WATERSHED MANAGEMENT FROM THE GROUND UP:, POLITICAL SCIENCE AND THE EXPLANATION OF REGIONAL GOVERNANCE ARRANGEMENTS

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PANEL 25-6

Prepared for delivery at the 1999 Annual Meeting of the American Political Science Association, Atlanta Marriott Marquis and Atlanta Hilton and Towers, September 2-5, 1999.

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INTRODUCTION

This paper responds to the meeting organizers' call to address the connection between political science and the challenges of problem solving in the "real world," and especially the relevance of political science knowledge to actual puzzles faced by policy makers. The context of the paper is water resources management in the western United States, which is both acutely "real" and intensely political.

For at least the past 25 years (since the publication of the National Water Commission's final report, Water Policies for the Future) and perhaps longer, prescriptions of the water policy literature have centered upon two themes. Political scientists and public administration scholars have contributed to both themes, as they did to the commission study and report. The first theme is that "the watershed" is the appropriate scale for organizing water resource management, because all water sources and uses within a watershed are interrelated. The second is that since watersheds are regions to which political jurisdictions almost never correspond, and watershed-scale decision making structures do not usually exist, they should be created. Watershed-scale decision making organizations would bring together all "stakeholders" and produce integrated watershed management policies that can be implemented efficiently, preferably through some form of watershed authority.

Despite the consistency of the message, the gap between prescription and practice is wide. Like many calls for regional approaches to public problems, this one seems to have been largely unheeded. The number of cases where watershed management has been undertaken in the prescribed fashion is, to state it delicately, small.

On the other hand, our observation of water resource management activities in western states has revealed that regional, watershed management *is* in fact developing in several places, but in an altogether different manner. Watershed-scale decision making arrangements and management activities are being assembled in various decentralized and polycentric forms that involve linked and nested relationships among smaller organizations. The emerging result may be characterized as watershed policy making without a watershed policy maker, or as watershed management from the ground up.

It may be unsurprising that practice has diverged from prescription; by itself, that finding would hardly count as "news" in political science anymore. The question for this paper—as perhaps for this meeting—is whether political science now has anything insightful or useful to say about the practices being observed. Is there a political science explanation

that can make sense of the decentralized, non-hierarchical, non-comprehensive fashion in which watershed management is evolving in the western states?

This paper describes four watersheds we have studied in California and Colorado that exhibit polycentric designs. It then offers an analysis drawing upon political economy and institutional analysis, to account for incremental and decentralized approaches to the development of regional-scale institutions and policies. The combined presentation is intended to provide an empirically-supported, political science-based explanation of the formation of regional governance arrangements, such as watershed management, from the ground up.

THE "WATERSHED MOVEMENT"

The watershed concept is fairly common now, but we should begin with a definition nonetheless. A watershed is a geographic area within which all water resources (rainfall and runoff, surface streams and underground water) drain toward a common point. A watershed typically includes higher and lower elevations forming one or more valleys, such that all water falling or flowing therein moves to the valley(s) and ordinarily toward a river or ocean (although there are some "closed basins" in which water drains toward an interior point such as a salt sink).

From the standpoint of water resources management, two characteristics are most relevant about the watershed concept. The first characteristic is that nearly all watersheds contain more than one type of water body or waterway. A typical watershed will include one or more creeks or streams draining the higher elevations, one or more groundwater areas in the valleys and underlying the streams, plus wetlands areas and (depending upon the terrain) ponds or lakes.

The second relevant characteristic is that, while each of the water resources within a watershed has its own features and uses (including supporting various habitats), they are related to one another because of their physical situation. The streams drain to a common body of water and probably also replenish the groundwater basins. The aquifers in those groundwater basins may support the base flow of the streams. And other surface water resources such as wetlands and lakes have complex interactions with the streams and aquifers that pass through or beneath them.

The combination of these characteristics supports the calls throughout this century in the United States (and elsewhere, too, but we confine the discussion in this paper to the U.S.) for managing water resources on a watershed basis. The fact that a watershed contains multiple water resources makes separate management of those resources possible, so the recommendation of watershed-based management is not superfluous or tautological—all water resource management is not watershed management. But the fact that all water resources within a watershed are physically related to one another lends a logic to watershed-based management—treating resources separately when they have interactive effects may produce suboptimal or even undesirable results.

In a very small nutshell, that is the logic behind what is sometimes called "the watershed movement." The "movement" is not so much a formally organized effort as a burgeoning literature of academic and practitioner recommendations to organize water resources management around whole watersheds rather than the discrete water resources—

streams, lakes, aquifers, wetlands—they contain (e.g., Bates et al., 1993; Doppelt et a!., 1993; Gregg et al., 1998; Harkins and Baggs, 1987; Hinchcliffe et al., 1998; MacKenzie, 1996; Naiman, 1994; Newsom, 1997; U.S. Coastal America Organization, 1994; U.S. EPA, 1991).

Before continuing to a brief description of the principles and design of watershed * · management, we insert here two observations to place our discussion of the watershed movement in context. First, while it is clear to anyone doing research in this area that the literature of the watershed movement has enlarged at a stunning pace in the past decade, the idea of organizing water resource management on a watershed basis is hardly new. The United States Inland Waterways Commission, appointed in the 1890s to undertake a comprehensive assessment of the nation's interior water resources, "reported to Congress in 1908 that each river system—from its headwaters in the mountains to its mouth at the coast—is an integrated system and must be treated as such" (U.S. EPA, 1995: 1-1). Second, the watershed movement is quite properly seen as one manifestation of a more general movement among environmental protection advocates and agencies, characterized by terms such as "ecosystem management" and "integrated resource management." Those terms are broader, and include resources such as land and its associated flora and fauna in addition to water, but the rationale and recommendations—as well as the rapid recent expansion of interest and literature—are the same as for watershed management.[1]

The watershed movement describes watershed management primarily in terms of concepts, principles, and processes.

- The concepts have to do with interrelatedness and integration, and include "ecosystems—interacting biological (including human) and physical components; conservation biology—sustainable areas of biodiversity within a native habitat; and, integrated organization—coordination of social institutions to achieve desired goals" (Milon, Kiker, and Lee, 1998: 38; also Walther, 1987: 443).
- The principles include: "All parties with a stake in the specific local situation should participate in the analysis of problems and the creation of solutions," and "The actions undertaken should draw on the full range of methods and tools available, integrating them into a coordinated, multiorganization *[sic]* attack on the problems" (U.S. EPA, 1991: 1).
- The processes entail stakeholder identification and involvement, leading to consensus on goals and an identification of actions to be taken to reach them, followed by assignment of responsibilities among agencies and organizations, producing implementation to be accompanied by monitoring and evaluation (see, e.g., U.S. EPA, 1991: 2; and 1995: 1-4). A more detailed set of process prescriptions for statewide oversight and coordination (U.S. EPA, 1995) included the establishment of basin management plans using rotating five-year cycles for

[1] Milon, Kiker, and Lee (1998: 37) observe: "Within the past decade ecosystem management has become a central theme in state and federal environmental resource management and a powerful issue in environmental policy debates. A recent survey [Yaffee et al.,] showed that more than 600 projects related to ecosystem management are underway around the U.S. Under the Clinton Administration, a high level of federal commitment to an ecosystem management approach has developed despite many obstacles."

the completion of planning, modeling, permitting, and monitoring among all the watersheds within a state.

Like most reform movements that promote improved methods of government or administration, the watershed movement presents two kinds of appeals. Critiques of the status quo highlight the need for change, and positive appeals emphasize the gaiqs to be realized by embracing the reform approach. Combined, these appeals support the movement's conclusion that watershed-based resource management is the best—for some, the only—option to pursue.

The watershed movement has provided the following criticisms of the status quo in U.S. water resources management.

- The jurisdictional boundaries of governmental units in the United States do not conform with watershed boundaries, contributing to a piecemeal and fragmented approach to managing water resources that are in fact physically interrelated (Gregg et al., 1998; U.S. EPA, 1995:1-7 and 1-8).
- Governments in the United States have added water programs—supply development, flood control, drainage, drought protection, contamination remediation, contamination prevention, wetlands protection, species preservation, and so on—in an incremental and uncoordinated fashion that does not recognize the connections among these programs and the water problems they are meant to address.
- The lack of coordination among programs has been exacerbated by the fact that the responsibility for their administration and evaluation has been parceled out among multiple agencies and multiple levels of government. Some agencies and their programs have even operated at cross-purposes (Behrman, 1993:11; U.S. EPA, 1995: iii).
- Still other water problems have remained unaddressed because they do not fit within established programs, and in the absence of such a fit no agency or unit of government is charged with responding to them (Kraft et al., 1999).
- The presence of multiple governmental units and agencies operating within any given watershed, each carrying out some program or policy that affects only one portion of the overall water environment therein, discourages active public participation. Citizens find it difficult to know or learn where to find information, whom to contact or how, and how to participate effectively (Nakamura and Born, 1993:812).
- The absence of watershed-scale jurisdictions or decision-making institutions, and the lack of coordination among water resource programs, has established and maintained a relatively lax management setting in which agricultural, industrial, and other forms of development have flourished, much to the detriment of the condition of the nation's water resources.

The labels applied to the status quo in the watershed movement literature conjure up negative images. Status quo approaches to water resource management in the United States are characterized as "fragmented," "piecemeal," "inadequate," "myopic" (Milon, Kiker, and Lee, 1998: 38), and the like.

Positive claims made for the watershed management approach include statements such as these.

- Watershed management can restore a vision of ecosystem health that recognizes the connections among the various dimensions of water resources and the life forms those resources support. At the same time, "the claim for integration is a sharp antithesis to specialization, differentiation, and profit maximization, which are dominant schemata of today's thought" (Walther, 1987: 439).
- Watershed management holds the potential for drawing together all of the human parties affected by an interconnected water resources system (i.e., the "stakeholders"), as well (U.S. EPA, 1991: 1). Citizen participation is made easier and more efficacious when there is a watershed management forum or entity pursuing a watershed management program (Nakamura and Born, 1993: 818).
- Watershed management promotes cooperation among agencies and coordination among programs (U.S. EPA, 1995: 1-5).
- By adjusting the scale of decision making to the scale of the resource, watershed management can restore rationality to policy making and implementation (Walther, 1987: 440). Science can be more successfully integrated into policy making when policy making is organized at the scale that science recognizes as appropriate. And the number of entities that state and federal policy makers have to deal with and keep track of can be reduced when resource management is organized at the watershed scale (U.S. EPA, 1995:1-8).

By contrast with the status quo, watershed management is more often labeled in the literature as "innovative," "experimental," "broad and ambitious" (Gregg et al., 1998), "dramatic and imaginative" (Nakamura and Born, 1993: 807), and the like. The U.S. EPA's "Watershed Protection" logo bears the motto, "An Integrated, Holistic Approach."

With the status quo deflated and the hope of the holistic approach raised, the conclusions in the literature follow clearly—watershed management is the best, and maybe the only, path to the future. A strong emphasis is placed on this being a "consensus" view, driven by the twin engines of science and experience. Here are some representative statements, in ascending order of intensity.

> There is… a growing consensus that the pollution and habitat degradation problems now facing society can best be solved by following a basin-wide approach that takes into account the dynamic relationships that sustain natural resources and their beneficial uses (U.S. EPA, 1991: 1).
>
> We now generally recognize that the critical environmental issues facing society are so intertwined that a comprehensive, ecosystem-based approach is *required....* The need to integrate across traditional program areas (e.g., flood control, wastewater, land use) and across levels of government (federal, state, tribal, local) is leading natural resource management toward a watershed approach (U.S. EPA, 1995: iii, emphasis added).
>
> As experience grows and techniques evolve, this holistic, locally tailored approach gradually will become—indeed, *must* become—a routine process for protecting and restoring water quality (U.S. EPA, 1991: 1, emphasis in original).

As there is no doubt that the research and policy literature on watershed management has expanded rapidly in the 1980s and 1990s, there is also no doubt that a number of initiatives have been undertaken in the United States to create watershed-based efforts at resource management. The concept has shown great appeal among academics and policy makers (Milan, Kiker, and Lee, 1998: 37; Walther, 1987: 439), and has spawned considerable activity (Kraft et al., 1999). That activity has been promoted in several ways by the national government, although it is occurring at the regional and substate levels (Gregg et al., 1998; Nakamura and Born, 1993).

Despite the confidence watershed management advocates possess and the amount of activity that has been occurring, many hopes remain unfulfilled. As Milon, Kiker, and Lee observed (1998: 37): "At present there are several well-recognized principles of ecosystem management, but relatively little agreement on the details of implementation." Processes have been slower and more cumbersome than may have been anticipated. Stakeholder consensus on goals and actions has proved elusive. The assignment of responsibilities among agencies, implementation of action plans, and follow-through on monitoring and evaluation have been as daunting an intergovernmental relations challenge in the water resources context as it has in every other policy area.

Watershed management advocates have been assessing some of the difficulties being encountered in the implementation of the watershed approach. The difficulties are being attributed primarily to political and institutional obstacles. As Kraft et al. (1999: 10) put it, these initiatives face numerous obstacles, more social than hydrologic."

The political obstacles include divergent opinions, interests, and even values among stakeholders that have made the achievement of consensus far more difficult than may have been envisioned (Gregg et al, 1998; Milon, Kiker, and Lee, 1998: 38). Institutional barriers include the persistence of conflicting missions, statutes, and regulations at multiple levels of government (U.S. EPA, 1995: 4-5), and particularly, the absence of watershed-scale jurisdictions.

Most watershed-scale arrangements established thus far have been on what Nakamura and Born (1993: 808) call the "weaker" end of the spectrum: watershed discussion forums, advisory bodies, inter-agency agreements to collaborate on research, and the like. These typically have little capacity and no authority to take formal decisions, implement activities, or sanction entities within the watershed whose behavior fails to conform to plans. Moreover, many of the watershed councils, basin commissions, and other forms of institutions that now exist or existed in the past were created by an overlying jurisdiction—a state or the national government—were sustained through subsidies from that overlying jurisdiction, and faltered or folded altogether once the mandate and/or subsidies expired.

Watershed management advocates have recognized that the absence of watershed-scale jurisdictions contributes to two significant problems. First, other groups that organize at the watershed level—whether they are citizen groups only, or inter-agency task forces, or groups with a mix of agency representatives and ordinary citizens—"face the challenge of acquiring legitimacy and authority" (Kraft et al., 1999: 10). Second, implementation of any watershed action plan or program depends upon inter-agency coordination, which can result in inadequate performance and insufficient accountability (Gregg et al., 1998).

Nevertheless, Nakamura and Born state succinctly what many other observers lament: "The establishment of powerful autonomous entities with comprehensive functional responsibilities and broad implementation powers—transcending existing units of government—tends to be a political rare event in the United States." Only in **a** handful of instances (they mention Florida's regional water management districts and Nebraska's Natural Resources Districts), have unified entities been created with regional resource management responsibilities *and* been assigned functions that were previously dispersed among other smaller or specialized units (Nakamura and Born, 1993: 808). They further acknowledge that the long-standing American tendency not to create strong regional governance entities is unlikely to be reversed any time soon.

Two important challenges, then, lie before us. One is to ascertain whether and how watershed-based water resource management may occur, and function effectively, in the absence of strong watershed-scale jurisdictions. This we address in the next section of the paper, by describing the evolution of watershed management in four cases in the western United States. The second is to provide a coherent political science explanation for these phenomena and their operation, which is the subject of the last section of the paper.

