment of money in the account. Tex. Water Code Ann. § 15.707 (West Supp. 1994).

[195]See discussion in earlier section 2.3.4.

[196]See Water Bank Rules, at § 359.8 (a). Some water users also expressed concern that, by transferring their water right to the bank, they will be subject to greater scrutiny by Texas water rights administrators. These users are concerned that they would have less control over their water rights. However, administrators believe there is little basis for concern except under extraordinary circumstances, for example, where the right has not been exercised for several years. Telephone conversations with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18 and Mar. 21, 1994).

[197]Municipalities are expected to be significant water bank depositors because many have secured a long-term water supply not yet needed, and as a result of water conservation programs. Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18, 1994).

[198]Under this case law, municipalities undertaking an obligation to provide water may be compelled to continue to provide water evèn at the expiration of a contract. Two cases on this point have been cited by Suzanne Schwartz, attorney for the Texas Water Development Board. In one case, the court found that the Texas Water Rights Commission, under its authority to set rates for the furnishing of water, may compel the

2.3.7 Conclusion

Although water marketing was occurring to some extent in Texas prior to 1993, it is hoped that the Texas Water Bank will spur increased marketing activity. Potential uses of the water bank include the leasing or permanent transfer of water rights (including possibly transfers for environmental purposes), emergency transfers of water use during drought conditions, conjunctive use and exchange of ground and surface water rights.[199]

2.4 LOWER COLORADO RIVER INTERSTATE WATER BANK

In 1991, Colorado River Basin States (AZ, CA, CO, NM, NV, UT, WY) considered a proposal for an interstate water bank. The bank proposal was one part of a broader Colorado River agreement developed by California during prolonged drought conditions in California.[200] California's proposed agreement, including the interstate bank, died due to concerns of the upper basin states (CO, NM, UT, WY), who were unwilling to agree to its terms. A year later, in 1992, Arizona and California agreed to a temporary underground water storage arrangement to help meet the needs of

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City of Dallas to continue to provide water to other cities it had been serving. Texas Water Rights Comm'n v. City of Dallas, 591 S.W.2d 609 (Tex. Civ. App., 1980), aff'd on remand, 674 S.W. 2d 900 (Tex. App. 3 Dist., 1984). In the other case, the court found that the Commission has no authority to decide delivery contract issues when there is no rate dispute. Town of Griffing Park v. City of Port Arthur, 628 S.W. 2d 101 (Tex. App. 1982).

[199]See Bowman, at 3.

[200]See "Conceptual Approach for Reaching Basin States Agreement on Interim Operation of Colorado River System Reservoirs, California's Use of Colorado River Water Above Its Basic Apportionment, and Implementation of an Interstate Water Bank," prepared by California for the Colorado River Basin States Meeting in Denver, Colorado, August 28, 1991 [hereinafter "1991 California Report"]. In addition to establishing an interstate water bank, the agreement would have allowed California, for the benefit of Metropolitan Water District of Southern California (MWD), to receive Colorado River water in excess of its allocated portion on an interim basis, while other measures were instituted to bring California's demands in line with its decreed allocation. A surplus of river water in other basin states during this interim period was projected. The agreement set decreasing annual limits on the quantity of excess water available to California during the interim period, and established a mitigation fund to compensate the other basin states in the event MWD's needs could not be met from these states' unused and surplus waters. Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (Jan. 24, 1994).

Metropolitan Water District of Southern California (MWD).[201] Success in reaching this agreement led to discussions of a more permanent underground storage arrangement. In addition, the lower basin states (AZ, CA, NV) along with the Bureau of Reclamation, in 1994 initiated discussions on another interstate bank proposal, involving (at least initially) only the lower basin states.[202]

2.4.1 Background

Allocation of Colorado River water among the seven basin states is based on each state's apportionment established in the 1922 Colorado River Compact (as between Upper and Lower States), the 1948 Colorado River Compact (as among the upper basin states), and Arizona v. California[203] (as among the lower basin states). "Operating Criteria" provided for in the 1968 Colorado River Basin Project Act set out guidelines for meeting these allocations.[204] These guidelines require the Secretary of the Interior to prepare a plan of operations annually that considers (1) the amount of water needed to satisfy project purposes (taking into account various hydrologic and climatic conditions); (2) the amount of water needed in storage in the upper basin reservoirs; (3) the amount of water available for delivery to Mexico pursuant to the Mexican Water Treaty of 1944; (4) the reasonable beneficial use requirements of users in the lower basin under "normal," "surplus," and "shortage" conditions; and (5) the amount of water apportioned to, but unused by, one or more lower basin states available to satisfy reasonable beneficial consumptive use requests of mainstream users in other lower basin states.

At the time the 1991 Colorado River agreement and bank were proposed, California's needs for water exceeded its mainstem Colorado River basic apportionment. Metropolitan Water District of Southern California (MWD) was requesting 1.3 million

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[201]See section 3.3.1.6 infra.

[202]Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (Jan. 24, 1994).

[203]373 U.S. 546 (1963). This case confirmed the allocation among lower basin states suggested in the earlier Boulder Canyon Project Act of 1928, Pub. L. No. 70-642, 45 Stat. 1057 (codified at 43 U.S.C. § 617 (1988)).

[204]82 Stat. 885 (1968).

acre-feet (maf) per year under its contract with the Secretary of the Interior, much of which exceeded California's basic apportionment of 4.4 maf per year. This request has been satisfied only because Arizona and Nevada have not used all of their apportionment. California water supply agencies have been pursuing both water supply augmentation and demand management that would allow the agencies to meet their combined Colorado River water needs from within the state's basic apportionment and its rights under surplus conditions.[205] The proposed interstate water bank provided a possible interim solution to the problem.

2.4.2 Proposed 1991 Colorado River Agreement

The proposed agreement contained both broad principles (tenets) and a number of proposed actions including the interstate bank. Since there was a concern that a water bank could modify traditional operations under current laws, court decrees, and other legal documents, potentially impacting state allocations, tenets were included to affirm the rules governing Colorado River administration, and to clarify the relationship between bank operations and the existing administrative system.[206] In addition to the bank, other components were (1) an agreement between MWD and the basin states to allow MWD to receive up to 1.3 maf of Colorado River water through the year 2010; (2) the establishment of an escrow account (under which MWD will compensate the other basin states if its use is not from these states' unused and surplus supply); and (3) interim operating criteria for river system reservoirs.[207]

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[205]In high-flow years like 1983 to 1987, a surplus condition may be declared by the Secretary on the Colorado River due to available water supplies, and MWD's request could be satisfied from the surplus. In addition to its Colorado River contract water entitlements, MWD holds rights to State Water Project water. Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (June 8, 1994).

[206]1991 California Report, Id. at 13-19.

[207]In essence, the escrow account assures the other basin states they would be compensated if MWD's use cuts into their actual water needs. However, MWD could purchase water from the bank, if water were available, in order to meet its needs. In a good water supply year, when MWD could use 1.3 million acre feet and the other basin states would still receive the amount of water they need, MWD would not need to pay for the excess use, so would have no incentive to buy water from the bank. Telephone conversation with

2.4.3 1991 Proposed Interstate Water Bank

The 1991 proposal called for an interstate water bank to be operated by a "Seven State Forum," with forum representatives selected by the seven Colorado River Basin states. The forum, in cooperation with the Bureau of Reclamation, would establish regulations for the bank's operation, and would annually set a price for bank water.[208] The purpose of the bank was to help the basin states meet individual and collective water needs during critical, unique, or emergency water supply periods. All interstate water transactions would be required to go through the bank.[209]

A general framework was suggested for how the bank would operate. The bank would accept water on a willing seller/willing buyer basis. The bank would accept only wet water (water previously used but currently conserved or saved) in an amount determined on an annual basis.[210] Thus, multiple year commitments to sell a fixed amount of water to the bank would not be allowed. The proposal would also have limited total sales to the bank or purchases from the bank to one million acre-feet annually.[211]

The proposal anticipated that within each participating state, an entity would be designated as the state purchaser and seller for bank transactions. For example, in California, this entity might be the Colorado River Board. Only the designated state entity could purchase or sell bank water, so an individual or water supply organization wishing to sell water to the bank would presumably need to first convey or assign the

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Gerald R. Zimmerman, Executive Director, Colorado River Board (Feb. 14, 1994).

[208]The California proposal, as set out in the 1991 California Report, states both that the forum will set the maximum price for all bank transactions and that the forum will annually establish a purchase price for bank water. See 1991 California Report, at 17 and C-1 (revised).

[209]1991 California Report, at 15-19.

[210]"Wet" water would not include water represented by a legal right but which had not been used for several years. It would also not include water that had never been perfected or put to beneficial use. Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (Mar. 8, 1994).

[211]1991 California Report, at 17.

water to the designated entity. Corresponding to this requirement, each state would address questions of third party injury prior to making a bank deposit.[212]

Water sold to the bank would be managed as non-Colorado River system water so river allocation and management rules would not apply to bank water. States would be offered available bank water on a pro-rata basis correlating to each states' Colorado River water supply allocation.[213] The state could use the water directly, place it in a reservoir or groundwater basin for storage, or enter an option to purchase (to be exercised as needed in the future). Any state's share of offered water not purchased would be proportionately offered to other basin states. Water purchased by a state could be used immediately or placed into storage. States could not accrue water in their accounts in excess of specified amounts, ranging from .2 million acre-feet (maf) for Nevada to 2.2 maf for California.[214]

Once purchased, there would be no restriction on how the bank water was used (as long as the use is beneficial) but the place of use would have to be within the purchasing state. Bank water could be resold to other willing purchasers, but only after repurchase by the bank administrator and an offer to all interested basin states, again on a pro-rata basis. Any water resold in this manner would not be subject to the 1 million acre-foot annual limit.

2.4.4 1994 Lower Basin State Bank Discussions

Discussions were initiated again in early 1994 regarding a possible interstate water bank arrangement among California, Arizona, Nevada. The meetings have also included

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[212]Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (Feb. 14, 1994).

[213]1991 California Report, at 17. The allocations are AZ (20.6%), CA (32.4%), CO (23.5%), NV (2.9%), NM (4.4%), UT (10.3%), and WY (5.9%).

[214]1991 California Report, at p. 19. The amounts again seem to correspond to each state's river water supply allocation: AZ (1.4 maf), CA (2.2 maf), CO (1.6 maf), NV (.2 maf), NM (.3 maf), UT (.7 maf), and WY (.4 maf).

some representatives of tribes in the Lower Colorado River Basin.[215] Building from the lessons and results of a pilot project under which the Palo Verde Irrigation District sold conserved water (from land fallowing) to the MWD,[216] the parties hope to develop a plan for improving water management in the Lower Colorado River Basin through the use of innovative programs that provide greater flexibility in moving and storing water resources. Water banking programs under consideration include regional water banks administered by an interstate committee and individual state banks with some kind of interstate link to allow interstate transfers of bank water. Storage of bank water is being considered within the Colorado River system reservoirs and in groundwater aquifers.[217]

2.4.5 Bureau of Reclamation's Draft Regulations for the Lower Colorado River Basin

Working with the lower basin states, the Bureau of Reclamation in 1994 drafted rules for an interstate bank as part of its draft regulations for administering mainstem Colorado River water in the Lower Colorado River Basin.[218] The Bureau's banking plan is independent of the lower basin state and tribal discussions, but any plan developed by these parties would need to be connected to and consistent with the Bureau's rules. For example, the states and the tribes may agree to allow "bottom" water banking which is not allowed under the Bureau's draft rules. In other words, water could

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[215]Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (June 17, 1994).

[216]Ultimately, the Palo Verde arrangement is expected to provide a total of approximately 186,000 acre feet per year of stored water for MWD. As of early 1994, MWD had not used any of the accrued water, and has about 6 years to do so. Telephone conversation with Robert W. Johnson, Acting Regional Director, Lower Colorado Regional Office, Bureau of Reclamation (Mar. 4, 1994).

[217]Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (June 17, 1994).

[218]See Memorandum to Colorado River Water Users in the Lower Colorado River Basin, et al from Robert W. Johnson, dated May 6, 1994, transmitting "Draft Regulations for Administering Entitlements to Colorado River Water in the Lower Colorado River Basin" [hereinafter "Draft Colorado River Rules"]. The Bureau had issued draft rules governing the Colorado River in 1992. This earlier version contained none of the later provisions on conserved water or banking. Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (May 27, 1994).

be banked that would not be the first to spill when flood control releases are required.[219] If they did reach this type of agreement, the parties would want the Bureau's rules to recognize the storage of this water in lower basin reservoirs. The lower basin states and tribes are working with the Bureau to ensure that the Bureau's rules permit the banking plan developed by these parties.[220]

In general, only conserved Colorado River water historically put to beneficial use or non-Colorado River water imported from outside the basin may be banked under the Bureau's draft rules.[221] Conserved river water means both Colorado River water saved as a result of quantifiable conservation measures such as (1) canal lining or (2) the use of non-Colorado River water (e.g., groundwater or a tributary) as a substitute for Colorado River water.[222]

Water that meets the definition of conserved water, and is deposited into the bank, takes on some attributes that facilitate the transfer or marketing of the water. First, approved conservation activities are deemed to be a beneficial consumptive use of water that is charged against the Colorado River entitlement of the conserving party for that year.[223] That is, for the purposes of decree accounting, the conserved water will be deemed "used" in the year conserved.[224] Second, and as a result of the changed character of the saved water, the water becomes non-Colorado River water. Third, the

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[219]Under the Draft Rules, as explained later in this section, banked water sits on top of the reservoir and thus is the first to spill when flood control guidelines require reservoir releases. Draft Colorado River Rules, at § 415.23(e)(1).

[220]Telephone conversation with Gerald R. Zimmerman, Executive Director, Colorado River Board (June 17, 1994).

[221]Draft Colorado River Rules, at § 415.23 (e)(5). The banking of other types of water, for example Colorado River system (not mainstem) water is anticipated by the parties if questions of third party injury could be addressed to everyone's satisfaction. Telephone conversation with Robert W. Johnson, Acting Regional Director, Lower Colorado Regional Office, Bureau of Reclamation (Mar. 4, 1994); and with Gerald R. Zimmerman, Executive Director, Colorado River Board (June 17, 1994).

[222]Id., at § 415.23 (d)(2); and telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (June 8, 1994).

[223]Draft Colorado River Rules, at § 415.23 (h).

[224]See "Deconstructing the Colorado River: Part II," Water Strategist, Vol. 8, No. 1 (April 1994), at 11.

rules provide that the entitlement (which occurs from conservation) is protected from forfeiture or loss from nonuse for a reasonable period of time while the depositor attempts to market or put the water to beneficial use.[225]

Conserved water may be transferred directly (without storage) to another use, or it may be deposited into storage in Lake Mead. In either case, the conserving party must apply to the Regional Director and follow the administrative process for approval discussed below. Once approved, the saved water may be credited to a bank water account under the name of the conserving party, or it may be transferred to another party's account. Before or after transfer to a storage account, the saved water can be marketed intrastate or interstate.[226]

Bank water may be used for any beneficial use including uses that exceed a state's apportionment or existing contract rights. The purchaser need not hold any entitlement to Colorado River water, but the use of the bank water must meet the beneficial use standard of the state in which used.[227]

Water deposited into the bank may be carried over for an indefinite period of time, subject to evaporation charges and the risk of being spilled. Evaporation charges

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[225]Draft Colorado River Rules, at § 415.13 (b)(1)iii). In contrast to the Imperial Irrigation District - MWD arrangement, the rules would make the act of conserving water a beneficial consumptive use. Therefore, junior water rights holders will have no claim to the saved water. Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (May 27, 1994).

Groundwater recharge is not mentioned in the rules as a place for storing bank water. However, since the three lower basins states already define groundwater recharge as a beneficial use of water, transfers to groundwater storage presumably are allowed under the current system as long as all three states and the Bureau are parties to the recharge agreement. It seems that recharge could nonetheless have been made a recognized option under the banking plan. Id., and telephone conversation with Robert W. Johnson, Acting Regional Director, Lower Colorado Regional Office, Bureau of Reclamation (Mar. 4, 1994).

[226]Draft Colorado River Rules, at § 415.23 (c) and (f). Where bank rules seem to allow activities not expressly allowed or prohibited under state law, the Bureau explanation is that the states, by participating in the bank, agree to these rules. Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (May 27, 1994).

[227]See Draft Colorado River Rules, at § 415.12 (b)(1). If the user of bank water returns some of the water to the system after use, it may be administered to fulfill Colorado River entitlements. Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (May 27, 1994).

are based on the *increase* in reservoir surface area attributable to banked water.[228] Banked water is the first to spill in the event flood control guidelines require excess releases from Hoover Dam. If the released water cannot be used by downstream entitlement holders, and results in excess deliveries to Mexico, the banked water would be lost. If some but not all of bank water is spilled, releases would be in the reverse order of deposits, following the "last in, first out" rule.[229]

In practice, long-term bank deposits may be unlikely because of the impact on the quantity of banked water from the evaporation charge and from periodic flood control spills. A recent article projected a severe loss of usable water for every year it remains in the bank, assuming a five percent evaporation charge and flood control releases, on average, every twelve years. For every acre-foot of water deposited into the bank, one year of storage would yield .87 acre-feet. After five years this figure would drop to .50 acre-feet, after ten years it would drop to .25 acre-feet and, after 20 years, the acre-foot would be reduced to .06 acre-feet.[230]

The bank would be managed by the Regional Director, Lower Colorado Region, as part of Lake Mead storage, in consultation with lower basin states and tribes. The rules call for the cooperative development of guidelines for bank administration.[231] Before water is deposited in a bank account, the applicant must enter a contract with the Bureau. The Regional Director is given broad discretion in determining how much water can be banked. For bank transactions involving non-Indian water, the amount of conserved water must be confirmed by a "verification committee" with one representative from each lower basin state and one representative from the Bureau, designated by the Regional Director. For transactions involving Indian water, the committee will include one representative from the Bureau of Indian Affairs, two tribal representatives and one

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[228]Id., at § 415.23 (e)(4).

[229]Draft Colorado River Rules, at § 415.23(e)(1).

[230]Water Strategist, at 11.

[231]Id., at § 415.23 (c).

representative from the Bureau.[232] The verification committee will assess the validity of the projected water savings and otherwise evaluate the feasibility of the conservation proposal.[233]

Concerns about water rights and third party impacts are addressed by a few specific provisions providing the Regional Director with broad discretion in evaluating potential bank deposits. For example, land fallowing, an expressly authorized method for conserving water, is limited to 50-year terms for any given parcel of land.[234] In reviewing applications to deposit water into the bank, the Regional Director may consider any relevant facts, including (1) impacts on other Colorado River entitlement holders; (2) economic impacts on the area from which the water will be saved; and (3) the amount of water consumptively used by the entitlement holder for the preceding 5 years.[235] Additionally, the proposed rules require the applicant, whenever the proposal involves idling lands currently in agricultural production, to submit some plan for the management of the land to control, for example, vegetation, dust, erosion and fire.[236]

According to the Bureau, the draft rules contemplate that injury to other water rights and third parties will be minimal because deposits are limited to "conserved water." Where potential negative impacts are not avoided by this limitation the Bureau has the discretion to impose conditions on the bank transaction to avoid harm, or require mitigation. For example, there is no express limit on the number of acres that may be

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[232]Id., at § 415.23 (g).

[233]Id. Although not required by the draft rules, it is anticipated that a representative technical committee will be established to make findings needed by the verification committee. This technical committee may adopt its own guidelines or rules for calculating historic consumptive use. Telephone conversation with Robert W. Johnson, Acting Regional Director, Lower Colorado Regional Office, Bureau of Reclamation (Mar. 4, 1994).

[234]See Draft Colorado River Rules, at § 415.23 (d)(3). Land idled beyond 50 years could result in the loss of the associated Colorado River water entitlement.

[235]See Draft Colorado River Rules, at § 415.23(d). The Regional Director is expected to consult with representatives of the interested lower basin states and tribes in making this determination. Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (May 27, 1994).

[236]Id., at § 415.23 (d)(4).

fallowed within a given area but, if a proposal is made to fallow a large amount of land, the Bureau could impose such an acreage limitation and/or require the establishment of an economic impact fund to mitigate potential economic harm.[237]

What is the role of the Bureau in marketing bank water? No authority is given in the rules for the Bureau to act as broker or otherwise facilitate transactions. The Bureau would, however, publish a periodic accounting to reflect who holds storage in the bank.[238]

Price is not discussed in the draft rules, so likely would be set between the buyer and seller in each transaction. According to the Bureau, the Regional Director may review the price along with all terms of the agreement, but is unlikely to regulate price. The draft rules generally authorize the imposition of administrative fees. The Regional Director has the discretion to impose additional costs on the parties on a case by case basis to mitigate any negative impacts from the bank transaction. For example, the establishment of an economic development fund might be required, as suggested above, to offset local economic impacts caused by land fallowing.[239]

The Bureau anticipates that the principal purchasers of Colorado River bank water at least initially will be Metropolitan Water District of Southern California and the Las Vegas Valley Water District. Apparently, these entities have already been contacted by agricultural water users wishing to enter some type of agreement to transfer water to the bank.[240]

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[237]Id.

[238]Telephone conversation with Walt Muir, Hydraulic Engineer, Lower Colorado Regional Office, Bureau of Reclamation (May 27, 1994).

[239]See Draft Colorado River Rules, at § 415.21, and telephone conversation with Robert W. Johnson, Lower Colorado River Regional Office, Bureau of Reclamation (Mar. 4, 1994).

[240]Id.

2.5 SURVEY OF OTHER BANKS IN THE WEST

2.5.1 Introduction

To facilitate the identification of water banks or bank-like mechanisms in use in western states, a survey was sent to water administrators in all 17 western states in the fall of 1992. Administrators were asked to describe potential examples that should be considered in this study. A broad definition of water banks was set out in the survey, in order to encourage respondents to consider a wide variety of practices aimed at making water available for alternative uses. Common dimensions of these practices were suggested: (1) water is not permanently changed to a new use; (2) ownership of the water right is not transferred; (3) the party entitled to the use forgoes use of water available under the right in exchange for compensation; and (4) the bank is the mechanism that facilitates the temporary change of use.

Survey responses were generous, both in terms of the number of states responding and in the detailed nature of mechanism descriptions. Moreover, the responses provided valuable insight into how states are attempting to address concerns over the adequacy of their water supply. These administrators' comments reveal that western states are, under various authorities and program titles, increasingly taking a proactive role in bringing about more efficient use of their limited water resources. While many of the mechanisms described in the survey responses are clearly aimed at facilitating the movement of water to other uses (as do water banks), some did not fall within the definition of water banks adopted for our study but are better characterized as water exchanges, short-term transfers, dry-year options, or groundwater recharge programs (discussed in Chapter 3, below). For example, Salt Lake City is able to use high quality water originating in streams on the eastern side of the valley for municipal purposes by substituting lower quality water from Utah Lake to irrigators holding the rights to the cleaner water.[241] Several states authorize the temporary or short-term transfer of water from one water

[241]Letter from Dee C. Hansen, Executive Director, Utah Department of Natural Resources to Lawrence J. MacDonnell, Natural Resources Law Center (Nov. 13, 1992).

user to another but, unlike with water banks, no mechanism is provided for linking willing sellers with willing buyers. Montana law recognizes temporary transfers, and also provides for temporary leasing by the state to supplement instream flows.[242] Finally, some states like Oregon and Montana allow users facing the potential of an inadequate water supply to enter dry-year options. In Oregon, emergency drought provisions allow the state Water Resources Commission to enter agreements with water users whereby the user agrees to forgo use of its available water supply for the duration of the drought in exchange for monetary compensation. The water thus made available to the Commission can be used, for example, to supplement flows for fish migration.[243] Montana, in 1991, amended its laws to allow temporary changes between consumptive uses, described as a dry-year option.[244]

Even among the examples described below that do fall within our definition of a bank, there are significant differences in the way the banks operate. Areas of differences include pricing and price controls, priorities among types of use, and level of governmental oversight. Some programs are strictly regulated by the state while others are controlled by a local entity, sometimes under the umbrella of a state program but in other cases with no specific state involvement. In every program described below, regardless of such differences, a common goal is apparent—to move available water to where it is needed, in an environment of fluctuating and often unpredictable water supply and demand.

2.5.2 State Controlled Storage in Kansas

To assist in the development, management and conservation of domestic and industrial water supplies, the State of Kansas, since the 1970s, has played an active role

[242]Letter from Gary Fritz, Administrator, Montana Department of Natural Resources to Lawrence J. MacDonnell, Director, Natural Resources Law Center (Nov. 6, 1992).

[243]All Oregon information in Letter from Martha O. Pagel, Director, Oregon Water Resources Department to Lawrence J. MacDonnell, Director, Natural Resources Law Center (Dec. 17, 1992).

[244]Letter from Gary Fritz, Administrator, Montana Department of Natural Resources to Lawrence J. MacDonnell, Director, Natural Resources Law Center (Nov. 6, 1992).

in two bank-like programs, the State Water Marketing Program and the Water Assurance Program. The origin of these programs can be traced to Kansas's decision to participate in the 1958 Water Supply Act,[245] a federal law authorizing the allocation of storage space in federal reservoirs to the states for the purpose of providing a domestic water supply. Kansas hoped to increase storage space in federal reservoirs to meet existing and projected municipal and industrial water needs.[246] Municipal and industrial users are the primary beneficiaries under both programs, and the price of the water would likely prevent use by, for example, irrigation users.

2.5.2.1 State Water Marketing Program

This program was adopted in 1974 to carry out the state's intent in purchasing additional storage under the 1958 Act. The program allows municipal and industrial water suppliers to purchase water from one of ten federal reservoirs located through the state. The state, through the Kansas Water Office, acts as facilitator and regulator of the use of the water.

The Kansas Water Office operates the program under broad statutory authority. The agency may contract with water purchasers for the sale of water from any reservoir included in the marketing program. Prospective purchasers (including individuals, partnerships, organization, association, private or public corporation, and any political subdivision or agency of the state) initiate the process by filing an application with the Water Office. There is no fee for the application. A contract between the Water Office and the purchaser is then negotiated (usually upon initiation by the applicant) generally addressing several details, including the duration of the contract and the withdrawal schedule. These contracts are generally long-term (40 years), although shorter terms are possible. Short term sales under this program have been negotiated as "surplus water"

[245]Water Supply Act of 1958, 43 U.S.C. § 3906 (1988).

[246]Kansas Water Office, 1991 Annual Report, Water Marketing Program, Water Assurance Program and Multipurpose Small Lakes Program, at 1.

contracts, limited to a term of less than one year and subject to water availability.[247] During drought years, surplus contracts have been entered with irrigation users.[248] All contracts negotiated through the Kansas Water Office must ultimately be approved by the Kansas Water Authority and by the State Legislature.[249]

Water rates are calculated each year based on statutory and regulatory guidelines.[250] Regardless of how much water the purchasers actually use, they must contractually agree to a "take or pay" provision. Municipal and industrial users must pay at least 50 percent of their contracted amount each year. The rate for short term contracts with irrigation users may go as high as 80 percent. In addition, the purchaser is assessed a modest fee for "holding" water contracted for but not used.[251]

Activity under this program has been strong. As of August 1994, there were 30 active contracts representing a total of 27.5 billion gallons of water per year. An additional 44 active applications are on file.[252]

2.5.2.2 Water Assurance Program

The Water Assurance program, established in 1986, was undertaken by the state to fill a need not being met by the state marketing program. The marketing program requires a long-term financial commitment for a water supply from a specific reservoir and, under many circumstances, a water supplier only needs "extra" water during low flow

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[247] Kan. Stat. Ann. § 82a-1305(b) (1989); see also, Kansas Water Office, "Water Marketing Program," Fact Sheet No. 8 (Jan. 1993).

[248] Telephone conversation with Terry Duvall, Policy Consultant, Kansas Water Office (Sept. 27, 1993).

[249] John C. Peck, "Legal Aspects of Water Storage in Federal Reservoirs in Kansas," 32 Kan. L. Rev. 785, 826 (1984).

[250] Kan. Stat. Ann. § 82a-1306 (1989).

[251] Telephone conversation with Terry Duvall (Sept. 27, 1993).

[252] Telephone conversation with Terry Duvall (Aug. 16, 1994). The application represents more of a request to negotiate for water in a particular reservoir, and does not reflect a firm request for a specific quantity of water.

or drought periods.[253] The Water Assurance Program allows for coordinated operation of state-owned or controlled water storage space in federal reservoirs in a designated basin to satisfy downstream municipal and industrial rights during these drought times.

As with the marketing program, the Kansas Water Office is authorized to enter into contracts with the federal government for storage space to be used for water assurance. Unlike the marketing program, however, water users downstream from the reservoir must organize into "Assurance Districts" according to specific statutory guidelines before they can contract with the Water Office for an "assured" water supply. Once a district is formed, participation is mandatory for all eligible water right holders. Like an irrigation district, the assurance districts can levy assessments against district members to cover costs for acquiring, operating and maintaining water supply storage.

While the activity under this program seems to be at a lower level than activity under the marketing program, the assurance program may fill a need for some areas of the state. A 1985 MOU with the Department of the Army gives the Water Office the first purchase option for additional storage in nine reservoirs. Also, in 1989, the Water Office and the Kansas River Basin Water Assurance District No. 1 (KWAD No. 1) entered a contract for storage in three reservoirs in the Kansas Basin. This same district requested the set aside of 60,400 acre-feet of storage in Milford, 13,850 acre-feet in Tuttle Creek, and 15,000 acre-feet in Perry, each with specific dates for the district to exercise its option to purchase this additional storage. The following year, in 1990, KWAD No. 1 negotiated a contract with the federal government for 27,500 acre-feet of storage space in Tuttle Creek Reservoir, and used 55,000 acre-feet from Milford Reservoir, and 25,000 acre-feet from Perry Reservoir.[254]

[253] Kan. Stat. Ann. §§ 82a-1330 et seq. (1989).

[254] Apparently, there is no law preventing districts from entering contracts directly with the federal government rather than through the state, but in general the state can obtain the storage at a lower price because of a contract with the Army Corps of Engineers that sets the price. Additionally, while the districts may not want the state to act as middleman in the transaction, the state is in a better position to more efficiently use the water in the entire basin, by working with more than one reservoir in the basin. Telephone conversation with Terry Duvall.

Two additional assurance districts have been formed since 1989. In 1990, a district was formed in the Marais des Cygnes Basin in eastern Kansas and involving water supply storage in Melvern and Pomona lakes. Kansas has a small contract with the federal government for storage in Melvern Lake, but more storage is needed. Before the state will negotiate additional storage, the district needs to decide how much storage they need. A third assurance district, in Neosho Basin, was formed August 31, 1993, and covers the central and southeastern part of the state. There are some state contracts in place for storage in the basin's reservoirs, but additional contracts and additional storage are anticipated. With the forming of the Neosho Basin District, about one-third of the state is now covered by a water assurance district.[255]

2.5.3 Water District Banks

In contrast to the state-level Kansas and Texas banks discussed above, a few survey respondents pointed out the existence of banking programs established on a more local level, both politically and geographically. Virtually all irrigation water supply organizations in the West allow informal seasonal trading of water to occur among users within the system. A few districts have established more formal structures for managing these transactions. Two such examples are discussed here.

2.5.3.1 The Dolores Project Bank

This bank, known as the Dolores Water Conservancy District (DWCD) Water Bank, began operating in 1991.[256] The Dolores District holds rights to 55,200 acre-feet of Dolores River water stored in McPhee Reservoir—a Bureau of Reclamation project. The district serves 27,981 acres of irrigated land in southwestern Colorado.

The purpose of the bank is to let water move around (or rotate) within the district rather than assigning a specific quantity of water to each user in the service area. Each

[255]Telephone conversation with Terry Duvall.

[256]Information on the Dolores Water Bank provided by John Porter, Manager, Dolores Water Conservancy District, and handouts provided by same (1993).

user is allocated a specific amount of water based on the number of irrigable acres and, while the user can use more or less than this amount, the cost of the water is tied to this allocation. The underlying premise of the bank is that irrigators, while raising different crops at different times, will not individually practice the ideal rotation (the ideal rotation for their allocation of 20.5 inches or 1.71 acre-feet per acre, would be 55 percent alfalfa, 20 percent small grains, 15 percent pinto beans, 7 percent corn silage and 3 percent pasture). Some will raise mostly alfalfa, while others will raise mostly grain and/or beans. The amount of water each irrigator actually uses can vary from year to year, depending on what crops are grown. Thus, the banking concept as applied here is expected to give district managers more flexibility, meet the demands of all crops, increase crop production, save water, and provide financial incentives to irrigators.

The pricing of project water is meant to encourage water conservation. The irrigator only pays for water used, even if this is less than the allocated amount. Additionally, the price of water used in excess of each user's baseline allocation is higher than the price for water used within the allocated amount. The revenues collected for amounts used over the allocation are pooled and paid to irrigators using less than the allocated amount. Thus, irrigators using less than their allocated amount pay less than the base price of the standard water allocation, and they also receive a "bonus" from the money taken in for excess use by others. In 1991, the first year the bank was in operation, this amounted to an average of $ .65 per acre-foot. The district's repayment obligation to the Bureau of Reclamation is a set fee based on the allocation to each user, and is assessed separately from water user fees.

Water not needed by one irrigator in the district can be pooled and moved to other irrigators who may be raising more water intensive crops. Twenty-four hours notice is required to change water delivery patterns. There is a limit to how much excess water can be purchased through the bank—no more than 28 inches per acre (approximately 2 1/3 acre-feet per acre). Irrigators who are approaching this limit are notified during the irrigation season.

Implementation has begun in the Dolores Bank, but the project is not yet completed, so all lands are not yet serviceable. In 1991, 30,487 acre-feet was available to

17,620 acres, although only 91 percent, or 27,695 acre-feet, were actually used. The balance, 2,792 acre-feet, was carried over in the reservoir for 1992. Excess water use, amounting to 1,818 acre-feet of water, generated $3,003 in fees that were refunded by those irrigators using less (in all, 4,592 acre-feet less) than their allocation (an average of 65 cents per acre-foot refunded). There was less use of the water bank in 1992, because it was a wet year. Irrigators used 25,293 acre-feet (70 percent of the available supply) on 19,815 acres of land. Excess use was small (only 228 acre-feet) and underuse was high (11,042 acre-feet), reducing the refund to underusers to $.00284 per acre-foot.

2.5.3.2 District banks in Washington State

Two banking programs were described in the survey response received from Washington.[257] One of three districts in the Columbia Basin Irrigation Project, the East Columbia Irrigation District, operates a small-scale bank. It was described as a pilot project, with only nine participants and 3700 acres involved.[258] The "participants" seem to be the parties needing water; the process requires the participants to approach other water users holding a "full service" water right who may have "excess" water due to improvements to their irrigation system and/or a change in cropping pattern to a crop requiring less water. Within some limitations, the party with the full service right may transfer some of this water to one of the nine participants.

[257]Letter from Hedia Adelsman, Program Manager, Water Resources, Washington State Department of Ecology to Larry MacDonnell, Natural Resources Law Center (Dec. 15, 1993). The other example is a water pooling program of the Roza Irrigation District in the Yakima River Basin.

[258]Telephone conversation with Richard Erickson, East Columbia Irrigation District (Mar. 1993).

Chapter 3

GROUNDWATER RECHARGE AS A WATER STORAGE AND SUPPLY OPTION

This section describes the practice of artificial groundwater recharge as an alternative or supplement to surface water development, provides an overview of state programs aimed at encouraging this practice, and describes several examples of groundwater recharge projects now underway. "Groundwater recharge" is a broad term that includes a variety of techniques to augment natural underground water reservoirs through direct and indirect means. Not all of the examples discussed below fit easily into the "water bank" model, but they share many characteristics with the surface water banking arrangements that are the focus of this report.

3.1 INTRODUCTION TO GROUNDWATER RECHARGE

Water occurring in underground reservoirs may be derived from natural or artificial sources. Natural groundwater recharge comes from percolating rainfall or streamflows. Natural recharge may be supplemented incidentally by irrigation and wastewater discharges, or by conscious efforts through use of spreading basins, injection wells, and other artificial recharge efforts. The following discussion focuses on artificial groundwater recharge through projects designed for that purpose.

Artificially recharging groundwater reservoirs may be more attractive than constructing surface water storage and/or delivery systems because, compared with surface water reservoirs, groundwater reservoirs have lower evaporation rates, require no construction, often have large storage capacities, generally do not interfere with surface land uses, are less subject to contamination and drought, and typically are more cost-effective and efficient.[1] In addition to storing water for future use, artificial groundwater

[1]Edward T.Oaksford, "Artificial Recharge: Methods, Hydraulics, and Monitoring," in Asano, Takashi, ed. Artificial Recharge of Groundwater 69, 70 (Boston: Butterworth Publishers, 1985); Bradley M. Crowder, and Anthony G. Willardson, "Artificial Recharge and Conjunctive Use: Benefits and Costs of

recharge is used to: counteract saltwater intrusion in coastal areas, and for salinity control in areas with naturally occurring poor quality water; maintain or restore declining groundwater tables, thus preventing land subsidence or the necessity of drilling deeper wells; and improve water quality through the natural filtration that occurs as water percolates from the surface downward.[2]

The two major categories of artificial groundwater recharge are direct surface and direct subsurface techniques. Direct surface water recharge approaches–in which water is applied to the surface of the soil and allowed to percolate downward–include the use of flooding, spreading basins, stream channel modification, and similar methods to apply water to land areas in which it can move quickly and directly to an underground reservoir. Although these are the most common types of artificial groundwater recharge methods, they require particular conditions: permeable soils and no impeding layers between the surface and the underground reservoir (an "unconfined" aquifer).[3] They may also require dedication of large areas of land on the surface on which spreading may occur, and certain direct surface recharge techniques (such as spreading or flooding) require relatively flat land.

Direct subsurface recharge approaches, on the other hand, are more appropriate in the following situations: in areas in which the surface land is separated from the underground reservoir by an impermeable or nearly impermeable layer of rock or clay (a "confined" aquifer); where the depth from surface to the groundwater is significant; or when there is a scarcity of appropriate land surface on which to apply water for recharge. Subsurface methods of recharge include injection wells, shafts, and other techniques that convey water directly from the surface into an aquifer. Because the water is introduced

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Groundwater Recharge in the Western United States," in Mary G.Wallace, ed. Abstracts of the AWRA 29th Annual Conference 255 (Bethesda, MD: American Water Resources Association, Tech. Pub. Series TPS-93-3, 1993).

[2]Oaksford, supra at 71.

[3]Margaret P.O'Hare, Deborah M. Fairchild, Paris A. Hajali, and Larry W. Canter, Artificial Recharge of Groundwater: Status and Potential in the Contiguous United States 10 (Chelsea, MI: Lewis Publishers, 1986).

underground without the filtration that occurs during percolation, the quality of injected water is very important.[4] Not only can contaminants be introduced with the injected water, but common constituents, such as calcium carbonate, in the injected water can react with the naturally occurring groundwater or the aquifer material and clog the aquifer or well. Although generally more expensive than direct surface recharge,[5] subsurface approaches offer several advantages: water may be stored deeper underground, and less surface land need be disturbed or dedicated for groundwater recharge.[6] Injection wells and other direct subsurface recharge techniques are commonly used in urban settings.

In addition to direct surface and subsurface recharge approaches, groundwater management goals may be achieved through indirect recharge techniques. For example, groundwater may be pumped out of an underground reservoir that is hydrologically connected to a surface water supply, so additional surface water is drawn into the groundwater reservoir. Underground barriers may be used to obstruct natural groundwater flow (retaining an artificially high groundwater table in an area in which the groundwater normally would discharge to another basin or to the surface, for example) or to impede the intrusion of saltwater in coastal areas.[7] In some instances, barriers have been used to create small artificial aquifers, suited to capture seasonal surface water runoff and to provide storage free from evaporation or contamination.[8]

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[4]Oaksford, supra at 81.

[5]Crowder et al., supra at 255.

[6]Oaksford, supra at 87.

[7]Oaksford, supra at 87-90.

[8]Oaksford, supra at 92.

3.2 WESTERN STATE PROGRAMS CONCERNING GROUNDWATER RECHARGE

The state-by-state summaries that follow were compiled from a variety of sources. Research began with state statutes and a 1990 report by the Western States Water Council.[9] To obtain more information on administrative as well as legislative approaches, and on groundwater recharge as an aspect of water banking, state personnel were contacted. In some instances, these contacts directed inquiries to people involved in local projects. Because the development of state legislative and administrative policies often begins with local projects, selected local examples have been included in the following summaries.

We may draw a few conclusions from this information. First, only four western states identified so far–Arizona, Nevada, Utah, and Oregon–have comprehensive groundwater statutes that include groundwater recharge. At least six others, including California, Idaho, Kansas, Montana, Nebraska, and Oklahoma, explicitly recognize groundwater recharge in their groundwater statutes, but lack a comprehensive statutory treatment. California has many recharge projects, but they are locally regulated, rather than by a comprehensive state statute. Second, despite the general lack of statutory provisions, at least 13 western states–Alaska, Arizona, California, Colorado, Kansas, Montana, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Texas, and Utah–have local groundwater recharge projects in operation or at least have attempted to implement groundwater recharge demonstration projects. Third, several states' groundwater laws–including New Mexico and Wyoming–present obstacles to groundwater recharge efforts, as they recognize no right to recharged groundwater.[10]

In some states, such as Idaho, groundwater recharge is a very hot topic, and overall, groundwater recharge is receiving increasing attention. Frequently it appeared that states were borrowing current laws, such as surface water appropriation permitting

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[9]Western States Water Council, Ground Water Recharge Projects in the Western United States (1990) [hereinafter "WSWC"]. This report was prepared for the Bureau of Reclamation, Denver, Colorado.

[10]Other states may have this problem, but these are the ones whose statutory provisions or regulations make the obstacle obvious.

procedures, and applying them to recharge projects if they arose. In almost every case, the details of how to regenerate groundwater recharge, where the aquifer would be used as a water storage bank, have not been fully settled.

If comprehensive state programs exist, they generally contain two elements, one addressing the quantity of water available for recharge and subsequent withdrawal and another addressing the quality of water used in recharge projects. The quantity element of state programs usually involves a two-step permitting process--one permit to recharge and one to withdraw. The quality element of state programs is significantly influenced by over-arching federal requirements, particularly those of the Environmental Protection Agency's injection well program, although the state may impose additional requirements as well.

