LIQUID ASSETS: Investing for Impact in the Colorado River Basin

SQUIRE PATTON BOGGS

encourage capital

With support from the Walton Family Foundation

Table of Contents

ACKNOWLEDGEMENTS

The authors wish to thank the Walton Family Foundation for their generous support in producing this report. We also wish to thank the numerous water managers, agencies, for-profit partners, stakeholders, non-governmental organizations, and individuals who contributed the invaluable advice, information, and guidance that made this work possible.

WATER IN THE WEST

EXECUTIVE SUMMARY

Over the past 15 years, much of the western United States has been in the grip of persistent local and regional droughts that have caused significant economic, political, and ecological disruption. Although water scarcity has long been a defining theme in the history of the American West, the extent and scale of the issues that are now facing the region are unprecedented. Substantial declines in agricultural production, loss of hydropower, municipal supply shortfalls, and declining reservoir levels have affected many western communities, while record low levels of precipitation and snowpack, low streamflows, higher water temperatures, the advance of drought-tolerant invasive species, and catastrophic wildfire and loss of forest cover have impacted most, if not all, western watersheds. As a result of decades of massive economic expansion in the arid Western States, these water problems are no longer just local or regional problems: they are national problems, affecting critical municipal and industrial centers and agricultural regions that represent a substantial portion of U.S. GDP.

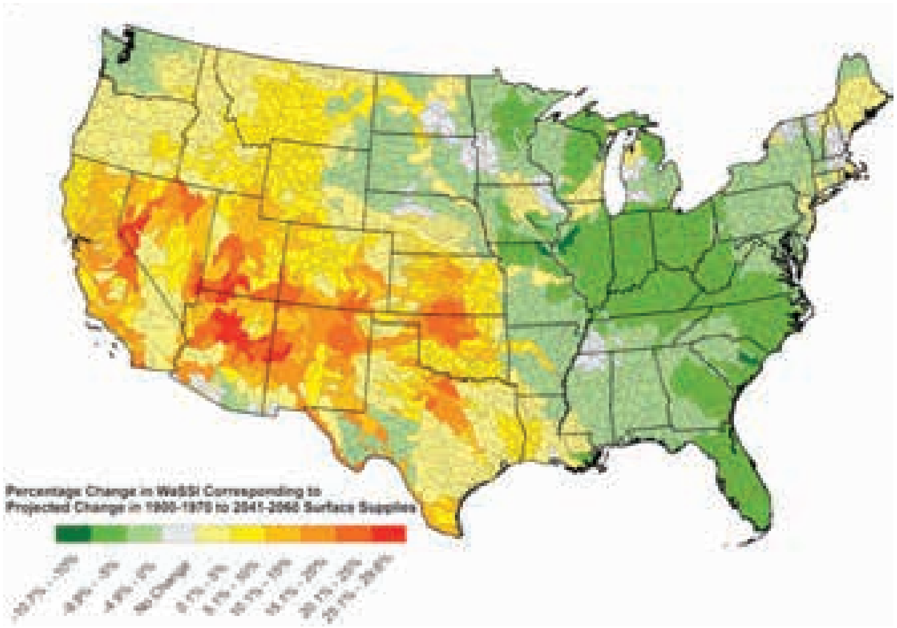


Figure 1. Projected Increase in Surface Water Stress. Map shows projected increases in surface water stress in U.S. watersheds over the next 4-5 decades. Source: K Averyt, et al., "Sectoral Contributions to Surface Water Stress in the Coterminous United States," Environmental Research Letters 8, no. 3 (Sept. 1, 2013).

As these issues have grown in their extent and severity, there has been increasing interest among investors, policymakers, and water managers alike in the potential for use of market-based mechanisms to manage complex, emerging issues around water scarcity and security, and to facilitate the entry of private capital to play a broader role in the management and financing of water resource solutions. This reflects a movement at a global scale towards the use of market-based mechanisms to manage a variety of natural resource issues, and to ensure that the value of ecosystem services to economies and societies are adequately captured in the marketplace. As the role of natural resource management and ecosystem function in supporting economic prosperity has achieved growing levels of recognition, successful markets have been created around a variety of resources and ecological processes. For example, cap-and-trade structures built around air pollutants such as sulfur dioxide, greenhouse gases, mitigation credits under the Clean Water Act, transferable development rights in land use regulation, and approaches such as catch limits and catch-shares in fisheries regulation each provide successful examples of efforts to transform relatively unmanaged, "frontier-style" exploitation of natural resources into a system of marketable rights that can be traded, leased, and otherwise controlled.

Unlike many natural resources, however, water in many parts of the world (and certainly in the American West) is already heavily regulated and governed (or is deliberately unregulated and ungoverned) by a well-developed system of water rights and laws, environmental controls, and governance institutions. In addition, water is somewhat different from many other natural resources in both its essential character, its role in the economy, and its social and political significance. This makes the transfer of water between uses practically, legally, ethically, and environmentally complex.

These differences -- together with significant physical, legal, and cultural barriers to the movement of water and the complex environmental challenges raised by water resource management issues -- have thus far made implementation of market-based strategies in the West far more difficult to achieve than they have been in the context of national water markets that have been adopted in countries such as Australia and Chile. Taken together, these restrictions have significantly limited opportunities for water investment in the past, with the majority of private investment focused on a relatively narrow range of "arbitrage"-driven opportunities to purchase and transfer water to new uses, or playing more traditional roles in support of bond financing for water infrastructure. However, these conditions are rapidly changing – and in light of emerging needs, there are now substantial opportunities for investing within existing regulatory frameworks (e.g. pursuing new approaches, technologies, and best management practices, financing projects with public benefit, etc.), as well as for investing in impact strategies that will realign stakeholder interests towards sustainable management and address broader water management issues, such as controlling growing water risk, reversing declines in watershed health, and other concerns that threaten both human water use and the ecosystem services provided by natural systems.

> there are now substantial opportunities for investing within existing regulatory frameworks as well as for investing in impact strategies that will realign stakeholder interests towards sustainable management and address broader water management issues.

In particular, there are relatively few examples of successful private investments today that have helped to address growing water scarcity issues, particularly with regard to the long-term sustainability of agricultural communities, the financing of water supply and water infrastructure in growth communities, the numerous environmental challenges resulting from altered stream flows, groundwater depletion, declining landscape health, and other critical concerns. There is an urgent need to identify new strategies to meet those challenges, as they are beginning to manifest at a rate and a scale that is outstripping the capacity of traditional federal, state, and charitable enterprises to address. This has created both a significant need and opportunity for private investment – and most particularly, for impact investors who are willing to use private capital in innovative ways to drive fundamental change while seeking to achieve a financial return.

This report reflects the results of an investigation undertaken by Encourage Capital and Squire Patton Boggs, in collaboration with the Walton Family Foundation, to identify potential impact investments that could be successfully deployed to finance water resource solutions, generate related environmental benefits, and create a financial return. This paper outlines eleven promising impact investment strategies that have been grouped into nine separate "investment blueprints" detailed below in Table 1. These strategies are intended for use as generic models in the development and investigation of specific investment opportunities on the ground. Some of these concepts represent a proposed re-tasking of existing investment tools and approaches that have been successfully deployed in other natural resource contexts; others represent unique approaches that combine or build on investment structures that have not previously been used in the context of natural resource management.

While these blueprints could potentially be deployed in many parts of the West, this investigation has focused on the Colorado River Basin, one of the most water-stressed watersheds in the Western United States, and one of the most heavily regulated and developed river systems in the world. Taken together, these blueprints *(outlined in Table 1)*, propose approaches to addressing a variety of complex environmental challenges in the Basin, ranging from improvements to forest, riparian and grassland health, to maintaining adequate instream flows through investments in agricultural lands and improvement of water efficiency in municipal systems,. They also cover the financing and development of environmentally-beneficial municipal infrastructure, as well as investments in new market institutions that could reduce systemic risks to human and environmental users alike.

Watershed Enhancement	A	Forest Health Environmental Impact Bond	Invest in a pay-for-performance vehicle to reduce the risk of wildfires and increase watershed yield via forest thinning, with investors repaid through savings in fire suppression cost and avoided water risk
	B	Riparian Restoration Environmental Impact Bond	Invest in a pay-for-performance vehicle to improve ecosystem health and increase watershed yield through invasive species removal and riparian restoration
Agricultural Water Use	C	Sustainable Ranching	Invest in cattle herds and ranch land to improve grassland health by employing higher-yield and more sustainable grazing practices
	D	Crop Conversion and Infrastructure Upgrades	Invest in agricultural water efficiency via on-farm conversion to higher-value, lower water-use crops and improvements to irrigation infrastructure
	E	Commodity-Indexed Dry-Year Option	Broker deals to better distribute hydrologic and economic risk between water uses with higher and lower tolerance for water supply loss via dry-year options and commodity price hedging
Muni Water Infrastructure	F	System Loss Pay for Performance	Invest in a pay for performance vehicle to upgrade municipal water infrastructure to reduce systems losses
	G	Green Bond with Sustainability Conditions	Provide low-cost financing for municipal water infrastructure tied to environmental and sustainability conditions
Market Development	H	Next Generation Water Trust	Develop an investment-driven next generation water trust to address environmental and system-wide water supply risks
	I	Water Storage Trading	Develop, implement, and operate storage trading markets in surface water reservoirs and groundwater aquifers

Table 1. Overview of the nine investment blueprints, representing the eleven proposed financing solutions detailed in the Liquid Assets: Investing for Impact in the Colorado River Basin report.

Many of the U.S. watersheds that are facing the greatest levels of water stress are located in the Colorado River Basin.

The Colorado River exhibits an extraordinarily broad diversity of federal, state, and institutional structures for water management (which are common to many western states), and engages water uses ranging from the individual diversions and small-scale farming operations that are prevalent in the Basin's higher elevations, to the massive dam and canal infrastructure, sprawling cities, and expansive production agriculture in the Basin's lower reaches. The challenges facing the Basin's users are thus shared in varying degrees by users throughout the West. As such, many of the solutions identified above – discussed in greater detail within this report – could be potentially transferable throughout the West. Some may even be applicable in other parts of the world.

I. The Colorado River Basin and the Law of the River

The Colorado River Basin has long been the iconic core of the historic vision for the West: to "make the desert bloom." Today, the Basin also stands at the center of efforts to manage issues surrounding water scarcity; as shown in Figure 1, many of the U.S. watersheds that are facing the greatest levels of water stress are located within the Colorado River Basin.