FOUR CASE STUDIES OF USER-CREATED WATERSHED GOVERNANCE INSTITUTIONS AND MANAGEMENT ACTIVITIES

In many locations within the United States, water users have developed watershed governance and management arrangements (see Kenney, 1997, and Davis, 1999 for reviews and summaries of several). Most of these arrangements are polycentric and multifaceted, involving extensive interorganizational and intergovernmental coordination. They might even be characterized by some observers as fragmented.

We have studied four cases—two in California, and two in Colorado. We do not claim that they are typical watersheds, nor would we claim that they present extremes of one dimension or another. They were not selected randomly.[2] Their governance and management arrangements are described here to provide some empirical referents for analysis.

The San Gabriel River Watershed in California

The San Gabriel River watershed is a complex physical system, situated in one of the largest metropolitan accumulations of people and commerce in the world. The watershed includes most of coastal Los Angeles County, from the San Gabriel Mountains to the Pacific Ocean. It contains two rivers—the San Gabriel and the Rio Hondo—several creeks and washes, and four major groundwater basins.

Toward the midpoint of the San Gabriel River's course from the mountains to the sea, the Whittier Narrows divide the watershed's Upper Area from its Lower Area. The upper area includes the Main San Gabriel and Raymond groundwater basins. The lower area

[2] Through a variety of circumstances, the authors have been fortunate to have had extensive access to information about these four watersheds.

contains the Central and West groundwater basins. These are coastal basins, in hydrologic contact with the Pacific Ocean and vulnerable to salt-water intrusion.

Three of the groundwater basins in the San Gabriel River watershed form an interconnected chain. Most of the Central Basin and all of the West Basin are confined by a surface layer of relatively impermeable clay-like soils, so only the northeastern portion of the Central Basin is susceptible to direct replenishment from the land surface. All of the natural fresh water replenishment to West Basin comes from subsurface inflow from the Central Basin, and most of the natural fresh water supply to Central Basin comes through Whittier Narrows from the Main San Gabriel Basin.

Virtually the entire area is urbanized; all or parts of 100 municipalities are found within the watershed. Urbanization brought the paving over of soils through which rainfall used to percolate into the underground water supply, the collection and export to the ocean of storm and waste water that used to return underground, and the lining of miles of surface water channels for flood control purposes.

Several water resource management problems have arisen in the San Gabriel River watershed, owing to the combined effects of the region's limited water supplies, its extensive agricultural and then urban development, and the hydrogeology of the watershed itself. Each of these problems has been multi-jurisdictional in scope. Water users responded to each by developing new institutional arrangements. Those arrangements are fitted together through a system of interorganizational and intergovernmental relationships.

Securing Supplemental Water Supplies to Support Urban Development. As the Los Angeles area began to urbanize at the beginning of this century, municipal water departments (some of which contracted with private water companies) became the principal water suppliers for urban residences and businesses. Local surface water supplies were scarce, unreliable, and already committed to agricultural uses. Several municipalities turned to groundwater production for a more reliable local supply. A subset also pursued more ambitious schemes of importing water from near or distant sources.[3]

In the 1920s, a group of 13 cities decided to form a partnership to pursue water importation from the Colorado River, and organized the Metropolitan Water District of Southern California (MWD). Nearly half of the original member cities were within the San Gabriel River watershed—Los Angeles, Pasadena, Compton, Long Beach, San Marino, and Torrance.

After MWD's aqueduct from the Colorado River was completed and began deliveries in the 1940s, MWD was interested in expanding its service areas and other communities were interested in joining MWD. The original member cities thought that allowing other communities to join one at a time would be administratively and financially tedious, and might ultimately expand the size of MWD's board of directors to more than a hundred members. MWD adopted a policy of requiring the formation of water districts covering multiple communities prior to annexation and membership in MWD.

[3] Los Angeles' efforts to bring water from the Sierras are legendary in this regard (infamous, if you prefer), but other municipalities such as Pasadena also explored water importation possibilities without Los Angeles' success.

This policy, and the desire of the remaining communities within the San Gabriel River watershed to annex to MWD for reasons described later, led to the formation of five municipal water districts within the watershed over the period from 1948 through 1960. The West Basin Municipal Water District brought a dozen coastal communities mostly overlying that groundwater basin into MWD. The Central Basin Municipal Water District encompassed another 37 municipalities on the coastal plain. The Foothill Municipal Water District gathered four of Pasadena's immediate neighbors in the upper area. The Upper San Gabriel Valley Municipal Water District covered 22 communities overlying most of the Main San Gabriel Basin. The Pomona Valley Municipal Water District (now renamed the Three Valleys Municipal Water District) straddled the hilly divide from the eastern edge of the San Gabriel watershed to the western portion of the Santa Ana River watershed, taking in some communities on the boundaries of each.

A few municipalities in the upper area of the watershed had chosen not to join any of these districts and come into MWD's service area. By the 1950s, the state of California was planning the State Water Project to bring northern California water to the central and southern regions of the state. The state was establishing its own contracts for northern California water, including one with MWD that brought all of MWD's member cities and districts potentially within reach of State Project water. But the option also existed to contract directly with the state without joining MWD, and a handful of municipalities in the upper area of the watershed chose to do so. Those four cities (Alhambra, Azusa, Monterey Park, and Sierra Madre) formed the watershed's sixth municipal water district—the San Gabriel Valley Municipal Water District—which has its own contract and facilities for delivery of State Project water.

Managing Groundwater Use. By the time imported supplies from the Colorado River and northern California reached the San Gabriel River watershed in the late 1940s and early 1970s respectively, the watershed had become home to millions of residents and an immense industrial economy. During that period of development, the public and private water suppliers had intensified their groundwater production, significantly exceeding the rate of natural replenishment and creating overdraft conditions in each of the watershed's four major groundwater basins.

The arrival of imported water supplies relieved some of the pressure on the local groundwater supplies, but also triggered a new debate. Since imported water was much more expensive than water pumped from underground, the pressing questions became who should curtail groundwater production, in what amounts, and how would any such arrangement be reached and enforced. Every water producer had a significant incentive to keep using groundwater in preference to imported water, but for each to do so would bring the detriment of all.

In this atmosphere, new organizations emerged. Water production in each basin was dominated by a mix of public and private organizations—municipalities, water districts, water companies, and industrial and other commercial entities that pumped their own water. Nongovernmental water user associations were formed in three of the four groundwater basins to bring these diverse organizations together for discussions of the condition of the water supply and of their common and conflicting interests therein. A

West Basin Water Association was formed in the 1940s, a Central Basin Water Association in 1950, and an Upper San Gabriel Valley Water Association in 1955.[4]

From the 1930s through the 1970s, groundwater production rights were defined and limited in each of the groundwater basins through a series of adjudications. The adjudications were adversarial, but once the issues had been brought to court, the devices of civil discovery were used to develop a shared information base from which the parties began negotiations. In each of the four basins, stipulated judgments were reached by the parties, presented to the court, and approved.

The adjudications occurred in a series rather than all at once because the circumstances of each basin were different. Overdraft problems had become acute first in the smaller Raymond Basin of the upper area, and in the coastal West Basin which was exposed to salt water intrusion from the ocean once underground water levels fell below sea level. The Raymond Basin litigation began in the late 1930s and concluded in the mid-1940s. The West Basin litigation began in the late 1940s and ended in the early 1960s.

Since West Basin receives its entire freshwater inflow from Central Basin, West Basin could not be brought back into balance once overdraft in Central Basin began choking off the underground flow from there. West Basin water users encouraged the Central Basin Water Association and the Central Basin Municipal Water District to adjudicate and limit pumping in that basin, too, which was done during the 1960s.

Finally, overdraft in the Main San Gabriel Basin was perceived to be a threat not only to pumpers there but to the supply of water coming across the Whittier Narrows from the upper area to the lower area. After the downstream interests had sued the upstream interests to guarantee an average annual flow (described in the next section), upper area pumpers used the leadership of the Upper San Gabriel Valley Water Association and the Upper San Gabriel Valley Municipal Water District to initiate and complete an adjudication and limitation of pumping rights in the Main San Gabriel Basin.

By the mid-1970s, groundwater use in each basin of the watershed was limited by a court judgment that was potentially enforceable by each pumper against all others. Pumpers were required by the terms of the judgment they had negotiated to report their groundwater production monthly, so compliance with the judgment could be monitored.

In each basin, the court appointed a "watermaster" to collect data on pumping and groundwater conditions and report annually to the court. In the first three basins to be adjudicated (Raymond, West, and Central), the court appointed the Southern District office of the California Department of Water Resources (DWR) as the watermaster, since DWR had produced several reports on water conditions in these basins already and had a base of data with which future conditions could be compared. Using DWR as watermaster also avoided creating a new organization with its own staff for each basin.

By the time the Main San Gabriel Basin adjudication was completed in 1973, however, new ideas had emerged about how to manage groundwater basins, resulting in a different watermaster arrangement there, as described later. And in 1984, watermaster

[4] Water users in the smaller Raymond Basin did not form a water association, but there were far fewer major pumpers there and they embarked upon an adjudication and limitation of pumping more than a decade sooner than in any of the other basins.

duties in Raymond Basin were transferred by the court from DWR to a new Raymond Basin Management Board. DWR continues to serve as watermaster for the West and Central Basin judgments.

Upstream-Downstream Division of the River. In addition to the groundwater supplies provided by the four basins, the San Gabriel River itself represented a significant local water supply source. Like the local groundwater, water carried by the river was less expensive to use than imported water. Continued growth in total water use in the upper area in the 1950s threatened to leave almost no San Gabriel River water crossing over to the lower area at Whittier Narrows, costing the lower area a valuable resource and leaving the downstream communities even more dependent on imported water.

Once the Upper San Gabriel Valley Water Association and the upper area municipal water districts had been formed, the Central Basin Municipal Water District and the cities of Compton and Long Beach on behalf of lower area water users took the major upper area water producers to court for a determination of the lower area's right to the waters of the San Gabriel River. The litigation began in 1959, but quickly turned into a negotiation that achieved a common statement of "Principles of Settlement" by 1961 and a stipulated judgment approved by the court in 1965.

The settlement guaranteed the lower area an annual average of 98,415 acre-feet of usable water through Whittier Narrows. The court appointed a 3-member San Gabriel River Watermaster, composed of representatives of the upper area and lower area chosen by the water users, to monitor compliance with the judgment. The data on river flow at the Narrows are provided to the San Gabriel River Watermaster by the Los Angeles County Department of Public Works, which operates a flood control facility there. Accordingly, the San Gabriel River Watermaster needs and has no staff, providing purely a governance function.

Conjunctive Management of Groundwater Basins. The judgments limiting pumping in the four groundwater basins and assuring a division of river water between the upper and lower areas were all essential for arresting the over-exploitation of local water resources and encouraging users to employ a combination of imported and local supplies. In and of themselves, however, these judgments did not provide for recovery of the local water resources from the damage that had already been done to them.

Recovering groundwater levels in the overdrafted basins meant not only limiting withdrawals but enhancing replenishment. West Basin had sustained the greatest damage due to the combined effects of water level declines and sea water intrusion, but it could not be directly replenished through normal means of surface water percolation because it is covered by a relatively impervious layer of marine clay deposits. The nearest recharge zone was upstream in Central Basin, from which water flows underground into West Basin. This placed any artificial replenishment program beyond the physical reach of the West Basin Water Association or the West Basin Municipal Water District. As a temporary measure, West Basin water users relied on the Los Angeles County Flood Control District (now part of the Los Angeles County Department of Public Works) to operate an artificial replenishment program financed through the creation of a special taxing district.

Central Basin and West Basin water producers then created a specialized organization to finance and direct an artificial replenishment program to benefit both basins. The

Central and West Basin Water Replenishment District (now renamed the Water Replenishment District of Southern California) was created in 1959. Forty years of enhanced replenishment have allowed groundwater levels in the Central and West basins to recover and stabilize.

The Water Replenishment District covers both basins, raises funds for the replenishment program by an assessment on local groundwater production, and purchases replenishment water from two sources. It buys treated water from water reclamation plants operated by the Los Angeles County Sanitation Districts, and imported MWD water from MWD members the Central Basin Municipal Water District and the West Basin Municipal Water District. The spreading grounds in Central Basin where these waters percolate underground are operated under contract by the Los Angeles County Department of Public Works. For its first 30 years, the Water Replenishment District functioned without a separate staff or office space, sharing with the Central Basin Municipal Water District.[5]

When the Main San Gabriel Basin was adjudicated from 1968 through 1973, a more flexible approach to managing groundwater basins had come into favor. Instead of establishing a fixed safe yield and managing the basin to that yield every year, this new approach of conjunctive management called for viewing groundwater resources in combination with surface water supplies. In a year of abundant surface water flows, groundwater production should be curtailed, surface water use encouraged, and a maximum amount of surface water stored underground. In dry years, surface water use could be curtailed and groundwater use increased. Thus, groundwater levels would rise or fall, depending on what was also happening with surface water supplies.

This conjunctive management approach shaped the Main San Gabriel Basin judgment, in which parties were assigned pumping *shares* in the basin's annual yield rather than fixed pumping quantities as had been done in the Raymond, West, and Central basin adjudications. This different approach also changed the role of the basin watermaster, as alluded to earlier. In addition to monitoring compliance and basin conditions, the Main San Gabriel Basin Watermaster also examines surface water conditions each year and declares the groundwater basin's safe yield for the coming year. This added a policy making function to the ministerial functions performed by other court-appointed watermasters in the region, and made the appointment of a staff agency such as the Southern District office of the California Department of Water Resources seem less appropriate. Instead, the Main San Gabriel Basin judgment established a nine-member Main San Gabriel Basin Watermaster, composed of some representatives appointed by the overlying water districts and others elected by the pumpers, to perform both the monitoring and policy making functions that determine how the basin is used each year.

In addition, as part of the conjunctive management approach, the Main San Gabriel Basin Watermaster is authorized by the judgment to enter into agreements with local water producers or agencies for the use of the Basin's storage capacity for the cyclic storage of water. The watermaster has entered into such agreements with the San Gabriel Valley Municipal Water District and with the Upper San Gabriel Valley Municipal

[5] In a 1990 reorganization, the Central Basin Municipal Water District and the West Basin Municipal Water District combined to share staff and space, and the Water Replenishment District secured its own.

Water District. Under these agreements, each district may store surplus imported water underground for later use within the basin.

The Main San Gabriel Basin Watermaster has no separate office and staff. It contracts with the Upper San Gabriel Valley Municipal Water District for office space and staff services, and purchases replenishment water through the upper area water districts.

In 1984, Raymond Basin water users decided they wanted to follow a similar approach. That prompted a modification of the Raymond Basin judgment, establishing a Raymond Basin Management Board composed of water user representatives, and turning the watermaster function over to the board. Like the Main San Gabriel Basin Watermaster, the Raymond Basin Management Board does not maintain its own offices and staff. It is housed at the Foothill Municipal Water District, which supplies staff support.

Sea Water Intrusion. Continued overdrafting through the 1940s and 1950s had visited another harm upon both West Basin and Central Basin: salt-water intrusion from the ocean. On the one hand, the key to halting any further intrusion seemed obvious: raise the groundwater levels back to and above sea level to keep the ocean out. But it turned out to be infeasible and uneconomical to maintain groundwater levels along the coast at or above sea level; indeed, as the concept of conjunctive management began to gain currency, it was felt that both basins could be managed more flexibly if they could be drawn down a little in dry years and replenished more in wet years without running the risk of accelerated sea-water intrusion in the dry years.