3.2.1 Alaska

The state has not developed any specific statutes or regulations for control of groundwater recharge projects. According to personnel in the Department of Natural Resources, one would need a permit to appropriate from a creek and would also need to have a groundwater right.[11] One recharge project was attempted in Anchorage, and the results were reported as part of a U.S. Geological Survey paper.[12] Unfortunately, the results were not positive: a gravel pit was used as the recharge site, but elevated groundwater levels at a nearby development were attributed to the recharge project. Also, differentiation of the impact of seasonal fluctuations was difficult.

3.2.2 Arizona

Significant and comprehensive procedures for starting and maintaining groundwater recharge programs have been authorized by statute.[13] The statute, enacted

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[11]Alaska Stat, § 46.15.030, .040, .065, .080, .120 (1991).

[12]William Meyer, Effects of Artificial Recharge Experiments at Ship Creek Alluvial Fan on Water Levels at Spring Acres Subdivision, Anchorage, Alaska, USGS Open-File Report 80-1284, 1980.

[13]Ariz. Rev. Stat. Ann. §§ 45-801 - 818 (1987 & Supp. 1993).

in 1986 and amended in 1987 and 1992, authorizes projects designed to store water underground for later withdrawal. The projects are operated pursuant to permits issued by the Director of the Department of Water Resources. Permits must be obtained for both the storage of the water and recovery of the water.[14] Both permits are submitted to a public process by which interested parties are notified and have an opportunity to raise objections to the issuance of the permit.

Groundwater storage permits, known as "underground storage and recovery project permits," are issued if the applicant can show the following: (1) technical and financial ability to operate the project; (2) a right to use the proposed recharging source of water; (3) the project is hydrologically feasible (a detailed hydrologic study must be submitted with the permit application); and (4) the project does not unreasonably harm other land, water users, or any other groundwater supply. The applicant must also show that he or she has separately applied for a water quality permit.[15]

Aquifer water quality is protected by the Arizona Department of Environmental Quality's aquifer protection program. Water quality may not fall below drinking water standards, or, if the aquifer is of a higher water quality than the drinking water standards, the groundwater cannot be degraded below that higher level.[16]

As mentioned, to recover the water, a recovery well permit must also be obtained from the Director (permits can be applied for and decided upon at the same time). To obtain this permit, one must demonstrate that the recovery of stored water will not unreasonably increase damage to surface land or water users. Additionally, the applicant must establish a right to use the well.[17] Recovered water can only be used in a manner in which the applicant had a right to use the water before it was stored underground.[18]

[14]Ariz. Rev. Stat. Ann. §§ 45-804, 807 (Supp. 1993).

[15]Ariz. Rev. Stat. Ann. § 45-804(B) (Supp. 1993).

[16]WSWC at IV-22, citing Arizona's response to WSWC's groundwater recharge questionnaire. See also Ariz. Rev. Stat. Ann. §§ 45-804 (F) (Supp. 1993), 49-243 (C) (1988).

[17]Ariz. Rev. Stat. Ann. § 45-807(B) (1988).

[18]Ariz. Rev. Stat. Ann. § 45-808 (Supp. 1993)

The Director accounts for stored groundwater through a detailed debit and credit storage account system. Water credits are limited to an amount the individual "could not reasonably have used directly."[19] Debits are generally recorded at 105 percent of the amount stored, in order to account for expected losses in storage.

The storage permit fee is expensive,[20] while the recovery permit fee is modest.[21] Fifteen permits have been issued as of February, 1994, but only twelve are currently active. Three were short-term projects where the permit has expired. A separate statute provides for a groundwater recharge program which grants permits to recharge groundwater, but does not provide for recovery.[22]

3.2.3 California

Of all the states surveyed, California has the largest number of groundwater recharge projects underway. Several are described in the case studies below. However, California does not have state-wide, comprehensive legislation governing the operation of recharge and withdrawal programs. The regulation or oversight of these types of projects are handled at the local level and vary significantly in terms of form and extent of governance.

There are twenty-two different types of water districts authorized by statute.[23] Although all the districts have certain general powers, some districts have gone back to the legislature and received specific authorizations for broader power. As a result, the

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[19]Ariz. Rev. Stat. Ann. § 45-809(c)(2) (1987 & Supp. 1993); that phrase is defined in many different ways.

[20]The storage permit fee is $1,000 for the original application fee, $500 for the permit fee, and an additional $300 if a conveyance is involved. Telephone conversation with Rosemary Lopez, Arizona Department of Water Resources (Feb. 2, 1994).

[21]The recovery permit fee is $50 for the first ten wells to be used and an additional $10 for every well over the first ten.

[22]Ariz. Rev. Stat. Ann. §§ 45-651 - 655 (1987 & Supp. 1993).

[23]Flood control districts, water storage districts and storm water districts are examples. E.g., Cal. Water Code App. § 13-2 (Supp. 1994) (storm water district); Telephone conversation with Karl Hauge, Director of Local Assistance, Department of Water Resources (Feb. 14, 1994).

local governing entities which could oversee a groundwater recharge and withdrawal project are very different throughout the state.[24] Additionally, in fourteen overdrafted basins all the groundwater rights have been adjudicated by court decree, and the governing district is constrained by the decree.[25]

Orange County Water District, for example, has expansive power, including the regulation of storage and use of groundwater within the District.[26] The District itself operates massive groundwater recharge and withdrawal programs for water conservation and for prevention of seawater intrusion into the aquifer.[27] The District runs its own, extensive, groundwater quality monitoring program.[28]

Although local agency control is very different across the state, there are some rules which are uniform. Protection of the right to withdrawal of recharged water is a statewide protection. A 1975 Supreme Court decision, City of Los Angeles v. City of San Fernando,[29] established a right to reclaim water which had been imported to the Los Angeles basin from the Owens River and other sources and had seeped into the aquifer as return flow. The Court recognized that the water commingles with natural groundwater, but that the right to recapture it is not dependent upon being able to physically identify it.[30] Some of the water to which a withdrawal right attached had also reached the aquifer by intentional spreading, a common recharge technique.[31]

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[24]Hauge, supra.

[25]Hauge supra; Groundwater Rights in California, Governor's Commission to Review California Water Rights Law, Staff Paper No. 2 (July 1977) citing Pasadena v. Alhambra, 207 P.2d 17 (1949).

[26]Cal. Water Code § 40-2 (West 1971 & Supp. 1994).

[27]"Groundwater Recharge Activities," (information paper produced by the Orange County Water District, not dated).

[28]Martin G. Rigby Ph.D., et al., "Groundwater Recharge with Reclaimed Water: Resolving Regulatory Issues" (information paper produced by the Orange County Water District, not dated).

[29]537 P.2d 1250, 1296, 1297 (Cal. 1975).

[30]Id.

[31]Id.

Another example of a uniform rule involves the use of reclaimed water. If a district was going to use reclaimed water to recharge the aquifer, it would have to get a permit from the California Regional Water Quality Control Board which governed its geographic area.[32] The permit required approval from the State Department of Health Services. However, with any other water supply, such as river water, there is no standard permitting requirement.[33]

Lastly, California has passed several major funding bills which encourage and provide financing to groundwater recharge and storage programs.[34]

3.2.4 Colorado

There is no comprehensive groundwater recharge statute that addresses storage and recovery of groundwater, although large recharge and withdrawal projects do exist. The Colorado Division of Water Resources has jurisdiction over groundwater. However, the state does not issue recharge permits. It does issue well permits for the withdrawal of groundwater. Permit requirements include proof of non-injury to vested water rights and the availability of unappropriated water.[35]

A party's ownership of the recharged water is a point of controversy. The Division of Water Resources maintains that one cannot obtain a groundwater storage right because underground water movement is unknown and therefore a party could not

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[32]Porter-Cologne Water Quality Control Act, Cal. Water Code § 13223 (1992) (Regional Board has authority to govern "waste discharge"). Telephone conversation with William Crooks, Central Valley Regional Water Quality Control Board (Feb. 16, 1994).

[33]But see, State Water Resources Control Board Order No. 68-16 which allows the Board to prohibit recharge if it degrades water quality. However, application of the policy to river water is unclear. Telephone conversation with Ken Harris, State Water Resources Control Board (Feb. 1994).

[34]Cal. Water Code §§ 12925 et seq., 13450 et seq., and 12879 et seq. (West 1992).

[35]Colo. Rev. Stat. § 37-90-137 (2) (1990 & Supp. 1993); Colorado distinguishes four different types of wells that require permits. These requirements are for non-exempt wells which would most likely be used in the recharge and withdrawal process. Telephone conversation with Jody Grantham, Administrative Officer, Division of Water Resources, Colo. Dept. of Natural Resources (Mar. 8, 1994).

prove dominion and control of the water.[36] Others, including the Willows Water District, have recently proposed rules and regulations to the state legislature to establish ownership rights which get away from the surface water concept of dominion and control.[37]

Groundwater quality is not protected by statute. The protection rests with the individual entity carrying on the project. Any recharge achieved by injection wells, however, must be accompanied by an EPA permit.

3.2.5 Hawaii

There are no specific statutes or regulations for control of groundwater recharge.

3.2.6 Idaho

No comprehensive statutes or regulations for the recharge and recovery of groundwater exist in Idaho. A special legislative committee, known as the Committee on Aquifer Recharge, was appointed to develop legislation that would facilitate artificial recharge. Some of the bills the Committee proposed were defeated in the legislature because of concerns regarding the impact on existing water rights. However, as a result of the Committee's work, a resolution was adopted by the legislature that declared artificial recharge to be in the public interest, called for public expenditures to construct recharge facilities, fund hydraulic studies and conduct education programs regarding artificial recharge.[38] The resolution also called for the creation of legal mechanisms to develop artificial recharge credits, recharge banking, and the protection of existing water rights. Additionally, recently developed administrative rules for the conjunctive

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[36]Grantham, supra. The Division adopts the concept of "dominion and control" from a surface water statute, § 37-82-106, as interpreted by City and County of Denver Bd. of W.C. v. Fulton Irr. D. Co., 506 P.2d 144 (Colo. 1972), which allows an owner to make a succession of uses of water if the water can be distinguished from the remaining water in the aquifer.

[37]Telephone conversation with Bruce Lytle, Sr. Project Engineer, Halepaska and Associates, Littleton, Colorado (groundwater engineering firm working with Willows Water District) (Feb. 1994).

[38]S. Con. Res. 140, 52nd Leg., 2d Sess. Idaho (1994).

management of surface water and groundwater encourage artificial recharge.[39] Since organized, artificial recharge and recovery rules and programs are in their development stage in Idaho, there are many concerns regarding the impact to existing water rights, conservation efforts, and instream needs which must be addressed.

3.2.7 Kansas

Kansas has no specific statute regarding groundwater recharge, although groundwater recharge is recognized as a beneficial use of water in the State Division of Water Resources administrative regulations.[40] The City of Hays currently has a major recharge and withdrawal program ready to go, but complications over funding and state water rights regulations have put the project on hold. The project would use the City's treated wastewater as its water source. State water right regulations are also an issue for the City of Wichita's newly proposed recharge and withdrawal program, which would use floodwater as its water source. The Department of Health and Environmental Regulations would have monitored the quality of recharge water under the current groundwater standards.[41]

3.2.8 Montana

This state has not developed any statutes or regulations governing groundwater recharge and withdrawal, except for a provision that encourages the use of water for

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[39]Idaho Admin. Code tit. 3, ch. 11 (draft, Feb. 7, 1994, obtained from Idaho Department of Water Resources, Boise, Idaho). The rules were prompted by a law suit initiated by a Snake River surface water right holder claiming that excessive groundwater pumping was depleting the river and affecting his rights. See Musser v. Higginson, 871 P.2d 809 (Idaho 1994). Artificial recharge is included in the rules as an acceptable form of mitigation for the groundwater pumping. Telephone conversation with Dick Sculley, Idaho Department of Fish and Game, and Ron Carlson, Snake River Watermaster (April 8, 1994).

[40]WSWC, supra at IV-40.

[41]Telephone Conversation with Mr. Hannes Zacharias, City Manager, City of Hays, Kansas (Dec. 16, 1993).

groundwater recharge.[42] One unique demonstration project exists in which snow is captured by wheat grass, grown next to a fallowed field. The snowmelt is allowed to sink down into the aquifer for later withdrawal by irrigators.[43] A state groundwater policy committee is being formed.[44]

3.2.9 Nebraska

There is no significant groundwater recharge and withdrawal legislation in Nebraska.[45] You can get a surface water permit from the Department of Water Resources to divert water to recharge underground aquifers, but withdrawal is not generally regulated, except in one overdrafted basin.[46]

3.2.10 Nevada

In 1987 Nevada enacted a groundwater recharge statute and gave the State Engineer authority over all recharge/recovery projects.[47] The legislation is almost identical to Arizona's statutory requirements. In order to operate an underground storage and recovery project, a person must obtain a project permit (storage permit) and

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[42]Mont. Code Ann. § 85-2-101(3) (1991): "The state encourages the development of facilities which store and conserve waters for beneficial use . . . and for ground water recharge."

[43]U.S. Bureau of Reclamation, High Plains States Groundwater Demonstration Program 37 (Interim Report, Oct. 1992).

[44]Montana Water Plan; Integrated Water Quality and Quantity Management Section, Water Resources Division, Department of Natural Resources and Conservation, Helena, Montana, p. 8 (Nov. 2, 1992). Telephone conversation with Kirk Warren, Montana Department of Natural Resources and Conservation (Oct. 8, 1993).

[45]One peculiar statute seemingly recognizes groundwater recharge as a beneficial use and establishes a right to the recharged water, but the legislation is misleading. It was actually enacted to protect irrigators' rights to water that had seeped from their delivery canals into the aquifer and was then pumped from the ground and used by them to irrigate their land. This legislation re-established the irrigators' rights to the water lost through seepage after it had been canceled for non-use. Telephone conversation with Don Blankenall, Legal Counsel, Nebraska Department of Water Resources (Dec. 16, 1993).

[46]Blankenall, supra.

[47]Nev. Rev. Stat. Ann. §§ 534.010 to .340 (1991 & Supp. 1993).

a recovery well permit from the State Engineer. The Engineer will issue the storage permit if the person demonstrates: (1) that the project is technically, financially, and hydrologically feasible; (2) that the applicant has a right to use the proposed source water; and (3) that the project will not cause harm to users of land, or other groundwater.[48] The application fee is $2,500.[49] The permit is submitted to a public process by which notice is given and any adversely affected party may protest.[50]

A recovery well permit adds no significant requirements to the process, since an applicant must have a storage permit to receive a recovery permit. Additionally, recovered water can only be used in a manner in which the applicant was previously able to use the water.[51] A storage account is established, and a person may only recover that amount of water which has "reached the aquifer and remains within the area of active management."[52] There are twelve to fifteen groundwater recharge projects underway in the state, primarily near population centers such as Las Vegas, Reno, and Carson City.

3.2.11 New Mexico

This state has no specific statutes or regulation for control of groundwater recharge projects. According to personnel at the State Engineer's office, no projects are ongoing, which probably reflects the lack of protection for water users who artificially recharge an area. At present, such users have no assurance they will able to retrieve an amount equivalent to the quantity of water injected.[53]

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[48] Id. at § 534.250.

[49] Id. at § 534.260 (1).

[50] Id. at § 534.270.

[51] Id. at § 534.290.

[52] Id. at § 534.300.

[53] Telephone conversation with George Shaw, Water Rights Division, New Mexico State Engineer's Office (Mar. 11, 1993).

3.2.12 North Dakota

This state does not have any comprehensive statutory provisions for groundwater recharge projects, nor does it specifically recognize groundwater recharge as a beneficial use.[54] A couple of small recharge and withdrawal projects are underway. Each recharge project is reviewed for feasibility by the State. This review includes operational and financial feasibility, impact to water quality and water levels of the aquifer, and impact to surface water rights.[55]

3.2.13 Oklahoma

This state has no comprehensive groundwater recharge statute. The Oklahoma Water Resources Board, which has statutory authority over the appropriation of surface and groundwater rights and water quality, issues permits for use of surface water to recharge an aquifer (at least one permit has been issued so far).[56] The Board has designated artificial recharge as a beneficial use.[57] There are no special requirements to use the appropriated water for recharge purposes, however. Rights to the recharged water are protected to the extent that the party can request a withdrawal permit for the amount "believed to be reasonably recharged." This amount is estimated by the applicant.[58] The party, however, must demonstrate the ability to recharge the amount withdrawn.

Water quality of the aquifer is generally protected by the state Pollution Remedies Act, and recharge wells are treated as Class V injection wells under the state underground injection control program, and must comply with those regulations.

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[54]N.D. Cent. Code §§ 61-04-01 -32 (1985 & Supp. 1993).

[55]Letter from William Schuh, Hydrologist, North Dakota State Water Commission (Aug. 3, 1993).

[56]Okla. Admin. Code § 785: 30-13-8. Telephone conversation with Bob Fabian, Oklahoma Water Resources Board (Aug. 24, 1993).

[57]Fabian, supra. Okla. Admin. Code § 785:20-1-5.

[58]WSWC at IV-75.

Additionally, a party cannot commit waste in using water to recharge an aquifer.[59] Little monitoring occurs, however.

There is one major demonstration project in Southwest Oklahoma which was begun in 1968 by local water users as a salinity control measure and involves over 40 active injection wells. The project is being studied by the state with funding from the Bureau of Reclamation to determine if the concept can be repeated elsewhere.[60]

3.2.14 Oregon

This state has a statute which addresses appropriation of water for groundwater recharge projects.[61] Such an appropriation is declared to be "for a beneficial purpose," and the permit for such an appropriation is subject to the same provisions as other surface water appropriations.[62] Protection of the artificially stored water is apparently provided in § 135(2), which sets forth the requirements for a "secondary permit" to use the artificially stored water. This "secondary permit" includes the written consent of the "holder of the recharge permit or certificate to appropriate the artificially recharged water."[63]

The statute requires that the Water Resources Commission "develop standards" for the primary appropriation permit and specifically requires the Commission to consider "the public interest."[64] Additionally, "The Water Resources Commission shall not issue a groundwater recharge permit unless the supplying stream has a minimum perennial stream flow established for the protection of aquatic and fish life."[65]

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[59]Okla. Admin. Code § 785: 30-13-8.

[60]Fabian, supra.

[61]Or. Rev. Stat. § 537.135 (1988).

[62]Or. Rev. Stat. § 537.135(1) (1988).

[63]Or. Rev. Stat. § 537.135(2) (1988).

[64]Or. Rev. Stat. § 537.135(3), (4) (1988).

[65]Or. Rev. Stat. § 537.135(5) (1988).

Two groundwater recharge projects are operational. Another project is on the verge of becoming operational, and another is in the planning process. Of these four operational or planned projects, two benefit municipalities and two benefit irrigation districts which were formed specifically to manage the project.

3.2.15 South Dakota

Groundwater recharge and withdrawal is not expressly recognized in the statutes as a beneficial use, but two pilot projects have been issued permits by the Division of Water Rights.[66] Otherwise, no significant legislation or regulation exists addressing groundwater recharge and withdrawal. The City of Sioux Falls and the City of Huron have been issued permits by the Division of Water Rights. The permits, however, are very loosely constructed. For example, under the permits, both cities have a right to withdrawal "the amount they put in, minus losses."[67] Water input and water loss is not measured or monitored in any way. There is no protection of water ownership in the aquifers. The permits, however, were subject to receipt of an underground injection permit from the EPA. No problems have arisen, so there has not been a need to develop the specifics.[68]

3.2.16 Texas

Although Texas does not have comprehensive legislation governing groundwater recharge and withdrawal, Texas does have several major demonstration projects underway. All require a standard water appropriation permit from the Texas Natural Resources Conservation Commission, but no special permitting process exists.[69]

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[66]S.D. Codified Laws Ann. § 46-1-6(3) (Supp. 1993).

[67]Telephone conversation with Mr. Eric Grontund, South Dakota Division of Water Rights (Dec. 16, 1993).

[68]Id.

[69]Telephone conversation with Tony Bagwell, Division Director, Texas Water Resources Planning Division (Dec. 1994).

3.2.17 Utah

Utah enacted comprehensive legislation governing groundwater recharge and recovery in 1991.[70] Like Arizona, Nevada and Oregon, Utah has a two-tiered permit system. A person needs a permit to recharge water and a separate permit to recover the stored water.[71] A recharge permit is issued if the applicant has a valid water right, demonstrates the financial and technical capability to recharge, and shows that the project will not cause unreasonable harm to land, other existing water rights, or the water quality of the aquifer.[72] The State Engineer determines on a case-by-case basis how much water has reached the aquifer and can therefore be withdrawn.[73] The recovery permit adds no additional requirements, but does indicate that the owner of the recovery permit need not be the owner of the recharge permit, so long as the two parties have an agreement as to the diversion and use of the water.[74] The party holding the recovery permit has responsibility for monitoring the project, including the quantity and quality of water stored and recovered, and must file monitoring reports with the State Engineer.[75] There is no formal protection regarding ownership of the recovered water. Water quality is monitored by the Utah Department of Environmental Quality through sampling and other methods.[76]

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[70]Groundwater Recharge & Recovery Act, Utah Code Ann. § 73-3b-101 to 402 (Supp. 1993).

[71]Utah Code Ann. § 73-3b-103 (Supp. 1993). The recharge permit has a flat fee of $2,500 and the cost of the recovery permit ranges from $75 to $500, varying with the rate of withdrawal. Telephone conversation with Bob Morgan, Utah State Engineer (April 8, 1994).

[72]Utah Code Ann. § 73-3b-202 (Supp. 1993).

[73]Utah Code Ann § 73-3b-107 (Supp. 1993); Morgan, supra.

[74]Utah Code Ann. § 73-3b-205 (Supp. 1993).

[75]Utah Code Ann. § 73-3b-301 (Supp. 1993).

[76]Morgan, supra.

3.2.18 Washington

This state has no groundwater recharge statute, although a state-sponsored group of eight different water interests (the Water Resources Forum) has recently completed a draft groundwater policy document which recommends that groundwater recharge be addressed at all levels of government.[77] It will be submitted to the State Department of Ecology for review and a possible ruling.

Although not set up to govern groundwater recharge and recovery, state law requires permits be obtained before diverting flowing water from a stream or stored water from a reservoir. A permit to withdraw groundwater is also required, and a person seeking to pursue a groundwater recharge program would need to obtain both permits. The permit requirements are not specific to a storage and recovery program, however.[78]

3.2.19 Wyoming

Groundwater recharge and withdrawal is not recognized as a beneficial use of water. No legislation, regulation, permitting process, or demonstration project exists.[79]

3.3 EXAMPLES OF GROUNDWATER RECHARGE ARRANGEMENTS

The following discussion provides a sampling of arrangements among various parties to augment surface water supplies with groundwater recharge.

3.3.1 Groundwater Recharge in the San Joaquin Valley: Kern Water Bank and Arvin-Edison/Metropolitan Water District Arrangement

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[77]Telephone conversation with Doug Rushton, Water Resources Program, Washington Department of Ecology (May 3, 1994).

[78]WSWC, supra at IV-100.

[79]Telephone Conversation with Dick Stockdale, Administrator, Groundwater Division, Wyoming State Engineer's Office (Dec. 14, 1993).

3.3.1.1 Description of the basin

Kern County, site of the Kern Water Bank (KWB) and the Arvin-Edison water storage facilities, is at the southern end of the San Joaquin Valley in Central California. In the 1800s this region was referred to as the Tulare basin. The basin supported four major types of freshwater aquatic communities: marshes, swamps, ponds, and lakes. Tulare Lake, once the central feature of the region, covered 486,400 acres 50 feet deep, at its highest level in 1862.[80] Today, the lake bed is dry, productive farmland.

The San Joaquin Valley is bounded by mountains on three sides: the Sierra Nevada Range to the east, the Coast Range to the west, and the Tehachapi Mountains to the south. The valley is 250 miles long and averages 35 miles wide (see Figure 3.3.1).[81] The Tulare basin, together with the Buena Vista and Kern Lake beds, historically provided interior drainage for the southern region. The Kern River and its tributaries are the area's principal water source.[82] The Kern River flows from the Sierra in the east southwest to Elk Hill, where it branches. The main fork continues southwest to the Buena Vista Lake bed, while, during high water, the secondary fork flows into the Buena Vista Slough, and continues north into the Tulare Lake bed.

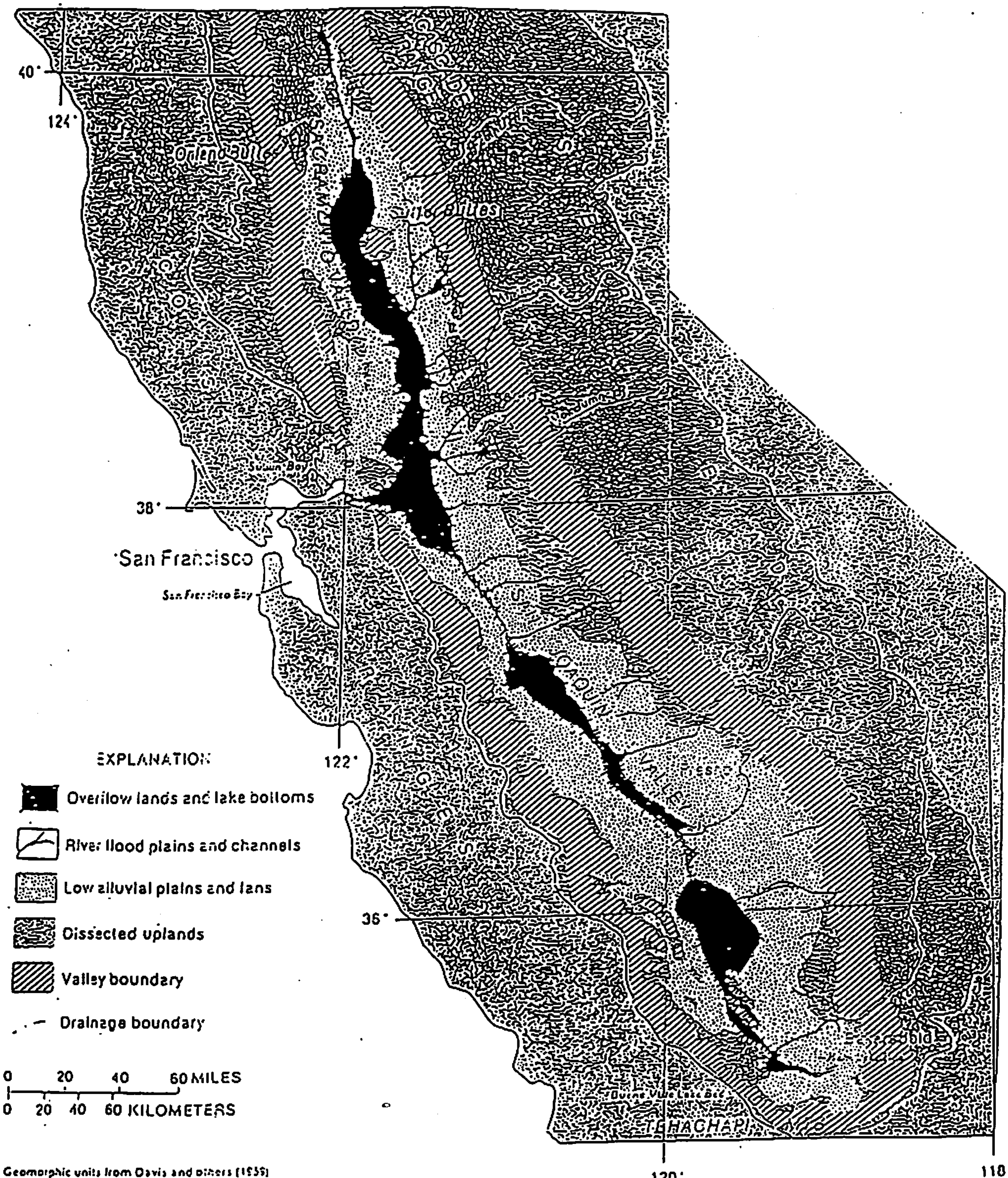
In addition to the Kern River, recharge in the Kern drainage area comes from seepage losses from canals, deep percolation of excess irrigation water after application, and by planned spreading. The groundwater reservoirs in the region have a succession of permeable sand and gravel "lenses" interbedded with less permeable finer materials (see Figure 3.3.2). Soils in the Kern drainage area have a relatively high permeability (except for the lakebeds), with the most permeable soils found in the alluvial fan of the Kern

[80]Gerald Haslam, The Great Central Valley: California's Heartland 157 (Berkeley: University of California Press, 1993).

[81]G.H. Davis, et. al., Ground-Water Condition and Storage Capacity in the San Joaquin Valley, California, Geological Survey Water Supply Paper 1469, 17 (Washington, D.C.: U.S. Government Printing Office, 1959).

[82]Davis, supra at 18.

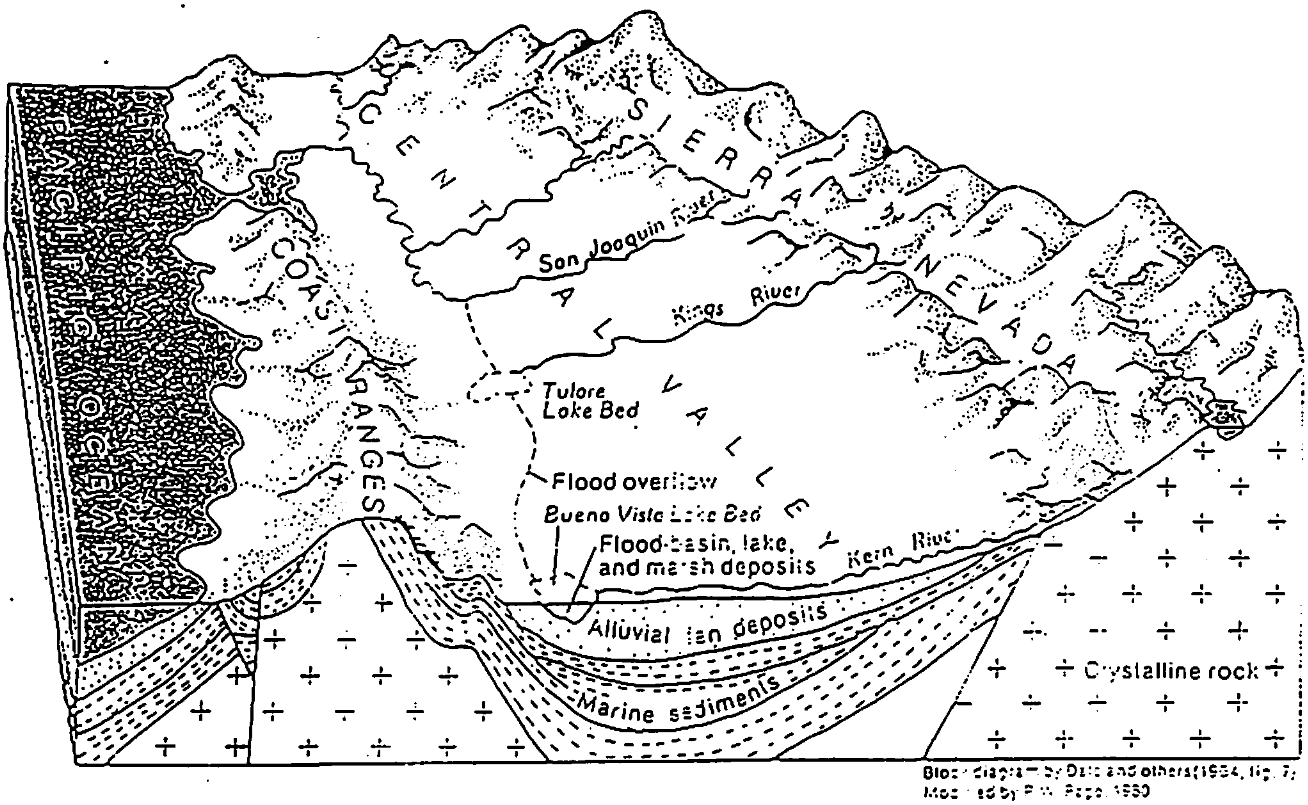
Figure 3.3.1 Geomorphic Map of Central Valley



Geomorphic units from Davis and others (1959) and Olmsted and Davis (1961) in Poland and Evenson (1966).

Source: R.W. Page, Geology of the Fresh Ground-Water Basin of the Central Valley, California, C6 U.S. Geological Survey Professional Paper (Washington, D.C.: U.S. Government Printing Office, 1986).

Figure 3.3.2 Generalized Geologic Section and View of the Central Valley



Source: R.W. Page, Geology of the Fresh Ground-Water Basin of the Central Valley, California, C6 U.S. Geological Survey Professional Paper (Washington, D.C.: U.S. Government Printing Office, 1986)

River.[83] Groundwater movement is restricted by anticlinal folds found throughout the region.[84]

The Arvin Edison region is located along the east side of the J-shaped Edison Maricopa front at the southeastern tip of the San Joaquin Valley (see Figure 3.3.3). Regional groundwater recharge comes from seepage from streams on the valley floor and canals, application of imported irrigation water, and subsurface flow from the Kern River unit.[85] In this area there are two distinct groundwater bodies: (1) a body of unconfined and semi-confined water in the upper part of the saturated deposits; and (2) the principal body of confined water, tapped by wells deeper than about 400 feet. As in the Kern area, the groundwater reservoirs are a mixture of sand and gravel layered with finer materials. The soils in this area are similarly of a high permeability and well drained, being conducive to groundwater recharge efforts. There are several fault barriers in the region which impede or prevent the movement of groundwater, thus breaking up the region into several hydraulic blocks.[86]

With the advent of water engineering and irrigation, the San Joaquin Valley has become one of the most productive agricultural regions in the country. High value crops, such as almonds, walnuts, olives, and tomatoes, predominate. While small farmers remain in the valley, agribusiness is now responsible for 53 percent of the regional production.[87] Agribusiness implies a large migrant work force; this is the home of the late Caesar Chavez and the birthplace of the National Farm Workers Association. The

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[83]Davis, supra at 232.

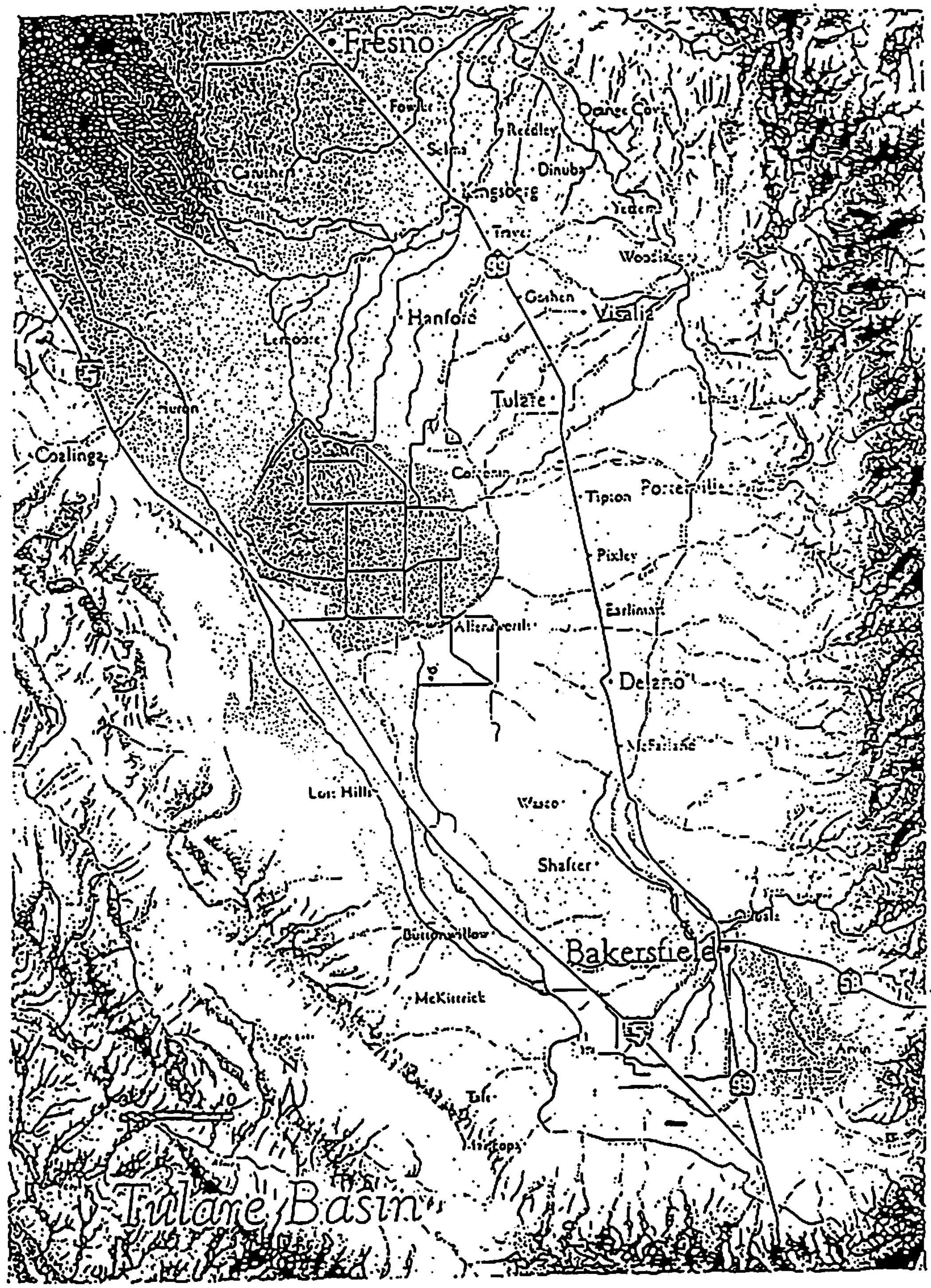
[84]R.W. Page, Geology of the Fresh Ground-Water Basin of the Central Valley, California, U.S. Geological Survey Professional Paper 1401-C, C19 (Washington, D.C.: U.S. Government Printing Office, 1986).

[85]Davis, supra at 140.

[86]Davis, supra at 140.

[87]Haslam, supra at 174.

Figure 3.3.3 Map of Tulare Basin



Source: Gerald Haslan, The Great Central Valley: California's Heartland 164 (Berkeley: University of California Press, 1993).

region is also rich in oil resources. Although oil production has decreased in recent years, it still contributes significantly to the local economy. However, water–or rather, the historical abundance of cheap water–is chiefly responsible for the region's transformation. Water is imported into the San Joaquin Valiley (and into other areas of Southern California) through a series of complex arrangements centered on the federal Central Valley Project (CVP) and California's State Water Project (SWP). Groundwater was first used for irrigation in 1908, and its use accelerated rapidly after 1916.[88]

As early as the 1950s it was recognized that groundwater withdrawals in Kern County, including the Arvin-Edison region, exceeded recharge capabilities.[89] Continuous, extensive groundwater pumping has created a groundwater overdraft. This long continued overdraft has resulted in a decline of water level in wells, requiring additional pumping. Moreover, if the overdraft occurs in confined deposits the water bearing materials that make up the aquifer tend to compact, causing the land to subside–in some areas the ground has sunk 50 feet from where it was 40 years ago.[90] Once subsidance has occurred most of that storage capacity is lost.

3.3.1.2 The Kern Water Bank

The Kern Water Bank (KWB) is a state project. The State Department of Water Resources (DWR) has developed an underground water bank consisting of various "elements" (separate or integrated recharge and extraction programs throughout the Kern County Groundwater Basin). Of the eight proposed or existing elements, seven involve local Kern County water districts: Buena Vista Water Storage District, Improvement District No. 4, Kern Delta Water District, North Kern Water Storage District, Rosedale-Rio Bravo Water Storage District, Semitropic Water Storage District, and West

[88]P.R. Wood, and R.H. Dale, Geology and Ground-Water Features of the Edison Maricopa Area, Kern County, California, Geological Survey Water Supply Paper 1656, 78 (Washington, D.C.: U.S. Government Printing Office, 1964).

[89]Davis, supra at 85.

[90]Davis, supra at 85; Haslam, supra at 184.

Kern Water District.[91] The eighth element, the Kern Fan Element, is a joint venture between the DWR and the Kern County Water Agency (KCWA). This element also involves the City of Bakersfield.

3.3.1.2.1 Terms of the Agreement

The DWR plans to use the KWB to store State Water Project (SWP) surface water in wet years and extract groundwater in dry years, thereby offsetting projected future deficiencies in SWP entitlement deliveries. A secondary goal is to decrease the current rate of groundwater overdraft--estimated to be 920,000 acre-feet for the southern San Joaquin Valley.[92] During wet years, low cost water is available from the Kern River system, the Kings, Tule, and Kaweah Rivers linked to Kern County by the Friant-Kern Canal, and Northern California linked by the California Aqueduct.[93]

The heart of this project is the Kern Fan Element (KFE), which involves a recharge and extraction program on a 20,000 acre parcel of land adjacent to the Kern River west of Bakersfield. The DWR purchased this land in 1988 for $31 million. Ultimately, it is hoped that the KFE will provide storage for up to 1 million acre-feet of groundwater. This element is to be completed in two stages, with the first stage using Bakersfield's 2,800-acre recharge area, 320 acres of existing recharge ponds, and 790 acres of new ponds. DWR expects to use existing wells within the KFE for extraction. Deliveries from the wells will be made through existing canals. Preliminary estimates place the capital cost of the first stage at approximately $2 million, with delivery capabilities of 65,000 acre-feet in a dry year. The second stage calls for increasing

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[91]Stuart T. Pyle, and Richard B. Igler, "The Promise of Water Banking: a Quantity and Quality Issue Update on Kern Water Bank," in University of California Water Resources Center et. al. eds., Coping with Water Scarcity: The Role of Ground Water, proceedings from the 17th Biennial Conference on Ground Water 195 (San Diego, California, 1989).

[92]"Kern County Water Agency Description for Long-Term Water Supply Project EIR," Draft (on file with NRLC) [hereinafter, "Kern County Draft"].