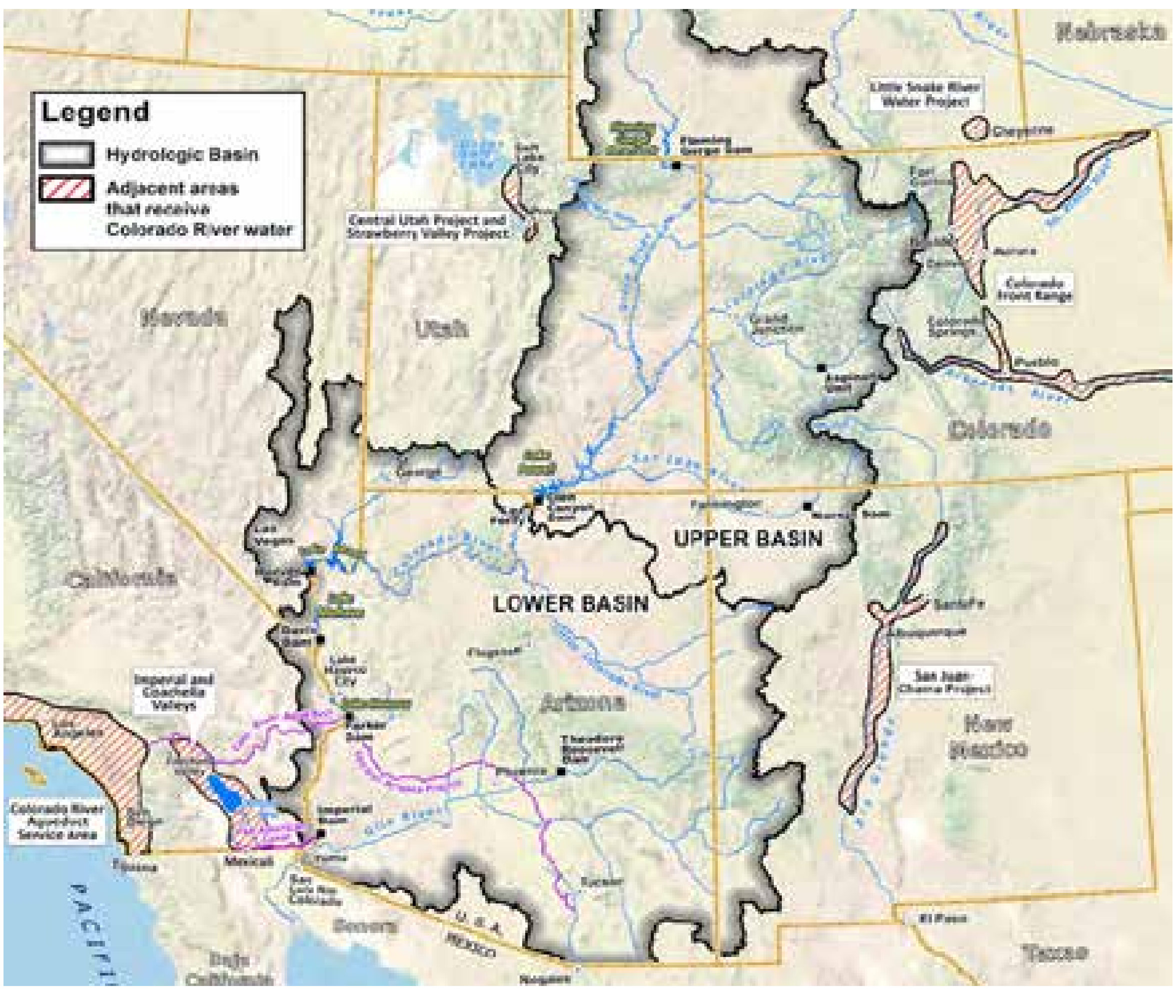


Figure 2. The Colorado River Basin. Source: U.S. Bureau of Reclamation (2012).

Historically, the Colorado was a wildly unpredictable, muddy river, prone to severe drought and intense seasonal flooding. Indeed, the name “coloreado” means “colored” or “red” in Spanish, and was given to the river because of its reddish, muddy color. When the Spaniards first arrived on the banks of the Colorado, the River supported an astonishing array of native fish and aquatic species—including 30 species of fish found nowhere else on Earth. Its delta was a vast, 2-million acre wetland that served as a critical stopover point for migratory birds on the Pacific Flyway, and supported a rich estuarine habitat and a major fishery in the Gulf of California. However, through more than nine decades of large-scale public and private investment, the once-wild Colorado River has been transformed into the most heavily managed and regulated river system in the world. Providing water to seven U.S. states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming), and two states in Mexico, and with a basin spanning some 246,000 square miles, the Colorado River now supports more than 35 million people, 4 million acres of irrigated agriculture, and an estimated 20% of U.S. national GDP.

For accounting and management purposes, the U.S. portion of the Colorado River is divided into an Upper and Lower Basin. Within the Colorado River’s primary system infrastructure, Lake Powell operates as the primary Upper Basin storage reservoir, and Lake Mead as the primary Lower Basin storage reservoir; however, these major storage and hydropower dams are supported by dozens of other smaller storage and diversion projects. This enormous infrastructure allows essentially every gallon of the Colorado River to be used and reused multiple times along its length, such that the River is completely consumed by the time it reaches its terminus in Mexico. In fact, the River has not reliably reached its former Delta at the head of the Gulf of California since the 1960s.

> The Colorado River now supports more than 35 million people, 4 million acres of irrigated agriculture, and an estimated 20% of U.S. national GDP.

The waters of the Colorado River are governed by what is loosely termed the “Law of the River,” a complex array of statutes, court decisions and decrees, contracts, interstate compacts, regulations, and treaties generated by a century of ongoing dispute over the allocation of water. At the core of the Law of the River is the 1922 Colorado River Compact (“Compact”), an interstate compact which divides the water of the Colorado River between the Upper Basin – composed of the states of Colorado, Wyoming, Utah, New Mexico, and a small section of Arizona – and the Lower Basin, which includes California, the remainder of Arizona, and Nevada. The Compact allocated to each Basin the right to an annual “beneficial consumptive use” of 7.5 million acre-feet (maf) of Colorado River water; a later 1944 treaty with Mexico also granted Mexico the right to 1.5 maf of water each year. Within the Upper Basin, the water is further divided among the individual states by the Upper Colorado River Basin Compact of 1948. In the Lower Basin, water is divided between the individual states, and among individual water users by the Boulder Canyon Project Act of 1928 (“BCPA”), a decree of the United States Supreme Court in Arizona v. California, and other federal laws, together with federal water delivery contracts issued by the U.S. Bureau of Reclamation ("Reclamation"). These primary provisions of the Law of the River, together with dozens of other smaller agreements, contracts, regulations, and other provisions, drive the operation of the major system reservoirs and diversions.

Within the constraints imposed by these primary federal and interstate controls on the Colorado River, the majority of intrastate water management is driven by state laws governing the appropriation of surface water and/or groundwater management. The variations between state laws create an incredibly diverse set of legal and institutional regimes within the Basin – a diversity common to water management throughout the Western U.S.[1] However, at the highest level, there are several primary legal categories of "water rights" at work in the Colorado River.

Surface water rights: Nearly all western states follow the law of prior appropriation—in essence, a rule of "first in time, first in right." Under the prior appropriation system, the first user to divert water from a stream and put it to beneficial use obtains a right to continue such diversions with a priority senior to all subsequent diverters. This system has tended to concentrate the ownership of water in historic uses (such as agriculture) at the expense of more recent uses (such as industry and cities). Most states allow these rights to be moved to a different place or type of use through a "sever-and-transfer" procedure, although this process can be complex and cumbersome. Importantly, the federal government also has significant "reserved rights" associated with specialized federal lands like parks and national forests; the most significant of these are held by Native American tribes, which in many cases have expansive claims to western rivers, streams, and groundwater basins.

Groundwater rights: State law approaches to the management of groundwater differ significantly from state to state, with some states recognizing the prior appropriation doctrine and its associated system of rights and priorities for both groundwater and surface water (in most cases, groundwater and surface water systems are hydrologically interconnected, such that the use of groundwater can eventually interfere with surface flows). Other states, however, only loosely regulate groundwater use, typically following the "reasonable use" doctrine, which essentially permits open access to groundwater resources by any overlying property owner, even if this harms other users. A few states, such as Arizona, have adopted laws that closely regulate groundwater use in some problematic areas, while leaving groundwater unregulated elsewhere.

Colorado River Delivery Contracts: In the Lower Basin, state law prior-appropriation systems only govern the use of water on Colorado River tributaries (such as the Little Colorado River, the Virgin River, and the Salt, Verde, and Gila River systems). Entitlements to Colorado River mainstem water are administered by the federal government through permanent Reclamation delivery contracts issued pursuant to the BCPA. These contracts are issued to users within each Lower Basin state pursuant to the basic allocations established in the BCPA (4.4 maf to California, 2.8 maf to Arizona, and 0.3 maf to Nevada), and are further governed by a complex set of priorities established in those contracts or by separate agreements among water users.

1 Unlike many other environmental issues and natural resources, water has traditionally been treated in the United States as a matter of state, not federal, law.

II. The Colorado River's Math Problem

The division of Colorado River water under the Compact and the Treaty of 1944 is responsible for a central problem of the Law of the River: it apportions more water than actually exists. Taken together, the Compact and the Treaty jointly allocate at least 16.5 maf of water between the Upper Basin, the Lower Basin, and Mexico. When the Compact was signed in 1922, the annual flow of the river past Lee's Ferry (the dividing line between the Upper and Lower Basins) was estimated to be at least equal to if not substantially larger than this figure. Unfortunately, modern tree-ring studies have demonstrated that the relatively short period of record that was used to estimate Colorado River flows for purposes of the Compact was among the wettest in the past several thousand years.

Until recently, this historic overestimation of available resources had not generated any serious problems, in large part because many of the Basin states and their individual users had not – and in many cases still do not - utilize their full legal allocations of water (in some cases, such as in the case of many Indian tribes, the amounts of these allocations are also still in dispute). However, this situation has been dramatically changing. Since 2003, the ever-increasing demand for Colorado River water has consistently exceeded the naturally available supply, even without considering ongoing overexploitation of groundwater. In other words, there is simply no more "surplus" water to grow into.