In 1950, an experiment was tried along the coast: a well in West Basin was converted from extraction to injection, and fresh water was pushed underground to see whether it could push the salty water away. The experiment worked, and led to the design of a row of injection wells that collectively could present a wall of fresh-water pressure against the sea. A pilot barrier was constructed in 1953 as a cooperative effort of the West Basin Water Association, the California Department of Water Resources, and the Los Angeles County Flood Control District. The pilot project was also successful, and a full-scale sea-water intrusion barrier project was constructed.

Operation of the barrier was temporarily financed through the creation of an Improvement Zone within the flood control district. Later, the financial responsibility for the sea-water barrier was assumed by the Water Replenishment District. The district purchases treated imported water for injection in the barrier projects, through the Central Basin and West Basin Municipal Water Districts. The barrier projects are operated and maintained by the County Department of Public Works.

Another barrier was built at the mouth of the San Gabriel River to protect the Central Basin. This second barrier at Alamitos Gap is on the Los Angeles County-Orange County boundary, and is jointly funded by the Orange County Water District and the Water Replenishment District, and jointly operated by the Orange County Water District and the Los Angeles County Department of Public Works.

Groundwater Contamination. More recent water resource management concerns in the watershed have focused on protecting water quality and remediating contamination. A significant area of the Main San Gabriel Basin has been found to be underlain by excessive concentrations of volatile organic chemicals. The Main San Gabriel Basin has been a major EPA Superfund site for 15 years. The contamination found in the

groundwater of the Main San Gabriel Basin has many points of origin, not all of which have been or probably ever will be identified.[6]

The contamination presented both immediate and potential threats to water resource management in the watershed. The immediate threat was to the local water supply in the Main San Gabriel Basin itself. Many production wells throughout the basin have been shut down since the late 1980s, which has increased the dependence of basin residents on more expensive imported water supplies. The potential threats, now being realized, were to the conjunctive use of the basin as an underground reservoir for water storage and to the downstream Central and West basins.

When the contamination was identified, the local water districts and the Main San Gabriel Basin Watermaster began working with the U.S. EPA on the Superfund program. This approach ran into three significant problems. First, the Main San Gabriel Basin Watermaster had a very small staff whose expertise was not in the areas of chemical contamination, public health, and environmental regulation. Second, the Watermaster's authority is defined by the court judgment under which it was created, and its representative structure is limited to pumpers—thus, the Watermaster was perceived as not having the authority to undertake contamination remediation and also as perhaps not including a broad enough array of interests. Third, the Superfund process is long and cumbersome, and was not remedying the contamination problem.

Some local residents and area legislators wanted to create a local "superagency" to cover the whole valley and lead the local-level response to the contamination incident. A bill to create such an agency was introduced in the California Senate in 1990 and passed the Senate in 1991. But in the meantime, in the latter half of 1990, the Main San Gabriel Basin Watermaster, the Upper San Gabriel Valley Municipal Water District, the San Gabriel Valley Municipal Water District, and the Three Valleys Municipal Water District established a joint-powers agency—the San Gabriel Valley Water Quality Authority—to coordinate the local response to contamination remediation and provide local financing for it.

The Water Quality Authority, in concert with EPA, has developed on-site treatment facilities to extract water at affected locations and remove contaminants. These efforts have arrested some of the highest concentrations of contaminants and kept them from moving elsewhere within the basin and across the Narrows into the lower area. There has, however, been evidence of movement of low concentrations of contaminants through the lower end of the Main San Gabriel Basin and into Central Basin.

Conclusion. The San Gabriel River watershed in Los Angeles County, California, might fit the description of "watershed management without a manager." It is an example of a regional management program achieved entirely through interorganizational and intergovernmental arrangements.

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[6] Because of the dynamic nature of the San Gabriel Valley, land use, economic activity, and even the demographic composition of the valley have changed in waves over the past 60 years. Many small commercial or industrial sites that may have contributed to the contamination problem had left the valley before the problems were identified.

In response to the water resource challenges they faced, water users in the San Gabriel River watershed have developed a set of tightly interrelated institutional arrangements. Those arrangements include:

- local water supply and distribution, conducted primarily by municipalities but also some small water districts and private water companies;
- imported water supply and distribution, performed by **a** regional water importer that supplies water to five municipal water districts and six member municipalities within the watershed, while one other municipal water district contracts directly with the state for imported water;
- water user associations that provide regular communication opportunities;
- court judgments limiting groundwater withdrawals and obligating the upper area of the watershed to guarantee an average annual supply to the lower area;
- court-appointed watermasters that monitor compliance with the judgments, including a three-member watermaster composed of upper and lower area representatives to monitor the river judgment;
- a replenishment district that finances and oversee artificial recharge and sea-water projects for the two lower area groundwater basins;
- multi-member boards in the two upper area groundwater basins that combine the watermaster function with the conjunctive management of those basins for water supply and storage.
- contracts with the operator of the flood control, water replenishment, and sea-water barrier facilities; and
- contracts with a supplier of reclaimed water for use in replenishment projects.

Despite the complexity of the physical system and the absence of "a manager," there is water resource management in the San Gabriel River watershed. The system of interorganizational and intergovernmental arrangements has demonstrated high levels of effectiveness, equity, and adaptability with low administrative and operating costs (Blomquist, 1992).

The Santa Ana River Watershed in California

Neighboring the San Gabriel River watershed to the south is the Santa Ana River watershed. The Santa Ana River watershed extends in a general southwesterly direction, from the crestlines of the San Bernardino Mountains to the Pacific Ocean, but with large valleys contributing water from the northwest and the southeast.
Like the San Gabriel River watershed, the Santa Ana River watershed is pinched in the middle by a lower coastal range, separating an upper watershed area from a lower watershed area. Unlike the San Gabriel River watershed, however, the two watershed areas are not nearly as equal in size. The upper portion of the Santa Ana River watershed covers nearly five times as large an area as the lower area, the Orange County coastal plain.

The Santa Ana River's drainage area is even larger than that of the San Gabriel and is rapidly becoming as fully developed and heavily populated. The river itself is more than 100 miles long, and the watershed encompasses over 2,650 square miles. The watershed includes several creeks draining mountains and hills and terminating in the river, and several groundwater basins, of which the two largest are the Chino Basin in the upper area and the Orange County basin in the lower area.

The population of the Santa Ana River watershed is approaching 5 million, and will almost certainly exceed that figure by 2010. Most of the watershed area is now urbanized, and includes the cities of Anaheim, Santa Ana, Fullerton, Riverside, San Bernardino, and Ontario as well as dozens of other smaller municipalities.

Whereas the San Gabriel River watershed lies almost entirely within Los Angeles * County, the Santa Ana River watershed includes portions of four counties. The lower area of the watershed lies within Orange County, adjacent to the boundary with Los Angeles County. The upper area of the watershed lies mostly within San Bernardino and Riverside counties, with a small portion of the western reach of the upper area in Los Angeles County.

As in the San Gabriel, water users in the Santa Ana River watershed have developed watershed governance and management arrangements gradually over time, usually in response to dangers posed to valuable resources therein.

Creation of Water User Associations and Water Districts. By the end of the 1920s, concerns about water scarcity within the Santa Ana River watershed had grown, fueled by the combined effects of rapid development of irrigated agriculture and the onset of a series of drier than normal years. Those concerns translated into the formation of some new organizations of water users trying to determine their mutual interests and protect them.

In 1929, Orange, Riverside, and San Bernardino counties created the Tri-Counties Water Conservation Association. This joint body was charged with establishing projects to impound surface water flows and runoff during the winter months and wet years so they could percolate into the ground to be available in drier periods. However, this initial effort at upstream-downstream cooperation was almost simultaneously accompanied by the creation of sub-watershed organizations defined around other communities of interest.

In 1931, irrigators using wells to produce groundwater from the upper area's Chino Basin formed the Chino Basin Protective Association, to supply a forum for information sharing about water conditions and to support water conservation projects that might benefit the basin and its pumpers. The same year, water users in the upper area's San Bernardino Valley organized the San Bernardino Valley Water Conservation District, to finance and operate their own facility to capture water flows coming off the mountains for controlled release and percolation into the underlying groundwater basin. And in the lower area, the Orange County Farm Bureau requested the California Legislature to create a water district to support water conservation and replenishment of the groundwater basin there.

From the 1930s through the 1960s, several other water districts were organized within the watershed, serving groups of water users who shared a valley, a creek, or other common interest. These included the Cucamonga County Water District, Monte Vista Water District, and Irvine Ranch Water District.

Even though several water districts grew out of the organizing efforts of water user associations, those nongovernmental associations have not been displaced. There remains, for example, an Upper Santa Ana Water Resources Association composed of municipalities, water districts, industrial and commercial water users, and other organizations in the upper area, and a similar Orange County Water Association in the

lower area. These associations continue to meet monthly and provide ongoing forums for discussion of subwatershed regional concerns.

Imported Water and the Creation of a New Set of Districts. As in the San Gabriel River watershed , the availability of Colorado River water and then State Project water to the Santa Ana River region triggered the formation of a new set of water districts with "the specialized function of contracting for, financing, and distributing imported water.

In the upper area, the Chino Basin Municipal Water District was established, overlying several communities and smaller water districts in the Chino Basin portion of San Bernardino County. The Western Municipal Water District of Riverside County was also established, straddling the Santa Ana River in the portion of the upper area just upstream of Prado Dam, and overlying several communities and smaller water districts in the Riverside County portion of the Chino Basin as well as on the eastern side of the river. Both of these districts became member agencies of the regional Metropolitan Water District of Southern California, gaining access to both Colorado River water and State Project water through Metropolitan. A third imported water district, the San Bernardino Valley Municipal Water District, was created in the upper portion of the upper area, overlying several communities and small water districts there, but it elected not to join Metropolitan and to contract separately for State Project water.[7]

In the lower area, one group of communities formed the Coastal Municipal Water District, and it joined Metropolitan to gain access to imported water for delivery to its service area. Most of the remainder of the county formed the Municipal Water District of Orange County, which also annexed to Metropolitan and purchases and distributes imported water to the communities within its service area. Three Orange County municipalities—Anaheim, Fullerton, and Santa Ana—were among the original 13 cities that created the Metropolitan Water District of Southern California. They already had entitlements to Metropolitan's imported water sources and therefore are not within either the Municipal Water District of Orange County or Coastal Municipal Water District.

All of these municipal water districts, formed between 1950 and 1965, were created for the specialized purpose of contracting for and gaining access to imported water supplies on behalf of the service areas they cover. They did not displace any other water resource management responsibilities that were being performed by previously established water districts.

Litigation and the Apportionment of River Flows. Rights to the flows of the Santa Ana River provided the basis for lawsuits within the watershed on four occasions, each expanding in scope and intensity. The earliest was a lawsuit between the cities of Riverside and San Bernardino in the upper portion of the watershed, which resulted in a

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[7] The upper area of the Santa Ana River watershed in this respect resembles the upper area of the San Gabriel River watershed, where the Upper San Gabriel Valley Municipal Water District joined Metropolitan but another water district, the San Gabriel Valley Municipal Water District, was formed and chose not to join Metropolitan but to contract separately for State Project water. Thus, even though the Metropolitan Water District of Southern California appears at first glance to cover all of coastal southern California from Ventura County to the Mexican border, there are portions of both the San Gabriel and Santa Ana River watersheds that are not within Metropolitan's service area.

1921 California Supreme Court decision that upheld both cities' rights to use the river while requiring their mutual non-interference.[8]

In 1932, the largest irrigator in the lower area, the Irvine Company, sued several upper area water companies, charging them with unlawful diversion of water in the upper area that was diminishing Santa Ana River flows to the lower area and interfering with the exercise of water rights. This was the first of three lower area-upper area lawsuits in the Santa Ana River watershed. It also contributed directly to the formation of the Orange County Water District, as a formal governmental unit responsible not only for improving the conditions of the Orange County groundwater basin but also for protecting the downstream area's interests against growing upper area water use. When finally settled in 1942, the Irvine lawsuit resulted in stipulated judgments setting limits on diversion and spreading of water by the defendants in the upper area.

Because local water resources provided by the Santa Ana River and its tributaries and groundwater basins are much less expensive to develop and use than imported water supplies brought from hundreds of miles away, the arrival of imported water contributed to two more lawsuits on the river. By 1951, the further development of upstream water use threatened once again to choke off Santa Ana River flows, which would leave the lower area almost entirely dependent upon imported water supplies while the upper area enjoyed greater use of local supplies. This disparity stimulated another lawsuit, brought by the Orange County Water District against four major upper area water users, the cities of Riverside, San Bernardino, Redlands, and Colton.[9] This lawsuit focused on the status of the appropriative water rights of these four cities relative to the appropriative water rights of lower area communities within the Orange County Water District. It went to trial in 1957, producing a judgment defining and limiting the appropriative rights of each of the upper area cities named as defendants.

In 1963, reduced Santa Ana River flows from the upper area to the lower area prompted the Orange County Water District to pursue yet another litigation against upstream water users.[10] This suit expanded to include more than 2,500 named defendants. The complaint requested an adjudication of the water rights of every user in the upper area. The defendants filed 13 cross-complaints, naming as cross-defendants essentially all of the water rights users and water rights owners in the lower area, and bringing the total number of named parties to over 4,000.

Serious negotiations ensued, and intensified after the 1965 settlement of the neighboring San Gabriel River adjudication, which had guaranteed the lower area in that watershed a minimum annual inflow from the upper area. In 1968 and 1969, four major water districts—the Orange County Water District in the lower area, and the upper area's Chino Basin Municipal Water District, Western Municipal Water District of Riverside County, and San Bernardino Valley Municipal Water District—negotiated a stipulated judgment and all complaints and cross-complaints against other parties were dropped.

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[8] City of San Bernardino v. City of Riverside, 186 Cal. 7 (1921).

[9] Orange County Water District v. City of Riverside et al., in the Superior Court of the State of California in and for the County of Orange, decided 1957.

[10] Orange County Water District v. City of Chino et al., in the Superior Court of the State of California in and for the County of Orange, decided 1969.

The Santa Ana River judgment—known locally as the 1969 judgment—requires San Bernardino Valley Municipal Water District to guarantee an average annual flow of 12,500 acre-feet of water passing a point in the upper area known as Riverside Narrows. Chino Basin Municipal Water District (which has since been renamed Inland Empire Utilities Agency) and Western Municipal Water District of Riverside County are together obliged by the 1969 judgment to guarantee an average annual flow of 42,000 acre-feet crossing Prado Dam and passing into the lower area. In addition, the OCWD was given a protected right to store water behind Prado Dam for controlled releases. Like the San Gabriel River judgment, the Santa Ana River judgment included some flexibility in meeting these long-term average obligations, with a system of cumulative credits and cumulative debits, and provisions for a long-term accounting every 10 years.

The Santa Ana River judgment included a consideration that had not been made part of the San Gabriel River approach. The Santa Ana River judgment took water quality into account in its formula for the calculation of the base flow received, both at Riverside Narrows and at Prado Dam. Using samples of the water passing each of these points, the amount of base flow could be adjusted downward when the total dissolved solids (TDS) of the water was too high, penalizing the upstream areas for delivering poorer quality water to the downstream area. On the other hand, when the TDS of the water was especially low, the calculation of base flow received would be adjusted upward, rewarding the upstream areas for providing better quality water to the downstream area.