[93]Kern County Draft, supra at 1.

pumping and recharge capacity for storage of an additional 350,000 acre-feet. DWR expects water to cost approximately $70/acre-foot under this program.[94]

Management of the KFE is largely the responsibility of DWR, although they have contracted with the KCWA to assist in project development–relying on the KCWA's knowledge of, and access to, local information necessary for the KWB.[95] The KCWA was responsible for procuring an agricultural land management firm to oversee the relocation of farmers on the KFE property. In order to ease the farmers' relocation, the DWR plans to phase out the leases over a five year period. The KCWA retained responsibility for general KFE property maintenance: canals, wells, pumps, etc.[96] Following the phase-out, the KCWA will remain responsible for the land management, including revegetation, regulation of public use, and prevention of misuse, such as dumping.[97]

The other elements involve storing water in various water districts and improving or adding extraction and delivery systems, according to the district's need. Some programs include in-lieu recharge, similar to that described below in the AE/MWD agreement, while others have direct recharge, or a combination. For example, the Semitropic Water Storage District proposal includes expanding Semitropic's delivery system to allow for full delivery of its SWP entitlement of 158,000 acre-feet in wet years. This will give farmers currently dependent on groundwater access to surface water. The discontinued groundwater pumping in wet years would then be credited to the KWB account. In dry years the farmers would use the existing groundwater and Semitropic would pump KWB account water to their lands that have contracted for SWP surface

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[94]Pyle, supra at 187.

[95]Pyle, supra at 191.

[96]Pyle, supra at 193.

[97]Pyle, supra at 195.

water. Thus Semitropic can release its SWP surface supply to DWR, thereby creating yield for the SWP.[98]

By capturing Kern River water during flooding periods, the KCWA expects to benefit by reducing flooding of agricultural lands in Tulare Lake. Additionally, the parties expect to have decreased pumping costs due to the raised groundwater levels. Finally, the planned conversion of roughly 15,000 acres from agricultural land to recharge facilities is expected to save about 30,000 acre-feet per year of groundwater now being used for irrigation.

3.3.1.3.2 Status

To date, DWR has operated the KWB on a limited scale through a series of interim agreements. DWR has agreements with the City of Bakersfield and the KCWA, for the use of the City's 2,800-acre spreading grounds. The agreements specifies the amount of water to be delivered, the delivery, storage and extraction facilities, cost and term.

DWR also entered an interim agreement with Semitropic, wherein recharge and storage was to begin in 1988, if water was available.[99]

Presently, however the Kern Water Bank including the seven local elements is inactive due to the uncertainty of the Sacramento - San Joaquin Delta (Delta) water supply. Since much of the water for the Kern Water Bank comes from the Delta, the current status of the water supply is unknown. For many years California water managers have been wrestling with Delta water management issues as the threat to the Delta's ecosystem, due to water transfers, has increased. Most recently the EPA has released a draft water management plan, the effects of which remain to be seen. Because the KWB managers do not have the same water supply as when they initially planned the project, they are currently re-evaluating and revising their plans, asking what

[98]Pyle, supra at 197.

[99]Pyle, supra at 197-98.

makes financial sense. Some options being considered are increasing recharge facilities to capture as much water as possible when available, or halting the project altogether.[100]

3.1.3.3.3 Unresolved Issues

If the project is continued the parties, prior to creating long term agreements, will need to consider the costs of defaulting, indemnification should a court rule against the DWR due to injured water rights, remedies for adverse conditions that may arise between the water bank program and established pumpers, and the amount of extraction via entitlement exchange or direct delivery.[101] Moreover, DWR may need to amend their current water rights diversion permit in order to store and extract Delta water. The amendment process could take many years and may not be completed until projects are specifically defined.[102]

A number of operational impediments exist as well. First, water districts adjacent to the KFE property are concerned about the impact of extraction (i.e., rapidly fluctuating groundwater levels during periods of heavy extraction). Also, local people resent the idea of exporting Kern County groundwater to Southern California. Another concern is water quality. The local community is concerned about the amount of salt carried by recharge water, and the State Water Contractors are concerned about the quality of extracted water. Finally, the issue of water loss during the delivery, recharge, and storage process has yet to be resolved.[103] Thus the KWB is not likely to be fully operational for a number of years.

3.3.1.3 Arvin Edison/ Metropolitan Water District Arrangement

The two major parties to this agreement are the Metropolitan Water District (MWD), the water supplier for the greater Los Angeles metropolitan area, and the

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[100]Telephone interview with Rick Erickson, Division of Planning, State Department of Water Resources, and Program Manager for the Kern Water Bank (Feb. 23, 1994).

[101]Pyle, supra at 198-99.

[102]Pyle, supra at 199.

[103]Pyle, supra at 199.

Arvin-Edison Water Storage District (AE) in Kern County. AE is a federal Central Valley Project (CVP) contractor. The District contains 132,000 acres of irrigated farmland, 52,000 acres of which have contracts with AE for surface water supply.[104]

Due to the nature of the agreement and AE's previous water supply arrangements, a number of different parties either have or may become involved. Foremost among this group is the Cross Valley Canal (CVC) Exchangers. The CVC, which will be used to transport the water, was built as a result of the CVC exchange agreements. The canal links the California Aqueduct (part of the State Water Project) with the Friant-Kern Canal (part of the federal Central Valley Project) and AE's intake canal. Under AE's agreement with the CVC Exchangers, AE receives the Exchangers' CVP (federal) water from the Sacramento/San Joaquin Delta, through the California Aqueduct, and the Exchangers receive AE's CVP Friant-Kern water. (The Exchangers entered this agreement because they did not have rights to Friant-Kern CVP water, while the CVP water they did have rights to was undeliverable.) Thus, the CVC Exchangers are a party to the agreement to the extent that it affects the Cross Valley Canal's capacity (see Figure 3.3.4).[105]

Furthermore, because the agreement involves federal and state water projects, the California Department of Water Resources (DWR), the U.S. Bureau of Reclamation (BOR), and the State Water Resources Control Board (SWRCB), as well as other local water agencies, have been involved in negotiations.[106]

3.3.1.3.1 Terms of the Agreement

Essentially, the AE/MWD agreement calls for storing water in groundwater aquifers in years of surplus and "banking" that water for use in dry years. Both parties have agreed that groundwater basin conditions under the program will maintain or

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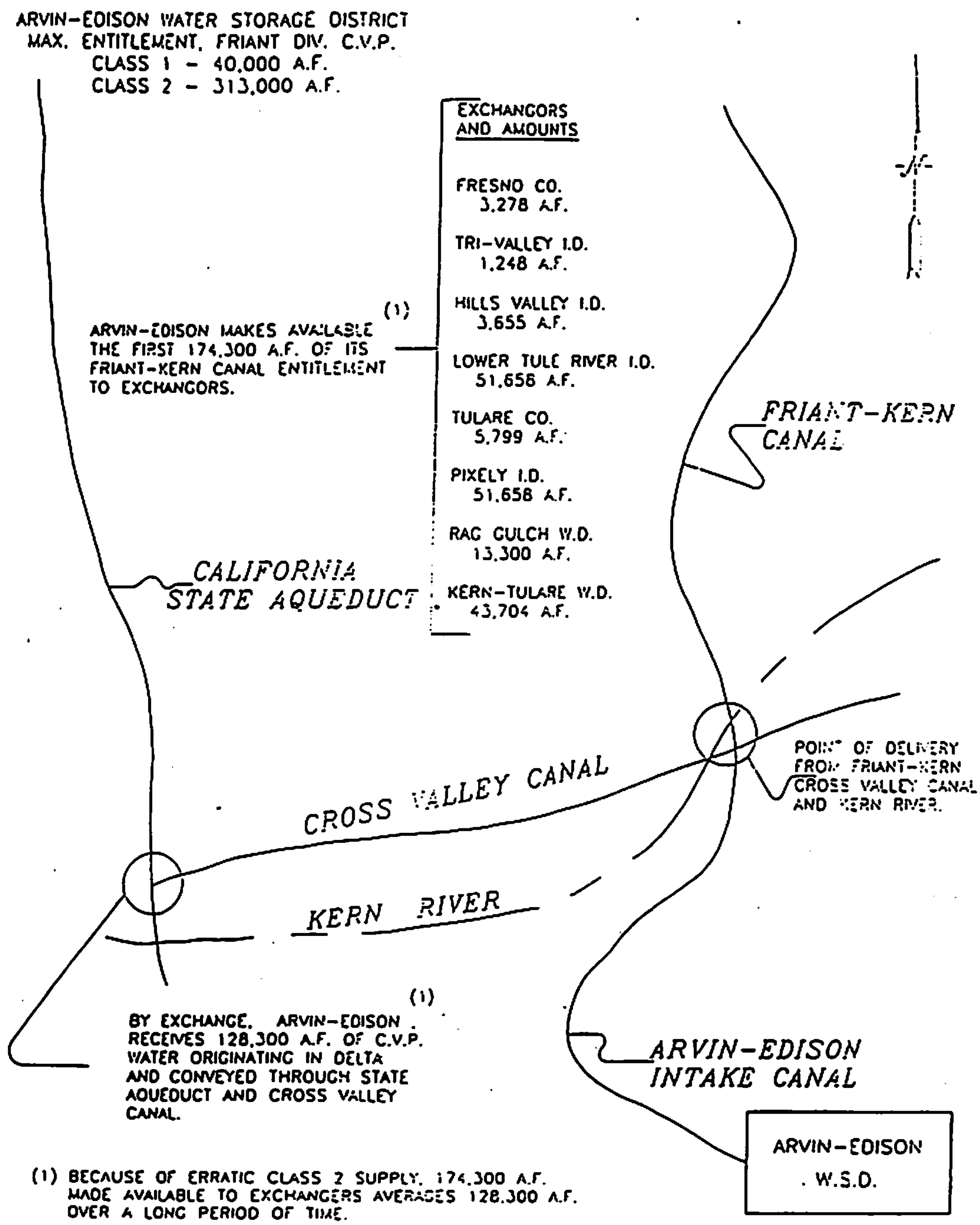
[104]Memorandum from Carl Boronkay, General Manager, Metropolitan Water District to Board of Directors, concerning the Arvin-Edison Water Storage and Exchange Program (Aug. 27, 1986) [hereinafter memoranda from Carl Boronkay on this subject are referred to as "Memo" or "Memos," with dates].

[105]Memos, April 25, 1988; Dec. 26, 1989; and Nov. 26, 1986.

[106]Memo, Jan. 27, 1989.

Figure 3.3.4 The Arvin-Edison Water District Management Program



ARVIN-EDISON WATER STORAGE DISTRICT
CROSS VALLEY CANAL WATER EXCHANGE PROGRAM

Source: Arvin-Edison Water Storage District, March 1994, p. 6.

improve upon current conditions.[107] MWD expects to store up to 800,000 acre-feet total, and to withdraw an average of 93,000 acre-feet in dry years.

Under the agreement, MWD would make available to AE its "surplus" of State Water Project (SWP) water, up to 135,000 acre-feet, at the CVC turnout from the California Aqueduct. The water would then be transported through the CVC to AE's service area for use in two replenishment programs: (1) direct artificial recharge of the AE groundwater basin by spreading; and (2) surface water delivery to farmers "in lieu" of groundwater pumping. MWD's water would accrue in a storage account and be made available to them on an acre-foot for acre-foot basis minus water loss factored in.[108] Water losses are expected from evaporation during spreading, in transportation, and in the aquifer itself. Altogether, MWD expects losses to be less than 5 percent of the total project water.[109] MWD will be responsible for all losses except for those associated with AE's delivery system.

Since the signing of the final agreement has continually been extended, the costs have risen accordingly. Currently the total projected capital costs are expected to exceed $21 million. This figure includes the acquisition of approximately 500 acres for spreading basins, an in-lieu surface distribution system for 5,000 acres of farmland, and approximately ten additional wells to allow AE to pump adequate groundwater upon MWD's request. The parties expect to share operating costs with AE paying operation, maintenance, and transportation costs through the CVC and AE system for the in-lieu program, and MWD paying spreading and incremental energy costs for pumping.[110] Excluding energy and other transportation costs in the California Aqueduct, MWD expects the program water to cost $90 per acre-foot.

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[107]Memo, Jan. 27, 1989.

[108]Memo, Aug. 27, 1986.

[109]Memo, Jan. 27, 1989.

[110]Memo, April 25, 1988.

Since the initial discussions in 1986, the two parties have modified the agreement to incorporate concerns of other affected parties. SWP contractors and the DWR expressed concerns about possible reductions in carryover storage (excess water available the following year). In response, MWD agreed to return any stored water or, preferably, not store water if storing would decrease available entitlement (carryover) water for other contractors.[111]

MWD expects this project to provide a reliable bank of water during water-short years. AE, in return, will benefit from an expanded distribution system, while farmers in the in-lieu program will switch from groundwater to lower-cost surface water, and farmers remaining with groundwater irrigation will benefit from a higher water table and subsequent reduced pumping costs.[112]

3.3.1.3.2 Status

Federal and state bureaucratic barriers have prevented AE and MWD from signing a long term agreement (see discussion below). However, from 1988 to 1991 the parties operated under yearly interim agreements. The interim agreement essentially reflects the basic tenets of the long term agreement without the in-lieu program and the extensive spreading basins. Due to a low water supply, water had not been stored as of 1991.[113] Presently, the AE project is on hold because Delta water has become highly unreliable.

3.3.1.3.3 Unresolved Issues

Presently there exists a controversy over federal contract renewal in the Friant Unit of the CVP. In response to an outcry for improvement of the water-related environment of the San Joaquin River Basin, the Bush Administration created the San Joaquin River Basin Resource Management Initiative to address environmental concerns highlighted by the Environmental Impact Statement (EIS) and the contract renewal process. In the meantime, the Natural Resources Defense Council and other

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[111]Memo, Aug. 8, 1989.

[112]Memo, Aug. 27, 1986.

[113]Memo, Nov. 26, 1991.

environmental organizations filed a lawsuit against the contract renewals, claiming that a renewal for the full amount of water is a discretionary act under federal reclamation law and that full compliance with the National Environmental Policy Act is required.

Although water under the program is CVC water from the Delta and not at issue in the contract dispute, CVC exchange agreements may need to be modified as a result of the Friant Unit Contract renewals, and AE's Friant Unit Contract is subject to renewal in 1995.[114]

Additionally, at the state level, the DWR must approve turning out water from the California Aqueduct to AE for storage and the terms and conditions under which water is reintroduced into the state project system. At the federal level, "key questions include whether AE requires an amendment to its contract with the United States Bureau of Reclamation, whether such an amendment would trigger full-cost pricing provisions of the Reclamation Reform Act, and whether Congress is required to extend the CVP service area.[115]

As previously mentioned, the Delta water has become highly unreliable in recent years due to regulatory decisions regarding the water management. The AE project is likely to remain on hold until the environmental issues surrounding the Delta are resolved.[116]

3.3.1.4 Orange County Water District, California

3.3.1.4.1 Description of the Basin

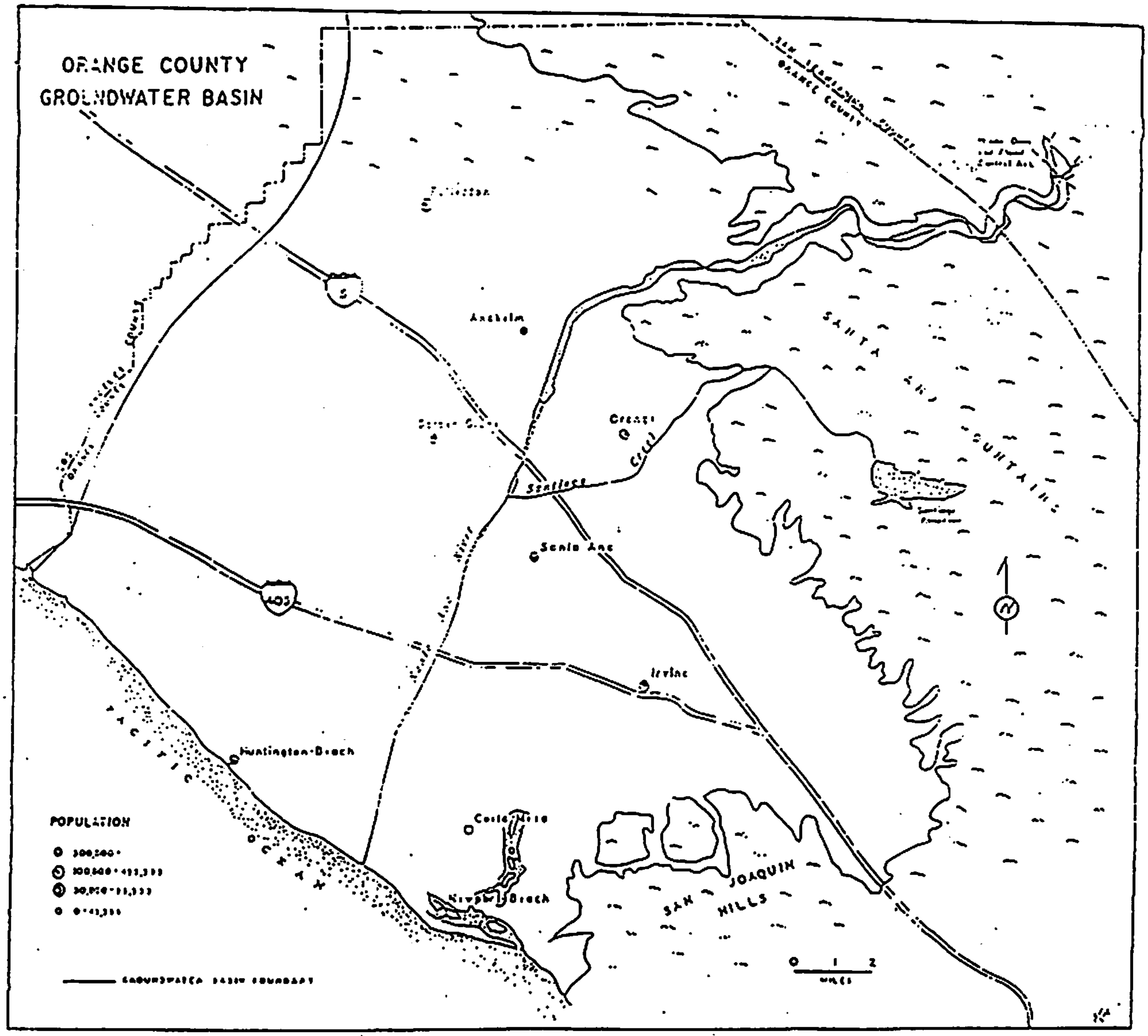
The Orange County Basin, in the Santa Ana River Watershed, underlies an area of about 300 square miles (192,000 acres) southeast of Los Angeles, along the coast of the Pacific Ocean (see Figure 3.3.5). The Orange County Water District (OCWD)

[114]Memo, Feb. 27, 1990.

[115]Memo, April 25, 1988.

[116]Telephone interview with Mr. Edward Thornhill, Water Transfers and Exchanges, Manager, Metropolitan Water District, Jan. 25, 1994. Although the AE - MWD Groundwater storage program is not operational, MWD has developed a similar program with the Semitropic Water Storage District which has a much more reliable water source through their state water program entitlement. Id.

Figure 3.3.5 Map of Orange County Groundwater Basin



Source: William Blomquist, Dividing the Waters: Governing Groundwater in Southern California 246 (San Francisco: The Center for Self-Governance, 1992).

originally had authority for groundwater management within 156,000 acres of the basin, based on the Orange County Water District Act, which was passed by the California legislature on June 4, 1933.[117] By 1968, the district area had been increased to encompass about 173,000 acres.[118]

The dominant land uses in this area have changed twice, and both changes occurred over relatively short periods of time. The first change was the development of agriculture. The area is relatively low-lying, and under natural conditions much of it was swampy or poorly drained and subject to flooding.[119] However, when settlers began draining the land and lowering the groundwater level by pumping, agriculture became feasible. Between 1910 and 1920, the amount of irrigated acreage essentially doubled to almost 100,000 acres, and the largest expanse of irrigated acreage, about 130,000 acres, was recorded in 1928.[120] The second change was the rapid expansion of urbanization and corresponding decline in the extent of agriculture. Between 1950 and 1960, the population of Orange County more than tripled, and between 1960 and 1970 it more than doubled, to the 1970 population of 1,421,233.[121] In contrast, between 1961 and 1964, the quantity of groundwater pumped for irrigation almost halved.[122] The area is now almost completely urban (see Figure 3.3.6).

The Orange County Basin is one of several, relatively similar basins in the Los Angeles area (see Figure 3.3.7). The basin boundaries include the San Joaquin Hills to the south, the Santa Ana Mountains to the east, and the Puente and Chino Hills to the north-northeast. The north-northwestern boundary of the basin is not as hydrologically

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[117]William Blomquist, Dividing the Waters: Governing Groundwater in Southern California 249 (San Francisco: The Center for Self-Governance, 1992).

[118]Louis F. Wechsler, Water Resources Management: The Orange County Experience 18 (Davis, Calif.: California Government Series No. 14, Jan. 1968).

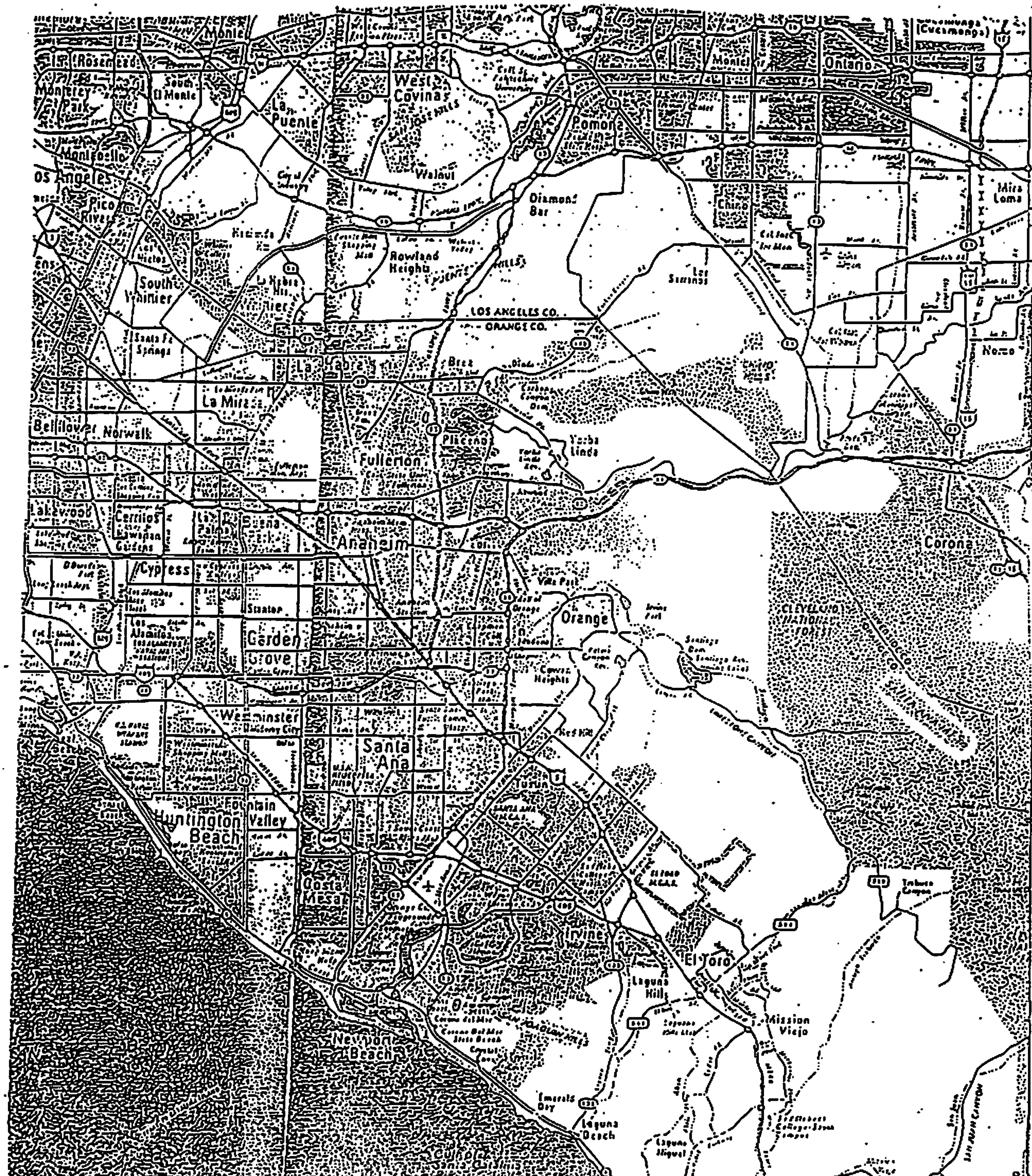
[119]Blomquist, supra at 245.

[120]Id. at 245-246.

[121]Id. at 51, Table 4.1.

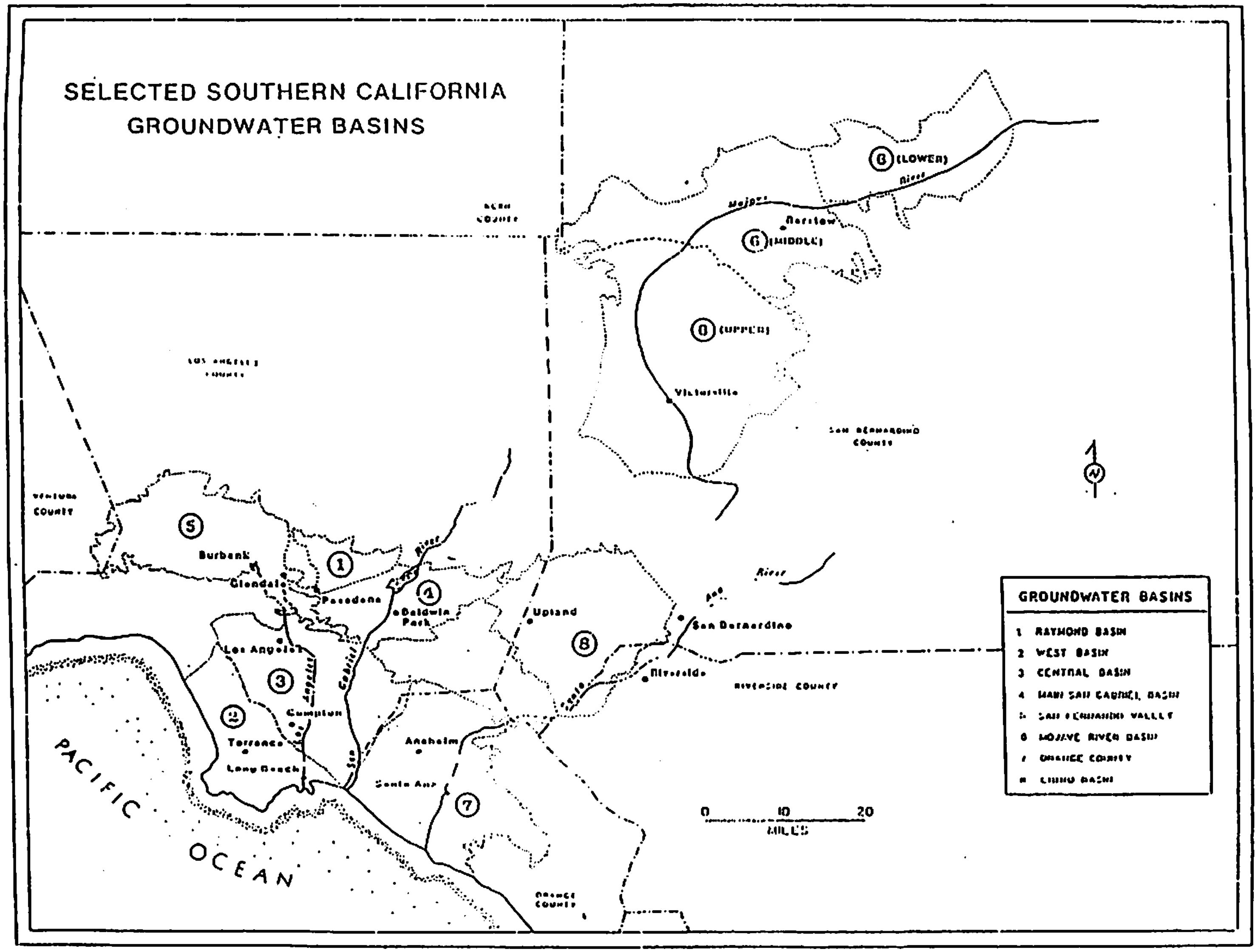
[122]Id. at 259.

Figure 3.3.6 Map Showing Urban Development in Orange County Area



Source: Rand McNally Road Atlas 1988

Figure 3.3.7 Map of Selected Southern California Groundwater Basins



Source: William Blomquist, Dividing the Waters: Governing Groundwater in Southern California, pp.xix-xx (San Francisco: The Center for Self-Governance, 1992).

well-defined, allowing for some interaction between the Central Basin of the San Gabriel River Watershed and the Orange County Basin.[123] The western boundary of the Orange County Basin is only evident in the subsurface,[124] but it is of special significance because of its proximity to the Pacific Ocean.

Without the western boundary, saltwater migration could have severely limited development of the area's groundwater resources. Such migration, or intrusion, occurs when the levels of fresh groundwater are drawn down, such as by pumping, below sea level. In the basin, the threat of such intrusion is reduced by the Newport-Inglewood Uplift, which forms the western boundary of the basin, a "sort of underground 'wall' between the ocean and the basin."[125] Even so, ancient channels of the Santa Ana and San Gabriel Rivers eroded four gaps through the wall (see Figure 3.3.8). Two of these gaps (Bolsa-Chica and Bolsa-Sunset) were at least partially sealed by later geologic movements, but the other two (Alamitas and Talbert or Santa Ana) allow saltwater intrusion when the amount of water pumped from the basin continually exceeds the amount of natural or artificial recharge. The methods OCWD has used to control saltwater intrusion are described below.

The Southern California coastal basins are filled with alternating layers of relatively permeable sands and gravels and relatively impermeable silts and clay. Three major aquifers occur in the Basin.[126] The uppermost aquifer extends from close to the ground surface to at most 1,500 feet below ground surface (fbs), depending on location within the basin.[127] The middle aquifer may occur from 1,300 to 2,600 fbs, and the lower aquifer may occur from 2,600 to 4,000 fbs. Although the maximum depth of freshwater in the basin is about 4,000 feet, most of the water in the lower aquifer is of

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[123] Id. at 31. Because of the hydrologic connection between some of these coastal basins, they are sometimes collectively referred to as the South Coastal Basin.

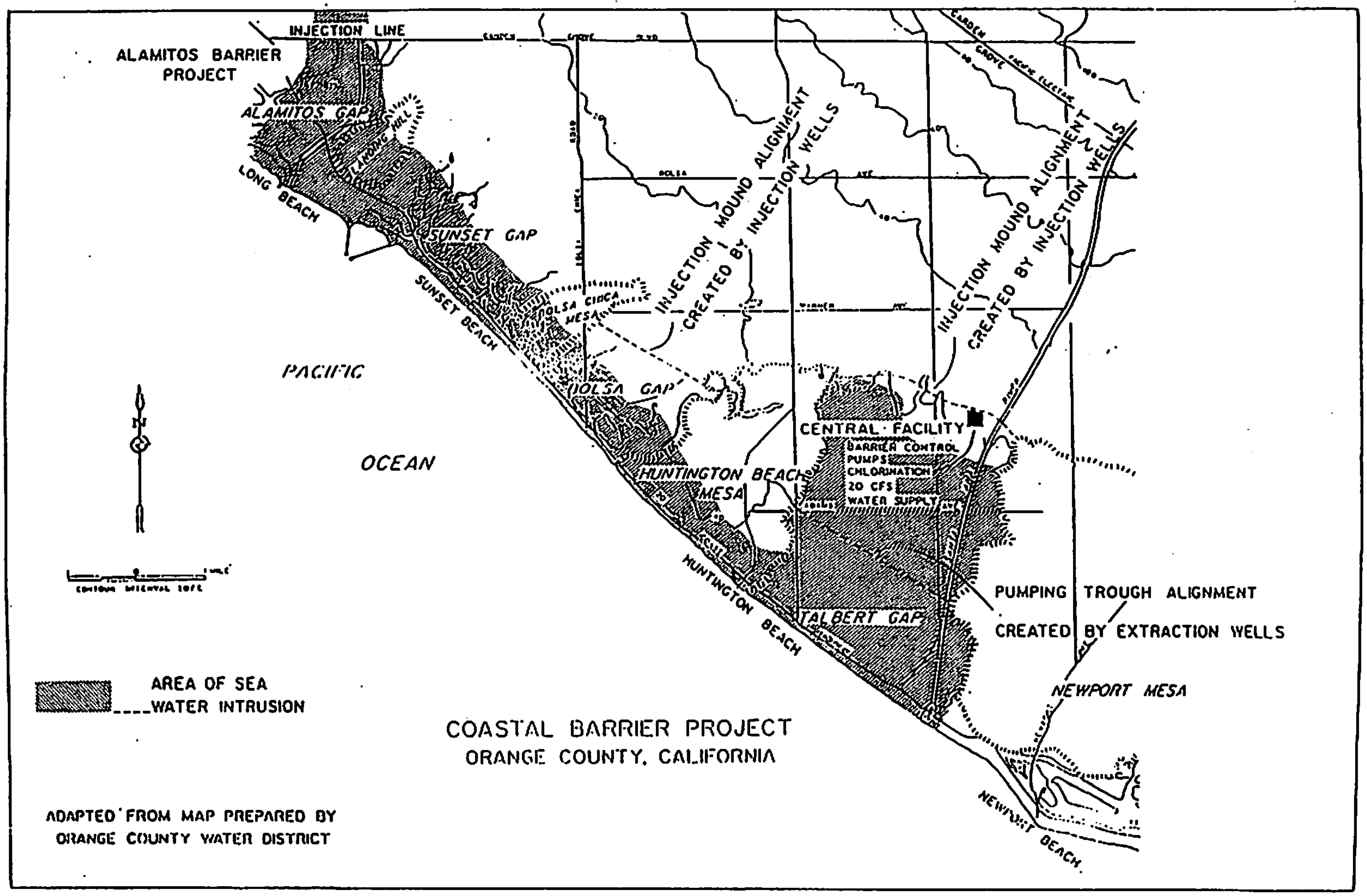
[124] Id. at 39.

[125] Id.

[126] Blomquist, supra at 38.

[127] Id.

Figure 3.3.8 Map Depicting Saltwater Intrusion in the Orange County Basin



Source: Langdon W. Owen, "The Challenge of Water Management: Orange County Water District, California," in Salt Water Encroachment into Aquifers 115 (Proceedings of the Limited Professional Symposium, May 4-5, 1967, Louisiana Water Resources Research Inst., Bull. 3, Oct. 1968).

poor quality because of high concentrations of dissolved solids. The most shallow layers in the basin are relatively flat-lying, but the deeper layers dip away from the ocean.[128]

Recharge from the surface, whether natural or artificial, is limited in the western portion of the basin because thick, relatively impermeable clays layers occur just below the ground surface.[129] This western portion is referred to as the "Pressure Area," and the eastern area, in which surface recharge occurs more readily, is referred to as the "Forebay Area (see Figure 3.3.9)."[130]

Precipitation provides some recharge. However, over the last century, the average annual precipitation in the Los Angeles area has been only 15 inches, and variations from 19 to 6 inches from year to year are not uncommon.[131] Because of evaporation and other losses, the amount of precipitation that may actually recharge the basin is only a fraction of that amount.[132]

Natural recharge to the basin is primarily by percolation of water from the Santa Ana River, which has a 2,500 square mile watershed.[133] The river flows into the basin from the east, through Santa Ana Canyon between the Chino Hills and the Santa Ana Mountains. The canyon effectively divides the river's watershed into an Upper Area, which includes eight groundwater basins, and a Lower Area, in which the Orange County

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[128]Langdon W. Owen, "The Challenge of Water Management: Orange County Water District, California," in Salt Water Encroachment into Aquifers 114 (Proceedings of the Limited Professional Symposium, May 4-5, 1967, Louisiana Water Resources Research Inst., Bull. 3, Oct. 1968).

[129]William R. Mills, "Orange County Ground Water Management," in Changing Practices in Ground Water Management: the Pros and Cons of Regulation 133 (Proceedings of the 18th Biennial Conference on Ground Water, Sept. 16-17, 1991; University of California Water Resources Center, California Department of Water Resources, and State Water Resources Control Board, Report No. 77, Sept. 1992).

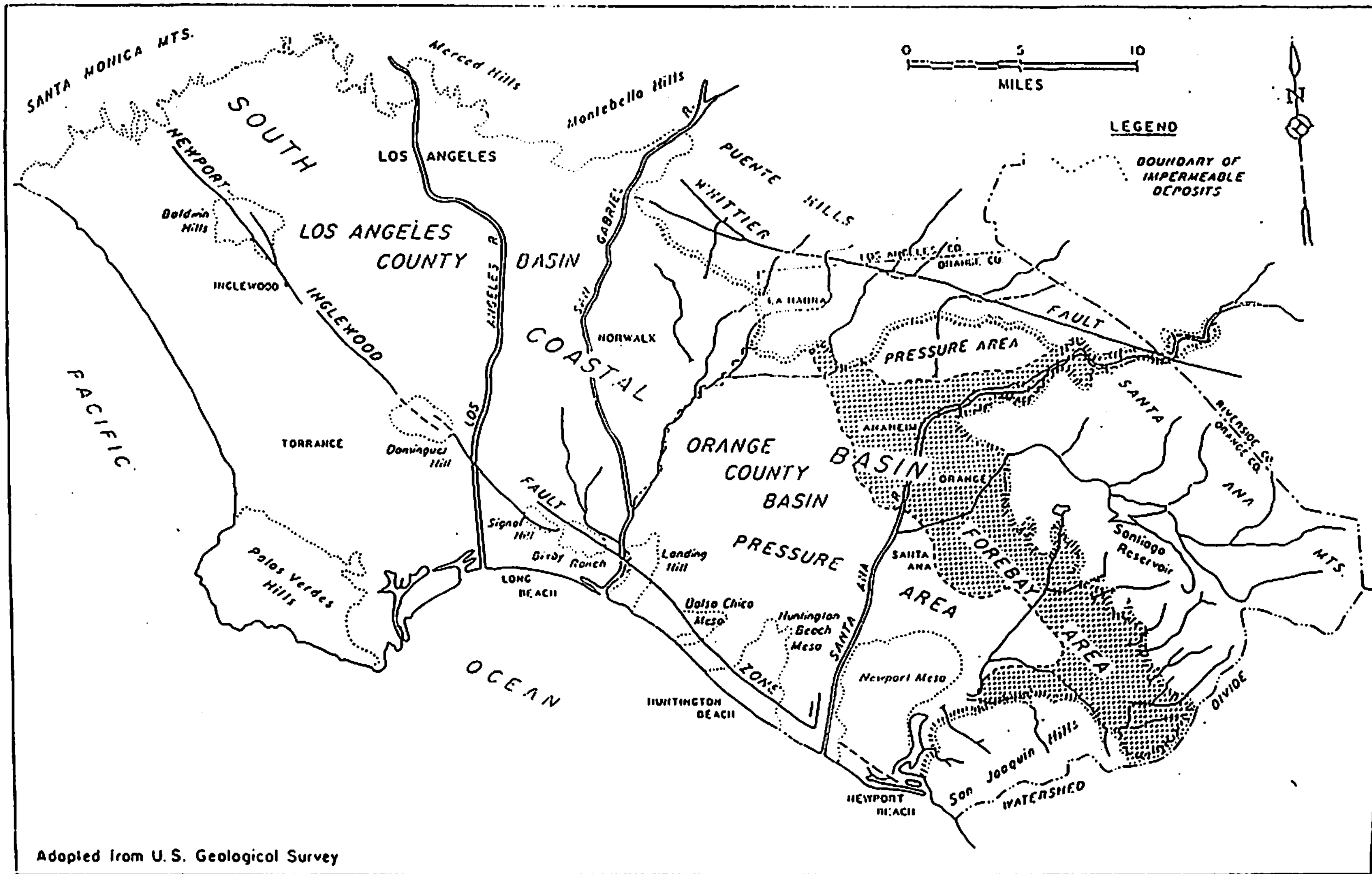
[130]Id.

[131]Norris Hundley, Jr., "There's No Reason to Celebrate the 'End' of the Seven-Year Drought; Water: It's a Serious Mistake to Think in Rainfall in Terms of Averages and Cycles, According to Recent and Prehistoric Data. Scarcity is Still Our Future," Los Angeles Times Opinion, Part M, Page 6, Column 1 (Mar. 14, 1993).

[132]C.W. Fetter, Jr., Applied Hydrogeology 379 (Columbus, Ohio: Charles E. Merrill Publishing Co., 1980).

[133]Blomquist, supra at 36.

Figure 3.3.9 Map Depecting Permeable and Impermeable Areas in Southern California Coastal Basins



Source: Langdon W. Owen, "The Challenge of Water Management: Orange County Water District, California," in Salt Water Encroachment into Aquifers 118 (Proceedings of the Limited Professional Symposium, May 4-5, 1967, Louisiana Water Resources Research Inst., Bull. 3, Oct. 1968).

Basin is the only groundwater basin.[134] The amount of recharge from the river varied considerably due to precipitation and runoff conditions in the Upper Area (see Figure 3.3.10). However, in 1941, the Prado Dam was completed in the canyon by the U.S. Army Corps of Engineers and the Orange County Flood Control District.[135]

Operation of the Prado Dam allowed for more control of the river flow into the Lower Area. The amount of river flow from the Upper Area was decreasing, though, because of increased demands in the Upper Area, and in 1960-61, the base flow was only 26,190 acre-feet.[136] Therefore, in 1963, OCWD filed for adjudication of the Upper Area, and was ultimately entitled to 42,000 acre-feet of base flow at Prado Dam and all the storms flows reaching the Prado Dam Flood Control Facility.[137] In addition to apportioning the obligation to meet the 42,000 acre-foot requirement among Upper Area users, the judgment included water quality specifications.

To use the Santa Ana River water for recharge, OCWD had developed over 1,600 acres of spreading basins along the Santa Ana river and has constructed deep, off-channel facilities which may be up to 150 feet deep for storage and percolation of stormwater flows.[138] Overall, the district owns a total of 3,400 acres for conservation and artificial recharge facilities.[139]

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[134] Id.

