1997

Restoring the Waters

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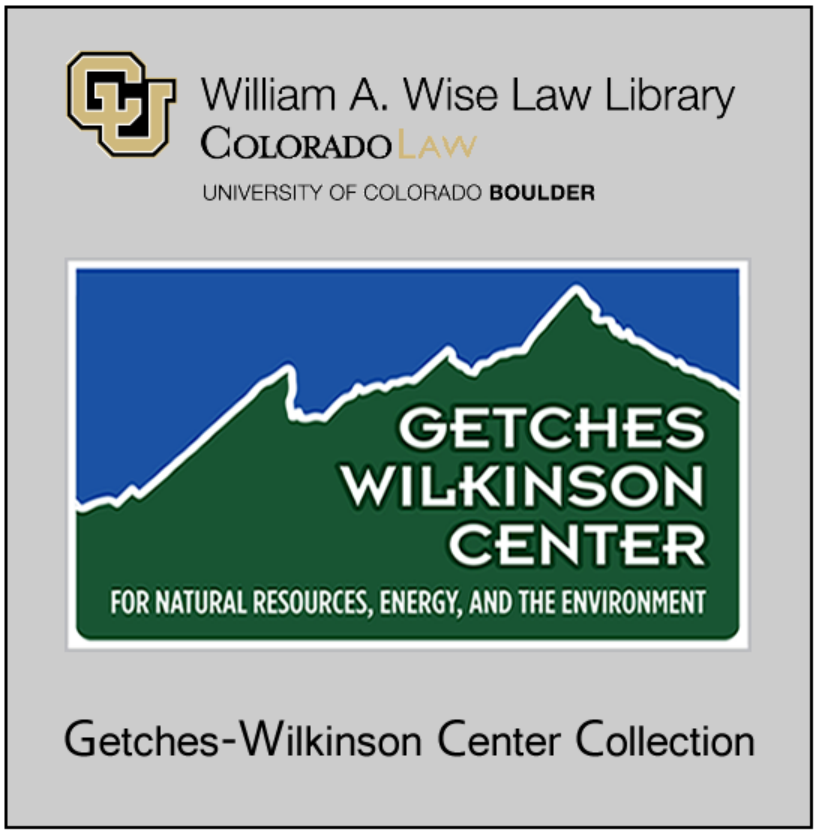

Restoring the Waters

Natural Resources Law Center
University of Colorado School of Law

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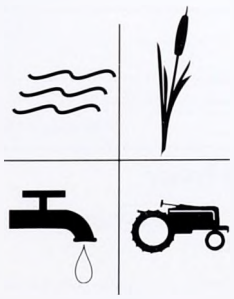

University of Colorado School of Law
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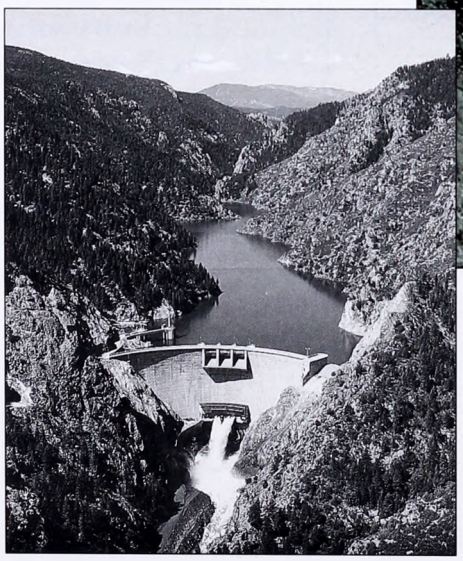
INTRODUCTION

Water development has fueled economic development of the West over the last century. Hundreds of large dams and thousands of miles of aqueducts and canals divert water from the West's rivers to sustain urban and agricultural economies. The large-scale development of water in California alone is the foundation for a $1 trillion overall economy and a farm economy with some $18 billion in annual sales.

Fish and wildlife, themselves dependent upon water, have paid a heavy price for this development. Water that flowed through rivers and wetlands and eventually out to sea has now been diverted. Land has been converted from wetlands into farmlands. Rivers have been converted into canals.

During the 1970s and 1980s, society at large began to put a much higher priority upon protecting remaining environmental resources and upon restoring those that had been damaged in the past by water development. For this reason, the large-scale development of new water supplies through traditional means (dams and diversions) has virtually ceased. In some cases, water that was once diverted has been put back into the rivers.

At the same time, the population and economies of the West have continued to grow. Ways must be found to provide the water needed for agriculture and the cities while protecting and restoring the environment. If not, the West's economic growth and environmental protection priorities will collide — most likely to the detriment of both.



What Do We Call "Success"?

The following stories illustrate just a few of the recent changes that have occurred in water use and management in the West. The stories also identify some of the public and private groups working to conserve, protect and restore water resources and some of the techniques they use to help restore life-giving waters to the environment.

Stories included here as "successes" are undoubtedly seen by some as failures, either because they adversely affect the interests of certain land and water users or because the strategies did not go far enough toward conservation, protection and restoration.

No single strategy illustrated in this document is adequate to assure that the West meets the water needs of both people and the environment. Each technique or strategy must be seen as a complement — rather than an alternative — to others. "Successful" strategies come in many forms and degrees:

- Some strategies — like water rights transfers (see WATER RIGHT TRANSFERS FOR INSTREAM FLOWS), and land and water purchases (see *Ash Meadows, Nevada*) — can assure that water will be left in a stream or wetland.
- Others strategies — like urban and agricultural water conservation and the development of water markets — may be simply the first important step in finding more water for maintaining our natural systems (see URBAN WATER CONSERVATION and AGRICULTURAL WATER CONSERVATION and *Westlands Water District, California*). Neither water conservation nor water trading necessarily yields water for the environment. But both, at a minimum, can lead to better use of water already allocated to out-of-stream uses. With conservation, new demands on water for these uses can be minimized while still maintaining a vigorous western economy.
- "Successes" may be short-term or only partial victories in the struggle to protect the environment. A negotiated one-year lease of agricultural water rights for instream flow maintenance may be only a temporary success from the perspective of the fish habitat that it sustains. But that lease agreement is also one step in establishing a relationship of trust between the environmental community and agricultural interests that control enormous quantities of water in the West (see *Oregon Water Trust, Trust Water Rights Program, Washington* and *Lahontan Valley Wetlands, Nevada*).

- Many of the stories demonstrate that no one group or government agency can achieve a "success" in isolation (see PROTECTING AND RESTORING THE WATERS). The cooperation of multiple parties is required to progress from the first stages of building trust and identifying solutions to the final stages of implementation and monitoring.
- Establishment of a watershed council does not guarantee sufficient water for agriculture, endangered species or recreation, but it can provide the crucial forum for breaking a stalemate or avoiding litigation over water management issues (see *Henry's Fork Watershed Council, Idaho and Wyoming*).
- Congressional action (see *Central Valley Project, California* and *Umatilla River Basin Project, Oregon*), negotiated settlements (see *Colorado River: Grand Canyon, Arizona* and *Bay-Delta Accord, California*), and use of both judicial and administrative forums (see *Mono Lake, California* and *Washington State Protection of Instream Flows*) can also be important steps toward returning water to western rivers. After a decision is reached in Congress, the conference room or court, however, actually seeing water in the streams often requires additional efforts of those committed to protection and restoration of the West's waters (see *Lahontan Valley Wetlands, Nevada*).

WATER RIGHTS TRANSFERS FOR INSTREAM FLOWS

Transferring water from an existing use to a new use can extend the utility of water. Since nearly 80% of existing water withdrawals in the West are for agriculture, most of the transfers are likely to be from agriculture to other uses. While municipal users are potential recipients of water transfers in many areas, instream uses — fisheries, recreation and aesthetic uses — are requesting, and in some cases receiving, an increasing share of western water.

Statutory Authority and Administrative Hurdles

- For a successful water right transfer for instream flows, the applicable state law must allow transfers of the type proposed. In nearly all of the western states, transfers are allowed, in theory at least, to any new beneficial use. But most of the western states treat instream flows differently from other kinds of water uses, and several either do not recognize water rights for instream purposes at all, or put severe restrictions on the transfer of water from offstream use to instream use.
- The particular transfer must also meet all applicable administrative requirements. No state leaves transfers entirely to the market. Instead, the state agency responsible for water rights administration must approve any change of place or type of use. Though private parties are free to make a deal to effect a transfer, the transfer will be contingent upon receiving administrative approval for the desired change. Since most western states use a "no injury" test to protect other water rights holders from a water rights transfer, the transfer will not be approved unless the agency is satisfied that no other rights, even those junior to the right seeking to be transferred, will be hurt by the transfer.

The Value of Water

For market transfers to occur, the value of water for the new use must exceed the value of water in its existing use and also cover the often substantial costs associated with transferring the right. In other words, the new user must be able and willing to pay an amount for the transfer that will convince the existing user to give up the water.

Thus, water transfers are not always possible or appropriate — they are dependent on variations in state law, an ability to avoid injury to other users and the relative value of water for different uses. Where these factors can be reconciled, transfers can, on a case-by-case basis, provide effective and voluntary water reallocation. The following Oregon, Washington and Colorado stories illustrate the use of voluntary water transfers to effect mutually beneficial reallocation of relatively small amounts of water from consumptive uses to instream uses, thereby augmenting existing water flows. The *Lahontan Valley Wetlands, Nevada,* story chronicles the acquisition of large amounts of agricultural water from the first large federal irrigation project for restoration of wetlands.

Most transfers are likely to be from agriculture to other uses.

Oregon Water Trust

After three years of operation, the Trust had 25 water rights transactions in various stages of completion.

The Oregon Water Trust is a non-profit corporation founded in 1993 to acquire consumptive water rights from existing users and convert them to instream flows. The Trust was modeled after The Nature Conservancy and The Trust for Public Lands to use voluntary market transactions to protect water flows.

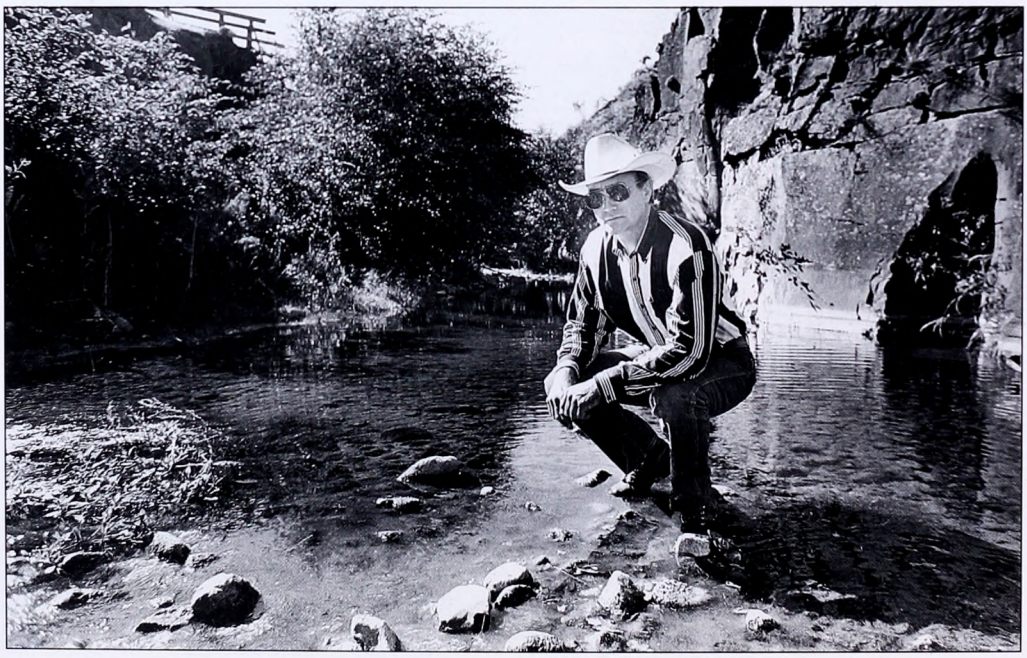
The Trust is currently funded primarily by private foundation grants and "mitigation payments" — monies obtained through other groups as a result of legal challenges to water withdrawals. Total current funding amounts to approximately $200,000 for annual operations and slightly over $300,000 for water rights acquisitions.

In January 1997, after three years of operation, the Trust had 25 water rights transactions in various stages of completion. Two are permanent purchases or donations; the remainder are leases ranging from one-year to ten-year terms. A total of approximately 20 cubic feet per second (cfs) of water has been converted from irrigation use to instream flows, at least on a temporary basis. Two representative acquisitions illustrate how the Trust operates.

Buck Hollow Lease

The Trust's first acquisition was negotiated as a one-year lease during the 1994 irrigation season; the lease has since been renewed annually. Buck Hollow Creek is a tributary of the Deschutes River, an internationally known salmon and steelhead stream, which in turn is a tributary of the Columbia River. Rancher Rocky Webb holds the only water right to irrigate from Buck Hollow Creek. For years, his family had irrigated pasture from the creek, which provides critical summer steelhead habitat. Webb's irrigation nearly dewatered the creek during the late summer, and over the years he had watched the number of fish decline.

Webb and the Trust created a lease agreement whereby all of the water is left in the creek and the Trust buys Webb replacement hay to feed his cattle. Prior to the agreement, at low water, the creek was supporting only about 30 pairs of fish. Converting the agricultural use to an instream use has the potential to create habitat for as many as 500 pairs.



Although the volume of water in this transaction is even less than in the Buck Hollow Creek lease and the right is one of several on the creek, the water right has an early priority date of 1857. It may represent the difference between flow and no flow for several miles of the creek during dry months of the year.

Small amounts of water can mean the difference between a dry creek bed and a stream that can support a fish population.

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The Trust has paid $6,600 annually, or about $34 per acre-foot, to lease approximately one cfs of water from Webb. This price reflects the purchase price for 68 tons of hay, equivalent to what Webb normally cut from his irrigated pasture, minus the costs Webb avoided by not irrigating. Although the volume of water covered by this lease is small, it represents the critical difference between a dry creek and a flowing creek. Meanwhile, the rancher is able to continue his cattle raising operation.

Sucker Creek

The Trust made its first permanent acquisition on Sucker Creek, a tributary of the Illinois River in the Rogue River Basin on the southern Oregon coast. Sucker Creek provides important habitat for coho and chinook salmon, as well as steelhead. A riparian property owner sold his water right of 0.16 cfs to the Trust for $8,800.

Trust Water Rights Program, Washington

In 1991, the Washington Legislature authorized a trust water rights program to be managed by the Washington Department of Ecology:

- The state may acquire all or portions of existing water rights from any person or entity, on a voluntary basis, to provide water for presently unmet needs and emerging needs.
- Trust water rights may not be acquired by condemnation and may not cause the involuntary impairment of any existing water rights.
- The state may acquire trust water rights by purchase or gift, or by providing assistance in financing water conservation projects.

Like many western states, Washington is experimenting with ways to improve instream conditions for fisheries. In areas where streams are overappropriated by existing consumptive use rights for irrigated agriculture, one prospect for improvement lies with transferring some of the senior agricultural water rights to instream uses. In Washington these instream rights are called "trust water rights."

Despite passage of the Trust Water Rights statute in 1991 and a 1989 statute establishing a Yakima River basin trust water rights program, the first trust water right was just nearing approval in May 1997. For this first trust water right, the Liberty Bell Corporation has donated saved water to be held by the State of Washington and dedicated to instream flow enhancement in Little Boulder Creek and the Methow River. In these transactions, no money changed hands to effect the acquisition of water for instream purposes. Instead, the reallocation of water to protect instream flows was accomplished as a settlement of a challenge to the state's decision to approve a water right permit application.

Little Boulder Creek Flows

Liberty Bell's 1894 irrigation water right, dating from well before the Washington Water Code was enacted in 1917, was used to irrigate 45 acres of hay pasture. Water was brought to the property through an unlined, gravity-flow diversion ditch and then used to flood irrigate pasture. The Liberty Bell property has been undergoing a transformation over the past 20 years from farm property to a residential development. In 1987, Liberty Bell applied to the Department of Ecology for authorization to withdraw water from two wells on its property to supply winter domestic water (December 1 through March 31) for 63 homes. Although the state granted a permit authorizing the Liberty Bell domestic water withdrawal, the Yakama Indian Nation appealed the decision. The state, the Yakamas and Liberty Bell then began a negotiation process to settle the dispute.

The settlement provides that the state grant Liberty Bell a permit to withdraw winter domestic water from its wells. In return, Liberty Bell agreed to completely eliminate its mile-long diversion ditch and obtain both its irrigation water and its domestic water from the wells. Liberty Bell will also take 29 of its 45 acres out of irrigation and fallow them permanently. The remaining 16 irrigated acres will be converted to an efficient modern sprinkler system. Water savings will accrue from both the permanent fallowing and the improved efficiency on the remaining acreage. Liberty Bell will sign over the saved water to the state for instream flows. The Department of Ecology will issue a certificate of trust water right in the name of the State of Washington to protect the saved water as instream flow. The right will have the same priority date as the original 1894 irrigation water right, the oldest diversionary right from Little Boulder Creek, and its May 15th through October 19th season of use.

The Liberty Bell trust water right will protect 0.58 cubic foot per second (cfs), for a total of 181.8 acre-feet per year (af/yr) of water flow in Little Boulder Creek from the location of the historic Liberty Bell diversion ditch downstream to the confluence of the creek with the Methow River, a distance of about three quarters of a mile. This quantity represents all of the water savings associated with:

- Eliminating the evapotranspiration of the pasture crop on the 29 fallowed acres;
- Eliminating the water loss associated with the inefficient flood irrigation practices historically used on those 29 acres;

- Converting from an inefficient flood irrigation system to a more efficient sprinkler irrigation system on the 16 acres that will continue to be irrigated; and
- Eliminating the conveyance loss associated with the leaky diversion ditch.

This flow will prevent the creek from being substantially dewatered in the late summer and early fall.

Methow River Flows

The trust water right will also protect 0.18 cfs or 47.85 af/yr of water flow in the Methow River from the mouth of Little Boulder Creek to the confluence of the Methow River with the Columbia River, many miles downstream. Conveyance-loss water from the original diversion ditch and excess water applied to the irrigated pasture lands by flood irrigation practices were historically returned to the Methow River immediately below the mouth of Little Boulder Creek. Since these return flows naturally rejoined the Methow River, the only actual gain in flow to the Methow River below this point is the gain created by terminating irrigation on the 29 acres — water historically lost through evapotranspiration by the crop. Therefore, while the Liberty Bell trust water right in the Methow River downstream to its confluence with the Columbia River also retains the 1894 priority date, it was limited to 0.18 cfs.

The Liberty Bell trust water right provides an incremental, though small, increase in the amount of flow protected in the Methow River as base flow or instream flow. The Methow River is a beautiful river with substantial public fishery and recreational values. The river has minimum flows established by state administrative rules. But those Methow River minimum flows have a 1976 priority.

