Water in the U.S. American West

150 Years of Adaptive Strategies

Policy Report for the
6th World Water Forum

March 2012

The findings contained in this report are based on the information collected from research, interviews, workshops and reviews and should not be construed as an official Department of Army position, policy or decision unless so designated by other official documentation. This report may be found at: www.building-collaboration-for-water.org.

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The final product represents an effort to gather, interpret, and draw lessons from an enormously complex history and institutional landscape. The observations and conclusions presented here do not represent positions of any individuals or organizations that participated in this process. This report is intended to provide background and catalyze productive conversation at the 6th World Water Forum.

Photo Courtesy of Mila Zinkova

Preface

The purpose of this policy report is to present the story of water management in the U.S. American West to the international water community at the 6th World Water Forum.

The World Water Forum, convened every three years, is the largest gathering in the world focused on water. The 6th World Water Forum will be hosted in Marseille, France in March 2012, and the organizing theme is "time for solutions." The goal is to move beyond identifying problems and exploring options, and to focus on the most effective strategies to local, regional, national, and international water issues.

Given the historic role that water resource policy and investments have played in transforming the U.S. American West, the organizers of WWF6 strongly believe that this story can inspire, inform, caution, and invigorate dialogue among members of the international water community. Many nations throughout the world are faced with increasing demands on scarce and variable water supplies, and are exploring the role of water in addressing social problems related to population growth, economic prosperity, public health, environmental quality, and social justice. This is a unique opportunity to share our regional experience with the international water community, learn from others, forge new partnerships, and build a sense of regional identity and common sense of purpose.

This policy report has been prepared to share the message of water solutions in the U.S. American West. The information and findings presented resulted from consultations with recognized leaders in western water, both individuals and organizations. Past water policy reports and other literature were also reviewed.

The Transformation of a Region

In just a few generations, an ambitious campaign to harness the rivers of the American West transformed the region, attracting tens of millions of new residents and encouraging a major growth-oriented economy. This strategic program of investment aimed at achieving broad social goals, many of which were spelled out in the influential *Report on Roads, Canals, Harbors and Rivers* by President Jefferson's Treasury Secretary Albert Gallatin.[1]

The multiple-purpose water projects constructed through the early to middle 20th Century flattened the great variations in water availability from season to season and year to year, making possible extraordinary expansion of economic activity and quality of life for the new settlers. Westerners enjoy many benefits of what one observer called the "Go-Go Years,"[2] but also face some unanticipated consequences of large-scale hydrologic manipulation. Moreover, the traditional lifeways of indigenous peoples were adversely affected by this development. Today's challenges include reallocating water to meet new and changing demands—driven in large part by demographic shifts and legal mandates to protect and recover endangered species—and addressing the realities of aging dams and other infrastructure. In short, the transformation continues.

This summary discussion provides an overview of the history of development in U.S. American West related to water development; key social, economic, and environmental changes that took place during this period; benefits and costs of infrastructure investments; evolution of laws and policies to guide water use and management within the American system of federalism; and the complex cast of players who influence water decisions, both in the private sector and at all levels of government—federal, state, tribal, and local.


Photo Courtesy of USACE

This is a brief and simplified treatment of a complicated story—a view from above, in effect, aimed at conveying the key features of a policy landscape shaping water decisions in the American West. The highlighted summary statements below provide guideposts to orient the reader through this broad survey.

[1] Gallatin, Albert. *Report on Roads, Canals, Harbors, and Rivers* (1808).
[2] Reisner, Marc. *Cadillac Desert: The American West and Its Disappearing Water* (Viking 1986).

Water development was essential to facilitate the expansion of the U.S. population into the American West in the late 19th and early 20th Centuries.

Because the distribution of rainfall is not uniform across the United States, water (or, more accurately, the lack thereof) defines the region known as the American West: 17 states located on and westward of the 100th Meridian. (See Fig. 1) Water has always been a vital, scarce, and variable resource in the American West, the source of both conflict and community long before this region became part of the United States.

The American West contains the headwaters of the continent's major river systems—including the Columbia, Missouri/Mississippi, Rio Grande, and Colorado rivers—as well as the driest parts of the country: the Mojave, Sonoran, Great Basin, and Chihuahua deserts. Much of the region is owned by the federal government and managed as public land, including national forests, national parks, wildlife refuges, and multiple-use public lands. (see Fig. 2).

A Geographic Note

This discussion of the U.S. American West focuses on the arid and semi-arid parts of that region—where water is scarce and variable, and institutional innovations relate most directly to water rights and allocation. Water management issues in the more humid Pacific Northwest, by contrast, focus far less on allocation and more on flood control, recovery of endangered species, and allocation of hydroelectric power generation benefits. This report draws some lessons from solutions developed in the Columbia River basin, but frames the challenges of water scarcity and variability from the drier Inland West.

Fig. 1: Map showing location of American West, including 100th Meridian. *Source: Water Availability for the Western United States, USGS*

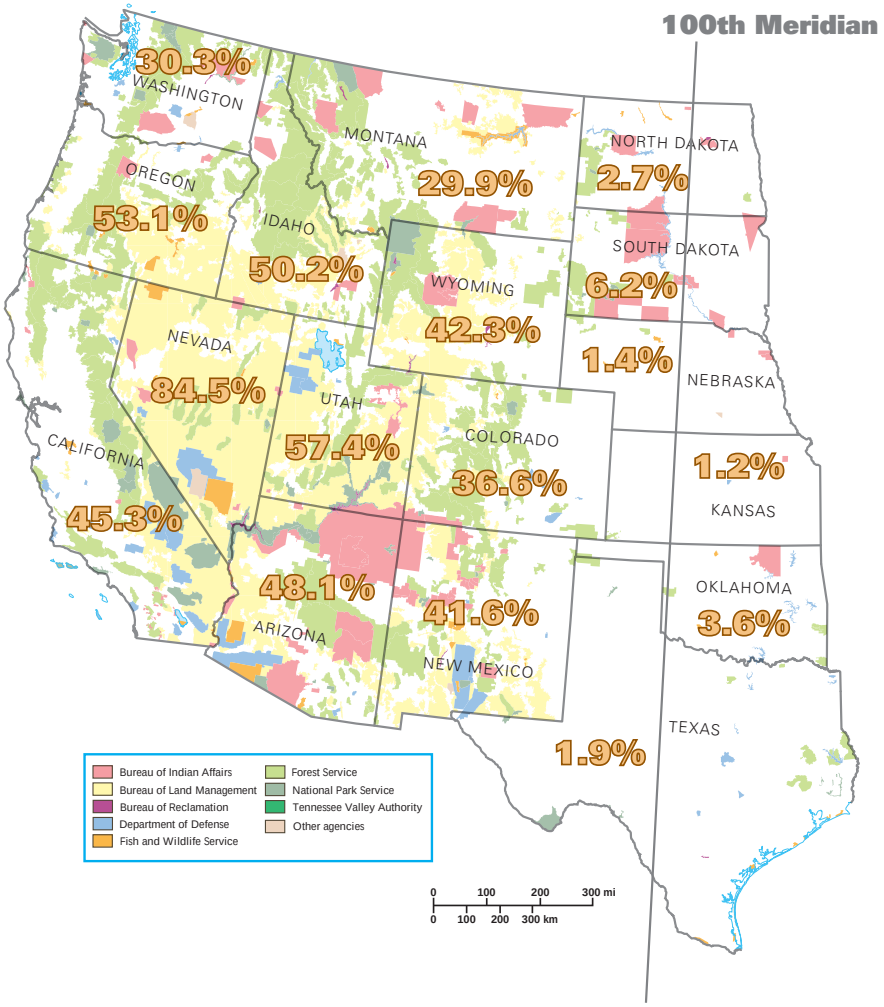


Fig. 2. Federal land ownership characterizes the American West. This public estate (shown here in percentage of each state owned by the federal government) includes national forests, national parks, and multiple-purpose public lands. *Source: Nationalatlas.gov*

Agriculture in this region depended on diversion of water for irrigation, as the rainfall is insufficient to grow most crops without supplemental water. More than a thousand years ago, the Hohokam civilization developed extensive water conveyance channels in what is now the Phoenix valley, and early Hispanic settlers organized around cooperative irrigation ditch associations known as *acequias*, many of which still operate in rural communities of northern New Mexico. For their part, Mormon settlers in the Salt Lake Valley (now part of Utah) laid out homesteads and townsites in relation to shared community water sources.

The scale of irrigation ramped up considerably when the United States sought to encourage agricultural settlers to stake private claims to the nation's newly acquired western lands in the late 1800s. Federal reclamation projects promised irrigation water to convert the arid desert to irrigable farmland, facilitating farming and economic development. Under congressional authority (and with a large infusion of federal funding), the U.S. Bureau of Reclamation constructed dams on many western rivers to store water to be used primarily for irrigated agriculture. Today the Bureau operates about 180 projects in the 17 western states, providing agricultural, household, and industrial water to about one-third of the population of the American West.

The U.S. Army Corps of Engineers also constructed numerous dams in the West and throughout the nation, primarily to improve navigation and protect lives and property from floods. These dams also provided economically important hydroelectric power, recreation, irrigation, and water supply for domestic and industrial uses. By 1975, Corps projects on the Columbia and Snake rivers alone were producing 27 percent of the total U.S. hydropower and 4.4 percent of all electrical energy output. (See Fig. 3.)

Fig. 3: Dams in the Columbia River Basin. Note: 15% of the land area of the Basin is in Canada, but 30% of the water flow originates in from Canada.
Source: U.S. Army Corps of Engineers

Large dams on major rivers enabled storage of spring snowmelt for use during drier periods later in the year, and to hedge against drought in subsequent years. Storage capacity in the West is enormous, with the dams on the Colorado River able to capture four years' worth of runoff; other western rivers have less storage capacity and operate as "run-of-the-river" operations for flood control and hydroelectric power generation. Canals, pumps, tunnels, and other structures carry water over long distances, even between river basins. Improved pumps made it possible to tap the underground water resources in vast aquifers, sometimes at considerable depth.

A variety of economic, political, and social factors led to a slowdown in federal investment in large new federal water projects in the latter half of the 20th Century. The U.S. Congress marked this shift with passage of the Water Resources Development Act of 1986 (P.L. 99-662), which reflected general agreement on several important signs of change:

- Nonfederal interests can, and should shoulder more of the financial and management burdens for federal water projects;
- Environmental considerations must be factored into federal water resources planning; and
- Marginal projects are unlikely to be constructed.

Federal water agencies now largely describe their missions in terms of water management rather than water development, with a strong emphasis on conservation and restoration. The fundamental goals of managing risk and providing a platform for economic growth remain important to the region's well-being.