Like the San Gabriel River judgment, the Santa Ana River judgment is administered by a multi-member, representative watermaster, with continuing jurisdiction retained by the court. The Santa Ana River Watermaster consists of five persons appointed by the court, two nominated by the OCWD, and one each by the three upstream districts. To avoid 3-2 Upper Area-Lower Area splits, the judgment also provides that all findings and determinations of the Watermaster had to be unanimous, with the court retaining the authority to settle issues on which unanimity could not be achieved.

A Watershed JPA and Increased Attention to Water Quality. In conjunction with the settlement of the lawsuit and the entry of the 1969 judgment, the water districts that were parties to that judgment also formed the Santa Ana Watershed Planning Agency (SAWPA). It was a joint-powers agency intended to develop plans for protecting water quality and to serve as an organizational vehicle for cooperating on water projects.

In the early 1970s, SAWPA and the Regional Water Quality Control Board for the Santa Ana region (a state agency charged with developing and enforcing water quality protection standards) collaborated on the development of a set of standards for water quality along the entire length of the Santa Ana River. The standards, known collectively as the "Basin Plan," place limits on total dissolved solids (TDS), total inorganic nitrogen (TIN), and total inorganic carbon and total organic carbon (TIC/TOC) that provide water quality targets to be met and maintained by wastewater and other dischargers to the river. The dischargers are responsible for keeping river water quality within the limits of the Basin Plan, and the Regional Water Quality Control Board is the regulatory agency responsible for monitoring river water quality conditions, investigating complaints, and bringing actions against violators. Water quality standards have been maintained with very little need for enforcement action, despite the growth and urbanization and industrialization of the upper area (the "Inland Empire") that have occurred since the Basin Plan was adopted.

Wastewater dischargers along the river who are subject to the constraints of the Basin Plan (primarily municipalities) have formed their own association, to provide a forum for regular communication. The membership of the Santa Ana River Dischargers Association (SARDA) spans both the upper area and lower area of the watershed.

The "Basin Plan," along with the 1969 judgment, are the principal institutional arrangements that govern the allocation of Santa Ana River water quantities and the protection of Santa Ana River water quality at the watershed level today. Both arrangements were in place by 1974, before the expansion of the watershed movement as we know it today. Together, they represent something like the "constitution" of the Santa Ana River watershed, defining for the governmental entities within the watershed what they may, must, and must not do under which conditions.

In 1974, SAWPA was reorganized as the Santa Ana Watershed Project Authority, keeping the same acronym but reflecting a change of focus from watershed planning to the financing and construction of particular water quality improvement projects. A fifth member agency has since joined SAWPA—the Eastern Municipal Water District of Riverside County. Most of this district's service area does not lie within the natural boundaries of the Santa Ana River watershed, but some of it does, and more important, the construction of some water distribution and wastewater discharge facilities linked the district's water resources to the rest of the Santa Ana River watershed.

SAWPA and its member agencies have built and maintained several projects designed to improve the quality of local water resources to make them usable for a broader array of purposes. Desalting facilities have treated marginal-quality groundwater so it could be used for municipal and industrial purposes when blended with imported water. A SAWPA pipeline—the Santa Ana Regional Interceptor (SARI)—allows the unusable products extracted from treated water (a "brine" of wastes and salts) to be shipped out of the upper area of the watershed to the Orange County Sanitation District's advanced wastewater treatment facility. Several extensions have been built and connected to the SARI line. SAWPA facilities were also instrumental in providing a means of disposing of the toxic chemicals found in one of the most renowned Superfund sites of the 1980s—the Stringfellow Acid Pits—thereby facilitating cleanup and recovery of that site.

Groundwater Management and Conjunctive Use. The Santa Ana River watershed contains several groundwater basins, but two stand out for their size, capacity, and importance to overall water resource management within the watershed—the Orange County groundwater basin in the lower area and the Chino Basin in the upper area.

The Orange County Water District has been responsible for protecting and enhancing the use of the Orange County groundwater basin since 1933. Over time, the district has constructed an extensive network of facilities for retarding surplus Santa Ana River flows, diverting them into spreading basins, and promoting percolation into and replenishment of the underlying aquifers. The district also purchases imported water supplies from Metropolitan via the Municipal Water District of Orange County when river supplies are inadequate to meet replenishment goals or when Metropolitan has excess supplies available and is willing to offer discounts. In order to operate the groundwater basin effectively as a water storage facility, the Orange County Water District has had to construct and maintain coastal barrier projects to keep ocean water from intruding into the aquifers when underground water levels are drawn down below sea level.

The Orange County Water District's actions have allowed the groundwater basin to be employed as a much larger source of water production than it would have been able to provide if pumpers were restricted to the basin's average annual yield of native fresh water. Pumpers therefore benefit by not having to pay for as much imported water, and a portion of this economic benefit to them is recaptured by the district in the form of a basin production assessment levied upon groundwater pumping. Proceeds from that assessment are used to finance most of the district's activities.

In the upper area of the watershed, the largest groundwater basin is the Chino Basin. It is also located at a crucial juncture from the standpoint of overall water resource management, as it is the groundwater basin furthest downstream in the upper area, situated just above Prado Dam. Thus, both water quantity and quality conditions in Chino Basin vitally affect the supply and quality of water reaching the lower area of the watershed, making the management of this basin vital to the upper area's ability to meet its mandated water supply and water quality obligations to the lower area.

The Chino Basin is governed by a separate set of institutional arrangements, although they are linked in several ways with other upper area institutions. Water rights in the Chino Basin were adjudicated in a large-scale lawsuit in the 1970s, resulting in a negotiated judgment in 1978 and the creation of a Chino Basin Watermaster. The watermaster is responsible for monitoring pumping within the basin, reporting to the court on the compliance with the terms of the judgment, and devising an Optimal Basin Management Plan and overseeing its implementation.

The first two responsibilities—monitoring and reporting—fulfilled with relatively few problems (other than delays in the program for getting all production wells in the basin metered) through the 1980s and 1990s. The third—devising an Optimal Basin Management Plan—became the focus of significant contention from the late 1980s through the late 1990s. Ultimately, the Chino Basin Watermaster was reorganized by the court in 1998 and given a timetable for completing an Optimal Basin Management Plan.

The pressure to create an Optimal Basin Management Plan and the controversy that accompanied it emerged over water quality concerns. The Chino Basin Watermaster had proceeded aggressively in the 1980s to redress overdrafting of the basin and to implement a conjunctive use program that involved storing massive quantities of water underground. At the downstream end of the basin, where elevations are lowest and the water table comes nearer the land surface, the water storage program raised underground water levels so high that overlying landowners began to experience problems.

Furthermore, the high water table came into contact with contaminants in the overlying soils, including the nitrates leaching from decades of manure deposition by dairy cattle. Chino Basin is home to the most highly concentrated dairy production industry in the United States, with hundreds of thousands of dairy cows inhabiting thousands of acres of land that are gradually giving way to urban development. The land has been covered with immense quantities of cow manure that now present a significant challenge to the maintenance of the underlying water resource. The Optimum Basin Management Plan that has been drafted for Chino Basin and remains to be implemented must therefore address the management of the dairy wastes as well as the maintenance of the basin as

an important source of water supply and storage. The effectiveness of the Chino Basin Watermaster in achieving these goals will have a profound effect upon the future prospects for water resource management in the Santa Ana River watershed.

A New Watershed Forum Develops, and SAWPA Reconsiders Its Role. In 1997, individuals from a couple of organizations discussed the need for a conversation within the watershed about the mounting problems of water quality degradation, especially relating to the dairies in Chino Basin, and emerging issues of habitat conservation and species protection. Those issues had not been addressed in any substantial way by SAWPA, and the individuals interested in increased attention to them were from organizations that are not SAWPA members and thus do not have direct representation on the SAWPA commission.

At the beginning of 1998, a first meeting was held with the stated purpose of providing a forum for discussion of a wide range of issues within the watershed. Thus began the Santa Ana River Watershed Group (SARWG), which has been meeting monthly since. Although SARWG always invites individuals from all kinds of potentially interested public and private entities within the watershed, most of the regular attendees have been from bodies that are not (or in some cases, cannot be) members of SAWPA. These include the Orange County Sanitation District (which has provided most of the funding and organizational support for the group), the Chino Basin Watermaster, the Milk Producers Council (a trade association to which most Chino Basin dairies belong), the Habitat Conservation League, a few municipalities, and the county governments of San Bernardino, Riverside, and Orange counties. Individuals from SAWPA member agencies have attended SARWG meetings, too, but non-SAWPA participants have provided most of SARWG's membership and leadership.

In addition to discussing issues that were perceived as insufficiently addressed by previously established entities, SARWG has adopted a purpose and an organizational style that are deliberately distinct from the formal water management bodies within the watershed. SARWG members have deliberately chosen to keep the group informal and nongovernmental in order to keep it open to all kinds of participating organizations. The definition of "membership" has been left loose, and in lieu of regular dues, participants are encouraged to elicit donations to the group's efforts from the organizations they represent. Those financial contributions help to support the time of the group's facilitator, an attorney with experience in assembling habitat conservation offsets that allow development in areas where there are also sensitive ecological properties.

As SARWG has moved beyond the discussion stages of the first few meetings toward an effort to stimulate action on some needed projects, it has adopted a more overtly political style than is the norm for more formal governmental entities such as SAWPA and its member agencies. SARWG mobilizes and focuses its members' political resources—the traditional lobbying power of the dairies, the more recent activism of environmental groups, and the intergovernmental connections between local and state and national officials—to press for authorization and funding support of projects in the watershed.

By the end of its first year, SARWG had helped to secure $10 million in federal funding for improvements to storm water control in the urbanized portion of the upper watershed area. Those improvements are intended to reduce the amount of runoff from the foothill areas during storm events. Urban storm water has often flooded the manure facilities of

the dairy area, causing not only damage and financial losses to the dairies but large pulses of manure-contaminated water hitting the river. That project was identified for focused effort by the group because it represented a "win-win-win" situation—upper-watershed cities received funding for storm water control improvements they wanted, the dairies will have better flood protection, and Orange County will have better protection from dairy waste contamination.

During 1999, SARWG has been identifying the next set of projects its members can support, some of which may find their way into a statewide bond issue making its way toward the ballot for March 2000. Members of the group periodically travel to Sacramento and Washington to lobby on behalf of watershed projects.

To some, SARWG's emergence was an implicit criticism of SAWPA. The level of participation and interest in SARWG reinforced views that SAWPA was insufficiently inclusive or representative of interests throughout the watershed. Although its member agencies cover nearly all of the watershed's geographical area, SAWPA has been perceived by several individuals and organizations within the watershed—particularly some municipalities, smaller water districts, and private organizations that lie within member agency boundaries—as not attentive enough to their concerns.[11]

Second, the issues identified and addressed by SARWG—including the successful campaign to win funding support for the storm control projects—reinforced perceptions that SAWPA had maintained too narrow an agenda, while the pressing issues within the watershed had changed. While maintaining its focus on building, maintaining, and operating projects for the collection and removal of salts and contaminants from the upper area, SAWPA had let issues such as the Chino Basin dairy problems and the looming threat of endangered species listings on the Santa Ana River pass by.

In 1998, largely in reaction to internal SAWPA disputes about representation, finances, and staffing, but partly out of an awareness of SARWG's emergence, SAWPA began a reexamination of its role within the watershed. The SAWPA commission hired a new general manager, who came from one of the smaller water districts within the watershed that is not a SAWPA member agency. The commission agreed to let the new manager define a more ambitious and extensive agenda for the JPA, involving it in a broader array of water quality improvement projects and studies of more nearly integrated approaches to water supply and water quality management within the watershed.

In conjunction with the enlarged scope of SAWPA's agenda, the SAWPA commission and the general manager began a reconsideration of the governance structure of SAWPA itself.[12] This process has included, and at the time of this writing continues to include, matters such as whether to expand SAWPA membership to make it more inclusive, and how SAWPA should relate to other groups within the watershed such as SARWG, SARDA, etc. The SAWPA commissioners are not of one accord on these

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[11] It should be added that the criticism of not representing or communicating with the interests in their areas of the watershed is heard more often about some SAWPA members than others.

[12] Although it does not affect the analysis, it is appropriate to state that one of the authors (Blomquist) was engaged by SAWPA as a consultant and facilitator for the first portion of its governance reexamination process, from October through December 1998.

questions. Some embrace the notion of reconstituting SAWPA's organization and agenda to make it more of a watershed planning and governing authority; others would prefer to let other entities address new issues while SAWPA maintains its focus on issues it understands well and projects it knows how to execute.

Conclusion. As in the San Gabriel River watershed, governance and management arrangements in the Santa Ana River watershed are polycentric and multifaceted. Those arrangements include:

- water districts with primary responsibility to develop and manage local water supplies;
- water districts with primary responsibility to develop, finance, and distribute imported water supplies;
- districts and municipal departments with primary responsibility for wastewater treatment;
- specialized entities—a water district in Orange County and a multi-member watermaster in Chino Basin—to manage the two largest groundwater basins within the watershed, each of which developed new basin management plans in the 1990s;
- a court judgment assigning water rights and limiting water production in the Chino Basin, with the watermaster monitoring compliance with the judgment and reporting to the parties and the court;
- a court judgment, negotiated by the parties, to guarantee a base annual flow from the upper watershed area to the lower watershed area, and a multi-member Santa Ana River watermaster to monitor compliance with that judgment and report to the parties and the court;
- a watershed project authority, organized as a joint-powers agency of five water districts that together overlie virtually all of the watershed, which has financed, built, and maintained several projects to improve or protection water quality and facilitate use of local water resources;
- several other nongovernmental organizations, established around subregions within the watershed (e.g., the Upper Santa Ana Water Resources Association, the Orange County Water Association), roles within the watershed (i.e., the Santa Ana River Dischargers Association), or particular collections of watershed issues (i.e., the Santa Ana River Watershed Group); and
- a Basin Plan, monitored by the Regional Water Quality Control Board, that establishes water quality targets and wastewater discharge standards for the entire length of the river.

A Note on the Role of Overlapping Jurisdictions. Leadership in the development of water resource management activities in the San Gabriel and Santa Ana watersheds has been primarily local. These local arrangements exist within a nested governmental system, and larger jurisdictions have played crucial roles. State and federal laws and regulations that establish requirements for the creation and operation of districts and agencies, the acquisition and exercise of water rights, and the protection of water quality and of species and their habitat.

The State of California has been particularly significant in both watersheds. The State of California has contributed to successful local water resource management in these ways.

- Water users have requested the California Legislature to authorize the creation of local governments or alter the powers of existing local governments, to enable

them to carry management designs into effect. Often, water user associations drafted such legislation and the legislature adopted it.

- The state's court system provided a forum in which water users worked out agreements that are used to apportion the water supplies in both watersheds.
- The California Department of Water Resources engaged in a systematic program of research into water supply conditions throughout the state. These investigations provided early data bases to which local water users referred, thereby gaining access to professional expertise about hydrologic conditions and a common picture of their situations. The Department of Water Resources is also a major water supplier, through its operation of the State Water Project.
- The state also establishes water quality standards and monitors compliance through its system of Regional Water Quality Control Boards.