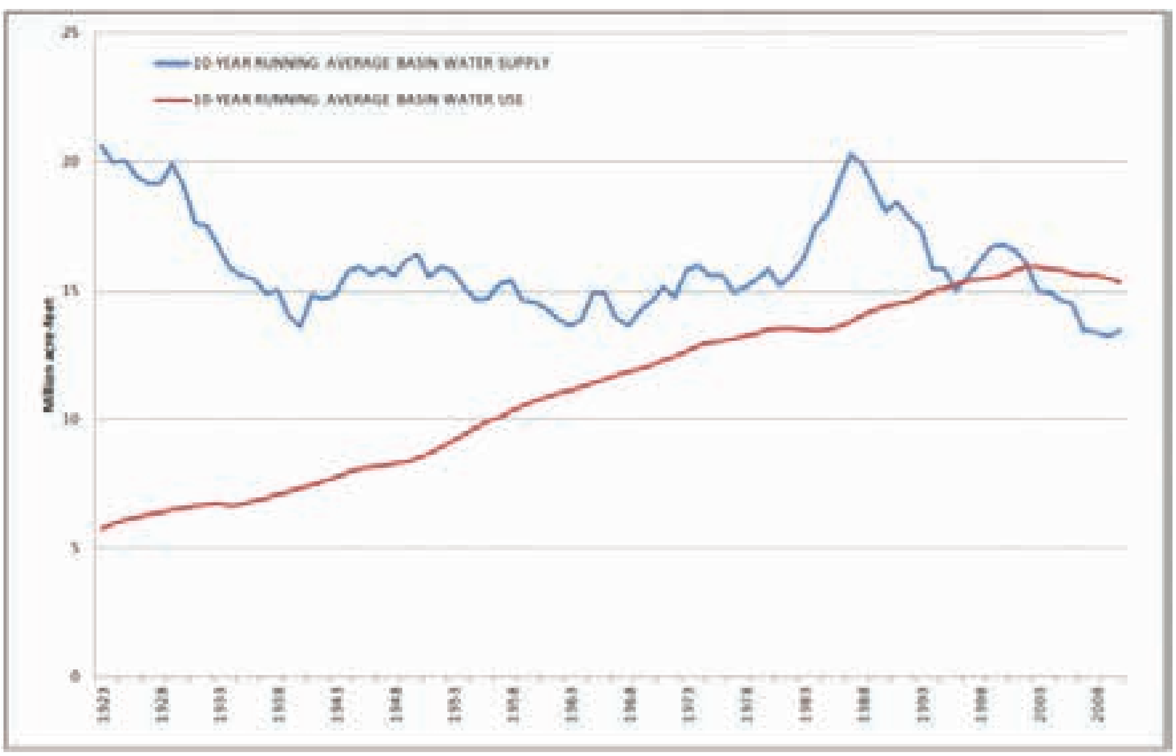


Figure 3. Historic Basin-Wide Supply and Demand. 10-year running averages for surface water supply (blue) and water demand (red) in the Colorado River Basin. As of 2003, surface water demand has exceeded naturally available supply (and the historical average supply) every year. Source: U.S. Bureau of Reclamation (2012).

Since 2003,

the ever-increasing demand for Colorado River water has consistently exceeded the naturally available supply.

For the Upper Basin states, which have the lowest priority under the Compact, this reality effectively limits Upper Basin water development to the amount of water that is actually available after the Upper Basin's delivery obligations to the Lower Basin and to Mexico are met. As a result, the amount of water that is potentially available to the Upper Basin each year is closer to 5.5 maf than to the Compact entitlement of 7.5 maf. Importantly, this reality also means that the Upper Basin bears the primary risk of reductions in Basin yield in the future -- whether those reductions result from drought, climate change, or other critical landscape-scale changes that are impacting water yields.

For the Lower Basin, the "math problem" plays out as an increasing risk of shortages, largely due to the overuse of water available to it under the Compact. BCPA contracts fully allocate Lower Basin water to water users, essentially assuming that other substantial Lower Basin system demands—such as evaporation at Lake Mead and other major reservoirs, phreatophyte use, the Lower Basin's share of the delivery obligations to Mexico, and other demands—will be met either from Lower Basin tributary inflows (which are fairly small) or from excess releases out of the Upper Basin. In practice, this results in an approximate 1.2 maf "deficit" in Lake Mead each year whenever the Upper Basin does not deliver more than the minimum amount it owes under the Compact -- translating to inevitable Lower Basin shortages as excess flows decrease (whether as a result of drought or the continued development of water for use in the Upper Basin).

In no small part due to this "math problem," the Colorado River system is now in the midst of an unprecedented crisis. Over the past 15 years, the River has been experiencing a dramatic multiyear drought that has brought the problems of overallocation and overuse into sharp relief, causing significant declines in hydropower production, localized shortages impacting municipal and agricultural uses, and reduced flows and reservoir levels that have negatively affected wildlife, fish, and recreation. Alarmingly, the principal storage reservoirs for the Colorado River Basin, built to insulate the Southwest against the River's dramatic natural variability, have seen their combined storage decline to a level lower than when Lake Powell first began to fill in the 1960s; Lake Mead has declined to a point not seen since it was first filling in the 1930s. These reservoirs are now rapidly approaching critical elevations that could jeopardize hydropower production at both the Hoover and Glen Canyon Dams, threaten Las Vegas' municipal intakes at Lake Mead, and trigger substantial shortages to central Arizona that could ultimately produce effects similar to those currently being experienced in central California.

Just as importantly, the probability of returning to and maintaining higher reservoir conditions is dropping every year, as a result of: ongoing changes in hydrology (believed to be a combination of climate change impacts, dust on snow, and invasive species), the Lake Mead "deficit" described above, and continued expected growth in water use. For the Upper Basin, this means more and more widespread risks of local water supply shortfalls that threaten human and environmental users alike. In the Lower Basin, this means ever-increasing risks of significant and potentially long-lasting shortages to major water users (particularly in Arizona, which will bear the brunt of initial shortages under current priority rules). Even assuming that the Basin's future hydrology returns to its long-term, lower average—and not the lower levels predicted from climate change—not only are frequent shortages the norm, but the risk of large-scale, catastrophic shortages are also becoming all too real.

III. Beyond the Math Problem

These current challenges also provide a preview of larger, longer-term challenges in the management of shrinking supply and growing water demand. The Colorado River Basin Water Supply and Demand Study ("Basin Study"), completed by the U.S. Bureau of Reclamation and the seven Colorado River Basin states in 2012, evaluated a variety of different future agricultural, municipal, and industrial demand scenarios and then matched them against a series of future water-supply scenarios, including scenarios built from downscaled global climate models. The Basin Study found that without further proactive steps, the long-term projected imbalance in future supply and demand could grow to an average of around 3.2 million acre-feet (approximately 20% of total system yield) over the next five decades.[2] The worst-case scenario suggests a potential annual imbalance of over 8 maf (greater than 50% of projected demand). In areas that face significant future supply-and-demand imbalances – generally driven by growing urban demand – major new investments in water infrastructure, conservation, or water supply acquisitions will be needed.

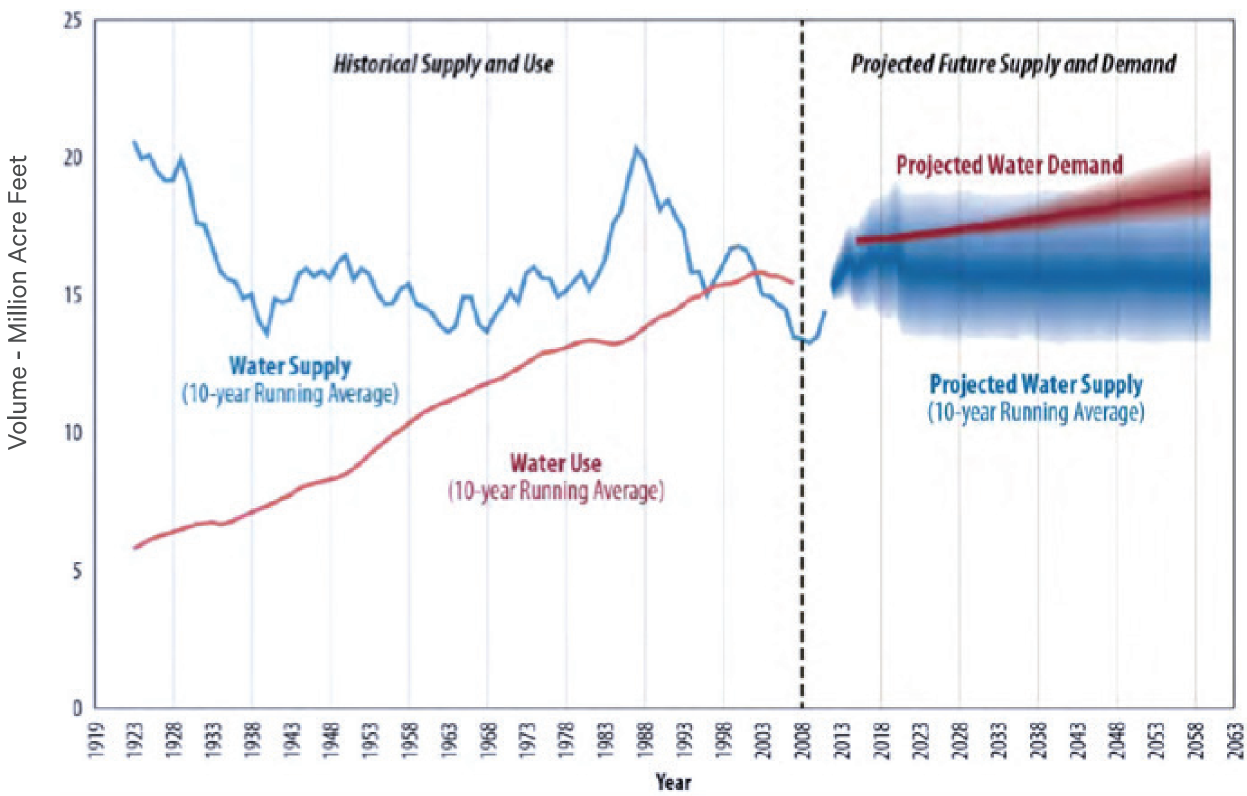


Figure 4. Historic Basin-Wide Supply and Demand. 10-year running averages for water supply (blue) and water demand (red) in the Colorado River Basin, continuing forward from the graph in Figure 3. Shading represents probability (darker areas represent higher probabilities). Projected future demand continues to grow under all scenarios, exceeding available supply by as much as 50% in some scenarios. Source: U.S. Bureau of Reclamation (2012).