[135] Id. at 251.

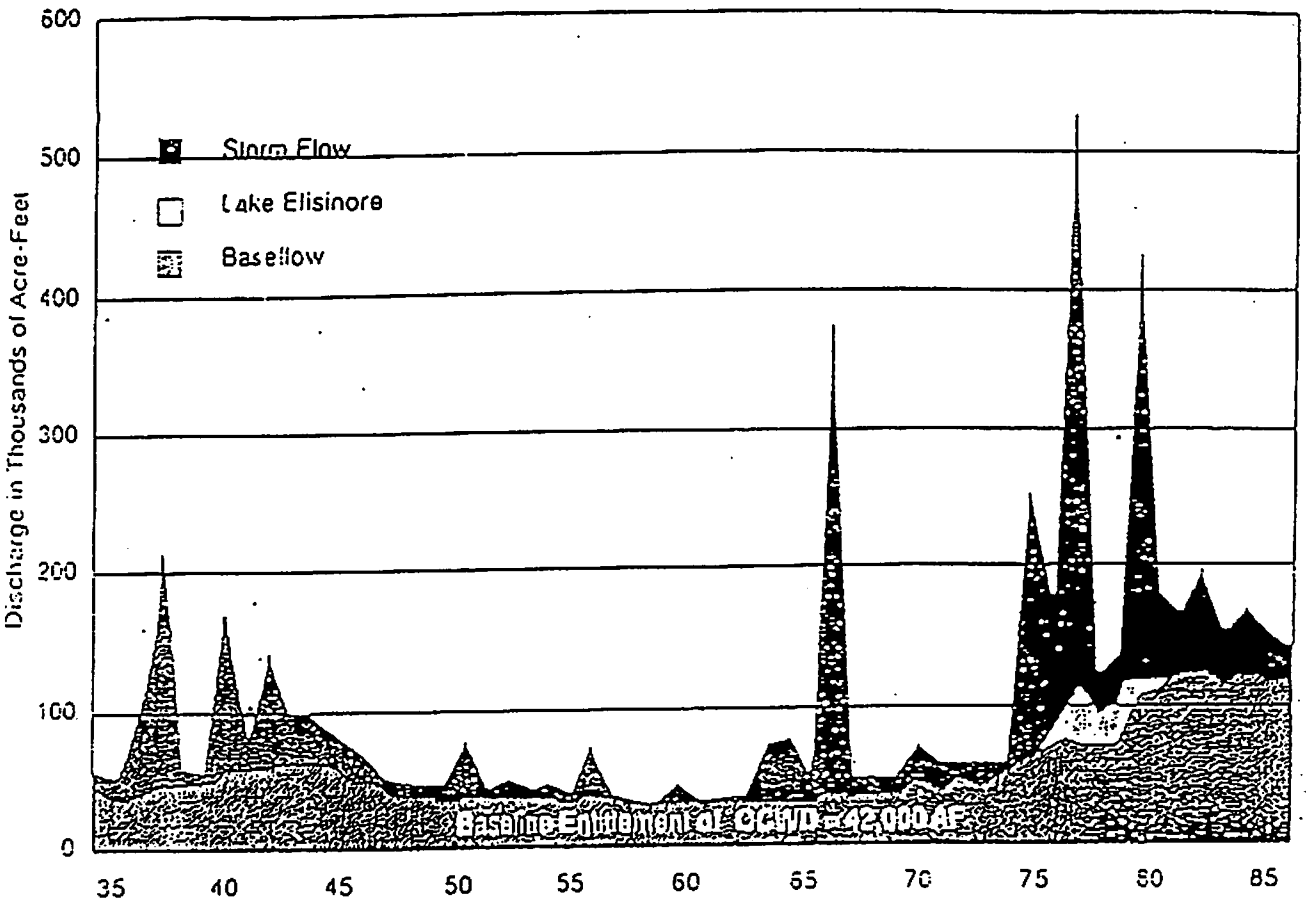
[136] Id. at 263.

[137] Id. at 262.

[138] Mills, supra at 135. The sand and gravel from these pits are sold to pay for the land. Id.

[139] Blomquist, supra at 264.

Figure 3.3.10 **Historical Flows of the Santa Ana River**



Source: Langdon W. Owen, "The Challenge of Water Management: Orange County Water District, California," in Salt Water Encroachment into Aquifers 118 (Proceedings of the Limited Professional Symposium, May 4-5, 1967, Louisiana Water Resources Research Inst., Bull. 3, Oct. 1968).

Because the basin boundaries are relatively effective barriers to the lateral movement of groundwater out of the basin and because of the layering of relatively permeable and impermeable zones within the basin, groundwater originally occurred under pressure or artesian conditions. The surface conditions and vertical, upward leakage contributed to the swampy conditions and early reports of artesian wells.[140] Although early pumping of groundwater from the basin provided a benefit by lowering the water level enough to allow development of previously waterlogged land, the basin has since been plagued by overdrafts and subsequent saltwater intrusion[141] and land subsidence.[142]

Because of saltwater intrusion if water levels in the basin drop below sea level, the "safe, usable" storage capacity of the basin is less than 200,000 acre-feet,[143] which is significantly less than the "potential" usable storage capacity of about 1.5 million acre-feet.[144] The intensity of groundwater use is evident in measurements of the basin overdraft (the difference between the amount of water discharged and the amount recharged) (see Figure 3.3.11). Since the mid-1930s, the overdraft of the basin has exceeded 200,000 acre-feet in more than half of the years, and has only been less than 100,000 acre-feet in fewer than one-third of the years.

Even in the few years that the basin has been almost "full" since the 1930s, the conditions were not the same as if the basin had never been drawn down. When the basin is "refilled," it appears to be full based on an average water level,[145] but the water levels in the Forebay Area, which is easily recharged from the surface, are actually higher

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[140]Blomquist, supra at 247; "An Occasional Look at Orange County Issues—Quenching Orange County's Thirst," L.A. Times, May 2, 1993, at B3.

[141]Blomquist, supra at 251.

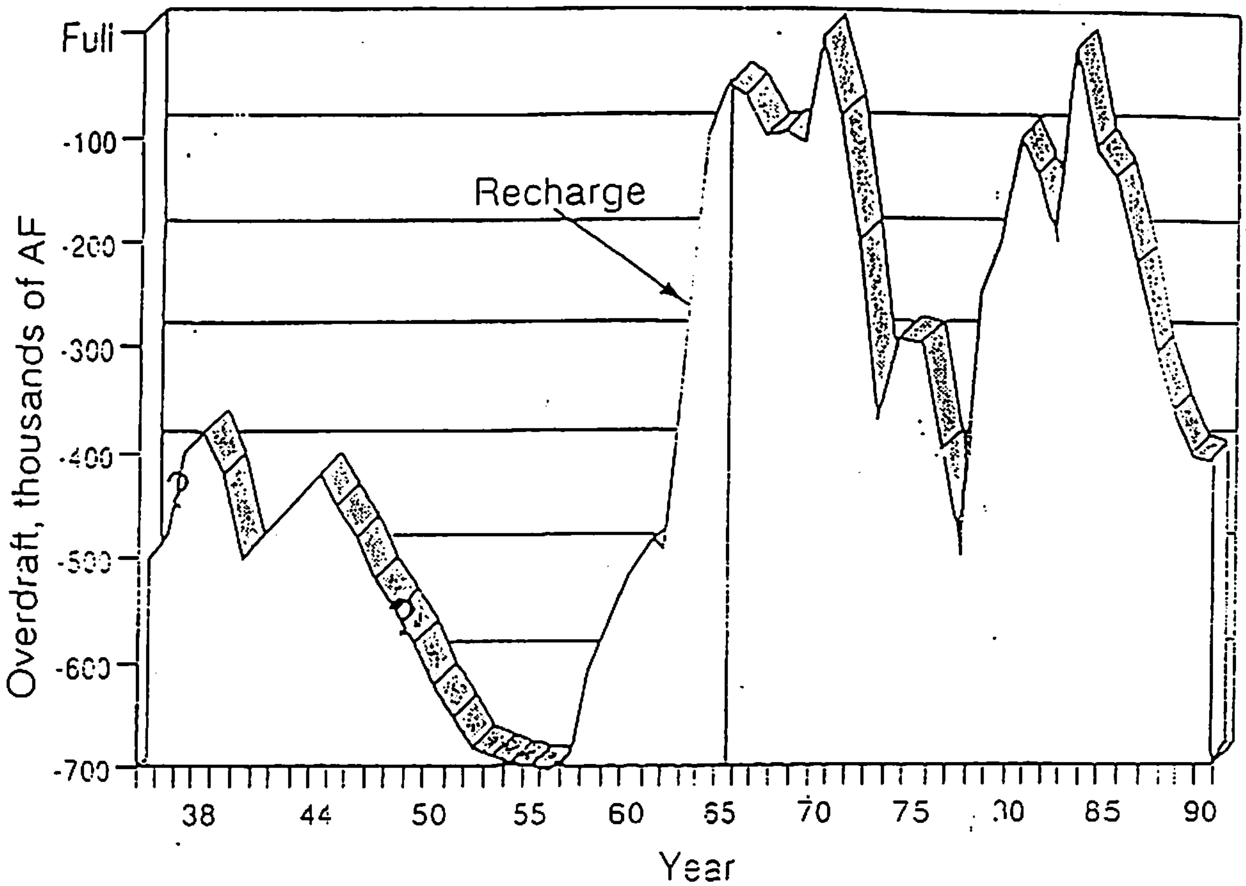
[142]Zachary A. Smith, Groundwater in the West 56 (San Diego, Calif.: Academic Press, Inc., 1989).

[143]Wechsler, supra at 113.

[144]Blomquist, supra at 38.

[145]Id. at 259.

Figure 3.3.11 Ground Water Storage in the Basin—1934-1990



Source: William R. Mills, "Orange County Ground Water Management," in Changing Practices in Ground Water Management: the Pros and Cons of Regulation 133 (Proceedings of the 18th Biennial Conference on Ground Water, Sept. 16-17, 1991; University of California Water Resources Center, California Department of Water Resources, and State Water Resources Control Board, Report No. 77, Sept. 1992).Mills, p.136

than those in the Pressure Area, which is more difficult to recharge.[146] Therefore, saltwater intrusion may still occur the Pressure Area when the Basin is refilled.[147]

OCWD uses all three of the most common techniques to control saltwater intrusion: injection wells; pumping wells; and artificial recharge (see Figure 3.3.12).[148] In the Alamitos Gap Barrier Project, 26 wells are used to inject about 4,000 acre-feet per year of fresh water purchased from the Metropolitan Water District (MWD).[149] This project is jointly operated by OCWD and Los Angeles County Flood Control District. The Orange County Coastal Barrier Project at the Talbert Gap project uses pumping wells, about two miles inland, and injection wells, about four miles inland, to alleviate saltwater intrusion.[150] The injected water is reclaimed wastewater from OCWD's Water Factory 21 and water pumped from a deep aquifer not affected by saltwater intrusion or used by other pumpers.[151]

3.3.1.5.2 Nature of the Arrangement

The development of groundwater management to alleviate overdraft problems in the Orange County Basin has been somewhat unusual in that the basin was never adjudicated in order to assign water rights and thereby provide a mechanism for limits on groundwater use.[152] In fact, when the OCWD was first formed in 1933, its functions were specifically restricted to management, rather than limitation, of water usage in the basin.[153]

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[146] Id. at 261.

[147] Id.

[148] Fetter, supra at 393-94.

[149] Blomquist, supra at 151.

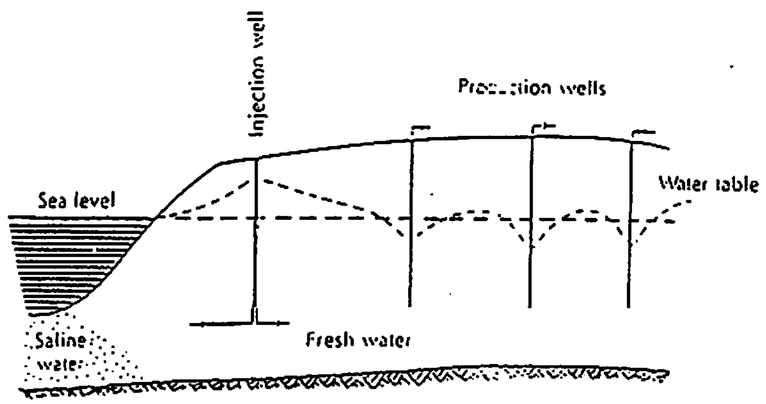
[150] Id. at 265-66.

[151] Id. at 266.

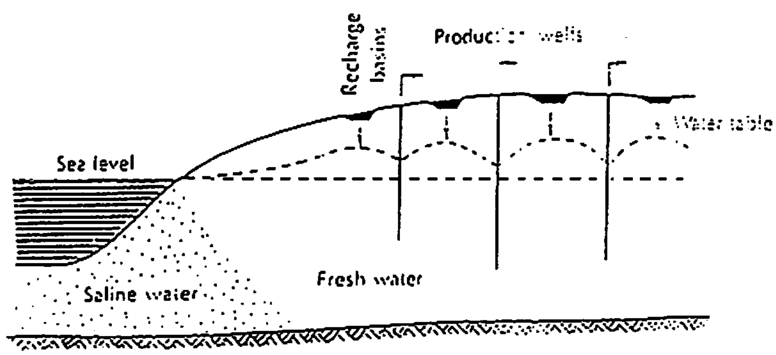
[152] Id. at 245.

[153] Id. at 249.

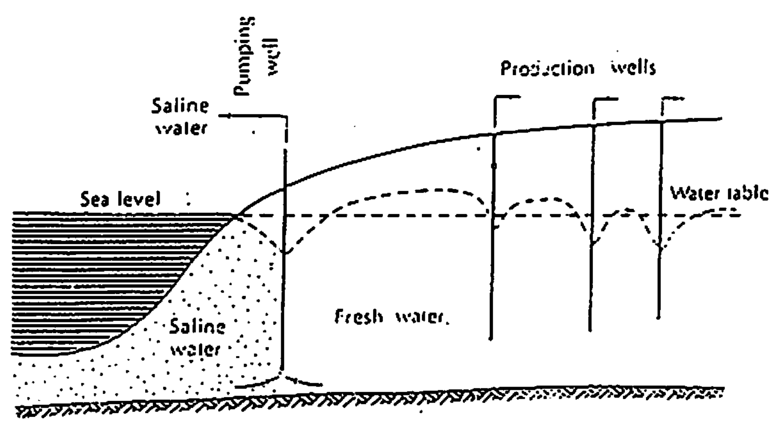
Figure 3.3.12 Common Saltwater Intrusion Control Techniques



Use of injection wells to form a pressure ridge to prevent saltwater intrusion in an unconfined coastal aquifer.



Use of artificial recharge in the area of production wells in an unconfined coastal aquifer. The artificially recharged water maintains the water table above sea level to prevent saltwater intrusion.



Use of pumping wells at the coastline to form a trench in the water table, which acts as a barrier to further saltwater encroachment.

Source: C.W. Fetter, Jr., Applied Hydrogeology 395 (Columbus, Ohio: Charles E. Merrill Publishing Co., 1980).

Three reasons seem to have contributed to the initial, and continued, preference for supply-side management. First, agricultural interests, which were dominant during the early years of the district, were more concerned at the time with protecting the main recharge source, the flow in the Santa Ana River.[154] OCWD was formed in large part to assist one of the dominant agricultural interests, The Irvine Company, in its litigation against upstream water users in the Santa Ana Watershed.[155] Second, even in the 1930s, the adjudication process would have been a costly, time-consuming process so most of the water users preferred to avoid the process.[156] Third, plentiful quantities of water were periodically available, either from the Santa Ana River or from sources outside of the watershed, so the water users wanted to take advantage of the times of plenty. Against this background, the district focused its early arrangements on ensuring an adequate supply of water to the basin rather than distributing a limited supply.[157] Costs were recovered primarily through ad valorem taxes.[158] However, because of continuing overdraft problems, increasing difficulties in ensuring adequate imported supplies, and apparent double payments for water,[159] OCWD has added two

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[154]Id. at 248.

[155]Id. at 248-49.

[156]Mills, supra at 137.

[157]Blomquist, supra at 250.

[158]The basic tax is a General Fund tax on all property owners, and its rate is limited to $0.08 per $100 of assessed value. Meyers, supra at 694. A second such tax was for the Water Reserve Fund, primarily for purchases of water to reduce the overdraft. The replenishment program, which was funded at least in part by this tax, was designed to take advantage of "surplus" MWD water which OCWD (correctly) projected would only be available for a few years. Wechsler, supra at 31. The tax was also of limited term and applied to all property owners, except owners of mineral rights, because the overdraft adversely affected development and property values throughout the district. Charles J.Meyers, A. Dan Tarlock, James N. Corbridge, Jr., and David H. Getches, Water Resource Management 694 (Mineola, NY: Foundation Press, Inc., 3rd ed., 1988). The ad valorem tax rate was limited to $0.12 per $100 of assessed value, although in 1970, the rate was only $0.06. Id.

[159]Water producers who were within the boundaries of MWD and OCWD paid: (1) taxes to MWD; (2) a charge for direct delivery of MWD water; and (3) taxes to OCWD to purchase water from MWD for ground water replenishment. Wechsler, supra at 16. Therefore, OCWD's taxes to pay for MWD water were perceived to be "double payments" for the water. Blomquist, supra at 253.

assessments,[160] based on water usage, that may function as limitations on water usage. The first assessment was designed to fund saltwater intrusion control measures, and the second assessment was designed to discourage use of groundwater in favor of imported water.

Because of the original restrictions on the function of the OCWD, which did not allow OCWD to tax pumping, the state legislature had to approve both of the new assessments.[161] Although neither of the assessments represents direct "demand-management" (or true limitation) techniques,[162] the assessments at least contribute to water users' awareness of the demands on the groundwater basin.

3.3.1.4.3 Parties Involved

OCWD Members: The first assessment, developed in the mid-1950s, was the Replenishment Assessment. This is applied uniformly to all groundwater pumpers in the district because of the basinwide benefits of control of saltwater intrusion.[163] The second assessment, the Basin Equity Assessment, was part of a multi-step conjunctive management plan which began in the 1960s.[164] This assessment applies only to those pumpers who withdraw more water than their annual allotment.

Other Water Agencies: OCWD's control of groundwater use in the Orange County Basin, through statutory authority, taxes and assessments, makes it an integral water agency in the county. However, it must also coordinate its activities with those of

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[160] In the references, the term "assessment" may refer to any tax imposed by OCWD. However, for clarity in this case study, the term "assessment" applies only to the those taxes based on the amount of groundwater pumped from the basin.

[161] Id. at 253-254.

[162] Id. at 255.

[163] Mills, supra at 135. An exception may be obtained through a public hearing, but the only exceptions noted were for pumping of seawater along the coast by OCWD and several oil companies. See Meyers, et al., supra at 694.

[164] Blomquist, supra at 266-267.

numerous other water agencies.[165] The geographic overlap between OCWD and MWD members is perhaps the most consequential. Three of the cities in OCWD were original members of MWD,[166] and almost all of the "assessed valuation" of Orange County was in MWD by 1960.[167]

OCWD Suppliers: Because of OCWD's express preference for supplying rather than controlling water use, OCWD is dependent on outside water suppliers. MWD has essentially had a monopoly on the supply of water to OCWD,[168] although OCWD eventually obtained some water from the State Water Project.[169] OCWD relies on various institutional "balances" to minimize the potential adverse impact of such a monopoly, including representation on boards of directors and purchase of MWD water through the Orange County Municipal Water District rather than directly from MWD.[170]

3.3.1.4.4 Terms of the Assessments

Replenishment Assessment: When this assessment was first imposed in 1956, the rate was $3.50 per acre-foot of groundwater pumped from the basin.[171] At the time, use of revenue from the assessment was restricted to water purchases for artificial recharge. In 1963, two separate rates were established, one for irrigation use and the other for non-irrigation use,[172] "in recognition that some prior rights lay with the area's

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[165]"Orange County Water District has day-to-day concern with the activities of more than fifteen public water districts, twenty municipal utilities, five commercial water companies (public utilities), over 140 mutual water companies, and several hundred individual private well owners." Wechsler, supra at 1.

[166]Blomquist, supra at 247.

[167]Id. at 259.

[168]Wechsler, supra at 25-26.

[169]Blomquist, supra at 264.

[170]Wechsler, supra at 25-26.

[171]Mills, supra at 135.

[172]Blomquist, supra at 256, Table 11.1.

farmers."[173] The irrigation and non-irrigation rates were originally $8.00 and $11.00, respectively and, by 1990, the rates had risen to $23.00 and $45.00, respectively.[174] Also, the revenue may now be used to finance water recycling and groundwater treatment projects as well as water purchases to maintain groundwater levels.[175]

Basin Equity Assessment: In the 1970s, OCWD began conjunctive management of surface and groundwater supplies to alter use patterns and preserve groundwater for emergency and peaking supplies.[176] OCWD's conjunctive management plan included four main steps: (1) establish a guaranteed minimum inflow from the Santa Ana River (see discussion above); (2) increase the capacity of the artificial recharge facilities in the basin; (3) "wall off" the basin from saltwater intrusion (see discussion above); and (4) consider a system of rewards and penalties for restraint from or reliance on use of groundwater.[177] The first three steps are directed at improving the physical situation in the basin. However, the fourth step represents the mechanism for management (limitation) of groundwater dependence, i.e. the Basin Equity Assessment.

In 1969, the District asked the state legislature for authority to implement an idealized limit on the amount of groundwater that can be pumped from the basin in comparison with the amount of water imported to the basin.[178] This ratio of groundwater to imported water, the Basin Production Percentage, applies to each pumper in the basin except those who produce less than 25 acre-feet of water per year for nonirrigation use (and use only a small percentage of the water pumped from the

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[173]Meyers, supra at 694.

[174]Blomquist, supra at 256, Table 11.1.

[175]Mills, supra at 135.

[176]Blomquist, supra at 261, 267.

[177]Blomquist, supra at 267.

[178]Mills, supra at 137.

basin).[179] To provide incentive for compliance with the Basin Production Percentage, a Basin Equity Assessment is levied on those who pump more than their allotment of groundwater. Users who pump less than their allotment are reimbursed.

The Basin Production Percentage and Equity Assessment are recalculated each year based on conditions in the basin and the availability of water from outside the basin. The assessment rate is usually based on the difference in cost between pumping groundwater and the more expensive alternative of importing MWD water. First, a target ratio of groundwater to imported water usage is calculated.[180] Then the performance of each user is compared with the target ratio. For example, if the basin Production Percentage is 60 percent, then a user may obtain 60 percent of his annual supply from groundwater. If the user obtains more than 60 percent of his supply from groundwater, then the Basin Equity Assessment is imposed to ensure the user does not benefit from using a greater percentage of the lower-cost groundwater than other users in the basin. Those users who obtain less than 60 percent of their annual supply from groundwater are reimbursed for their higher costs of using imported water.

In 1982-83, the Basin Equity Assessment was $62 per acre-foot.[181] However, the assessment may be individualized on several different bases.[182] The costs of water pumping or importation vary from user to user, so the individual assessment would need to reflect the variances. A higher assessment should encourage less groundwater pumping, as might be desired near the ocean; a lower assessment should encourage more groundwater pumping, as might be desired to reduce groundwater migration to the Central Basin.

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[179]Blomquist, supra at 266.

[180]Meyers, supra at 695.

[181]Smith, Paula K., "Coercion and Groundwater Management: Three Case Studies and a 'Market Approach,'" 16 Envt'l. Law 797, 833 (1986).

[182]Mills, supra at 137.

3.3.1.4.5 Physical requirements

The physical requirements for the assessments include record keeping, facilities for delivering imported water to the basin, and adequate artificial recharge facilities. The record keeping system was established when the Replenishment Assessment was implemented.[183] The facilities for delivery of imported water to the basin are in place because of the geographic overlap of MWD and OCWD members and OCWD's reliance on MWD water. Construction of adequate recharge facilities has proven more difficult in recent years as the price of land has escalated.[184]

3.3.1.4.6 Status

Both the Replenishment Assessment and Basin Equity Assessment have been imposed on an annual basis since they were started, and indications are that the programs will be continued.

3.3.1.4.7 Unresolved issues

To date, the OCWD's arrangements for limitation of groundwater usage in the basin have improved the protection for the basin groundwater users.[185] Although the amount of groundwater production has risen by about 50,000 acre-feet since the mid-1950s, groundwater is now only about one-half of the total water obtained for use in the basin (see Table 3.3.1). However, concerns have been expressed as to the long-term stability of the arrangement, the effectiveness of these assessments as limitations on groundwater use,[186] and the fairness of the assessments.[187]

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[183]Blomquist, <u>supra</u> at 254.

[184]<u>Id.</u> at 264.

[185]<u>Id.</u>

[186]<u>Id.</u> at 270.

[187]Smith (1986), <u>supra</u> at 833.

Table 3.3.1 **Orange County Groundwater Production and Total Water Obtained, 1953—1990 (acre-feet)**

Year	Groundwater production	Total water obtained	Groundwater percentage
1953	213,800	230,386	92.8
1954	210,000	229,113	91.7
1955	148,224	173,281	85.5
1956	153,677	181,822	84.5
1957	186,025	233,290	79.7
1958	160,247	203,724	78.7
1959	208,572	260,587	80.0
1960	207,448	278,605	74.4
1961	226,025	309,188	73.1
1962	177,172	255,190	69.2
1963	186,093	273,285	68.0
1964	188,603	290,039	65.0
1965	179,798	283,278	63.5
1966	182,172	272,813	66.8
1967	169,375	264,295	64.1
1968	193,656	303,860	63.7
1969	178,798	288,413	62.0
1970	194,379	331,660	58.6
1971	203,923	337,763	60.4
1972	229,048	372,737	61.5
1973	214,983	332,960	64.6
1974	218,863	353,723	61.9
1975	225,597	356,256	63.3
1976	245,456	399,728	61.4
1977	243,511	392,919	62.0
1978	188,407	347,290	54.3
1979	213,290	376,797	56.6
1980	221,453	402,129	55.1
1981	228,943	445,308	51.4
1982	244,184	416,463	58.6
1983	249,548	392,480	63.6
1984	223,207	450,130	49.6
1985	252,070	414,000	60.9
1986	270,932	459,569	59.0
1987	276,354	459,949	60.1
1988	265,226	489,609	54.2
1989	275,077	507,380	54.2
1990	261,190	516,873	50.5

Source: William Blomquist, Dividing the Waters: Governing Groundwater in Southern California 260 (San Francisco: The Center for Self-Governance, 1992).

One concern centers on the performance of the system during droughts and energy shortages.[188] The amount of water available for imports may be low and the cost of importing what water is available high. Because the basin is dependent in large part on imported supplies, significant pressure could be imposed to increase groundwater production if costs for imported water are high, as in the late 1970s.[189] Two other concerns include: the lack of uniformity in imposition of the assessments, particularly between agricultural and non-agricultural users;[190] and the different methods that could be used to calculate the costs which go into the assessments.[191]

Perhaps the greatest concern involves the lack of transferable water rights in OCWD. Under the present arrangement, a water user who stops using groundwater receives no benefit; therefore, no market exists for transferring water to a higher-value use.[192]

3.3.1.5 Las Vegas Valley Groundwater Recharge, Nevada

3.3.1.5.1 Description of the basin

The Las Vegas Valley basin is an area of about 350 square miles (224,000 acres) in the southeastern part of Nevada (see Figure 3.3.13).[193] Spanish explorers designated

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[188]Blomquist, supra at 270.

[189]Id. at 264.

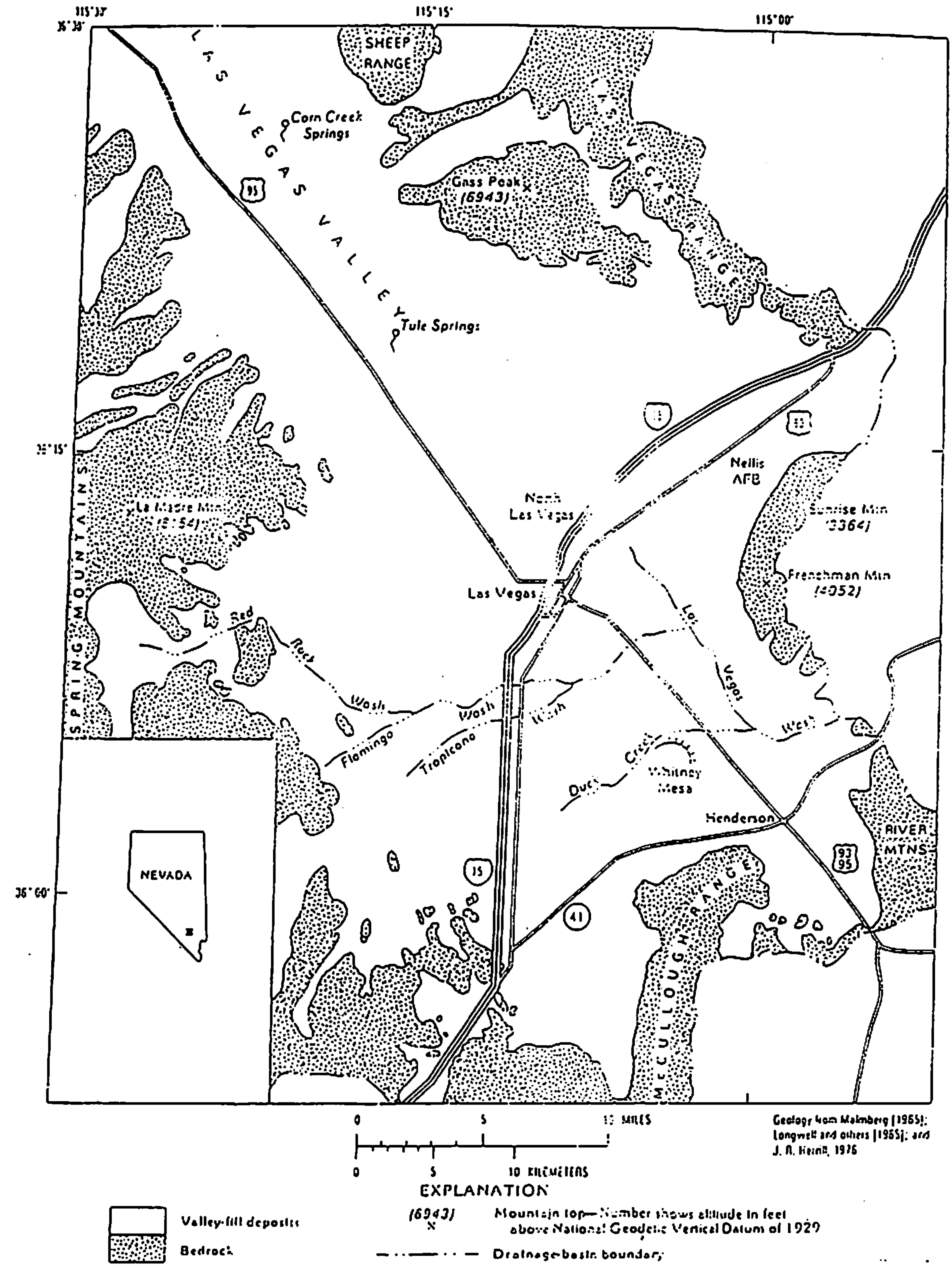
[190]Smith (1986), supra at 841.

[191]Wechsler, supra at 55-56.

[192]Blomquist, supra at 270.

[193]P.A. Domenico, Ground Water in Las Vegas Valley 9 (Reno, NV: Desert Research Institute, University of Nevada, Tech. Rep. No. 7, April 1964, prepared in cooperation with the Dept. of Conservation and Natural Resources, State of Nevada). Malmberg describes the Las Vegas Ground-Water Basin (the Basin) which covers an area of about 3,000 square miles and includes parts of four different valleys (Las Vegas, Indian Spring, Three Lakes, and Ivanpah). Glenn T.Malmberg, Available Water Supply of the Las Vegas Ground-Water Basin, Nevada 2-3 (USGS Water Supply Paper 1780, 1965). The Las Vegas Valley covers the majority of the Basin, but Malmberg included the other three valleys in his water supply study because of possible interconnection with Las Vegas Valley. Id. at 3-4.

Figure 3.3.13 **Las Vegas Valley, Nevada**



Source: Russell W. Plume, Ground-Water Conditions in Las Vegas Valley, Clark County, Nevada, Part 1, Hydrogeologic Framework A3 (USGS Water Supply Paper 2320-A, 1989; prepared in cooperation with the Clark County Dept. of Comprehensive Planning).

the area "Las Vegas" ("The Meadows") because of grasslands near springs in the Valley.[194]

The valley was first developed for agriculture in the mid-1800s.[195] However, wells did not need to be drilled for water supplies until the early 1900s because the valley springs provided sufficient water initially. More intensive urban development began in the 1920s and 1930s as a result of federal construction projects and military facilities, such as Hoover Dam and Nellis Air Force Base. Tourism became a dominant industry after World War II, and in recent years urban growth has been rapid. In 1955 the population was about 50,000.[196] In 1992 the population of the valley was approximately 850,000, with an annual "tourist population" of 20 million.[197]

The aquifers in the Las Vegas Valley are typical of those in many areas of the western United States, occurring in north-south trending valleys bounded by mountain ranges. The Las Vegas Valley boundaries include: the Spring Mountains on the west; the Sheep and Las Vegas Ranges on the north; the River Mountains and McCullough Ranges on the south; and the Sunrise and Frenchman Mountains on the east (see Figure 3.3.13).[198] Material eroded from the surrounding mountains has filled the valley with layers of unconsolidated sands, gravels, silts, and clays.[199] Relatively permeable sand and gravel layers in the valley fill, vertically separated by less permeable clay and silt layers, comprise the three main aquifers in the valley (shallow, middle, and deep), which

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[194]Carpenter, Everett, Ground Water in Southeastern Nevada 31 (USGS Water Supply Paper 365, 1915).

[195]Domenico, supra at 11.

[196]Malmberg, supra at 17.

[197]Lou Cannon, "Las Vegas Looks to Santa Barbara for Share of Pacific Ocean Water," Los Angeles Times, Metro Part B, p.6 (7/26/92).

[198]Russell W.Plume, Ground-Water Conditions in Las Vegas Valley, Clark County, Nevada, Part 1, Hydrogeologic Framework A2 (USGS Water Supply Paper 2320-A, 1989; prepared in cooperation with the Clark County Dept. of Comprehensive Planning).

[199]Id. at A9.

are confined under natural conditions (see Figure 3.3.14).[200] The vertical separation is not perfect, however. Some vertical leakage can occur through the clay and silt layers, and the valley springs were supplied by a series of faults which provided natural conduits for upward leakage of ground water. The upward leakage also contributed to a fourth, near surface, aquifer, which is under water table or artesian conditions, depending on location.

The valley fill is up to 5,000 feet thick beneath most of the valley, but is only approximately 2,000 feet thick on the west side.[201] The variation in the thickness of the valley fill is the result of faulting. The fill in the west side of the valley is also composed of more sand and gravel than in east side.[202] The variation in composition is probably the result of changes in the extent and erosion of the surrounding mountains.[203] Most of the bedrock underlying the valley consists of limestone and dolomite.[204] The annual natural recharge to the valley is estimated to be between 25,000 and 35,000 acre-feet per year.[205] The average annual rainfall in the valley is only 4.5 inches, based on the 1896-1955 records.[206] However, the mountain watersheds which drain to the valley cover an area of about 3,000 square miles (almost 2 million acres),[207] and the average annual precipitation in the mountains may be as much as 40 inches per year.[208] Therefore, most of the valley recharge is from snowmelt in the spring.[209] Also, most of that

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[200]Malmberg, supra at 27.

[201]Plume, supra at A13.

[202]Malmberg, supra at 24-25.

[203]Plume, supra at A11.

[204]Id. at A4.

[205]Malmberg, supra at 57; Smith (1989) at 151.

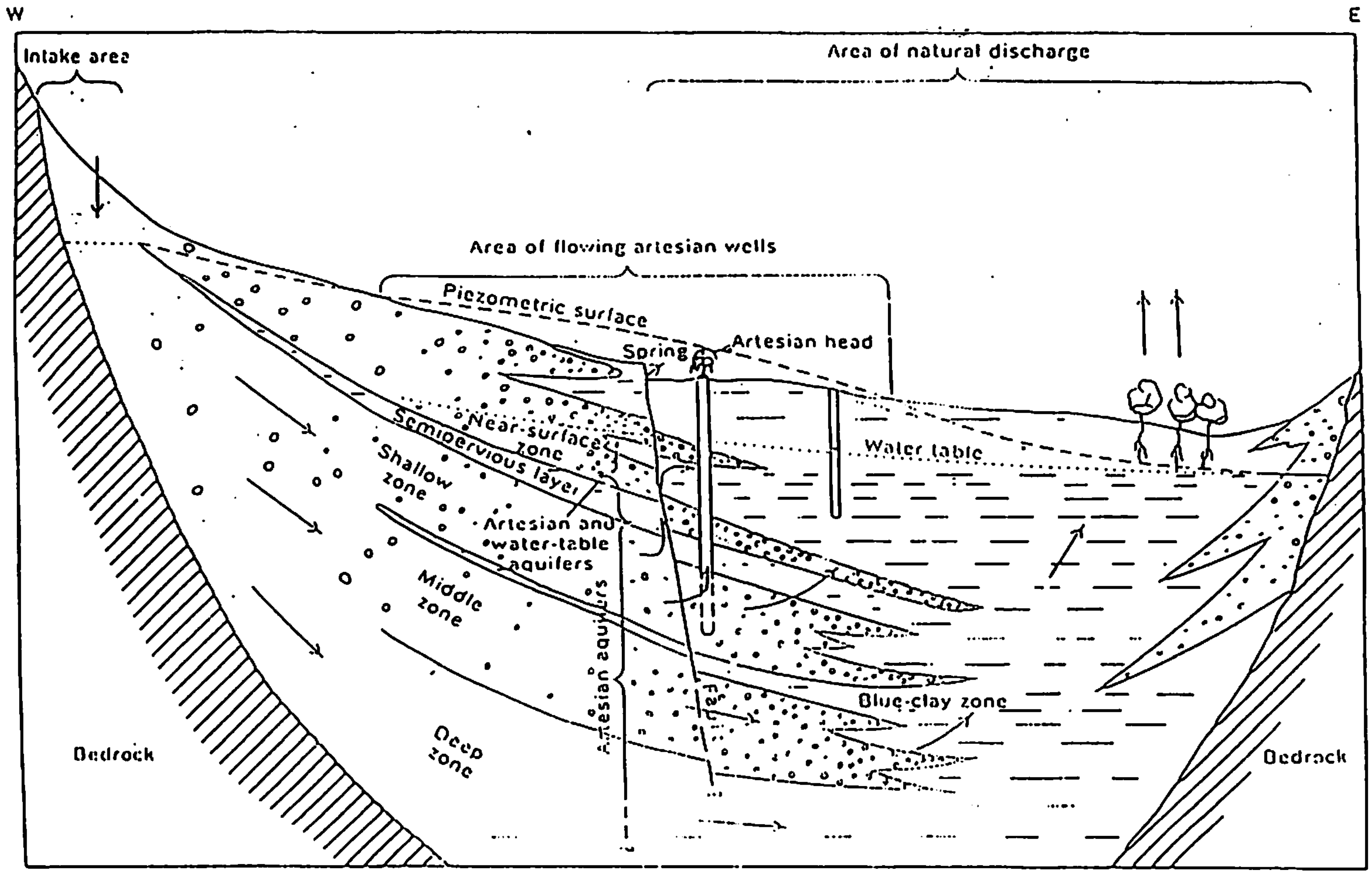
[206]Malmberg, supra at 13.

[207]Domenico, supra at 9.

[208]Smith (1989), supra at 149.

[209]Malmberg, supra at 16.

Figure 3.3.14 Las Vegas Valley Showing the Principal Zones of Aquifers, Direction of Ground-water Movement, and General Geology of the Valley Fill



Source: Glenn T.Malmberg, Available Water Supply of the Las Vegas Ground-Water Basin, Nevada 28 (USGS Water Supply Paper 1780, 1965).

recharge probably enters the valley fill through the bedrock rather than as infiltration of runoff.[210] Historically, the amount of recharge to the valley was sufficient to create artesian conditions, evidenced by the springs and flowing wells. However, as groundwater development increased, pumping of groundwater drew down the water levels to the point where springs and wells no longer flowed, deeper wells had to be drilled,[211] and land subsidence became a problem.[212]

The only outlet for water from the basin is Las Vegas Wash which flows to the east through a gap between Frenchman Mountain and the River Mountains.[213] Before water development began in the valley, this wash did not flow except during floods.[214] The wash now flows due to contributions from: the near-surface aquifer, which is recharged by inefficient lawn and agricultural irrigation;[215] stormwater runoff from urban areas; discharge from sewage treatment plants; and cooling water discharge from a power plant.[216]

Overdraft of the valley (withdrawal of more water than is recharged) is chronic, a problem shared by many western urban areas. Examples of the estimated annual overdrafts in the valley include: 1955, 23,000 acre-feet;[217] 1968, 88,000 acre-feet; and 1988, 33,000 acre-feet.[218] Also, as is typical across the western United States, the highest demand for water usage coincides with the hottest, driest months. The groundwater recharge project was started in part because the systems for delivery of

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[210]Plume, supra at A7-A8.

[211]Domenico, supra at 11.

[212]Plume, supra at A7.

[213]Malmberg, supra at 58-59.

[214]Malmberg, supra at 29.

[215]Id. at 69.

[216]Plume, supra at A2.

[217]Malmberg, supra at 1.

[218]Smith (1989), supra at 151.

water to the valley from Lake Mead, in which Colorado River water is stored, would not be sufficient to meet projected peak summer requirements, although the delivery systems were more than adequate for winter requirements.[219] The arrangement was designed to take advantage of the seasonal fluctuation in demand.

3.3.1.5.2 Nature of the arrangement

Parties Involved: The Las Vegas Valley Water District (LVVWD) provides most of the municipal water supply, and relies on surface and groundwater storage. At present, the arrangements for groundwater storage and withdrawal by LVVWD are relatively straightforward. LVVWD is essentially taking part of its share of Colorado River water, which has been stored in Lake Mead, treating that water, and storing it in the valley aquifers.[220] Therefore, the only potential "outside" parties would be other groundwater users within the area of influence of the recharging wells. However, no mention of such users was found in the literature. As discussed below, the arrangements will become more complicated if the groundwater recharge program expands.