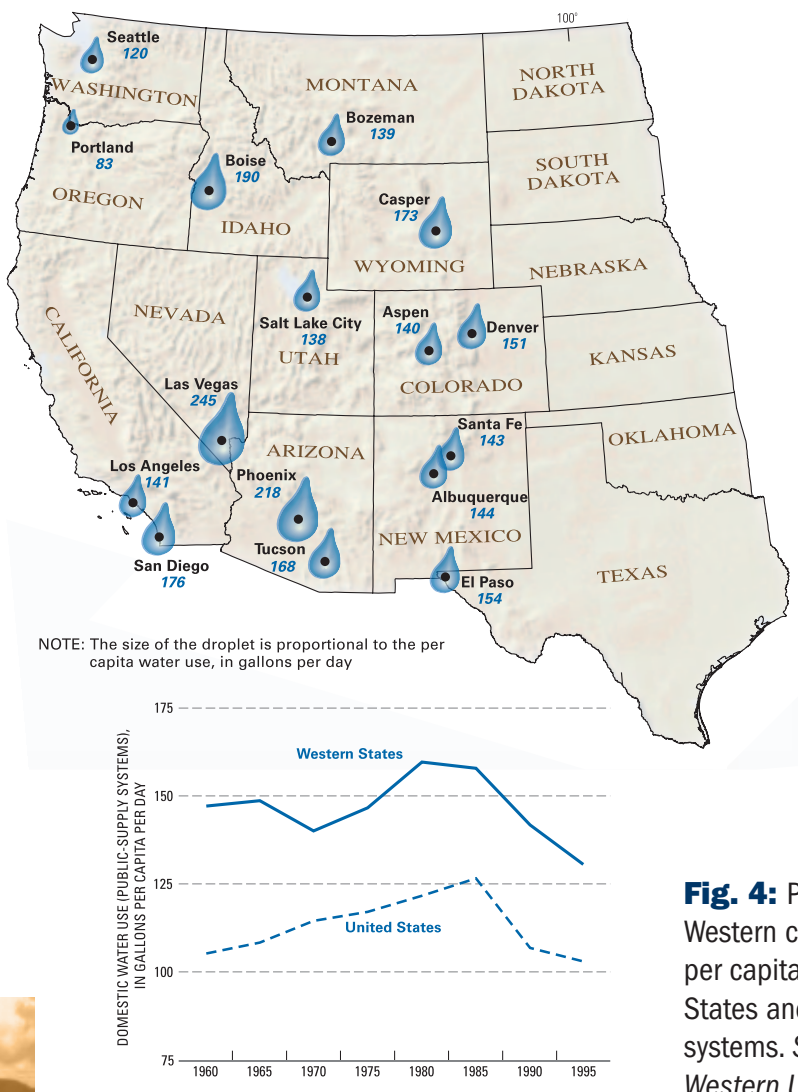
Federal investment in major water development projects significantly transformed the American West; new and changing demands continue this transformation today.

Ambitious water development projects in the western U.S. achieved most of their goals. Federally subsidized water and power, in addition to free and inexpensive land, encouraged massive in-migration from other parts of the country. Some of the newcomers established farms; many gathered in urban areas and established new engines of economic growth. Water scarcity and variability seldom proved insurmountable limiting factors, thanks to the considerable investment in infrastructure to capture, store, and move water to meet human needs.

Much of the industry in the West—including mining, mineral processing, manufacturing, and agricultural operations—would not have been possible without substantial public and private investment in water and power through multiple-purpose dams and related projects. Clean, reliable water supply remains a key factor in locating newer high-technology industrial sites. And the rapid expansion of both carbon-based and renewable energy development in the region requires access water (more for some sectors than others).

Given all these demands, it is useful to understand the current allocation of water resources in the western U.S. Irrigated agriculture accounts for most of the water used in the West today. Basic human needs (drinking, cooking, bathing, washing, and sanitation) require about 49 liters per person daily, but American households in many U.S. cities use far more, typically averaging 750-1,140 liters daily. (See Fig. 4.) In the arid regions of the United States, a significant amount of domestic water use is for lawn and garden irrigation.

In addition to these diverse out-of-stream uses of water, the past several decades have seen a revolutionary shift in scientific and public appreciation for the value of water flowing in its river of origin. "Environmental" or "instream" flows offer myriad values, ranging from commercially profitable recreation (boating and fisheries) to protection of tribal fishing rights and less tangible but important ecosystem services and aesthetic values to residents drawn to the region by its scenic beauty.



Western water sources have been utilized to the point that there are few undeveloped resources to draw upon to satisfy new demands or to restore depleted rivers and aquifers. Most rivers have been dammed to capture high spring runoff and to recapture water downstream for subsequent use. Although some states' laws prohibit ground water mining (that is, pumping more water out of an aquifer than the replenishment rate), ground water in many basins has been tapped at rates beyond the ability of aquifers to recharge, sometimes affecting associated surface waters and water users.

Fig. 4: Per capita water use for selected Western cities and comparison of average daily per capita water use for the contiguous Western States and the United States for public-supply systems. *Source: Water Availability for the Western United States, USGS*

As two experienced observers noted in a 2007 policy brief, "Without doubt, the biggest water-related challenge facing the . . . West is how to meet increasing water demands associated with a growing population with a fully committed but less secure water supply."[3] This is particularly true in light of projected impacts of global climate change. Although predictions vary (see sidebar), some models include substantial reductions in late-season streamflows in the American Southwest, where water is already scarce and variable. Markets and other forces may push for water to move from one sector to another, all within the framework of uses protected under state water law.

Water conservation—stretching existing supplies as far as possible through more efficient uses—is already emerging as a key strategy in meeting this challenge. Cities have launched a variety of programs to encourage household and commercial water use efficiency, including retrofitting showerheads and toilets with more efficient models, charging more for excessive water use, and encouraging landscaping using less thirsty native vegetation. (In some areas, outdoor landscaping consumes half of households' water usage.) Given the overall distribution of water use in the region, however, total savings from urban water conservation are dwarfed by the potential for agricultural water savings.

Water in a Warming West

The American West—already a region with dramatic variations in precipitation and river flow from year to year and season to season—may face far more dramatic variability in the decades to come as a result of global climate change. Warming temperatures may increase precipitation in some areas, reduce it in others, and increase evaporation from the reservoirs that form the linchpin in the region's water supply infrastructure. Moreover, scientists anticipate additional hydrologic trends related to climate change:

- Snowlines moving to higher elevations, with more precipitation falling as rain instead of snow in the winter, and earlier, "flashier" runoff patterns;
- Flooding and erosion during high-runoff events, causing murkier rivers and damaging riparian habitat;
- Low streamflows during the hottest months of the summer and early fall, with related fish kills, water quality problems, and competition among water users; and
- Drier western forests with more extensive insect infestations, leading to tree deaths and more frequent and intense fires.

[3] MacDonnell, Lawrence & Denise Fort, *New Western Water Agenda*, The Water Report (Feb. 15, 2008).

In short, today's allocation of water, and the federal and state laws protecting this allocation, reflect the campaign of U.S. expansion into the arid American West, with a strong emphasis on irrigated agriculture, hydroelectric power generation, and flood control. The region's transformation continues, as westerners seek water for a far wider range of applications, particularly urban uses and meeting fish and wildlife needs, while still valuing agriculture as an important cultural and economic use of water. This water infrastructure will be challenged further if the region grows warmer in coming decades and its water supplies become less predictable.

Westerners enjoy many benefits of water development, but also face previously under-appreciated economic, social, and environmental costs of development.

In part because of the tremendous public investment in water infrastructure, the American West assumed an important role in the nation's economy—consistently showing up at the top of the charts for population growth rates, creation of new economic opportunities, and quality of life. People flocked to the region from other parts of the country, drawn by economic opportunities, freedom, vibrant cities, open landscapes, and opportunities for unparalleled recreation, much of it water-based. Low-cost hydroelectric power generated from federal dams fueled growth in the Pacific Northwest and the American Southwest.

Much of the most dramatic growth in the American West is occurring in suburbs around core cities—comprising large, linked areas of population concentration that now are known as "megaregions" (see Fig. 5). This development pattern requires a great deal of water, as suburban developments often include large landscaped lots requiring irrigation. Moreover, contaminated runoff from vast paved surfaces and other sources of contaminants have polluted western rivers and impaired aquatic life. Sprawling development consumes lands previously dedicated to agricultural production, leading some to express concerns about the opportunities for locally grown food and preservation of open, working landscapes.


Photo Courtesy of Samir Mahendra

On the other hand, agricultural irrigation prompts its own suite of water quality concerns: runoff from irrigated fields leads to loadings of nutrients, pesticides, and trace elements to surface waters, leaching of agrichemicals into groundwater supplies, and overheated stream water due to diversions. A U.S. Geological Survey study of agricultural land in watersheds with poor water quality estimated that 71 percent of U.S. cropland (nearly 120 million hectares) is located in watersheds where the concentration of at least one

of four common surface-water contaminants (nitrate, phosphorus, fecal coliform bacteria, and suspended sediment) exceeded generally accepted instream criteria for supporting water-based recreation activities.

A major study of western water policy noted that federal water projects supported by political and market forces at the time successfully transformed western rivers into economically and socially productive assets, but concluded that the environmental costs have been high:

> Dams have flooded valleys and displaced farmers and communities, blocked or disrupted fish migrations, reduced naturally occurring flood frequencies and magnitudes, disrupted natural temperature fluctuations, altered low flows (sometimes increased, sometimes decreased to zero), reduced sediment and nutrient loads, changed channel-sediment characteristics (especially particle size and mobility), narrowed and shrunk river channels, changed channel patterns, and eliminated flood plains.[4]

Much of the major water infrastructure in place is nearing the end of its planned design life and is beginning to break down from under-maintenance or simple wear and tear. Dams that are not up to current safety codes necessitate lower pool elevations and water release restrictions. Shrinking surface waters from droughts and urbanization as well as population growth increasingly tap ground water and testify to the need for new water supply infrastructure and water treatment plants and increased aquifer storage.