2 Bureau of Reclamation, Colorado River Basin Study, 2012.

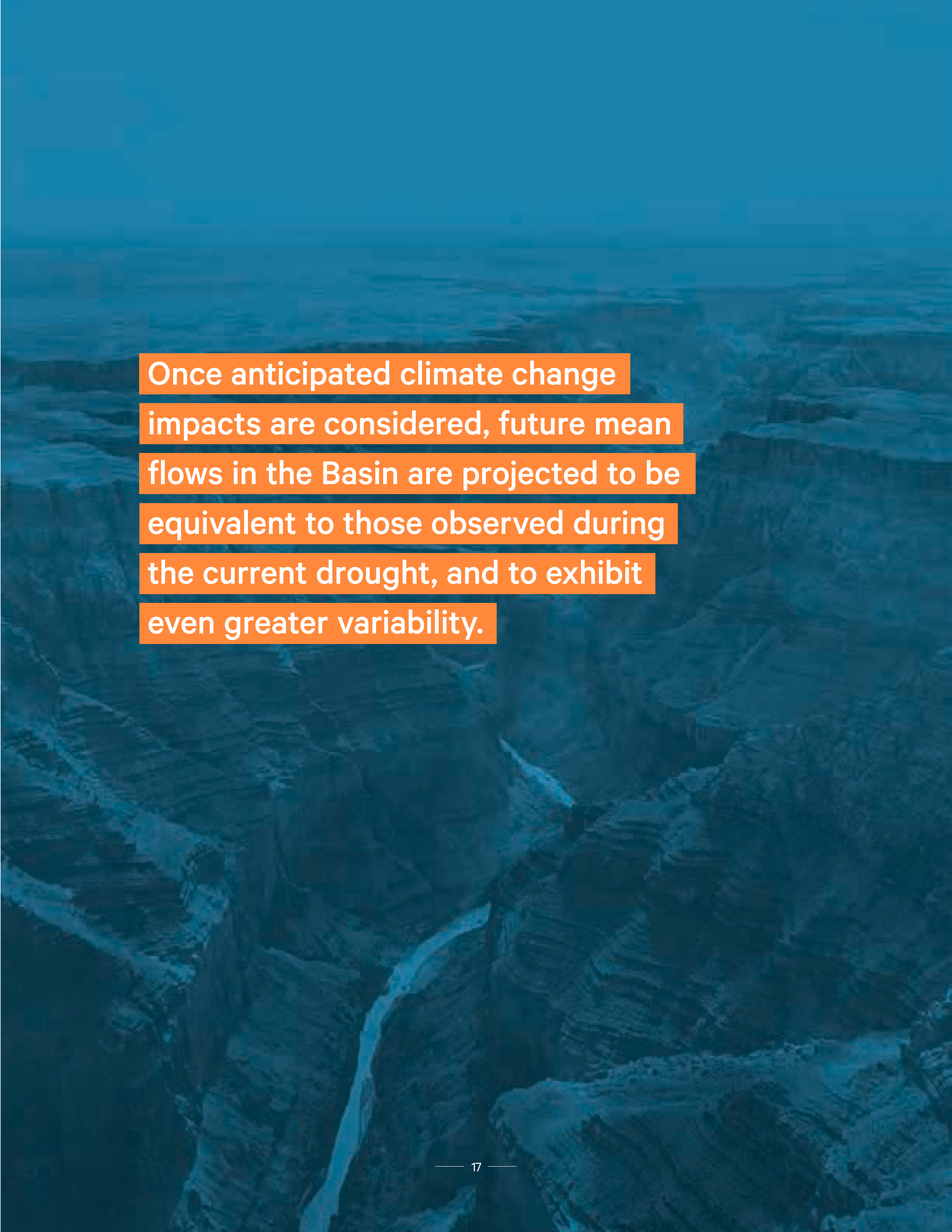
Perhaps even more significantly, on the water supply side, the Study suggests that Basin users can expect both a net reduction in streamflow and increasing variability in water supply over the coming decades. Studies of long-term streamflow in the Basin show that the past century has in fact been unusually wet – and that in the past, the Basin has seen more extreme drought conditions than have occurred within recent experience. Once anticipated climate change impacts are considered, future mean flows in the Basin are projected to be equivalent to those observed during the current drought, and to exhibit even greater variability. This would translate to a significant overall decline in water availability in the Basin, as well as the potential for both larger droughts and larger flood events in coming decades.

These concerns are compounded by another significant issue facing water users in the Basin: the continued, unsustainable use of groundwater resources in many areas. The overexploitation of aquifers, proceeding under the above-described "reasonable use" doctrine and similar open-access policies, has caused widespread groundwater depletion in many parts of the Basin. Recent NASA studies, which used satellite remote sensing technology to evaluate the impact of drought and overuse on water supplies, estimate that, overall, the Colorado River Basin may have lost some 65 cubic kilometers of freshwater storage over the past decade (approximately 53 maf). Nearly 75% of this net water loss to the system was estimated to have occurred as a result of the unsustainable pumping of groundwater. This vast overexploitation of groundwater resources is rapidly eroding the critical buffer against long-term drought that aquifer storage provides, creates significant issues with land subsidence, and risks leaving communities and farmers alike without supply options once aquifer resources have been mined out.

In addition to the direct threat that water shortages pose to municipal, industrial, and agricultural users, water shortages can also create a variety of ancillary economic, political, and perception-driven risks, such as uncertainty in real estate markets and municipal bond markets. They can also weaken the adaptive capacity of local communities. For agricultural users – as the Central Valley of California has recently experienced -- water shortages can precipitate the involuntary fallowing of tens or even hundreds of thousands of acres of productive cropland, and wreak havoc with agricultural enterprises and markets alike. Many of the Basin's farmers, even those growing high-value crops, are highly dependent on annual farming returns and cannot easily weather significant water shortages. Permanent crop farmers—of almond, citrus, and other tree-based crops—can be particularly vulnerable, since even a brief shortage can result in the loss of trees that can take decades to replace. There is also now widespread business recognition of water-related risk across economic sectors, not only among obvious water users, such as utilities, developers, and the mining industry, but also among other water-intensive businesses that either have or are contemplating significant operations in the West.

IV. Environmental Challenges

Some of the most fundamental challenges facing the Basin relate to the future of ecosystem values. The capture of close to 100% of existing flows in the Colorado Basin by dams, diversions, and groundwater use has created a situation where water flows may be significantly reduced or absent during all



Once anticipated climate change impacts are considered, future mean flows in the Basin are projected to be equivalent to those observed during the current drought, and to exhibit even greater variability.

or key portions of the year in many of the Basin's rivers and streams. Adding to these issues are the impacts of dam operations, which can reduce or completely eliminate natural flooding and variations in streamflow by releasing water at a more predictable rate over the course of the year. Waters that were once flood-prone, relatively warm, and sediment rich become steady, cold releases from dams that trap sediment behind them (sediment that once flowed down-river). The lack of sediment can prevent the natural formation of sandbars, riffles, and backwater habitats critical to many species. These poor streamflow conditions tend to inhibit recruitment of native fish and create conditions that favor the success of nonnative aquatic species or cause the outright loss of native species. Of the Basin's 30 endemic warm-water fish species, four are extinct, 12 are listed as endangered, and another four are threatened. Variable streamflow conditions may also cause the loss of riparian vegetation or significant long-term changes to riparian areas, including the spread of undesirable invasive species, such as the now-ubiquitous tamarisk tree.

Where flow-dependent environmental values continue to exist in the Basin, these tend to exist either as a byproduct of the "run of the river" (e.g., because they are located upstream of a use or diversion and are thereby guaranteed to receive water in connection with the delivery of water to a downstream use) or because they are dependent on the "waste" stream from an upstream user, such as municipal effluent, agricultural drainage, or flood releases from reservoirs. Environmental values themselves have few recognized "rights" to water, and where flows are protected, they tend to be designed to maintain only the environmental minimums that are necessary to protect already endangered species.

Groundwater depletions can add to these environmental impacts. The pumping of groundwater in the vicinity of a surface stream can reduce streamflows over time in the same manner as a direct surface diversion, intercepting groundwater that would otherwise have surfaced via springs and seeps as "base flow" in a surface stream, or by directly pulling water away from surface streams. In areas such as California and Arizona where significant levels of groundwater pumping are occurring, substantial regional deficits in groundwater storage can accumulate that will take decades, centuries, or even millennia to replace. This can ultimately disconnect rivers from the groundwater table altogether, transforming perennial rivers and streams into dry channels.

While these may be the most pressing issues, the Basin also faces other environmental challenges. Low flows exacerbate issues with water quality – particularly salt and pollutant loading - resulting from agriculture, industry, and urban development. Salt pollution, for example, results in water that is approximately 10 times more salty at the bottom of the Colorado River than at its headwaters, creating both environmental and economic impacts.[3] Altered stream flows create conditions where invasive species can supplant native vegetation and further contribute to overall declines in water supply. The invasive tamarisk tree, for example, is now estimated to use as much water each year as a large metropolitan area.

A combination of other factors resulting from unsustainable land-use practices and the introduction and spread of invasive species have also led to the deterioration of landscape health throughout the

3 In fully or partially closed systems in the Basin, such as the Salton Sea in California, salinity levels can exceed those found in the ocean, rendering wetland areas incapable of supporting life.

Basin. This has significant implications for both water availability and river health in the Basin. These issues are particularly pronounced in forested headwaters regions, where the history of fire suppression, combined with prolonged drought and expansion of pine bark beetle infestations, has dramatically increased the risk of catastrophic wildfire and led to substantially reduced watershed yields. Grassland ecosystems throughout the Basin are also substantially altered at a landscape scale as a result of a legacy of unsustainable grazing practices, ongoing drought, and encroachment of woody plants and shrubs. All of this, coupled with a veritable plaque of invasive species, is impacting both groundwater aquifers and stream flows.

Adding to these already daunting challenges are the impacts of climate change, which appear to be already detectable in the Colorado River Basin. Data collected in recent decades show significantly increased average temperatures; intensified drought conditions; changes in landscape-scale vegetation; and altered precipitation patterns, evaporation rates, and the timing of runoff from Basin headwaters. For example, increases in the amount of winter precipitation falling as rain rather than snow in the high country, combined with dust pollution that darkens mountain snowpack, have led to changes in evaporative loss and increased use of water by vegetation that affect downstream environmental and human users. Loss of snowpack has also led to less runoff during the spring and summer months, which has both impacted reservoir storage and lowered streamflow during the hottest months of the year, when aquatic systems are most stressed.