Water rights senior to 1976 are not subject to curtailment or regulation to maintain those minimum flows. Thus, the 1894 trust water right has the effect of substantially improving the priority of a portion of the river's instream flows.

As in the Oregon Water Trust examples, the Liberty Bell transfer may mean the difference between a dry creek and a flowing creek in the late irrigation season.

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Boulder Creek, Colorado

Boulder's planning process accounted for tributary and mainstream water and dealt with land planning issues so the city could predict its water needs at the time of complete build-out. Boulder may be unique in that, by 1988, the city had acquired sufficient rights to supply all anticipated development, even in the case of drought.

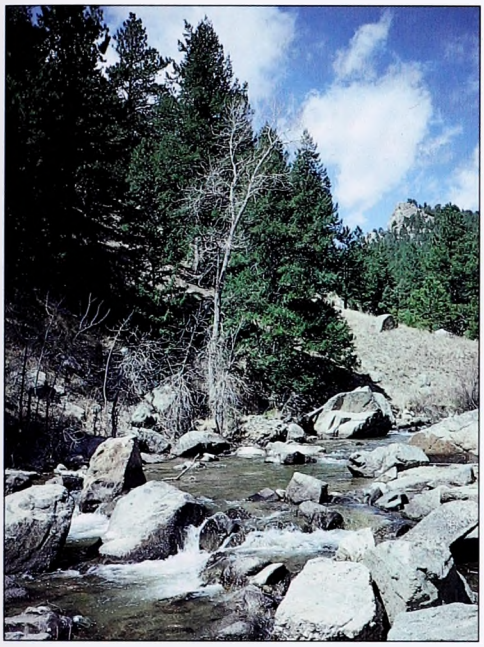
Boulder Creek, Colorado, provides another example of the use of water rights transfers to maintain instream flows for fisheries and, as a collateral benefit, for urban aesthetics.

Boulder Creek arises as North, Middle and South Boulder Creeks in the mountains west of the City of Boulder. The city-owned Arapahoe Glacier and the Silver Lake watershed, which feed the Boulder creeks, supply about 40% of the water used by the city's 125,000 water customers via diversion points on North Boulder Creek. Another 40% of the city's water supply is diverted from Middle Boulder Creek at Barker Reservoir. South Boulder Creek runs a gauntlet of headgates east of the city to provide water for the cities of Denver, Louisville and Lafayette and for numerous irrigation ditches. Historically, diversions on all three branches have dried up the creeks at various locations during periods of low flow — mostly in late summer and winter.

Protecting Instream Flows

In 1987, the City of Boulder began in earnest to consider ways to maintain streamflow in the creeks to preserve fish habitat and enhance the aesthetics of the stream corridor. Since 1973, the Colorado Water Conservation Board (CWCB), the only agency under Colorado law allowed to hold water rights for instream purposes, had held a 15 cubic feet per second (cfs) right for instream flow for the portion of Boulder Creek flowing through the city (from Orodell gauging station to 75th Street). While this junior right prevented conditions on the stream from worsening, it could not secure flows during dry periods because calls of senior rights — held by both agricultural interests and the City of Boulder — could dry up the stream during low flow periods.

In 1988, the city completed a planning process resulting in the Raw Water Master Plan, which called for a goal of maintaining a 5 cfs minimum flow in main Boulder Creek during droughts and the winter low flow season, as well as 15 cfs during normal or above-normal flow periods. The plan also established a goal of achieving instream flows in the tributaries of Boulder Creek outside of the city.



To meet its master plan goal, Boulder and the CWCB negotiated a contract, signed in 1990 and amended twice since then. The contract deeds ownership of a portion of Boulder's senior water rights to the CWCB. Most of these rights derived from shares in agricultural ditch companies, dating from 1859, 1860 and 1862. The contract also deeds use of certain other water rights whose ownership the city retained. The contract provides that the CWCB must use the water for instream flow purposes and it makes the City of Boulder CWCB's agent for administering the rights. Consequently, the city monitors the stream and ditches to assure that sufficient water remains in the stream.

After contracting for the transfer of water rights, Boulder and CWCB filed a joint petition for a decree from the Colorado water court to use the water rights and storage releases for instream flow. The filing was contested by eight stream users, but the City of Boulder and CWCB received approval of the change of use and a joint decree for instream and municipal use after settling with seven of the eight objectors, and prevailing at a trial over the eighth objector.

Flexibility Yields Results

Instream flow use of the transferred Boulder water rights is not exclusive; the city may use the water right when it is not needed for providing the minimum instream flows. Further, in time of a drought or emergency, the City of Boulder is allowed to call the water for municipal purposes, after first tapping all their other available sources. Neither "drought" nor "facility emergency" is defined in the CWCB contract, but based on the availability of other water, a call on the water due to drought is likely to occur only once every 70 years. It is more likely that a failure of the city's raw water piping system would create an emergency that could permit a call on the transferred rights to dry up an otherwise protected portion of Boulder Creek.

While the drought/emergency provision limits the protection of instream resources, it provides a safety net for the city's domestic users that was instrumental in getting the City of Boulder to donate the rights for instream protection.

How much water is enough?

- The Colorado Division of Wildlife studied the stream reaches of Boulder Creek and its tributaries and designated separate summer and winter minimum flows ranging from 1.5 cfs at the headwaters to 15 cfs through the city.
- The Boulder Creek project recognized that use of water rights to maintain instream flows is a use of water comparable to any other use. The minimum flows provided were not intended to return the stream to any pre-development, "natural" condition. Rather, they were calculated by the fisheries experts to meet a specific goal — maintenance of minimum summer and winter flows necessary for healthy fish habitat.

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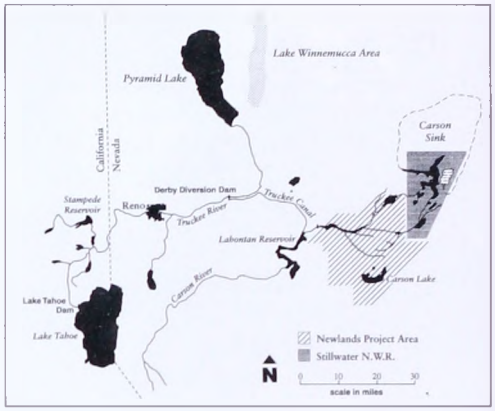
Lahontan Valley Wetlands, Nevada

Settlement Act Water Right Transfer Conditions:

- Water rights can be purchased only from willing sellers.
- Water rights, lands and related interests may be acquired by purchase or other means.
- Purchases may be targeted to areas deemed most beneficial to the overall program.
- Water rights must be transferred consistent with state law, applicable decrees and regulations.
- Concurrent environmental and socio-economic reviews must be performed.

The Truckee and Carson Rivers flow east from California's Sierra Nevada mountains into historically expansive closed-basin lakes and marshes at the western edge of the Great Basin desert in Nevada. At the end of the Truckee River lies Pyramid Lake, home of the endangered cui-ui, the threatened Lahontan cutthroat trout, and, at the Anaho Island National Wildlife Refuge, what was once the largest white pelican rookery in North America. The Carson River ends up in the Carson Sink, supporting at its delta the Stillwater National Wildlife Refuge, the Carson Lake Wildlife Management Area and other Lahontan Valley wetlands. The wetland ecosystem, an island stepping-stone on the Pacific Flyway, is among the most important of the western Great Basin.

Although naturally distinct, the two rivers have been linked since 1905 by the Truckee Canal, which carries significant portions of the Truckee's flow to Lahontan Reservoir near the end of the Carson River. There diversions supplement Carson River supplies for the federal Newlands Project, the first large-scale irrigation project initiated following enactment of the federal Reclamation Act in 1902.



As the single largest diverter of water from both river systems, the Newlands Project has caused or exacerbated a host of environmental problems at both Pyramid Lake and the Lahontan Valley wetlands. These include:

- Dramatic reductions in flow and substantial modification of the natural hydrologic regime;
- Significant declines in Pyramid Lake volume and elevation with resulting delta formation that inhibits cui-ui migration;
- Extirpation of the native strain of Lahontan cutthroat trout;
- Destruction of the Winnemucca Lake and Fallon National Wildlife Refuges;
- Severe water quality deterioration from depleted flows and agricultural drainage; and
- Extreme loss of shaded riparian, instream, wetland and other Great Basin aquatic habitats.

Ironically, the plight of Pyramid Lake and the Lahontan Valley wetlands was long seen to be rooted in an inherent conflict between the environmental health of the Carson and the Truckee rivers. Finding more water for one was assumed to result in less water for the other. But the origins

of any such conflict can be traced to the advent of the Newlands Project itself. Here, as elsewhere in the arid West, too much water was promised to too many people for pennies on the taxpayers' dollar, with little if any regard for the needs of, or impacts upon, public environmental resources.

Forging a Settlement

Tired of being asked to choose between the two rivers and fearful of the ultimate demise of both resources, a handful of local, state and national conservation organizations joined together in 1987 to form the Reno-based Lahontan Valley Wetlands Coalition. Their principal purpose was promoting the acquisition of water from willing landowners to protect the Lahontan Valley wetlands without further impact to Pyramid Lake.

Three years later, in June of 1990, a large and diverse crowd gathered to celebrate the first deliveries of water purchased for the drought-parched Stillwater marsh. Later that year the Fallon Paiute-Shoshone and Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Settlement Act) became law. Title II of the Settlement Act provides direction and authority for a long-term program to acquire rights sufficient to protect and restore approximately 25,000 acres of wetlands at Stillwater and Carson Lake, including wetlands within the Fallon Indian Reservation.

An Environmental Assessment completed by the U.S. Fish and Wildlife Service evaluated the impacts of state and federal purchases of up to 20,000 acre-feet of water. This document helped to ensure that, consistent with the Settlement Act, concurrent progress would be made on interim acquisitions while a more comprehensive evaluation of the socio-economic and environmental effects of a long-term acquisition program was completed. By December 1996, 19,700 acre-feet of water rights had been purchased for the wetlands.

As part of these early water rights purchases, the agencies and stakeholders negotiated several interim agreements that helped to inform development of a long-term water acquisition strategy. The Record of Decision on the Final

20,000 acre-feet of water constitutes about 10% of the Newlands Project total annual headgate water deliveries.

The key to success of the interim acquisition program was the fact that, by decree, Project landowners are understood to own clear title to the property interest in Newlands Project water.

Key agreements under the Interim Acquisition Program

- Eligibility for transfer of water rights offered for sale
- Overall transfer rate (acre-feet/acre/year) per acre of water right purchased
- Payment of associated operation and maintenance charges

Environmental Impact Statement (ROD) for the long-term program, issued in 1996, called for purchase of up to 75,000 acre-feet of Newlands Project water rights.

The ROD further identified a host of supplemental acquisition options that would also be pursued to minimize the potential for adverse effects. ROD acquisition options include:

- Purchase of water rights from landowners along the middle and upper Carson River;
- Conservation efforts at the Fallon Naval Air Station;
- Ground water pumped near the primary wetland areas;
- Conservation agreements on privately owned wetlands;
- Shared use of acquired rights; and
- Use of good quality irrigation return flows and drainage, treated sewage effluent and spills.

An Unfinished Story

It remains to be seen whether the long-term acquisition strategy will fully meet the Settlement Act's wetland restoration objectives. For example, while water leasing may be a viable supplementary option (see *Oregon Water Trust*), it will not be a reliable option without a dedicated, sustained and sufficient source of funds. In fact, most of the listed options (and many others) were the subject of intense discussion or part of a 1994–95 round of basin-wide settlement negotiations. But the use of these options continues to face a variety of implementation hurdles as well as larger basin-wide uncertainties, due to the largely unsuccessful conclusion of those efforts. Because of these uncertainties, the program includes an elaborate system for monitoring, measuring and reporting, as well as a feedback mechanism for long-term adjustments.

Though not without controversy, the water rights acquisition program is nonetheless a noteworthy success: it has breathed new life into what was a neglected and dying marsh. It has done so through an agency-stakeholder partnership that relies on the voluntary participation of willing sellers, which accomplishes its objectives without impact to other environments and which advances in numerous ways the difficult task of developing and implementing creative, contemporary solutions to the arid West's most complex environmental problems.

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CONCLUSION: Challenges For Water Rights Transfers

Authority to Hold Instream Flow Rights

State laws differ on who may acquire and hold instream flow rights. For example, the Oregon Water Trust was established because the Oregon law appears to be favorable to instream rights, since it explicitly allows for their creation and makes them equivalent to other water rights. But Oregon law is unclear on whether a private party such as the Trust may be the holder of an instream water right.

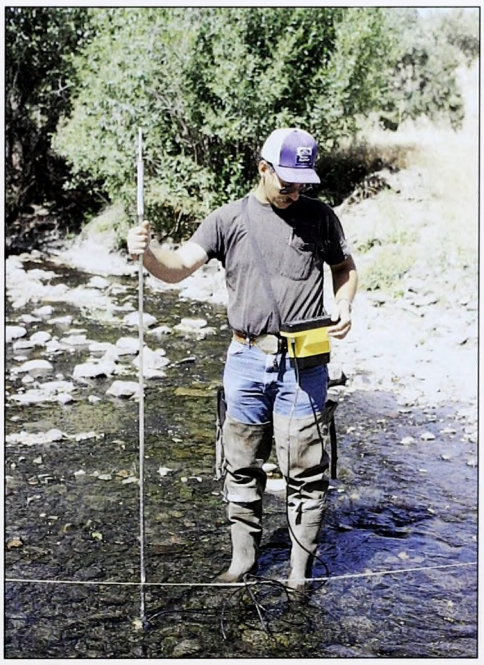
Oregon law defines an instream water right to be a right held by the State Water Resources Department in trust for the people of the state. The only entities that may apply for new instream rights are three state agencies: the Departments of Fish and Wildlife, Parks and Recreation, and Environmental Quality. The statute specifies that if a right is granted upon an agency's request, the water rights certificate is issued in the name of the Water Resources Department. Another provision of the instream rights statute (which the Trust relied on in its establishment) provides that any person may purchase, lease or accept a gift of an existing water right for conversion to an instream water right. This portion of the statute states that the Water Resources Department will issue a new certificate for the instream water right, but it does not say whether the certificate will be in the name of the state or the private party.

The Trust, relying on the "purchase, lease or gift" statute, has taken the position that it may legally hold an instream water right in its own name. However, the Water Resources Department, relying on the definition language and the explicit statement that the department will hold any rights requested by other state agencies, disagrees. Whether the Trust's position will eventually be adopted remains to be seen. If it is not, only time will tell if the Trust can create a long-term successful program as a broker for acquiring instream water rights to be held by the state. In the meantime, the Water Resources Department is exploring creative ways for instream water rights to be managed by parties other than the state even without explicit private "holdership."

Calculating the Value of Water Rights

There are as yet no extensive, established markets for leasing or buying water rights for conversion to instream rights. Entities must, therefore, calculate the value of the water in a particular consumptive or instream use to set their own prices for these transactions.

Oregon Water Trust: In Oregon, the Trust is on the cutting edge of setting prices for instream flow transactions, along with



Does it matter who holds the water right?

State law may preclude all but a specified state agency from holding an instream flow right, but there are several reasons that entities such as the Trust might be allowed to hold such rights:

- A private entity may be more effective at monitoring and enforcing rights. State agencies may be hampered by lack of resources (both money and personnel) and by political pressures to favor consumptive uses.
- The state agency may find itself with a conflict of interest. The state must be the neutral administrator — allocating and policing consumptive water rights and balancing interest group and public involvement — as well as a water right holder, advocating protection of its own right in potential competition with the other right holders.
- A private entity may be able to operate in the market more effectively, to obtain funds for water rights acquisition and to negotiate deals with water rights holders.
- To preclude a private entity from holding instream water rights relegates these rights to second-class status. The prior appropriation system creates strong private property rights in water rights holders. To deny similar status to instream rights makes them different from all other appropriative rights — unstable and vulnerable to attack as local politics change.

By their nature, instream benefits may be slow to develop and hard to measure.

some federal agencies and other environmental groups trying to acquire water for instream flows. Sometimes it is difficult to arrive at a price that properly aligns the value to the seller or lessor and the value to the Trust. In the Buck Hollow lease transaction (see *Oregon Water Trust*), it was relatively easy for the rancher to value his water right. He used the water on a particular pasture to irrigate hay to feed his cattle. He knew the pasture normally produced 68 tons of hay and, at the going rate, that amounted to $6,600 worth of hay. That became his asking price. It was more difficult for the Trust to be sure that it was going to achieve $6,600 worth of fisheries benefit in one season of leaving the water in the creek. By nature, instream benefits may be slow to develop and hard to measure. To some extent, then, the Trust is operating on faith that over time its investments will pay off.

Boulder Creek: When a water right is donated, the donor may have to justify the cost of the instream flow right to its constituents. In the City of Boulder's transaction, the city estimates the value of the transferred rights at $12 million, calculated as the yield of the water right times the tap fee for that amount of water. In addition, the water right donation costs the city about $150 per acre foot per year in additional operation and maintenance (O&M) costs since the city treats poorer quality water from other sources to replace the water left in Boulder Creek. This extra O&M cost adds from $87,500 to $265,000 per year to the cost of Boulder water, depending on how much water must be left in the creek to meet the minimum flow requirements.

The entire value of instream flow water may not, however, be lost to a city. Boulder Creek's instream flow right is dedicated only to a point east of the city where the sewage treatment plant discharges. Beyond this point, there is no scarcity of stream flow, and the water left in the stream that formerly was consumptively used is considered "new" to the stream at this point. Boulder retains ownership of this water downstream of the treatment plant and can, therefore, lease, store or exchange it out at other locations.

Justifying Instream Flows

Water In-place as a "Beneficial Use"

While the entities involved in the transaction must be satisfied with the negotiated price, most states must also be persuaded that the instream flow has been put to a "beneficial use" to protect the rights from challenge by other water rights holders. A monitoring and enforcement plan is needed for each acquisition to assure that the dedicated water actually remains in the stream. The proponents of minimum instream flows must also be able to determine, by a method acceptable to the state, whether actual instream public benefits, such as improved fisheries habitat, are being achieved. Unfortunately, fisheries and hydrologic experts do not always agree on appropriate methods for demonstrating the links between water flows and fish populations.

Public Acceptance of Transfers

Attempts to transfer water rights to instream flow may also face political opposition. Even when market transfers between willing buyers and willing sellers are used as an alternative to regulatory mechanisms for improving instream flows, there is still a perception among many in the agricultural community that this is simply another scheme to take away farmers' water rights and "separate water from the land."