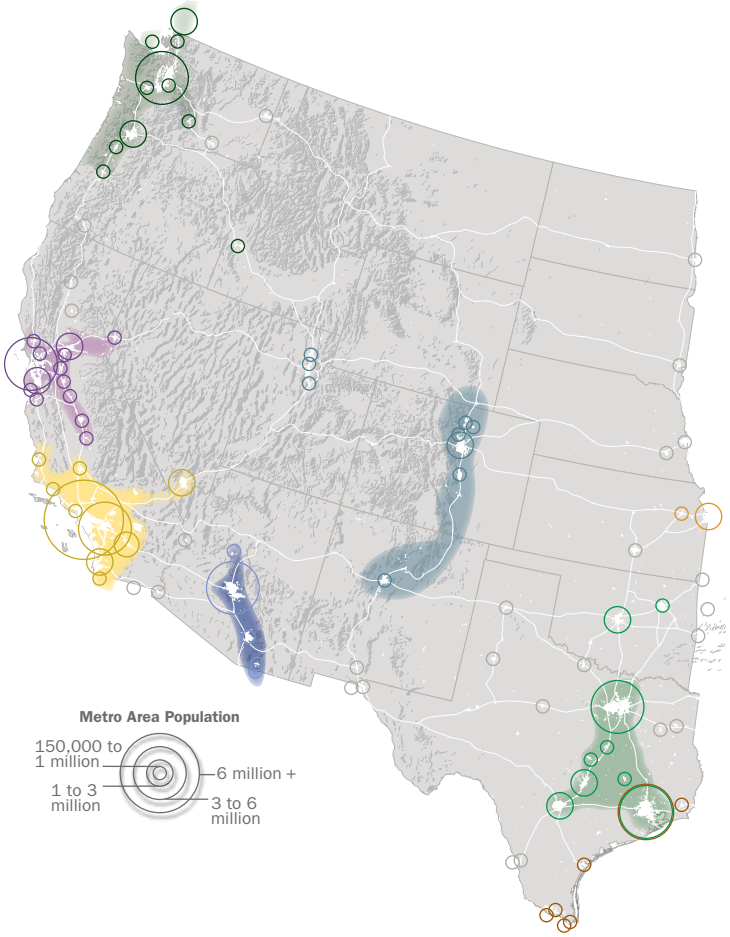


Fig. 5: Western United States "megaregions," defined as population areas with interlocking economic systems, shared natural resources and ecosystems, and common transportation systems links. *Source: America 2050, www.america2050.org/megaregions.html*

[4] Western Water Policy Review Advisory Commission, *Water in the West: Challenge for the Next Century* (June 1998).

Nearly every western river is now harnessed by dams and diversions, to the point that natural flows are a matter of estimate or distant memory. Vast stretches of rivers have been inundated or depleted to achieve economic benefits, but ecological considerations often received limited attention in early decisions governing dam location and operation. Indeed, some dam operators today still follow management regimes that were worked out many decades ago to serve the objectives of navigation (primarily barge traffic), hydroelectric power generation, and water diversions for agricultural irrigation, industries, and municipalities.

Restoration, reoperation, and even removing dams are emerging as important new areas of study, investment, and action in the 21st Century. On the Columbia River system, for example, there has been considerable investment in retrofitting dams to accommodate native fish—installing "fish-friendly" turbines and water flow channeling both above and below dams to adjust flows and temperatures in response to fish and other environmental concerns. Dam removals, while still uncommon, are on the increase and gaining a great deal of public attention.[5]

Pressure to allocate scarce and variable water to meet changing demands prompted new state water laws and risk allocation schemes, which are now evolving to address new values and demands for water.

Much economic growth in the American West relied upon a legal system that recognizes private rights to put water to productive, economic use, while the water itself remains a public resource. In fact, a strong thread of public interest in water underlies a system that emphasizes private rights and decentralized decisions.

At the outset, it is important to note that these institutions developed within a system of U.S. federalism. In this system, the fundamental roles of the national government are to protect water quality through national standards and enforcement; ensure minimum flows for navigation, fish and wildlife species; and protect Indian treaty rights to water. In some instances, Congress has mandated that federal water and environmental protection laws take priority over state water allocation laws. For water in excess of these legally protected needs, states have the legal authority to grant rights to *use* water to private and public entities. The states issue and enforce water right *use* permits; they do not issue rights to *own* water analogous to the right to own property. Western water law today is an amalgam of state, tribal, and federal laws and regulations, but states play the most visible lead role. This relationship is constantly in flux as environmental needs and protection of tribal water rights demand increased attention.

[5] See, for example, "*Elwha Dam Removal Illustrates National Movement*," *Washington Post* (Sep. 26, 2011), www.washingtonpost.com/national/health-science/elwha-dam-removal-illustrates-growing-movement/2011/09/13/gIQAZFjtYK_story.html.

The West's practical set of rules concerning water use evolved from customs in western mining camps, and is often referred to in shorthand as "first in time, first in right" or, more formally, as "prior appropriation." Unlike legal traditions in the eastern part of the U.S., prior appropriation allows the earliest water users to claim as much water as they can use, in some cases far away from the river of origin, and protects the "senior" rights holders to full satisfaction of their claims in times of shortage. Such rights are issued in perpetuity, as long as the water right holder continues to use the same quantity of water for the authorized uses. If not, the portion of the water right not used is subject to being lost, and re-allocated to other uses in order of their respective priorities.

This state-based water rights system provides important security for those who construct ditches and other infrastructure investments to move water to where it is needed, ensuring that they will not lose their access to reliable water to interference by a later-arriving upstream settler. Subsequent claimants can identify sources of water not yet committed to legally protected uses and develop these sources to meet new demands and uses, understanding the risk of being cut off in times of shortage. Water rights may be transferred among users (following a public review process to make sure the change would not impair other rights), with seniority providing the key measure of value. This flexibility has been an important factor in the system's ability to adapt to changing water needs in the region, as water can move through voluntary, market-based transactions to higher-valued uses.

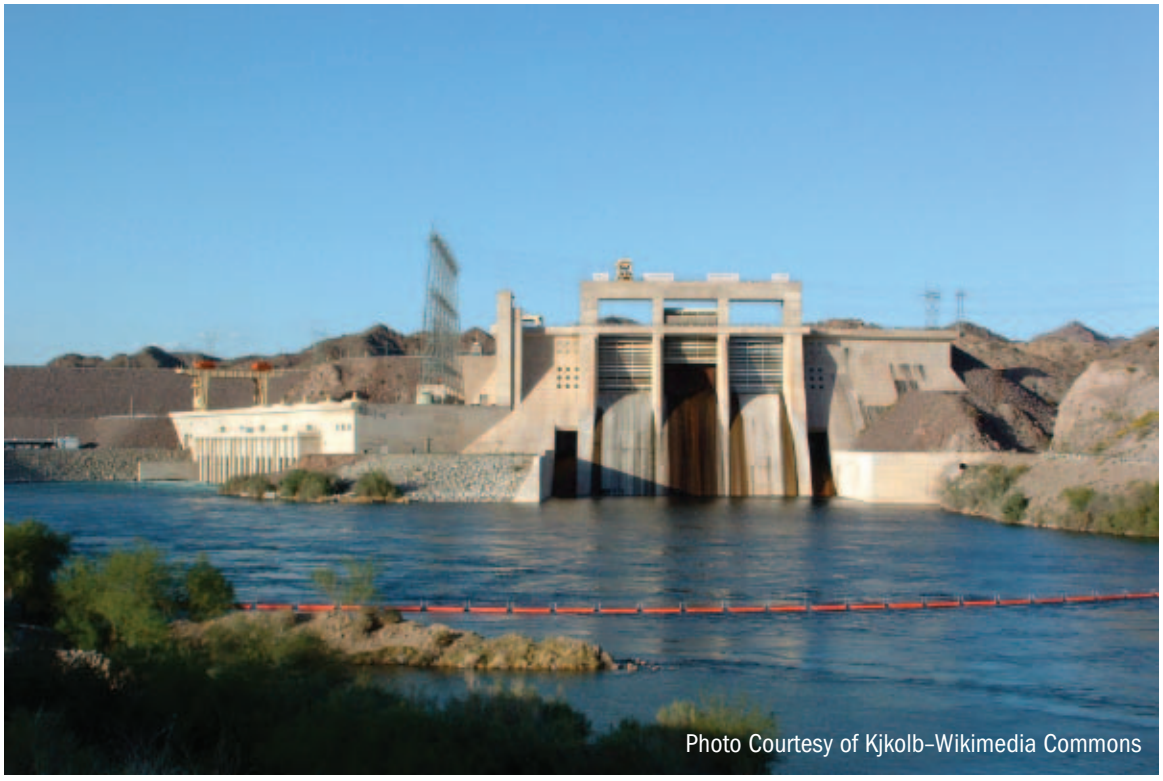


Photo Courtesy of Kjkolb–Wikimedia Commons

This state-based water rights system leaves a good deal of discretion to individual water users and their associations—mutual ditch companies, water districts, and private utilities. State water laws developed with little overall vision except to encourage water development for productive uses. Thus, western water "policy" comprises an accumulation of thousands of individual or localized decisions about water use and application, as well as ongoing negotiations among competing parties affected by water decisions. State laws provide a mechanism to resolve some of these disputes, and place some constraints on the range of options available to water right holders. Increasingly, state water leaders have embraced the notion of comprehensive planning for a sustainable water future.


Photo Courtesy of USACE

Prior appropriation (codified in state law) remains the basic rule for water allocation throughout the American West, though it has evolved to reflect changing uses of and values for water. For example, the doctrine originally required that water be physically diverted from a stream for a valid water right, as a measure to prevent speculation and hoarding. Yet, beginning in the 1970s, western states recognized beneficial uses of water flowing instream to maintain fisheries, improve water quality, support recreation, and other purposes (referred to in this report as "environmental flows"). State laws vary in their breadth, with some allowing only state agencies to hold rights to environmental flows and others allowing nongovernmental organizations and private parties to purchase or lease water for such purposes.

In short, the legal system evolved in western states to allocate rights to use water reflected a strong emphasis on economic development, but little overall vision for the long term. Its inherent flexibility allows changes in water use to meet new and changing demands, including satisfying the needs of growing urban areas and re-watering valuable western river ecosystems. The foundation of public ownership of water places state governments in a position that is sometimes likened to that of a trustee, responsible for ensuring that the value of the resource as a whole is not destroyed by valid private rights to make use of it.

Water management in the American West today involves multiple government agencies, private entities, and nongovernmental organizations operating in a federal system of shared sovereignty and responsibility.

The division of power between states and the national government has always been a balancing act in the American West—an ongoing test of the parameters of federalism. Early in the emergence of water law in the American West, the federal government opted to allow states to take the lead in administering private rights to use water. Each western state developed its own laws and administrative procedures for quantifying water rights and sorting out disputes. Some rely on specialized courts, while others do most of the work though administrative agencies.

Because the federal government manages about half the lands in the American West (see Fig. 2 above) and has special fiduciary responsibilities regarding Native American tribes and Indian reserved water rights, there is an entire category of water rights founded on federal, not state, law. Congressional and executive reservations of federal lands, such as for Indian reservations, national forests, and wildlife refuges, include the right to sufficient water to accomplish the primary purposes of each reservation. These rights cannot be lost by nonuse, and have priority dates not later than the date the reservation was established. In 1952 the U.S. Congress consented to judicial adjudication of federal reserved water rights in state courts, as long as the adjudication includes all water rights in a basin.[6]

In addition to federal water rights, the federal role in western water management remains strong because of the numerous flood control, hydroelectric, and water supply projects throughout the region. Federal agencies usually deliver project water by contract under authority of federal statutes. Most of the time, state water law and federal water project law operate synchronously. However, when the laws conflict, the scope and strength of the rights to use the water become much less certain.


Photo Courtesy of USACE

[6] This is known as the McCarran Amendment, and is codified at 43 U.S.C. § 666.

As mentioned earlier, the federal role in western water management has shifted from construction of new facilities to management of existing projects to meet changing societal needs, particularly those related to urban growth and fish and wildlife needs. Federal agencies provide important national leadership in protecting water quality, wetlands, and endangered species under explicit congressional mandates. Many of these mandates are implemented through a system of cooperative federalism, in which states and Indian tribes administer environmental protection programs within the sideboards of national standards.