V. The Case for Private Capital

These growing challenges and water supply risks for human and environmental users mean the Basin's users must begin moving deliberately to reduce the physical, ecological, and economic fragility of critical systems—and must ensure that planning for urban, agricultural, and ecological needs anticipates the potential for increasingly variable water supplies. This, in turn, means designing systems of water use to be able to both survive and thrive in the face of variability and the inevitable disruption in water supply. In other words, humans on the Colorado River will need to design systems which permit water to be used – and moved – more flexibly to serve changing conditions, values, and demands. To accomplish this, there is a significant need to design and build new institutions that will increase the flexibility and adaptive capacity in the system, at the same time that they help individual water users adjust to changing conditions from year to year and help to protect critical economic and ecosystem values from the growing risks associated with deep levels of uncertainty in water supply. Importantly, these new approaches should also be relevant – and potentially transferable – throughout the West or even to other water-stressed parts of the world.

Growing recognition of this need has already led to a series of important policy developments over the past decade, including a 2007 agreement among the Basin states and Reclamation with regard to shortage management, the recent Minute 319 agreement between the U.S. and Mexico, and a number of "contingency planning" measures under discussion or implementation in the Upper and Lower Basins, such as a proposed Upper Basin Water Bank, and a new demonstration program to conserve water for system benefit known as the Colorado River System Conservation Program. However, the recognition of the need for

	Delta	Mead to Imperial	Lower Basin Tributaries	Mainstem to Mead	Collector Tributaries	High-Order Tributaries	Headwaters
Forest Health Issues	N/A	N/A	Serious	OK	OK	Concern	Serious
Poor Grassland Health	N/A	N/A	Serious	N/A	Concern	Concern	Serious
Invasive Riparian Vegetation	Serious	Serious	Serious	Serious	Serious	Concern	Concern
Habitat Destruction Due to Channelization	Serious	Serious	N/A	N/A	OK	Concern	OK
Invasive/Non-Native Aquatic Species (Fish, Mollusks)	N/A	Serious	Serious	Serious	Serious	Concern	Concern
Dust on Snow	N/A	N/A	N/A	N/A	N/A	Concern	Serious
Fish Barriers due to	N/A	N/A	N/A	N/A	Concern	Concern	Serious
Depleted Stream Flow from Groundwater Pumping	Serious	OK	Serious	OK	OK	Concern	Serious
Out-of-Basin Diversions	Concern	Concern	OK	OK	Concern	Serious	Serious
Changes in Stream Flow due to Dam Operations	Serious	Serious	Concern	Serious	Serious	Concern	OK
Changes in Water Temperature	Serious	Serious	Concern	Serious	Serious	OK	OK
Shortage Risks Due to Local Run-off Shortfalls	OK	OK	Serious	OK	OK	Concern	Serious
Shortage Risks due to Structural Deficit	Serious	Serious	OK	OK	OK	OK	OK
High Salinity	Serious	Concern	Concern	OK	OK	OK	OK

Serious
Concern
OK
N/A

Table 2. Environmental challenges and geographies impacted within the Colorado River Basin.

greater flexibility and adaptability has also led to a significant increase in interest among water managers, policymakers, and academics alike in the deployment of greater amounts of private capital through the use of market mechanisms and other investment-driven approaches.

Although much of the historic water development and water infrastructure of the West—including the vast network of existing dams, delivery canals, irrigation projects, and other projects—has been constructed with and subsidized by enormous investments of public resources (largely federal and state tax dollars and low-interest government loans), private investment, particularly in the form of traditional tax-exempt bond financing, has long played a critical role in water management, including in helping finance the vast majority of municipal water delivery systems. The role for private capital in meeting these needs is likely to be even more significant in the future, as federal and state funding sources and support for large-scale water-related infrastructure has been declining since the 1980s. At the same time, legislative appropriations to support agencies responsible for managing water supplies have shrunk in many Western States, substantially contracting the scope of government activities and the government's capacity to support water resource management, even where this could threaten long-term economic vitality.

> The role for private capital in meeting these needs is likely to be even more significant in the future, as federal and state support continues to decline.

In this respect, although physical unavailability of water will clearly be a defining element of the future of economic development and ecosystem protection in the Colorado River Basin, the most pressing issue in many cases will not necessarily relate to the unavailability of water resources, but rather will be about how to pay for the infrastructure, water rights, and institutions needed to manage and distribute scarce supplies. Rapid growth has left many small and medium-size urban areas and rural development areas facing significant accumulated infrastructure deficits and/or rapidly aging infrastructure. Farming communities have also become increasingly marginal when it comes to water security. The development of agriculture in most parts of the Basin was enabled by significant state and federal public works, but with these sources of funding increasingly constrained, agricultural communities must cope with less and less support to finance the rehabilitation or improvement of infrastructure and the deployment of new management techniques. All of this points to a need for more expansive, flexible, direct, and creative types of private investment in water resource management in the future.

VI. Thinking Beyond Water Markets

There has been an extensive literature in recent years about the potential for the development of "water markets" that would allow water to be more readily traded between buyers and sellers in the manner of a commodity. However, for a market to function, willing buyers and sellers must exist and be able to interact with each other to facilitate the trade in the resources, goods, or services in question. Markets also require the establishment of physical, economic, or legal conditions and incentives to allow transfers to occur, and are fundamentally premised on supportive physical and legal infrastructure – the practical conditions and rules that make exchange possible. For this reason, a critical factor in the success of the majority of nontraditional natural resource markets involving ecosystem services has been the establishment of a regulatory environment that both provides for property rights and forces (or at least encourages) participation in the market. As noted above, however, water exhibits important differences from many other natural resources, both in terms of the nature and depth of existing institutions of property rights and regulations, and in terms of its physical character, role in the economy, and social and political significance.

Not the least of these issues are the significant physical infrastructure and costs associated with the movement of water at any significant scale from one place to another, as well as the environmental impacts that can be associated with removing water from natural streams or changing the timing and volume of flows. Even where physical infrastructure already exists, changes in the diversion and disposition of water can generate significant economic and environmental costs. It is also critical to recognize that water transactions that propose to change the use of water will also inevitably confront a broad water culture in the West that has been built around access to water via subsidized, large-scale public water infrastructure, and that regards current and future access to local water supplies as a “birthright” that is essential to future economic prosperity. This culture is understandably hostile toward entities (particularly outsiders) who are engaged in “speculation” that could threaten future access to resources.

Even in areas where the political and environmental conditions for water transactions are relatively favorable, most transactions will face significant legal and regulatory hurdles. Both the Law of the River and state-level regimes for surface water and groundwater management create significant barriers to water trade, including historic water rights laws that create uncertainty in the nature of property ownership in water (i.e. unadjudicated and uncertain water rights, together with forfeiture rules), and third-party impact doctrines that limit transferability. Given the legal character of most types of “water rights” in the Basin and the complex laws and regulations that govern the ownership and control of water across states and water management districts, what would normally be understood to be market “enabling conditions” are present in only a few areas within the Colorado River Basin.

Although some of these existing rules are designed to inhibit transfers in order to protect local resources from expropriation, many reflect the very real complications created by the inherent interconnectedness of water across rivers, streams, and groundwater basins. The Colorado River is no exception. With the same water used and re-used multiple times along the length of the River, a change in the use of water at one location can automatically impact the availability of water to downstream users. As a result of these complications, in most cases, creating active, robust water markets will envtail large-scale reforms that would take decades and would implicate major, controversial policy issues involving a broad range of opposed interests.

However, trading opportunities are broadening in the Basin. Some states, for example, now expressly permit short- or long-term leasing of water rights. In other states, forbearance or dry-year option agreements (where one user agrees to temporarily forbear use for the benefit of another), creative sever-and-transfer arrangements or changes in points of diversion, the construction and operation of shared infrastructure within districts, or local or regional water settlements may provide substitute means to accomplish similar outcomes. Water banks and trusts can provide increased flexibility and allow for the protection of instream flows; land use controls, interjurisdictional agreements, and settlements can help to provide basic controls needed to facilitate transactions. Even on the heavily-controlled mainstem of the Colorado River, recent agreements among the Basin states now permit some limited mechanisms for interstate storage and release of water among Lower Basin states, as well as the storage and transfer of conserved water among users in individual states. A recent agreement (known as Minute 319) has authorized a first-ever "water exchange" between U.S. and Mexican water users, based on investments in water conservation in the Mexicali Valley.

It is also important to note that the record of direct water investing in the West (where it has occurred) has been at best mixed. Significant investments in water resources—particularly in the form of investments in agricultural lands with associated water rights—have been and are continuing to take place; in particular, a growing number of investment entities are presently engaged in the acquisition and management of agricultural lands with the expectation of repurposing some or all of the associated historic water rights for future urban or other higher-value uses. A basic (and readily defensible) thesis of these investments is that the growing and ever-more-publicized disparities and disconnects in water pricing between historic agricultural users and growing, recent urban users (which in some places have urban users paying hundreds or even thousands of times more money for water) will inevitably drive transactions to occur in spite of current legal or practical obstacles. However, it is also important to recognize that many of these types of investments have failed in the face of unrealistic expectations around investment return, the time and costs associated with meeting regulatory requirements, and/or the failure to appreciate the political, legal, and cultural nuances and sensitivities surrounding water resource management.

> Hydrologic systems can be expected to behave in ever-more-unpredictable ways and produce ever-increasing risks of significant, uncontrollable physical water shortages.

In addition, many successful investments have been in the form of relatively straightforward buy-low, sell-high transactions in which investors have inserted themselves as a bridge (or in other cases just as intermediaries) between a historic agricultural user and a future urban buyer. While these types of investments may well provide opportunities for investment returns and create more appropriate pricing signals for water, their actual value as a water management tool and associated public benefit is often murky. At best, they provide a vehicle to drive transfers from agricultural to urban use to address supply / demand imbalances in the urban sector; however, this addresses only a narrow band of growing issues, and may create associated environmental problems. Challenges associated with the long-term sustainability of agricultural communities, the financing of needed water supply and water infrastructure in growth communities, the numerous environmental challenges facing Basin users as a result of altered stream flows, groundwater depletion, and declining landscape health, and other critical needs are unlikely to be addressed through these investments (or may be worsened by them). At present, few examples exist of private-sector approaches to these broader issues in the Basin.