Although the agricultural community generally views an individual's water right as a form of private property, when an individual farmer considers selling or leasing his right, the water right is viewed by some as community property. Surrounding farmers become very concerned about the water leaving the land and going back instream. In Oregon, this has been so even though none of the transactions that the Oregon Water Trust has negotiated to date have involved taking entire working farms out of agricultural production. In the Buck Hollow transaction, ranching continued with substitute hay; the Sucker Creek transaction did not involve land currently being farmed or ranched.

In rural communities, concern about losing control of irrigation water (and ultimately of farmland) extends beyond farmers to other members of the community dependent on the agricultural economy. The local feed, farm implement and grocery store owners all share the concern that transfers of water rights from agricultural to instream use will cause a decline in the community's economy, reducing their income and job opportunities for their children. These concerns about the future of rural economies are the major reason that most of the Trust's transfers have been temporary lease transactions rather than permanent acquisitions. The next few years will be a critical period for the Trust to build a sense of "trust" among the water rights holders and rural communities — to demonstrate that allowing the market to operate can be beneficial, or at least not harmful, to all affected interests.

Proposals were introduced in the 1995 and 1997 Oregon legislative sessions to repeal the instream water rights law completely, and to prevent the sale of any agricultural water right to any party other than another agricultural interest. Although these bills were not adopted, they did make some headway through the legislative process and illustrate the controversial nature of water rights transfers for instream flows.

PROTECTING AND RESTORING THE WATERS

The stories in this section demonstrate that a diverse array of public and private groups can make significant progress in protecting and restoring the natural environment. Private groups participating in these ventures range from international environmental groups like The Nature Conservancy (TNC) (see *Ash Meadows, Nevada*) to ad hoc groups like the Mono Lake Committee, formed specifically to stop the destruction of a unique but very localized resource (see *Mono Lake, California*). The role of private groups varies from TNC and the Trust for Public Land arranging land purchases (see *Trinity River Basin, California*) to the Henry's Fork Foundation co-facilitating watershed council meetings (see *Henry's Fork Watershed Council, Idaho and Wyoming*) to the Natural Heritage Institute advocating protection and restoration in administrative and judicial proceedings (see *Trinity River Basin, California* and *Mono Lake, California*).

Government interest and involvement in the projects also varies — from county governments trying to protect the economic base of their area (see *Trinity River Basin, California*) to Indian Tribes protecting the natural resource that is at the core of their culture (see *Umatilla River Basin Project, Oregon*). In the negotiations depicted in the *Bay-Delta Accord, California*, state and federal agencies ultimately succeeded in working out an agreement to protect the water quality and endangered species in the Bay-Delta. In the *Umatilla River Basin Project, Oregon*, Bureau of Reclamation and Bonneville Power Administration funds and personnel facilitated planning and continue to operate the pumps to allow farmers and fish to coexist. In Washington, the Department of Ecology helped set important legal precedent after denying ground water use permits that would have harmed existing

surface water rights — including rights for maintaining minimum stream flows (see *Washington State Protection of Instream Flows*).

Most remarkable is that the following stories illustrate that no one group or government entity can accomplish the goal in isolation. All of the stories demonstrate that cooperation is required to initiate the planning, develop the trust, attain the consensus, generate the funding and implement the actions required to preserve and restore the West's waters.

Umatilla River Basin Project, Oregon

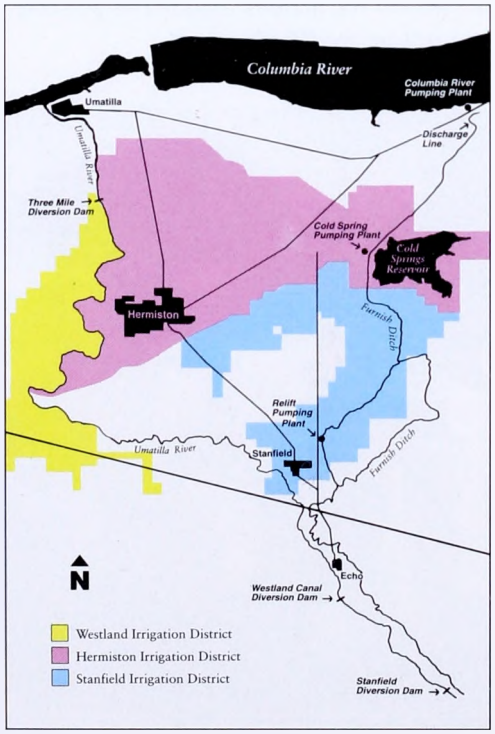
Since the early 1900s, the Umatilla River had been depleted by private and Bureau of Reclamation (Reclamation) irrigation projects, leaving inadequate water in the river for native fish. Complete dewatering and an array of dams in the lower Umatilla River blocked passage of anadromous fish to their headwater spawning grounds in and around the Umatilla Reservation, violating the provisions of the 1855 Treaty with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Spring chinook, fall chinook and coho were extirpated from the river early in the century, and steelhead survived in remnant populations.

In 1980, the Pacific Northwest Electric Power Planning and Conservation Act mandated protection and restoration of anadromous fisheries in the Columbia River System. Under this act, the State of Oregon and the Bonneville Power Administration (BPA) cooperated with the CTUIR to provide fish-rearing facilities and reestablish fish populations using innovative hatchery techniques. In 1986, the Corps of Engineers excavated a low-flow fish passage channel in the Umatilla River from Three Mile Falls Diversion Dam (TMFD Dam) to the mouth of the Umatilla River. By the fall of 1988, the BPA began constructing fish ladders and traps on the five irrigation district dams.

At the urging of the CTUIR, local irrigators and the state of Oregon, Congress authorized the Umatilla Basin Project at a cost of over $42 million over 10 years to further mitigate losses to the fishery. Under this 1988 law, Reclamation developed a plan to begin restoring instream flows for anadromous fish while allowing established irrigation to continue. The plan set target instream flows for the Umatilla River to be achieved by reducing irrigation diversions from the Umatilla, while continuing to irrigate using replacement water from the Columbia River. Under the plan, Reclamation is responsible for design and construction of the project; BPA provides power for pumping water up to the agricultural fields from the Columbia River.

Columbia River replacement irrigation water is supplied through water exchange facilities:

- Pumping facilities in the Columbia River deliver up to 140 cubic feet per second (cfs) of Columbia River water for irrigation in the West Extension Irrigation District (WEID) under Phase I of the project.
- In exchange, WEID reduces its withdrawals of Umatilla River flows from TMFD Dam at critical times of the year, facilitating adult fish return and juvenile out-migration.
- At the same time, irrigation is unimpaired since bucket-for-bucket exchange water is diverted directly from the Columbia River into the WEID irrigation canal.



Water spreading

During planning for the water exchange, it became evident that the irrigation districts had allowed significant unauthorized project water deliveries outside district boundaries. Such deliveries have the potential for impacting the exchange program. Reclamation has been working with the districts since 1991 to resolve the unauthorized water use. Since 1995, one-year temporary water service contracts, which include mitigation measures, have been negotiated to allow water service to the out-of-boundary lands.

1996 legislation that would have settled the water spreading controversy died in Congressional committees. Whether new legislation will be introduced is unclear, but the NEPA process addressing this conflict is expected to be completed by 1998. If the conflict over unauthorized project water deliveries is finally resolved through either legislation or the NEPA process, success will also be measured in substantial funds saved by avoiding litigation.

Under Phase II of the Umatilla Basin Project, similar water exchanges operate in the Hermiston Irrigation District (HID) and the Stanfield Irrigation District (SID). SID historically diverted water from the Umatilla River into their Furnish Ditch for direct supply to irrigation district lands. HID historically diverted water from the Umatilla River in November through May, stored it in Cold Springs Reservoir, and then drew water from the reservoir for summer irrigation. In both districts, diversions have been reduced to leave Umatilla River water instream for fish passage; foregone Umatilla diversions have been replaced by water from the Columbia River. This has allowed flows to be increased during critical spring and fall salmon migration periods.

The 1988 law, while a significant step forward, does not fully restore necessary instream flows. At times, adult and young migrating salmon must be trapped and hauled around impassable reaches because flows for instream migration are inadequate above TMFD Dam. If passed by Congress, a proposed Phase III of the project should provide flows sufficient for a natural migration of the adults.

A Measure of Success

Success of the Umatilla Basin Project is measured by the number of adult fish returning to the basin. In 1996, about 2300 spring chinook adults returned to the Umatilla Basin. While this number is still small compared to the historic migration, it compares favorably with the 1996 return of only about 6,000 spring chinooks to the

much larger Snake River basin. Already, Umatilla salmon are being harvested by Indians and non-Indians in the Umatilla Basin, the Columbia River and the Pacific Ocean. Meanwhile, the local irrigation economy continues to thrive. All of this was accomplished without litigation.

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Trinity River Basin, California

From its headwaters in the impressive Salmon-Trinity mountains in northwestern California, the Trinity River flows 200 miles to the Pacific Ocean, draining over 2,900 square miles of mountainous and forested land. Historically, the Trinity River supported one of the premier anadromous fisheries in the United States. A tributary to the Klamath River, the Trinity contributed half to one-third of the total number of salmon originating from the Klamath-Trinity River Basin, California's top steelhead-producing region and second-largest salmon-producing region after the Sacramento River basin. The Hoopa, Yurok and Karok tribes occupied lands along the river and depended on the fishery for their subsistence. In the late 1800s, the estimated annual run of chinook salmon adults was between 150,000 and 200,000, with an additional 50,000 steelhead and 5,000 coho salmon. This natural phenomenon ended after the turn of the century.

The exceptional fishery was reduced to a mere remnant by human activities, such as the canning industry that peaked in 1919, mining and logging, and most importantly, federal water diversions by the Central Valley Project (CVP). The CVP ensured that the Trinity basin would be forever changed. The construction of Trinity and Lewiston Dams forty years ago eliminated 109 miles of anadromous fish habitat, including 59 miles of chinook salmon spawning and rearing habitat. The river lost 80% of its flow and 90% of its anadromous fish production to out-of-basin diversions amounting to 1,000,000 acre-feet of water annually, to irrigate drylands in the Central Valley farming region of California.

Basin of Origin Water

In 1990, the Natural Heritage Institute (NHI) began assisting Trinity County, as its special counsel, in developing a program for repairing the fishery resources of the Trinity River watershed. The broad objective of the project was to demonstrate an effective means for impoverished rural communities in the West, such as Trinity County, to obtain priority access to the waters that originate in their basins and are critical to their long-term environmental protection and economic growth. The Trinity River watershed is just one of the economically depressed and water-dependent local economies in the western United States whose future depends upon

Temperature emergencies

Temperature emergencies have been the norm on California's developed rivers, particularly the Trinity. These emergencies occur in part because there is insufficient water dedicated to the river to moderate the natural warming during the late summer when the Trinity salmon eggs incubate. Drought periods — common in recent years — result in ever lower flows that exacerbate the late summer temperature problems.

Lethal temperatures at these critical times not only destroy a year's stock of young salmon, they effectively waste all of the water that has been allocated to fishery maintenance during the preceding water year.

its ability to reclaim a portion of the water that is now diverted from its basin.

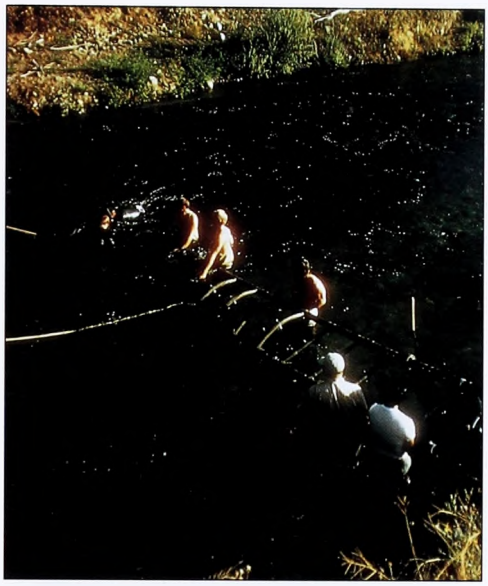
The fishery is the chief asset of Trinity County's rural economy. To improve the fishery, the county was challenged with increasing instream flows sufficiently to create the hydrologic conditions necessary for spawning and survival of anadromous stocks, specifically, to:

- Maintain river temperatures below the lethal threshold during critical life stages of the anadromous fish; and
- Arrest the severe sediment loading of the river from the disturbed commercial timberlands in the watershed because sediments compact the spawning gravels and impair reproduction.

Accomplishing Watershed Objectives

Trinity County was able to accomplish its watershed restoration objectives through three strategies. First, in 1992, Trinity County and the Hoopa Valley Tribe were successful in inserting into federal legislation reforming the CVP a mandate for greatly improving the Trinity stream flow regime to restore the fishery (see *Central Valley Project, California*). It is estimated that the increased flows will restore some 56% of the historic anadromous fish habitat in the river below project dams. While this is a major achievement for the downstream resources, the continued operation of the dams on the upper portion of the river remains a barrier to migrating fish.

Second, pending the improved flow regime, Trinity County was successful in proceedings before the local and state water boards advocating a legally enforceable temperature standard for the Trinity River. The result of this effort was the amendment of the basin plan required under the federal Clean Water Act to direct the Bureau of Reclamation (which operates the CVP) to maintain temperatures below the lethal threshold in critical reaches of the stream. The temperature objectives



adopted by the boards were approved by the Environmental Protection Agency and are binding under both federal and state law.

Third, the Trinity River Task Force adopted an innovative program for erosion control in the basin to ensure long-term maintenance of the Trinity fishery. The task force devised a management strategy for the acquisition of an entire watershed of industrial forestlands for erosion control. In 1992, NHI worked with the Trust for Public Land to secure federal funds for the forestland acquisition.

Trinity River Task Force

In 1992 legislation, Congress charged the Trinity River Task Force — local, state and federal natural resource management agencies and municipal authorities — with overseeing watershed restoration.

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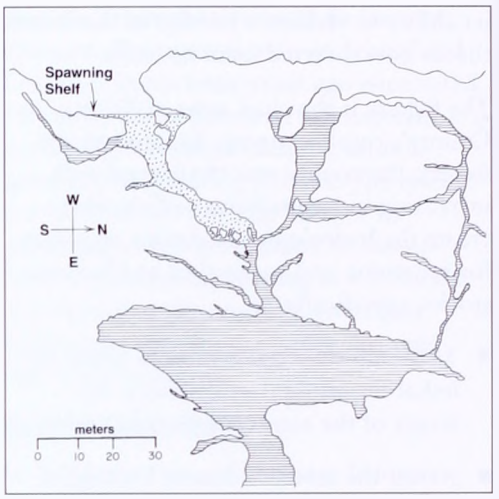
Ash Meadows, Nevada

Ash Meadows National Wildlife Refuge and the Devil's Hole Unit of Death Valley National Park are located approximately 90 miles northwest of Las Vegas, Nevada in the Amargosa Valley. Ash Meadows is the discharge point for a vast underground water system stretching 100 miles to the northeast. Nearly all the water at Ash Meadows is "fossil" water, believed to have entered the ground water system thousands of years ago. Ground water flows through carbonate rock faults and fractures to the Ash Meadows area where a buried fault acts as a barrier to flow. Waterbearing strata come to the surface in more than 30 seeps and springs, providing a rich and complex variety of habitats.

The wildlife refuge is composed of about 22,000 acres of spring-fed wetlands and alkaline desert uplands. Fifteen major springs on the refuge discharge over 10,000 gallons of water per minute, supporting at least 24 plants and animals endemic to the area. Four of its fishes and one plant species are listed as endangered under the Endangered Species Act.



The Devil's Hole unit of Death Valley National Park consists of 40 acres within the Ash Meadows refuge surrounding Devil's Hole — a water-filled cavern cut into the side of a hill. The cavern, which is over 300 feet deep, provides an environment of constant temperature (92° F) and salinity for the Devil's Hole Pupfish (*Cyprinodon diabolis*).

Devil's Hole Unit of Death Valley National Park

1952: Unit added to Death Valley National Monument.

1962: Park Service begins to monitor water levels.

1967: Devil's Hole Pupfish listed as endangered.

1968: Hydrograph begins decline as large capacity wells are drilled and pumped for 12,000 acre agricultural development.

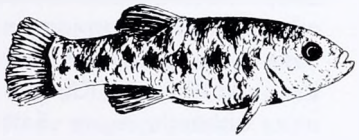
1970: Drastic conservation measures begin.

1971: Federal court temporary injunction issued to halt pumping.

1976: U.S. Supreme Court decision in *Cappaert v. U.S.* recognizes prior water right of Devil's Hole due to its designation as part of a national monument; permanent injunction limits future pumping.

Threats to Pupfish Survival

In the 1960s and 1970s, most of the Ash Meadows spring-fed streams were diverted for irrigated agriculture. Ground water was also pumped for irrigation. Depletion of the springs and seeps, as well as the introduction of crayfish, bullfrogs, bass and tropical fish, caused extinction of the Ash Meadow Killifish and the Longstreet Springsnail. The ground water pumping led to a decline in the water level in Devil's Hole, which threatened to expose the hole's critical spawning and feeding rock shelf and precipitated actions to protect the hole and its inhabitants.



In 1976, the U.S. Supreme Court upheld a permanent injunction issued by the District Court for the District of Nevada enjoining any pumping that would lower the water below a certain level necessary to preserve the fish. The Court held that in establishing Devil's Hole as a national monument, the President reserved appurtenant, unappropriated waters necessary to the purpose of the reservation, including preservation of the pool and its fish.

While this action secured the water source for the national park unit, the remainder of Ash Meadows' water supply was still unprotected, and a land development corporation planned to subdivide the area into 30,000 residential lots. This new threat prompted a proposal in 1981 by California Senator Alan Cranston to establish a national wildlife refuge to protect the desert pupfish. While this effort failed, the U.S. Fish and Wildlife Service (USFWS) emergency-listed as endangered two more of the fish species of Ash Meadows — an action that conferred protection to waters in the area.

Finally, the refuge was established by Congress in 1984 through cooperative efforts of The Nature Conservancy (TNC), the Bureau of Land Management and the USFWS. TNC, a private conservation organization, recognized the need to protect the unique area, purchased 12,613 acres (5106 hectares) and subsequently sold the lands to the USFWS, which now manages the area as a wildlife refuge. Along with the surface acreage, the Department of the Interior holds rights to about 16,000 acre-feet of water.

Ongoing Restoration Efforts

Purchase of the land and water rights has protected Ash Meadows from additional destructive development. Recovery of the hydrograph has also led to the reestablishment of some native plant species and recovery of pupfish populations. But work remains to be done to restore the area to pre-pumping condition. With the help of funds from the Bureau of Reclamation, the USFWS is dismantling culverts, returning streams once diverted into concrete irrigation ditches back to their natural water courses, removing nonnative plants and animals that compete with native populations and planting native vegetation.

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U.S. Supreme Court Holding in *Cappaert v. U.S.*

When the United States reserved Devil's Hole, it acquired by reservation water rights in unappropriated appurtenant water sufficient to maintain the level of the underground pool to preserve its scientific value and thereby implement the presidential proclamation establishing Devil's Hole as a national monument (now part of a national park).