In addition to the important and continued federal presence in western water policy, many local and nongovernmental entities are involved in water management. Voluntary watershed associations link water users to other residents through shared concerns for land and water health. Private organizations such as water trusts and conservation groups acquire water rights from irrigators and transfer that water to environmental flows. Land trusts protect habitat along streams to enhance water quality and fish and wildlife resources. Advocacy groups of all persuasions demand a voice in water decisions, and are increasingly recognized as legitimate stakeholders.

Water in the American West presents something of a political conundrum: a fundamentally public resource, shared by all in a broad sense, but to which deeply valued private rights of use and priority have attached. From a history of water rights and straightforward conflict resolution has emerged a more complicated structure of water governance, mutual accommodation, and public engagement. Like the region itself, this institutional transformation is far from complete.

Photo Courtesy of USACE

Adaptive Strategies for Water Scarcity and Variability

Challenges of managing water in the American West have given rise to innovative and adaptive management strategies, many of which continue to evolve today. This discussion highlights the key strategies developed in the arid inland western states, described in six categories that relate to "water solutions" themes laid out for discussion at the 6th World Water Forum. Key resources for learning more about each identified strategy are listed in Appendix A at the end of this report. Fig. 6 relates these strategies to the 6th World Water Forum themes and conditions for success.

CORRELATION BETWEEN WESTERN WATER ADAPTIVE STRATEGIES AND 6th WORLD WATER FORUM THEMES AND CONDITIONS FOR SUCCESS

U.S. AMERICAN WEST	6TH WORLD WATER FORUM PRIORITIES FOR ACTION
Managing Water as a Scarce and Variable Resource	1.4 – Prevent and Respond to Water-related Risks and Crisis
Protecting River Ecosystem Values	2.4 – Promote Green Growth and the Value of Ecosystem Services 3.1 – Improve the Quality of Water and Ecosystems
Honoring Indigenous Water Rights	1.1 – Guarantee Access to Water for All and the Right to Water
Engaging Diverse Stakeholders in Developing New Solutions	CS 1 – Good Governance
Managing Water Across State and International Boundaries	1.5 – Cooperation and Peace through Water 2.1 – Balance Multiple Uses through Integrated Water Resources Management
Innovative Tools for Water Infrastructure Financing	1.1 CS 2 – Financing Water for All

Fig. 6 Correlation of western water adaptive strategies to the WWF6 Priorities for Action. For more information on the 6th World Water Forum, go to www.worldwaterforum6.org.

Again, it is important to note that these strategies emerged and exist today in a political system of federalism. States play the primary role in enacting laws and administering water rights. Federal laws provide an overlay aimed at achieving broad national objectives (clean water, endangered species recovery, etc.), and the federal government long played an important role in funding and constructing multi-purpose water projects. Indian nations assert sovereignty over the resources on their reservations, as well as those within treaty guarantees (such as fisheries). The amalgam we call "western water policy" thus comprises the interplay between all these government bodies, as well as private decisions of many individual water users and water organizations.

1. MANAGING WATER AS A SCARCE AND VARIABLE RESOURCE

Western states' water laws emerged as an adaptive conflict resolution tool in a historical period with few courts or government officials. Their system of prior appropriation thus works as a means of allocating private rights to *use* water, the ownership of which remains in the hands of the public. These state laws are notable for their duality, as they: (1) consistently recognize water as a highly valued public resource, managed on behalf of present and future generations under duties sometimes described in terms of a public trust; and, at the same time (2) strongly emphasize and protect the individual's right to use water as a private property right, and rely upon decentralized individual and localized decision processes to control most water management decisions.

This public-private duality reflects the role of water as an essential tool of economic development in an arid landscape, as well as the fact that it is a shared resource that crosses many jurisdictional divides. This section highlights several features of western states' water institutions that facilitate investment security, allow flexibility to meet evolving needs, and provide incentives to make more efficient use of limited resources for a more sustainable future.

- **States' prior appropriation laws provide a means of risk allocation and conflict resolution among water users consistent with public goals for water use.**
  - **Self-initiated**: Water is available to meet new needs so long as there is unclaimed water in the river. As most streams are over-appropriated, there is little "unclaimed" water to satisfy new uses.
  - **Use right separate from land ownership**: One need not own land adjacent to a watercourse to claim a right to use that water. Because a water right is separate from land ownership, water transfers are an increasingly important way for interested parties to seek new water supplies.
  - **Security/risk allocation**: Protecting senior water rights holders from injury is a means of protecting investment capital of those holding the longest-established rights while allowing others to establish new rights with an understanding that water supplies may be curtailed in times of shortage.

- **Prevent waste and speculation**: State law only protects claims for recognized "beneficial uses" (typically including irrigation, stock watering, municipal, industrial, domestic, power generation, and environmental flow uses such as maintaining fisheries and providing recreational opportunities), to encourage uses of water valued by the public while discouraging waste and speculation.

- **Voluntary market-based water transfers help meet new and changing needs.**
  - **Adaptive:** Despite the fact that most western rivers are now over-appropriated, new demands for water may be satisfied by transferring existing rights through voluntary, market-based transactions. Given the current allocation of water uses, the most common transfers are from irrigated agriculture to urban or environmental uses.
  - **Flexible:** Transfers may, but do not always, result in retired farmland. Increasingly, flexible mechanisms such as leasing, dry-year options, and temporary fallowing allow continued farming using less water.
  - **Public review:** State law usually requires a review of proposed changes in water use to ensure that other water rights holders will not be harmed, and that the new use is in the public interest.

- **Incentives for conservation and efficiency maximize the benefits from developed water supplies.**
  - **Legal tools:** Wasteful applications are not "beneficial" uses protected by state law; water use may be constrained by enforcement of state anti-waste rules.
  - **Cost-effective:** Water suppliers recognize conservation in increasingly the least expensive source of "new" water, and regularly include it as an important component in water supply strategies.
  - **Urban emphasis:** Many states and municipalities now encourage or mandate water savings through building codes, public education programs, subsidies to encourage retrofitting with more efficient appliances, and pricing structures that penalize excessive use.
  - **Agricultural potential:** Given the large proportion of western water devoted to irrigated agriculture, this sector promises large potential savings through installation of efficient water delivery technology, growing less water-consumptive crops, and reducing evaporation.
  - **Water re-use as the next frontier:** In addition to reducing demands for water, the broad category of conservation includes measures to capture, clean up, and make water available for additional uses. Such programs remain relatively new in the American West, typically focused on ground water replenishment areas near urban areas.

- **Conjunctive management links surface and ground water.**
  - **Overcoming "divided waters":** Historically, states regulated access to surface and ground water separately, with little control of individuals' rights to pump from aquifers. Most western states apply the prior appropriation doctrine to both surface and ground water, but their approaches vary a good deal. As surface water supplies have become fully appropriated, many water users have turned to ground water, sometimes pumping at unsustainable rates or impairing the flows of adjacent rivers and impairing the rights of nearby water rights holders. Western states are beginning to address the relationship between surface and ground water through new legal rules and practices, but there is little consistency and many loopholes remain.
  - **State law recognizes, encourages solutions:** In some cases, water users from distant parts of a river system have negotiated creative and practical means of coordinating surface and ground water use through exchange and augmentation agreements. State law can facilitate and provide incentives for such solutions, as Colorado has done with respect to urban and agricultural water users on the South Platte River.
- **The federal government supports state primacy in water management with a large and ongoing investment in scientific research and data sharing.**
  - **Cooperative climate information sharing:** For example, in 2011, the Western Governors' Association and the National Oceanic and Atmospheric Administration announced a joint agreement for improving the development and delivery of climate science and services to western states to inform their planning and management decisions.

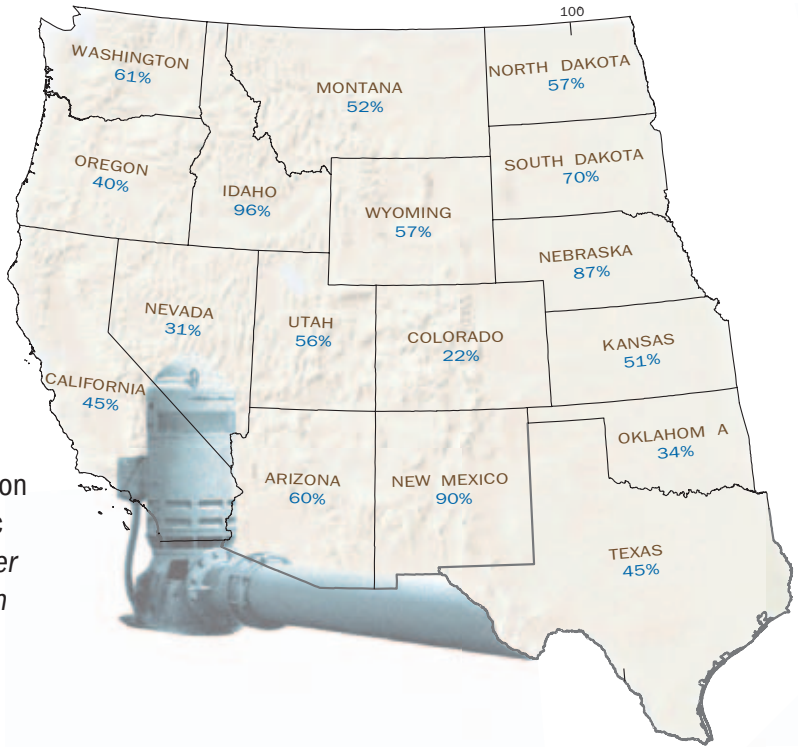


FIG 7. Percentage of population of each State in the contiguous Western United States dependent on ground water for domestic water needs. *Source: Water Availability for the Western United States, USGS*

2. PROTECTING RIVER ECOSYSTEM VALUES

Historically, western states' water laws emphasized economic development by encouraging utilitarian approaches to putting the West's rivers to work—storing water for use during dry periods; moving water over the landscape to satisfy human demands; and maximizing a limited number of "beneficial" uses such as irrigation, municipal, industrial, and domestic supplies. As one U.S. water official observed recently, "What worked is what we valued when we set up the system—water for new communities, irrigation, and flood control. Our challenges today arise from the consequences of what we didn't prioritize or plan for—water for ecosystem services and to fulfill our promises to Indian tribes."

At their most extreme, historical policy choices resulted in over-appropriated and dewatered streams, depleted aquifers, and degraded river ecosystems. In some cases, water withdrawals and land development practices compromised water quality in both surface and ground water. Demographic shifts have changed the very structure of demand for water in the West, but institutions continue to reflect historical distribution patterns.