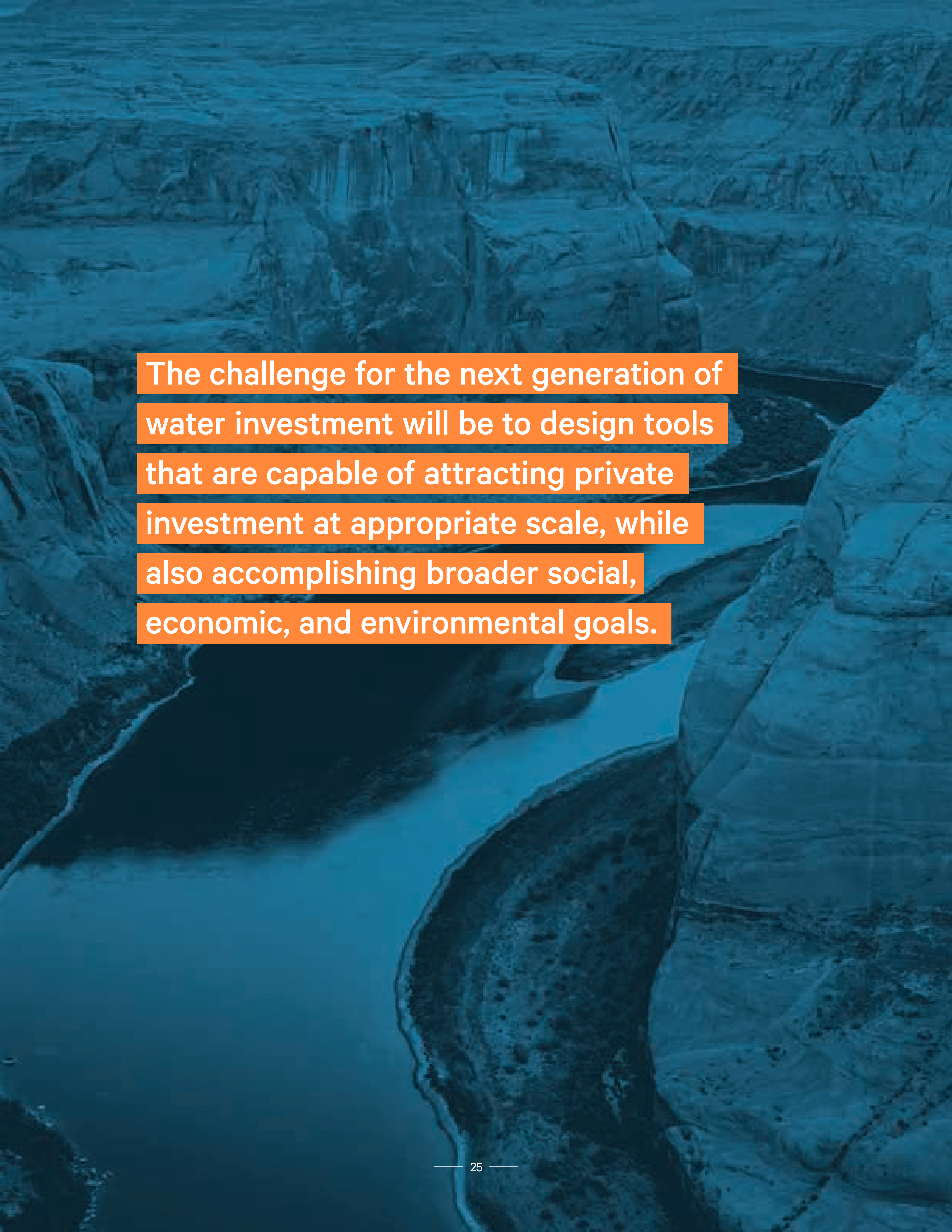
VII. The Case for Impact Investment

The challenge for the next generation of water investment will be to design tools that are capable of attracting private investment at appropriate scale, while also accomplishing broader social, economic, and environmental goals. These tools will need to accomplish more than a simple reallocation of water resources from low-to-high value uses and the creation of reasonable investment returns; they will need to contribute to the management of growing systemic risk across sectors in the Basin, and they will also need to reflect a different kind of thinking about the management of water as a finite resource.

As noted above, like many western water management systems, the Colorado River system has long been dominated by centrally managed water infrastructure planned around a "stationarity" principle, with water management based on rigid, priority-driven allocations, with risks managed largely through publicly-funded infrastructure. Let's call this the "big engineering, grey infrastructure" approach to water management. While this approach was central to achieving the remarkable development of agriculture, industry, and cities in the Basin, this approach is also proving to be inherently slow-moving, heavily subsidized, and fragile in the face of changing hydrologies and natural systems that depart from historical experience.

It is also notable that, consistent with this original stationarity principle, the Basin's water problems frequently tend to be framed as a problem of simple allocation—typically as a supply/demand imbalance "gap" that could be addressed by allowing transfers of water from lower-value to higher-value uses. Similarly, thinking about environmental problems has also tended to be somewhat "static"; most of the Basin's applicable federal and state environmental laws, for example, are set up to defend a presumed status quo in natural systems—essentially, trying to preserve (or restore) a natural ecosystem and its associated species as it exists today, or as it existed in the past. But the emerging impacts of climate change, landscape change, and the exploitation of water resources are creating conditions where systems can be expected to behave in ever-more-unpredictable ways and produce ever-increasing risks of significant, uncontrollable physical water shortages, and a situation where ecosystems are literally moving out from underneath us. What is needed is a more adaptive, a more fluid and "green infrastructure" approach to water management.

In this context, the widespread focus on simple reallocation of water between users is missing both the fundamental emerging threat to water managers and the environment in the West, as well as a key opportunity for investment. Market mechanisms and investment-driven transactions can obviously provide a tool for reallocation of scarce resources, but they can be, and in some cases have been, also used to develop sophisticated risk management and distribution strategies; strategies such as financial hedging, innovative insurance mechanisms, and the creative use of futures and options. Given the importance of risk management to the future of the Basin, adapting and modifying these types of risk management tools to address water management and ecosystem risks represents both a key need and perhaps the most significant investment opportunity on the Colorado River.



The challenge for the next generation of water investment will be to design tools that are capable of attracting private investment at appropriate scale, while also accomplishing broader social, economic, and environmental goals.

Given the close interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk also provides an important opportunity to integrate economic and ecosystem values into the management of water. By addressing risk in water management and priorities for human use, while at the same time addressing the risks to continued provision of important ecosystem services by natural systems and robustly integrating economic and ecological systems, investors can gain a powerful tool to transform markets in a manner that will ensure long-term returns as well as attain sustainability goals for both human society and the natural world. Properly designed, the water management systems of the future could help to internalize the ecological externalities that have been at the heart of the environmental problems on the Colorado.

Given the close interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk also provides an important opportunity to integrate economic and ecosystem values into the management of water.

Although the current regulatory environment is not necessarily friendly to water transfers in all places, it nevertheless offers significant opportunities for impact investment. Indeed, given the uncertain character of future water markets, the present lack of water market structures actually represents a potentially important opportunity to advance the interests of ecosystem protection and other public values through structured investments. Although the barriers to water transactions must be carefully managed, in many parts of the Basin there are a range of potential workarounds that can be employed to effectively permit certain types of market-style transactions. In fact, in the context of a highly restricted "market," impact investments are more likely to succeed than strict arm's-lengvth investment transactions, since impact investments provide the potential for public benefits that justify needed regulatory relief and/or more readily satisfy regulatory requirements related to environmental protection, avoidance of unacceptable third-party impacts, and other considerations.

VIII. Summary of Investment Tools

Below are a number of potential water-based impact investments that could be successfully deployed in various contexts within the Colorado River Basin (and potentially more broadly in the West) to provide innovative approaches to financing water resource solutions while also generating linked environmental benefits. Eleven of these strategies, representing some of the most promising that were evaluated, have been grouped into nine separate "investment blueprints" [4] that are intended for use as generic models for the development and investigation of specific investment opportunities on the ground. Some of these concepts represent a proposed "re-tooling" of existing investment structures and approaches that have been successfully deployed in other natural resource contexts; others represent essentially unique approaches that combine or improvise upon investment structures that have not previously been used in natural resource management.

4 Two of the eleven described tools represent variations on the same essential structure, and are therefore presented together.

The water investments discussed in this report have the potential to address a variety of complex environmental challenges in the Basin, from improvements to forest, riparian and grassland health, to maintaining adequate instream flows through investments in agricultural lands and improvement of water efficiency in municipal systems. They also cover the financing and development of environmentally-beneficial municipal infrastructure, as well as investments in new market institutions that could reduce systemic risks to human and environmental users alike. In many cases, the ability of a particular investment to achieve the desired outcome will depend upon specific contractual or other investment conditions; in other cases, the outcomes will be driven more heavily by the relative location within the system at which the investment is pursued. For example, investments in efficiency that result in the transfer of water downstream will have different potential benefits and tradeoffs than a similar investment undertaken along an off-stream canal.