The proclamation expressed an intention:

- To reserve unappropriated water;
- That the United States could protect its water from subsequent diversion of surface water or ground water; and;
- That determination of reserved water rights was not governed by state law.

Colorado River: Grand Canyon, Arizona

The experimental flood consisted of:

- Four days of 8,000 cfs discharge for pre-flood data collections
- Ten hours of up-ramping to the peak flood
- One week of a 45,000 cfs peak
- Stepwise down-ramping to four days of 8,000 cfs flows for post-flood data collection

The construction of Glen Canyon dam was controversial from the outset. However, critics at the time focused attention on upstream impacts — specifically the drowning of Glen Canyon. While many still lament the loss of those sculptured canyons, recent controversy has focused on the operations of the dam and their impact on the natural and cultural resources downstream in Grand Canyon National Park. In March 1996, the Bureau of Reclamation let loose a deluge from Glen Canyon Dam. The event was the culmination of a remarkable consensus process that may significantly change how we manage our western rivers.

Prior to its damming, the Colorado River was dominated by variability. Flows ranged from over 120,000 cubic feet per second (cfs) in the spring to less than 1,000 cfs by late summer, and temperatures varied from 65 degrees to below freezing. When the gates of Glen Canyon dam closed in 1963, the Colorado River above and below was fundamentally altered by the removal of the system's dynamics.

Once characterized by muddy, raging annual floods, the river was transformed into a clear, cold stream. Seasonal water flows were stabilized and replaced by daily fluctuations in river level of as much as 15 feet, driven by electrical demands for peaking power. A band of exotic vegetation colonized a river corridor no longer scoured by spring floods. Five of eight native fishes disappeared and the broad sand beaches of the pre-dam river melted away. The dam provided financing for other reclamation projects in the upper basin states of Colorado, New Mexico, Utah and Wyoming. Utilities and communities within the region came to rely on the dam's low cost power.

The Experimental Flood

The principal goal of the experimental flood was to restore disturbance and dynamics to the river ecosystem. Planners expected that additional sand would be deposited on canyon beaches and that backwaters, important rearing areas for native fish, would be revitalized. They also hoped that new sand deposits would stabilize eroding cultural sites and that the high flows would flush some of the exotic fish species out of the system.

Despite being limited to a magnitude of less than half the annual pre-dam floods, the experimental flood was successful. Over 55 new sandbars were created and the majority of existing sandbars were enhanced; few decreased in size or volume. Cultural sites were stabilized, but the restoration of backwaters was less successful. The impact on exotic fish populations and the long-term potential for the river's native biological community remain to be determined.

Success in the Process

One overarching success of the experimental flood of 1996 was evident before it even started: the unprecedented flood took place in an atmosphere of consensus and without litigation. This success was the result of a six-year process led by the

Bureau of Reclamation that brought diverse and contentious stakeholders together regularly to discuss issues involved in the Environmental Impact Statement on the operations of Glen Canyon Dam (EIS). This process was guided by the Grand Canyon Protection Act of 1992, which mandated that the dam be operated to protect, mitigate and improve the natural and cultural resources of the river downstream. Slowly, static positions between differing interests broke down and trust and respect were established. Participants worked through each issue, moving only as fast as comfort levels would allow. While the pace seemed glacial, the results may prove lasting.

The outcome of the EIS was the formation of a more formal and long-term consensus process. The lack of absolute certainty in understanding the many related components of the river ecosystem brought a recognition that management decisions must be made with available knowledge. A process called "adaptive management" was adopted. Its objectives are to actively involve all of the stakeholders in management decisions. Each decision effectively becomes an experiment, based on clearly defined hypotheses and with expected results. A long-term monitoring and research program collects and analyzes

data necessary to measure success and to recommend adjustments. Subsequent management incorporates the lessons learned to date.

The challenge of this new philosophy now lies in its successful implementation. It will take all of the skills and experience, not to mention patience and wisdom, generated throughout the preceding effort to succeed. However, if successful, it will be one more step toward more productive solutions to water resource issues.

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Mono Lake, California

In 1994, following fifteen years of litigation, the California Water Resources Control Board (Water Board) amended Los Angeles's rights to divert from the creeks that flow into Mono Lake, to restore the natural values of the tributaries and the lake itself. The Mono Lake action is the first time in California history that a city's water diversions have been limited for the express purpose of protecting the public trust values of a navigable lake.

History of the Mono Lake Litigation

Since the turn of the century, Los Angeles has looked north to supplement its limited local water resources. In 1934, it applied to the Water Board for permits to divert from the five tributaries to Mono Lake, located approximately 350 miles north of the city on the eastern side of the Sierra mountains. In 1940, the Water Board granted permits authorizing diversions in excess of the average natural flows of these tributaries. Los Angeles promptly completed the necessary diversion facilities, although its diversions averaged only two-fifths of the permitted maximum. In 1974, the Water Board finalized the permits as licenses, and Los Angeles expanded the capacity of its aqueduct. Thereafter, until 1979 when the Mono Lake litigation was inititiated, Los Angeles diverted nearly four-fifths of the average flows of the tributaries.

These diversions caused significant damage to Mono Lake and its tributaries. By 1979, the lake level had sunk more than forty vertical feet, stranding boat docks and beaches and creating a broad, dusty shoreline. By nature a sink without outlet, the lake became substantially more saline as a result of the diversions, thus endangering its suitability for migratory waterfowl. The diversions also periodically dried up the tributaries, greatly damaging the riparian vegetation and fish habitat.

In 1979, the Mono Lake Committee (MLC) and the National Audubon Society sued to enjoin Los Angeles's diversions on the theory that the waters, bed and shores of the navigable Mono Lake are protected by the public trust doctrine. This complaint was an unprecedented effort to apply this judge-made or common law doctrine to limit a municipal water diversion in California.

Public Trust Doctrine

- A state owns "all of its navigable waterways and the lands lying beneath them 'as trustee of a public trust for the benefit of the people.'"
- The doctrine was imported from English common law into U.S. state law through the equal footing doctrine.
- The state holds a generally irrevocable interest in the lands (*City of Berkeley v. Superior Court*).
- The state may regulate structures or activities that impair navigation and similar trust purposes (*People v. Gold Run Ditch and Mining Company*).
- The California water code establishes the exclusive method for appropriation of water in the state but does not subsume the public trust doctrine (*National Audubon Society v. Superior Court*).

Plaintiffs' strategies

- Documented the nature and extent of degradation caused by the diversions through extensive use of historical photographs, land surveys, diaries and other records that preceded the 1940 permits;
- Invested heavily in expert testimony in all scientific disciplines pertinent to evaluating how alternative diversion schedules and other remedies would affect the natural resources of the Mono Basin; and
- Helped secure public funding to develop a replacement for the water supply lost to Los Angeles as a result of the court and water board decisions

In the Mono Lake litigation, the court found that "both the public trust doctrine and the water rights system embody important precepts which make the law more responsive to the diverse needs and interests involved in the planning and allocation of water resources" (*National Audubon Society v. Superior Court*). Because Los Angeles's rights had been granted without consideration of public trust values, the court held that the doctrine had been violated, and it mandated that the Water Board undertake further proceedings to apply the doctrine.

Legal Precedents

The Mono Lake cases have established significant precedents in applying the public trust doctrine to limit water diversions in California:

- The doctrine applies to water rights to navigable waters, like Mono Lake, and to a non-navigable tributary if diversion from the tributary may cause injury to the trust values of the downstream navigable waters.
- In issuing a new water right or regulating an existing one, the Water Board must, "whenever feasible," avoid harm to public trust uses of the subject waters.
- Neither the California Water Code (establishing municipal supply as the highest use) nor the public trust doctrine has an absolute priority. The law of the state is an "integration" of the two.
- The state may "surrender the right of protection only in those rare cases when the abandonment of that right is consistent with the purposes of the trust" (*National Audubon Society v. Superior Court*).
- No vested water right exists to damage public trust values. The Water Board has a duty of "continuing supervision" over each existing water right and may reexamine past allocation decisions to assure protection of trust values.
- While the doctrine continues to protect the traditional trust values of fishing and navigation and commerce related to water uses, it also protects more modern values, including recreation, scientific study and aesthetic enjoyment.
- Where a water right has been used to cause unnecessary harm to trust values, the remedy may include physical measures to restore those values, not merely cessation of the offensive diversion.
- The Water Board and courts share jurisdiction to determine whether an existing right has caused unnecessary harm to trust values.

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Protection of tributary streams

Additional complaints were filed in the early to mid-1980s to enforce the public trust doctrine to protect tributary streams. They also asserted California Fish and Game code §5937 that requires dams to pass sufficient water "to keep in good condition any fish that may be planted or exist below the dam."

- Based on this statute, the California Court of Appeals required the Water Board to condition Los Angeles's water rights to provide permanent protection for the tributary fisheries.
- Interim relief from the court prohibited virtually all diversions.
- After extensive hearings, the Water Board amended Los Angeles's water rights licenses to prohibit diversions until the lake rises to the bare minimum for ecological quality and, thereafter, to not more than one-fourth of the tributaries' average flow.
- Both the interim relief and final order (Water Rights Decision 1631, issued in 1994) also required Los Angeles to undertake restoration of the tributary channels and lake wetlands.

Washington State Protection of Instream Flows

The Board found that the Department of Ecology has "no authority for impairing the public's rights in instream flows to serve a private appropriator's interest."

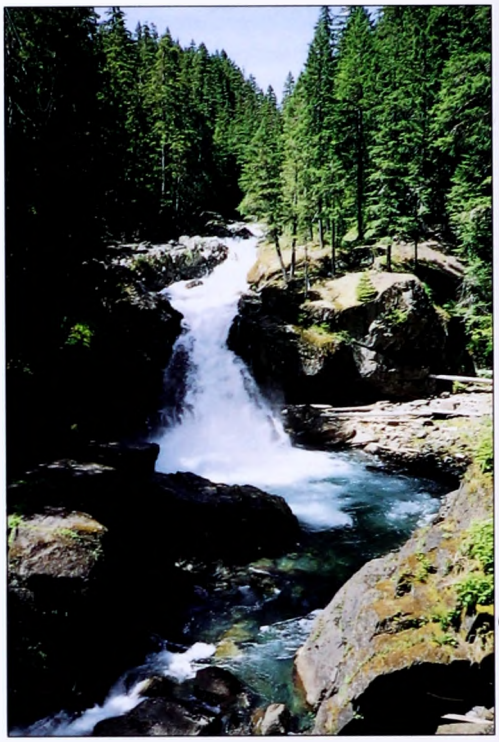
The State of Washington recently began to protect instream flow rights more vigorously by rethinking its policy of freely issuing new water rights. Factors that have led to this new policy of the Department of Ecology (Department) include:

- Projected influx of two million new residents to Washington in the next two decades;
- Continuing degradation of fish populations and water quality;
- Potential for regulatory actions against the state under the Clean Water Act and Endangered Species Act; and
- A new state policy — the 1989 Centennial Accord — requiring reconsideration of treaty-protected fishing rights that require adequate instream flows and habitat.

In 1996, the Pollution Control Hearing Board (Board), the State of Washington's water court, issued a landmark decision that supports the Department's new policy. The decision:

- Confirmed the protected status of instream flows;
- Established standards for consideration of environmental values in the water right decision process;
- Required integrated management of ground and surface waters; and
- Applied the public trust doctrine to the state water code.

The Board's decision was made in response to appeals of 140 decisions of the Department of Ecology denying offstream water rights. The Department had denied 250 applications, mostly requests for ground water rights for future municipal supply and residential/industrial development, to prevent continued depletion of instream flows.



Board Decision Recognizes Surface-Ground Water Connection

The Board's decision was based on two important legal concepts. First, Washington's Surface Water Code, Ground Water Code and Water Resources Act mandate that the Department manage Washington's ground and surface waters as an integrated resource. Second, senior water rights, which include minimum stream flows set by regulation, are entitled to protection from impairment by subsequent users. The Board also relied on consensus among testifying hydrogeologists that all aquifers are connected to some surface water.

With these legal and scientific concepts as its basis, the Board created a two-step hydraulic continuity test for evaluating ground water right requests. Under the new test, the Department must, before issuing a new ground water right:

- Identify the surface water body to which the aquifer proposed for use discharges; and
- Determine how a new use could affect existing rights to that surface water.

If surface water flows are inadequate to supply existing legal uses, including instream flows, then the Department must deny an application for a new right that would tap water feeding that source.

The Public Trust Doctrine

In its decision, the Board accepted the public trust doctrine as a component of state water allocation law (see *Mono Lake, California* story for discussion of the public trust doctrine). Noting that the principles of the public trust doctrine were embodied in several existing water statutes, the Board found that the Legislature intended that "the public trust responsibilities of the state be recognized in the management and development of the public's water resources." The Board's ruling requires the Department to protect the public's interests in navigation, recreation, public health, fishing, wildlife and vegetation whenever a proposed water appropriation would impair a navigable water of the state.

The Board's hydraulic continuity ruling is a step toward grounding water policy on good science. Because it and the Board's application of the public trust doctrine could significantly limit the issuance of new water rights in Washington, they will receive attention from both the courts and the Legislature. Legislation is already afoot to undermine the Board's order.

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Ambivalence on public trust doctrine

In Washington and other states where courts have recognized the public trust doctrine as a component of state water allocation law, comsumptive water users, such as irrigators and municipalities, have sometimes attempted to use legislation to undermine the court opinions.

They find it unacceptable that a proposed water appropriation might be denied, or an established water right even be reopened, on the basis of public trust interests in navigable waters — interests such as navigation, recreation, public health, fishing, wildlife and vegetation.

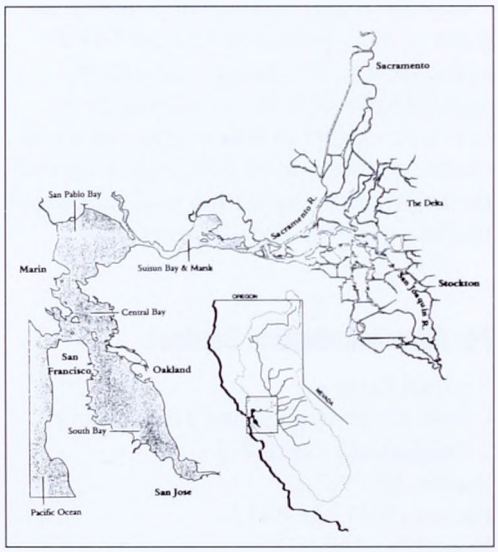
These attempts to reverse court opinions illustrate the controversial nature of the public trust doctrine.

Bay-Delta Accord, California

The accord guarantees:

- More reliable supplies both for the environment and for cities and farms for a period of three years
- Increased fresh water flows through the Delta — an additional 400,000 acre-feet in normal years and an additional 1.1 million acre-feet in critically dry years
- Any additional water needed, due to new ESA listings, to be purchased with federal funds from willing sellers
- Greater state control over water allocation policies through a return to state primacy in water quality decisions; EPA withdrew its water quality standards as soon as California adopted its own

The Bay-Delta is the West Coast's largest estuary lying at the confluence of the San Joaquin and Sacramento Rivers. Water that reaches the confluence flows into a series of bays, including San Francisco Bay, that are bordered by the urban areas of San Francisco, Oakland and Marin County. This area is a highly altered, exquisitely complex hydrologic and biologic system.



The Bay-Delta is the hub of California's water collection and distribution system. It captures almost 50% of the state's runoff and supports the largest wetland habitat in the western United States. The area's tidal marsh communities sustain 120 species of fish.

- Fresh water flows in from the Sacramento River in the north, from the San Joaquin River in the south, and from a few additional streams in the east.
- Saline water flows in from the west with the tides.

The Problem and Years of Conflict

Massive diversions reduced natural freshwater inflow to the Bay-Delta and diverted directly from it. These diversions provide for:

- 40% of the state's drinking water — serving over 20 million people; and
- Irrigation water for 200 crops, including 45% of the nation's fruits and vegetables.

Through the 1970s and 1980s, indigenous fish populations experienced dramatic declines due to:

- Diversion of fresh water;
- "Reverse flows" created by the large pumping plants;
- Extended drought; and
- Increases in non-native fish species.

By spring 1993, two area fish had been listed under the Endangered Species Act (ESA), and petitions to list others had been filed.

During this period, California's state agency charged with adopting appropriate water quality standards under the Clean Water Act (CWA) repeatedly proposed, but failed to adopt, a water quality control plan that would stem the decline of fish populations. The Environmental Protection Agency (EPA), charged with adopting protective water quality standards when a state fails to do so, likewise did not take action. In addition, northern and southern California fought over "water wheeling" — the artificial movement of northern water through or around the Bay-Delta for use by southern cities and farms.

By the spring of 1992, Governor Pete Wilson had announced a Bay-Delta water policy initiative to provide reliable water supplies for urban, industrial, agricultural and environmental uses including development of adequate water quality standards for the Bay-Delta. But by April 1993, the governor, bowing to pressure from the agricultural sector, had withdrawn the water quality initiative. Federal officials, after being sued by environmental groups, initiated steps to create federal water quality standards and other protective measures to comply with the CWA and

ESA if the state of California refused to act. It appeared as if the parties were headed for confrontation and for court.

A Consensus Agreement

In December 1994, a consensus agreement was announced by Governor Wilson, the federal government, and representatives of agricultural, business, environmental and urban interests. The agreement that emerged represents a stride toward sustainability for the Bay-Delta environment and for water users dependent on diversions from the Bay-Delta and its tributaries.

Essential to completing the Bay-Delta accord were:

- Collaborative decision making with interest groups disposed to finding a solution after so many years of gridlock;
- A substantial incentive for Delta water users to support new water quality standards — the accord contained a commitment to continued efforts to devise alternative pumping or other transportation facilities to produce a long-term solution to the Bay-Delta problem;
- Clearly articulated federal resolve to proceed with a federal solution that would comply with CWA and ESA mandates, while unequivocally supporting development of state solutions; and
- A farsighted decision by the environmental community to make some key compromises when it appeared as if the negotiations would fail.

The 1994 negotiations also led to establishment of a joint state-federal effort, the CALFED Bay-Delta Program, to develop a long-term solution to four categories of Bay-Delta problems:

- Ecosystem quality
- Water quality
- Water supply reliability
- System vulnerability

That program, with many opportunities for stakeholder participation, has developed three alternative solutions and is scheduled to develop a preferred alternative by the fall of 1998. In the meantime, the state's voters have passed a massive bond issue promising over $600,000 for restoration of the Bay-Delta and its tributaries. Thus, a situation that once seemed mired in confrontational attitudes is currently moving, even if slowly, in a more positive direction.