Terms: The timing of LVVWD's withdrawals from Lake Mead is the key to the arrangement because LVVWD takes water from the river in the winter, when the demand is low, and "banks'" it for peaking requirements in the summer.[221] LVVWD has contracts for 247,833 acre-feet per year of water from the Colorado River,[222] and permits for about 25,000 acre-feet per year of groundwater in the Las Vegas Valley.[223]

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[219]Kay Brothers, and Terry Katzer, "Water Banking through Artificial Recharge, Las Vegas Valley, Clark County, Nevada," Journal of Hydrology, vol. 115, pp. 77, 78 (1990).

[220]Las Vegas Valley Water District, 1992 Artificial Recharge Summary 2-3 (submitted to the Nevada State Engineer, Feb. 10, 1993).

[221]Id., at 4, Fig. 1.

[222]Telephone conversation with Daryl Crow, Colorado River Commission (Sept. 27, 1993).

[223]Brothers, supra at 77.

3.3.1.5.3 Physical Requirements

Because LVVWD already had delivery systems for water from Lake Mead, only recharge wells, production wells, and the associated local delivery and retrieval systems were needed for the groundwater recharge program. Under its groundwater permits, Las Vegas may pump from all 30 of its public wells during the summer months but is limited to six wells in the winter.[224] Because the valley did not use its production wells all year, the groundwater recharge system was designed to use the production wells as recharge wells, rather than using separate recharge and production wells.[225] In other words, water is pumped from the wells during the summer and pumped into the same wells during the winter. This overlap was particularly convenient because the LVVWD well field is about two miles west of the municipal area.

One concern for groundwater recharge is the compatibility of the recharge water with the naturally occurring groundwater and aquifer material.[226] For the LVVWD, the particular concern was the potential for calcium precipitation.[227] The chemical composition of Colorado River water depends on the volume of runoff over the previous few years, the quality of tributary flow into Lake Mead, the quality of upstream releases, and retention time in Lake Mead.[228] LVVWD uses the Alfred Merritt Smith treatment facility at Lake Mead to clean the water it withdraws from the lake, but the treatment does not substantially change the characteristics that would contribute to calcium precipitation, such as alkalinity.[229]

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[224]Smith (1989), supra at 151.

[225]Brothers, supra at 79.

[226]C.W. Fetter, Jr., Applied Hydrogeology 392 (Columbus, Ohio: Charles E. Merrill Publishing Co., 1980).

[227]Brothers, supra at 78.

[228]Terry Katzer, and Kay Brothers, "Artificial Recharge in Las Vegas Valley, Clark County, Nevada," 27 Ground Water, 50, 52 (Jan.-Feb. 1989).

[229]Id. at 53.

3.3.1.5.4 Status

Las Vegas began studying the possibilities of artificial recharge and subsequent withdrawal with a pilot project in 1987 and a demonstration project in 1988 which were designed to test both the potential for calcium precipitation and the efficiency of using production wells as recharge wells.[230] In 1988, 1150 acre-feet of water were injected using two wells.[231] This recharge was used to cover groundwater withdrawals by LVVWD in excess of their permits. Since 1988, the program has expanded annually (see Table 3.3.2). Also since 1988, none of the recharge water has been used to "cover" excessive groundwater withdrawals, so all of the recharged water, 44,302 acre-feet total, has been allocated to LVVWD's "artificial recharge storage account."[232]

Table 3.3.2 Groundwater Recharge - Las Vegas Valley Water District

YEAR	AMOUNT OF WATER INJECTED (ACRE-FEET)	NUMBER OF INJECTION WELLS
1989	3,677	8
1990	10,389	13
1991	14,621	16
1992	15,616	24

Source: Las Vegas Valley Water District, 1992 Artificial Recharge Summary (submitted to the Nevada State Engineer, Feb. 10, 1993) p. 2,4.

3.3.1.5.5 Unresolved Issues

The existing framework for water allocation in the Colorado River drainage and in Nevada and the demand for water in the Las Vegas Valley have contributed in part to

[230]Brothers, supra at 79.

[231]Las Vegas Valley Water District, supra at 2.

[232]Id.

the difficulties that LVVWD continues to face. First, the valley relies on water imported from the Colorado River. Because the valley was able to negotiate the right to import this water in the past, similar negotiations for importing water from other sources are a logical next step. Second, the limited water resources of the valley have been over-appropriated, so demand continues to exceed renewable supply.

Nevada's share of Colorado River water was negotiated before the extensive urbanization in the Las Vegas Valley. It has been predicted that, by the year 2006, even with conservation efforts, Nevada will use its full, annual Colorado River entitlement of 300,000 acre-feet per year.[233] In 1989, because of the poor prospects for LVVWD to obtain additional water from the Colorado River, LVVWD filed applications with the Nevada State Engineer for an appropriation of 185,000 acre-feet of groundwater in other valleys in southeastern Nevada and an appropriation of 70,000 acre-feet of surface and groundwater from the Virgin River Valley.[234] This project is termed the Cooperative Water Project, and covers an area of about 20,000 square miles.[235]

In the Las Vegas Valley, the Nevada State Engineer's Office has recognized appropriations for 70,000 acre-feet per year in permanent water rights, an amount twice that of optimistic estimates of natural recharge to the valley.[236] In addition, 40,000 acre-feet of temporary water rights have been assigned, reportedly to allow users to develop sufficient economic base to finance permanent solutions.[237] In recognition of the fact that the valley water supplies are overappropriated, the State Engineer plans to reduce the appropriations in the Valley to 50,000 acre-feet.[238] Unfortunately, once reliance on a water supply is established, it is usually difficult to curtail that reliance.

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[233]Terry Katzer, "Meeting Urban Water Demands in Nevada, the Las Vegas Proposal," in Groundwater Law, Hydrology and Policy in the 1990s 1 (Natural Resources Law Center, June 15-17, 1992).

[234]Id. at 1-2.

[235]Id. at 2.

[236]Smith (1989), supra at 155.

[237]Id.

[238]Id.

3.3.1.6 Arizona-California Colorado River Water Storage Agreement

On October 15, 1992, the Central Arizona Water Conservation District (CAWCD) and the Metropolitan Water District of Southern California (MWD) entered into a written agreement "for a demonstration project on underground storage of Colorado River water." The agreement has two purposes: (1) to allow MWD to use Colorado River water that otherwise would be released from Lake Mead for flood control purposes (and thus flow unused to Mexico), and (2) to alleviate the impacts of shortages on CAWCD in dry years.

The agreement is based upon the detailed allocation of Colorado River water among the states in the Lower Colorado River basin (Arizona, Nevada, and California) and the Central Arizona Project (CAP). The CAP delivers Arizona's allotment of Colorado River water from Lake Mead to Central Arizona. The two organizations that developed the Colorado River Water Storage Agreement have diverse responsibilities. MWD's service area includes heavily urbanized areas in the southern part of California. MWD was authorized by the California legislature in 1927 as "the agency representing a coalition of municipalities advocating the construction of an aqueduct from the Colorado River to serve the growing Southern California region."[239] MWD had the exclusive rights for allocation of this water, and similar arrangements were made with MWD in the 1950s for water from California's State Water Project.[240] In contrast, CAWCD is the central contracting authority for a variety of water-using entities, including Indian tribes, irrigation districts, municipalities, and industries who want access to water from the Central Arizona Project. CAWCD was authorized by the Arizona legislature in 1971 as the "umbrella agency" responsible for coordinating the water allocation and project operation with federal agencies, primarily the Bureau of Reclamation.[241]

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[239] Robert Gottlieb & Margaret FitzSimmons, A Thirst for Growth—Water Agencies as Hidden Government in California 6 (1991).

[240] Id.

[241] Richard W. Wahl, Markets for Federal Water—Subsidies, Property Rights, and the Bureau of Rreclamation 226 (1989).

The general delivery area for the CAP water consists of a series of inter-montane basins,[242] similar in both topography and climate to the Southern Nevada region in which the Las Vegas Basin is located. Agriculture is the dominant industry in most of these basins, with the exception of population centers such as Phoenix. Groundwater development began in the mid-1800s, primarily for agriculture, and as in Orange County and Las Vegas, overdrafts of the basins are widespread and chronic.[243]

3.3.1.6.1 Characterizing the agreement

The agreement is described as similar to a bank account, in which the currency is water from the Colorado River transported through the Central Arizona Project (CAP) canal to underground basins in Arizona.[244] CAWCD plays the role of a banker, keeping track of and maintaining physical control over water deposited underground. MWD is a depositor, of sorts, paying to cover the operation and maintenance and energy costs of transporting the water, and in exchange receiving credits for the water. The conditions for MWD to "cash in" its credits are quite limited, only available when certain conditions are met. Similarly, CAWCD may only put the stored groundwater to use if certain conditions are present.

The bank account model is not entirely accurate, and is somewhat misleading. The deposited water does not come from MWD's allocation of Colorado River water, but rather represents surplus water that otherwise would flow to Mexico if not diverted. Thus, MWD is not "depositing" its own water into the Arizona groundwater basins, but rather is helping fund CAWCD's diversion of this water. CAWCD, not MWD, holds the legal title to water diverted through the CAP pursuant to this agreement. Thus, this is

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[242]T.W. Anderson, Geoffrey W. Freethey, and Patrick Tucci, Geohydrology and Water Resources of Alluvial Basins in South-Central Arizona and Parts of Adjacent States, U.S. Geological Survey Prof. Paper 1406-B, B1 (Washington, D.C.: U.S. Government Printing Office, 1992).

[243]Id. at B62.

[244]It is called the "Interstate Underground Storage Account." Agreement for Demonstration Project—Underground Storage of Colorado River Water, Oct. 15, 1992, Central Arizona Water Conservation District and Metropolitan Water District of Southern California, § 3.5 [hereinafter "Agreement"].

not a transfer of water rights from one entity to another, but rather is an accommodation between two entities that both hold water rights in a single, somewhat unpredictable source. Our contact at CAWCD described this as a "forbearance agreement," not an interstate transfer of water. A publication produced by MWD, however, describes the arrangement in language implying that the stored water belongs to MWD.[245]

3.3.1.6.2 Establishment of the account

The demonstration project (essentially a first phase of the agreement) is set up to take advantage of unused CAP capacity in 1992, 1993, and 1994—the time remaining before a notice of completion is filed on the CAP. Up to 100,000 acre-feet may be transported through the CAP to Arizona groundwater basins pursuant to the demonstration project. In 1992, 30,000 acre-feet of credits were accumulated; CAWCD expects to receive an additional 40,000 acre-feet in 1993 and 30,000 acre-feet in 1994. Although CAWCD bears the original cost of transporting and storing the water, MWD in 1992 compensated CAWCD at a rate of either $68 or $80/acre-foot, depending on the type of storage mechanism CAWCD used under Arizona law.[246]

3.3.1.6.3 Operation of the account

The Interstate Underground Storage Account thus begins with water obtained by CAWCD with MWD's financial assistance. In subsequent years, CAWCD will divert surplus water from the Colorado River (as described below), but for now the parties' agreement refers only to the waters accumulated for the demonstration project–unused water in the CAP. At the start, MWD has no right to claim this water or to claim other

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[245] "In water abundant years . . . Metropolitan will store surplus water from Lake Mead in Arizona groundwater basins. . . . Believed to be the first instance of an agency storing water in another state, the exchange is an example of how California water agencies are developing new supplies without building additional facilities." Focus (Metropolitan Water District of Southern California newsletter, 1993).

[246] The $68/acre-foot charge includes the costs of operation and maintenance ($32/af) and pumping energy ($35/acre-foot) for delivery of water through the CAP system. The $80/af charge includes these same CAP delivery costs, as well as the additional costs ($12/acre-foot) for operation, maintenance, and development of an Underground Storage and Recovery Project (an entity defined by state law). Agreement, supra at § 6.

Colorado River water in exchange for it. MWD's rights to withdraw water develop over time as it accumulates "credits" as described below.

3.3.1.6.4 Credits to the account

According to the agreement, MWD may build credits in the underground storage account in several instances: (1) the Secretary of the Interior declares that Colorado River water must be released from Lake Mead pursuant to flood control regulations; (2) the Secretary orders anticipatory flood control releases; or (3) the Secretary declares a surplus on the river (i.e., projected demands for consumptive use by lower basin states are forecast to be less than 7.5 million acre-feet). Under any of these conditions, CAWCD will assign "Interstate Underground Storage credits" to MWD's account. The credits (measured in acre-feet) will equal the spilled or surplus water, up to a maximum accumulation of the total acre-feet previously transferred to and stored in Arizona groundwater basins.[247]

3.3.1.6.5 Withdrawals from the Account

The account may be drawn down in two ways: (1) MWD takes water from the Colorado River that otherwise would belong to CAWCD; or (2) CAWCD withdraws stored groundwater to alleviate shortage conditions.

Withdrawals by the MWD: The MWD may draw against its account through exchanges for Colorado River water. The first condition, of course, is that credits have accumulated pursuant to the process described above. The second condition is that the Colorado River must be flowing high enough to entitle Arizona to its full 2.8 million

[247]Presumably, once the period of the demonstration project has expired, CAWCD will divert and store (at MWD's expense) this surplus water, up to the maximum capacity of its storage basins. However, once again, the parties' agreement refers only to the demonstration project.

acre-feet diversion. Third, MWD must give advance notice to CAWCD that it intends to claim credits from the account.[248]

If these conditions are met, MWD may take water in addition to its entitlement from the Colorado River, and CAWCD will reduce its diversions through the CAP accordingly. (This is the "forbearance" aspect of the account that our CAWCD contact mentioned.) The CAWCD will reduce MWD's credits in the Interstate Underground Storage account by 110 percent of the amount of water that MWD withdraws from the Colorado River. (The 110 percent figure is necessary to account for the Arizona state law requirement to leave part of the stored water underground; it is a kind of insurance policy for groundwater storage.) MWD may withdraw up to 15,000 acre-feet per month if all the conditions are met.

Withdrawals by the CAWCD: In years in which the Secretary of the Interior declares shortage conditions resulting in at least 300,000 acre-feet less than 7.5 million acre-feet of Colorado River water being available to the lower basin <u>and</u> CAWCD is required to reduce its diversions from the Colorado River by a specified amount, CAWCD may withdraw water from the underground basins. This water will offset the shortage and thus reduce the impact of dry conditions on CAWCD's customers. Every acre-foot that CAWCD withdraws under these conditions is one less acre-foot available for MWD to claim as a credit in a wet year.

3.3.1.6.6 Participation by Other Parties

The agreement permits the joinder of the Southern Nevada Water Agency (SNWA) and three California agricultural water suppliers.[249] SNWA's participation is limited to a maximum of 50 percent of the stored water credits; the California agencies

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[248] The MWD newsletter mentions another condition: "As a protection for Arizona, water levels in [Lake Mead] must return to the pre-transfer levels before Metropolitan can use the additional Colorado River water." <u>Focus</u> (Metropolitan Water District of Southern California newsletter, 1993). This requirement does not appear explicitly in the agreement, although it is implied by the conditions for building MWD's credits in the account (flood conditions or a surplus indicate that the reservoir has filled).

[249] These agencies include Palo Verde Irrigation District, Imperial Irrigation District, and Coachella Valley Water District. Agreement, <u>supra</u> at § 18.1.

may participate up to 25 percent of the stored credits. We understand that SNWA has agreed to participate, although we do not have any documents describing the agreement. The California agencies have not signed on or contributed funds for the demonstration project.

Chapter 4

ISSUES IN THE DESIGN AND OPERATION OF A WATER BANK

The preceding sections have established the rationale for the establishment of water banks and have described the major water banks that have operated to date. Those banks have exhibited quite different designs in terms of participants, types of water involved, and pricing and allocation rules. In this section, we will discuss the issues that need to be addressed in designing a water bank and alternative ways of dealing with those issues. The section concludes with general recommendations for water bank design under conditions prevailing in the western United States.

4.1 FUNDAMENTAL ISSUES IN DESIGNING A WATER BANK

The issues involved in designing the institutional features of a water bank and its operations can be addressed at three different levels: (1) general issues in allocation mechanism design; (2) issues specific to water allocation mechanisms; and (3) detailed issues specific to water banks.

4.1.1 General Issues

The theory of allocative mechanisms has a large literature, especially the work of Hurwicz.[1] Table 4.1.1 exhibits the major characteristics that one would like to see incorporated in any (abstract) allocative mechanism.

Economic efficiency is best thought of as the generation of the greatest social net benefits from the resources committed to the allocation process. These resources include the commodity (or amenity) being allocated and the resources used by all participants in

[1]Hurwicz, Leonid, 1973, "The Design of Mechanisms for Resource Allocation," American Economic Review, 62(13), 1-30; Hurwicz, Leonid, 1972, "On Informationally Decentralized Systems" in (eds.) C. B. McGuire and R. Radner, Decision and Organization, Amsterdam: North Holland.

the allocation process, e.g. the volume of water being traded and the costs encountered by the buyers, the sellers and the trading agency.

TABLE 4.1.1 Desirable Characteristics of General Allocative Mechanisms	
1.	Economic efficiency.
2.	Equity or fairness to all affected parties.
3.	Low transactions costs.
4.	Absence of strategic behavior.
5.	All externalities considered in the allocation process.
6.	Distribution of risk explicitly considered in the allocation process.

Equity or fairness must be judged by each participant, but no one should be made worse off as a result of the allocation process. Most would feel that absence of injury is not sufficient, that a "fair" distribution of net benefits among parties (participants and others) is required.

Low transactions costs are desirable so that benefits from exchange will be maximized. The costs that must be considered are those borne by buyers, sellers and the allocative agency itself. Transactions costs in the water resources area would thus include: physical transfer costs; search costs by buyers, sellers, and the agency; costs of legal and engineering studies; bargaining costs; and administrative overhead. For example, Howe et al studied the transactions costs (ATC) per acre-foot of water involved in permanent water rights transfers in Colorado.[2] They found that the transactions costs in dollars per acre-foot were significantly related to the size of the transaction in acre-feet, AF, the priority date of the right being transferred (relative to other rights on the

[2]Howe, Charles W., Carolyn S. Boggs and Peter Butler, 1990, "Transaction Costs As Determinants of Water Transfers," University of Colorado Law Review, Vol. 61(2), 393-405.

same stream, PD), and to whether or not the transfer was legally opposed by other parties, LO:

$$(1)\ \ ATC = \$428 - 125\ln AF + 4PD + 750LO$$

A major justification for water banks is to reduce transactions costs so that water can be traded in small quantities, thus avoiding the drying up of large areas with adverse economic consequences for the economy of the area of origin.[3] The difficulty with unsupervised water rights transfers is that a large part of the transactions costs is fixed, i.e. independent of the size of the transfer, thus inducing large transfers with consequent large impacts.

The presence of transactions costs tends to maintain the status quo of resource allocation. Stavins points out that in the presence of transactions costs, the initial distribution of a commodity in fixed supply (like water or pollution permits) will affect the equilibrium attained, once trading is opened (in contrast to Coase's analysis).[4]

The method of organizing the market, the nature of the commodity being allocated, and the number and locations of the potential participants will all affect the level of transactions costs. In a study of air pollution permit trading in the Los Angeles Air Basin, Foster and Hahn[5] point out that high transaction costs follow from (1) widely scattered sources (participants); (2) small numbers of participants (thin markets); (3) small transactions; and (4) the need to verify or certify that the trade has really taken place in accord with the registered transaction.[6] Two cases that exhibit low transaction

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[3]Economic models that omit transactions costs imply that small quantities of water would be sold from marginal uses in marginal areas. Because transactions costs do exist and have a large fixed component, economies of scale stimulate large transactions - often with serious damage to the area of origin. Dallas Burtraw of Resources for the Future, Inc. pointed out the value of water banks in facilitating small transactions.

[4]Stavins, Robert N., 1983, "Trading Conservation Investments for Water," Environmental Defense Fund, New York.

[5]Foster, Vivian and Robert Hahn, 1994, "ET in LA: Looking Back to the Future," Center for Science and International Affairs, Kennedy School of Government, Harvard University, paper P-94-01, January.

[6]Stavins, Robert N., 1993, "Transaction Costs and the Performance of Markets for Pollution Control," paper presented at the AEA Meetings, Boston, January, 1994.

costs, frequent transactions and large benefits are the current SO_2 trading program among electric utilities authorized by the 1990 Clean Air Act and the 1982-87 program of tetraethyl lead trading (for gasoline) among refineries. In both cases, there was a highly identifiable set of potential participants who already knew each other and a uniform commodity to be allocated.

Strategic behavior can take two main forms: (1) non-competitive behavior (the exercise of monopoly or monopsony power); or (2) the misrepresentation of values or quantities during bargaining or other allocative activities. Non-competitive behavior clearly leads to inefficient outcomes (even though it benefits the monopolist). Misrepresentation of a participant's willingness-to-pay (WTP) or willingness-to-accept (WTA) or the quantities desired to be traded can be induced by the trading rules of the allocative agency. For example, in the Idaho water banks, proceeds from water sales are prorated among depositors in proportion to the volumes deposited. In most years, not all water offered is sold. Thus, sellers are motivated to deposit more than they really want to sell.

Another example is found in the sealed bid procedure used by the Chicago Board of Trade in auctioning SO_2 allowances for the EPA.[7] The published rules call for matching the lowest priced offer to sell with the highest priced offer to buy. This appears likely to induce artificially low offers to sell with a consequent distortion in the number of allowances traded. These are examples of "non-incentive-compatible" trading mechanisms.

Externalities represent real costs or real benefits, but since they accrue to parties other than the direct participants, they can be difficult to identify and quantify. Whether or not they are taken into account by the participants depends on the trading mechanism, but their inclusion requires either some degree of central control over trading or a system of appropriate taxes or subsidies.

[7] Cason, Timothy N., 1993, "Seller Incentive Properties of EPA's Emission Trading Auction," Journal of Environmental Economics and Management, Vol. 25, No. 2, September, 177-195.

The allocation of risk that is implied by a particular mechanism is important because risk-bearing is a cost and thus will affect participation and the distribution of benefits and costs. In the 1991 California Water Bank, all climatic and hydrologic risks were borne by the water bank itself since it entered unconditional contracts to buy and sell. In the Idaho water banks, the risk of failing to sell water deposited in the bank rests directly on the seller. Risk also is present whenever streamflows (as opposed to stored water or groundwater) are banked.

4.1.2 Issues Specific to Water Allocation Mechanisms

The allocation of water involves issues that are especially important to—even if not unique to—that resource. Table 4.1.2 lists some of these issues. They clearly overlap with some of the more general issues listed in Table 4.1.1 (e.g. having prices reflect real social opportunity costs, including non-market public values is essential for economic efficiency). However, their importance warrants additional emphasis and discussion.

Flexibility in the allocation of existing supplies among changing uses is, of course, the reason for establishing water markets and facilitating their functioning through water banks. Wahl has discussed the problems that exist because of the inflexibility of contract provisions for water from federal projects and the large potential benefits that could be generated by freeing such water for sale.[8] Such sales have been facilitated by the Central Valley Project (California) Improvement Act of 1992 that permits up to 20 percent of contract water to be sold outside the contracting district.

Flexibility must not, however, produce lack of security in title to water—security is needed to allow longer-term development and investment decisions to be made. Thus, flexibility must be of the "willing seller, willing buyer" type.

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[8] Wahl, Richard W., 1989, Markets for Federal Water: Subsidies, Property Rights and the Bureau of Reclamation, Washington, D. C.: Resources for the Future, Inc.

Table 4.1.2

	Issues in the Design of Water Allocation Mechanisms
1.	The allocation process should allow (even encourage) flexibility in the allocation of existing supplies.
2.	At the same time, there should be security of tenure for those holding claims to water.
3.	Prices or fees paid for water should include all externalities and foregone non-market values.
4.	The outcome of the allocative process should be reasonably predictable for all participants, i.e. the rules of the process should be known and the decision process should be expeditious.
5.	The process must be capable of reflecting public values associated with water that may not be reflected in buyer and seller valuations.
6.	The process should encourage and facilitate marginal transfers of marginal water.
7.	In the cases of stored surface water and groundwater, the allocation should be intertemporarily efficient.

Source: Howe et al, 1986.

Any decentralized efficient water allocation mechanism must confront a prospective buyer with the full social opportunity cost of the resource being purchased. Most contractual arrangements for water from large projects fail to do this. Irrigation districts receiving Central Valley Project water pay from \$7.50 to \$15.00 per acre-foot while the same raw water would be worth many times as much to urban water utilities. Wahl has pointed out that, while such contracts may politically and legally be difficult to amend, the establishment of a market would confront these water users with most of the social opportunity cost of that water.[9]

Predictability of the outcome of the allocative process is crucial. If proposed transfers are subjected to substantial amendments or delays through the required legal and administrative steps, they become unattractive. Examples are found in the extensive litigation against some rural-to-urban transfers and in environmental mitigation requirements imposed on other transfers. While some of these requirements and litigation are warranted, a lack of clearly stated "rules of the game" can make the outcome of the transfer process quite unpredictable and thus unattractive.

Water use can generate or detract from a wide range of public values, some market values, some non-market. Wildlife habitat and fisheries, water quality, and water-based recreation are typical non-market public values. Since these benefits (or costs) are not capturable by water buyers and sellers, they will be given too little weight in the private decision process. Even market values like hydro-electric power are ignored by some allocation systems, usually due to divided jurisdictions and an absence of a holistic system view. When upper Colorado River Basin water users increase consumptive use, no account is taken of lower basin losses, e.g. power and water quality. This is a problem that confronts any kind of water transfer process and requires some form of public intervention in the allocation process.

It is desirable that smaller transfers of water from lower-valued uses be encouraged. This is frequently prevented by high fixed costs (legal and engineering) of the transfer process plus the costs of negotiating with more sellers. The resultant large transfers often have significant negative impacts on the area of origin - an aspect that has made both short-term and permanent water transfers quite unpopular in some areas of high transfer activity (e.g. the Arkansas River Valley of Colorado and the Sacramento Valley of California).

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[9]Some Central Valley Project irrigation water leads to severe drainage and environmental problems. These damages constitute part of the social opportunity cost. [Id.] Wahl, Richard W., 1989, Markets for Federal Water: Subsidies, Property Rights and the Bureau of Reclamation, Washington, D. C.: Resources for the Future, Inc.

Finally, intertemporal efficiency in the use of stocks of stored water is a part of the general efficiency issue but warrants special mention for water systems. The time horizon for intertemporal efficiency can range from the seasonal drawdown of reservoir storage to decades or more in the exploitation of non-renewable groundwater. In the former case, efficient allocation would be stimulated by more accurate forecasts of season-long water demands and supplies. In the latter case, the major issues are avoiding the excesses of open access (common property) and deviations between private and public discount rates. In Colorado, open access is controlled through limitations on permits issued, while discount rate differences are implicitly handled through the rules governing the number of permits.

4.1.3 Detailed Issues Relevant to the Design of Water Banks

The water bank must be compatible with the larger legal-institutional framework. Table 4.1.3 lists these issues. Only the key economic issues in Table 4.1.3 will be discussed here. The first is location—of the buyer, the seller and any necessary water infrastructure, especially storage. Since a water bank deals only in short-term trades, a bank is initially limited by the existing "plumbing" that is needed to effect the physical transfers. Transfers need not involve the same physical units of water for buyer and seller since exchanges can be made.

If the bank is permanent, the persistence of offers to buy and sell from points beyond capabilities of the existing delivery system could indicate the desirability of expanding the delivery system, financed perhaps by charges on the new participants or from revenues retained by the bank.

The type of water right underlying the water being sold is important. The water banks cited in the earlier sections of this report dealt with stored water (at least water that could be stored) and groundwater. Both those sources can be accurately measured and held until needed (subject to evaporative and bank losses). An interesting question is the potential for the sale of direct streamflow through a water bank. Three possibilities exist:

Table 4.1.3

Detailed Issues in Designing A Water Bank

I. What Water Can Be Banked?

1. By source: surface, ground.
2. By location.
3. By type of water right: direct flow, storage right, ditch shares, etc.
4. By class of owner, e.g. public agencies, individuals, private companies, etc.
5. Limitations based on authorized type of use.
6. Required evidence of ownership.
7. Procedures for determining bankable quantity.

II. Who Can Buy Banked Water?

1. Priorities among users.
2. Purposes of use.
3. Location of use.
4. Evidence of need.
5. Limitations on quantities.
6. Limitations on timing of purchases.

III. Detailed Procedures.

1. Who sets basic policies?
2. Who administers operation?
3. How are disputes handles?
4. Bank buy/sell on own account?
5. Price determination.
6. Duration of bank: year-by-year, permanent?
7. Strength of bank's authority and legitimation.
8. Special rules for drought?

Source: Larry MacDonnell Memo of November, 1993.

1. that there is a nearly continuous "spot" market so that water known to be in the stream can be sold before it escapes;
2. that anticipated future flows be sold volumetrically; and
3. that the underlying water rights be rented with the risk of delivery resting on the lessee.

Continuous spot markets will be possible only among neighboring water users. As noted earlier, water markets are typically "thin." The small number of buyers and sellers certainly rules out continuous trading like that found on the commodity markets, but does not rule out continuous posting of offers to buy or sell.

The sale of future flow volumes is complicated by their uncertainty. The seller might be obliged to locate additional water for the buyer if the right failed to yield the agreed upon volume. This would appear to be too risky to be attractive to potential sellers.

The third possibility is frequently practiced among irrigators. The water right is rented to a new user, with the volume of withdrawals being determined by actual streamflows and the seniority of the right. Third party impacts might limit withdrawals to former consumptive use and timing, depending on the locations of other users.

A final issue is whether or not the water bank would be allowed to buy and sell on its own account. In the California Water Bank of 1991, the bank bought water without necessarily having a ready buyer (as noted earlier, the bank ended up with 265,000 acre-feet of unsold water). The bank could play an intra-seasonal (or even inter-seasonal) role by buying or selling water in anticipation of future supplies and demands. Such seasonal "smoothing" assumes that the bank is better informed about future conditions than the typical participant. Such a role is analogous to the role of the speculator in the commodity futures markets: buying or selling to balance out the positions of long and short hedgers. This will be discussed further in the section on market organizations.

4.2 ISSUES UNDERLYING SUPPLY (Offers to the Bank to Sell) AND DEMAND (Offers to Buy)

Long-term trends in water allocation indicate increasing water use by cities and industries and reduced water use in agriculture. In the short-term, however, water can move either way. For example, in a "typical" year, many western cities rent water to the agricultural sector because the cities own more water than they need as insurance against drought. Thus, a water bank can expect to find a mix of buyers and sellers in most years. In drought years, it is likely that water will move from agriculture to urban and industrial uses. In the following sub-sections, we characterize the farmer as the supplier and the city as the buyer of short-term water.

4.2.1 Behavior of the Agricultural Seller of Water

The dominant factor in determining a water owner's willingness-to-sell is the <u>opportunity cost</u> of the water to the owner, i.e. what the owner will give up in the way of income or water-related amenities as a result of selling. We will not discuss non-monetary opportunity costs further, but they could take the form of maintaining recreational ponds, streamflows or wetlands. Naturally if the farmer has more water in storage or in the ground than can be beneficially applied the opportunity cost is zero. The opportunity cost of water to an agriculturalist depends upon the timing within the season of the decision to sell. Two situations can be identified:

a. pre-planting sales of water;

b. post-planting sales of water.

If the decision to sell can be made before commitments to crops have been made, the usual "with-the-sale <u>versus</u> without-the-sale" analysis shows that the sale would involve:

a. a loss of the anticipated market value of the crop;

b. elimination of all of the variable expenses of land preparation, seeds, fertilizers, water control and harvesting.

The algebraic sum of these two items is simply the anticipated net operating income from the crops being eliminated. The lost after-tax net operating income is then the water owner's opportunity cost.[10]

Pre-season water sales might, of course, be generated by reducing irrigation applications by (i) reducing irrigation applications on the same acreage of the same crops; or (ii) changing the cropping pattern. In both of these cases, there would be a reduction in the anticipated sales value of the crop and possibly a change in some expenses.

After planting has taken place, the variable costs are sunk (unrecoverable and not transferable to other useful activities). They then become irrelevant to the "sell or not sell" decision. If the crops are totally destroyed by failure to irrigate, their total market value is lost, offset in part by the reduction in harvesting costs. If yields are reduced, then the changes in anticipated market values less the reduction in harvest costs is the relevant measure.

In all cases, some inducement beyond compensation for opportunity cost will be needed. That is, the price offered for the farmer's water would have to exceed opportunity costs as defined above. It also is likely that the farmer would engage in some "strategic behavior" in placing water for sale, e.g. asking for a higher price than is really necessary or feigning reluctance to sell. This problem will be discussed further in the section on market organization.

Another factor affecting the farmer's willingness to sell water is the degree of hydrologic uncertainty surrounding his/her water supply. Stored water that can be called for at any time is quite certain. A very senior surface water right may also be quite certain, but more junior surface rights will be subject to more frequent call-outs and, under drought conditions, may get no water at all. Appendix 4 A. suggests that, under plausible agricultural production conditions, a farmer will be less willing to sell water the more variable his/her water supply.

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[10]The fixed costs associated with the eliminated acreage will be incurred whatever happens and thus do not enter the calculation except as they affect taxes.

Legal uncertainties about the water supply will have the same effect as hydrological uncertainty. One of the functions of a water bank is to reduce legal uncertainties related to beneficial use, possible abandonment and third party liability. The act establishing the 1991 California Water Bank expressly protected those selling water to the bank from any of these liabilities.

Environmental concerns also can increase uncertainty of the farmer's water supply. A short-term sale involving a change in point of diversion might result in reduction of instream flow below some protected minimum. The sale would then have to be restricted to meet the flow requirement.

Appendix 4 A. provides a simple mathematical model of some of the factors affecting a farmer's willingness to sell. The following points are clear:

a. the higher farm product prices, the less will be sold;

b. the higher farm input prices, the more will be sold;

c. the higher the price offered for water, the more will be sold.

4.2.2 Factors Underlying the Demand for Water

Towns and industry generally desire to have reliable, high quality raw water supplies. They often develop a portfolio of supplies to reduce overall variability and to reduce the risk of micro-drought conditions affecting the entire supply.

Cities strive to provide reliable supplies of treated water for their customers. Urban and industrial customers value the reliability of their supplies and are willing to pay higher prices for more reliable supplies.[11] When supplies fall short of demand (say during a drought), customers' supplies have to be rationed, usually by restricting outside uses for gardens and lawns. Customers frequently resent these restrictions and make life

[11] See Howe, Charles W. and Mark Griffin Smith, 1993, "Incorporating Public Preferences in Planning Urban Water Supply Reliability," Water Resources Research, Vol. 29, No. 10 (3363-3369).

unpleasant for water officials.[12] Thus, one can characterize urban water planning as an attempt to minimize

infrastructure costs
+
raw water costs (owned and purchased)
+
penalty costs from shortages

Appendix 4 B. presents a simple model of such a planning exercise. The following conclusions are clear:

a. the more sensitive water customers are to water price, the less towns will buy from other sources;

b. the more variable a town's supply, the more likely the town is to purchase outside water;

c. the greater the public's willingness-to-pay for supply reliability (i.e. the greater the penalty for shortage), the more towns will buy outside.

4.3 ALTERNATIVE METHODS OF WATER BANK ORGANIZATION

The choice of water bank organization will be influenced by several general physical characteristics of the water system and of the demands the bank is designed to fill. Some of these features were discussed in Section 4.1.3 in conjunction with Table 4.1.3. We expand on several key features here.

A general issue is the degree of homogeneity of the water resource being bought and sold. It may be water of uniform quality stored behind a dam, or it can take the

[12]A small Colorado town had an inadequate supply of water despite a new treatment plant. Every third day watering restrictions were imposed, and the police department was directed to issue $35 tickets to violators. The public reaction was so strong that the mayor and water manager were recalled from office.

form of a water right being rented for a season. In the latter case, nearly every right is unique, requiring quite a different banking mechanism.

Another important feature is the timing of delivery. If a water right is being rented, then delivery is limited to times when the right is in priority. If the water is in a reservoir or in the ground, it can be taken any time. Since reservoir storage is managed to fulfill several purposes, a buyer cannot leave purchased water in the reservoir indefinitely. In the Idaho water banks, purchased water can be carried over until the following March. The longer the permitted storage period, the greater the potential utility to the buyer.

A feature of water markets that must be taken into account in considering alternative bank designs is that water markets are typically "thin," i.e. that there are relatively few buyers and sellers. Thinness usually stems from geographical limitations imposed by the ability to move water around. This ability is related both to physical infrastructure and to the natural configuration of drainage basins. (Water can often be "transferred" from one tributary to another through exchanges). Thinness implies that:

a. the outcome of the banking exchange process is highly dependent on the particular buy-sell matching mechanism and, for some of the mechanisms, on the initial distribution of supplies and demands (i.e. the outcome is often "path dependent");

b. there will be increased likelihood of manipulation of the trading process by some buyers and/or sellers;

c. transactions costs may be high, depending on the matching mechanism used.

An important feature of the bank design itself is the degree of bank activism. Will the bank act mostly as a "bulletin board," putting buyers and sellers in touch with each other or, at the other extreme, will it restructure holdings of water into new "packages" more suitable to potential buyers? The implications for staffing requirements, the availability of technical expertise, and costs of operation are quite different.

The sub-sections below discuss a variety of water bank designs and their advantages and disadvantages. Table 4.3.1 lists these designs.

Table 4.3.1

Alternative Methods of Water Bank Organization	
1.	The "Bulletin Board" Water Bank.
2.	Standing offers to buy and sell at fixed prices.
3.	Sealed-bid double auctions.
4.	Repeated sealed-bid auctions.
5.	Live auctions for water.
6.	Auctions for water rights.
7.	Contingent water markets.
8.	Futures markets for water
9.	Other market-making activities.

4.3.1 The "Bulletin Board Bank"

The simplest form of bank organization is to maintain a physical or electronic bulletin board where potential buyers and sellers of short-term water can post their offers. Such a market has been in operation at the office of the Northern Colorado Water Conservancy District since the late 1950s.[13] The volume of short-term "rentals" goes up sharply during dry periods. The governing board of the District has a policy of encouraging a price for rentals of around $15 per acre-foot. Attempts to raise prices are rebuked by the board as "price gouging." Price-fixing of this type is inefficient and is not

[13]See Howe, Charles W., Dennis R. Schurmeier and William D. Shaw, Jr., 1986b, "Innovations in Water Management: Lessons from the Colorado-Big Thompson Project and Northern Colorado Water Conservancy District," Chapter 6 in Kenneth D. Frederick (ed.), Scarce Water and Institutional Change, Washington, DC: Resources for the Future, Inc. 1986b.

a necessary feature of this market. In addition to this bulletin board at the District office, short-term rentals are frequently made by cities to agriculture. Since the rented water is a backup for drought, the same rental arrangements can go on for years.

BULLETIN BOARD	
Advantage:	simple market organization
Disadvantages:	outcome is "path dependent" prices not uniform to all participants

"Path dependence" means that the number of transactions and the total net benefits generated by the exchanges depend upon "who meets whom" first. Consider the following simple example in which two sellers, S_1 and S_2, each are offering one unit of water, while two buyers, B_1 and B_2, are each seeking one unit. The willingness-to-accept (WTA) of the sellers and the willingness-to-pay (WTP) of the buyers are:

$$\begin{aligned} WTA\ (S_1) &= \$10 \\ WTA\ (S_2) &= \$20 \\ WTP\ (B_1) &= \$11 \\ WTP\ (B_2) &= \$21 \end{aligned}$$

If B_1 happens to meet S_1 first, leaving B_2 to meet S_2, then there will be two transactions resulting in a total net benefit (excess of WTP over WTA) of \$2. If, however, B_2 first meets S_1, there will be one transaction only with a surplus of \$11 (the efficient solution). Path dependence is a general attribute of bilateral trading mechanisms.

The bulletin board operation can be continued alongside other models of market organization to permit advantageous trades that cannot await organized auctions. It has been noted that, in the market for SO_2 allowances (to be discussed under 4.3.3 below), the number of privately arranged trades has exceeded the number traded in the organized auction.[14]

4.3.2 Standing Offers to Buy and Sell at Fixed Prices

The 1991 California Water Bank (described earlier) stood ready to pay $125 per acre-foot. As noted earlier, the buying price of $125 was based on estimates of average net income per acre-foot in irrigated wheat, one of the largest crops in the buying area. The bank added its overhead plus an allowance for water that would have to be released to the Delta for salinity control to arrive at the selling price of $175.

The problem was that there was no way of knowing whether or not those prices would equate demand and supply. While the supply side estimates appear to have been fairly accurate, the non-binding solicitation of purchase offers turned out to be quite inaccurate as would-be buyers backed out. The bank was left with approximately 265,000 acre-feet of water.

STANDING OFFERS TO BUY AND SELL	
Advantages:	i) prices known ii) assured ability to sell while the offer stands iii) ability to buy while supplies last
Disadvantages:	i) prices not responsive to supply and demand ii) prices not responsive to changing climate conditions iii) no incentives for sellers or buyers to commit early.[15]

[14] Wall Street Journal, 1993, "CBOT Plan for Pollution Rights Market Is Encountering Plenty of Competition," Tuesday, August 24th, p. C1.

[15] In the 1991 California water bank, early sellers were guaranteed that, should the price be raised later in the season, they would be paid the higher price.

In summary, this appears to be a relatively inefficient bank mechanism that could be improved upon. This is not to deny that the 1991 California Water Bank was successful with large net benefits for the state.[16]

4.3.3 Sealed-bid Double Auctions

Double auctions refer to the presence of multiple buyers and sellers while the "sealed bid" feature describes the "mailed-in" nature of the buy and sell bids. The bank arrays the selling bids in ascending order of reservation price and the buying bids in descending order of offer price. This permits the identification of an approximate market clearing price ("price discovery") and determines the volume of transactions. Assuming revelation of true WTP by buyers and WTA by sellers, this volume also will maximize the net benefits from trades, i.e. it will be efficient. This is exhibited in Figure 4.3.1.