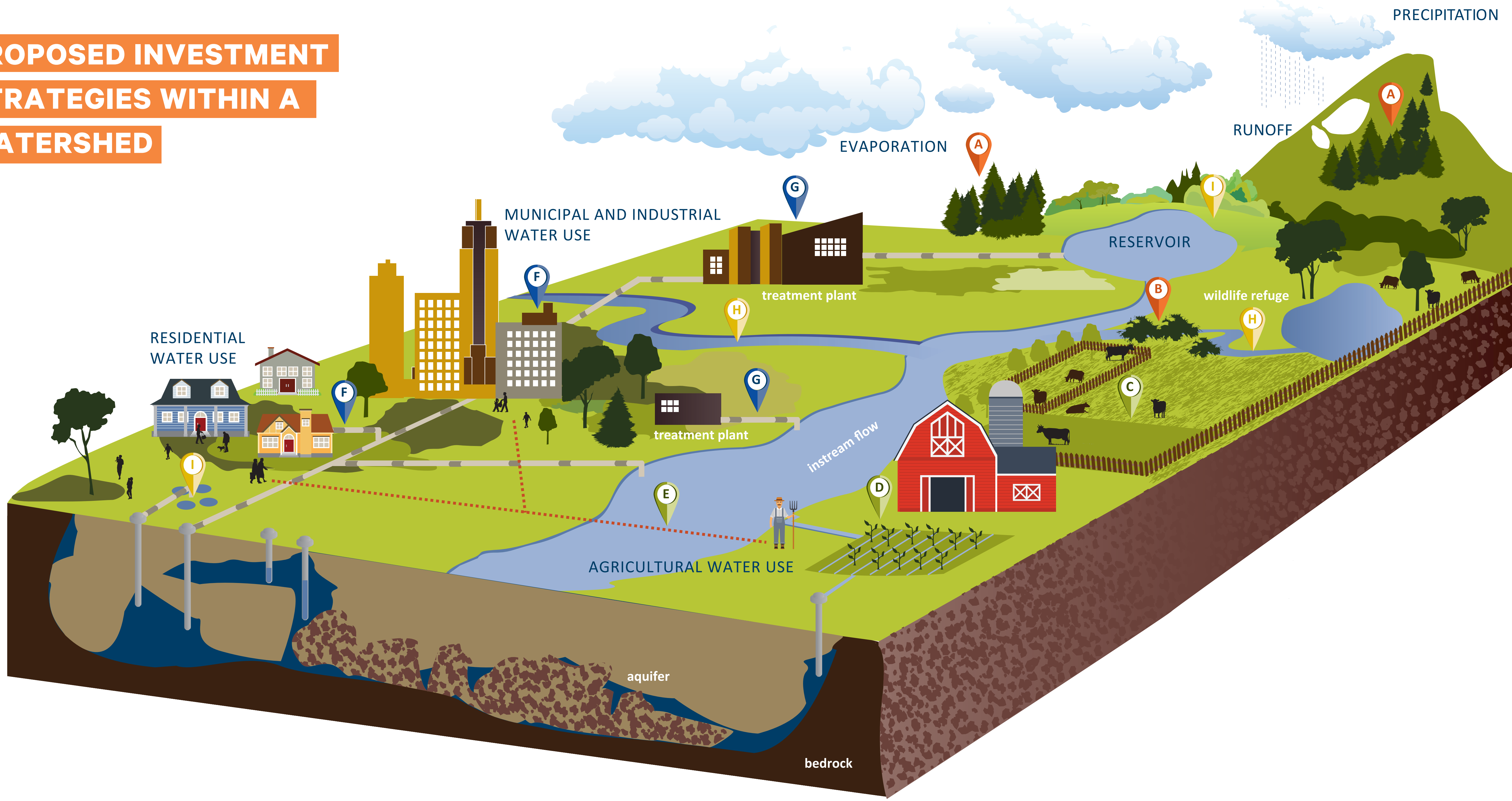
For each tool described above, the report provides a description and explanation of the environmental challenge and context that the approach is designed for, the specific structure of the investment, and the expected environmental benefit that could be obtained from its application, together with a generic case study describing how the tool would work and a hypothetical financial model demonstrating the potential revenue and return profile of the investment. The nine blueprints are grouped into four broad general categories: tools related to (a) watershed enhancement; (b) agricultural water use; (c) municipal water use; and (d) market development. Table 3 below provides a summary of the environmental benefits that could be associated with each of these investment tools. A brief summary and outline of each of these tools is provided in the pages following, with more detailed blueprints of each tool can be found in the main body of the report.

○ LOW
◑ MEDIUM
● HIGH

									Environmental Impact				
			Financial Return	Market Size	Liquidity	Deal Execution Risk	Public/Charitable Funding Interest	Policy Change Required	Watershed Health	Instream Flow	Groundwater Levels	Water Quality	Reduced Risk/ Enviro Pressure
Watershed Enhancement	A	Forest Health Environmental Impact Bond	◑	◕	○	◑	●	◑	●	◑	◔	●	●
	B	Riparian Restoration Environmental Impact Bond	◔	◔	○	●	●	◑	◕	◑	◔	◔	◔
Agricultural Water Use	C	Sustainable Ranching	◕	◕	◕	◔	◑	○	●	◔	◔	◕	◕
	D	Crop Conversion and Infrastructure Upgrades	●	●	●	◔	◔	○	○	◕	○	○	◔
	E	Commodity-Indexed Dry-Year Option	◕	◑	◑	◕	○	○	○	◔	◑	○	●
Muni Water Infrastructure	F	System Loss Pay for Performance	◑	◑	◔	◔	◑	○	○	◔	◑	○	◑
	G	Green Bond with Sustainability Conditions	◑	◑	◔	◑	●	○	◑	◕	●	●	◕
Market Development	H	Next Generation Water Trust	◔	◔	○	◕	●	◔	◔	●	○	◑	◕
	I	Water Storage Trading	◑	◔	◕	◑	◑	●	○	◑	◕	○	◑

Table 3 Summary of investment tools and relative assessment of performance

PROPOSED INVESTMENT STRATEGIES WITHIN A WATERSHED



WATERSHED ENHANCEMENT

A **Forest Health Environmental Impact Bond**
Invest in a pay-for-performance vehicle to reduce the risk of wildfires and increase watershed yield via forest thinning, with investors repaid through savings in fire suppression cost and avoided water risk

B **Riparian Restoration Environmental Impact Bond**
Invest in a pay-for-performance vehicle to improve ecosystem health and increase watershed yield through invasive species removal and riparian restoration

AGRICULTURAL WATER USE

C **Holistic Management of Working Lands**
Invest in cattle herds and ranch land to improve grassland health by employing higher-yield and more sustainable grazing practices.

D **Crop Conversion and Infrastructure Upgrades**
Invest in agricultural water efficiency via on-farm conversion to higher-value, lower water-use crops and improvements to irrigation infrastructure.

E **Commodity-Indexed Dry-Year Option**
Broker deals to better distribute hydrologic and economic risk between water uses with higher and lower tolerance for water supply loss via dry-year options and commodity price hedging

MUNICIPAL USE AND WATER INFRASTRUCTURE

F **System Loss Pay for Performance**
Invest in a pay for performance vehicle to upgrade municipal water infrastructure to reduce systems losses

G **Green Bond with Sustainability Conditions**
Provide low-cost financing for municipal water infrastructure tied to environmental and sustainability conditions

MARKET DEVELOPMENT

H **Next Generation Water Trust**
Develop an investment-driven next generation water trust to address environmental and system-wide water supply risks

I **Water Storage Trading**
Develop, implement, and operate storage trading markets in surface water reservoirs and groundwater aquifers

SQUIRE PATTON BOGGS

encourage capital

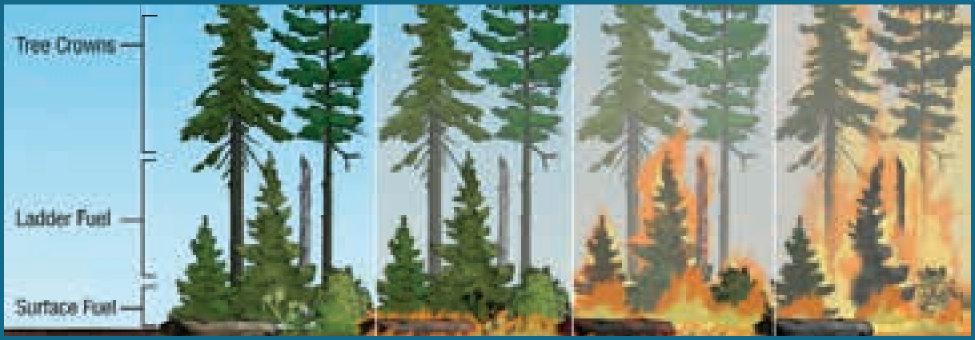
With support from the Walton Family Foundation

1. Watershed Enhancement:

Forest Health Treatments via Environmental Impact Bond

In the absence of human interference, North American forests once burned naturally at regular intervals, removing downed and small diameter trees, disposing of accumulated forest litter, and returning nutrients to the soil. However, as a result of more than a century of total fire suppression and unsustainable forest management practices, virtually all western forests—including those of the Colorado River Basin—are now blanketed with excess vegetation. According to recent research by The Nature Conservancy, the Arizona Rural Policy Institute, and others, preventative fuel-reduction forest treatments, including thinning and preventative fires, can improve forest health, reduce fire risk, and potentially increase watershed yields by up to 20% or more, benefiting both headwater streams and aquifers as well as downstream water users.

More critically, these forest treatments also help to reduce the potential for the large, intense, and catastrophically destructive wildfires that are occurring with increasing frequency in unhealthy Western forests. These fires destroy vast tracts of land and badly damage watersheds due to post-fire flood and erosion (unlike the lower-intensity burns that predominated in natural forest cycles before European settlement). Although interest and funding for preventative forest treatments is growing, and there is now clear evidence of the significant cost savings associated with undertaking preventative treatments, available government funding for forest health treatment tends to be consumed in annual fire suppression expenses.



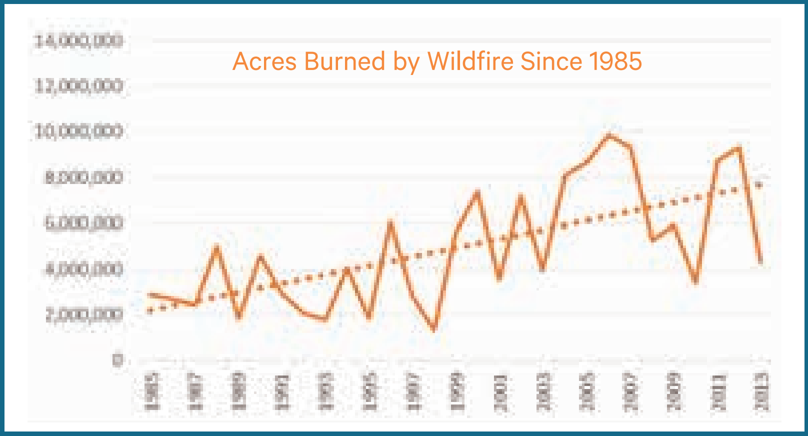
In a forest where fires rarely happen, fuel builds up: There's surface fuel (grass, logs, woody debris, brush); Ladder fuel (shrubs, small tress, smags); and tree crowns

1 Surface fires spread quickly through brush and woody debris.

2 Ladder fuels allow the fire to move up toward the forest canopy.

3 Tree crown fires are so intense, they're difficult to control.

Where forest fires have been suppressed and there has been little to no active treatment, fires can become catastrophic due to overgrowth.
Credit: Adam Cole, Nelson Hsu/NPR, http://www.npr.org/2012/08/23/159373770/the-new-normal-for-wildfires-forest-killing-megablazes



Acres of land burned by wildfires in the U.S. (solid line) with corresponding trend line (dotted line).
Source: "Federal Firefighting Costs," National Interagency Fire Center, accessed December 14, 2014 www.nifc.gov/fireInfo/fireInfo_documents/SuppCosts.pdf