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Collaboration that works

- Commitment of key interest groups to finding a solution that protected the Bay-Delta environment without an adverse impact on water supplies
- Agencies and organizations with the financial and technical wherewithal to develop alternatives and a willingness to take risks in leadership
- Prior working relations among interest group members
- Real and apparent potential for mutual gains

Henry's Fork Watershed Council, Idaho and Wyoming

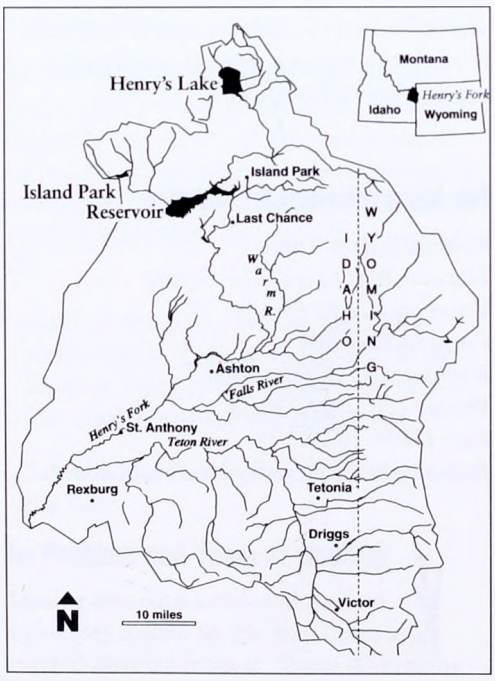
Council goals:

- To better understand and manage the watershed and its resources
- To promote cooperation across jurisdictional boundaries
- To review and prioritize proposed watershed projects
- To identify and coordinate funding for research, planning, implementing and monitoring programs
- To abide by all local, state and federal laws
- To serve as an educational resource on the Henry's Fork Basin

The Henry's Fork Basin encompasses more than 3,000 miles of rivers, streams and irrigation canals in eastern Idaho and western Wyoming, including the southwest corner of Yellowstone National Park. The basin, with a population of about 40,000, supports numerous fish and wildlife populations, including several threatened and endangered species. Mainstays of the local economy include irrigated agriculture, recreation and tourism, government and timber products.

Within this area, the Henry's Fork Watershed Council is a grass-roots, consensus-based forum composed of diverse interests seeking to advance the ecological health of the Henry's Fork Basin and the economic sustainability of its communities. Participants include farmers, conservationists, agency and community representatives, elected officials and others who "reside, recreate, make a living and/or have legal responsibilities in" the 1.7 million acre basin. Members of the Council are organized into three component groups:

- **Citizen's Group:** Members of the public with commodity, conservation and/or community development interests;
- **Technical Team:** Scientists and technicians from government, academia and the private sector serving the Council as resource specialists; and
- **Agency Roundtable:** Representatives of all local, state and federal entities with rights and responsibilities in the basin.



The Council was founded in 1993 as an alternative to the conflict and polarization that had marked resource management debates in the basin for decades and had grown especially intense in the early 1990s. Formation of the organization was prompted by a critical need for more basin-wide agency coordination within the watershed following severe sediment discharges into the Henry's Fork River in 1992. The Council's founders drafted a charter and mission statement that the Idaho Legislature adopted in 1994.

Meetings of the Council are co-facilitated by members of the Henry's Fork Foundation, a leading conservation organization in the basin, and the Fremont-Madison Irrigation District, which represents 1,700 farmers who rely on water stored in the watershed's reservoirs, including some of the oldest irrigation interests in Idaho. The Council encourages these and other once-bitter adversaries to work together in a non-hostile setting to develop common goals and objectives for the Henry's Fork Basin. The Council creates a relatively safe and friendly forum for discussing potentially contentious issues, thereby expanding the ability of basin residents to discuss, evaluate and resolve issues and conflicts on their own.

Council Activities

Within the watershed, the Council encourages members to work together in a non-hostile setting to develop common goals and objectives for the basin. It also serves as an educational forum and evaluates basin projects against a checklist of criteria to promote watershed health and vitality (see sidebar for WIRE criteria). The Council also uses some of its funding from the Idaho Legislature to encourage stewardship projects. In its first two years, the Council has approved 12 projects through its WIRE process and has allocated over $25,000.

The Sheridan Creek project, for example, is a cooperative effort among the Council, the Idaho Soil Conservation Commission, the U.S. Forest Service and private landowners to facilitate physical and water quality recovery of the creek. The project includes fencing of riparian areas in Harriman State Park to control livestock use of the riparian zone, a water well to ease the need for Sheridan Creek water for livestock and ultimately the diversion of the lower end of the creek — currently diverted into a canal — back into its original channel.

Unqualified Success?

No one is willing to declare the Council an unqualified success. So far, the Council has mainly encouraged people to talk to each other. It is still relatively new — untested against the real tough issues where give and take is really needed. Yet the Council is charting relatively untraveled waters. To be successful, the Council needs to create its own legitimacy — basin residents and others need to embrace the idea that the Council is the forum for discussion and action.

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Watershed Integrity Review and Evaluation (WIRE) criteria

- ***Watershed Perspective:*** Does the project employ or reflect a total watershed perspective?
- ***Credibility:*** Is the project based upon credible research or scientific data?
- ***Problem and Solution:*** Does the project clearly identify the resource problems and propose workable solutions that consider the relevant resources?
- ***Water Supply:*** Does the project demonstrate an understanding of water supply?
- ***Project Management:*** Does project management employ accepted or innovative practices, set realistic time frames for their implementation and employ an effective monitoring plan?
- ***Sustainability:*** Does the project emphasize sustainable ecosystems?
- ***Social and Cultural:*** Does the project sufficiently address the watershed's social and cultural concerns?
- ***Economy:*** Does the project promote economic diversity within the watershed and help sustain a healthy economic base?
- ***Cooperation and Coordination:*** Does the project maximize cooperation among all parties and demonstrate sufficient coordination among appropriate groups or agencies?
- ***Legality:*** Is the project lawful and respectful of agencies' legal responsibilities?

Central Valley Project, California

"Within the first year of implementation of the CVPIA, we witnessed a 300% increase in mid-September waterfowl use on private wetlands habitat within Grasslands [wildlife area]. This was a direct result of being able to apply spring and summer water which was simply not available for use prior to CVPIA's passage."

Don Marciochi,
General Manager of the
Grasslands Water District

For over forty years, the Central Valley Project, a system of more than 20 dams and 500 miles of canals in California's Central Valley, has diverted approximately 90% of the project's water out of area rivers for use in irrigated agriculture. Because of a priority scheme that favored agriculture, fish and wildlife generally received project water only when other users would not be negatively affected by such deliveries.

A diverse coalition of interests — including environmental groups, commercial and sport fishermen, duck hunters, waterfowl organizations, Native Americans and urban and business interests — came together to address the long-standing environmental degradation caused by the massive water diversions. The coalition helped pass the Central Valley Project Improvement Act of 1992 (CVPIA or Improvement Act), a federal law that provides a legislative mandate to reallocate water to fish and wildlife.

Central Valley Project Improvement Act

The new law dramatically changes the Central Valley Project's priorities by ranking environmental purposes on a par with irrigation and domestic uses. It also reallocates some project water back to the original users, including salmon, steelhead trout, sandhill cranes, mallards and other fish and wildlife. Three separate provisions of the Improvement Act establish three distinct pots of environmental water — one for wildlife refuges, another for instream use in Central Valley rivers and streams and a third for instream flows in the Trinity River in the northwestern part of the state (see *Trinity River Basin, California*).

Water for Wetlands and Wildlife Refuges

Prior to the Gold Rush of 1849, California's Central Valley included four million acres of wetlands. Today, that number is roughly 350,000 acres, a decline of over 90%. A variety of factors contributed to wetlands decimation, including construction of the Central Valley Project, starting in the 1940s. Sixty percent of the Central Valley's remaining wetlands are authorized to receive Central Valley Project water. These "managed wetlands" comprise state, federal and privately owned lands that are important habitat for millions of migrating and nesting waterfowl and other birds. Located along the Pacific Flyway, the ancient migratory "highway" stretching from Alaska to South America, Central Valley wetlands are wintering grounds for an estimated 60% of the Flyway's millions of migrating birds.

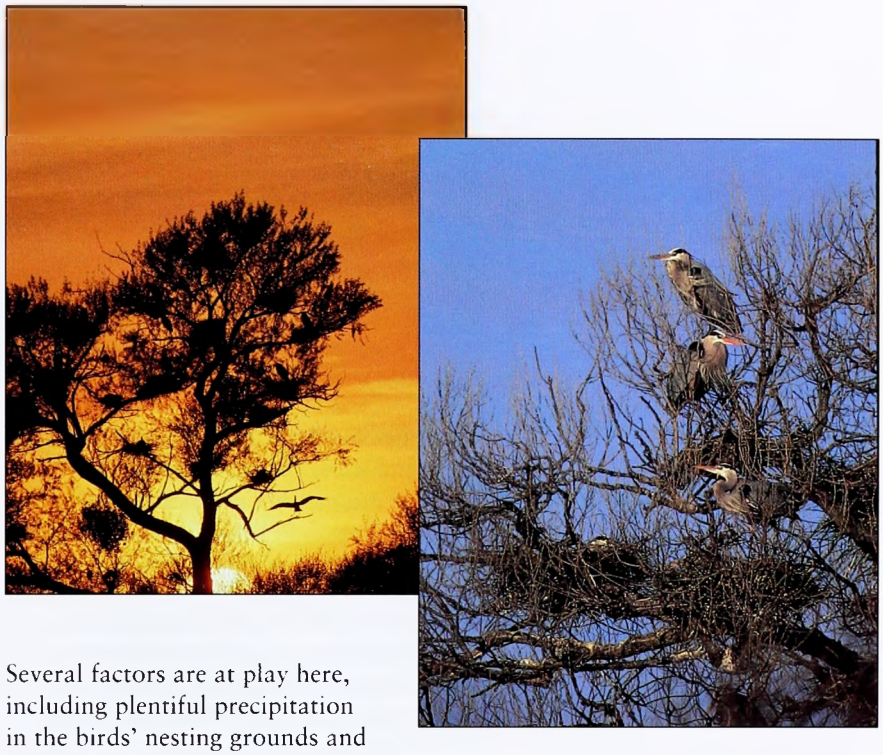
Prior to the Improvement Act, total water supplies for these wetlands and wildlife refuges were not guaranteed. The amount of water provided by the Central Valley Project varied each year and commonly was not delivered in quantities and at times necessary for proper wetland management. As a consequence, habitat conditions were poor, especially during drought years.

To address this degradation, CVPIA provides firm water supplies to refuges dependent on the Central Valley Project. Supplies are provided according to specific biologically driven delivery schedules and will be phased in over 10 years. Deliveries to refuges can be reduced on a temporary basis to 25% due to drought. In total, the Improvement Act will allocate almost 335,000 acre-feet (af) of new water to wildlife refuges and wetlands. This is in addition to any water that may be purchased from willing sellers under the CVPIA Water Acquisitions Program.

This relatively small amount of water has provided tremendous results since 1992. The firm deliveries to refuges benefit over 550 species of birds, animals and plants, including 47 species that are federally listed under the Endangered Species Act, such as the bald eagle and the giant garter snake. Firm water supplies have:

- Increased food production for migrating birds and other wetland-dependent wildlife;
- Provided a "safe harbor" for threatened and endangered species that might otherwise be drawn to marginal habitat on private farmland; and
- Improved water quality on the refuges. Federal biologists report that selenium concentration levels in certain wetlands are lower after four years of firm, good quality water deliveries.

The Improvement Act's firm water supplies have coincided with dramatic increases of Pacific Flyway migrating waterfowl.



Several factors are at play here, including plentiful precipitation in the birds' nesting grounds and other state and federal conservation programs, but firm water supplies in the wetlands and refuges have certainly played an important role. Resident and migratory bird use of Central Valley refuges has increased markedly with the Improvement Act. Additional public benefits from firm water supplies to Central Valley wetlands include improved educational and recreational opportunities, such as wildlife viewing and duck hunting, which generate revenue for local economies.

Instream Flows for Central Valley Rivers

Just as the Central Valley Project was a key factor in the destruction and degradation of California's wetlands, it significantly harmed salmon, steelhead trout and other anadromous fish by diverting massive amounts of water, damming off fish access to freshwater habitat and trapping fish in unscreened irrigation diversion pipes. One dam alone, the Friant Dam on the San Joaquin River, eliminated a run of chinook salmon that once numbered over 100,000 returning spawners annually. Similar statistics apply to other streams and rivers

"[T]he survival of juvenile Central Valley chinook salmon spawned in 1992 and 1993 benefited from Central Valley Project flow management actions in 1993 and 1994. These progeny provided much of the increased ocean harvest in 1995 as age-2 and age-3 fish."

Frank R. Warrens, Chairman, Pacific Fishery Management Council

Los Banos Wildlife Management Unit

Two nests located in one 180-acre unit under nonirrigated conditions; 78 nests found the year after irrigation

Grassland Resource Conservation District

Waterfowl and other waterbird production habitat increased 400% since 1992

Grey Lodge Wildlife Management Area

Waterfowl production increased over 20% since 1992; waterfowl use days increased by 18 million

Additional Water for Wildlife: Purchases Under the CVPIA Water Acquisition Program

Year	Purpose	Total Amount Transferred	Cost (U.S. dollars)
1997	San Joaquin Valley Refuges	37,150 af	1,535,710
1996	San Joaquin Valley Refuges	25,000 af	1,000,000
	Kern Wildlife Refuge	5,200 af	130,000
1995	Sacramento and San Joaquin Valley Refuges	70,042 af	2,689,512
1994	San Joaquin Valley Refuges	32,526 af	440,164

controlled by the project. Commercial, sport and tribal fisheries suffered as a result of decimated Central Valley fish populations.

A central purpose of the Improvement Act is to restore the Central Valley's once vibrant anadromous fish populations. Critical to this effort are provisions dedicating water to instream use for fish and wildlife.

Because of the Improvement Act's dedicated yield provision, Department of the Interior biologists have been able to secure flow improvements for salmon and other fish in major Central Valley rivers since 1993. It is difficult to quantify the benefits to the fish, given the length of the salmon's life cycle and the numerous variables in salmon survival, such as hydrology and ocean conditions. But initial results seem promising. For example, in 1995, the Sacramento River fall run of chinook salmon was strong, with almost 268,000 returning spawners, the highest number in over 25 years. On one stream in particular, Clear Creek, returning chinook salmon spawners increased from roughly 1,000 fish to 7,000–9,000 fish in 1995 and 1996.

Success Through Legislation

The Bureau of Reclamation is the largest water provider in the West and the Central Valley Project is its largest project. The Improvement Act gives the Bureau and the Department of the Interior a unique opportunity to mitigate past harms and restore fish and wildlife and their associated habitats. The new law's early successes are a strong indication that legislative efforts to reallocate water to instream and wetland uses are worthwhile.

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URBAN WATER CONSERVATION

Water conservation is the most environmentally beneficial and in many cases the least-cost approach to bridging the gap between water supply and demand. A wide range of efficient technologies are available to reduce urban water use in all sectors and new technologies continue to emerge. Conservation offers major benefits to urban water agencies and to the environment.

Conservation:

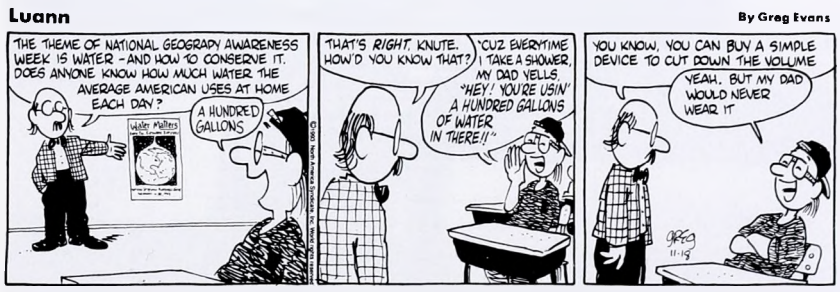
- Reduces demand for water, thereby allowing more water to remain in the environment, or allowing for more economic output for the same volume of water;
- Stretches existing water supplies, thereby avoiding the need for expensive and controversial water development projects;
- Can be implemented in phases as needed, without major capital expenditures; and
- Can eliminate or delay capital expenditures for sewage treatment capacity.

Water conservation can, however, create new challenges and risks for urban water agencies:

- Estimation of water conservation savings and cost effectiveness can be difficult.
- Conservation reduces water sales. Since most water utility costs are fixed, water conservation can reduce revenues and cause rate hikes, although with conservation, the water user's total bill may actually decrease.
- The impacts of water shortages during a drought period may be more severe for an efficient water system.

Water agencies have, however, found various ways to mitigate these risks. As conservation becomes increasingly widespread, estimates of cost savings and cost effectiveness are becoming more readily available and reliable (see *Seattle Water Department Home Water Saver Program, Washington*). Agencies have also recognized the need for drought contingency planning to offset the additional inpacts of drought on efficient water systems.

The following stories describe residential conservation programs in Los Angeles and Seattle, a wastewater effluent reuse and recharge program in Arizona, and an institutional mechanism developed in California to promote urban conservation.



Los Angeles Department of Water and Power Ultra Low Flush Toilet Rebate Program, California

Other factors motivating LADWP to initiate the ULFT program

- The Board of Commissioners felt that conservation was critical.
- LADWP had nearly saturated the market with efficient showerheads.
- Nearby towns of Goleta and Santa Monica already had implemented ULFT programs.
- Studies by the Metropolitan Water District of Southern California indicated that significant water savings were available from ULFT retrofits.

The Los Angeles Department of Water and Power (LADWP) sells water to retail customers in the City of Los Angeles, California. To conserve water and to meet its commitments under a Memorandum of Understanding Regarding Urban Water Conservation, LADWP initiated a program to replace standard toilets, which use 5 to 7 gallons per flush, with ultra low flush models (ULFTs), which use only 1.6 gallons per flush.

Basic Retrofit Program

The key element of the initial ULFT retrofit program was customers' involvement in the work. Customers would select, buy and install an approved ULFT and provide the necessary documentation; then LADWP would provide a rebate. The standard program, which began in 1990, offers a rebate to all customers who install an approved model ULFT. Current rebate levels are $100 per ULFT for single-family residential and condominium customers, and $75 per ULFT for all other customers.