In the San Gabriel River watershed (which, unlike the Santa Ana watershed, lies within one county), County of Los Angeles organizations have also facilitated and participated in water resource management activities. The Los Angeles County Department of Public Works operates the flood control, groundwater replenishment, and sea-water barrier facilities. The Los Angeles County Sanitation Districts operate water reclamation plants from which the local water districts have purchased water to satisfy the lower area's entitlement to water from the upper area, and for recharge in Central Basin.

Colorado Watersheds

Like most western states, Colorado relies on the prior appropriation doctrine to govern surface water. Unlike most western states, however, Colorado administers the prior appropriation doctrine primarily at the local level, as opposed to the state level, through multiple overlapping jurisdictions with authority exercised by a variety of officials and water users. Thus, in Colorado, no single watershed possesses a watershed manager; rather, a complex mosaic of actors and organizations characterizes watersheds. These actors, at varying times and under varying circumstances, cooperate, compete, and fight with one another over different water issues. The character of such conflict and cooperation varies by watershed because each watershed presents different sets of physical circumstances. Some problems more readily call forth conflict and others cooperation. Overall, however, Colorado water appropriators have developed a relatively complex set of arrangements that coordinate water use within watersheds. A brief discussion of two different watersheds in Colorado, the South Platte and the Arkansas, illustrate these two points.

The South Platte and Arkansas River Watersheds. The South Platte River watershed, located in the northeastern quarter of the state, is home to more than half of the state's population, and much of its most productive agricultural land. The river originates in the Rocky Mountains, south and west of Denver, near Leadville. It flows east for a short distance, then north through the metropolitan region, before turning to the east/northeast, eventually flowing into Nebraska. On average, the Platte River carries 250,000 acre feet of water each year (Whitney 1983:47; Huber 1993). The European settlers who arrived in the region with the gold rush of 1859 described the Platte River as "a mile wide and an inch deep - too thin to plough and too thick to drink" (Huber 1993: 155).

Prior to the introduction of agriculture, the Platte would occasionally dry up during the hot summer months. Today, the South Platte is considered a gaining river, that is, its volume of flow is increasing. Increased flows originate from numerous transmountain water projects developed by Denver and surrounding cities, and by the Colorado-Big Thompson Water Project that is managed by the Northern Colorado Water Conservation District. In addition, irrigation has contributed to the increased flows of the river through a hydrologically connected groundwater basin. Water not consumed by crops seeps into the underlying basin. Several decades of irrigation have increased water tables and water from the basin flows into the river. Unlike one hundred years ago, the South Platte River supports a relatively rich riparian habitat.

The Arkansas River watershed is located in the southeastern quarter of the state. The river originates high in the Rocky Mountains near Leadville, Colorado, just west of the headwaters of the South Platte River. From Leadville, it flows south approximately 60 miles before turning east to flow through Canon City, Pueblo, and Lamar, before finally entering Kansas. The Arkansas River, on average, only carries 500,000 acre feet of water past Pueblo each year (Whitney 1983:47). During particularly dry years, it would dry up and cease to flow (Sherow 1990). Currently, even during dry years, it flows year around because of the dams and reservoirs located on it. In 1943, the Army Corps of Engineers completed the John Martin Dam and Reservoir, located 58 miles west of the Kansas State Line. The reservoir is used for flood control, irrigation, and recreation. Storage and release of irrigation water is governed by the Arkansas River Compact, signed by Kansas and Colorado in 1948, and administered by the Arkansas River Compact Commission (Abbott 1985). Later the Pueblo Dam and Reservoir located just southwest of Pueblo was completed by the Bureau of Reclamation. The Pueblo Reservoir is part of the Frying Pan-Arkansas Project, which is a multipurpose project built by the Bureau, but managed by the Southeastern Colorado Water Conservancy District (Abbott 1985). Between the many water rights and the capturing and storing of water in the large reservoirs the Arkansas River rarely holds any surplus water not claimed by someone.

The Administration of the Prior Appropriation Doctrine. The prior appropriation doctrine and its administration define the character of water governance in the South Platte and Arkansas River watersheds. Prior appropriation allocates water on the basis of first in time, first in right. The person making the first appropriation of water from a stream holds rights to a portion of the water senior to all subsequent appropriators. The next person in time to appropriate water from that same stream holds rights to a portion of the water senior to all subsequent appropriators, but not to the first appropriator. Under such an allocation rule, if water is scarce, appropriators do not equally share in reductions, instead, the rights of senior appropriators are satisfied and junior appropriators are foreclosed. The justification for this is that in times of shortage, if all were to share equally in reductions no one would receive sufficient water to serve their purposes. Instead, it is better that at least some be served (Vranesh 1988:71).

In Colorado, a citizen acquires a right to use a certain portion of water by first diverting the water from a stream or river and then putting the water to beneficial use. Conflict emerges as appropriators fight over whose right is most senior and whether appropriators are taking more than their allocated amount of water. In other words, the prior appropriation doctrine requires substantial coordination across appropriators if it is to work properly. This became abundantly clear early in Colorado's history. Following an irrigation boom in the 1870s intense conflict erupted among appropriators in the South

Platte River watershed. Farmers organized a convention in which they wrote legislation that would create an administrative process for defining and administering water rights that would reduce conflict (Abbott et al. 1994:168). The legislation, passed by the state legislature, allowed for the creation of water districts. Each water district was to be served by a water commissioner who was to keep a record of water rights in the district and who was to ensure that water rights were satisfied in the proper priority (Vranesh 1987:468). Furthermore, if an appropriator wanted an enforceable priority date for a water right, he would have to have the right decreed in court (Vranesh 1986:379).

A single river or stream typically winds through several water districts. Coordination of water rights across districts quickly became a problem. In 1887, the state legislature followed up on legislation passed in 1881, which created a state engineer and water divisions coterminous with watersheds, to add division engineers. Division engineers, who reported to the State Engineer, were authorized to coordinate water rights across districts. Water commissioners were to follow the direction of the division engineer, as the division engineer shutdown diversions in one district to satisfy senior rights in another district. Thus, by 1887 the institutional infrastructure for creating, administering, and enforcing property rights according to the prior appropriation doctrine had been established, and that institutional infrastructure centered on watersheds.

The institutional infrastructure is polycentric in form. Water rights are defined, changed, transferred, and protected by water courts, which are independent of, and separately constituted from the State Engineer's Office. Until 1969, every county court judge could hear water cases. Two or more judges often staffed each county court, each water district encompassed more than one county, and each division encompassed several water districts and numerous counties. Thus, within each water division, which encompassed an entire watershed, several judges heard water cases. With the passage, in 1969, of the Water Rights Determination and Administration Act, the Colorado Supreme Court was authorized to appoint a single water judge from among the county district judges, to hear all water cases in a division. This permitted the development of water expertise on behalf of the judge, and it allowed appropriators to more easily monitor one another. Instead of tracking multiple courts and judges within a division to learn of water rights filings, appropriators only had to attend to a single court and judge.

The water court decision making process is based on consensus. Once an application for a water right, or for a change of water right, is filed it is turned over to a water referee. A referee, who is a "nonlawyer, technically trained" individual gathers evidence and makes an initial determination concerning water rights (Vranesh 1987:456). Often, a referee conducts an unstructured hearing to discuss the issues with the applicant and with any objectors. If consensus on the issues is achieved, the referee will often ask the applicant to draft the appropriate decree, which the water judge enters as a decree (Vranesh 1987:444). If consensus is not reached, and the referee's ruling is objected to, a trial takes place before the water judge. While the trial is more formal than the hearing held by the referee, the intention is the same, to develop a consensus on the issues so that a decree may be entered. If a consensus is not achieved, the ruling by the water judge may be appealed to the Colorado Supreme Court. The referees handle most applications, only a few cases are ever appealed to the Supreme Court.

Besides the water court, the only other watershed level decisionmaker is the State Engineer, who is assisted by a division engineer in each watershed. In turn, a water

commissioner in each water district assists each division engineer. The water commissioners, the division engineers, and the State Engineer primarily act as coordinators. Water commissioners measure and monitor water appropriations. At the direction of the division engineer they shutdown junior appropriators so as to satisfy the water rights of senior appropriators. The division engineers maintain and update lists of appropriation rights and priorities in each division. They determine the accuracy of statements made in water applications and protests. They measure water flows, determine who is in priority, and order junior appropriators shutdown. They inspect and monitor diversion works, reservoirs, and dams, ensuring safety and accurate measurement of diversions (Vranesh 1987:509).

The State Engineer also possesses rule-making authority. Such authority has been exercised on a watershed scale only twice, in both instances to regulate wells. Both instances set precedents for how such rulemaking authority could be exercised. The Colorado Supreme Court defined the procedural requirements of such authority after the State Engineer attempted to shutdown wells in the Arkansas River Watershed. After the State Engineer was peppered with lawsuits over its proposed rules in the South Platte River Watershed, the suits were combined and a single trial was held before the water court. After extensive negotiations, the judge decreed the rules, which were then implemented. This established the precedent of having watershed level rules vetted through water court.

Even though the division and State Engineers and the water courts operate at the watershed level, neither arrangement qualifies as a watershed manager. The water courts are limited to hearing only those cases brought before them by water appropriators. The courts decree rights on a case by case basis, and rarely does a case raise watershed level issues. Furthermore, water courts are limited in the types of cases that they may adjudicate. They exercise authority only over water allocation. While allocation is critical, particularly in the West where water is scarce, it is just one of many issues that constitute watershed level management. The state and division engineers are limited in their authority too. They administer water rights, and they ensure their coordination, but they do not define them.

Water Appropriation Organizations. The appropriators who played the central role in devising the state's water administrative machinery and who rely most heavily on water native to the South Platte River and Arkansas River watersheds are irrigators. Raising crops in eastern Colorado requires the artificial application of water to the land. The artificial application of water requires substantial infrastructure, well beyond the reach of any single farmer. Irrigation is the product of relatively complex sets of institutional arrangements devised by farmers to transport large amounts of water, long distances from a water source, to large amounts of land. Farmers rely on combinations of companies, districts, and associations to marshal the resources and expertise to build, maintain, and operate reservoirs, ditches, canals, laterals, and headgates.

One relatively complex combination is that of a ditch company, a special district, and lateral associations. The Bijou Irrigation Company and District, located in the South Platte Watershed, is such an example. The ditch company owns rights to decreed amounts of South Platte River water and a canal for delivering the water. Farmers purchase shares in the company, which entitle them to a proportion of the company's water. An irrigation district, which is often formed by the same farmers who own the ditch company, owns and operates a storage reservoir, the ditches and diversion works that

transport the water from the river to the reservoir, and from the reservoir to the ditch company's canal, and the rights to decreed amounts of river water to be used to fill the district's reservoirs. The company and the district share a single board of directors and the membership of each organization is co-terminus. Furthermore, farmers formed lateral associations to build and maintain the laterals that are used to deliver water to individual fields. The lateral associations have formed a single association which represents all laterals before the board of directors of the company and district.

Other irrigation systems are not as complex. For instance, the Lower Platte and Beaver Canal Company and the Hillside Irrigation District work closely together, but they do not share a board of directors nor is their membership co-terminus. In addition, neither organization owns a reservoir, but the canal company owns a ditch and rights in the river and in a reservoir, and the District owns rights in a reservoir Districts, companies, and associations are the basic organizational building blocks that may be combined in different ways to create irrigation systems. Other irrigation systems are quite simple. The Weldon Valley Irrigation Company, consist solely of a ditch and water rights (Dille 1960).

Irrigation systems, regardless of how they are organized, coordinate water across farmers. In some instances, the irrigation systems in a single district will form an association to coordinate their activities with one another. The irrigation systems located in District One, Division One, formed the Irrigationists Association. The purpose of the organization is for the irrigation systems to consult with one another about activities that might affect each other's water rights. Systems attempt to work out their differences with one another within the context of the association before entering court to obtain a decree. Furthermore, the Irrigationists Association monitors the activities of Division One Water Court. If an application is filed that appears to affect the water rights of an irrigation system within district one, the association will file a protest in response.

Not all irrigators are so heavily dependent on the South Platte River and the Arkansas River for their livelihoods. Irrigation systems that reside within the core of the Northern Colorado Water Conservancy District and within the boundaries of the Southeastern Colorado Water Conservancy District receive at least a portion of their water from the Colorado River Watershed. Conservancy Districts plan, construct, and operate large water projects. Their purpose is to allow the citizens of Colorado to make more complete use of the waters of the state (Radosevich et al. 1976). The Northern Colorado Water Conservancy District is the oldest conservancy district and it operates the largest project - The Colorado-Big Thompson (C-BT) Project.

The C-BT Project was authorized by Congress in 1937. Water from the Colorado River is stored in a series of reservoirs on the west slope of the Rocky Mountains, transported across the mountains through a 13 mile long tunnel, and stored in a series of reservoirs on the east slope. The project yields an average of 236,000 acre feet each year (Vranesh 1987:790).

While the Bureau of Reclamation built the project, the Conservancy District, through a contract with the Bureau, financed a portion of it, and operates and maintains it. The District, which encompasses several cities such as Boulder, Longmont, Loveland, Greeley, and Fort Collins, and more than 600,000 acres of farmland, finances the project through property tax assessments. When the project was almost complete in the late 1940s, the District allocated units of water to irrigation systems, municipalities, industries, and individuals within its boundaries. CB-T units may be leased or transferred

among entities within the District's boundaries. Not surprisingly, units are flowing from agriculture to municipal use. For instance, in 1957, 85% of C-BT units were owned by agriculture, but by 1990, only 57% of the units were owned by agriculture (Tyler 1992:461).

The conservancy district, through the C-BT project provides a supplemental source of high quality water to its residents. The district uses a market to allocate water within in its boundaries. It also collaborates with municipalities and irrigation systems to develop new sources of water, such as the Windy Gap project, which increased urban water supplies, and augmentation plans and recharge sites, which have allowed well owners to continue using their wells. Furthermore, the district works with its members maximize the use of existing supplies through a series of water exchanges that minimize transportation losses and that more nearly match water quality with water use (Tyler 1992).

Most municipalities in the South Platte and Arkansas Watersheds rely heavily for their water supplies on waters transported over the Rocky Mountains from the Colorado River Watershed. Numerous transmountain water projects have been developed singly and jointly by the cities of the Denver Metropolitan region, such as the Denver Water Board in the South Platte Basin, and by the cities of Colorado Springs and Pueblo in the Arkansas Basin. For instance, Colorado Springs has developed several projects alone and with others that produce close to 180,000 acre feet of water annually (Abbott 1983:11). Very little of the water is native to the Arkansas Basin. The water originates from several different watersheds ranging from 30 miles to 160 miles from the city. Colorado Springs has developed the water in its closest watersheds, such as Pikes Peak, but has worked with different cities and with the Southeastern Colorado Water Conservancy District to develop water in the Colorado River Watershed.

Water appropriators in both watersheds are tied together through their mutual dependence on different sources of water and through their collaborative efforts to develop and allocate that water. Appropriators exchange different sources of water with one another. For instance, irrigation systems will exchange their Colorado-Big Thompson Project water with cities for South Platte River water. In the exchange, cities receive a much higher quality of water and irrigation systems receive a larger volume of water that is of satisfactory quality for irrigation. Appropriators collaborate on different water projects. Both watersheds are laced with reservoirs, dams, aqueducts, pumping stations, pipelines, ditches and canals that extend into neighboring watersheds. And, appropriators fight and contest each other's actions in water court, protecting their current water rights and attempting to gain advantage in developing future rights.