Two issues must be confronted: (1) the "incentive compatibility" of this design; and (2) the method of payment (two interrelated issues). The usual concept of market equilibrium is that through some process of "price discovery," all buyers and sellers pay or receive the same price, namely the price that equates supply and demand. A competitive market with low transactions costs and many buyers and sellers would work that way, but a managed auction may not mimic the market. As noted earlier, the Chicago Board of Trade (CBOT) has organized an annual sealed-bid auction for EPA for SO_2 allowances.[17] In that auction, the highest bid buyer is matched (approximately) with the lowest bid seller, the latter receiving the buyer's bid. The problem with this procedure is that it motivates sellers to understate their ask prices (willingness-to-accept) in the hope of getting paired with a high bid buyer. The procedure is, therefore, not "incentive

[16] See Howitt, Richard, Nancy Moore and Rodney T. Smith, 1992, "A Retrospective on California's 1991 Emergency Drought Water Bank," a report prepared for the California Department of Water Resources, University of California, Davis, March 4.

[17] U. S. EPA, 1993, "How To Bid In the EPA SO_2 Allowance Auctions," EPA 430/F-93/054, November.

compatible" and the resultant volume of trades will be somewhat inefficient. Cason also has shown that the distortion increases with an increase in the number of sellers.[18]

Several payment mechanisms are possible. Successful buyers could be required to pay their bid prices, while sellers could be reimbursed their bid prices. This would leave a surplus (possibly quite large) for the water bank and would overcome the main source of bias in the CBOT procedure. We know, however, that this mechanism is not incentive compatible.[19] It is much more desirable to determine the equilibrium price (as shown in Fig. 4.3.1) which is charged to all buyers and paid to all sellers.

4.3.4 Repeated Sealed-bid Auctions Through the Season

The thinness of water markets precludes continuous organized trading of the type that is found in the major commodity markets. As the season progresses, however, new information is gained concerning weather, water availability, crop prices, etc. Thus, additional trading can be worthwhile. Several sealed-bid auction sessions could be held, perhaps corresponding to the times of traditional irrigation applications or following unexpected weather events. The CBOT, for example, is considering holding quarterly SO_2 allowance auctions starting in 1994.

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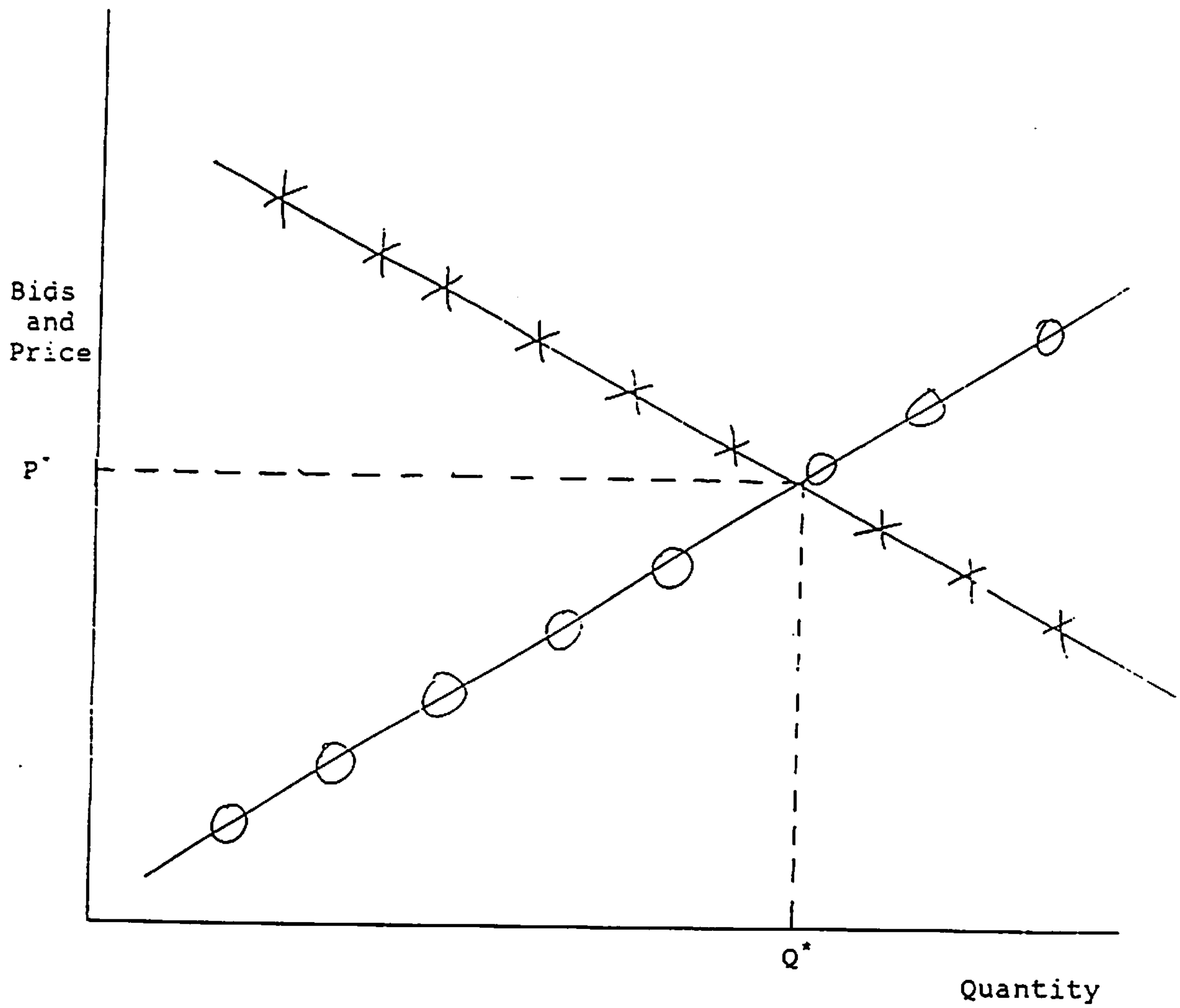
[18]Cason, Timothy N., 1993, "Seller Incentive Properties of EPA's Emission Trading Auction," Journal of Environmental Economics and Management, Vol. 25, No. 2, September, 177-195. [supra]

[19]When strategic behavior (misstating bids from true WTP or WTA) is thought to be a problem, use of the "Vickrey auction" or "second bid" auction procedure has been recommended. Vickery, William, 1961, "Counterspeculation, Auctions, andCompetitive Sealed Tenders," Journal of Finance, Vol. 16 (8-37). If an auction were for one unit or item, buyers would bid knowing that the successful bidder would have to pay only the second highest price. Theoretical and experimental analysis has shown that this should result in true WTP revelation Binger, Brian R. and Elizabeth Hoffman, 1988, Microeconomics with Calculus, Glenview, IL: Scott, Foresman & Co. (Chapter 15). Its application to the simultaneous auctioning of multiple units is, however, hard to interpret since it would involve different buyers and sellers paying and receiving different prices. Administratively, this would be difficult and might be perceived as unfair. The revenue consequences, too, are not clear. It thus seems impractical in sealed-bid water banking.

Figure 4.3.1

Arraying Bids (X's) and Offers (O's) to Determine the Equilibrium Price and Quantity



4.3.5 Auctions for Water Rights

When the water being sold is uniform "reliable" water, live auctions can be held. The town of Akron, Colorado, held such an auction for part of its water from the Colorado-Big Thompson Project during the drought of 1981 GIR. Prices were considerably above the $15 per acre-foot considered "proper" by the Northern Colorado Water Conservancy District. Maass and Anderson have described the longstanding water auctions in Valencia, Murcia, Orihuela and Alicante, Spain where irrigation water is auctioned weekly during the irrigation season.[20]

Under the prior appropriation doctrine, each water right is unique so a double auction process is not applicable. Either bilateral bargaining or organized live or sealed-auctions in which rights or groups of rights are sold could be used. In the case of auctions, the rights available could be advertised ahead of the sale so buyers would have time to evaluate them as is done in many western U. S. cattle auction houses where quite disparate groups of cattle are put up for live bid.

As noted earlier, when the water to be bought and sold is unregulated streamflow, it must be sold for nearly immediate use or the water rights owner must "rent" his/her water rights to water users with the user assuming the risk associated with the particular right. A sharing of this risk could be accomplished by making payment contingent on water received.

4.3.6 "Contingent" Water Markets

A contingent market is one in which participants can enter contracts, the execution of which is contingent upon conditions existing at a future point in time. The simplest case would consist of a pair of pre-season sealed-bid double auctions, the first consisting of buy and sell bids in the case of a "wet summer," the second in the case of a "dry summer." The buy and sell bids would be for delivery at a specific future point in time (say, 1 July) at which time it would be possible to determine the actual state of the

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[20]Maass, Arthur and Raymond L. Anderson, 1978, And the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments, Cambridge, MA: The MIT Press.

water system—wet or dry. At that time, the set of bids corresponding to the actual state of the system would be executed, the other set ignored. The equilibrium prices corresponding to wet and dry summers would, however, be announced at the beginning of the season, just following submission of bids. This allows a degree of "hedging" of future prices (discussed in the following sub-section on "futures markets").

A special case of a contingent market is found in the "agricultural lease-out" contract.[21] In the case of a rural-to-urban water sale, such a contract might read:

> "City A will be allowed to take N acre-feet of water from Irrigation District B in the month of July at a price of $200 per acre-foot, if the average monthly temperature in June is in excess of 80 degrees and if June precipitation has been less than 10 cm. In addition, City A will pay District B $5,000 per year for the duration of the contract."

Designing and bargaining over such contracts is a complicated and time consuming process, so it does not fit into the usual mold of a water bank. However, a water bank could stand ready to facilitate such contracts by identifying likely parties. This type of contract has become increasingly popular as drought protection for cities since it does not result in the permanent transfer of water from farming. The major example is the Metropolitan Water District—Palo Verde Irrigation District lease-out described in Rice and MacDonnell.[22]

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[21]Booker James F., and Robert A. Young, 1991 "Economic Impacts of Alternative Water Allocation Institutions in the Colorado River Basin," Completion Report No. 161, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO 80523; Michaelson, Ari M. and Robert A. Young, 1993, "Optioning Agricultural Water Rights for Urban Water Supplies During Drought," American Journal of Agricultural Economics, Vol. 75, No. 4 (1010-1020); Whittlesey Normal, Joel Hamilton and Philip Halverson, 1986, "An Economic Study of the Potential for Water Markets in Idaho," for the Snake River Studies Advisory Committee, State of Idaho, Idaho Water Resources Research Institute.

[22]Rice, Teresa A. and Lawrence J. MacDonnell, 1993, "Agricultural to Urban Water Transfers in Colorado: An Assessment of the Issues and Options," Completion Report No. 177, Colorado Water Resources Research Institute, Colorado State University, December.

4.3.7 Futures Markets for Water

Futures markets are extremely important in the U. S. for the major agricultural and metallic commodities (wheat, corn, soy beans, silver, gold, etc.) and for financial instruments (treasury notes and bonds). Futures markets allow participants to "hedge" or protect themselves against unforeseen price changes in a particular commodity.[23] They do not, however, provide protection against risks such as crop failure or changes in production costs.

Carlton notes that successful futures markets tend to have the following characteristics: significant price uncertainty; significant price correlations across different grades of the commodity; a large number of potential participants; and unregulated price determination.[24] The significance of price uncertainty is obvious: if there is very little, there is no need to hedge. Correlations of prices across different grades of the commodity are necessary since futures contracts will be limited in number (to guarantee sufficient volume) and defined in terms of standardized grades and maturity dates. Spot markets usually deal in a large number of highly differentiated commodity grades and locations for delivery. Thus, hedging protection depends on a high degree of co-movement of the standardized futures grade and the various spot commodities. In a study of futures markets in Malaysia, Arshad and Shamsudin note that futures trading has flourished for palm oil but has failed for rubber and cocoa for exactly these reasons.[25]

Current U. S. futures markets exist for very high volume commodities only, i.e. where the markets are thick. The contracts are for various standardized dates (e.g. May, July, November) reaching not more than two years into the future. For these

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[23]Kolb, Robert W. and Robert S. Hamada, 1988, Understanding Future Markets (2nd edition), Glenview, IL: Scott Foresman/Little Brown College Division; Hieronymus, Thomas A., Economics of Futures Trading for Commercial and Personal Profit, New York: Commodity Research Bureau, 1971; Williams, Jeffrey, The Economic Function of Futures Markets, Cambridge, London and New York: Cambridge University Press, 1986; Chicago Board of Trade, "Introduction to Agricultural Hedging: A Home Study Course," Education and Marketing Services Department, Chicago, IL, 1988.

[24]Carlton, D. W., 1984, "Futures Markets: Their Purpose, History, Growth, Success and Failures," Journal of Futures Markets, (4(3): 237-271.

[25]Arshad, Fatimah Mohd. and Mad Nasir Shamsudin, 1992, "Marketing of Sabah's Agricultural Primary Commodities: Issues and Challenges," Borneo Review, (3)1: 96-123.

commodities, there are both continuous "spot" and futures markets. The "spot" market is for immediate sale of quality-and-place-specific commodities, e.g. "1,000 tons of hard red winter wheat, moisture content 10 percent or less and delivered at Kansas City". Futures contracts are stated in terms of highly standardized commodities and terms of delivery, terms that would be inappropriate and inconvenient for most buyers and sellers. The intent is that all purchases or sales of futures contracts will be reversed before maturity of the contract, so that no deliveries will actually be made under them.

A brief example will help in assessing the possible application of futures markets to water. In March, a farmer contemplates planting corn which will mature in September. The cost of production is, say, $2 per bushel. The spot price of corn in September is uncertain, but September futures contracts are currently selling for $2.50 per bushel. The farmer anticipates total production of 10,000 bushels but, being uncertain, decides to "hedge" 8,000 bushels. This is done by selling a September contract for 8,000 bushels at $2.50 per bushel.

The season turns out to be ideal for corn, so by September, the spot price has fallen to $1.50 per bushel, and September futures contracts converge to $1.50 per bushel also since both require delivery of the same commodity in September. The farmer buys back September futures contracts in the amount of 8,000 bushels at the lower price of $1.50, thus making a profit of $1 per bushel on the 8,000 bushel futures contract. He or she then sells the actual production in the spot market at $1.50 per bushel. For the 8,000 hedged bushels, the farmer realizes $2.50 per bushel consisting of the $1.50 spot price plus the profit of $1 per bushel in the futures market. Naturally, the farmer loses 50 cents per bushel ($1.50 selling price less the $2.00 production cost) on the unhedged output.

On the "opposite side" of the futures market there will be either a "long hedger" or a speculator (or both) who is willing to buy the futures contract in March from the farmer. The long hedger might be a feed lot operator who knows he/she will need 8,000 bushels of corn in September. Before he/she decides to put cattle on the feed lot, he/she notes that September corn futures are available at $2.50 per bushel, a cost that makes the cattle feeding profitable. Thus, he/she buys September futures at $2.50 per bushel.

In September, the feed lot operator finds that futures contracts and spot prices have fallen to $1.50 per bushel. He/she sells the futures contracts bought in March, realizing a loss of $1 per bushel. He/she then enters the spot market and buys 8,000 bushels at the net cost of $2.50 per bushel—still a profitable venture.

The application of futures markets to seasonal water is interesting to contemplate. The thinness of the market precludes continuous trading. Presumably, sealed-bid double auction trading would open in, say, January for contracts deliverable in future months, say May and July. Thus, prices for May and July water will be set initially in January. From time to time but at least in May and July, there would then be double auctions for futures that have not matured and for spot water. Because of the uniform nature of the water being sold in terms of quality and location, it should be perfectly acceptable simply to let the futures contracts mature and take delivery (make delivery). If changing conditions motivate some buyers or sellers to get out of the market before their contracts mature, they can do so during the periodic double auctions.

4.3.8 Other Market-making Activities

The level of activism of the bank in making "deals" was one of the principal issues mentioned at the beginning of this section. Obviously, the level of activism across the market structures described above differs a great deal from the passivity of the bulletin board mode to a sophisticated level of management and expertise for some of the auction modes, contingent and futures markets.

Even more active roles for the bank would be possible if justified by the volumes of trades. The bank could actively seek buyers and sellers. It could promote "agricultural lease-outs," and it could package various water supplies into portfolios that suit particular buyers' meeds. For example, water rights from several local but meteorologically different drainage basins could be packaged into a larger, more reliable water rental package.

4.3.9 Guaranteeing Performance on Trading Contracts

The 1991 California Water Bank experienced problems in part because their selling price was based on a survey of potential buyers, many of whom in fact never bought water. They backed out of their expressed intention to buy. Some of the trading mechanisms discussed above would require some type of enforcement mechanism to assure that buyers and sellers would carry out their obligations.

In the case of CBOT commodities futures, holders of contracts (to buy or sell) must maintain "margin accounts" with their dealers, e.g. 5 percent of the initial value of their contracts. Since performance of the futures contract is not required until the maturity date, there must be some way of insuring that the contracted buyers and sellers don't "leave town" without either canceling their position with an offsetting purchase or sale or executing the contract itself at maturity. A party who has sold futures maintains a margin account with the dealer. If the price of that futures contract rises, it will cost more to offset the sale than the original sale was worth. The difference must be made up by the seller's margin deposit with the dealer. This allows the dealer to offset the sale without incurring a loss should the seller default. If the margin is "impaired" by an increase in the futures price, the dealer requires the seller to post more margin money. If the seller is unwilling to do so, the dealer will offset the long position by buying back the futures, the difference in values being made up by the margin money.

In the case of "face-to-face" trading procedures like the "bulletin board," standing offers and live auctions described above, there is little problem in guaranteeing either payment by the buyer or delivery of water by the seller. With water in storage, delivery is usually controlled by a public authority or special district and can be guaranteed by passing the sales agreement on to that authority. If payment is not made by the buyer, the transaction is simply not completed, and no water is delivered.

In the sealed-bid double auctions, contingent auctions and futures markets, however, there must be some mechanism for enforcing performance by buyers (to pay according to the established rules) and sellers. Failure to do so will result in incorrect equilibrium prices and imbalance between supplies and demands. For example, a buyer might submit a sealed bid to buy 100 acre-feet at a high price. This bid constitutes a segment of the demand function used by the bank to determine the equilibrium price and quantity to be traded. If the buyer then backs out, more water will be supplied than purchased, and the announced equilibrium price will be too high.

Thus, the credit worthiness of the buyers must be established to guarantee performance. Since most are public agencies or districts, this may not be as difficult as it is with a large number of private market participants.

4.4 CONCLUSIONS REGARDING PRACTICAL WATER BANK DESIGN

In the light of the above investigation of major trading mechanisms that could be used by a water bank, the following conclusions are drawn, followed by further justification:

1. a water bank, under circumstances that prevail in much of the western U.S., should foster more than one type of short-term water trading;
2. where a large part of the water to be traded is already in storage, snowpack or in the ground before the start of the irrigation season, the primary trading mechanism should be a sequence of closed-bid double auctions that bring buy and sell bids together at important trading dates, say pre-season, mid-season and late season;
3. live (English) auctions for the rental of water rights (as opposed to stored water) could be carried out with risk-sharing being determined by the method of payment;
4. the bank should continuously maintain a bulletin board, physical and/or electronic, to facilitate bilateral trades that prefer not to await the organized market sessions;
5. other marketing activities such as "packaging" portfolios of water rights can be undertaken if warranted by the volume of trades;
6. commissions or service charges by the bank would be split between buyer and seller;

7. buying and selling on the bank's own account would have to be determined on the basis of climate information available to the bank compared with that readily available to the participants.

Thus, we envision several trading procedures being carried on through the season. The closed-bid double auction assembles much of the bid and offer information in the determination of a market equilibrium (as shown in Figure 4.3.1). The procedure validates all efficient trades (those represented by bids and offers to the left of Q^*, the equilibrium aggregate quantity) and precludes trades that are inefficient even though individually worthwhile (the \$21 - \$20 and \$11 - \$10 trades illustrated above).

While a bulletin board to facilitate bilateral trading is warranted to take care of special cases (e.g. when water is suddenly needed or found to be in excess supply), bilateral trading is path-dependent and is quite likely to consummate some inefficient trades while precluding other efficient ones.

When the water to be traded is in storage (or at least is highly predictable), pre-season trading acts as a forward trade in that the price is fixed and the water can be taken any time. Subsequent mid-season and late season sealed-bid auctions then allow participants to change their positions in the light of new information, e.g. to buy more water or to sell unneeded water as warranted by evolving weather conditions. This sequence of auctions thus appears capable of approximating the results that would be generated by continuous spot and futures markets.

Occasional live auctions for the rental of individual water rights or portfolios of water rights appear to be the most reasonable approach to the marketing of water rights, each of which is unique. The hydrologic-meteorological risk on the party renting the rights can be controlled by making some or all of the payment contingent upon the water actually received.

Facilitating bilateral trading through maintenance of a bulletin board would be inexpensive but of great assistance to those who find it inconvenient or impossible to participate in the periodic auctions. In the U. S. market for SO_2 allowances, trades occur both through the annual auction and bilaterally, many large trades taking place outside the auction.[26]

The issues of the pricing of auctioned water and charges made by the bank must be resolved. First, we recommend that the efficient price (P* in Figure 4.3.1) be paid by all buyers and paid to all sellers, modified by any service charges. This rewards both sellers and buyers for participating in the auction by dividing the surplus of WTP over WTA between the two groups and prevents inefficient trades like those illustrated earlier. While there may still be some motivation for strategic understatement of WTP and over-statement of WTA, it is greatly reduced by uniform equilibrium pricing, especially in a setting where buyers and sellers anticipate being in the market frequently (theory of repeated games).

The costs of operating the bank should be paid by the participants through service charges attached equally to sales and purchases. Thus, if experience shows that bank costs average $5 per acre-foot, $2.50 would be added to buyers' bills, and $2.50 would be subtracted from proceeds paid to the sellers.

Undoubtedly, other variants exist and may be appropriate for particular settings. Each setting will have unique hydrologic, topographic, climatic and legal features. Ingenuity and concern with details are always required, but it is our hope that the guideline suggestions above will be a helpful starting point in the design and establishment of effective new institutions-water banks.

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[26]Howe, Charles W., 1994, "Taxes versus Tradable Permits: A Review in the Light of the U. S. and European Experience," Environmental and Resource Economics, forthcoming 1994.; WSJ, 1993, supra.

APPENDIX 4 A.

Variability of Water Supply and the Farmer's Willingness-to-Sell

Let the farmer's net income be defined by

$$(1) \qquad NI(L, W_1) = p_Y \cdot g(L, \hat{W} - W_1) - p_L \cdot L + p_{W_1} \cdot W_1$$

where W_1 is the volume of water sold to the bank, $\hat{W}$ is the random water supply available to the farmer, $g(\cdot)$ the production function using land (L) and water ($\hat{W}$ - W_1) as inputs. The prices are for output, the use of land, and the sale of water to the bank. Assume L to be fixed in the short run.

Since $\hat{W}$ is random, we can assume that the farmer decides on the volume of water to sell, W_1, by maximizing the expected value of the net income given in (1). Using a second-order Taylor series expansion of the production function, g, it is straightforward to arrive at (2).

$$(2) \qquad \begin{aligned} E\{NI(L, W_1)\} &= p_y \cdot g(L, \mu_{\hat{W}} - W_1) \\ &+ \frac{p_y}{2} \cdot \frac{\partial^2 g(L, \mu_{\hat{W}} - W_1)}{\partial W^2} \cdot \sigma^2_{\hat{W}} \\ &- p_L \cdot L + p_{W_1} \cdot W_1 \end{aligned}$$

Since $\frac{\partial^2 g}{\partial W^2}$ is surely negative, it is clear that E(NI) falls as $\sigma^2_{\hat{W}}$ rises if no change takes place in W_1. But what happens to W_1^*? Differentiating (2) with respect to W_1 yields the necessary condition for W_1^*:

$$\frac{\partial E(NI)}{\partial W_1} = -p_y \cdot \frac{\partial g(L, \mu_{\hat{W}} - W_1)}{\partial W}$$

(3)

$$- \frac{p_y}{2} \cdot \frac{\partial^3 g(L, \mu_{\hat{W}} - W_1)}{\partial W^3} \cdot \sigma^2_{\hat{W}}$$

$$+ p_{W_1} = 0$$

If the second-order Taylor expansion really is an adequate representation of g(·), then $\frac{\partial^3 g}{\partial W^3} = 0$ and W_1^* will not vary with $\sigma^2_{\hat{W}}$. That is, if the farmer is risk neutral, the variability of his/her water supply will not affect the quantity sold. If, however, the farmer is risk averse, he/she will sell less water to reduce the variability of the total supply.

APPENDIX 4 B.

Model of Urban Water Demands

We distinguish between the water demand by the customers of the utility, W^d, and the demand by the city for water from the water bank, W_B. Cities typically try to meet the demands exerted by their customers, but if it is too costly to do so, shortages have to be met by means of price or non-price rationing.

The demand anticipated by the city is determined by (random) climate factors, $\hat{C}$ (essentially the same factors that determine water available to the farmers, $\hat{W}$) and the price charged by the city for water delivered to its customers. We simplify by assuming they simply charge the price they have to pay the water bank as the city's marginal source of supply.

$$(3) \quad W^d = w^d(\hat{C}, p_{w_1})$$

We assume each city has some reliable base supply, S_C, and can go to the WB for more water, W_B, or to sell water in case of a surplus. Thus the city's water supply for the season is

$$(4) \quad W^s = S_c + W_B$$

When the water available, W^S, is less than the amount demanded, W^d, a penalty, D, is incurred, possibly taking the form of customers' willingness-to-pay for the extra water.[27]

$$(5) \quad Penalty = D[W^d(\hat{C}, p_{w_1}), S_c + W_B]$$

[27] See Howe, Smith et al, 1993, supra.

The city's objective in buying water from the WB is to minimize expected penalty costs plus water purchase cost, i.e. to choose W_B so as to

$$(6) \quad \underset{W_B}{minimize} \quad E\{TC = D[W^d(\hat{C}, p_{w_1}), S_c + W_B] + p_{w_1} \cdot W_B\}$$

TC (total cost) is a RV (a function of $\hat{C}$) so the city must, at Stage 1, minimize E(TC) through the appropriate choice of W_B. In general, the penalty function, D, is non-linear, so the expression E(TC) may be complicated. The objective is to derive W_B^* as a function of the parameters of the problem, including the probability distribution of $\hat{C}$.

Example. Let

$$W^d = K - \beta_1 \hat{C} - \beta_2 p_{w_1}$$

i.e. a linear demand function.

(7)

$$D = [W^d - (S_c + W_B)]^2$$

i.e. a quadratic penalty function.

In this case, it can be shown that

$$(8) \quad W_B^* = (K - S_c) - \beta_1 E(\hat{C}) - (\frac{1}{2} + \beta_2) p_{w_1}$$

This is the representative city's demand curve to buy water from the WB at the beginning of the season.

4.5 THIRD PARTY EFFECTS OF WATER BANKING

There are several different types of potential third party effects of water transfers through water banks. These fall into three broad categories: 1) impacts on other water users 2) local economic impacts on parties other than water users and 3) impacts on environmental values. In general, the management of such third party impacts is complicated by the difficulty of measuring the impacts. The problem of measurability varies both with the type of impact and with the amount of normal variability in water and land use. A variety of options can be identified for reducing adverse third-party impacts, each with its own set of advantages and disadvantages.

4.5.1 Types of Third Party Effects

4.5.1.1 Impacts on other water users

A transfer of water through a water bank can affect the availability or quality of water to other water users or the cost of water delivery through an irrigation organization's ditch system. To avoid adverse impacts on downstream parties from a transfer of surface water, the quantity of water delivered to the buyer must accurately reflect both the quantity and timing of the foregone consumptive use of the seller. Errors in estimating the seller's pattern of consumptive use or the time lag at which the return flows would normally re-enter the river could affect the availability of water to satisfy other water rights. If it is not possible to modify storage releases to exactly duplicate the return-flow time lag, downstream water users might derive third-party benefits from water sales to a further downstream location. For example, if the return flows normally would not have reached the river until winter, a sale that leaves the full diversion right in the river in the summer in order to transfer the expected consumptive use could improve summer streamflows for other water users.

Similarly, third parties might benefit from quality improvements if the water is left in the river as a result of a sale to a downstream location rather than being diverted and partially returned as agricultural runoff. Quality degradation is also possible if water is sold from a downstream user, for example in the Delta area to an upstream junior agricultural user. In practice, the California Water Bank transfers were not of that type. In 1992, when a significant amount of water was transferred from the water bank to agricultural users, the water was transferred through the Delta to agricultural users in southern California. Idaho water bank transfers have, in some cases, resulted in water being left in the river for a longer distance than would have occurred under the original use, particularly with transfers from the Payette and Upper Snake banks to benefit downstream fisheries.

Transfers or water sales out of a ditch system can adversely affect others who continue to receive their water through the ditch. The magnitude of the impact depends upon whether or not the irrigation organization is required to reduce its diversion into the ditch system by the full quantity that would otherwise have been diverted for delivery to the seller. Such a requirement would result in the maximum impact. In that case, other ditch users would be deprived of the opportunity to reuse that portion of the seller's return flows that would have re-entered the ditch system or would have recharged the local groundwater system. In addition, the transfer out of the system would reduce the hydraulic head, slowing the movement of water through the system and increasing the proportion of the available supply lost to seepage, thus impairing the efficiency of water delivery to the remaining users. Removing a large fraction of the water from a ditch could make it impossible to move water to the tail of the system. While the "loss of return flow" impact would be avoided if the organization is only required to reduce its diversion by the seller's foregone consumptive use, the efficiency of the ditch operation would still be adversely impacted due to the reduced total volume of water in the ditch system. The average cost of delivered water would also tend to be higher than without the sale.

In California, the Department of Water Resources (DWR) attempted to minimize adverse effects on other water users by basing payments to sellers on the DWR's estimates of "new water" introduced into the system by the transfers supported by evidence of the water use intentions of these parties in the absence of the bank. The DWR also operated its storage facilities to coordinate the timing of water availability and demand so as to avoid impacts on Sacramento River water rights and to minimize environmental damages from the transfers at the Delta pumps.

The DWR required irrigation district participation in water transfers involving district supplies. For example, the 1991 district fallowing contract obligated the district to reduce its surface diversions and specified that DWR would make a payment of $3.00 per acre fallowed directly to the district. This may or may not have been sufficient to offset increased operating costs associated with the transfer and lost economies of scale in operating the district's delivery system. The increased costs would have arisen from the district's obligation, under the contract to cooperate with the grower in documenting the reduced use. It does not appear that the contract restricted further side payments between the grower and the district. Therefore, it would have been possible for the district to levy charges sufficient to offset impacts on other district members.

In the case of the groundwater substitution contracts, impacts on other water users could have been either immediate or delayed. Immediate impacts would include direct well-to-well interference and direct stream depletions, while delayed impacts would include increased future pumping costs, subsidence and delayed impacts on surface water rights. The DWR attempted to avoid immediate impacts on surface water availability by examining well-logs to establish the absence of immediate connections to surface water sources. Under the groundwater substitution contracts, pumping was metered and a well could be shut down if it interfered with other wells. According to Steve Macaulay use of at least one such well was shut down by DWR.[28] However, the Rand report suggests that monitoring of the effects of the groundwater contracts may have been left largely to the water districts, because most of the groundwater substitution contracts were made directly with districts acting as agents for their members.[29] This arrangement also allowed the districts to "tax" the groundwater sales to compensate for adverse local

[28]Personal conversation with Steve Macaulay, California Department of Water Resources, May 10, 1993.

[29]Dixon, Lloyd S., Nancy Y. Moore and Susan W. Schechter 1993. *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions*. Santa Monica: Rand.

impacts. For example, the Yuba County Water Agency retained 20 percent of the proceeds from groundwater sales to the bank.

For the 1991 and 1992 Water Banks, the DWR did not directly attempt to control impacts on aquifer drawdown, subsidence or delayed impacts on surface water rights. However the potential for adverse impacts was recognized and the DWR supported local efforts to monitor impacts. For example, Yolo and Butte Counties negotiated a 2 percent payment from DWR on groundwater contracts. Proceeds were used for monitoring impacts and for updating the Yolo County water plan.

Regarding delayed impacts on surface water availability Macaulay notes that " In essence, ground water withdrawals are borrowed from future streamflow. From a system standpoint, new water results only to the extent that the borrowing can be repaid from future surplus flows."[30] In the Sacramento system, the risk of increased stream depletions during non-surplus periods would fall mainly on the SWP and the CVP.

Idaho banks largely avoid the problem of impacts on other water rights by limiting bankable water to stored water. In addition, in the Upper Snake Rental Pool, third party impacts that might be caused by bank sales for uses below Milner Dam are addressed by a rule requiring that this water will be the last space to fill the following year. At the same time, all Upper Snake Basin (above Milner Dam) stored water is allocated for uses upstream of Milner. This means that, if stored water is transferred for use below Milner, return flows or recharge to groundwater levels that previously benefitted upstream users will not be available. Storage reservoirs in the Upper Snake Basin are filled in a coordinated manner, so that some reservoirs will be filled before others. For example, space in American Falls Reservoir will fill before space in Palisades Reservoir. The decision of a party holding space in American Falls to sell water through the bank for uses below Milner (or for use anywhere) could impact Palisade spaceholders' ability to fill the following season. To offset impacts from a transfer for

[30]Macaulay, Steve, 1993. "Water Transfers in California: Translating Concept into Reality," DRAFT MANUSCRIPT dated 6/3/93.

use below Milner, bank rules put the risk of not filling on the party selling water.[31] While there is no direct correlation between impacts from transfers below Milner and the ability to fill storage space the following year, the last to fill rule is used as an expedited tool to generally compensate other users in the basin for the loss of return flows and groundwater recharge as a result of the transfer.[32] In practice, the rule operates as a preference for irrigation uses, since all bank sales for use below Milner are for non-irrigation uses, and bank sales for use above Milner are for irrigation use.

Both the Payette and Boise rental pools have recently adopted similar "last to fill" rules, in recognition of growing pressure to provide water for the benefit of anadromous fish. In the Payette, the rule applies to bank sales for any type of use below the mouth of the Payette River,[33] and in the Boise, the rule applies to bank sales for any uses below the mouth of the Boise River.[34] Again, these rules in effect operate as a preference for irrigation uses.[35]

Idaho's statewide bank does not limit deposits to stored water, allowing the Idaho Water Resource Board to acquire rights to natural flow or stored water.[36] Explicit language regarding protection of other water rights falls on the side of approving rentals from the bank, rather than approving acquisitions for deposit into the bank. Preliminary plans for administering the Texas Water Bank call for a similar approach. That is, bank transfer impacts on other water rights would be assessed during the process of approving

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[31]Upper Snake Rental Pool Rule 3.6.

[32]Conversation with Ronald D. Carlson, Watermaster, Water District 1, Idaho Department of Water Resources, Feb. 2, 1994.

[33]Payette Rental Pool Rule 3.6.

[34]Boise Rental Pool Rule 3.5.

[35]Conversations with David R. Tuthill, Manager, Western Regional Office, Idaho Department of Water Resources, Feb. 2, 1994; and Lee Cisco, Watermaster, Water District 63, Idaho Department of Water Resources, Feb. 8, 1994.

[36]Idaho Code § 42-1762; Water Supply Bank Rule 3,6.

sales from the bank rather than deposits into the bank.[37] The Director of the Idaho Department of Water Resources may reject or conditionally approve "any proposed rental of water from the water supply bank where the proposed use is such that it will reduce the quantity of water available under other existing water rights."[38] The statewide bank also requires the written consent of the water supply organization (e.g. mutual ditch company) if the water right to be acquired for the bank is represented by shares of stock in a company or if the water right is conveyed through facilities owned by an irrigation district.[39]

4.5.1.2 Local economic impacts

Water bank sales can also affect parties who derive their income from sales to irrigated farms, processing of the produce of such farms or employment by the farms or dependent businesses. Experience with the 1991 and 1992 California Water Banks suggests that such impacts can be both positive and negative. Suppliers of seed, fertilizer, other chemicals and hauling and application services lost income, as did some segments of the farm labor force, while firms specializing in laser leveling and other types of farm improvements had increased sales.

The available evidence suggests that fears of major adverse local economic impacts from the 1991 and 1992 Water Banks were not borne out. Selected tables from the Rand study are included in the Appendix to this section. The study finds that the 1991 Bank caused less than a 1 percent decline in income in all counties that contributed water to the bank, and to a large extent, the estimated negative impacts were offset by

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[37]Conversation with Daniel Beckett, Manager, Texas Water Bank, Jan. 18, 1994.

[38]Idaho Code § 42-1763.

[39]Water Supply Rule 3,2,5.

water bank payments.[40] In fact, in only one county was the estimated negative impact of the bank on personal income larger than revenues received from the bank.[41]

The Rand study relied on survey responses from a sample of the farmers who actually sold water to the 1991 water bank either on no-irrigation contracts or on groundwater exchange contracts.[42] They estimated what farm operating costs would have been in 1991 in the absence of the bank. The percentage difference between that number and actual 1991 operating costs was used as one element in estimating the negative impact of the water bank on third parties. The survey responses were also used to estimate the percentage change in crop sales due to the water bank. To estimate the negative impact of the bank, the Rand researchers assumed "...that the personal income in the farm sector fell by the same percentage as the average percentage change in farm operating costs and crop revenues for each county."[43]

Farmers were also asked how much their farm investments differed from "normal." The results indicate that increased investment partially offset the reduction in operating costs.[44] However, as detailed in the previous paragraph, their estimates of the impact of the water bank on county-level personal income are not adjusted for the offsetting effect of increased investment.[45]

The Rand study suggests that many of the sellers of water to the bank entered only part of their acreage into the program and shifted inputs to other land in their

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[40]Dixon, Lloyd S., Nancy Y. Moore and Susan W. Schechter 1993. *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions*. Santa Monica: Rand.

[41]Table 4C.1.

[42]Table 4C.2 displays water sales by contract type for the 11 counties from which water was sold in 1991.

[43]Dixon et al., 1993, p. 82; e.g., for Butte County, the 6 percent decline in operating costs was averaged with a 4% decline in crop sales and the 8 percent of county income normally arising from agriculture was multiplied by the resulting 5 percent to arrive at a negative impact on personal income of 0.4 percent. See tables 4C.3, 4C.4, and 4C.5.

[44]See Table 4C.6.

[45]Tables 4C.1 and 4C.4.

operation. This tended to reduce the overall negative impacts on purchases of inputs and total crop output. Unlike previous estimates of economic impacts computed by Howitt et al.,[46] the Rand estimates are based on changes in the entire farming operation and thus adjust for such input shifting.

However, the Rand estimates may overstate the true third party impacts in other ways. The ideal measure would be the change in net income of suppliers, processors and farm sector workers. Since only a portion of expenditures on such items as fuel and equipment would have represented profits to the local suppliers, counting the entire change as equivalent to a change in local personal income overstates the impact. The report notes that no multiplier effects are incorporated in the analysis. Since revenues obtained from sales to the bank exceed the estimated negative local effects, ignoring multiplier effects may also tend to exaggerate the adverse effects of the bank.

Not surprisingly, it was found that impacts varied both with the type of contract, and for fallowing contracts, with the crop involved. The groundwater exchange contracts were found to have much smaller impacts on suppliers and processors than the fallowing contracts.[47] For the latter, the change in operating costs was generally higher for crops normally requiring higher per acre expenditures on labor, machinery and other inputs. The Rand study identified rice, alfalfa and sugar beets as high impact crops. As indicated in the report the reduction in operating costs per acre in the bank was often substantially less than UC estimates of crop budgets for those crops, even for crops not planted.[48] This may reflect both preplanting costs that were incurred before the bank was announced as well increased inputs applied to other land within the farmer's operation.

The Rand study also surveyed potentially affected businesses directly, in an effort to corroborate the estimates from the farm survey. It was found that in the six counties

[46]Howitt, Richard, Nancy Moore, and Rodney T. Smith, 1992. *A Retrospective on California's 1991 Emergency Drought Water Bank*, Report prepared for the California Department of Water Resources.

[47]Table 4C.6.

[48]Tables 4C.7 and 4C.8.

that sold the most water to the bank, agricultural suppliers suffered losses in gross revenues ranging up to 15 percent, with the impacts falling most heavily on firms conducting the majority of their business in the affected counties.[49] They note, however, that these changes in gross revenues cannot be attributed solely to the water bank because these businesses were also affected by the Christmas 1990 freeze, the deepening general recession and drought-induced water shortages. Given those confounding factors the Rand researchers concluded that: "...we think it likely that the bank caused gross revenues to fall 3 to 5 percent for business done in the six counties most impacted, 1 to 2 percent for business done in other counties directly affected by the bank, and 2 to 3 percent overall for business in the counties where DWR bought water."[50]

In addition, no statistically significant relationship was found between their estimates of the county-level negative impacts of the bank and the percentage change in countywide employment between 1990 and 1991. From this, they concluded that: "The lack of any consistent or statistically significant differences between the counties where the negative impacts are proportionately largest and the other counties may be because, once the positive impacts of the bank are included, there truly are no negative overall impacts of the bank. It may also be that the impacts are small, and we have insufficient data to sort them out from a large number of potentially confounding factors."[51]

In Idaho, local economic impacts are generally avoided as a result of the combination of the irrigation preference and the pricing mechanisms employed in the local rental pools. In fact, there may be positive impacts under current bank operations. Prices are set for the local rental pools by the local committee subject to a few statutory requirements. The local committees are authorized to annually review and set water rental prices including the portion of the price to be retained by the water district. Currently, rates collected by the rental pools range from 32 cents per acre foot (Boise Rental Pool) to 75 cents per acre foot (Upper Snake Rental Pool). Revenues accruing

[49]Table 4C.9.

[50]Dixon et al., 1993, p. 47., supra and Table 4C.10.

[51]Id. p. 52.

to the district are managed by the local committee and may be used for making facilities improvements or for other public purposes allowed under the statute.[52] These monies can be significant for the district. For example, in 1992, the Payette River Water District collected $69,307.50 in "administrative" fees.

In addition, local businesses are likely to benefit from the increased local income generated by sales to the water banks. In Idaho, agricultural preference rules, coupled with low prices tend to ensure that water bank sales either allow increased local agricultural production or bring payments into the community for water that otherwise would not have been used for irrigation that season.