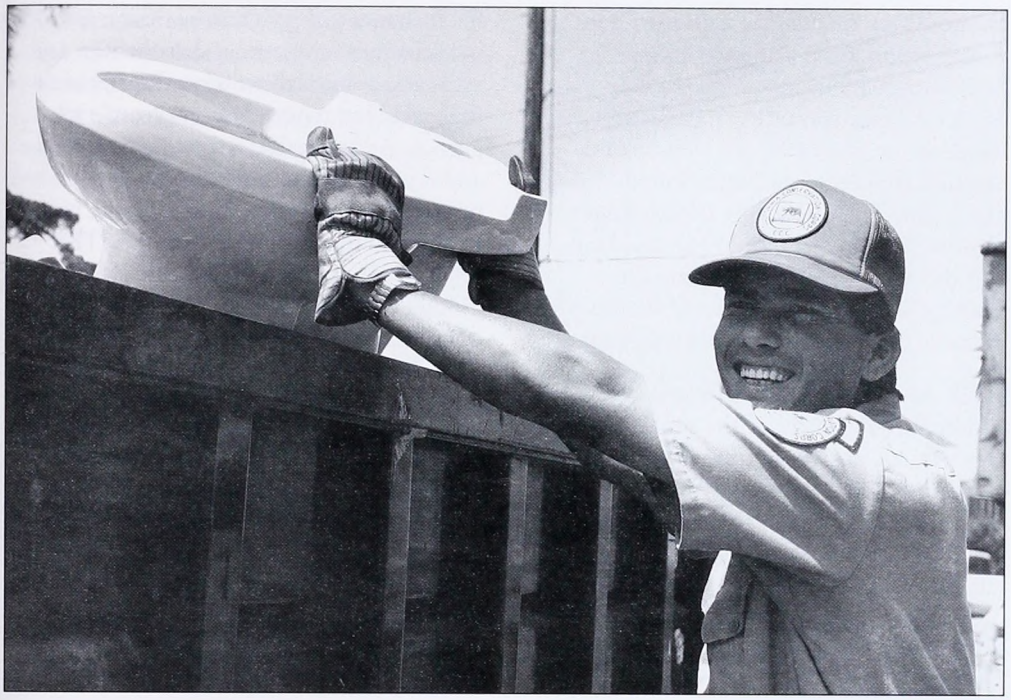
- The program goal for the first year was to install 7,500 ULFTs.
- The program actually installed 90,000 ULFTs during that time.
- An extended drought and mandatory water rationing were the primary reasons for the unexpected participation level.
- The current goal is to maximize the number of installed ULFTs, subject to funding limitations.

Community-Based Organization Program

The LADWP initiated a variant of the program in September 1992. The Community-Based Organization (CBO) program offers a ULFT to residents at no cost and provides the CBO with $25 per installed toilet to cover its program costs. Generally, the CBO staff market the program door-to-door and establish a depot where residents can pick up the ULFT. Some CBOs also offer direct installation for participants or installation by local plumbers at discounted rates. CBOs generally do not have much funding available and would not be able to operate the program if not provided the $25 subsidy by LADWP.

The CBO program targets low-income customers, who were not responding to the standard rebate offer. The Mothers of East Los Angeles approached LADWP and offered to run a program in their neighborhood. Because many low-income customers do not have the cash to purchase a ULFT, the rebate program was not an effective incentive for them. By offering residents a free toilet, LADWP has been able to achieve a much higher participation rate in low-income areas.

As with the standard rebate program, LADWP has removed itself from most of the details of administering the CBO program. For the first ten months of the program, LADWP paid $100 to a subcontractor for each installed ULFT. For this price the subcontractor handled all aspects



of the program, including toilet purchase and storage and the $25 CBO payment. The subcontractor locates a willing CBO and procures the ULFTs. The subcontractor also trains the CBO members on program operations, such as how to maintain a database to track participation and how to install the ULFTs.

The CBO component of the ULFT program is increasing. The CBOs distributed 10,000 ULFTs during fiscal year 1992 through 1993. For fiscal year 1993 through 1994, CBOs distributed about 63,000 ULFTs. As of December 1996, CBOs had distributed 236,660 ULFTs.

CBOs involved with the program have included:

- Mothers of East Los Angeles
- Korean Youth Community Center
- First African Methodist Episcopal Church
- Keeping the World at Peace
- Iglesia Poder de Dios

Overall, LADWP has retrofit 675,387 toilets since the program's inception, resulting in annual water savings of 24,000 acre-feet.

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Starting in June 1993, LADWP created a separate agreement with The Metropolitan Water District of Southern California (MWD) for the CBO program. LADWP buys some of its water from MWD, and MWD has a Conservation Credits Program through which it helps its customers finance conservation programs. In this case, MWD pays the full program costs to the contractor and LADWP reimburses MWD for its share (50%). Recently, the rebate to CBOs increased to $110 per toilet to cover a $10 per toilet fee to have the old toilets recycled.

Seattle Water Department Home Water Saver Program, Washington

Benefits of collaborating

- Reduced each utility's program costs
- Increased program credibility
- Allowed customer participation regardless of energy source for their water heater

Free kit contents

- One water- and energy-efficient showerhead (2.5 gallons per minute [gpm])
- One bathroom faucet aerator (1.5 gpm)
- One toilet fill cycle diverter
- Toilet leak detection dye tablets
- Plumber's teflon tape
- An instruction booklet, including instructions on installing a glass jar as a toilet tank displacement device

Home Water Savers was a door-to-door conservation kit distribution program offered initially in June through October 1992 by a regional utility partnership that included the Seattle Water Department, Seattle City Light and Puget Sound Power and Light. The Bonneville Power Administration (BPA), Washington Natural Gas and the Municipality of Metropolitan Seattle (METRO) (the regional wastewater agency) also contributed financial support.

While conducting studies to update the conservation element of the Seattle Water Department's water supply plan, the Department identified efficient showerheads as one of the most cost-effective measures to reduce demand. In late 1989, the Seattle Water Department conducted a pilot study of 2,000 single-family homes to test distribution methods and installation rates for various devices. Based on the results of this pilot, the water department decided to pursue an efficient showerhead program using a door-to-door drop-off distribution method.

Economic analysis showed that the program would be cost-effective even if the Seattle Water Department had to cover the entire program cost. Nevertheless, the department sought involvement from other regional utilities because of the energy and wastewater savings the program could achieve along with water savings.

The Water Saver Program

The overall goal of the program was to reduce consumption of water and energy resources in the participating utilities' service territories. High installation rate of kit devices was a corresponding program goal, which influenced product selection, choice of delivery mechanism, marketing approaches and other program features.

Each element of program planning (product selection, marketing, distribution and evaluation) involved a committee process that included representatives from each agency. Additionally, a steering committee and a planning committee were established to ensure coordination and to make overall policy and management decisions. The 1992 summer "household blitz" was mounted by the electric utilities, which contracted with a service agency and a private contractor to perform the distribution.

To ensure customer satisfaction and measure persistence, the utilities conducted an extensive customer preference study to determine which showerhead should be included in the kits. The study included on-site product comparison testing as well as a survey component. Customers in the survey were offered six showerhead models to choose from. The model selected for the program was preferred by 67% of the customers surveyed.

The initial phase of the program, from June through October 1992, involved door-to-door distribution of kits to all one- to four-unit dwellings (330,000 house-

holds) in the Seattle Water Department direct and wholesale service area. In October 1992, the program began a second phase targeting larger multifamily buildings. Commercial customers were added to the program in 1994.

Kits were delivered free of charge, door-to-door, with both prenotification by postcard and follow-up services, including pick up of unused devices. A private contractor distributed the kits in the Puget Power service territory, and the Seattle Conservation Corps, a division of Seattle's Department of Housing and Human Services, delivered kits in the Seattle City Light service territory. Telephone hotlines were established to answer questions, solve problems and send additional kit materials.

Shower-arm adapters and additional kit materials were available at no charge upon request. In addition, customers with electric water heaters received a kitchen faucet aerator with adjustable spray when they requested additional kits or when they brought their old showerhead to community centers. The cost of aerators was covered by Seattle City Light and Puget Power.

Free installation of devices was available to elderly or disabled customers upon their request. This service was requested by less than 1% of participating households.

Cost Effectiveness

The program imposed few if any economic costs on participants, other than toilet repair costs for leaks discovered as a result of the use of the leak detection tablets. Economic benefits are in the form of water, energy and sewer bill reductions. With a water savings of 19.6 gallons per day, customers average over $54 in savings per year.

Kit Components

Component	One year Installation Rate	Water Savings (gallons per day)
Showerheads	64%	11
Faucet aerators	44%	2
Leak detection tablets	31%	N.A.
Toilet fill cycle diverter	32%	3.3
Glass displacement jars	21%	3.3
Total Water Savings	**19.6 gallons/day 9.56 hundred cubic-feet/year (ccf)**	

This program was also highly cost-effective from the utilities' perspective after factoring in the water savings per device, installation rate, lifetime of the device and the costs that the utility avoids by not having to deliver as much water or energy or treat as much sewage.

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Average savings per customer

Water
- Average marginal water rate/ billing unit = $1.36
- Average water bill savings/year = 9.56 ccf at $1.36/ccf = $13.00

Sewer
- Marginal sewer rate/billing unit = $2.81/ccf
- Average sewer bill savings/year = 9.56 ccf at $2.81/ccf = $26.86

Electricity
- Average electricity savings = 430 kWh/year
- Average electricity rates = 3.45 cents/kWh
- Average electricity bill savings/ year = $14.84

Average customer combined annual water, sewer and electricity bill savings = $54.70.

Effluent Reuse and Recharge, Tucson, Arizona

Primary tools for meeting Tucson AMA goals

- Prohibition on irrigation of new agricultural land
- Mandatory conservation for all water-use sectors
- Incentive-based augmentation program
- Conservation assistance program for water users
- Assured Water Supply program

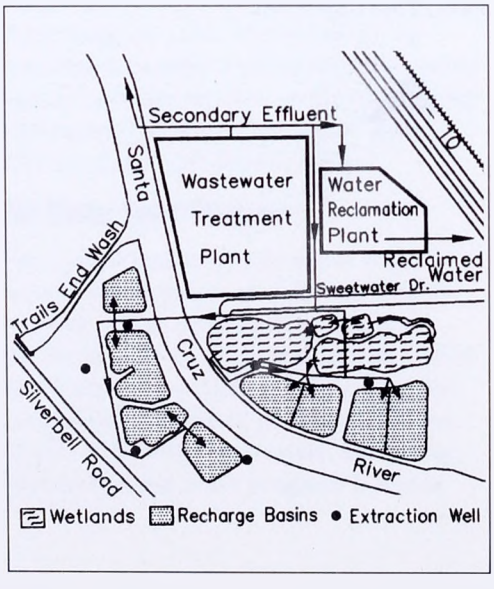
"Constructed recharge facilities" include injection wells and spreading basins.

"Managed facilities" include streambeds for passive recharge.

By passing the Groundwater Management Act of 1980 (GWMA), Arizona took a major step toward managing water resources to reduce its overdraft (mining) of ground water. Pursuant to the Act, five active management areas (AMAs) have been established and plans prepared to move the three urban AMAs toward the goal of "safe-yield" by 2025. The goal of safe-yield is to be met through mandatory and incentive-based conservation programs and increased utilization of renewable water supplies in lieu of ground water.

The Assured Water Supply Program, one of the most innovative aspects of the GWMA, will help meet the safe-yield goals. This program, implemented through rules in 1995, requires that new subdivisions use renewable supplies such as Central Arizona Project (CAP) water — part of Arizona's share of the Colorado River water — or effluent for the majority of their needs. Subdivisions can use the renewable supplies directly or replenish the ground water used anywhere in the AMA through aquifer storage and recovery.

But achieving safe-yield will not be easy. The Tucson AMA currently depends on overdrafted ground water for about 50% of its supplies. Overdraft in the Tucson AMA was about 160,000 acre-feet in 1995, over four times what had been predicted. The large discrepancy was primarily due to less-than-expected use of CAP water. The Tucson AMA plans to reduce its overdraft of ground water, in part, with use of sewage treatment plant effluent — another renewable water source — by recycling it and using it to recharge the aquifer.



Effluent Production and Reuse

As of 1995, about 65,000 acre-feet of effluent was produced annually at Tucson area wastewater treatment plants. Based on population and effluent flow projections, area effluent production is predicted to increase to about 90,000 acre-feet by the year 2010.

Tucson has one of the country's earliest and largest effluent reuse programs. Close to 19% of its current effluent production is being reused as reclaimed water on turf (golf courses, playgrounds and parks) or delivered to agricultural users.

Tucson's Sweetwater Reclamation Plant began distributing reclaimed water in 1984. Today, more than 80 private and public facilities are customers. Treated wastewater effluent is pumped from the adjacent wastewater treatment plant to the water reclamation plant. There it is filtered, disinfected and tested to ensure quality control. The treated effluent is then gravity fed to a 3-million gallon reservoir for distribution. The distribution system has grown to an 80-mile network of transmission lines.

Aquifer Recharge

Currently, the remaining 81% of the effluent is discharged into the Santa Cruz River where it supports riparian habitat and percolates into the water table. The

Arizona Department of Water Resources estimates that about 75% of the discharge to the Santa Cruz eventually recharges the aquifer.

Legislation adopted in 1994 consolidated various recharge-related legislation into the Underground Water Storage, Savings and Replenishment Program. This program broadened the opportunities for aquifer recharge programs and developed criteria for both constructed and managed recharge facilities. A number of sites within the Tucson AMA are suitable for recharge and storage of tens of 1,000s of acre-feet of water. Some potential sites, however, have been found unsuitable due to localized ground water contamination or long distances between the recharge sites and either the source water or point of use.

Despite these limitations, several entities have joined in efforts to construct recharge projects that also enhance adjacent riparian areas. During periods of low demand for effluent, Tucson's Sweetwater recharge facilities pump excess effluent into eight basins where it is allowed to sink into the water table. Wetlands are also used to treat backwash water from the water reclamation plant to meet secondary effluent water quality standards. The treated backwash water is then recharged.

The basins can recharge up to 6,500 acre-feet of effluent per year. Extraction wells pump the recharged water back into the water reclamation plant for distribution during peak summer demand.

An experimental project is also underway on the lower Santa Cruz River within the Town of Marana. The site was chosen because it is one of the few stable places where effluent can be diverted from the river channel without invasive earthworks and without diminishing flows to the most significant effluent-supported riparian areas along the river.

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Factors limiting effluent reuse in Tucson

- ***Timing***
  About 75% of reclaimed water is used in the summer and demand on any given day can exceed effluent production more than 2 to 1.
- ***Limited distribution systems***
  Distribution systems are not currently available for transport to large agricultural users and mines or to turf-related users outside of the Tucson metropolitan area.
- ***Chemical incompatibility***
  The chemical composition of the effluent is not always compatible with certain metallurgical processes, thereby making use of effluent in mining operation problematic.
- ***Southern Arizona Water Rights Settlement Act***
  This act entitles the Secretary of the Interior to 28,000 acre-feet of effluent annually to settle Indian water rights claims. The tribes may not want to use the water directly, and distribution and marketing mechanisms are not yet in place.

Cooperative Urban Water Conservation, California

Principal Urban Conservation BMPs

- State requirements to mandate the installation of only ultra low flush toilets (ULFTs) in the future (now state law)
- Replacement of existing high water using toilets with ULFTs, either through regulations or by offering customers incentives for making the change
- Installation of more efficient showerheads
- More sophisticated pricing structures to encourage greater efficiency by customers
- Audits for industrial users, large landscapes and homes
- Incentive programs designed to make implementation of conservation measures attractive to the customers
- Leak detection programs to minimize agency distribution system losses

Because of the perceived risks associated with water conservation and an historical bias toward meeting all water demands, California utilities did not aggressively pursue water conservation strategies until the late 1980s, when they were hit simultaneously with a major drought and the likelihood of major reallocations of water back to the environment. At that point, many urban utilities decided that major water conservation programs were desirable, but only if their concerns about conservation programs could be reduced to manageable levels.

Non-governmental environmental organizations had long criticized urban water agencies for failing to pursue conservation more aggressively. These groups felt that large conservation savings could be achieved easily and inexpensively, and that the reluctance of urban agencies to implement conservation was based on their desire for additional water development. These environmental organizations pushed for regulatory programs that would have mandated high levels of conservation by urban water agencies.

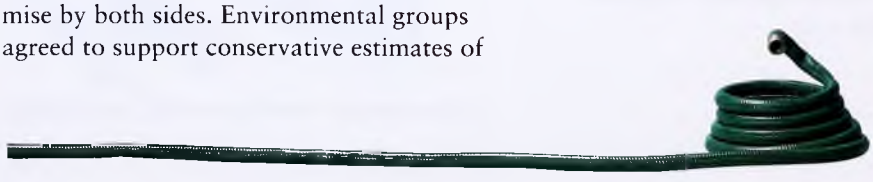
In the mid 1980s, this difference in posture between urban water agencies and environmental organizations threatened to derail urban conservation efforts, as the two sides emphasized their differences, while ignoring their basic agreement on the desirability of water conservation to the cities and the environment.

Memorandum of Understanding

In an attempt to surmount the impasse over urban water conservation, the major California urban water agencies and environmental groups negotiated an agreement in 1991 entitled, "A Memorandum of Understanding Regarding Urban Water Conservation in California" (MOU). The MOU represented a compromise by both sides. Environmental groups agreed to support conservative estimates of water savings potential when considering future urban water demand. Urban water agencies made a commitment to implement 16 water conservation "Best Management Practices" (BMPs) over the next 10 years unless agencies could show that the measures were not cost effective (including the environmental costs and benefits of conservation). Thus, whatever savings were available would be extracted, but urban agencies would not be at risk of losing supplies based upon unproven estimates of savings potential.

Urban Water Conservation Council

The MOU also created a new organization, the California Urban Water Conservation Council (CUWCC) to monitor implementation by the urban agencies, to identify new BMPs and to advance the state of the art in urban water conservation.



- Since most of the key urban water agencies in California are signatories to the MOU and members of CUWCC, any decision by the CUWCC to change or create a new conservation BMP is effectively the same as a state requirement to implement the BMP. Thus, the CUWCC has a statewide impact through the action of a voluntary association, without the need for centralized government control.
- Urban water agencies and environmental organizations must agree before the Council can take any action. Thus, urban water agencies and environmental groups have an equal say in how water conservation will be carried out in California.

As of 1996, the CUWCC was involved in studies on cost-effectiveness analysis, rate-setting (e.g., conservation rates that also provide revenue stability), financial incentives and the savings potential from residential and commercial ultra low flush toilets. A new BMP requiring urban water agencies to offer incentives to customers for the purchase of high-efficiency washing machines is likely to be enacted during 1997.

A Qualified Success

The California experiment in institutionalizing water conservation — the development of BMPs and the creation of the CUWCC — has been a qualified success:

- Over 150 urban agencies, representing over 13,000,000 customers, have signed the urban conservation MOU.
- Total annual expenditures for urban conservation exceed $30 million. By the year 2010, savings from implementation of the BMPs should exceed 1,000,000 acre-feet per year — valued at over 10 times expected expenditures.
- Most major urban water agencies now treat water conservation as a source of new supplies on an equal basis with other possible water supplies.
- The Council has become the key urban conservation forum in California. Within the Council, urban agencies and environmental groups have worked constructively to support legislation, perform technical studies, upgrade the BMPs and encourage implementation of the BMPs.