Over time, societal values have shifted and recognized the value of water flowing in rivers, where it supports natural ecosystem functions (including water quality) and supports a diversity of living creatures. In some cases, new information revealed important linkages between development practices and the security of water for future generations, raising additional concerns and desires for protection. Projected impacts from climate change have sparked a broader and more focused conversation about necessary measures to ensure healthy and resilient watersheds and rivers in the coming decades. One piece of federal legislation alone—the Endangered Species Act—arguably prompted more creative, innovative ecosystem-based solutions than any other factor in this region.

This section highlights the evolution of federal and state laws aimed at protecting and restoring western water resources, as well as emerging policies reflecting new concerns about the consequences of development practices and climate change.

As described above, it is important to remember that water law in the American West is an amalgam of state, tribal, and federal laws and regulations, all within a system of federalism. Thus, while states play the primary role in managing water allocation and use, the national government asserts important rights and regulatory authorities that sometimes limit the private exercise of state-granted water use authority. This section highlights the broad parameters of both separate and shared legal authorities.

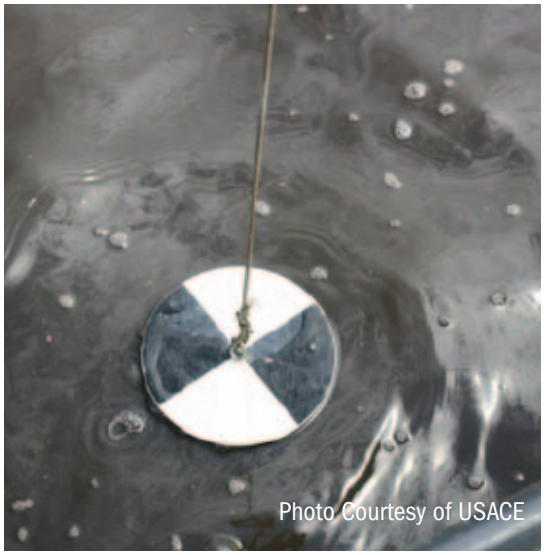


Photo Courtesy of USACE

- **Federal standards protect water quality and species diversity.**
  - **National standards:** Congress sets minimum uniform standards through legislation such as the Clean Water Act and the Safe Drinking Water Act.
  - **State/Tribal implementation:** When delegated authority by federal officials, states and tribes may implement federal standards through their own enforcement programs, supported with federal funds and other resources.
  - **Express federal mandates:** Under the U.S. system of federalism, states retain all legal authority not expressly ceded to the national government through the Constitution. Federal environmental laws illustrate one area in which federal powers have been interpreted broadly. Some congressional mandates (e.g. Endangered Species Act) do not allow delegation to states or tribes. Nonetheless, implementation of these programs increasingly involves shared responsibilities though innovative partnerships and habitat protection agreements.
- **State laws enable protection of environmental flows.**
  - **Legal rights:** All western states recognize some instream uses as "beneficial" and thus deserving legal protection in prior appropriation scheme. Some states recognize a broad range of environmental flows; others limit protection to coldwater fishery habitat.
  - **Voluntary transfers:** Since most rivers are over-appropriated, environmental flows are usually obtained through voluntary transfers from existing water right holders. The environmental flows assume the seniority of the original water use.
  - **Essential partnerships:** Although many western states do not allow nongovernmental organizations (NGOs) to hold environmental flow rights, these entities play a critical role in financing and facilitating these transactions.
  - **Inherent tribal authority:** Tribes also possess and exercise important regulatory authority. Tribal water rights for environmental flows also protect the ecosystem and species diversity.
- **Energy development poses new challenges to water quality and quantity.**
  - **Water-energy nexus:** Pumping and transporting water requires a great deal of energy; producing energy sometimes consumes a great deal of water. This relationship has gained new attention in recent years.[7] With the exception of the Columbia River Basin, where integrated planning for hydropower, flood control, and fish and wildlife needs is long established, public understanding of the water and energy nexus is still in its infancy. At the very least, managers are recognizing that water conservation saves energy (and vice versa), and are beginning to calculate energy costs of new water projects.

[7] See, for example, the recent report of the Pacific Institute, *Water for Energy: Future Water Needs for Electricity in the Intermountain West* (Nov. 2011), www.pacinst.org/reports/water_for_energy/.

– **New technologies outpace regulations:** Large portions of the American West are experiencing rapid energy development, both renewable (solar, wind, and geothermal) and carbon-based (including shale-oil development through hydraulic fracturing). New technologies may impair the reliability and quality of local water supplies. Federal and state regulatory agencies are working to study and develop new regulations to address these potential impacts.

- **River restoration includes multi-stakeholder partnerships that work out mutually beneficial plans for operating projects differently—in some cases, decommissioning them.**

  – **Evolving federal and tribal role**: Federal agencies, including the Bureau of Reclamation and the U.S. Army Corps of Engineers, and Indian tribes are now playing an active role and working with diverse partners in assessing opportunities for river ecosystem restoration.

  – **Multiple purposes and funding sources**: River restoration, including dam reoperation and decommissioning, may be driven by a number of factors, including endangered species mandates, safety concerns, Indian fishing rights claims, or some combination of these factors. In some cases, private entities cover much of the cost of removal due to liability for past environmental harms (whether through application of the federal "Superfund" law or various "good Samaritan" legal protections); more frequently, restoration efforts depend on congressional appropriations.

Photo Courtesy of Ben Cody

3. HONORING INDIGENOUS WATER RIGHTS


Photo Courtesy of USACE

What is now the American West was inhabited by Indian tribes long before the formation of the United States. In ceding portions of their land, Indian nations reserved rights to hunt, fish, and continue other traditional uses of their historical homelands and reserved the water necessary to support those rights. They also reserved rights for irrigated agriculture and other uses necessary to a sustainable homeland. In subsequent years, the federal government did not adequately protect Indian reserved water rights, allowing and even encouraging subsequent development that led to conflicts over access to scarce and variable water supplies. Litigation and negotiated settlements in recent decades have resolved some of these disputes and clarified the various roles of federal, state, and tribal authorities in western water management.

This section provides an overview of the legal basis for Indian reserved water rights, the proceedings under which these have been recognized and quantified, and the complex jurisdictional arrangements through which these matters are resolved.

- **Indian reserved water rights are based on inherent sovereignty, protected by the U.S. Constitution.**
  - **Pre-existing rights, recognized by legal treaties:** Many sovereign Indian nations entered into legal agreements with the federal government, which were ratified by Congress under authority of the U.S. Constitution's Treaty Clause. Importantly, these treaties recognized pre-existing indigenous rights to water; they did not create or grant new rights. The imposition of the European notion of legal rights to resource use onto existing values and traditions of Indian people in the U.S. is a challenging and often unsatisfying process.
  - **Scope of rights:** As recognized by the U.S. Supreme Court in *Winters v. United States* (1908), the establishment of an Indian land reservation includes reservation of sufficient water to achieve the purposes of the reservation. In the American West, where one purpose of reservations included irrigated agriculture, courts interpreted this as a right to a quantity of water sufficient to grow crops on all "practicably irrigable acreage." Tribes also reserved instream water rights to support their traditional lifestyle and to make their homelands sustainable. These Indian reserved rights have seniority dates no later than the date of the reservation, and are not lost by non-use.

- **Indian water rights may be decided in federal court or in state court in general stream adjudications.**
  - **Constitutional law foundation**: Indian reserved water rights are based on constitutional law, and their exercise within a reservation may not be limited or impaired by state statutes.
  - **Consent to state jurisdiction**: In 1952, the U.S. Congress consented to state court jurisdiction over adjudication of reserved Indian right in a "general stream adjudication"—that is, a comprehensive judicial proceeding that sorts out and quantifies all the water rights in a river or water source.
- **Indian reserved water rights are increasingly settled through negotiation rather than litigation.**
  - **Time-consuming, expensive litigation**: Some Indian reserved rights cases have stretched over several decades, consuming many millions of dollars and hardening positions of various affected parties. During the pendency of these cases, Indian people may be left with nothing but conceptual water rights, and little opportunity for economic development requiring water on their reservations.
  - **Trend toward negotiated settlements**: In recent years, some Indian reserved water rights have been resolved through negotiated settlements involving other affected water users as well as the tribes and state and federal officials. Frequently, the settlement includes federal funding to develop new water infrastructure to fulfill historical promises to Indian people while minimizing impacts on those who developed water from the same source in the intervening years. (See sidebar for an example from Montana.)

Montana Reserved Rights Compact Commission

The Montana Legislature created the *Reserved Water Rights Compact Commission* in 1979 to negotiate compacts for the equitable division and apportionment of waters between the state and its people and the several Indian Tribes claiming reserved water rights within the state, and between the state and its people and the federal government claiming non-Indian reserved waters within the state. All but one of the tribes in Montana has concluded negotiations with the state, producing a compact. These agreements typically include quantification of the tribal water right, guidelines for shared jurisdiction in administering water rights, and financial support for new water infrastructure.

4. ENGAGING DIVERSE STAKEHOLDERS IN DEVELOPING NEW SOLUTIONS

Many competing interests wish to participate in governance of the West's valuable water resources. Sorting out these diverse demands through enforcement of legal rights alone results in winners and losers, often costing a good deal of money and leaving many unsatisfied. Increasingly, westerners are discovering new means of dialogue and cooperation, often outside the strict boundaries of legal regimes, resulting in more creative and mutually satisfying outcomes that make better use of limited water resources and resolve problems creatively.

Historically, the federal government attempted an orderly development of water resources through large, interstate river basin planning entities. These efforts shaped some of the major federal multiple-purpose development on western rivers, and variations on the idea of organizing institutions around river basins continues to emerge (see, for example, the recommendations of the Western Water Policy Review Advisory Commission in 1998). As described in the next section on managing across political boundaries, river basins are the organizing units for some important interstate and international entities, but the federally driven river basin entity does not dominate the institutional landscape in the American West. Instead, state governments and others are increasingly initiating watershed-based planning efforts for water resources and related habitat.

This section highlights several types of innovative partnerships and inclusive dialogues that help reduce conflicts and foster innovative solutions to water challenges. Perhaps the key point is that there is no single formula for a successful collaborative initiative and no "best" scale at which to work. Water users and other stakeholders create their own strategies based on the problems at hand, given the nature and interests of the parties and available resources. The federal government has assumed a facilitative role, providing critical monetary and in-kind support for these initiatives, as well as recognizing their value in achieving national water resource goals. For their part, states and tribes have enabled innovative water sharing through negotiations and agreements.

Diverse networks and dialogues foster innovation.