In setting a price, the local committees appear to be constrained by factors outside their statutory and regulatory mandates. The perceived Bureau of Reclamation policy on profits was mentioned by some bank administrators as one control. Second, there is some concern about potential public criticism and consequential threat to their water rights if the price for bank water was set too high, and if the fee to the water district becomes too high. Third, the price may be kept relatively low to ensure that local irrigators have access to the water bank market. For whatever reason, all three local rental pools maintain relatively low prices for bank water, ranging from about $2.70 to $6.50 per acre foot. Payette administrators indicated they were considering a dual pricing structure, wherein sales for irrigation would be charged at one rate, and sales for non-irrigation use at another. But no action has been taken by the committee to initiate this change.[53]

Added to this type of pricing structure are preference rules that protect the local economy by ensuring that the water first be made available for local needs, generally irrigation use. Bank rules favor uses within the local area in several ways. All three local

[52]Idaho Code § 42-613A.

[53]Interview with Helen Bivens, Watermaster, Water District 65, Idaho Department of Water Resources (April 28, 1992).

rental pools give a preference to sales for irrigation uses within the state water district.[54] Additionally, as mentioned above, deposits into the statewide water bank may require the written consent of the water supply organization prior to allowing water to be sold for uses outside of the district.[55]

Local preference may also be recognized through rules allowing administrators to consider local interests. The statewide bank rules, for example, give the bank administrator broad discretion to protect the local public interest. In evaluating whether to accept water for deposit or whether to sell water from the bank, the administrator must consider whether acceptance would be "in the local public interest," defined as the affairs of the people in the area directly affected by the proposed use.[56] Similarly, the three local rental pools require an evaluation of whether acceptance of water or space for deposit into the bank is in the best interest of the rental pool or the water district.[57] With this type of discretion, bank administrators could conclude that, in order to protect the local public interest or "the best interest of the rental pool or the water district," only irrigation buyers will be permitted to purchase all or some identifiable rights from the statewide bank.

Finally, the local agricultural economy is protected by a statutory provision that prohibits bank sales for out of state use.[58] This provision tends to protect local interests at the expense of broader state and national environmental and economic interests. Nevertheless, sales were made to Idaho Power Company in 1991 intended to provide water downstream for anadromous fish. Because of regional and federal efforts to improve the fishery, Idaho Legislators amended the law to provide interim authority for

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[54]Payette Rules 1.2,7; Boise Rules 1.2, 7; Upper Snake Rules 1.3, 7. The Upper Snake rules also give a preference to lessees eligible for mitigation under the Fort Hall Indian Water Rights Settlement Agreement who are stockholders in the Mitigation Corporation to the extent that water is unavailable through Corporation sources.

[55]Water Supply Bank Rule 3,2,5.

[56]Idaho Code § 42-1763, Water Supply Rule 3,5,6.

[57]Payette Rule 5.4, Boise Rule 5.4, Upper Snake Rule 5.3.

[58]Idaho Code § 42-1763.

the rental of storage water to enhance salmon migration downstream.[59] This authority expires January 1, 1995, but will likely be extended.[60]

4.5.1.3 Impacts on Environmental Values

Transfers through a water bank may have either beneficial or adverse environmental impacts, and as the California experience demonstrates, there may be multiple partially-offsetting impacts. In the case of the California Drought Water Banks, possible adverse impacts that have been identified include: 1) damage to bird and wildlife forage and habitat caused by the removal of grain crops from lands around the Sacramento Delta 2) reductions in groundwater levels and quality resulting from accelerated pumping and reduced aquifer recharge and possible acceleration of subsidence and 3) possible adverse impacts on endangered and threatened fishery resources in the Delta caused by increased operation of Delta pumping plants. Possible beneficial impacts include: 1) lower water temperatures during periods critical for salmonid survival and improved water quality in the Sacramento River 2) reduced entrainment of fish in the unscreened diversions of Delta farms participating in the fallowing program 3) possible benefits of increased Delta outflows and 4) improved streamflows and water quality in purchasing areas.

Benefits to fish stocks below major water storage facilities were possible because DWR was able to time the of release of banked water when most beneficial for sensitive fish populations. For example, the 1991 Bank allowed cooler water temperatures to be maintained below Shasta Dam during August and September, which benefitted fish reproduction. The 1991 Bank also allowed summer water temperatures in and below Oroville reservoir to be significantly cooler than would otherwise have been possible. In 1992, releases of water to the water bank from sales on the Stanislaus River and by the Merced Irrigation District were timed to provide local fishery benefits.

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[59] Idaho Code § 42-1763A (Supp. 1993).

[60] Conversation with David R. Tuthill, Manager, Western Regional Office, Idaho Department of Water Resources, Feb. 2, 1994.

Increased losses of threatened and endangered fish at the SWP Delta pumps proved to be a major concern, particularly since the drought and other environmental changes had already severely reduced those populations. In particular, reduced streamflows and associated changes in riverine and Delta conditions during the drought led to sharp reductions in populations of wiriter-run Chinook salmon and of Delta Smelt. The DWR attempted to time its water bank pumping operations during the late summer and early fall to minimize impacts on the winter-run Chinook. However, increased mortality of this and other species were unavoidable, particularly for the 1991 Bank which moved considerably more water across the Delta than did the 1992 Bank. Since the Delta is a slack-water estuary, the environmental damage caused by the pumping could not be entirely offset by provision of carriage water as mandated under the regulations then controlling movement of water across the Delta. In a fast moving river, the environmental effects of adding a certain quantity of water at one point and withdrawing it downstream (after adjustment for channel losses) tend to be relatively small. Given the slow movement of water and tidal influences in the Delta, however, introducing new water into the system does not ensure that a similar quantity can be pumped from the Delta without causing reverse flows in the vicinity of the pumps which causes increased entrainment of fish.

Estimates of the increased fish losses for the 1991 and 1992 Banks are provided in the DWR's EIR.[61] DWR estimates, for example, that pumping for the 1991 Water Bank resulted in an increased loss of 67,730 Striped Bass and 3,089 Chinook while estimated incremental losses in 1992 were 1,366 for Striped Bass and only 2 for Chinook. The difference can be accounted for by both the smaller volume of water transferred and by the even greater concentration of 1992 pumping in the late summer and fall.

Conflicts also arose between the protection of different fish populations. For example, concentration of pumping operations in the late summer acted to protect several fish populations, but may have increased the impact on American Shad which are

[61] California Department of Water Reosurces, *Program Environmental Impact Report: State Drought Water Bank* (1993) at 124-125.

most abundant in the Delta during that period. In addition, the 1992 transfer between Merced Irrigation District and the California Department of Fish and Game that was designed to benefit both fall-run Chinook in the Merced River and a wetlands area was shut down when juvenile winter-run Chinook were discovered in the Delta.[62]

It is difficult to separate the impacts of the 1991 and 1992 Water Banks on groundwater levels and quality and on bird and wildlife populations from the impacts of the drought itself. Although the problems of reduced forage and nesting habitat have been widely mentioned, estimates of actual impacts do not appear to be available.[63]

For groundwater exchange contracts, DWR instituted a monitoring program. Some well-interference problems were identified and pumping operations were terminated or modified to resolve the problems. Attempts were made to assess the impacts of the 1991 Water Bank on groundwater depletion. McBean, for example, estimated that the 1991 Bank directly caused increased depletion of 47,000 acre-feet in Yolo County, out of an overall increase in depletion of 139,700 acre-feet caused by a general, unregulated increase in groundwater use.[64] McBean's estimate of the impact of the water bank is based on pumping pursuant to the groundwater exchange contracts. However, evidence from the Rand study, together with the fact that Yolo County irrigated acreage declined far less than the 45,700 acres entered in the 1991 fallowing program, suggests that the fallowing contracts may have contributed to the increased utilization of other lands relying on groundwater. Thus, the true impact of the 1991 Bank on groundwater depletion in Yolo County was probably larger than estimated by McBean. No adverse groundwater quality effects or changes in rates of subsidence have been attributed to the 1991 and 1992 Water Banks.

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[62]Id.

[63]Id.

[64]McBean, Ed, 1993. "Environmental Effects," in Coppock, Raymond H., and Marcia Kreith, eds., *California Water Transfers: Gainers and Losers in Two Northern Counties,* Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center. Davis: University of California [hereinafter McBean].

Bank water has been transferred under Idaho banks to provide instream flows for the benefit of anadromous fish. EPA officials commented that fish flows released in the Upper Snake Basin have had the added benefit of improving water quality below Milner Dam.[65] However, in the Payette Basin, releasing large quantities of water for fish flows has raised concerns about the potential impact on bald eagle habitat at the reservoir site. Releases from Cascade Reservoir have resulted in lowering the level of the reservoir below levels historically reached. These examples illustrate the difficulty in predicting the type and extent of environmental impacts associated with bank operations.

4.5.2 The Problem of Measurability

For each of the various types of third party impacts there are measurement difficulties and attendant uncertainties. For example, even with its considerable expertise, DWR found that it was not always easy to determine the amount of "new" water introduced into the system as a result of a sale. In some cases payments were made for no-irrigation contracts that did not actually result in an increased availability of water in the Sacramento River because subsequent rains reduced the amount of water that would have been applied to such crops as wheat that were planted but not irrigated under the contracts. That type of error affected the distribution of income between the sellers and the SWP contractors who ended up footing the bill for excess purchases and over-payments in 1991. However, the impact, if any, on other water right holders was probably minimal.

It is also possible that not all of the water purchased under groundwater substitution contracts was really "new" water in that, with some lag, stream depletions may have been increased by the pumping. California's general lack of reliable information on local hydrologic relationships between groundwater levels and rates of aquifer recharge and discharge makes assessment of such impacts particularly difficult. However, a unique feature of the California situation is the fact that the DWR has a

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[65]Conversation with John Olson, Watershed Manager, Middle Snake River, Environmental Protection Agency (Nov. 2, 1993).

strong interest in ensuring accurate measurement, since errors would affect the storage release obligations of the SWP to maintain Delta water quality standards.

Considerable efforts have been directed at assessing the third-party economic impacts of the California water banks, particularly given widespread fears and claims of significant impacts expressed during 1991. As the Rand study demonstrates, the presence of confounding factors such as the general recession, the drought itself and the Christmas 1990 freeze create considerable uncertainty for estimation of these impacts. In addition, the normal year-to-year variability in agricultural activity within the Central Valley makes it difficult to ascribe changes occurring in 1991 and 1992 to operation of the water banks. For example, in Yolo County, total cropped acreage had fluctuated between 300,000 and 400,000 acres over the decade of the 1980s. The inventory of idle, irrigable land available as a result of this normal variability may have allowed participants in fallowing contracts to move their labor, capital and managerial inputs to other lands where groundwater was available. Thus while 45,700 Yolo County acres were idled as a result of the fallowing contracts, total irrigated acreage decreased between 1990 and 1991 by only 1,400 acres.[46]

Estimates of third party economic impacts based on acreage in the fallowing program suggest a loss of 404 agricultural sector jobs in Yolo County and approximately a 5 percent decline in agricultural sector income.[47] The Rand study, relying on farmer survey responses, estimated a 3 percent decline in farm operating costs and a 6 percent decline in farm sales for Yolo County as a result of the 1991 Bank. This resulted in a 0.5 percent negative impact on Yolo County personal income, that was more than offset by the 0.6 percent increase in County personal income derived from bank payments. Despite very different methods, the two studies produced similar estimates of the negative agricultural sector impacts of the 1991 Bank. The fact that ex-post estimates of county-level impacts appear fairly robust does not suggest, however, that it would be an

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[46]McBean, supra.

[47]Howitt, Richard, 1993b. "Economic and Social Factors," in Coppock, Raymond H., and Marcia Kreith, eds., *California Water Transfers: Gainers and Losers in Two Northern Counties*, Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center, University of California.

easy matter to estimate the impacts of water transfers on individual businesses or on individual workers either before, during or long after the actual water bank sales.

As for environmental impacts, quantification was possible for some impacts such as fish entrainment at the Delta pumps but not for other impacts, such as reduced fish losses at Delta farm diversions, improved spawning success resulting from lower water temperatures in the rivers or adverse impacts on bird populations. In general, it appears that environmental impacts may be highly case-specific.[68] For example, fallowing of row crops was believed to have few impacts on the availability of forage and habitat. On the other hand, fallowing of rice was suspected to have potentially significant impacts, the magnitude of which may have varied by location and by the amount of other rice-land fallowed in the same vicinity.

Similarly, groundwater impacts varied by the location of the well and DWR argues that continued monitoring will be a necessary requirement of future water banks involving groundwater substitution.

The Texas water banking program provides that no more than 50 percent of a water right may be deposited into the bank.[69] This rule could have the effect of reducing impacts on water rights and other third party impacts, although this goal is not mentioned in the statute. The language has presented some definitional and measurability problems, however, as the state works on drafting program rules. "Water right" is defined in the rules as "a right acquired or authorized under the laws of this state to impound, divert, or use state water, underground water, or water from any source to the extent authorized by law."[70] Deposits of water rights representing conserved water may also be accepted into the bank.[71] The Board will not accept water

[68]California Department of Water Resources, *Program Environmental Impact Report: State Drought Water Bank.*

[69]Tex. Code § 15.704.

[70]Water Bank Rules, Texas Water Development Board, adopted May 13, 1994, at 31 Texas Administrative Code § 359.1, at §§ 359.7 and 359.2.

[71]§ 359.7(b).

rights if any portion of the right is, at the time of the application for deposit, involved in a cancellation or forfeiture proceeding.[72] One unsettled issue at this time is the meaning of the 50 percent cap. The rules do not explain how administrators are to determine this amount. For surface water, administrators are assuming this means 50 percent of the amount of water diverted or 50 percent of the consumptive use. In the case of groundwater, where the quantity may be described as a "right of capture," it is expected to be difficult to reach a threshold determination of the precise quantity of water associated with the right.[73]

4.5.3 Options for Addressing Impacts

4.5.3.1 Impacts on other water users

The 1991 and 1992 California Water Banks primarily involved the movement of water from northern California through the Sacramento/San Joaquin Delta to users in Central and Southern California. This situation put the SWP together with the CVP in the position of being the parties most likely to be affected by streamflow depletions arising from the transfers. The DWR worked to reduce the possibility of adverse effects on itself and other water-right holders by attempting to ensure that all transfers to the water banks introduced "new water" into the system.

Estimated foregone consumptive use was the measure used for fallowing contracts. This was based on the crop intended for production in 1991 and since crops vary in their consumptive use, the quantity of bankable water and thus payments per acre differed depending on the crop. For example, rice, pasture and alfalfa were each assumed to consume 3.5 acre-feet per acre while field corn was assumed to consume 2.5 acre-feet per acre and a crop of dry beans, 2.1 acre-feet per acre. Therefore, the payment was $450 per acre for rice, pasture or alfalfa but only $325 for field corn and $263 for dry beans. Given the short lead time for the 1991 Bank, and the required documentation of

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[72] § 359.6(c).

[73] Telephone conversation with Daniel E. Beckett, Manager, Texas Water Bank (Jan. 18, 1994). See section 2.3.2 supra.

cropping plans, it does not appear that there was much strategic behavior in the form of "planning" to plant a water intensive crop in order to secure higher payments. However, DWR has identified such behavior as a concern for the operation of future water banks.[74]

This suggests that if sales to a water bank are based on fallowing, or other methods of reducing consumptive use on a routine basis rather than only for occasional responses to drought emergencies, it will be important to define the quantity of bankable water in a way that does not create an incentive to maximize consumptive use in anticipation of future sales. Otherwise, a general increase in rates in consumptive use may result, leading to ongoing impacts on downstream water users. It might be possible to decouple the bankable quantity of water from the planting decisions of prospective sellers by defining a fixed percentage of any diversion right that can be banked on a routine basis. This could be based, for example, on the lowest rate of consumptive use for crops commonly grown in the locality, such as dry beans in the California case.

Following such a practice would remove any incentive to switch to more water-intensive crops in order to build up a bigger base of bankable water. If water banking is to be a routine, year-after-year phenomenon, the advantages of such an approach might outweigh its disadvantages. The disadvantage is that less water would be made available for transfer in any single year because growers of highly water-consumptive crops would not have as great an incentive to sell as under the pricing scheme adopted by the 1991 California Water Bank. If a water bank is only to be operated occasionally, under rare drought conditions, the expected gains from strategic crop switching may be small enough that such behavior will not arise. If that is the case, a differential pricing scheme, as was applied in 1991 would probably be the most efficient option.

In California, the DWR has adopted the position that state-run water banks should only be an occasional drought-response phenomenon. According to the DWR's final EIR, the department will generally follow a strategy of favoring groundwater

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[74]Macaulay, Steve, 1993. "Water Transfers in California: Translating Concept into Reality," DRAFT MANUSCRIPT dated 6/3/93.

exchange contracts and purchases of stored water over fallowing in order to minimize local socioeconomic impacts. However, DWR proposes "...to consider transfers on a case-by-case basis, where ground water substitution might be the favored source in one region while fallowing would be the preferred source in another."[75] This policy position was adopted in response to criticisms of the DWR's earlier proposal to avoid fallowing contracts except in years of severe shortage.

In Idaho, as mentioned earlier, impacts on other water rights have been largely avoided by limiting bankable water in the local rental pools to stored water, and through the "last to fill" rule. The storage water limitation does not preclude the transfer of other types of water rights since the statewide bank would still be available for this purpose. In practice, few transfers have occurred through the statewide bank, suggesting the process may not be attractive to potential sellers. While the "last to fill" rule imposes a penalty on water sales for non-local uses, it is not clear that the penalty is large enough to significantly inhibit sales to downstream uses in the Upper Snake or Payette.[76]

4.5.3.2 Local economic impacts

The efforts that have been undertaken in California to document third-party economic impacts demonstrate that even in retrospect considerable uncertainty surrounds the magnitude and incidence of such effects. This suggests that it would not be practical to seek specific mitigation at the time of water-banking operations, for example through local hearings of individual claims for compensation.

The California evidence also demonstrates that certain types of water bank transfers, such as fallowing contracts that result in a large decrease in the use of purchased inputs can have real effects on agriculture-sector businesses and some segments of the labor force. For California these impacts appeared to be well within the

[75]California Department of Water Resources, *Program Environmental Impact Report: State Drought Water Bank.*, p. 5.

[76]Under rental pool rules, the lessor receives compensation if the space does not fill. Specifically, a portion of the surcharge for downstream sales is returned to the lessor if the space does not fill (e.g., Rule 8.2, Water District 1 Rules).

normal range of variability and small relative to county-level personal income. However, the impacts of fallowing might be more problematic in other settings, for example where agriculture represents a larger fraction of the local economy, where potential water sales are larger relative to local supplies, where normal interannual variability in agricultural activity is small or where there is no unregulated groundwater and idle irrigable land available to allow the type of input-shifting that apparently occurred in some northern California counties in 1991.

In California, suggestions have been made to limit both the aggregate level and the local concentration of such impacts by limiting the total quantity of water that can be transferred out of a given locality.[77] Howitt's model suggests that local impacts per thousand acre-feet sold are likely to be an increasing function of total sales from the area. From this he argues that aggregate third party economic impacts can be reduced by spreading water purchases evenly over a large geographic area rather than allowing them to be concentrated in a few localities.

The limitation on sales by area might be accomplished by either by cutting off purchases from a given area when a pre-set ceiling is reached or by limiting the individual right to transfer to some fraction of consumptive use, as Texas has done (although it is not clear if 50 percent cap refers to diversion right or consumptive use). To the extent that the local quantity constraints are binding, neither option would allow the market to establish a market-clearing price and quantity. For example, the first option would create an incentive for prospective sellers to rush to sell early at a lower price than they could obtain in an unrestricted market. In Figure 4.5.1, sellers would likely accept P_s under option 1, while the equilibrium price in an unrestricted market would be P_c. This option would also result in excess demand because the marginal willingness to pay for the restricted quantity is P_d. Non-price rationing on the demand side would therefore become more important under this option.

[77]Howitt, Richard, 1993a. "Empirical Measures of Water Market Supply," Paper presented June 23, 1992 at the 69th Western Economic Association International Conference, Lake Tahoe; Howitt, Richard, 1993b. "Economic and Social Factors," in Coppock, Raymond H., and Marcia Kreith, eds., *California Water Transfers: Gainers and Losers in Two Northern Counties,* Proceedings of a Conference Sponsored by Agricultural Issues Center, Water Resources Center, University of California.

Under the second option, individuals wishing to sell their entire supply to the water bank could acquire transfer rights from other parties. Price would tend to rise towards P_d, eliminating excess demand and increasing the share of the gains from trade going to the selling areas. A disadvantage of such an option is that it could increase overall transaction costs by increasing the number of transactions necessary to acquire any particular quantity of water. However, it is not clear how many such side-deals would really be needed, because according to the Rand study participating farmers generally had very large operations and sold only part of their water to the bank.[78]

Howitt's model suggests that by reducing the aggregate level of third party impacts, a judiciously selected restriction on the total quantity that can be sold from a locality will generate larger net benefits than could be obtained under the unrestricted market alternative. In Figure 4.5.1, this would correspond to a situation in which the reduction in third-party impacts was larger than the shaded area, which corresponds to the deadweight loss arising from restricting quantity to Q_r. The optimal quantitative restriction would be that at which the reduction of third party impacts net of the deadweight loss is maximized. (Note that under some circumstances no restriction might be optimal—for example if the marginal third party impact at the unrestricted equilibrium is smaller than the incremental deadweight loss of imposing a restriction plus the cost of administering such a restriction).

Idaho has no express limit on the amount of water that may be deposited from irrigation uses from any given locality, but maintains some control over local economic impacts through other bank restrictions, discussed above. However, these restrictions might preclude some mutually beneficial transfers, particularly under extremely dry conditions. Indeed, in a few dry years during the 1980s, Idaho Power Company (IPC) requested more water through the Upper Snake bank than it was able to purchase

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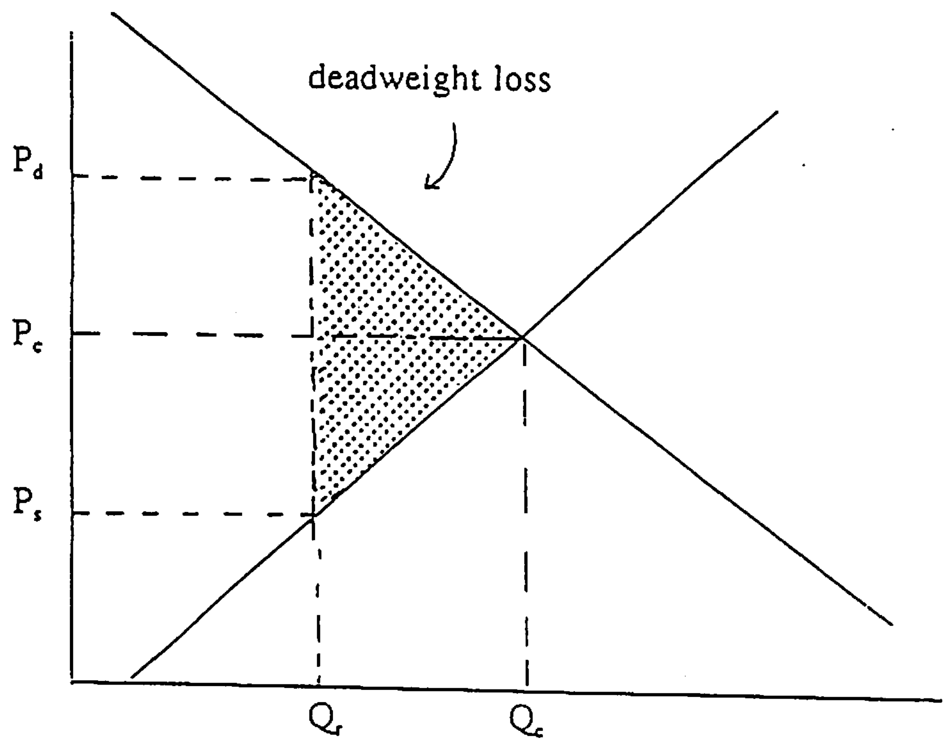
[78]Dixon, Lloyd S., Nancy Y. Moore and Susan W. Schechter 1993. *California's 1991 Drought Water Bank: Economic Impacts in the Selling Regions*. Santa Monica: Rand.

Figure 4.5.1 Price and Partial Efficiency Effects of Restriction on Quantity Sold



Q_c, P_c = unrestricted equilibrium price and quantity.

Q_r = restricted quantity

because of restrictions in the bank's rules. As bank sales turned out for those years, some water went unrented.[79]

The local watermaster for the Upper Snake sees the issue a bit differently. He argues that in the 1980s, IPC bought more water through the bank than probably could be economically justified considering opportunity costs. Eventually, the water will reach IPC facilities; it's just a matter of accelerating the timing of flow releases. In more recent years, IPC has enlisted the help of hydrologists and other specialists to look more carefully at the cost/benefit analysis of bank purchases, and has been decreasing its bank activity. Therefore, it seems less likely that IPC will in the future request more bank water than it is able to purchase due to bank restrictions.[80] In contrast, Whittlesey *et al.*[81] argue that the value to IPC of accelerating the timing of flow releases depends on the size of the differential between the summer and spring avoided cost of hydropower generation.[82] If the seasonal differential is large, they estimate that the value to IPC of water bank purchases could be substantially greater than the current water bank price. In particular, water bank purchases would be valuable in years when IPC must either purchase power or operate its thermal plants to meet the summer demand peak while regional power prices are expected to be lower during the following spring, when the stored water would otherwise become available to IPC's turbines. Thus, power supply and demand conditions on the entire regional market will affect the value of IPC's water bank purchases.

In the California case, the Rand study put forward other suggestions for reducing third party economic impacts. Their suggestions include reducing purchases from crops

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[79]Miller, K.A., "Hydropower, Water Institutions and Climate Change," 5 Water Resources Development 71 (June 1989), at 80.

[80]Telephone conversation with Ronald D. Carlson, Watermaster, Water District 1, Idaho Department of Water Resources, Feb. 2, 1994.

[81]Whittlesey, Norman, Joel Hamilton and Philip Halverson, 1986, "An Economic Study of the Potential for Water Markets in Idaho," for the Snake River Studies Advisory Committee, State of Idah, Idaho Water Resources Research Institute.

[82]Id.

with high impacts on operating costs and downstream processors. We would argue that this suggestion should be approached cautiously. As mentioned above, true third-party economic impacts may not be exactly proportional to the change in operating costs. More importantly, if a fallowing contract for a particular crop leads to a relatively large reduction in operating costs, the net gains to the farmer from fallowing that crop may also be the largest.[83] Therefore, prohibiting the fallowing of such crops could greatly reduce the net social gains arising from operation of a water bank. A better approach might be to allow farmers to freely choose which crops to fallow, but to place a small tax on water sales from fallowing contracts to be returned to the local community. The tax rate could be differentiated according to crop, but a more thorough analysis of net impacts should precede the selection of such differential rates.

Sax has expounded the merits of using a severance tax to provide compensation for impacts in the selling area together with relatively simple rules for mitigating environmental impacts.[84]

The Rand study also suggested "rotating" farmers participating in the bank by limiting the frequency with which an individual farmer could participate. Their reasoning for this suggestion is that participating farmers are likely to invest part of the proceeds in their farms, thus generating local economic activity, but that there may be an upper limit

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[83]Table 4C.11 suggests that the fallowing contracts, in general, resulted in larger net benefits to farmers than did the groundwater substitution contracts.

[84]Sax, Joseph, 1993. "Understanding Transfers: Comunity Rights and the Privatization of Water," DRAFT CHAPTER, dated May 14, 1993 in Vaux, et al., eds. *Sharing Scarcity: Gainers and Losers in California Water Transfers*, (forthcoming book). He argues that: "Formulae for taxes on transfers, compensation to in-stream uses, and prioritization of favored and disfavored types of transfers can be employed to assure mitigation without making transactional costs unduly burdensome. Large and pervasive impacts can be treated differently from small and ephemeral ones; and different standards can be imposed for in-basin and out-of-basin transfers." He further argues that:

> Of course, a formulaic approach is a second-best solution, and will not produce the appropriate result in every individual case. But the alternative—extensive participation and elaborate public interest hearings—while theoretically appropriate, threatens to make all but the largest water transfers uneconomic and untimely. Certainly some review process is necessary, but the goal should be to make it largely a fall-back device for especially hard cases. For the most part, some sort of formulaic approach will have to be adopted, or the whole system is likely to sink of its own weight.

to the amount of such investment that an individual would undertake. They suggest rotation as a way of increasing the total volume of such investment. We would argue that this proposal has serious shortcomings. The net benefit of using water on some farms may be lower than on others and therefore the net benefit of selling the water from those operations may be higher. To limit the frequency with which such farmers can participate would create an inefficient distortion in the market. In addition, an individual water seller could invest the proceeds on land other than that from which the water was sold and still generate local economic benefits. Given relatively well-functioning land and capital markets, the identity of the farmers selling water should not have much of an impact on the amount of investment resulting from the infusion of water bank payments.

4.5.1.3 Impacts on environmental values

California has taken the following steps to address environmental concerns raised by its water bank operations.

Aquifers: According to the EIR prepared by the DWR, recent changes in the California Water Code should facilitate the protection of groundwater resources.[85] These include the following provisions:

> 1745.10. A water user that transfers surface water pursuant to this article may not replace that water with ground water unless the ground water use is either of the following:
>
> (a) Consistent with a ground water management plan adopted pursuant to State law for the affected area.
>
> (b) Approved by the water supplier from whose service area the water is to be transferred and that water supplier, if a ground water management plan has not been adopted, determines that the

[85] California Department of Water Resources, *Program Environmental Impact Report: State Drought Water Bank*, 1993.

> transfer will not create, or contribute to, conditions of long-term overdraft in the affected ground water basin.

In addition, the DWR proposes to continue its monitoring of wells involved in groundwater substitution contracts and the EIR states that:

> Similar to 1992 contracts, all contracts for future drought water banks will have a requirement that the seller avoid adverse impacts related to subsidence, water levels and water quality. The seller and DWR will jointly investigate any identified or claimed adverse effect. If such investigation should determine that a significant adverse effect is occurring as a result of the water bank, pumping from wells contributing to the problem will be reduced, modified or terminated as appropriate. Additional mitigation measures may be appropriate in some cases.[86]

Fish: In California, the fisheries impacts of water bank transfers that involve movement of water across the Delta will continue to be problematic and it appears that the active involvement of the DWR in such transfers will continue to be required.. While manipulating the timing of pumping can avoid impacts to some populations, the Draft EIR notes that: "With over 40 species of fish present in the Delta...it is not possible to select a period which avoids impacts to all fish. ...Transfers during 1991 and 1992 were designed to avoid Delta impacts on winter run Chinook salmon and achieved this goal. If other species (such as the Delta and longfin smelts and the splittail) are listed or remain at low levels, it will become increasingly difficult to find "fish friendly" periods in which bank water can be transferred."[87] Future water banks will operate within the limits imposed by biological opinions issued by the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) for Delta Smelt and winter run Chinook salmon. In addition, it is proposed that current mitigation efforts be continued. For example, the CVP and the SWP have instituted predator control programs and facility improvements to reduce losses of several species of fish in the

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[86] Id., p.150.

[87] Id., p.151.

vicinity of the Delta pumps and funding has been provided for spawning habitat improvements.

Birds/Wildlife: DWR proposes a number of options for mitigating the wildlife impacts of fallowing contracts.[88] These include providing waste grain by requiring that a small portion of the fallowed land be planted but not harvested, reducing grain harvest efficiencies on nearby land, delaying mowing or disking until mid-summer, after the end of the nesting season, maintaining vegetation on border strips or planting certain cover crops. Howitt's suggestion of limiting the local concentration of sales might also be helpful as would a differential "severance" tax placed on sales that would have potentially large impacts on forage and habitat. The approaches suggested by DWR, however, appear more direct and therefore perhaps more effective.

In general, the California experience demonstrates that environmental considerations vary according to the specific circumstances of a transfer. This suggests that the design of any future water banks should provide some means for such impacts to be addressed on a case-by-case basis.

To date, environmental impacts from banking operations in Idaho appear to be limited to fisheries although water quality has indirectly been affected and there is an emerging concern with resources dependant on the maintenance of lake levels. Anadromous fisheries have experienced positive impacts with flow releases from water bank purchases. While not the primary objective of these releases, water quality—particularly in the section of the Snake River below Milner Dam impacted by irrigation return flows, and feedlot and fish hatchery effluent—can be improved by increased flows.[89] The Payette Rental Pool has experienced the conflicts that can arise between the water needs of environmental resources at the reservoir site versus the instream needs of anadromous fish. Previous stability in the lake level due to the establishment of a minimum pool has contributed to the increase in the nesting bald eagle population over the past 15 years. These minimum pools may be at risk as the

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[88]Id.

[89]U.S. Geological Survey, Hydrologic Unit 17040212, Water Quality Assessment, Middle Snake River.

pressure increases to provide additional flows from the bank for anadromous fish downstream.[90]

4.5.4 Generalizations and Implications

We can draw the following generalizations regarding the third-party and environmental impacts of water banking and their management. First, observations applicable to all types of impacts will be presented. Then generalizations pertaining specifically to impacts on other water users, on local economies and on environmental values are described.

4.5.4.1. Cross-cutting generalizations

1) Water banks are designed to facilitate potentially large numbers of short term water transfers, which may result in considerable year-to-year variation in water use patterns. Given the temporary and variable nature of the transfers, it would not be appropriate to perform as detailed an analysis of their potential third party and environmental impacts as would be required for permanent transfers. Efficient operation of a water bank will require streamlined procedures for managing such potential impacts.

2) Not all third party and environmental impacts are detrimental. There may, in fact, be substantial beneficial side-effects from water banking—for example improved streamflows, water quality and fish survival in some river reaches. However, the beneficial and adverse impacts will generally fall on different parties or different aspects of the environment so that they do not necessarily "wash out" from an equity or ecological standpoint. In addition, a large and diverse set of individuals is interested in impacts on stream quality and on fish and wildlife populations. These broad interests are generally represented by public agencies. Local economic impacts, potential impacts on other water rights and impacts on the operation of water delivery systems may tend to be more concentrated on particular individuals, businesses or organizations.

[90]Hoy, Roberta, Natural Resources Law Center, EPA/BOR Case Study, Cascade and Deadwood Reservoirs, Payette River Basin, Idaho, Oct. 1993.

3) Adverse third-party impacts can be reduced or avoided by imposing restrictions on the type and amount of water that can be sold and/or the location or type of use to which it can be moved. However, imposing such restrictions also entails costs in the form of lost opportunities to move water to more valuable uses. An optimization rule for the design of such restrictions would focus on maximizing the gains from banking net of third party impacts. Attainment of this goal will only be approximate since it would be prohibitively costly to fully and accurately measure all third party and environmental impacts.

4.5.4.2. Impacts on other water rights

1) It is not a simple matter to define bankable water in a way that avoids all possible impacts on other water rights. While transfers of stored water that has not been dedicated to specific annual consumptive uses are relatively straightforward, there can be impacts on other storage owners depending on storage allocation rules and refill priorities. In addition, it is difficult to determine how much "new water" is really being released by a groundwater substitution contract or by a contract calling for reduced consumptive use by the seller either through fallowing or crop switching. This suggests that specific attention to the definition of bankable water and increased monitoring of use patterns will be needed for the successful operation of any ongoing water bank. To reduce transaction costs, it may be useful to perform engineering studies documenting historical water uses within the area to be covered by the bank in order to obtain acceptable estimates of bankable water that will serve as the presumption agreed to by the state engineer for water banking purposes.

2) For transfers of stored water, impacts on other water right holders can be controlled by ensuring that there is no adverse impact on the ability of other storage owners to fill their space and no adverse impact on the rights of downstream users. The appropriate refill rule depends upon whether, how and where the water would have been used in the absence of the water bank transaction.

3) For the type of groundwater substitution arrangement used in California, it will be difficult to avoid impacts on groundwater tables and/or impacts on surface water

flows, particularly if they are used on a continuing basis. If such arrangements are only used during occasional droughts in a system like the Sacramento Basin, where groundwater recharge is normally rapid and where surplus flows are usually available during a portion of the year, the potential impacts on other water rights may be small enough to ignore. However, where groundwater and surface water resources are fully allocated, any water sale involving groundwater substitution would have to include a provision for replenishing the increased groundwater depletion caused by the sale. For example, groundwater substitution might be allowed in dry years, provided that an equivalent amount of surface water had previously been acquired and devoted to either artificial recharge or reduced pumping.

4) For other transfers involving reduced use of surface water or groundwater, bankable water should be quantified on the basis of consumptive use. The major difficulty here is verifying what consumptive use would have been in the absence of the water bank. If all of the crops grown in the area have similar rates of consumptive use and similar time patterns of water demand, then relatively simple rules of thumb can be used to translate a change in diversion quantities into a change in consumptive use. However, where crops differ greatly in their water requirements while water rights are defined on the basis of diversion quantities, the quantity of new water made available by a water bank sale depends on the crop that actually would have been grown. Basing payments on the actual reduction in consumptive use will increase the availability of water to the bank by encouraging growers of water-intensive crops to sell their water, but over the long term this can encourage strategic switching to more water-intensive crops. It should be noted that since water rights are universally defined on the basis of diversion rather than consumptive use, changes in cropping patterns can affect other water rights even in the absence of a water bank. The goal, therefore, should be to simplify the analysis of bankable water while avoiding creating any additional incentive to switch to more water intensive crops than would be chosen in the absence of water banking opportunities.

5) For transfers involving the movement of water out of a local delivery system, sufficient water should be left in the system to maintain its functionality. In general, the

proportion of water lost in transit increases as the quantity of water delivered through a ditch system declines. Therefore, a ditch user should be allowed to transfer a quantity smaller than his/her on-farm consumptive use. Ditch companies and irrigation districts should be encouraged to adopt rules for water sales and system operation plans that maintain the physical and financial integrity of their systems while allowing system users to participate in water bank transactions.

6) For all types of water sales, attention should be given to maintaining the quantity and timing of return flows to both surface water bodies and to aquifers. This is a necessary condition for ensuring the protection of other water rights.

4.5.4.3. Local economic impacts

1) Local banks (through which water can only be traded within a limited geographic area) can have an advantage in avoiding, monitoring and mitigating impacts. However, restricting sales to the local area would impair the efficiency of the bank. Rather, specific attention should be given to the differential impacts of local and out-of-area sales and the rules and pricing policies of the bank should be designed to mitigate those identified differential impacts.

2) It would be extremely difficult and costly to measure local economic impacts in a sufficiently timely manner to provide specific compensation for the effects of current water bank transactions-- especially since any offer of such compensation would be likely to elicit spurious claims.

3) Despite the relatively small size of measured third-party economic impacts, citizens of exporting regions tend to fear the potential local impacts of water exports. This suggests that local representation in the administration of a water bank will be valuable—both for insuring that local information on potential impacts receives full consideration and for providing an avenue for addressing local concerns.

4.5.4.4 Environmental Impacts

1) The environmental effects of banking operations can be complex and there may be conflicts between beneficial and detrimental impacts on different aspects of the

environment. In addition, impacts often depend heavily on particular physical circumstances that vary from case to case. This suggest a need for continuing public monitoring and management of water banking, particularly where transfers over long distances are involved.

2) Given ongoing environmental variability, complex environmental interactions and potential lags in effects it may be quite costly to fully and accurately monitor the impacts of water banking on groundwater resources and environmental values. Sufficient monitoring should be maintained to avoid readily identifiable and serious damages to aquifers and environmental resources. However, efforts to fully and accurately measure and mitigate the impacts of each individual transaction may not be the most effective approach.

APPENDIX 4C.
Rand Study Tables

Table 4C.1

APPROXIMATE MAGNITUDE OF IMPACTS OF THE BANK ON THE OVERALL COUNTY ECONOMY[91]

County	1990 Personal Income ($millions)	Estimated Negative Impact of Bank on Personal Income (percent)	Bank Payments as a Percentage of Personal Income
Butte	2,759	-0.4	0.5
Colusa	278	-0.7	2.1
Contra Costa	20,647	-0.1	<0.1
Glenn	390	<-0.1	0.1
Sacramento	19,874	-0.1	<0.1
San Joaquin	7,484	-0.4	0.2
Shasta	2,409	<-0.1	0.1
Solano	5,935	-0.1	0.1
Stanislaus	5,699	0	0
Sutter	1,032	-0.2	0.4
Tehama	612	0	0
Yolo	2,801	-0.5	0.6
Yuba	726	-0.3	3.8

[91] Id. Table 3.7.

Table 4C.2

ACRE-FEET SOLD TO BANK BY COUNTY AND CONTRACT TYPE[92]
(000s acre-feet)

County	NIL	GWEL	Total
Butte	40	62	102
Colusa	8	26	34
Contra Costa	27	0	27
Glenn	1	2	3
Sacramento	67	0	67
San Joaquin	123	0	123
Shasta	16	0	16
Solano	47	0	47
Sutter	18	10	28
Yolo	106	27	133
Yuba	0	79	79
Total	453	207	660

[92]Dixon et al., 1993 Table 2.17.

Table 4C.3

CHANGE IN COUNTYWIDE FARM OPERATING COSTS DUE TO THE WATER BANK[93]

($million)					
County	NIL	GWEL	Total	Estimated 1991 Operating Costs Without Bank	Percent Change
Butte	-3.0	0.2	-3.2	56.3	-6
Colusa	-0.7	-0.1	-0.8	57.7	-1
Contra Costa	-0.7	0	-0.7	12.2	-6
Glenn	0.1	0	0.1	48.8	-0.2
Sacramento	-2.3	0	-2.3	71.0	-3
San Joaquin	-4.4	0	-4.4	127.5	-3
Shasta	-0.3	0	-0.3	14.9	-2
Solano	-1.3	0	-1.3	100.9	-1
Sutter	-1.1	0	-1.1	84.1	-1
Yolo	-3.3	-0.1	-3.4	132.8	-3
Yuba	0	-0.2	-0.2	20.0	-1
Total	-17.1	-0.6	-17.7	726.2	-2

[93] Id. Table 2.18.