On the other hand, there are still problems:

- The MOU is voluntary and unenforceable.
- Many agencies have not signed the MOU.
- Of those agencies that have signed, some are not implementing the BMPs at required levels and others are not implementing the BMPs at all.

For this reason, conservation is reemerging as a major issue for environmental groups. Environmental groups and some urban agencies have begun to support state-imposed sanctions on urban agencies that fail to comply with the BMPs. Negotiations are currently underway in California to make the BMPs enforceable without losing the flexibility and collegiality generated by the CUWCC.

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Water conservation is a source of new water supply for urban water agencies.

Principal non-utility signatories of MOU

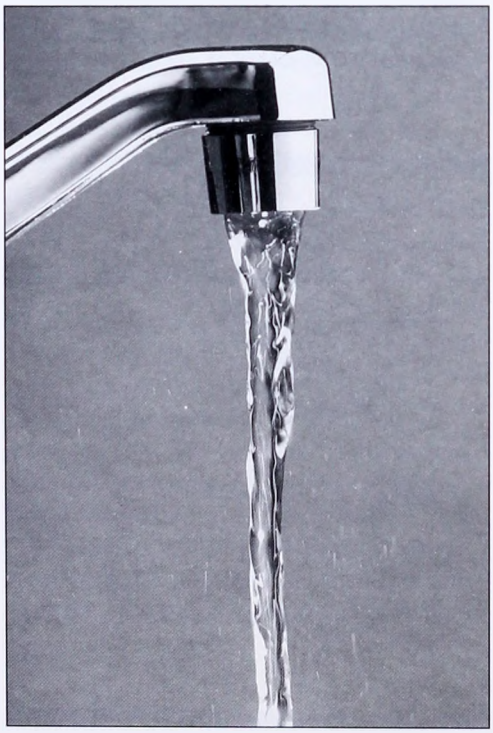
- Natural Resources Defense Council
- Sierra Club
- Mono Lake Committee
- National Wildlife Federation
- League of Women Voters of California
- Save San Francisco Bay Association
- Planning and Conservation League
- Natural Heritage Institute
- Heal the Bay
- Environmental Defense Fund
- Friends of the River
- California Trout, Inc.

CONCLUSION: Promoting Urban Conservation

Environmental groups and urban water agencies generally have a common interest in promoting water conservation measures.

The approaches described in this section should be readily transferrable to other areas. Those interested in promoting similar approaches should consider the following:

- The amount of water that can be saved through cost-effective water conservation practices is substantial. Most agencies in California, for example, should be able to save 15% or more.
- What is cost-effective for voluntary retrofit programs like those in Seattle and Los Angeles depends in large part on the cost of water. Both low water savings per retrofit and low water rates mean that a higher rebate to consumers is needed to entice participation. At the same time, lower savings per retrofit translate into lower affordable rebates by the utility because less cost has been avoided. Higher water rates make payback periods shorter, and the increased marginal costs raise the value to the utility of each retrofit.
- Environmental groups and urban water agencies generally have a common interest in promoting water conservation measures. However, environmental and urban interests are not identical. Urban agencies should be willing to pursue conservation measures that are cost-effective from the agency perspective, but environmental organizations may wish to argue for a higher level of conservation, based upon the resulting environmental benefits. The greater the mismatch between what urban agencies should be willing to commit to and what environmental groups think is necessary, the more difficult cooperation will be. In areas like California, where the economic value of conservation is high for most agencies, bridging the gap should be possible.
- Voluntary use of best management practices will have limited effectiveness. Short-sighted agencies may not allocate the money or hire the staff needed to implement conservation measures, even though such measures represent a good long-term investment. For this reason, an agreement to adopt such practices should include some type of enforcement mechanism.



AGRICULTURAL WATER CONSERVATION

Agriculture uses over 80% of the developed water supply in California and a similarly large percentage in other western states. The federal government heavily subsidizes the cost of delivering much of this water.

By providing farmers with cheap water, irrigation subsidies have encouraged inefficient irrigation practices as well as inefficient patterns of water use in the western United States, including production of water-intensive crops in arid regions, such as irrigated pasture, alfalfa and rice.

Irrigation subsidies also foster agricultural production on marginal lands in the West where cultivation requires excessive use of chemicals or where agricultural drainage problems can harm the environment.

Irrigation of these marginal lands contributes to the degradation of rivers and streams as well as to the contamination of aquifers, the destruction of wetlands and the poisoning of fish and wildlife due to polluted runoff and agricultural drainage.

The disaster at Kesterson National Wildlife Refuge in California is just one example of the impacts of this agricultural pollution. At Kesterson, selenium-laden agricultural drainage from the Westlands Water District led to widespread deaths and deformities among the waterfowl population and the eventual closure of the wildlife refuge. Recent studies have shown that agricultural runoff and irrigation drainage continue to pose threats to fish and wildlife.

Elements of agricultural water conservation

- Increase irrigation efficiency
- Shift to less water-intensive crops
- Retire marginal farmland from production

Washington's Trust Water Rights statute and Oregon's Conserved Water statute both provide for the dedication of a portion of conserved water to instream flows.

Increased Irrigation Efficiency 1976–1993

- Acres irrigated with micro-irrigation systems, including drip irrigation, increased from 155,000 to 1,631,000 acres westwide.
- Acres irrigated with sprinklers increased from 12 million to 18 million acres.
- Acres irrigated with surface irrigation systems decreased from about 37 million to 26.6 million acres.

Water conservation can:

- Alleviate the need for new, environmentally damaging water supply projects;
- Reduce diversions from rivers, leaving additional fresh water instream for fish and wildlife, if there is a mechanism for reallocating conserved water to instream purposes; and
- Reduce selenium and pesticides in rivers and estuaries by reducing agricultural drainage and runoff from excess irrigation.

When water is reallocated from agriculture to the environment to comply with provisions of the Endangered Species Act, Central Valley Project Improvement Act (see *Central Valley Project, California*), or other laws, water conservation can also help mitigate the economic impacts to agriculture by enabling farmers to maintain their output with reduced water supplies.

While there are many individual cases of successful water conservation efforts, much of agricultural water use is still inefficient, and there is still much resistance to institutionalizing conservation. For example, measurement is a key to on-farm conservation, yet many irrigation districts throughout the West do not measure water deliveries to farmers. Rather than charging farmers for what they use, these districts charge a per-acre flat fee. Without measurement devices, it is impossible for these districts to implement even the simplest water use pricing scheme to encourage conservation.

Encouraging Conservation

The recent droughts in various parts of the West spurred the adoption of improved methods of irrigation as well as a switch to less water-intensive crops. In many cases, improving irrigation efficiency has at the same time led to increased yields and reduced costs for farmers. Three of the following case studies demonstrate that farmers can decrease their water use and generate benefits for the environment while increasing on-farm yields and lowering costs.

How can additional programs be developed to encourage farmers to conserve water to meet the demands of both crop production and environmental protection? In Colorado, one of the major water conservancy districts runs an irrigation management service to encourage and assist farmers with equipment and training to improve their water management (see *Northern Colorado Water Conservancy District, Colorado*).

In California, there are innovative demonstration programs underway within two of the largest and most sophisticated agricultural water districts to demonstrate how financial incentives can be created by the districts themselves to induce improved water use efficiency by farmers. The objective is to increase the value of agricultural water to farmers without increasing its cost, thereby creating an incentive to save water.

Arvin Edison Water Storage District, California, illustrates the potential for implementing water price reforms as incentives to conserve water. *Westlands Water District, California*, identifies the potential for establishing a water market to induce greater conservation via an electronic water trading system in the largest agricultural water district in California.

These demonstrations highlight the most promising tools for promoting water conservation and help clarify the amount of water the agricultural community could conserve for reallocation to the environment if given the proper incentives.

Claude and Linda Sheppard, San Joaquin Valley, California

Claude and Linda Sheppard grow organic cotton and grains in California's San Joaquin Valley. They have been farming cotton most of their lives. Claude's family started growing cotton in Texas before the turn of the century; his great-grandfather moved to California during the Dust Bowl. For the past four years, the Sheppards have been growing their cotton organically, without the use of synthetic pesticides and fertilizers. They report a water use reduction of 25%.

Water Supply and Management

The Sheppards receive their water from Chowchilla Water District, which contracts for federal water supplies from Friant Dam and Buchanan Dam. Their water is measured by weirs and delivered through a canal. The Sheppards have access to some deep wells, but they try to conserve ground water and rely primarily on surface supplies. Current surface water costs $35 per acre-foot, with an additional $12 per acre flat charge. Although the Sheppards see it as a disincentive to conservation, the district charges farmers for a minimum of 1.5 acre-feet of water per acre farmed, whether or not they use it. Ground water costs approximately $25 per acre-foot.

Water conservation and organic production are interrelated and complementary in the Sheppards' operation. According to the Sheppards, their primary methods for conserving water include the following:

- For the first three waterings (out of a total of eight), they irrigate every other row. This allows them to rely on hoeing for weed control and also prevents the cotton from growing too quickly. Conventional growers irrigate every row and use chemicals to stop growth once the cotton has achieved the appropriate height.
- The Sheppards stop irrigating earlier in the season than conventional farmers because they use cessation of irrigation as a defoliant. Conventional growers use chemicals for this purpose.
- The Sheppards irrigate on 12-hour sets (for 12 hours at a time) instead of 24-hour sets. This keeps growth in check and reduces weed and grass growth. Conventional farmers use herbicides to control these plants.
- Laborers who irrigate the fields carry beneficial insects with them and are trained to recognize problems and release the insects where appropriate.

The Sheppards are cautiously optimistic about the future of organic cotton. In addition to their own farming operation, they provide services for other farmers, such as monitoring crop and pest conditions, purchasing beneficial insects and helping the farmers make the transition away from chemical-intensive farming.

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Lundberg Family Farms, Sacramento Valley, California

The Lundbergs support water metering

- Farmers are "a little more judicious" if they are paying on a per-acre basis.
- Metering enables the districts to more equitably allocate supplies and reward efficient water users.
- Drought rationing need not limit the number of acres cultivated if a farmer can cultivate all of his or her acreage with a reduced water supply because of efficiency improvements.

The Lundberg family has been growing rice in the Sacramento Valley for over 60 years, after leaving western Nebraska during the Dust Bowl. The Lundbergs are agricultural pioneers with a long commitment to growing organic rice and an equally long commitment to preservation of natural resources. Their preservation commitment includes never burning their rice stubble, exploring approaches to minimize chemical use, building their soil, conserving water and maintaining wildlife habitat on their fields. The Lundbergs are not afraid to experiment with weed control, irrigation practices, cultivation of new varieties of rice or new product development. The environment is frequently a beneficiary of these experiments.

The Lundbergs farm 3,200 acres of their own land each year; one thousand of these acres are certified organic. The Lundbergs also work with adjacent farmers who grow rice according to their specifications on approximately 3,500 acres annually. About 75% of this land is also certified organic. But even on non-certified lands, the Lundbergs try to farm using ecologically friendly practices. Indeed, the total pool of land on which rice is grown to the Lundbergs' specifications is much larger since much of the land is fallowed each year.

Water Supply and Management

Before construction of the Oroville Dam by the State of California, the Lundbergs irrigated their land with water from the Feather River. Now, they irrigate with water delivered by the Western Canal Irrigation District from the Oroville Afterbay. This water is delivered to the

fields either through gravity feed or low-lift pumps. Water for the Lundberg Farm, like all farms served by the district, is metered at every turnout. According to the Lundbergs, surface water from the district costs $3 per acre-foot, plus a $5 per acre standby charge. Ground water costs $15 to $35 per acre-foot depending on the lift height, efficiency of the pump and maintenance costs.

Through careful water management, the Lundbergs apparently use at least 25% less than the district average. The Lundbergs have reduced their water use through a variety of techniques:

- All fields are laser leveled to assure even water application. This practice reduced water use from 5 to 6 acre-feet per acre to 3.5 acre-feet per acre.
- A ring-roller is used to flatten clods of earth while providing a groove to protect the rice seeds. This avoids having to raise the water level over the top of the biggest clods.
- After planting and flushing the fields to germinate the rice, the fields are left to dry for two weeks so that the weeds will die. Only then is permanent flood irrigation applied.
- The water level on the fields is measured with stakes and carefully monitored.
- Irrigation is curtailed early in the season, allowing fields to dry, often without releasing any water.
- The Lundbergs grow early varieties of rice, which need to be covered with water for only 135 days instead of 160 days. With less consumptive water use, these varieties have the same yields as the full season varieties and are less subject to damage by early or late rains.

The Lundbergs are proud of the wide variety and large numbers of waterfowl and other birds that use their fields, especially in the winter. The Lundbergs cooperate with wildlife groups in bird counts, post their lands with no hunting signs and, most importantly, leave rice stubble for winter bird feed rather than burning their fields. In turn the birds are vital to the Lundbergs' soil building program, providing natural fertilization.

According to the Lundbergs, the birds especially seem to like the fields planted with Wehani rice, a variety developed and grown only by the Lundbergs.

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Northern Colorado Water Conservancy District, Colorado

NCWCD's irrigation management services help fulfill the district's mandate to encourage wise resource management by promoting best management practices that make good business sense.

For over sixteen years, the Northern Colorado Water Conservancy District (NCWCD) has run an irrigation management service to assist area farmers in voluntary efforts to improve water management and conservation practices. The NCWCD's conservation program includes:

- Irrigation scheduling demonstrations on about 100 fields annually involving about 40 farmers who participate for two to three years each;
- Fourteen automatic weather stations to provide weather and calculated crop water use data to the NCWCD via cellular phones;
- Non-point source pollution education through demonstration plots of best management practices for irrigation and fertilization of agricultural row crops;
- On-farm demonstrations of surge irrigation methods, made possible through the annual lending of over 30 surge valves to area farmers, coupled with technical assistance in setting up and programming the controls; and
- Assistance to farmers in the establishment and monitoring of agricultural water quality standards — focusing on return flows from municipal wastewater treatment plants.

Surge Valves and Irrigation Scheduling

One of the NCWCD's principal conservation efforts combines the use of surge irrigation and root zone water-balance measurements to help farmers achieve optimal irrigation applications. Surge irrigation uses special valves to advance water down the furrows through wetting and drying cycles. The valves put surges of water onto crops, letting the water soak into the soil before the next surge. The NCWCD program lends the valves to farmers to use on their fields for a one-year trial period. The farmers then have an option to buy the valves at a reduced price.

Advantages of surge irrigation

- Increases irrigation efficiency 15 to 30% over conventional furrow irrigation
- Reduces labor required to manage furrow irrigated ground
- Reduces soil erosion at the top of the field
- Reduces runoff of chemical-laden irrigation water

Surge irrigation is used in conjunction with tensiometers, which help schedule the irrigation cycles. The soil moisture measurement devices are installed in fields at different levels in the soil profile. The farmer, with the help of NCWCD personnel, keeps track of how much water the crop uses. Then readings of the tensiometer are used to determine how much water remains in the soil profile. The soil profile moisture readings help farmers prioritize fields for irrigation and can help eliminate unnecessary watering. Chlorophyll meters can also be used to determine when to add fertilizer to the surge irrigations.

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Tensiometer —
A tensiometer is a vacuum tube with a gauge that simulates the uptake of water by the crop's root zone.

Westlands Water District, California

***WaterLink* was designed by members of the Collaborative Field Demonstration Project: The Natural Heritage Institute, University of California at Berkeley and Davis, farmers and water district administrators.**

The first and largest electronic water marketing system has been established in Westlands Water District. The system, called *WaterLink*, went on-line in Westlands in March 1996. Westlands contains close to 600,000 acres and over 600 farmers. Its water users trade many different types of water, including Central Valley Project (CVP) contract water, ground water and water imported by Westlands from neighboring water districts. In a given year, hundreds of thousands of acre-feet change hands in the Westlands District, and the market may soon expand to include additional water districts.

WaterLink enables water users to buy and sell water from their home computers. They can post and read bids and asks, and access weekly and seasonal statistics on average prices and trading volumes. Buyers and sellers can then use *WaterLink* to negotiate deals and record trades with their water district.

WaterLink also provides many other services. Water users can schedule their water deliveries electronically, and soon they will be able to obtain water account balances much like one obtains a bank account balance at an ATM. This accounting feature will enable water users to

manage their water supplies more effectively and will streamline water district operations. Water districts can also use *WaterLink* to provide public information in a cost-effective manner, such as rainfall summaries, water storage levels and access to on-line irrigation advice from the State of California.

Why Water Markets?

Well-functioning water markets are a key component of more efficient water use. They can provide water users with more short-run flexibility to adjust to volatile weather conditions and more long-run flexibility to adjust to shifts in production technology and consumer preferences. Markets provide a financially attractive alternative to spreading more water on fields than is necessary. In economic terms, markets confront users with the real opportunity cost of water and create incentives for water to be used in its highest-value use. Under traditional "use-it-or-lose-it" systems, a water user with abundant supplies has little incentive to invest in water-conservation technology or engage in best-management practices. However, if a water user is able to sell water in a market, the user has an incentive to conserve. Given the potential gains from trade for both buyers and sellers, market-based systems of water allocation are achieving broader acceptance among a wide array of groups — urban, agricultural and environmental.

Local water markets have been active for years in agricultural water districts throughout the West. Broader inter-sector water markets, in which long-term water rights are actually bought and sold, have been slower to develop.

The value of *WaterLink* lies in its potential to lower transaction costs by providing market information, reducing negotiation costs and expediting communication between water users and water districts. As with other network technologies, the worth of *WaterLink* will increase as the number of users increases. *WaterLink*'s adoption rates have been promising. There are currently about 50 users on the system. Expansion of *WaterLink* to over 20 additional Central Valley Project water districts in the San Joaquin Valley is being discussed. *WaterLink* can be adapted to meet the specific needs of each water district in multiple intra-district markets, or in one large inter-district market network.

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Obstacles to water market transactions

- Physical infrastructure may not exist to transport water from potential sellers to buyers.
- Institutional and/or political barriers may prevent inter-sector transfers.
- Property rights in water are difficult to define given the interdependence among water users in terms of return-flow quantities, ground water levels and water quality.
- Large-scale water sales from one region to another may damage the local economy in the basin of origin.
- Market participants may face high transaction costs.

Arvin Edison Water Storage District, California

Importance for drought-contingent tiered pricing

- District costs increase with pumping of ground water.
- District pumping capacity is limited and thus the value of the water increases as the pumping capacity is reached in times of drought.

The Arvin Edison Water Storage District (District), in California's southern San Joaquin Valley coordinates both surface and ground water supplies. Because of the regional climate and favorable soils, farmers in the District grow a variety of crops. They also use a wide variety of irrigation technologies. With these features, the District is ideal for analysis of water pricing. While there is high variability, the area is relatively small, so the growers participate in many of the same markets and institutions.