For most of the first one hundred years of Colorado's existence, citizens were busily creating organizations through which they could access and make use of the water necessary to support towns and cities and large scale irrigation systems. The institutional structure for developing and administering water rights, and the organizations necessary to marshal the resources to build water projects were created in a burst of innovation shortly after Colorado achieved statehood in 1876. By 1881, the state's water administrative structure - the courts, engineers, and commissioners - was in place. By 1905, state laws governing the creation of ditch companies, irrigation districts, and conservancy districts had been adopted (Radosevich et al. 1976). For most of the 20th century, watershed activities in the South Platte River and Arkansas River Basins consisted of appropriators building water systems and fighting over water rights within a specific institutional structure that they had created for themselves.

The Tributary Groundwater Crises. Beginning in the 1950s, drought plagued the eastern half of Colorado, precipitating a crisis among appropriators that eventually led to a series of institutional innovations that have only partially resolved the crisis. In turn, those same innovations are now being used to address a second contentious issue - protecting endangered species.

The initial crisis centered on groundwater pumping. The South Platte River is hydologically connected to a groundwater aquifer that is estimated to contain approximately 8 million acre feet of water (McDonnell 1988:585). The Arkansas River is hydologically connected to a an aquifer that is estimated to contain 2 million acre feet of water. Most of the groundwater is inaccessible, not because of technological hurdles, but because of the prior appropriation doctrine. The prior appropriation doctrine is not well suited for governing groundwater. Drawing upon groundwater necessarily lowers the water table. Lowering the water table reduces surface water flows. The surface stream can disappear if the water table is sufficiently lowered. Drawing upon the groundwater basin injures senior surface water rights holders. The tradeoff is clear. Protecting surface water rights holders forecloses access to much of the water in the aquifer. Actively using the aquifer decimates the rights of surface water appropriators.

In response to the 1950s drought, farmers drilled wells and pumped groundwater to irrigate their crops. For instance, in 1940, in the Arkansas River Basin an estimated 40 irrigation wells were in operation. By 1972, 1,477 wells pumped 208,000 AF of water (McDonnell 1988:582). Noticeable effects on surface water flows appeared in the 1960s. Colorado courts had long recognized that tributary groundwater was governed by the prior appropriation system. Thus, the answer to the problem of pumping tributary groundwater seemed obvious. The groundwater pumpers' water rights are junior to those of surface water appropriators. When a senior surface water appropriator calls for sufficient water to remain in the river in order to satisfy his water right the appropriations of the most junior rights holders should cease until the senior appropriator's rights are satisfied. Wells should be shutdown.

Two issues prevented such a direct solution. First, the Colorado constitution, legislature, and supreme court advocated the development and use of the waters of the state to the greatest extent possible for the benefit of the citizens of the state. Foreclosing the timely use of tributary groundwater violated such intentions. Second, the concept of the futile call made it difficult, in practice, to shutdown well pumping. A futile call occurs when a senior appropriator's rights would not be satisfied even if appropriations junior to it were shutdown. In such a case, junior appropriators are allowed to continue to divert water. Shutting down wells to satisfy senior surface water calls is often futile because of a time lag between groundwater pumping and surface water flows. In most cases, shutting down wells will not have an appreciable effect on surface water flows for weeks or months. Even if a senior appropriator made a call, and wells were shutoff, the senior appropriator would not realize any water for his crops in many cases until the irrigation season was coming to a close.

In 1965, the Colorado Legislature passed legislation providing the State Engineer with the opportunity to directly address the conflict between surface water and tributary groundwater appropriations by granting that office rulemaking authority (Radosevich 1976:138). In the summer of 1966, the Engineer exercised his new authority and ordered 39 wells in the Arkansas River Valley shutdown in order to satisfy senior

rightsholders with appropriations dating to 1887 (Radosevich et al. 1976:139). This action triggered a decade of conflict culminating in tributary groundwater being incorporated within the prior appropriation system only in the South Platte River Basin. Not until 1992, after the U.S. Supreme Court found in favor of Kansas against Colorado in relation to the Arkansas River was tributary groundwater incorporated within the prior appropriation doctrine in the Arkansas River Basin.

Tributary Groundwater and the South Platte River Basin. After several attempted rulemakings, numerous lawsuits, threats by senior appropriators to abandon the prior appropriation doctrine if junior well pumpers were not regulated, and the passage of the 1969 Water Rights and Determination Act, agreement was reached on a set of rules for incorporating tributary groundwater into the prior appropriation system in the South Platte River Valley (Radosevich et al. 1976:148-149). These rules were hammered out among surface and ground water appropriators and the State Engineer's Office, in the context of the Division One Water Court (Radosevich, et al. 1976; Vranesh 1987).

The 1969 Act provided two mechanisms to ease the entry of well owners into the prior appropriation system. First, the act required that ail tributary groundwater rights be adjudicated. Wellowners were provided an attractive incentive to firm up their water rights. If they adjudicated their wells prior to 1972, their priority would be fixed at the time they first pumped the well, and not at the time that they adjudicated their right, as was customary. Wellowners responded by adjudicating their rights. This helped to settle a severe information problem. Prior to these adjudications, the state engineer (including the water commissioners), the courts, and all other appropriators did not know the number, location, and volume of water pumped by wells, nor their order of priority. Such information is central if water rights are to be administered in accordance with the laws.

Second, the Act provided a mechanism by which junior rightsholders could withdraw water out of priority. An augmentation plan "provides a highly flexible tool enabling new uses of water without strict regard for the priority system, so long as existing rights are not injuriously affected" (McDonnell 1988:589). In other words, junior appropriators, whether of surface water or of tributary groundwater, can protect their diversions from "calls" by senior appropriators by augmenting stream flow. A plan of augmentation for a well, or series of wells, involves determining the depletions to stream flows, or injury to the river, caused by well pumping, and identifying a source of water that will be made available to the river at the time and place of injury to senior appropriators.

The rules adopted for the South Platte River Basin are conceptually quite simple. First, the rules defined a time table for phasing out well pumping. Second, wells covered by a decreed plan of augmentation could continue to operate. Third, wells covered by a temporary plan of augmentation could continue to operate. Augmentation plans that allow out of priority depletions were key to incorporating tributary groundwater into the prior appropriation system.

Decreed Plans of Augmentation. Some irrigation systems chose to obtain a decreed plan of augmentation to cover their members' wells. Obtaining a decreed plan of augmentation is similar to obtaining a right to appropriate water. Appropriations of water for augmentation are placed within the priority system (McDonnell 1988:596). For instance, the Fort Morgan Irrigation Company and District's augmentation plan includes a list of each well to be covered, a list of each augmentation structure to be used to recharge water to the aquifer and eventually the South Platte River, the methods for

measuring well depletions and augmentation accretions, and a decreed right of 235 cfs for augmentation use with a priority date of May 19, 1972.

The operation, administration, and monitoring of the augmentation plan is shared among the Fort Morgan Irrigation Company, the district one water commissioner, the Division One Engineer's Office, and the Northern Colorado Water Conservancy District. The. irrigation company has incorporated its augmentation activities within its existing irrigation infrastructure. Augmentation structures consist of the Fort Morgan canal, several stretches of Badger Creek adjoining the canal, and several prairie "potholes" and ponds located adjacent to or at the end of the canal. During the non-irrigation season (October-March), Fort Morgan diverts water from the South Platte River under its augmentation decree. The water is run in the augmentation structures, seeps underground, slowly flows back to the river, and enhances the stream flow of the river primarily during the summer peak demand. Members' wells can continue to operate, even though they are drawing out of priority water, because of the replacement water to the South Platte River provided by the augmentation structures.

Temporary Plans of Augmentation. In 1972, with the encouragement of the State Engineer, a group of well owners formed GASP, the Groundwater Appropriators of the South Platte, a nonprofit organization, to develop a portfolio of water to be used to cover members' out of priority depletions caused by well pumping. The organization agreed to provide a list of its members, a list of wells, an estimate of the amount of water to be pumped in the coming irrigation season, the actual amount of water pumped in the previous irrigation season, and an amount of water to be placed at the State Engineer's disposal to replace out of priority depletions and offset any injury to senior rights (McDonnell 1988:591). The State Engineer accepted the offer. The substitute supply plan must be approved on an annual basis.

GASP covers several thousand wells in the South Platte River Basin, primarily between Greeley, Colorado and the border with Nebraska. To become a member, a well owner must pay a fee equal to the cumulative annual fees charged by GASP since its inception in 1972. In addition, an annual fee must be paid, based on the amount of water the well owner expects to pump during the year. For each 100AF, or portion thereof that is pumped, one unit of membership must be purchased. In 1972, the unit fee was $15, in 1986 it was $90, and in 1992 it was approximately $120 (McDonnell 1988:592; GASP no date).

GASP leases shares of water from ditch companies and reservoirs, and it leases augmentation credits. The organization pools this water together to cover out of priority well pumping over a two hundred mile reach of the South Platte River. GASP is a controversial organization. It is controversial because it operates in apparent violation of the prior appropriation doctrine. The prior appropriation doctrine is based on the no injury rule. Appropriators can develop, change, and use their water rights, they can even take water out of priority, so long as no other appropriators are injured. Courts, in decreeing augmentation plans, have required that out of priority well pumping must be measured and completely offset by a reliable source of water available at the time and at the point of injury. GASP does not completely offset it's members well pumping, meaning that senior appropriators are still being harmed by junior appropriators' well pumping.

"The GASP approach has been characterized as 'call management'"(McDonnell 1988:592). The GASP water portfolio is of a sufficient size and is strategically located so

as to "minimize the call on the lower portion of the South Platte River" (McDonnell 1988:612). Until very recently, GASP has been allowed to drill wells relatively close to the river, near the canals of the most senior appropriators. Instead of the senior appropriators making a call on the river, GASP turns on its wells and diverts the water into the seniors' canals to satisfy their water demands. The wells do not affect the river flow until winter when the South Platte River is free flowing, i.e., carries sufficient water for all water rights to be satisfied.

Call management violates the prior appropriation doctrine because it does not fully replace out of priority depletions to the river. Call management simply quiets the protests of the senior appropriators most likely to complain about well pumping. In other words, GASP has managed to reclaim the status quo prior to the widespread introduction of well-pumping. Those senior appropriators who historically had their water rights consistently satisfied continue to have their rights protected from well pumping. However, the status quo that GASP reclaimed is threatened once again by twin challenges.

First, flows in the South Platte River are likely to be reduced over time. The water produced by the transmountain projects that Front Range cities developed to satisfy their residential and industrial consumers is not subject to the prior appropriation doctrine and such water may be used and reused by the organization that first developed it. For instance, treated waste water, which originated from a water project remains the property of the organization that developed it. Even if the organization chooses to place the treated water in the South Platte River, that water is not available to be appropriated and to have rights defined in it by downstream users. Until very recently, Front Range cities have chosen to use the water from their transmountain projects only once, and then they have released the water to the South Platte River. These waters have served two purposes. They have masked the effects of well pumping on surface water flows, and they have allowed Colorado to meet the South Platte River compact requirements with Nebraska.

The Front Range cities, faced with rapidly growing populations and limited sources of water, are beginning to capture and reuse their transmountain project water. Overtime the South Platte River will be deprived of these flows, exposing the fragility of GASP and threatening the River Compact.

Second, the U.S. Fish and Wildlife Service has listed the whooping crane, the least tern, the piping plover, and the pallid sturgeon as endangered. All four species use the central Platte River region located in Nebraska. Wyoming, through which the North Platte River flows, Colorado, Nebraska and the Department of the Interior have entered into a cooperative agreement designed to develop and implement a recovery program for the four species. One aspect of the recovery program focuses on water flows. The USFWS has developed recommended flows needed at different times of the year by endangered species. Initially, the three states are attempting to change the timing of flows for approximately 70,000 acre feet of water, capturing water when flows exceed USFWS recommendations and releasing them when flows fall below recommendations. Colorado has committed to making available 10,000 acre feet of water between April and September each year through changing the timing of the flow of the water.

Colorado intends to make 10,000 acre feet of water available through a recharge program located 40 miles from the state line with Nebraska at the Tamarack Ranch

State Wildlife Area. The recharge program is being developed and adminstered through a coalition of Colorado appropriators involving Front Range cities, GASP, the Northern Colorado Water Conservancy District, and the Colorado Department of Fish and Wildlife. The group meets monthly to assess progress in the design and operation of the recharge program.

The Tamarack recharge program consists of a series of wells and recharge ponds. The wells, located very near to the South Platte River are pumped during times when there is surplus water in the river. The water is placed in recharge ponds at differing distances from the river. The water percolates into the tributary groundwater aquifer and eventually returns to the river. The ponds are filled in the winter and early spring so that the water that percolates from them enters the river between April and September, satisfying Colorado's commitment to the three state partnership for recovering endangered species. In addition, if the project produces water in excess of that needed by endangered species, GASP may lease it and use it to cover well pumping.

Tributary Groundwater and the Arkansas River Basin. Augmentation, as practiced in the Arkansas River Basin (Division Two), although engaged in for the same purposes as that of the South Platte Watershed (Division One), is executed in an entirely different manner. The well owners in Division Two have acted and responded differently than their Division One counterparts to the process of incorporating tributary groundwater into the prior appropriation system. These differences are driven partly by physical circumstances, and partly by institutional circumstances.

In the late 1960s and early 1970s, large well-owner associations were formed to defend their interests as the Division Engineer's Office attempted to incorporate well-owners into the prior appropriation system. When a call came on the River, the Engineer ordered a number of wells shutdown in order to satisfy the rights of senior appropriators. The well-owners filed suit against the Engineer. The well-owners prevailed. In 1968, the Colorado Supreme Court ruled that the Engineer did not have to demonstrate that the pumping of a specific well was causing an injury to a specific senior appropriator. In order to regulate wells, the Engineer would have to develop a plan through which to implement well regulation and the plan and its associated rules must lessen injury to senior appropriators. Also, the Engineer would have to explore alternatives to simply shutting down wells as a means of protecting senior appropriators (Fellhauer v. People, 167 Colo 320, 447 P.2d 986).

By 1973, a set of rules regulating well-pumping was adopted in Division Two. The rules limited pumping to three days per week - Monday, Tuesday, and Wednesday. In 1974, the Division Engineer attempted to adopt the same well-pumping regulations as those in Division One - phasing out pumping over a three year period, unless the wells were part of an approved augmentation plan. Again, the pumpers challenged this rule, and again the Supreme Court sided with the pumpers, deciding that the Engineer did not demonstrate that such measures would make additional water available to senior appropriators (In re Arkansas River, 195 Colo. 557, 581, P. 2d 293, 1978).

The 3-day a week rule did not limit pumping, in part because it was not enforced. Other mechanisms, however, did ensure an upper bound on pumping. Under the 1969 Water Rights and Administration Act, well owners adjudicated their wells, which placed upper limits on pumping. Each decree defined the volume of water that could be put to

beneficial use. Furthermore, through its well permitting authority, the Division Engineer did not permit any new irrigation wells.