- **Leaders' networks**: The Western Governors' Association (WGA), Western States Water Council (WSWC), and other networks of leaders working on water issues in the western U.S. have engaged in productive, forward-looking conversations about management challenges, policy reforms, and common interests. In the early 1990s, for example, the WGA produced a set of principles for water policy reform in the region known as the "Park City Principles"[8]; more recently, the WSWC facilitated high-level discussions about key elements of a national water policy.
- **Issue-specific dialogues**: Increasingly, people from diverse interest groups have participated in productive facilitated dialogues in which they explore common interests and potential solutions. One recent example is the Agricultural/Urban/Environmental Water Sharing Group, which evaluated innovative water sharing strategies in the Colorado River Basin.[9]

[8] Available at library.wrds.uwyo.edu/wrp/96-08/96-08.html

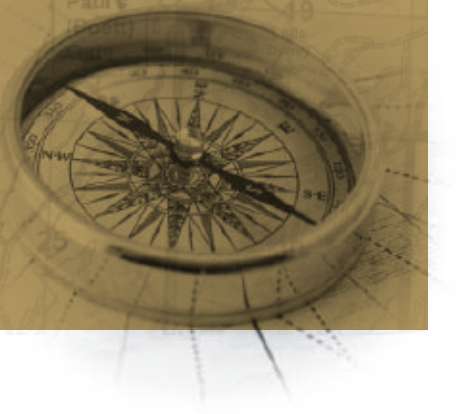
[9] Smith, MaryLou & James Pritchett, *Agricultural/Urban/Environmental Water Sharing: Innovative Strategies for the Colorado River Basin and the West* (Colo. Water Inst. Special Report Series No. 22, 2010), www.cwi.colostate.edu/watersharing.

Strategies to Engage Stakeholders in Water Management Decisions
Examples from the American West

- **COLORADO INTER-BASIN COMPACT COMMITTEE**
  Established by the Colorado Legislature in 2005 to facilitate conversations among Colorado's river basins and and to address statewide water issues. By engaging locally based Basin roundtables, the IBCC encourages dialogue on water, broadens the range of stakeholders actively participating in the state's water decisions and creates a locally driven process where the decision-making power rests with those living in the state's river basins. Information: www.cwcb.state.co.us/about-us/about-the-ibcc-brts/Pages/main.aspx/Templates/Home.aspx

- **BLACKFOOT CHALLENGE**
  A landowner-based group in western Montana with roots in the 1970s but organized formally in 1993, this group's mission is to coordinate efforts that conserve and enhance the natural resources and rural way of life in the Blackfoot River Valley for present and future generations. Its Drought Committee coordinates diverse water conservation efforts during low-flow periods to reduce stresses on fish and protect stream resources. Information: www.blackfootchallenge.org/

- **MISSOURI RIVER RECOVERY IMPLEMENTATION COMMITTEE**
  This advisory body provides guidance to the U.S. Army Corps of Engineers and affected federal agencies, state agencies, and tribes on a study of the Missouri River and its tributaries to determine the actions required to mitigate losses of aquatic and terrestrial habitat, to recover federally listed species protected under the Endangered Species Act, and to restore the river's ecosystem to prevent further declines among other native species. Membership includes representatives of federal agencies, eight states, up to 28 tribes, and 16 stakeholder categories. Information: www.moriverrecovery.org/mrrp/



Innovative partnerships link water users and other stakeholders.

- **Collaborative approach:** Mutual water associations date back to the mid-19th Century, and offer early models of cooperative water management. More recently, responding to years or decades of conflict over water management and resource protection, a wide variety of "odd bedfellows" gathered in collaborative groups to learn about their watershed, focus on mutual concerns, and explore possible solutions. These types of voluntary associations expanded rapidly in the 1990s and beyond. Today, there are hundreds of watershed groups in the American West, as well as, many other types of collaborative entities concerned with issues including water.
- **Diverse models:** There are many variations on place-based collaborative groups, ranging from neighbors focused on a local watershed to inter-agency public resource managers reaching across international boundaries to coordinate research and management policies. (See sidebar for examples.)
- **Practical outcomes:** With a few exceptions, these groups typically do not deal with broad policy issues, but instead focus on practical, on-the-ground management challenges—reducing the impact of cattle grazing on water quality, thinning forests to achieve local economic benefits and reduce wildfire risks (and thus protect water supplies), and removing unnecessary roads that impede fish passage and add sediment to streams.

Photo Courtesy of www.rodjonesphotography.co.uk

5. MANAGING WATER ACROSS STATE AND INTERNATIONAL BOUNDARIES

Like air, rivers are a quintessential shared resource, linking people and landscapes through mutual reliance on precious water. The visionary 19th-Century explorer and federal geologist, John Wesley Powell, recommended that the American West's political boundaries be drawn around hydrological divides, with human settlements linked to necessary irrigation infrastructure. His watershed-based notion found little political support, and today's western state boundaries pay little heed to the contours of river basins.

Years of serious conflict between states ensued, with those that developed their water resources earlier claiming permanent rights to that water, to the extent that other affected states viewed such actions as disproportionate, excessive, and unfair. The federal government stepped in, and most major interstate conflicts were resolved through legally enforceable agreements. In some cases, where rivers cross national boundaries, the agreements are between nations, in the form of international treaties.

The Northwest Power and Conservation Council[10] illustrates the benefits of interstate river agreements. Congress invited the Council's creation through passage of the Northwest Power Act in 1980, aimed at facilitating implementation of the Columbia River Treaty. The Governor of each of the four participating states appoints two members to the Council. The Council is a partner with the U.S. government in implementing the U.S.-Canada Columbia River Treaty. The Council:

- Adopts a widely respected and influential regional 20-year Power Plan with which the Bonneville Power Authority must operate consistently. BPA markets the power generated by federal dams on the river, and is co-manager of the U.S. Entity which implements the Columbia River Treaty.
- Develops a fish and wildlife program every five years to mitigate impacts from federal hydropower projects in the Columbia River Basin.
- Recommends hydropower operations for the "mainstem" river, which affect the timing and flows from dams and reservoirs through the two-nation system and which becomes a component of the Power Plan.

[10] See www.nwcouncil.org/

There is a great diversity of interstate agreements and international treaties affecting rivers in the American West. Summarized below is a sample of new and emerging approaches to resolving conflicts over shared waterways in the American West. They reflect efforts of water users and public officials to employ more flexible institutional mechanisms to respond to less secure water resources in light of projected impacts of climate change, as well as other factors, such as actual or potential treaty expiration dates.

One area that has received very little attention in the western U.S. is the transboundary nature of ground water resources, although these are implicated in the interstate compacts described below. Recent scholarship on the subject[11] suggests promising directions, but elected officials have not yet taken this on in a significant way.

- **Interstate compacts address conflicts, with creative, unique mutual efforts.**
  - **Federal law foundation**: The U.S. Constitution (Art. I, § 10, Cl. 3) authorizes Congress to approve certain binding agreements between states, known as "compacts." These are, in effect, treaties between states. Thus, although the federal government cannot force states to reach agreement concerning interstate river management, it has ultimate authority over compact terms. If states are unable to reach agreement, the federal government may assert its authority to allocate water through equitable apportionment—an extremely rare and politically unpopular solution.
  - **State government role**: Interstate compacts, which are Congressionally approved, are sometimes initiated by states and other times by the national government. The process includes major negotiations involving top state officials, approval by state legislatures, and final approval by Congress. (However, some interstate compacts do not require Congressional approval, pursuant to constitutional interpretations by the U.S. Supreme Court.)
  - **Relationship to water management in the American West**: Interstate compacts vary considerably in terms of purposes and structures for implementation. There are more than 20 such compacts in the U.S. West. (See sidebar for a representative sample.)
  - **Compacts promote and assure cooperation**: Often compacts designate an implementing entity. Typically, but not always, appointees to the entity include representatives from signatory states and/or federal officials. Generally, their compact authority relates to infrastructure and/or regulatory management. A compact might provide for a proportional allocation of water, commit upstream states or countries to deliver a specific quantity of water to downstream states or countries, or an exchange of water. It might also address water quality, hydropower infrastructure and operations, flood control, habitat protection and restoration, and other needs.

[11] See, e.g., Campana, Michael E., Alyssa M. Neir & Geoffrey T. Klise, *Dynamics of Transboundary Ground Water Management: Lessons from North America* (Water Resources Program, Univ. N.M. and Universities Partnership for Transboundary Waters, 2006), www.unm.edu/~wrp/WRP_16.pdf

– **Alternatives to interstate compacts:**

  - The federal government may assert its authority to independently allocate water in a way it views as equitable pursuant to the U.S. Constitution's Interstate Commerce Clause (Art. I, § 10, Cl. 3).
  - States may enter into a variety of voluntary agreements with each other without Congressional consent or other federal involvement. Many of these exist. For example, a compact may provide a proportional allocation or may commit upstream states to deliver a specific quantity of water to downstream states. Compacts may also address water quality and other issues. New issues or information may prompt amendments or side agreements that refine compact implementation and address unanticipated conflicts.