Effect of Pricing

Water pricing is an excellent tool for encouraging water conservation because it allows agricultural producers the most flexible responses. Flexibility is important because growers operate under different agronomic and physical conditions. For example, depending on the crop or the soil type for a given field, the profit-maximizing response for one grower to a change in water policy may be to adopt a modern irrigation technology. The profit-maximizing response for a different grower may be to make improvements in the scheduling of irrigation or the length of furrows.

A study of water pricing in the District showed that, in general, where fields are assessed a higher price for water, they are more likely to have an efficient irrigation technology. However, water price is not the only important determinant of changing technology. For example, drip irrigation technologies are more likely to be adopted on a field that has a relatively steep slope as compared to a field that is flat, even when the water price and the crop are the same for both fields.

Effect of Fixed and Volumetric Components of Rate Structure

It has historically been common for growers to contract with water districts for a fixed quantity of water per acre of land for agricultural production. However, due to changing weather conditions it is not always necessary to use the contracted quantity of water to produce the intended crop. Yet the water rate structure is often set so that the grower pays for the full amount under his or her water contract regardless of whether he or she uses that amount. This encourages inefficient use of water because there is little incentive to use less than the contracted amount. If growers have water left over at the end of the year they typically use it on low-value cover crops or for preirrigation.

In the spring of 1995, the District changed its rate structure from fixed rates per acre to volumetric or "use-based" rates. These changes have removed the perception that the price of water is independent of the amount used and encourage more efficient water use.

Based on cropping data for 1995, the change in rate structure appears to have achieved its goal: an increase in the productivity (or profitability) of water per acre-foot applied. Additionally, there was a substantial reduction in the production of low-value cover crops and an increase in the production of medium- to high-value truck crops. However, one year's data is insufficient to determine whether the new rate structure has led to permanent changes in water use and cropping patterns.

Tiered Pricing

Tiered pricing has been used extensively in the electric utility industry to induce energy conservation. In a tiered pricing structure, the volumetric charge increases as demand increases. While this structure can be used under all water flow conditions, the Arvin Edison demonstration was designed as a drought-contingent tiered pricing policy to increase water use efficiency during periods of low water flow.

Implementation of a drought-contingent tiered pricing structure should produce both short- and long-run improvements in

water use efficiency. Short-run effects should consist primarily of better water management techniques. Long-run effects should include increased investment in efficient irrigation systems and switching to high-value crops. It may, however, take a long time to realize a shift in water use due to the implementation of price reforms. Water conservation induced via the water rate structure cannot be effectively measured in two to three years, but will need to be measured over the course of a decade. This suggests the need to initiate conservation incentives as early as possible, before supply crises emerge.

Influencing Water Conservation

These studies have shown that water price is an important policy tool for encouraging water use efficiency. Not only the level, but the structure of the water rate is important. Setting the fixed component of a water rate too high may have little effect on reducing water use and will reduce a grower's flexibility in making production decisions. The structure and level of the use-based component will also affect water use incentives. However, there is no one "best" policy that will fit all water districts. The best rate structure for a given water district will depend on the characteristics of that district, the district's water conservation goals and the agronomic conditions faced by growers in that district.

There are many factors influencing decisions to conserve water in the agricultural sector. In the Arvin Edison study, the farmers indicated that the price of water was only the fifth most important factor to induce farmer conservation. The other factors include commodity marketing arrangements, soil types and, at the top of the list, the different perceptions of the new versus the old generation of farmers. New-generation farmers are more aware of the competing demands for water and of the need to adopt more efficient irrigation methods.

While the study indicates that water prices are only the fifth-ranked factor influencing farm water management decisions, the study determined that price is the factor that can be most influenced by government policy. Thus, it is important for policy makers to focus on pricing programs to influence change in on-farm water management.

Reallocating Conserved Water to the Environment

To obtain farmer participation in the Arvin Edison experiments, it was necessary to give farmers discretion on how to use the "saved" water — whether the water saved should be reallocated to other agricultural users or transferred to the environment. This suggests that effectively using water conservation to reallocate water to the environment will require that the environment effectively compete with agriculture and urban water users for conserved water. Some of the ways in which agricultural water has been reallocated to the environment are discussed in the WATER RIGHTS TRANSFERS FOR INSTREAM FLOWS section.

Drought-dependent factors in rate structure

- Increase in cost to the District of increasing water supply
- Value of water to the grower
- How growers will respond to a tiered price rate structure

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John Texiera, Los Banos, California

As John Texiera says, "People don't realize it, but soil is alive."

John Texiera farms on the west side of California's Central Valley. Soils in this region are high in salts and low in organic matter, inducing most farmers to use high levels of synthetic fertilizers and pesticides. John, a third-generation farmer, has a vision and a plan for rebuilding the soil fertility and reducing the use of chemicals and water.

Most of John's acreage is devoted to growing tomatoes, both for the fresh market and for processing. After two years of tomatoes, he rotates with either melons or cotton. About 12% of his fresh market tomatoes and 20% of his processing tomatoes are grown organically.

Water Management

For the past eight years, John has utilized subsurface drip irrigation equipment, which is currently used on less than 1% of California's irrigated acreage. Although it took him at least a year to get the drip system working efficiently, he reports reducing water use by as much as 50% (from 32 inches per acre under furrow to 16 inches per acre under drip). John also adds his synthetic nitrogen fertilizer directly to the irrigation water in a process called fertigation. Because the fertilizer is directed beneath plant roots, he has reduced fertilizer use by 25%. Drip tubing has the added advantage of not watering weeds that grow between the tomato beds, thereby reducing the need for herbicides.

Another distinguishing feature of John's approach to farming is his extensive soil-building program. On 14 acres of land he has developed 7,500 tons of compost derived from cotton gin trash, the woody parts of the cotton plant left over from harvest that would otherwise be disposed of as waste.

A primary benefit of adding compost to the soil is the creation of organic matter, which increases the soil's water holding capacity. For every 1% increase in organic matter, the soil retains an additional 50 pounds of water. In just 10 months, John has seen the addition of compost increase his organic matter from 0.9 to 1.2%. For John, getting into the business of using compost has made farming fun again.

Compost from cotton gin trash

Trash donated by a local gin is laid out in fields in long piles about three feet high. Since the key to creating compost is the right mixture of water and oxygen, each pile is periodically sprayed with water and stirred for 90 to 120 days. According to John, residues of pesticides and other contaminants in the cotton gin trash are removed by the intense heat (up to 140° F) created by micro-organisms inside a compost pile.

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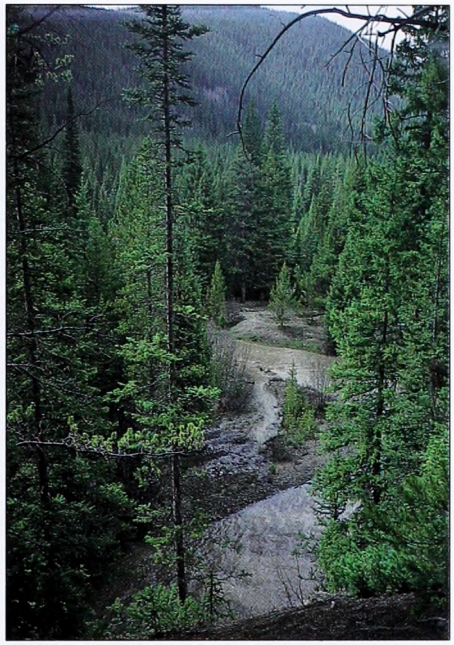
STRATEGIES FOR SUCCESS

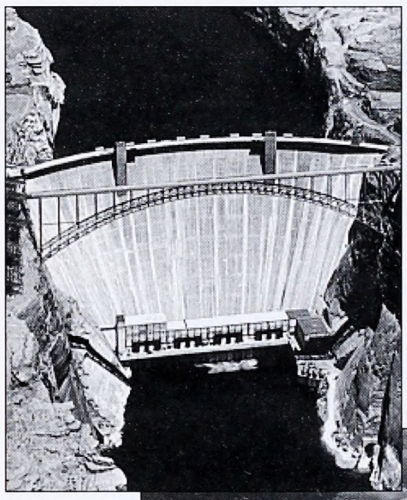
The stories of this booklet illustrate a variety of stategies used to conserve water and to protect and restore water resources in the West. While each problem and solution is unique, a few generalizations may be helpful to those continuing the quest for balanced use of western waters.

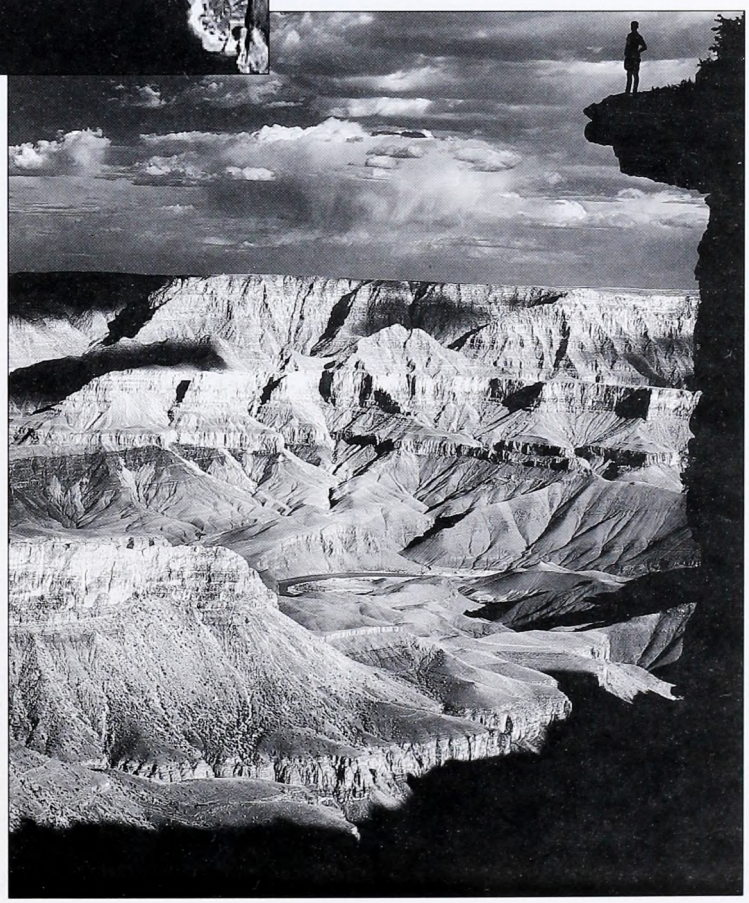
Consider the big picture. Those who seek water conservation or natural resource protection and restoration should consider the impact of their project on other environments and resources. Efforts to protect one important resource at the expense of another should be avoided.

Collaboration is key. Projects are most likely to be successful when they involve collaboration among a variety of groups.

- Partners must be willing to understand the positions and needs of other interests.
- The involvement of individuals and groups possessing a range of experience and skills helps to develop and implement successful strategies.
- American Indian tribes often share with others a common understanding of the importance of preserving natural habitats and fishery resources, particularly as a means of ensuring sustainable livelihoods for their people. Tribes often command protective doctrines and special political considerations that they alone can invoke.
- Local governmental agencies and quasi-governmental agencies may be especially effective in spearheading campaigns. These groups exercise governmental functions that private groups cannot hope to emulate (e.g., lead agency status under state environmental laws, permitting authority for water development projects). They can also provide some of the financial support and, if they do this, will be that much more committed to the campaign.







Flexibility yields opportunities. Groups should remain flexible — taking advantage of opportunities and changes as they occur.

- Focusing on promoting innovative legal precedents through litigation may be the best vehicle for further development of legal tools, but it may not accomplish the immediate project goal.
- Interim measures may provide a partial solution for the resource while a larger controversy is being resolved.
- Even if litigation is the appropriate avenue for action, success may not turn on formal strategies that plaintiffs adopt, but on tactics that they stumble into as the litigation proceeds.

Regulatory tools have limits. Groups seeking to conserve and protect water resources should clearly understand the limits of regulatory tools for accomplishing their objectives and should consider instead the use of incentives, such as compensated transfers of property rights.

Be prepared for the long haul. Some of the most important western water issues have taken years to resolve. A successful project may require consistent fund-raising or the willingness of attorneys to defer payments of fees and expenses until litigation awards have been obtained.

Public opinion can be crucial. The appropriate use of western water is a value judgment and a matter of public policy. Enlisting public support for the project can mean the difference between stalemate and progress.

PHOTO AND GRAPHICS CREDITS

INTRODUCTION

1929 view of Hoover Dam site: Bureau of Reclamation, Department of the Interior
1966 view of Hoover Dam: Bureau of Reclamation, Department of the Interior
Canal flanked by irrigated fields: Bureau of Reclamation, Department of the Interior
Tucson skyline: David Bean, American Water Works Association
Child in a sprinkler: American Water Works Association

WATER RIGHTS TRANSFERS FOR INSTREAM FLOWS

Oregon Water Trust
Rocky Webb in Buck Hollow Creek: Oregon Water Trust
Buck Hollow Creek: Oregon Water Trust
Oregon Water Trust staff at Sucker Creek: Oregon Water Trust

Trust Water Rights Program, Washington
Stream in western Washington: Susan Barbetti, Seattle

Boulder Creek, Colorado
Boulder Creek upstream of city: Kathryn Mutz, Natural Resources Law Center
Boulder Creek adjacent to bike path: Kathryn Mutz, Natural Resources Law Center

Lahontan Valley Wetlands, Nevada
Map of Truckee-Carson basins: Drawn by Charles Sensiba from Natural Resources Law Center publication
Canvasback Club: Graham Chisholm, Reno
White pelicans flock in flight: Gary Zahm, U.S. Fish and Wildlife Service
White pelican in flight: Graham Chisholm, Reno

Challenges for Water Rights Transfers
Eastern Oregon Field Coordinator measuring creek flow: Oregon Water Trust
White Pelicans: Gary Zahm, U.S. Fish and Wildlife Service

PROTECTING AND RESTORING THE WATERS

Henry's Fork Watershed Council group discussion: Henry's Fork Watershed Center
Stockpiling ultra low flush toilets: Western Municipal Water District, City of Riverside Metropolitan Water District of Southern California

Umatilla River Basin Project, Oregon
Map of Umatilla Basin Project area: Drawn by Charles Sensiba from Bureau of Reclamation base map
Tribal Members net-fishing from a scaffold: David Wolf, Confederated Tribes of the Umatilla Indian Reservation Fisheries Program
Three Mile Dam, Umatilla River: Jim Esget, Bureau of Reclamation, Department of the Interior

Trinity River Basin, California
Trinity Dam and river passing through Lewiston, California: Bureau of Reclamation, Department of the Interior
Trinity River downstream of dam: Bureau of Reclamation, Department of the Interior
Monitoring salmon numbers with sonar fish counter: Bureau of Reclamation, Department of the Interior

Ash Meadows, Nevada
Underground Map of Devil's Hole: Redrawn from figure courtesy of J.E. Deacon in Soltz, David, L. and Robert J. Naiman, *The Natural History of Native Fishes in the Death Valley System*, Natural History Museum of Los Angeles County, Science Series 30, 1978.
Big Springs, Ash Meadows National Wildlife Refuge: Dave Ledig, Ash Meadows National Wildlife Refuge
Pupfish from Death Valley, CA: Original drawing by Tah Madsen, Death Valley National Park

Colorado River: Grand Canyon, Arizona
Construction of Glen Canyon Dam: Bureau of Reclamation, Department of the Interior
Discharge of flood flows from Glen Canyon Dam: Bureau of Reclamation, Department of the Interior
Beach formed at 122 Mile Canyon, April 1996: Tom Moody, Grand Canyon Trust

Mono Lake, California
Tufa and Poconip Sunrise at Mono Lake: ©Don Jackson, Forestville, California

Washington State Protection of Instream Flows
Silver Falls, western Washington: Susan Barbetti, Seattle
Silver Falls area channel: Susan Barbetti, Seattle

Bay-Delta Accord, California
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Great blue heron and egrets: Gary Zahm, U.S. Fish and Wildlife Service

Henry's Fork Watershed Council, Idaho and Wyoming
Henry's Fork watershed map: Henry's Fork Foundation
Group meeting, 1996: Henry's Fork Watershed Center

Central Valley Project, California
Orchard in Central Valley Project: Bureau of Reclamation, Department of the Interior
Great blue heron rookery at sunset, Grasslands Ecological Area: Gary Zahm, U.S. Fish and Wildlife Service
Great blue heron rookery, Grasslands Ecological Area: Gary Zahm, U.S. Fish and Wildlife Service

URBAN WATER CONSERVATION

Glass of water: American Water Works Association
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Los Angeles Department of Water and Power Ultra Low Flush Toilet Rebate Program, California
Jefferson High toilet rebate day; Unloading an ultra low flush toilet: Metropolitan Water District of Southern California
Disposing of an inefficient toilet: Metropolitan Water District of Southern California

Seattle Water Department Home Water Saver Program, Washington
Low flow shower heads: American Water Works Association
Measuring water flow: American Water Works Association

Effluent Reuse and Recharge, Tucson, Arizona
Schematic of Sweetwater recharge facilities: Tucson Water, Arizona
Aerial view of Sweetwater recharge facilities: Tucson Water, Arizona

Cooperative Urban Water Conservation, California
Water pouring into hands: American Water Works Association
Coiled hose: American Water Works Association

Promoting Urban Conservation
Faucet and water: American Water Works Association

AGRICULTURAL WATER CONSERVATION

Drip, flood and sprinkler irrigation: Bureau of Reclamation, Department of the Interior

Claude and Linda Sheppard, San Joaquin Valley, California
Cotton field in San Luis Unit of the Central Valley Project: Bureau of Reclamation, Department of the Interior
Claude and Linda Sheppard with their grandson: Jennifer Curtis, Natural Resources Defense Council

Lundberg Family Farms, Sacramento Valley, California
Irrigated rice: Bureau of Reclamation, Department of the Interior
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Northern Colorado Water Conservancy District, Colorado
Surge valve in field: Mark Crookston, Northern Colorado Water Conservancy District
Tensiometers measuring soil moisture: Mark Crookston, Northern Colorado Water Conservancy District

Westlands Water District, California
Computer station: American Water Works Association

John Texiera, Los Banos California
John Texiera holding compost: Chris Caldwell, Natural Resources Defense Council
Tomatoes: Bureau of Reclamation, Department of the Interior

STRATEGIES FOR SUCCESS

Colorado River Headwaters in Rocky Mountain National Park: Douglas Kenney, Natural Resources Law Center
Glen Canyon Dam and Reservoir: Bureau of Reclamation, Department of the Interior
Grand Canyon National Park, North Rim: Union Pacific Railroad

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