Table 4C.4

APPROXIMATE MAGNITUDE OF NEGATIVE IMPACTS OF BANK ON OVERALL COUNTY ECONOMY[94]

County	Percentage of Income from Agriculture	Impact of the Bank on Agricultural Businesses (percent)	Negative Impact of Bank on Personal Income (percent)
Butte	8	-5	-0.4
Colusa	71	-1	-0.7
Contra Costa	1	-5	-0.1
Glenn	42	-0.2	0
Sacramento	2	-4	-0.1
San Joaquin	13	-3	-0.4
Shasta	2	-2	<-0.1
Solano	5	-2	-0.1
Stanislaus	22	0	0
Sutter	24	-1	-0.2
Tehama	20	0	0
Yolo	10	-5	-0.5
Yuba	8	-3	-0.3

[94]Id. Table B.3.

Table 4C.5

CHANGE IN COUNTYWIDE CROP SALES DUE TO THE WATER BANK[95]

($million)					
County	NIL	GWEL	Total	Estimated 1991 Crop Sales Without Bank	Percent Change
Butte	-4.3	-5.8	-10.1	249	-4
Colusa	-0.9	-2.5	-3.4	221	-2
Contra Costa	-3.1	0.0	-3.1	73	-4
Glenn	-0.1	-0.2	-0.3	184	-0.2
Sacramento	-8.6	0.0	-8.6	234	-4
San Joaquin	-18.1	0.0	-18.1	663	-2
Shasta	-1.0	0.0	-1.0	60	-2
Solano	-5.7	0.0	-5.7	187	-3
Sutter	-2.6	-0.9	-3.5	273	-1
Yolo	-13.6	-2.3	-15.9	246	-6
Yuba	0	-7.3	-7.3	118	-6
Total	-58.0	-19.1	-77.1	2,708	-3

[95] Id. Table 2.19.

Table 4C.6

IMPACT OF TOTAL BANK PURCHASES ON OPERATING COSTS, FARM INVESTMENT, AND TOTAL INPUT PURCHASES BY CONTRACT TYPE[96]

($million)		
	NIL	GWEL
Operating costs	-17.1	-0.6
90-percent confidence interval	[-25.7, -8.5]	[-2.5, 1.2]
Farm investment	2.5	3.2
90-percent confidence interval	[-2.3, 7.3]	[-2.8, 9.2]
Total input purchases	-14.6	2.6
90-percent confidence interval	[-25.4, -3.8]	[-4.1, 9.3]

[96] Id. Table 2.10.

Table 4C.7

COMPARISON OF STATISTICAL ESTIMATE OF CHANGE IN OPERATING COST DUE TO BANK WITH CROP BUDGET DATA FOR NIL CONTRACTS[97]

	Change per AF sold (1)	AF per Acre in Bank (2)	Impact per Acre in Bank (3)=(1) X (2)	UC Crop Budget (4)
High impact				
Rice	-79	3.4	-269	401
Alfalfa	-52	3.3	-171	418
Sugar Beets	-48	2.8	-134	594
Medium impact				
Other	-30	2.5	-75	—
Corn	-32	2.2	-70	355
Wheat	-35	1.8	-63	265
Low impact				
Pasture	-3	3.1	-9	103

[97] Id. Table 2.6.

Table 4C.8

RELATION OF IMPACT OF BANK ON OPERATING COSTS TO CROP BUDGET BY TYPE OF NIL CONTRACT[98]

Type of Fallowing Contract	Impact per Acre Fallowed (1)	Crop Budget (2)	Ratio (1)/(2)
Planted not irrigated			
Alfalfa	-171	418	-0.41
Wheat	-63	265	-0.24
Pasture	-9	103	-0.08
Not planted			
Rice	-269	401	-0.67
Sugar beets	-134	594	-0.23
Corn	-70	355	-0.20

[98] Id. Table 2.7.

Table 4C.9

AVERAGE PERCENTAGE CHANGE IN GROSS REVENUE BETWEEN 1990 AND 1991 BY FIRM CHARACTERISTIC[99]

	Number of Firms	Average Percent Change
All firms	62	-11
1990 gross revenues ($million)		
Less than 1	15	-14
1 to 10	26	-11
Greater than 10	21	-9
Type business		
Provides farm inputs		
Applicators	8	-12
Fuel	7	-5
Equipment	11	-13
Seed, chemicals, other	16	-15
Handles farm output	20	-9
Percent of 1990 sales/purchases in 6 counties most impacted[a]		
35 percent or less	16	-9
36 to 74 percent	14	-11
75 percent or greater	26	-11

[a]Butte, Contra Costa, Sacramento, San Joaquin, Yolo, and Yuba.

[99]Id. Table 3.2.

Table 4C.10

IMPACT OF BANK ON AGRICULTURAL BUSINESSES AND PERCENTAGE OF COUNTY AGRICULTURAL LAND NOT IRRIGATED[100]

County	Percent Drop in Agricultural Businesses Due to Bank	Percent of Acres Not Irrigated
Butte	-5	14
Colusa	-1	1
Contra Costa	-5	29
Glenn	0	0
Sacramento	-4	17
San Joaquin	-3	10
Shasta	-2	6
Solano	-2	8
Stanislaus	0	<1
Sutter	-1	2
Tehama	0	1
Yolo	-5	11
Yuba	-2	0

[100] Id. Table C2.

Table 4C.11

NET BENEFITS OF THE BANK
TO FARMERS, LANDLORDS, AND WATER AGENCIES[101]

	NIL		GWEL	
	Total ($million)	Per AF Sold ($/AF)	Total ($million)	Per AF Sold ($/AF)
Water Bank payments	56.6	125	25.9	125
Saving on inputs	17.1	38	0.6	3
Increased pumping cost	0	0	-3.9	-19
Change in crop revenues	-58.0	-128	-19.1	-92
Net contract revenue	15.7	35	3.5	17
Payments to landlord	3.4	8	8.8	42
Payment to water agency	0.6	1	4.4	21
Net benefit to farmer	11.7	26	-9.7	-46

[101] Id. Table 2.20.

4.6 CREATING WATER BANKS: SOME RECOMMENDATIONS

This section draws together the analysis of water banking experience to date and the discussion of allocation mechanisms to offer our general recommendations for establishing water banks. It begins from the assumption that water banks can provide a much needed means by which the rights to use water in the western states can be more flexibly available for alternative uses. It also assumes that there is no single model by which a water bank can or should operate.

Our general conclusion is that there should be broad authorizing legislation enacted at the state level. Such legislation should provide inducements for water banking while setting up a general framework within which banks would operate. Conceptually at least it should be possible to trade any legally sanctioned water use through a bank so long as clear guidelines are established defining the use right, the amount of water available, and the requirements for offsetting unacceptable adverse effects. Banks should be operable at different scales ranging from interstate, to state, to basin, to district, to ditch and should be authorized to be established at any level so long as certain minimum requirements are met. A variety of allocative mechanisms are available and should be considered according to the size of the bank, the likely number of transactions, the type of water use entitlement involved, and other factors. Within the general framework recommended below we urge that transactions occur at a "market" established price.

4.6.1 State Authorization

Water banks have been created by legislation in three states: Idaho, California, and Texas. In Idaho the legislation ratified and expanded upon practices already in place while in California the statute simply authorized an emergency process put in place to respond to continued drought. The Texas approach, the most recent of the three, is perhaps the closest in concept to the model we propose here.
We distinguish between "state created" and "state authorized" in recommending legislation that would establish a framework within which banks could be set up. There may be legitimate reasons for setting up a state-run water bank but, in general, we favor

banks established and run by those parties most interested in the availability of a bank under a set of general guidelines and requirements. State authorizing legislation provides a number of important advantages:

1. Such legislation could (and should) remove the usual "use-it-or-lose-it" requirements of prior appropriation law for water rights placed into a water bank. Freedom from state forfeiture and abandonment requirements presumably would act as an incentive for some water right holders to place their rights into a water bank.

2. Water bank transactions also should be freed from the usual state-law requirements associated with permanent water rights transfers. Each water bank should be authorized to set rules governing transactions within a general framework of standards and requirements. Such specially authorized procedures should be simplified to help facilitate water transfers through water banking.

3. State legislation should establish policy support for water transfers through water banking and should direct state agencies to support such transactions within the general framework established.

In our view water banks potentially should be able to manage transactions involving any type of water use entitlement. We recognize the diversity of legally sanctioned water uses within the western states and acknowledge that certain of these entitlements lend themselves more readily to transfer through a water bank than others. Nevertheless we recommend that water banks be broadly authorized to operate, subject to meeting certain minimum requirements. We expect that banks will be created to meet available opportunities and should be encouraged to explore ways to facilitate transfers within a general framework.

We suggest that state authorizing legislation contain the following general requirements:

1. The water banking authority must establish a procedure for determining the types of water use entitlements that are eligible for banking and for determining the quantity of water that may be banked. This would include such things as evidence of the legal basis of the entitlement, of ownership, of validity, of recent historical use, and of freedom from any legal restrictions against changes in purpose or place of use. The intention is simply to insure that the water to be banked is legally available for this purpose.

2. The water banking authority must establish a procedure for insuring that banking of water will not cause injury to other water rights. This procedure would operate in lieu of the usual state level procedure governing changes of water rights and could be streamlined by adopting a <u>presumption</u> of no injury if the bankable water is limited to demonstrated consumptive use or perhaps to assumed consumptive use. We recommend that the authority retain jurisdiction to reconsider the question of injury for one year after each transaction and, upon evidence of measurable injury by any water right holder, award compensation from the user for the injury.

3. To address possible third party effects of transfers through a water bank the authority should be required to assess a mitigation fee on each transaction. Funds from this assessment would be divided equally into two accounts: one for distribution to offset possible adverse local economic impacts and one for mitigation of environmental damages. We recommend that the fee be assessed at some percent of the sale price of the banked water. The bank may wish to establish different fees depending on the new place of use with the highest fee for out-of-basin uses. We suggest establishing separate entities to manage distribution of funds. One possibility is to simply make funds available to the county commissioners of the county from which the banked water originates and to allow the commissioners to distribute the funds as necessary to address possible local economic effects. To manage funds for environmental uses a trust could be

established and run by a board of local and state environmental interests. In any event we favor distribution of funds according to perceived general needs rather than exclusively on the basis of directly measuring adverse economic and environmental effects of banking water and then attempting to directly mitigate these effects.

4. State authorizing legislation should require that the boards of water banks be "representative" of the water-based interests within the area in which the bank operates. It will be critical to have substantial representation from the water rights holder community since their participation is essential for the bank to operate. It will be equally important to insure that other interests have a voice in establishing bank policy and procedures so that the full community participates. One possible approach for a state or regional bank, for example, would be for the members of the water bank authority to be appointed by the governor for fixed terms with a member of the state's water resources department to serve as staff director. The structure should be designed to fit the situation in which the particular bank operates.

5. State legislation should require that disputes arising out of water bank transactions or related to rules or procedures of the water bank be submitted to binding arbitration for resolution. In keeping with the intention to facilitate transfers of water through banks, bank-specific disputes should be addressed to the degree possible within this framework.

6. State legislation should provide the necessary authority for the water bank to carry out the activities of the bank.

4.6.2 Bank Design and Operation

We expect that banks will develop according to the opportunities that are perceived within given areas. It is our general view that those creating a bank should be given considerable flexibility in its design and operation. We have already recommended that any water use entitlement potentially be bankable so long as the holder of the entitlement can establish its legal validity, its transferability, and its bankable quantity. The bank would establish guidelines by which these requirements would be met. Conceptually it is easiest to understand a water bank in settings in which banked water is contained in reservoirs. A physical sum of water hydrologically and legally available is deposited into an account (stored in available reservoir space), and can be withdrawn (released). The bank is the mechanism that manages the deposit and withdrawal (which results in a change of the water's use). In most cases it is likely that reservoir storage will be a component of the water bank, though water may instead be recharged into aquifers which can serve as the storage vessel, and water banks can also manage water use entitlements involving transferable water without any storage at all. A single bank could operate using all three of these options in some circumstances.

The mechanics of the water bank transaction will vary depending upon the approach involved. Banks based on reservoir storage must, of course, have such storage available within the area of the bank. In addition it will be necessary to have the full cooperation of the owners of the reservoirs including those with rights to the storage space. Agreements must be established by which physical space within a reservoir may be used to deposit bankable water and then have the water released when necessary for use by the purchaser. In the case of a groundwater bank the considerations outlined in chapter 3 above must be addressed. Banks managing transfers of non-stored water will have to work out procedures for administering such transfers, particularly relating to matters of injury to other water rights and who bears the risk regarding the amount of water actually available.

One critical choice to be made by the bank concerns who may purchase water from the bank. As a general matter we recommend that the bank be open to any qualified purchaser. We favor market-driven reallocation of water in which all willing buyers and sellers are able to participate. Restrictions placed on participation tend to limit the market and may impede the market's effectiveness in efficiently allocating scarce water resources. Thus we do not favor requiring purchasers to be "members" of the bank, nor do we support restricting purchases to certain types of uses such as only for irrigation or certain places of use such as only within the water bank area boundaries. Imposing conditions such as requiring the purchaser to demonstrate need or efficient utilization of existing supplies should be balanced against the transactions costs such conditions are likely to produce. In general, we believe such conditions should not be imposed.

At the same time we recognize that water transfers raise concerns in some parts of the West, particularly in rural agricultural areas where there are few apparent alternative economic uses of water. The acceptability of a water bank in such areas may depend on structuring a market that is viewed as at least not harmful to local interests. Rather than creating absolute barriers to certain types of transfers, however, we would recommend utilizing fees to provide differential incentives within an otherwise open market arrangement. Thus if there is a high degree of concern about water leaving local use to move to use in another part of the basin, fees could be assessed on such transactions in a manner that clearly differentiates the price of such transfers from transfers for use within the bank area. Similarly, fees could be used to differentiate transfers involving a change of type of use (say, from agricultural to urban use) if that is a concern. Proceeds from the fees would go into the two funds described earlier to provide local economic and environmental benefits. It should be kept in mind, however, that fees always discourage transactions.

Another major choice that must be made by a bank concerns the allocation mechanism(s) it uses. There are relatively few areas in the West in which there currently are sufficient transactions involving the buying and selling of water use entitlements to constitute a true market. We believe that well designed water banks offer an opportunity for water markets to develop. Our analysis leads us to recommend the use of closed bid auctions to the degree possible, held at specified intervals at which all offers to sell and offers to buy are matched. In the simplest model, water available through a bank is fungible, allowing this aggregated market to operate. In practice it is likely that either the bank itself or brokers operating through a bank would need to "package" banked water so as to make it equally usable by any purchaser. Because water banks are likely to involve a relatively large number of annual transactions such packaging may be feasible in many situations.

The primary attraction of the closed bid auction is its effectiveness at "price discovery" for banked water. Rather than the present rather random process by which sellers and buyers of water rights find one another and negotiate a price, the bank can bring all interested sellers and buyers into a unified determination of the market clearing price. There may be value in staging two or three auctions over the year to take advantage of the somewhat different markets likely to exist at those times. Some kind of guarantee arrangement is necessary to insure that bank participants follow through on their sell and buy offers.

For water use entitlements that cannot be pooled together in the bank (e.g., relatively junior water rights), it may be that the open English style auction will be the best mechanism for allocation. Bidders can use their own judgment in deciding the worth of the entitlement.

Banks also should stand ready to match buyers and sellers on an ad hoc basis. Thus a bulletin board could be maintained through which willing sellers and buyers could locate one another to meet immediate needs or to provide an alternative, low cost means of facilitating transfers.

In addition to mitigation fees, administrative fees should be established that cover the full costs of running the water bank. We recommend that the fees be based on the quantity of water that is placed into the bank (x dollars per acre foot of bankable water) and on the quantity of water that is purchased from the bank. These fees should be clearly identified in advance so that bank participants can factor the costs into their considerations.

4.6.3 A State Bank

Our discussion to this point has emphasized the use of regional or local banks. State-level banks may provide additional opportunities. For example, experience in California suggests that a state-level water bank may be an effective response to drought because of its ability to act as a single point of reference for potential bank participants and to use state resources to facilitate the process. Idaho established its state-level bank as a vehicle for transactions outside of locally established banks. Thus a state bank might serve to fill in gaps until such time as other banks are established. Texas proposes to use its state-level bank to facilitate permanent changes of water rights. The attraction of using the bank is its presumed ability to smooth the way through the legal requirements necessary to accomplish a permanent transfer in that state.

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Chapter 5

APPLYING OUR PROPOSED FRAMEWORK

In this chapter we examine three water bank proposals in light of the general framework developed at the conclusion of the preceding chapter. The proposals are for a water bank on the lower Colorado River, for a water bank in Texas, and for a water bank for the Fort Lyon Canal Company in Colorado. The Texas bank has, in fact, been established while the other two are in the proposal phase. We selected these three examples because they are still in the formative stage and offer considerably different approaches, including their scope, which ranges from interstate in the case of the lower Colorado River, to state-level in Texas, to ditch-specific in Colorado. The Colorado River and Texas banks were introduced originally in chapter two while the Fort Lyon is being described for the first time in this chapter.

5.1 INTERSTATE LOWER COLORADO RIVER WATER BANK

The history leading up to the current proposal for a lower Colorado River water bank is described in Section 2.4. As a continuation of earlier efforts, the lower basin states and representatives of lower Colorado River Basin Indian tribes in early 1994 began meeting again to discuss the possible establishment of an interstate water bank. Banking programs being considered by the parties included a regional water bank administered by an interstate committee and individual state banks with some kind of link that would allow interstate transfers of bank water. While these discussions were proceeding, the Bureau of Reclamation issued draft rules for an interstate water bank as part of its regulations for administering mainstem Colorado River water in the Lower Colorado River Basin. The draft rules contemplate that more specific guidelines will be developed by the Bureau's Regional Director. In this section our general framework is applied to the interstate bank proposed in these draft rules for the lower Colorado River.

An interstate bank operating on an apportioned interstate river presents some unique issues in designing a banking system. Each state's right to a share of the interstate river needs to be protected while allowing water to be moved between states. One or more legal documents, including federal court decrees and federally-approved compacts, may govern river allocation. Bank rules would need to recognize water management restrictions contained in these documents. In addition, state water law differences may require more general language in bank rules—for example, in describing beneficial uses of bank water.

The proposed rules for the Lower Colorado River Bank afford a promising framework for a workable interstate banking system that would facilitate new water uses while protecting each state's river allocation and rules of water administration. The bank is primarily designed for the transfer of Colorado River water made available through water conservation measures and land fallowing. An interstate committee would examine each proposed bank transaction and evaluate the amount of water that can be deposited into the bank. Storage of bank water is facilitated in the lower Colorado River by the availability of excess storage in Lake Mead. The proposed bank protects deposited water from forfeiture or loss from nonuse for a reasonable period of time.

The type of water that may be banked is limited to conserved Colorado River water historically put to beneficial use or non-Colorado River water imported from outside the basin. Thus, the draft rules would not allow the banking of water from a tributary of the mainstem Colorado River. Future banking of other types of water is anticipated by the Bureau and lower basin states if questions of third party injury can adequately be addressed. We would support broadening the source and types of water that could be managed through the bank

Proposed bank rules provide that all "entitlement-holders" (those with a decreed, contract or reserved water right to use Colorado River water) may deposit water into the bank. The draft rules give the Regional Director much discretion to assess the amount of water that will be accepted for deposit. If the deposit offered is conserved water, a committee made up of interstate representatives must verify the amount of deposit.[1] As drafted, the rules list a number of factors for consideration in determining how much water will be saved by proposed conservation measures or land fallowing. We generally favor up-front procedures like these for determining how much water can be banked and for insuring that no injury will result from bank transactions. However, the proposed committee and Regional Director approval process might prove to be cumbersome since each proposal approved would require detailed case-by-case analysis. We would encourage considering the adoption of generalized criteria wherever possible for evaluating how much water has been saved through proposed conservation practices or through land fallowing.

Since the bank contemplates land fallowing, draft rules specifically address mitigation of local impacts from bank transactions. They require that the parties guarantee the maintenance of idle lands by making contractual commitments for the management of such lands, or by setting up an escrow account to provide revenue to cover such costs. We support this approach to addressing site-specific impacts. In addition we would suggest consideration of assessing a fee that could be used to provide funds to help mitigate more general local economic or environmental impacts.

To satisfy the apparent requirement of the "Law of the River" that state apportionments of Colorado River water must be "beneficially consumptively used" within each state, the proposed rules state that the act of conserving and banking Colorado River water will be regarded as a beneficial consumptive use of the water. Thus the water will be charged against the state's entitlement but then will be freely transferable to other uses, including uses in other lower basin states. Either this or some other comparable legal fiction probably is necessary to get around the inflexibility in the current interpretation of the Colorado River apportionments. Whatever the ultimate approach, it will be essential to have the agreement of all the basin states as well as other interests.

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[1]For water conserved by tribes, tribal and BIA representatives would be on the Committee.

Once water is approved for deposit into the bank, rules relax with fewer restrictions on who may purchase the water or how the water may be used. This general idea is consistent with our preference for addressing questions of injury at the front end or deposit side of the bank transaction, with a presumption of non-injury once a deposit is accepted. The purchaser need not be a "member" of the bank, nor hold any entitlement to Colorado River water. Bank water may be used to make up for excess uses of Colorado River water entitlements, or any other beneficial use. The only requirement is that the use must meet the beneficial use standard of the state in which the bank water is used.

The functions of the bank appear to be those of referee and manager, not as a broker. The bank would assure that the transactions do not result in injury to other water users or to third parties, and will keep an accounting of the water banked and sold. It would, of course, manage the physical storage facility, Lake Mead, and would spill banked water first if necessary to meet its primary obligation under the Law of the River. Provision is made for assessing fees against those who deposit water in the bank but the nature and extent of such fees is not specified. We recommend that a clear schedule or formula for determining fees be developed so that potential bank users will know what the costs are likely to be. Consideration should be given to the assessment of fees against purchasers of bank water as well if necessary to recover administration costs associated with delivery of water.

The proposed Lower Colorado River Water Bank offers a promising mechanism for increasing the flexibility with which water in the lower basin can be used. It would take advantage of available storage space in the system, the central administration role of the Bureau of Reclamation, and the existing mismatch between lower basin state apportionments of Colorado River water and state demands for the water . While the particulars of the proposed approach are certain to change, the general framework appears workable.

5.2 THE TEXAS WATER BANK

As described in Section 2.3 above, the Texas legislature established a water banking program in 1993. The Texas Water Development Board, designated as the administrator of the program, adopted implementing rules in 1994. In this section we apply our general framework for creating water banks against the approach taken in Texas.

At present Texas has established only a state-level bank, though regional banks are authorized under the general legislation. In many respects the Texas approach parallels the framework we recommend. The implementing rules take a very broad view of the types of water rights that may be banked.[2] The authorizing legislation represents a clear statement of state policy supporting water banking. Some incentive to use the bank is given by the provision that a water right deposited in the bank is protected from cancellation for up to 10 years. The Texas Water Development Board is given broad general authority to operate the bank. The bank is authorized to handle both short-term as well as permanent transfers of water rights.

The mechanics of the Texas bank are not yet well defined. It appears that the bank may operate as a facilitator (applying its expertise to help get a privately negotiated transfer through the state review process), as a registry (a central location where water rights for sale or lease are listed), a broker (where specifically requested to do so by seller and buyer), an agent (holding banked water rights for sale or lease to interested purchasers), and a purchaser (acquiring rights for resale or other use). Perhaps because the actual functions of the bank are not yet clear the mechanics of bank operation are not well articulated. For example, there is nothing in the rules regarding how buyers and sellers are matched and the process of price determination. By statute, no more than 50 percent of a water right may be deposited in the bank. Apparently this provision is interpreted as meaning up to one-half of the face value of the water that would be

[2]Water Bank Rules §359.2.

available under the right, not necessarily 50 percent of the historical diversions or withdrawals.

The transaction fee is based on a sliding scale determined by the quantity of water involved up to a maximum of $500. The entities most expected to use the bank, political subdivisions (e.g. cities), are exempt from paying any fee. We support the use of a sliding scale to set fees but favor an open-ended fee that reflects the total quantity of water involved. There may be political reasons in Texas for waiving fees for cities but certainly the small transaction fee proposed cannot be regarded as too great an economic burden.

One major weakness of the Texas bank is that all transactions (at least those involving surface water) still must go through the traditional change of water right process. The bank apparently has not established clear rules representing the bankable quantity of water that would address issues of non-injury to other water rights. Such determination will be made by Texas Natural Resources Conservation Commission when there is a buyer for the water right. The Commission also must consider public welfare issues. It is expected that the processing of the water right transfer by the bank will facilitate the review process, particularly as the bank gains experience and clarifies its own procedures.

The Texas water bank has several attractive features. In addition to its openness to all types of water rights (mentioned above), it encourages the banking of conserved water. Conserved water is defined as "[t]he development of water resources, and those practices, techniques and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses." Moreover, participation in the bank, either as buyers or sellers, appears to be unrestricted as are the uses to which banked water may be put.

The general statute authorizes the creation of regional banks. Such banks are to be established through petition to the Texas Water Development Board. The petition is to set out proposed rules for operation of the bank. The state bank rules for establishing regional banks are very general at this point and suggest that there may be some flexibility in the manner in which such banks are set up and operated, subject to conformance with the basic statutory requirements.

In sum, the Texas approach contains several features that closely parallel our proposed approach but it also has a number of weaknesses. In some cases these weaknesses may simply reflect the bank's early stage of development. As experience is gained and the function of the bank becomes better defined, its procedures and rules also will become more clear. Viewed broadly, the bank may be seen simply as state-level encouragement for more water marketing. Assuming this broader objective is successful the mechanics should work themselves out.

5.3 THE FORT LYON WATER BANK

The Fort Lyon Canal Company is the largest irrigation company on the Arkansas River of Colorado, providing irrigation water through its 120-mile canal to more than 92,000 acres of land.[3] (See Figure 5.3.1.) A 1991 proposal to purchase a majority of shares in the company for permanent transfer of the associated water to urban users in the Front Range of Colorado prompted the state of Colorado to sponsor a study of "alternatives." The resulting analysis proposed the creation of a water bank. In this section we examine the proposal in relation to our water bank framework.

5.3.1 Summary of Proposed Bank

The water bank design outlined in the Fort Lyon Study would establish a non-profit organization with a full-time manager and a board of directors.[4] All shareholders within the Fort Lyon Canal Company would be eligible to lease their shares to the bank. Lands irrigated with water available under these shares would have to be "fallowed."[5]

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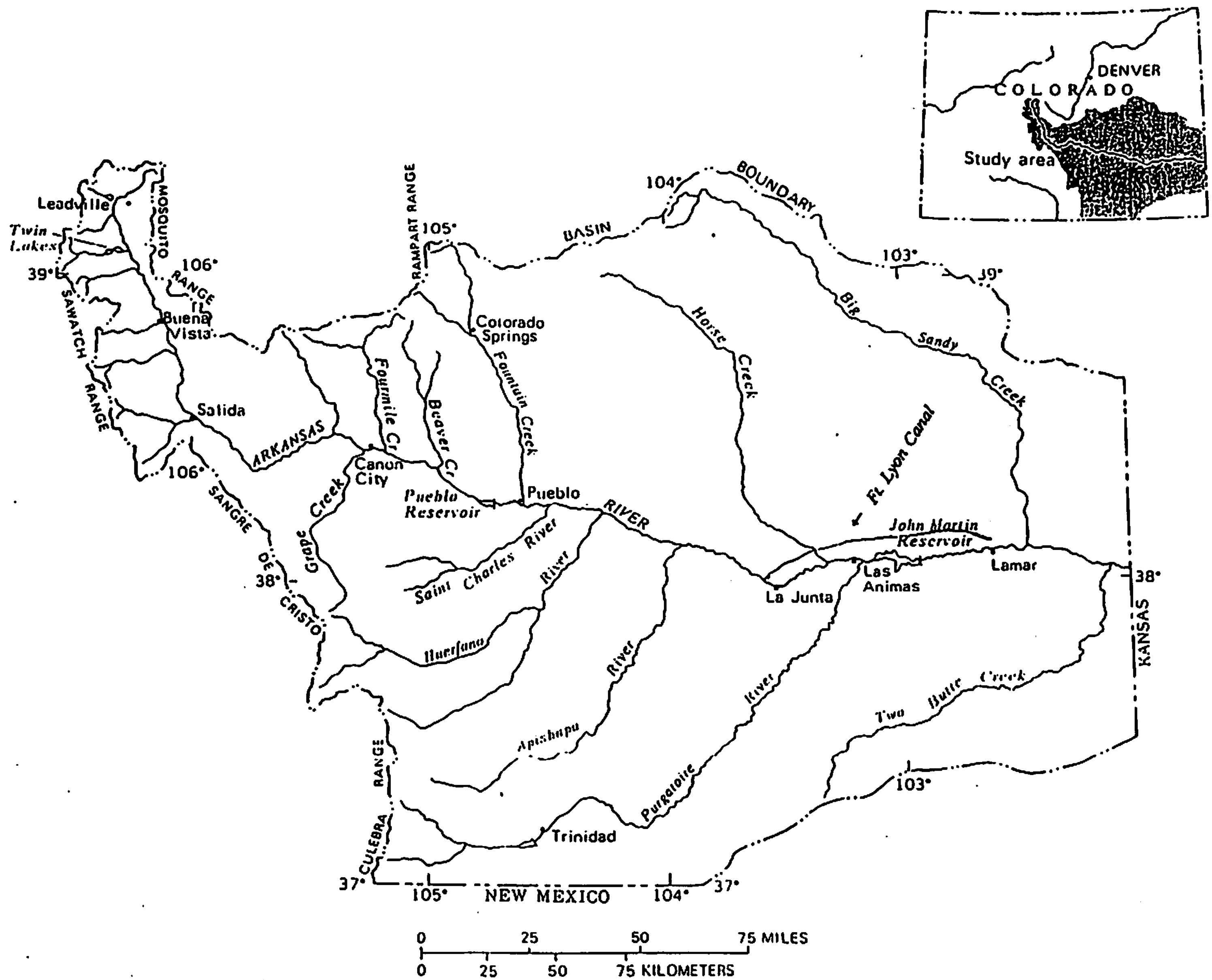
[3]Gronning Engineering Company, Final Report—Fort Lyon Canal Company Water Transfer Alternative Study, Colorado Water Conservation Board (February 1994).

[4]Id. at 7-31.

[5]Id. at 7-28.

Figure 5.3.1

The Arkansas River Basin of Colorado



Any water user located below Pueblo Dam in Colorado could rent water from the bank. Sealed lease and rental offers would be accepted by the bank until March 5th of each year.[6] Apparently the bank would "acquire" leased water from the lowest cost bidders up to some "goal" for acquisitions determined as of February 15th. Presumably the goal would be established through prior discussion with potential renters of bank water. Apparently, the bank would then rent the water to those submitting the highest price bids, up to the amount of water leased. A second bid opening would occur on July 20th. Renters from the previous years would have a right of first refusal "at the highest bid price." Renters may hold multi-year contracts for water at an established price.

Transactions are based on "transferable yield," essentially the consumptive use of the leased water less any adjustments necessary to account for losses incurred in storing and delivering the banked water.[7] There is considerable discussion in the proposal regarding the manner in which the bank would be operated to avoid injury to other water users—both within the Fort Lyon Canal and elsewhere in the lower Arkansas River. Apparently there would be detailed case-by-case analysis of all transactions each year to protect against possible injury. Based on an analysis of the Fort Lyon system, factors for return flows, main canal losses, and lateral losses are presented.[8] It is not clear whether these factors will operate as working assumptions for all water to be leased out of the Fort Lyon or whether there will need to be a site-specific analysis for each transaction. The proposal concludes that about 1½ units of consumptive use water must be leased by the bank to provide one unit of rented water.[9]

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[6] Id. at 7-43.

[7] Id. at 7-14.

[8] Id. at 7-16.

[9] Id. at 7-33.

5.3.2. Comparing the Proposal and the Framework

The Fort Lyon water bank proposal is tailored to fit a particular situation. It contains considerable detail regarding operational issues in utilizing particular storage systems and in utilizing exchanges to move Fort Lyon water to other users in the lower Arkansas. At this stage it is simply a consultant's proposal in a report. It would require a substantial number of actions to be taken before it actually became operational, assuming there was support for the proposal from the shareholders of the Fort Lyon Canal Company.

As a canal-specific bank, only shareholders of the Fort Lyon Canal Co. are eligible to lease water to the bank. Furthermore, the water available for the bank may only be rented to users in the lower Arkansas Valley of Colorado below Pueblo Reservoir. In general we favor banks that avoid such up-front restrictions. In this case, however, there may be some value in focusing just on a single (very large) canal to gain experience and win support for the general approach in Colorado. Some shareholders in the Fort Lyon system have expressed interest in permanently selling their company shares while others have aggressively resisted such sales because of fears about detrimental effects to their water rights and to the irrigated agricultural community in the area. A well-crafted bank could provide alternative economic uses of some of the water (and thus, benefits to those shareholders wanting to lease water), while limiting the place of use to the lower Arkansas Valley helps to assure that the economy of this area would continue to benefit from the use of the water.

Generally the proposed bank would follow a market approach and would utilize a sealed bid process twice a year to rent banked water. The proposed approach, however, varies from our recommendations in that it would apparently attempt to predetermine demand for rental water and would acquire leased water accordingly. It would not simply allow supply and demand to match up. While bidders would be free to indicate their leasing and renting price the proposal contains prices, assumed for purposes of analysis, of $60 per acre-foot of consumptive use (leased) and $140 per acre-foot of consumptive use (rented). The difference would be used by the bank to cover its operating expenses and to ensure that there is no injury to other water rights. Thus there is no direct fee but the implicit cost of the transaction is $80 per acre-foot. The single largest part of the cost is the .5 acre-foot of consumptive use water assumed to be necessary for release to avoid possible injury to other water rights. The major bank expense is the fixed cost of staff and office. Fees for water storage are the next largest category of expenses. After some initial substantial start-up losses the bank as projected to generate "profits" in most years.

Expenses for the proposed bank appear to be high relative to the quantity of water expected to be transferred. The proposal suggests that about 5,000 acre-feet of consumptive use water would be rented each year and would require the full-time equivalent of 2½ employees to operate.

We favor a bank that does not acquire and then sell (rent) the water but that matches buyers and sellers through a bidding process and charges a fee for its services. Fees to the lessor of water should cover the costs of evaluating the transferability of the right and determining the quantity of bankable water. Fees to the renter should cover the costs of making the water available at some place of storage or point of diversion. The bank also should provide "bulletin board" service to help match individual buyers and sellers.

Considerable attention is given to ensuring that water users will not be injured because of operation of the water bank. Such attention probably reflects the extraordinary sensitivities of many water users in the Arkansas River Basin (and other parts of Colorado) that the long-established return flow interdependencies among users be protected. For example, even though the transferable yield is restricted to consumptive use the new use would not be credited with any return flows without a special showing of the existence of such return flows.[10] We understand the importance of protecting water rights but note that the extremely conservative approach recommended here may impose an unnecessarily high cost on possible water bank transactions.

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[10] Id. at 7-8.

The proposed bank will require either the approval of a substitute supply plan by the state engineer or a court decree authorizing its operation. No legislative approval would be necessary. While we appreciate the wisdom of working within the existing system we urge consideration of creating a state authorized umbrella to give support to the use of water banks and to ensure the protection of water rights that are leased to the bank from questions of abandonment or waste.

Chapter 6

SUMMARY AND CONCLUSIONS

In an arid setting the manner in which water resources are used is an especially good indicator of the value attached to water. When these uses do not change, however, to keep pace with changing needs for water, conflicts develop. Those with control of the water, and with a historical sense of the importance of that water use, are reluctant to give up that control. Those desiring greater access to the resource for themselves or for their interests are frustrated by what they see as an imbalance in the way limited water resources are being used.

In the western United States water uses are accorded legal recognition and protection. While, for the most part, these legal entitlements can be sold to others and even, subject to certain rules, changed in their manner of use, existing water transfer mechanisms are inadequate. They are dominated by transfers from agricultural to urban uses. They usually involve the permanent removal of irrigated lands from production. Because of the substantial, essentially fixed costs associated with the transactions and with moving the water to a new place of use, those transferring water prefer to acquire large blocks of water, thereby measurably reducing agricultural production in a particular area. Concerns about the local economic effects of losing the agricultural production (and, of course, the possibility of some alternative economic use of the water) prompt resistance to water transfers.

Water banks offer a highly flexible framework within which water transfers may occur. They can operate at any level, ranging from interstate down to water district or ditch company. They can be designed to manage different types of water use entitlements. As an institutionalized mechanism intended to facilitate water transfers they can develop clear, well-defined rules and procedures that should help reduce transaction costs. They are particularly well suited to facilitate temporary water transfers, providing an option to both buyers and sellers that often does not now exist. They can create differentiated markets through pricing and other means as a way of attempting to effectuate policy objectives such as supporting local uses of water.

The use of water banks is certainly not new. The Upper Snake River Bank in Idaho has been in operation for about 60 years. This bank resulted from the somewhat unique situation of having storage water available in many years that exceeded the direct needs of those holding the storage rights. It is worth noting that water banks also formed in the Boise and Payette watersheds, generally following the upper Snake model, and that the Idaho legislature gave state-level sanction to the operation of these banks. These banks favor local use of banked water and have successfully increased the flexibility with which water resources within the bank district are available. Efforts to utilize the banks to increase flows of water available for downstream salmon migration have been much less successful, however. Water banks are no quick fix for reallocating the water resources of the West.

Experience with the California Water Bank is perhaps a more dramatic example of how a bank can facilitate temporary water reallocation. Despite the growing urbanization of California and the consequently greatly increased needs for more urban water there had been virtually no transfer of water from irrigation to urban use until the bank came into operation in 1991 on an emergency basis. The California bank reflects that state's rather centralized approach to water management. Large organizations dominate control of water in California. With the State Department of Water Resources acting as manager, the primary water suppliers and water users worked out a framework within which drought water needs could be met on a market basis. The volume of water placed into the bank by water users in 1991 exceeded all expectations and demonstrated beyond a doubt that market-based transfers of water in California could work.

Bank rules and procedures were modified in some respects during the three years of bank operation to reflect experience with such things as price and with environmental concerns. Creative approaches were found to deal with such issues as transferability of riparian water rights, while some issues such as the long-term effects of increased groundwater pumping on surface water availability were simply not addressed.

Whether or not the state bank continues in operation, market-based transfers of water now appear to be more acceptable in California. Particularly the Metropolitan Water District of Southern California is now pursuing a large number of creative arrangements involving water transfers in the southern part of the state and, with the possibility of transfers of water from the Central Valley Project because of the Central Valley Project Improvement Act, also is pursuing transfers from the San Joaquin Valley. It seems possible that more regional or even local water banks may develop in California in the not-too-distant future.

Groundwater recharge is actively used in some parts of the West and seems certain to be used much more widely in years to come. Laws governing recharge of water and its subsequent withdrawal now exist in many western states, giving increased clarity and certainty to this process. To this point groundwater recharge is used simply as a means of water storage rather than as part of a water bank. Given the value that storage adds to a water bank operation, however, it seems likely that groundwater recharge will be operated increasingly in connection with water banks.

There is no set formula for designing a water bank. The possibilities are truly limitless—banks should be tailored to meet the particular opportunities and needs presented by the situation at hand. At the same time there are some general considerations that must be taken account of in putting a bank together. Moreover our analysis—both at a conceptual level and based on our evaluation of experience to date—leads us to make a number of recommendations respecting water bank design and operation.

Among other things we favor state authorizing legislation within which water banks can operate. Water banks are explicitly intended to facilitate transfers, and state legislation can help by supporting this objective and by providing assistance in ways such as explicitly protecting banked water rights from threats of abandonment or forfeiture, and by taking temporary transfers through the bank out of the usual state change-of-water right review process. Certainly states will be concerned to assure that water banks operate within certain rules such as no injury to other water rights and no unacceptable adverse environmental effects.

Respecting water bank operation we favor banks that are as open to use by interested participants as possible. Thus we support allowing the banking of any valid water use entitlement that allows transfer of water use. We support open participation in acquiring water from the bank, possibly subject to the existence of banked water pools rentable at different prices reflecting, for example, whether the water would be used for urban, environmental, or agricultural purposes or whether the water would be used within or outside the original area of use. We favor market-based allocation of banked water and believe that, when possible, the bank should utilize closed bid auctions on a periodic basis as a means of encouraging efficient allocation of water.

To address the potential adverse effects of water bank transfers while minimizing transaction costs, we favor the use of presumptions regarding consumptive water use that would need to be disproved (e.g., the consumptive water use of an acre of alfalfa is "x" acre-feet) and the assessment of mitigation fees that would be utilized to make economic and environmental improvements in the water bank area. Because we expect that water banks primarily will be dealing in temporary transfers (e.g., for one year or less) and because we expect that banks could be handling a large number of transactions, we support looking for ways to avoid the detailed, case-by-case analysis that is typical of most state change-of-water right processes. We are more concerned that participants in the bank and those particularly affected by bank activities regard the procedures and requirements as fair and effective than we are with any particular approach.

The manner in which various interests are included in the design and operation of the water bank could be critical. At the front end it will be essential to get the participation and support of those holding the water use entitlements that might be placed in the bank. If storage facilities are expected to be an integral part of the bank, the owners of these facilities and the associated storage rights must be parties to the bank. Participation of local governmental representatives may be helpful to reflect economic and community interests. Representatives of environmental interests may also be helpful.

The relatively recent creation of a state water bank in Texas and proposed water banks in such diverse settings as the Lower Colorado River and the Fort Lyon Canal suggest a growing interest in the use of water banks. We believe such interest is well-founded. There is a need throughout the West to provide greater flexibility in the utilization of the limited water supply. Well-designed and operated banks offer a framework within which voluntary water transfers can be facilitated more readily than under existing options. Implementation of water banks will, of course, raise another whole set of issues (concerning such things as pricing, participation, and protections). Change will come slowly and in many different forms. We are persuaded, however, that the general mechanism represented by the water bank can be a key element in untangling the Gordian knot of western water and in bringing water uses in the West more closely in line with the way water is valued.[1]

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[1]For a discussion of the Gordian knot, see Sarah Bates, David Getches, Lawrence MacDonnell, and Charles Wilkinson, *Searching Out the Headwaters* (Island Press, 1993).