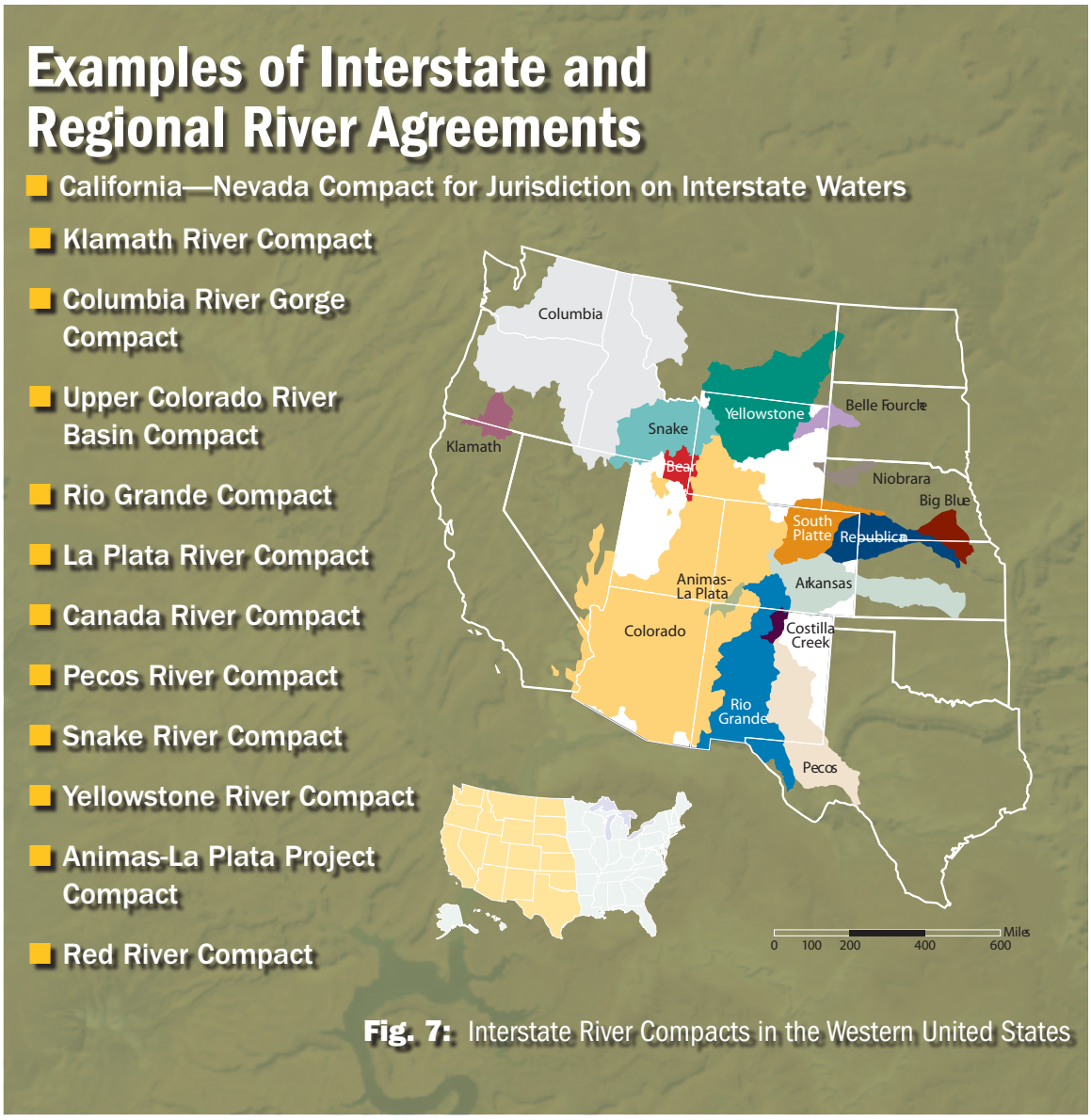


Fig. 7: Interstate River Compacts in the Western United States

- **International agreements offer similar benefits, and may foster broader approaches to river basin governance.**
  - **Constitutional law foundation**: The U.S. Constitution (Art. II, § 2, Cl. 2) grants power to the President to make treaties with the "advice and consent" of two-thirds of the U.S. Senate. International agreements regarding shared watercourses are negotiated by the U.S. Department of State, often in consultation with affected states, tribes, and stakeholders. Once ratified by the U.S. Senate, a treaty has the force of federal law, and overrides any relevant state law.
  - **Implementation by international bodies**: Typically, an international water treaty establishes a new commission or other entity to resolve issues that arise and refine the details of the broad agreement. Two prominent international bodies in the American West include the International Boundary and Water Commission (U.S.-Mexico) and the International Joint Commission (U.S.-Canada).
  - **Opportunities to adjust treaties**: Treaties may be binding in perpetuity (unless amended) or may have terms that expire after a specified number of years. In either case, the signatory parties may seek (or be presented with) opportunities to revisit assumptions or terms of the treaty. In the case of the Columbia River Treaty (see sidebar), it has no specified end date. However, either country may terminate most of the treaty provisions with a 10-year notice sentence and, the flood control provisions automatically expire in 2024, independent of any treaty decision. Major studies of options are currently taking place, and the notice deadline prompted a broad public consultation process, along with organizing efforts among Indian nations who did not participate as sovereign parties in the original treaty negotiation in 1964.

The U.S.-Canada Columbia River Treaty

The U.S.-Canada Columbia River Treaty is jointly administered by two bodies: a "U.S. Entity" (defined in the treaty as the Bonneville Power Authority and the U.S. Army Corps of Engineers) and a Canadian Entity (British Columbia Hydro).Through this treaty, the U.S. and Canada jointly manage the Columbia River system. This is one of the largest river systems and has the largest hydropower system in North America, with numerous large dams and reservoirs in both countries. About 15 percent of the river basin is in the Province of British Columbia, Canada, and about 30 percent of average river flows come from Canada. Complex, detailed agreements cover dams, reservoirs, river flows, power purchases, power system operations, and flood control.

6. INNOVATIVE TOOLS FOR WATER INFRASTRUCTURE FINANCING

The federal government served as a major source of financial support to enable construction and operation of the water infrastructure that transformed the American West, but private investment has also been immensely important to the water facilities and institutions in the region. Strategic policies early in the 20th Century produced ambitious reclamation, flood control, and power generation projects that harnessed the economic potential of western rivers.


Photo Courtesy of Cinch Design

Beginning in the latter part of the 20th Century, public support for new dams and Congressional willingness to provide subsidized water for additional development resulted in a rapid deceleration of water-related construction. In some cases, previously approved projects were downscaled or defunded. Federal agencies announced new mandates for water management rather than development, and turned their attention to conservation, efficiency improvements, and restoration activities. Recent years of deficit concerns and budget cuts have further constrained the federal government's investment ability. Some states (California, Texas, and Utah, for example) now have their own infrastructure financing programs.

This reduced federal funding role raises concerns about how to deal with aging water infrastructure, ensure water security in a time of climate variability, and meet pressing demands to find water for growing urban areas and valuable river ecosystems. Private investment will be an increasingly important component of the strategy. Experts predict that people are likely to pay more for their water in the future.

Additionally, "infrastructure" likely will be defined more broadly in coming decades, including natural processes (such as healthy and intact watersheds and wetlands) and dispersed initiatives (such as rainwater catchments and gray-water irrigation systems) to stretch water supplies more efficiently, protect human safety and property values, and improve water quality. In some cases, western urban water providers have entered into innovative partnerships with public land managers to collect modest user surcharges which are directed at wildfire protection and other measures to protect and enhance the watersheds from which urban water flows.[12]

[12] See *Watershed Investment Programs in the American West. An Updated Look: Linking Upstream Watershed Health & Downstream Security* (Carpe Diem West 2011), available at www.carpediemwest.org/reports/policy-briefs.

- **Federal water funding programs today emphasize grants that leverage state and local resources to achieve national goals of conservation, efficiency, ecosystem restoration, and water security:** As the federal investment in western water projects is reduced, new mechanisms such as revolving funds will become a more typical model. In this approach, an initial federal investment establishes an endowment that individual states maintain and control.

- **Cooperative funding and user fee-based strategies have emerged as important means to deal with federal funding shortfalls and to accomplish goals that were not envisioned a century ago:** For example, in the Columbia River basin, a portion of revenues from hydroelectric power generation is devoted to funding efficiency improvements and mitigation for impacts of dams on fish and wildlife in the basin. This source of funding has enabled extensive restoration work in the tributaries of the river, providing valuable new habitat, restored streamflows, and improved water quality.

Photo Courtesy of USACE

Looking Ahead: Key Trends in Water Management

This sampling of solutions emerging from a century and a half of water management in the American West suggests some cross-cutting trends shaping the direction of water policy evolution in the years ahead. This section highlights these trends and briefly notes the ways in which they are influencing water management decisions in the region today.

Disputes among water interests increasingly are resolved by negotiation and collaborative problem-solving rather than by resort to "pure" water rights enforcement.

Although there is little risk of large-scale unemployment for western water lawyers, the nature of dispute resolution has shifted in the past several decades, with more emphasis on resolution outside of formal litigation. Negotiated settlements and effective collaboration can result in better-informed decisions, reduced conflict among competing interests, and better chances of successful implementation and environmental gains. Examples highlighted in this report include:

- Negotiated settlements of Indian reserved water rights, including provisions to address impacts on other affected water users.
- Interstate compacts and international treaties for managing shared rivers, with a trend toward including a broader range of sovereign parties and stakeholders in a consultative role, if not as formal decision makers.
- Broadly inclusive restoration initiatives aimed at improving water quality and recovering endangered species while accommodating existing economic and other interests.

Photo Courtesy of Cinch Design

Voluntary market transactions offer mutually beneficial means of moving water to meet new and changing needs.

One of the key features of state water law in the American West is its treatment of water rights as separate from land ownership, available to transfer to other parties through voluntary market transactions so long as no other water rights holders will be harmed by the change. As illustrated by the examples in this report, the opportunity to move water from one use to another is the source of continued innovation in western water management:

- Cities purchase permanent water rights or temporary access to water from willing sellers, usually those involved in irrigated agriculture. Increasingly, these transactions are structured to allow continued farming, but with more efficient means, freeing up water for other uses.
- Conservation groups and public resource managers acquire water rights from existing users for conversion to environmental flows, allowing restoration of critical stream segments and enhancement of recreational and other economic uses of waterways. These transfers may be permanent or temporary, and often allow the farmer to continue irrigation using less water.

Water users and others reach across jurisdictional lines to address shared issues and concerns throughout a watershed or larger geographic region.

Water users are all part of an interconnected network that extends the entire breadth of a river basin and—when water is transported to uses farther away—sometimes well beyond those hydrographic boundaries. Political and jurisdictional lines typically do not match these areas, requiring special efforts to assemble the right combination of people to address shared issues. Among the many examples of cross-boundary water solutions mentioned in this report, a few exemplify the larger trend toward working on whatever scale is necessary to address the problem at hand:

- Voluntary watershed groups engage water users and others with an interest in land and water health in a shared geographic region, often focused on improving water quality through restoration and coordinated land use practices.
- Regional collaborations such as the Roundtable on the Crown of the Continent[13] link together multiple networks of stakeholders, local leaders, and resource managers, offering a forum to share information, engage in dialogue, and develop regional strategies for cooperation.
- More formal tools for cross-jurisdictional cooperation include interstate compacts, international treaties, and other legally enforceable agreements. Pressing needs for water security in the American West have motivated generations of forward-looking leaders involved in negotiating and maintaining the integrity of these institutional arrangements.

[13] www.crownroundtable.org/

Climate change and other hydrological variability require adaptive institutions and technologies capable of responding to new and changing information.

Several climate scientists have observed that, "Water will be the delivery mechanism for climate change in the West." As summarized in this report and described in far more detail in many recent reports, the American West is likely heading into a period of less reliable water, with greater variability between wet and dry periods. This will challenge managers of fully (or over-) allocated rivers, who will need every possible tool to encourage efficient use of existing supplies and to facilitate transfers of water from existing uses to where it is most critically needed to respond to shortages. Important tools to support this adaptation—better modeling at finer scales, improved reservoir operations, and more detailed forecasts of risks to human safety from larger hydrological fluctuations—will require sustained investment in long-term water data: stream-gaging, diversion records, and groundwater monitoring.

Some examples of emerging adaptations include:

- Incentives and mandates to reduce energy and water consumption.
- Clear guidelines to review potential water transfers.
- Cooperative efforts to protect and restore watersheds, wetlands, and floodplains to maximize their ability to provide valuable ecosystem services.
- Emerging efforts to share data and prioritize data needs among federal and state and local agencies and Indian tribes, and across international boundaries.
- Aggressive development of technological adaptations, including desalination of ocean and brackish groundwater, and wastewater treatment and re-use.
- Attention to the impacts of pumping ground water, and improved methods of conjunctive management of surface and groundwater.

Photo Courtesy of USACE

Water managers and policy leaders are demanding access to understandable information on science and risk assessment to make long-term water decisions.

In spite of conflicting views on climate change, water utilities and other water managers have moved ahead in planning for more volatile conditions with less secure water supplies, including direct consultation with leading climate change researchers. For example, the Colorado Water Conservation Board, in cooperation with federal and academic researchers, has embarked on a variety of initiatives aimed at assessing the state's risks and options for addressing climate change impacts. A report on the subject[14] describes observed trends and projections of temperature, precipitation, snow, and runoff. The report gives water resource managers a synthesis of the best scientific knowledge of what is expected for Colorado's climate over the next few decades to help them plan now for drought and adaptation to climate change.