This was the status quo until the mid-1980s, when Kansas filed suit against Colorado, claiming that Colorado did not maintain adequate Arkansas River flows across the stateline into Kansas, in violation of the Arkansas River Compact. The special master, appointed by the U.S. Supreme Court, sided with Kansas. Among other things, Colorado was directed to regulate well pumping in the Arkansas River Basin. The State of Colorado acted quickly to bring Division Two wells within the prior appropriation system so as to minimize the penalties the state will have to pay Kansas. Similar to what transpired in South Platte River Basin two decades before, the State and Division Engineers, the State Attorney General, and the well owners associations, within the context of the Division Two water court, devised a set of rules to regulate well pumping.

The rules created replacement plans, which are a cross between decreed plans of augmentation and temporary plans of augmentation. Replacement plans are similar to decreed plans in that they fully replace each out of priority depletion at the time and point of injury. Replacement plans are also similar to temporary plans in that they are not adjudicated, rather they are approved by the Division engineer each year. Each year, the well associations provide a list of wells by river reach; the amount of water each well expects to pump; and the actual water, by river reach, that the well association will make available to the Engineer to cover out of priority depletions. The Engineer's office collects monthly data on well-pumping, stream depletions, and stream replacements data. Each month the Engineer, the well-owner associations and a representative of the State of Kansas review the accounts to ensure that the out of priority stream depletions have been covered.

The replacement plans developed by the well-owner associations are in lieu recharge programs. Instead of directly recharging water into the aquifer, as do some of their counterparts in the South Platte Basin, they purchase or lease rights to surface water. The surface water is released to the stream over the course of the irrigation season so as to replace the water taken out of priority by well pumping. Sources of replacement water are surface storage and distribution projects developed by the Southeastern Colorado Water Conservancy District, the Cities of Pueblo and Colorado Springs, and the Bureau of Reclamation. In addition, well-owner associations have purchased shares of water of mutual ditch companies.

Well-owner associations along the Arkansas River have chosen to develop in lieu recharge programs because of the circumstances in which they find themselves. First, the tributary aquifer of the Arkansas River is narrower than that of the South Platte, and water tables are higher. There is very little room to recharge into the aquifer. Second, the Arkansas River is under a "call" year around. Only rarely would a very junior augmentation decree be in priority so that water could be drawn from the river and placed in recharge ponds. Third, cities located upstream of the well owners have developed surface storage systems whose volume currently exceeds their water needs. Cities have, and probably will have for the next 50 years, surplus surface water to lease.

Augmentation plans and replacement plans have softened the harshest edges of the prior appropriation doctrine. The prior appropriation doctrine, based on first in time, first in right, protects the earliest appropriations, forcing the burden of scarcity on to later appropriations. Augmentation plans allow junior appropriators to confront scarcity, not by

shutting down their appropriations, but by developing and using additional sources of water to satisfy the water rights of senior appropriators. These plans have been particularly crucial in allowing for greater use of groundwater resources than would have otherwise been the case if the prior appropriation doctrine had been strictly enforced.

The groundwater crises in each watershed and the institutional response of augmentation plans have led to a higher level of coordination among water appropriators. Well owners represented another group of appropriators to be incorporated into the prior appropriation system. Such incorporation required substantial coordination between surface water sources and groundwater sources. Large associations of well owners formed to pool water resources to cover well pumping. These associations, in conjunction with the Division Engineers, coordinate the allocation and use of water among thousands of appropriators over vast reaches of the two rivers.

Augmentation plans are also pressed into service to provide flows of water when needed by endangered species. For the first time appropriators who typically fight over water, cities and irrigators, are engaging in cooperative projects which protect and enhance critical habitat. In so doing, they protect their existing water rights from minimum streamflow requirements being imposed on them either from the USFWS or from a lawsuit by Nebraska.

Conclusion. Governance and management arrangements in Colorado watersheds are polycentric and multifaceted. Those arrangements include:

- Irrigation companies and districts with primary responsibility to develop and manage irrigation water supplies;
- Municipal water departments, districts, and boards with primary responsibility to develop, finance, and distribute imported water supplies;
- Conservancy Districts that develop, finance and distribute imported water supplies;
- Well-owners associations that pool water across thousands of well owners
- Voluntary associations formed for a special purpose, such as creating and managing the Tamarack Project or monitoring water courts
- Water courts, operating at the watershed level, that allow water appropriators to define, change, and contest water rights
- Water commissioners, division engineers, and the State Engineer that provide vital information and that coordinate water appropriators at the watershed level

Despite the complexity of the physical system and the absence of "a manager," there is water resource management in both the South Platte and Arkansas River Watersheds. Management has focused on the development and allocation of water supplies. More recently, new forms of water, i.e., groundwater, have been incorporated in the system, and endangered species have been addressed. Looming inter-related problems include endangered species, water quality, and water development as eastern Colorado experiences booming population growth.

A POLITICAL SCIENCE EXPLANATION FOR THE EMERGENCE OF USER-CREATED WATERSHED GOVERNANCE AND MANAGEMENT

The watershed movement has advocated the management of water resources at the watershed level, and it has stimulated a significant amount of activity intended to achieve that. In at least some significant watersheds, the watershed-scale arrangements for

governing and managing water resources are quite complex and multi-faceted. (To some, they may not look like watershed management arrangements at all.) They seem to meet the watershed movement's criteria of involving the local water resource users—indeed, the arrangements were devised by the users themselves—but they probably don't look like the kinds of watershed management institutions the watershed movement literature often seems to be recommending: comprehensive, inclusive, watershed-wide institutions capable of addressing the full array of resource problems and properties. There is, as we stated in the introduction, a gap between what the policy literature seems to be advocating and what is happening on the ground.

Traditional public administration theory, and the allied literature advocating rational-comprehensive planning, would certainly be able to fill that gap with a *critique* of the governance and management arrangements in these four watersheds. But neither school of thought would be able to provide an *explanation* of those arrangements—how and why they came into existence the way they did, how they function, and how and why they have succeeded in some ways while falling short in others. Such an explanation will have to come from other traditions within political science.

It may seem to some that the obvious place to begin a political science explanation of these watersheds is with the concept of incrementalism. According to incrementalist explanations, policy and institutional changes occur in small steps, as needed, applying a conservative "muddling through" approach that may forego ambitious efforts to reap big gains in order to avoid risking huge mistakes. We disagree that incrementalism is the place to start explaining watershed management from the ground up. The only thing incrementalism can explain about the four case studies we have presented is that the governance and management arrangements there took a long time to develop. But they did not represent a "muddling through" approach on the part of water users.

The water users who assembled these arrangements constituted new organizations, reconstituted old ones, created physical structures, and invented and applied legal doctrines—all of which represented significant (and risky) innovations.[13] Their efforts did take a long time, but that does not necessarily reflect an incrementalist approach. It fits the facts just as well to say that their efforts took a long time because on many occasions they were trying to design and implement things that had never existed before.

We will attempt to present the principal elements of an alternative political science explanation in three major parts. The first part addresses the general concept of user-created governance arrangements. The second part addresses some of the administrative features of the watershed arrangements the users have created. The second addresses their political properties.

Levels of Action, and Self-Governance as an Adaptive Process. To explain the actions of the water users in the four watersheds described in this paper (and probably in

[13] A partial list would include: in California, groundwater basin adjudication, quantified and transferable pumping rights, the legal doctrine of "mutual prescription," multi-member policy-making watermasters, allocating river flows on the basis of "usable water," replenishment districts, coastal injection barriers to resist sea-water intrusion, the SARI line, and Orange County's groundwater replenishment system; in Colorado, water courts, the integration of surface and groundwater rights, augmentation plans, and a market in water project units.

others), it helps to draw upon the concept of levels of action (Kiser and Ostrom, 1982). Individuals in any group are capable of acting at three levels: an operational level at which they interact with each other and the rest of the world, a collective-choice level at which they take decisions about how to interact with each other and the world, and a constitutional level at which they take decisions about how decisions will be made. Individuals in social situations usually behave at the operational level (working, playing a game, using a common resource), but may shift to collective-choice actions to change the rules governing their operational-level behavior, and may even shift to constitutional actions to establish or revise the arrangements for deciding how the rules will be made.

The concept of levels of action helps to account for patterns of behavior by the water users in the four watersheds in a few ways. First, it casts the users themselves as active principals in the creation and re-creation of the situations within which they act—they became actors who may redefine institutional arrangements rather than objects who merely respond to them. Self-governance becomes a possibility in the design and implementation of watershed management arrangements. In most of the instances of institutional design and creation described in this paper, users were establishing their own arrangements rather than waiting for water resource management programs to be designed and implemented by others.

Second, the concept of levels of action includes an acknowledgement that while collective-choice and constitutional actions are possible, they are costly to engage in (if nothing else, the opportunity cost of the time spent designing or changing the rules). We expect to see individuals acting at the operational level most of the time, and shifting levels of action only when they perceive sufficient gains to be achieved by doing so or they become sufficiently dissatisfied with the results their operational-level behavior is yielding. This helps to explain why long periods sometimes pass between institutional innovations, while resource conditions deteriorate.

Water users are not necessarily myopic or irrational because they continue existing use patterns for a period while matters continue to worsen. Because change is itself costly, it is not surprising to see the status quo preserved for a while, perhaps followed by a burst of activity intended to arrest and reverse the undesirable trend. Indeed, Libecap (1994: 563-566) has suggested that the deterioration of a resource may be a necessary condition for collective action, as it is the losses resource users are experiencing that provides the incentive to invest in more beneficial institutional arrangements.

Third, the concept of levels of action helps us to see and explain institutional design as an adaptive process. Water users have experimented with new organizations, physical structures, rules, and relationships, examined their results, made adjustments and adaptations, and so on in an ongoing process of shifting between levels of action as a way of trying to achieve desired water resource management results. In light of the risks they undertook and the innovations they designed and implemented, their behavior is probably better characterized as adaptive than incremental.

Polycentricity, Specialization, and Scale. Perhaps the question that begs hardest to be asked about the watershed governance and management arrangements in these four watersheds is, why not just establish a watershed-scale organization to engage in water resource management activities? The complexity of the interorganizational and intergovernmental arrangements in these watersheds and the amount of coordination required are obviously great. What explanation can be given of the motivations and

choices of these water users in crafting such complicated and multi-layered arrangements?

Here too a political science explanation can be constructed to provide an understandable account. It would draw heavily upon the literature on local public economies that has emerged to explain complex polycentric systems such as the governance of metropolitan areas in the absence of a metropolitan government (U.S. ACIR, 1987; U.S. ACIR, 1988; Oakerson, 1999). The most important components of such a "public economies" explanation would be the provision-production distinction, specialization, economies and diseconomies of scale, and coordination versus hierarchy.

In all social settings—from households to watersheds—decisions about provision of desired resources, goods, and services may be made without actually engaging in the production of those desired resources, goods, and services. Members of a household decide how (and how much) they will obtain of the necessities and conveniences of life—housing, food, schooling, entertainment—but they do not necessarily produce their own housing, their own food, their own schooling, or all of their own entertainment. Similarly, a community of individuals may organize a town, a water district, or a Web page and decide what services they want to receive, what forms and amounts of revenue they will contribute, what content they want to disseminate, and so forth. These are provision decisions. They do not imply that the individuals in the community will actually police the streets, construct wells or pipes, or make the home page; they may choose to procure any or all of those services from other individuals or organizations that produce them.

In a watershed, the provision-production distinction can help to explain some of the number and variety of organizations that exist when water users create those organizations themselves. As in the watersheds described here, there may be a few organizations that produce water from large-scale projects but a large number of smaller organizations that decide how much they want to receive and pay for relative to other water sources to which they may have access. A group of pumpers who share the same groundwater basin may decide to establish a replenishment program, but they may choose to contract with an agency that operates flood control facilities to use those facilities for water conservation rather than construct and operate their own. Many of the organizations described in the cases here were primarily *providers,* representing or organizing smaller communities of individuals and then entering into contractual or other arrangements with *producers* of water supplies, flood control, contamination remediation, etc. Classifying the organizations within a watershed into provider and producer categories[14] can help to begin sorting out the arrangements among them and making a different kind of sense out of what may appear at first blush to be mere fragmentation.

The distinction between provision and production brings into view the concept of functional specialization. There may be, and often are, advantages in organizing activities by taking advantage of specialization. Operating physical facilities such as dams is a task that could be undertaken by the same agency that also contracts for

[14] Such an effort appears in the appendix, using the first case in this paper—the San Gabriel River watershed.

water supplies, monitors water quality, and sets groundwater production targets for every basin within a watershed, but it certainly does not have to be. There may even be good reasons for having a separate organization perform that task—or for that matter, a separate organization performing each of the tasks in that short list. In the watersheds described in this paper, water users appear to have made deliberate choices in both directions—sometimes adding a new function to the portfolio of an existing organization (e.g., having the county flood control district operate the sea-water barrier in the San Gabriel watershed), other times creating a new organization (e.g., a joint-powers agency to organize and finance contamination remediation efforts in the Main San Gabriel Basin).

The choice about whether to add another organization or increase the responsibilities of an existing one will depend upon matters such as the skills required for the function, the resources available within existing organizations, the costs of coordination if a new organization is created, and the political issues of governance and control. There is not a single answer that fits all situations. When watershed management occurs from the ground up, it is to be expected that water users will create some single-function entities and other multiple-function ones based on considerations such as these. Their choices do not necessarily reflect hapless fragmentation or rampant duplication; indeed, when organizations truly specialize, they are not duplicates.

The other concept that follows closely with those of specialization and the distinction between provision and production is that of scale. Some activities are less costly and more efficient if organized on a large scale. Others exhibit diseconomies of scale, becoming inefficient or cumbersome when too many people or too diverse a set of interests is involved.

It might well represent wasteful duplication if each municipality in a watershed such as those in southern California had built its own aqueduct to the Colorado River or to northern California, because such a facility exhibits significant economies of scale. Instead, municipalities in southern California chose to either join the regional Metropolitan Water District, or to contract with the state for access to its State Water Project. These arrangements allowed local communities to take advantage of scale economies. At the other extreme, having a watershed-scale organization financing and/or operating the coastal barrier projects that halted the sea-water intrusion in the San Gabriel or Santa Ana watersheds would not necessarily have made sense, either. It would have involved individuals or communities as much as 100 miles away in decisions about which they knew very little and that did not affect them as it did the coastal communities and their residents.

In addition to building an explanation of the governance and management arrangements seen in these four watersheds, these observations raise some appropriate caution about the view in the watershed movement literature that the watershed or some other hydrologic phenomenon is always the right scale of organization for policy making. Helen Ingram and colleagues made this point 15 years ago (Ingram et al., 1984: 326):

> The appropriate geographical and other boundaries within which to identify interests in institutional assessments should be drawn from an understanding of the stakes rather than river basin boundaries, subject matter, or other artificially imposed limits....
>
> It is important to look at consequences from a particularized or localized perspective as well as basinwide. Despite the fact that physical

> scientists describe river basins as general, interconnected systems, the experience of impacts is often discrete and localized.

In keeping with this logic, we may say that provision decisions may be appropriately organized on a smaller scale than production decisions. The subwatershed organizations observed in our four cases are generally organizations of a group of water users with something in common (the same basin, the same part of the watershed, etc.). Most of the interorganizational and intergovernmental relationships for water resource management in these watersheds involve smaller, service provision organizations contracting or otherwise arranging with larger, service production organizations for the performance of desired functions.

In the smaller provider organizations, water users or their representatives consider information about water supply conditions and decide how much project water to provide themselves with, how much to divert from a stream or pump from underground, how much water to purchase for replenishment or augmentation, how much to pay, and how to raise the money. In some cases, there are multiple producers, and the provider organizations act as "buyers' cooperatives" on behalf of water users, securing the combination of water supplies that nets the best "deal" for them.