Summary: Western water policy continues to be a work in progress, addressing ongoing tensions between protecting past water uses and addressing new values and demands for water.

The strategies highlighted in this report reflect enduring qualities of the state water laws that emerged from the needs of people who put water to work to transform the American West. This legal system offers security to water right holders, and, in combination with other federal, state, and tribal policies, it also can influence sustainable water use protection for the broader public interests—but this balance is far from a static condition. Instead, as the transformation of the West continues to unfold, hard choices about water uses, and the rules that govern them, will keep emerging. Perhaps the most important trend in western water policy is that it is a work in progress, ever responding to new values and demands for water and new information about the environment in which that water exists.

[14] For a summary of the CWCB's climate adaptation planning and strategies, see cwcb.state.co.us/environment/climate-change/Pages/main.aspx.

Conclusion

Despite its decentralized nature and lack of central policy direction, several identifiable values and principles appear to be shared among those involved in western water policy:

- There is a strong public value in managing water to promote vibrant economic development, livable communities, and a healthy environment.
- Water institutions should provide security to water rights holders, recognizing that needs and values for water will change over time.
- Organizing around watersheds and other hydrographic regions offers opportunities for productive, durable solutions to shared challenges.
- National, tribal, and state-level policy decisions may best be informed by solutions and strategies developed locally through a variety of collaborative groups.
- Indian tribes' sovereignty and legal rights to water, both on and off reservations, are an integral component of western water solutions.
- Values for water extend beyond the traditional economic uses to which it has been put. Policies now recognize and protect (if imperfectly) spiritual, cultural, aesthetic, and other values for water.

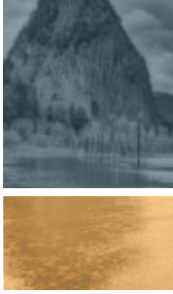
Photo Courtesy of USACE

Among many challenges to sustainable water management are the legacies of past choices, including:

- **Water institutions that do not adequately recognize the relationships between:**
  - Land use and water decisions
  - Surface and ground water
  - Water quality and water quantity
- **Water rights holders' assumptions that hydrological conditions will continue relatively unchanged are likely to be disrupted by extreme variations due to climate change and prolonged drought.**
- **"New" water users (including dedication of water for ecosystem services) are not yet fully incorporated into the system of traditional water rights, and remain poorly represented in water management decisions.**

It is challenging to draw lessons and guiding principles from western water policy, dominated as it is by myriad individual and local decisions and strategies. Experts regularly call for a more cohesive national or regional water policy (see **Appendix B**), but no leader has succeeded in corralling the many parts into a single well-oiled machine with logical operating instructions. Indeed, many argue that the very complexity that bedevils commentators is in fact its source of strength and resilience—that it will, as needs arise, adapt and shift to meet new and changing needs. Yet, the pressing needs of population growth and the imminent threats of climate change may demand more coordinated policies with clear value choices for water use in the future. Western water policy, like the region itself, continues its transformation.

Photo Courtesy of USACE



Appendix A
Key Resources on Western Water Solutions

1. MANAGING WATER AS A SCARCE AND VARIABLE RESOURCE

The Western Governors' Association (www.westgov.org) and Western States Water Council (www.westgov.org/wswc/) offer a variety of useful publications on western states' water laws, management strategies, and governance issues, for example:

- **Water Needs and Strategies for a Sustainable Future (2006),**
  www.westgov.org/component/joomdoc/doc_download/83-water-needs-and-strategies-for-a-sustainable-future
- **Water Needs and Strategies: Next Steps (2008),**
  www.westgov.org/component/joomdoc/doc_download/83-water-needs-and-strategies-for-a-sustainable-future

There are many useful state-specific guides to water laws and administrative programs, for example:

- **An Introduction to Washington Water Law (Wash. State Office of the Attorney General, 2000),**
  www.atg.wa.gov/uploadedFiles/Home/About_the_Office/Divisions/Ecology/Intro%20WA%20Water%20Law.pdf
- **Citizens' Guide to Colorado Water Law (Colo. Found. For Water Education, 2003),**
  www.cfwe.org/flip/catalog.php?catalog=waterlaw

The partnership between western states and the National Oceanic and Atmospheric Administration provides valuable information at the National Integrated Drought Information System, www.drought.gov

Other important sources on hydrologic monitoring and analysis include:

- **The State Water Resources Research Institute Program,** water.usgs.gov/wrri/
- **The Consortium of Universities for the Advancement of Hydrologic Science, Inc.,**
  www.cuahsi.org
- **The American Society Of Civil Engineers,** www.asce.org
- **The American Water Resources Association,** www.awra.org
- **The National Ground Water Association,** www.ngwa.org
- **The U.S. Geological Survey Cooperative Water Program,** water.usgs.gov/coop
- **A portal for Federal hydrologic data,** nccwsc.usgs.gov/
- **The Department of the Interior Climate Science Centers,** www.doi.gov/csc/index.cfm **and**
  https://nccwsc.usgs.gov/
- **Access to free global Landsat imagery,** www.glovis.usgs.gov/

2. PROTECTING RIVER ECOSYSTEM VALUES

The U.S. Forest Service embraces watershed protection as a fundamental value of national forest and grassland management. Accordingly, the agency recently launched its **Watershed Condition Framework**, aimed at establishing a new consistent, comparable, and credible process for improving the health of watersheds on national forests and grasslands. This framework will help focus efforts in a consistent and accountable manner and facilitate new investments in watershed restoration that will provide economic and environmental benefits to local communities. www.fs.fed.us/publications/watershed/

The **Instream Flow Council** provides information and resources to state, provincial and territorial fish and wildlife management agencies establish, maintain, and administer effective programs for quantification, protection, and restoration of instream flows for aquatic resources. The organization also promote sound instream flow science and encourages and facilitates the regular exchange of information among all levels of instream flow scientists, natural resource administrators, and aquatic resource managers. For information: www.instreamflowcouncil.org/

3. HONORING INDIGENOUS WATER RIGHTS

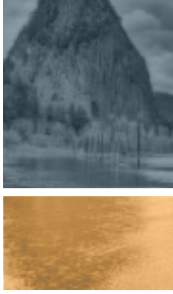
- Cohen's Handbook of Federal Indian Law (LEXIS/NEXIS 2005).
- United Nations Declaration on the Rights of Indigenous Peoples
  www.un.org/esa/socdev/unpfii/en/declaration.html
- Winters v. United States, 207 U.S. 564 (1908)
  caselaw.lp.findlaw.com/cgi-bin/getcase.pl?court=us&vol=207&invol=564

4. ENGAGING DIVERSE STAKEHOLDERS IN DEVELOPING NEW SOLUTIONS

Red Lodge Clearing House, a web-based resource on public resource management law, public involvement, and collaboration, provides stories and resources focused on stakeholder engagement. Information: www.rlch.org/

U.S. Institute for Environmental Conflict Resolution, an independent and impartial federal program, has a mission and history of helping people find workable solutions to tough environmental conflicts. Information: www.ecr.gov/

Carpe Diem West, an interdisciplinary network of professionals interested in western water policy and climate change, regularly convenes forward-looking dialogues on critical issues facing the region, including the energy-water nexus, river basin governance, and financing watershed improvements. Information: www.carpediemwest.org/



5. MANAGING WATER ACROSS STATE AND INTERNATIONAL BOUNDARIES

Council on State Governments' National Center for Interstate Compact resources:

- **Searchable database on interstate compacts**
  apps.csg.org/ncic/SearchResults.aspx?&category=2
- **Fact Sheet,** www.csg.org/knowledgecenter/docs/ncic/FactSheet.pdf
- **Frequently asked questions about compacts,** www.csg.org/knowledgecenter/docs/ncic/CompactFAQ.pdf
- **Compacts as Tools,** www.csg.org/knowledgecenter/docs/ncic/ToolGame.pdf
- **Primer on Compacts:** www.csg.org/NCIC/CompactsPrimers_000.aspx
- **Utton Transboundary Resource Center (Univ. New Mexico), Model Interstate Water Compact Project:** uttoncenter.unm.edu/projects/model-compacts.php

6. INNOVATIVE TOOLS FOR WATER INFRASTRUCTURE FINANCING

- Coy, Debra, *Alternative Capital for Infrastructure Finance* (Sustainable Water Infrastructure Coalition, Nov. 2011),
- Western States Water Council, *Western Water Resources Infrastructure Strategies: Identifying, Prioritizing and Financing Needs* (June 2011),
  www.westgov.org/wswc/infrastructure%20report_final_lowresolution.pdf

Appendix B
Selected Western Water Policy Statements and Summaries

American Water Resources Association, *National Water Policy Dialogues* (2008): These water policy dialogues focused on water policy and management at the local, state and federal levels.

Longs Peak Working Group, *America's Waters: A New Era of Sustainability* (originally published in 1992), reprinted with commentary in *Environmental Law*, vol. 34, No. 1 (Jan. 1994): The Natural Resources Law Center of the University of Colorado convened a working group of 30 national experts in water policy at Allenspark, Colorado, near Longs Peak on December 6-8, 1992. The Keystone Center facilitated the meeting, which was aimed at focusing our collective expertise on the critical water policy issues and opportunities for action by the newly elected Clinton-Gore Administration.

U.S. Army Corps of Engineers, *National Report: Responding to National Water Resources Challenge* (2010): The Army Corps of Engineers conducted listening sessions to hear from citizens about pressing water resources needs, problems, and potential opportunities. The focus of these sessions was solutions. www.building-collaboration-for-water.org.

Western Governors' Association, *Park City Principles* (1992): Principles for developing sustainable western water policies were generated from discussions at three workshops over two years in Park City, Utah, sponsored by the Western Governors' Association and the Western States Water Council.

Western Governors' Association, *Water Needs and Strategies for a Sustainable Future* (2006): Sets out broad areas of action for managing water policy with population growth and strategies states can employ to meet future demands. The report covers topics including; energy development, scarcity of unappropriated resources, and the role of partnerships.

Western States Water Council, *Water Needs and Strategies for a Sustainable Future: Next Steps* (2008): Reference resource for stakeholders interested in future issues of water and growth. The report provides several recommendations and strategies for implementing them including "Water Policy and Growth," "State Needs and Strategies to Meeting Future Demands," "Water Infrastructure Needs and Promising Strategies for Meeting Them," "Resolution of Indian Water Rights," "Preparations for Climate Change Impacts," and "Coordination and Cooperation in Protecting Aquatic Species under the Endangered Species Act."

Western Water Policy Review Advisory Commission, *Water in the West: Challenge for the Next Century* (June 1998): This congressionally chartered commission studied issues related to water supply and management in the western U.S., producing a report that outlined "Principles of Water Management for the 21st Century."

Photo Courtesy of USACE