Again, though, we are brought back to the questions at the outset of this section. With all these organizations—provider organizations and producer organizations, specialized by function, and created with some effort to capture scale economies and avoid diseconomies—aren't the coordination costs immense? Don't they overwhelm whatever advantages of scale and specialization may be gained? Why not just organize a watershed authority encompassing all these activities? They are profound questions; ones that have motivated nearly a century of debate in public administration, public policy, and political science.

A political science explanation would acknowledge that interorganizational coordination is costly, but the alternatives are not costless, either. As Ingram et al. (1984:) noted,

> There are a variety of institutional structures through which decisions about water resources allocation and use occur. These structures are likely to have different policy orientations. They are also likely to vary in their accessibility and responsiveness to particular interests, their capacity to generate the appropriate flow of information, and their preference for certain problem solutions (Ingram et al., 1984: 328).

As just one recent example, Milon, Kiker, and Lee (1998) point out that the watershed-scale approach to Everglades restoration produced an unintended bias toward engineering analyses and the construction of physical structures to alleviate problems rather than addressing institutional alternatives based on social science analyses.

Furthermore, organizational integration has its own costs of internal coordination and communication, information distortion, control losses, and the like, described in the political economy literature on bureaucratic pathologies. The costs of integration on the scale of a watershed may be quite substantial, as suggested by Behrman (1993: 11-12):

> There was a study made some years ago.... of the Columbia River basin, which is if anything even more complicated than the South Platte basin. The study looked for any empirical evidence (and there again, the control is very fractured) that a unified control system would produce superior results compared to the existing system, which is very similar to the South

Platte. The conclusion was that there was no evidence that it would be superior. The unified system, by bringing in bureaucratic control, creates unanticipated results that are not all that favorable.

On balance, whether organizational integration or interorganizational coordination is more costly is an empirical inquiry, the answer to which will vary from one situation to another.

Polycentricity, Representation, and Power. At California's Biennial Conference on Ground Water in 1993, keynote speaker John Thorson talked about the many connections among demography, development, water, and community. He suggested that a key to attaining the goal of sustainable water use is "the rebirth and strengthening of communities throughout our region. Legislatures are necessary. Courts have an important role. But the most reliable safeguard of our water is a social judgment, reached by citizens at the local level or in the watershed, that the water should be protected" (Thorson, 1994: 5). No doubt this is true, but for political scientists it brings in train the question of how that social judgment of the citizens at the local or watershed levels should be reached.

A watershed may be a single, interrelated physical system, but it also places people in distinctly different positions. Some will be downstream, others up. Some may overlie a capacious and easily replenished groundwater basin, others will not. Some may reside adjacent to wetlands or riparian habitat that others wish to see preserved. Some may be at risk from contamination while others enjoy relatively pristine water. Within this single physical system is a more complicated social one.

Now overlay upon those differences among people's situations within a watershed the myriad other distinctions that come from the broader social, economic, and cultural setting within which the watershed is found. Distinctions of wealth, ethnicity, religion, occupation, social status and the like too will exist among and between watershed residents and the groups or communities with which they identify.

When water users create water resource management institutions from the ground up, they tend to organize at least some of those entities around communities of interest. Their communities of interest may be defined by their physical position in the watershed, by their identity in the larger social system, or (most likely) a mixture of both.

The existence of these kinds of subwatershed organizations, which necessitate greater interorganizational and intergovernmental coordination in order to achieve something that may be called watershed management, may be criticized as manifestations of parochialism or turf protection. That explanation cannot be ruled out, and it undoubtedly accounts for some of what is observed within watersheds (as within metropolitan areas).

Representation of communities of interest establishes a decision making framework within watersheds that requires agreement among organizations representing groups. Thus, watershed decision making is likely to be characterized primarily by bargaining, as each group that is relevant to some project or activity retains some measure of control over whether to cooperate or participate. Such decision making can involve protracted (and frustrating) negotiation. It may (and often does) break down for a time. It can be very difficult to get anything done, and in the meantime resource conditions may be in peril.

This is a legitimate and serious criticism. Why would water users construct watershed governance and management arrangements in this way? Are they irrational, stubborn, really that parochial in their views?

An alternative political science explanation could begin with a recognition that for watershed management to exist, there will have to be some way of aggregating views and reaching decisions. If that is not by bargaining and agreement among subwatershed communities, it will have to be by some other means.

The watershed movement literature often recommends consensus decision making. Two points need to be made here. First, as a practical matter, it is difficult to picture anything that may truly be called consensus decision making working smoothly and swiftly in a watershed of, say, a million or more people, some of whom are upstream and others down, some of whom are wealthy and others poor, some of whom would gladly forsake additional economic development for ecosystem restoration and others who couldn't care less, and so on. Second, to be fair but also candid, that kind of watershed-wide consensus is not really what advocates have in mind. When read and considered carefully, what most proponents of "consensus decision making" at the watershed level appear to be trying to convey is a sort of elite consensus—a consensus reached among representatives acting on behalf of groups identified with certain interests or values thought to be at stake in the watershed. Not only does this approach draw into question the validity of the "consensus," it actually shifts the real politics to another, often unseen level—namely, the level at which some persons or some process identifies who the "stakeholders" are in the watershed and assigns or awards them a place at the table.

Watershed management from the ground up has been occurring in a different fashion. Communities of interest appear to have largely identified, defined, and organized themselves—granted, in a seemingly innumerable diversity of forms, from the most informal sorts of associations to the most formal incorporations of municipalities. Then, as efforts to assemble subwatershed or watershed-wide responses to problems get under way, these previously established communities of interest claim their place at the table. Having already organized, they are often in a position to either withhold their cooperation (the stick) or offer resources along with their cooperation (the carrot) in interorganizational or intergovernmental water resource management arrangements.

But suppose we leave the idea of consensus aside for a moment, while continuing to search for watershed-scale decision making arrangements. What other alternatives might we consider for taking decisions at the watershed scale? Majority rule? A system of votes based on land ownership, water use, or some other criterion that connects individuals to the watershed?

Here is the essential political problem: in any watershed in the real world, each such aggregation rule will open opportunities for some individuals or groups to ignore, exploit, or oppress others. Majoritarian or resource-based aggregation rules institutionalize and reinforce the distinctions in physical position or in social, cultural, or economic position in any watershed.[15] When the watershed is reconceived as a political unit, fundamental

[15] Those who doubt the ability of more powerful and sophisticated users to overlook or even undermine the interests of others when decisions are made at a watershed scale should review the description provided by Jacobs (1978). She recounts the unhappy experience of Latino and Native American communities in a portion of the Rio Grande watershed when regional planning

questions of political theory return to be debated and decided once again in this new setting—what will it be, a Rousseauian community or a Madisonian compound republic?

In the watersheds we have examined, and in most others of which we are aware, the water users are opting for the latter. In a study of intergovernmental arrangements for deciding upon and implementing alternatives for wastewater treatment, OToole (1993) observed that the governance issue of community autonomy was itself one of the values with which participants were concerned, along with the management issues of efficiency and regulatory compliance.

In addition to some sort of identity-based concern for autonomy for its own sake, there may be a pragmatic political calculus at work that recognizes the uncertainty and surprise inherent in resource management (Walters, 1986). In a changeable ecosystem nested within a changeable social, political, and economic setting, where multiple values are mingled with multiple constraints, one can never really be sure whether one's position today will prevail tomorrow: in a physical or cultural or regulatory context, any group can be "downstream" sometime. The Rawlsian bargain under those circumstances may be to be part of a community that has to be recognized and reckoned with, rather than to be just one contributor to the *vox watershed.*

For whatever combination of reasons it is occurring, some of the consequences of watershed management from the ground up are apparent.

- Assembling polycentric water resource management arrangements takes a really long time, and in the meantime, resource conditions usually get worse.
- On the other hand, polycentric approaches encourage innovation, adaptation, and learning.
- There is the "fiefdom" problem, as individuals and organizations entering into interorganizational arrangements protect "turf."
- On the other hand, polycentric approaches allow organizations to cooperate/coordinate on things when it's worthwhile, but do not require everyone to be involved in everything.
- Considerable costs of coordination are required and borne in polycentric systems.
- On the other hand, when coordination occurs, it has considerable legitimacy.
- Dependence upon agreements negotiated among established organizations also provides fewer opportunities for exploitation and oppression, and preserves a measure of autonomy, which appears to be one of the benefits for which people will pay the costs of coordination.

Political science has much more to do and to learn from the real world in order to be helpful in understanding, explaining, and perhaps even providing some advice about watershed management. A better understanding of inter-organizational and intergovernmental arrangements, including especially federalism and systems of separated and shared powers, is still needed. A better understanding of non-governmental governance arrangements is needed, too, since water (and probably other natural) resource arrangements seem often to begin with groups, associations,

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processes were captured by a coalition of local urban and Anglo interests and the U.S. Bureau of Reclamation. The water projects they planned risked wiping out the farmers, even though the planners observed the prescribed processes for public notice, hearings, and opportunities for participation.

cooperatives, and a variety of forums that have no formal governmental recognition or existence but nevertheless provide essential governance functions. The systems devised in the real world for the management of natural resources may have a lot to teach us about the enduring questions of who governs, and how.

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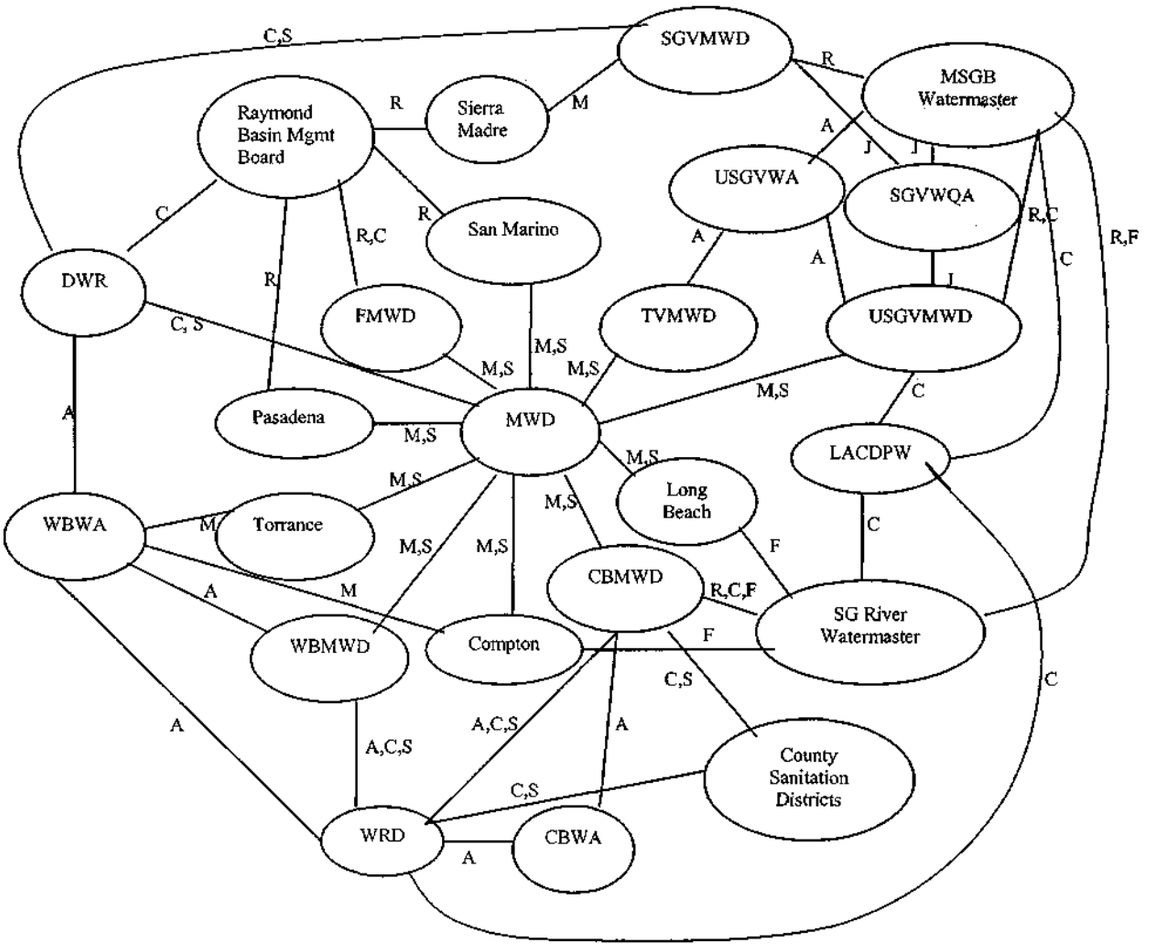
APPENDIX: Diagramming the San Gabriel River Watershed



Relationships

A = Advisory	C = Contract	F = Funding	G = Regulatory
J = Joint-Powers	M = Membership	R = Representation	S = Water Sales
T = Staffing			

Acronyms

CBMWD	Central Basin Municipal Water District
CBWA	Central Basin Water Association
DWR	California Department of Water Resources
FMWD	Foothill Municipal Water District

LACDPW	Los Angeles County Department of Public Works
MSGB	Main San Gabriel Basin
MWD	Metropolitan Water District of Southern California
SGRWM	San Gabriel River Watermaster
SGVMWD	San Gabriel Valley Municipal Water District
SGVWQA	San Gabriel Valley Water Quality Authority
TVMWD	Three Valleys Municipal Water District
USGVMWD	Upper San Gabriel Valley Municipal Water District
USGVWA	Upper San Gabriel Valley Water Association
WBMWD	West Basin Municipal Water District
WBWA	West Basin Water Association
WRD	Water Replenishment District of Southern California

Categories of Organizations Engaged in
San Gabriel River Watershed Management

Service Provider Organizations

Central Basin Municipal Water District
Foothill Municipal Water District
Main San Gabriel Basin Watermaster
Raymond Basin Management Board
San Gabriel River Watermaster
San Gabriel Valley Municipal Water District
Three Valleys Municipal Water District
Upper San Gabriel Valley Municipal Water District
West Basin Municipal Water District
Water Replenishment District of Southern California

Service Producer Organizations

California Department of Water Resources
County Sanitation Districts of Los Angeles County
Los Angeles County Department of Public Works
Metropolitan Water District of Southern California
San Gabriel Valley Water Quality Authority

Representative Associations

Central Basin Water Association
Upper San Gabriel Valley Water Association
West Basin Water Association

Court-Appointed Watermasters

California Department of Water Resources (Central Basin, West Basin)
Main San Gabriel Basin Watermaster (Main San Gabriel Basin)
Raymond Basin Management Board (Raymond Basin)
San Gabriel River Watermaster (San Gabriel River)

MWD Member Agencies

Central Basin Municipal Water District
Compton, City of
Foothill Municipal Water District
Long Beach, City of
Los Angeles, City of
Pasadena, City of
San Marino, City of
Three Valleys Municipal Water District
Torrance, City of
Upper San Gabriel Valley Municipal Water District
West Basin Municipal Water District

State Water Project Contractors

Metropolitan Water District of Southern California
San Gabriel Valley Municipal Water District

Cyclic Storage Contractors in Main San Gabriel Basin

Metropolitan Water District/Upper San Gabriel Valley Municipal Water District
San Gabriel Valley Municipal Water District