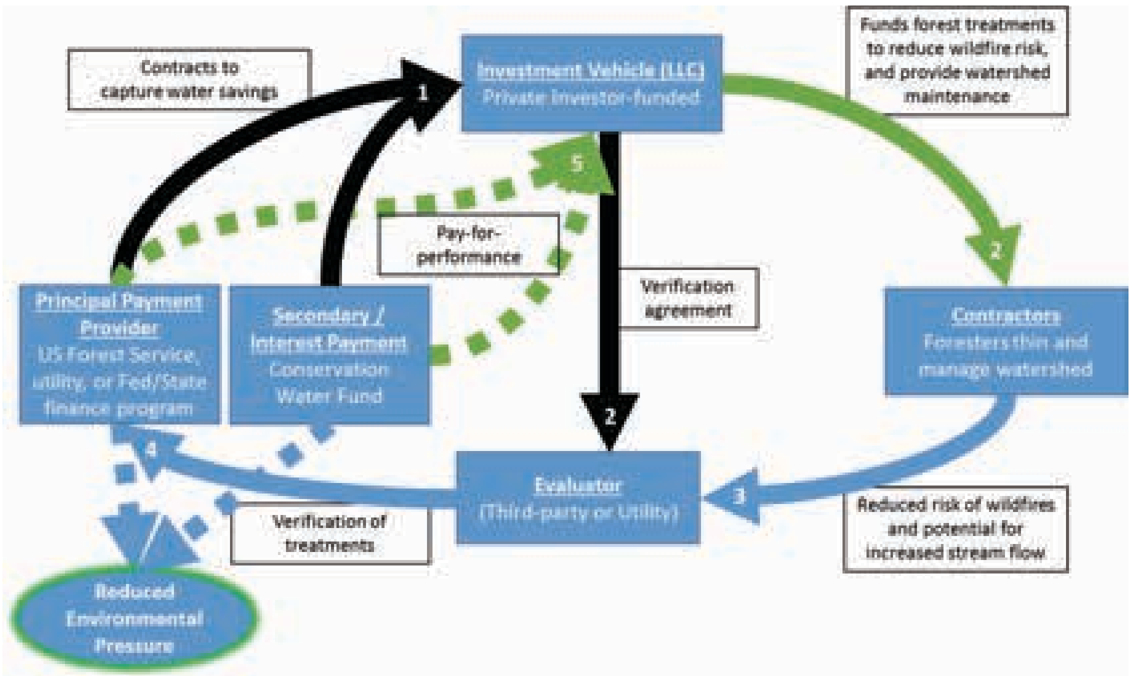


Figure 5. Structure of Forest Management and Wildfire Reduction Environmental Impact Bond.

This "environmental impact bond" ("EIB"), modeled after the "social impact bonds" that have been pioneered in various social service settings, utilizes private capital to provide the large, up-front investments that will be needed to bring forest health improvement investments to an appropriate scale. These investments would be made in watersheds exhibiting poor existing forest health conditions and a recognized increased fire risk under a performance-based repayment agreement with local forest management agencies. Once prevention treatment objectives are met and evaluated by a third party, the beneficiary (in this case, the forest management agency, with potential assistance from a "Watershed Conservation Fund" supported by specific downstream users) would repay the investors for the costs of work completed and return a portion of the resulting future fire suppression savings, as well as small payments for the risk reduction and increased yield of water in the targeted watershed. This breaks the cycle of underfunding for watershed health initiatives, saving the government and end-users money, enhancing watershed yields, and protecting water supplies.

2. Watershed Enhancement

Tamarisk Removal and Riparian Restoration

Prior to the nineteenth century, native cottonwood and willow trees lined rivers throughout the Colorado River Basin, supporting abundant wildlife in the form of resident and migratory birds, fish, amphibians, rodents, reptiles, and mammals. However, human intervention in the Basin, including the creation of dams and diversions, groundwater pumping, and cattle grazing, has dramatically impacted natural riparian habitat through reductions in water flow, changes in groundwater levels, direct disturbance, and alteration of natural flow patterns. The growing presence of invasive species such as the tamarisk tree (also known as saltcedar), an invasive shrub that establishes in riparian areas, has been a critical feature of these ecological and hydrological impacts.

Tamarisk in particular has proven to be extremely resilient to harsh conditions and has rapidly outcompeted native species like cottonwood and willow where natural flood cycles have been disrupted. Tamarisk is now the second most abundant plant on river corridors, covering some 250,000 acres in the Colorado River Basin, and the expansion of the tree is responsible for damaging wildlife habitat and increasing salinity. Because tamarisk colonize upland areas in addition to growing along stream channels, tamarisk-infested riparian areas also consume more water than healthy areas dominated by native species, lowering water tables and reducing the contributions of floodplain aquifers to surface flow. Removing tamarisk (and other similar invasives, like Russian olive) and restoring native species can produce both important environmental benefits for wildlife and potentially save significant amounts of water.

A number of successful tamarisk removal strategies are currently being employed throughout the Basin, and more recent watershed-wide planning efforts have created the opportunity for much broader interventions to control invasives. However, capacity and funding is not presently available at sufficient scale to increase ecological resiliency overall or realize the potential for water savings from restoration. Similar to the performance-based environmental impact bond for forest management, this "environmental impact bond" would utilize a pay-for-performance mechanism in order to bring private capital to bear to significantly scale up invasive species removal and riparian restoration efforts. Watersheds exhibiting extensive tamarisk, Russian olive, and other invasives infestation would be targeted, ideally where these could contribute water savings to downstream users; investors that fund riparian restoration projects would receive compensatory payments on a per-acre basis if restoration projects achieve predetermined objectives (with overall compensation levels based on the average water yield that recent research has suggested are associated with tamarisk removal and restoration of native vegetation).

Healthy cottonwood-willow forest on Gila River.
Credit: National Geographic, Sandra Postel.

Tamarisk tree.
Credit: National Park Service.

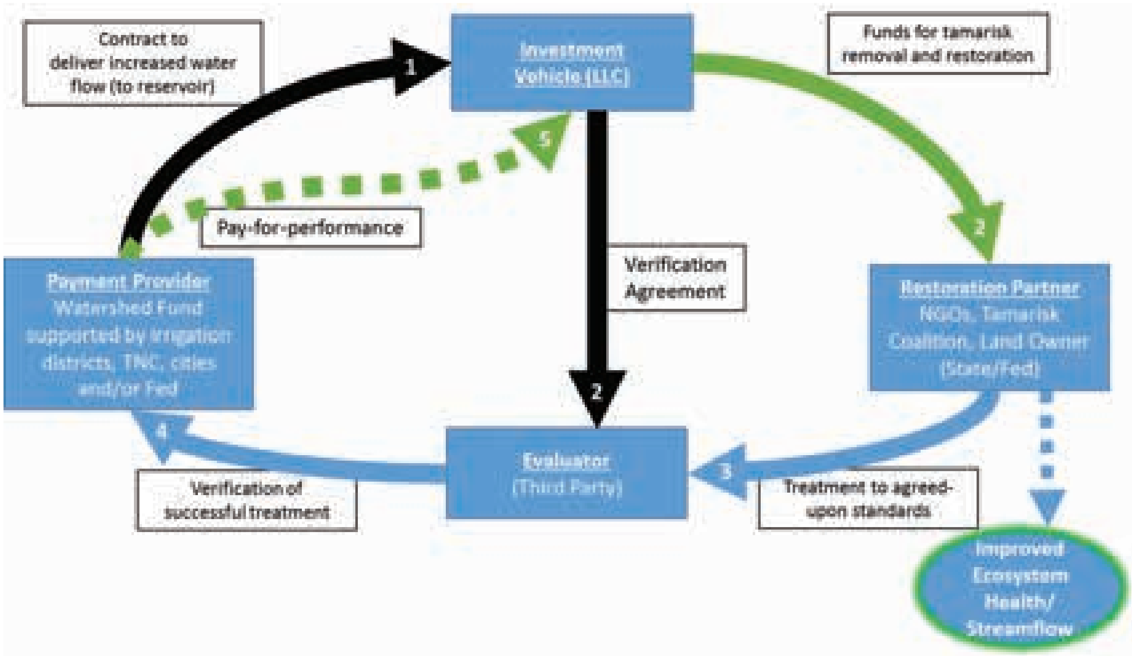


Figure 6. Structure of the Riparian Restoration Environmental Impact Bond.

Because the water and habitat benefits from such enhancements would necessarily be distributed across the system (and would not clearly traceable to a single user), similar to the funding sources for the forest health EIB, the revenue stream for a riparian restoration EIB would necessarily need to be provided by public or government sources (or via cooperative arrangements among downstream water users like the current Colorado River System Conservation Program or The Colorado River Basin Salinity Control Program) that would be willing to pay for system-level benefits This would require the creation of a "Watershed Conservation Fund" to make contributions toward these types of restoration treatments -- funded by government agencies, downstream users who could expect a relative low cost-per-acre-foot benefit to system water supplies, and local communities and businesses who would benefit from improved river access and associated recreation opportunities. Local communities could also commit interested volunteers and/or provide labor in connection with local employment programs to address temporary labor needs and help to reduce the net costs of restoration activities.

3. Holistic Management of Working Ranch Lands

Improving Soil and Grasslands Health

Livestock production has a deep and widespread influence on the ecology and hydrology of the Colorado River Basin, both as a result of the use of water for feed production (nearly 80% of all Upper Basin water use) and as a result of the impacts of grazing, which occurs throughout the Upper and Lower Basins on the vast majority of private and public lands. Where grasslands are maintained in good condition, grazing and the deposition of manure are a critical part of the ecosystem, helping to build soil, improve water infiltration, and increase nutrient cycling. However, grazing practices involving cattle (and to a lesser extent sheep) have caused extensive landscape changes due to selective pressures on specific types of grasses and edible plants, the spread of undesirable invasives and inedible plants, disturbance from trampling in grasslands and riparian areas, water pollution, and other factors. Very few examples of healthy, native grasslands remain anywhere in the Basin; many have disappeared altogether.

Although the impacts of these changes on the Basin's hydrology are difficult to quantify precisely, grazing practices are widely understood to have led to increased desertification of grasslands, erosion and changes in surface runoff, lowered water tables, and the loss of wetlands, cienegas, and springs. Grazing practices have also led to the spread of juniper and other tree species (such as mesquite), which can also lower groundwater levels, into former grassland areas. Poor grassland health has additionally contributed to the emerging issue of "dust on snow," in which dust deposits on mountain snow packs leads to the snow melting faster and earlier in the season, increasing evaporative losses and losses due to early growth of vegetation (believed to have caused an approximate 5% reduction in total runoff Basin-wide).

Some emerging range management strategies suggest significant potential for private investment in holistic "regenerative agriculture" techniques. Essentially, these are targeted approaches to livestock production that can improve grassland conditions and increase net livestock yields across rangelands. For example, intensive rotational livestock grazing (which grew out of the 1980s-era "Savory method" and other holistic management approaches) actively manages livestock to graze on a confined plot of land for a short period and then move elsewhere, allowing grasses to recover while opening up soils and leaving animal manure behind to build soil nutrients. These practices have substantially improved grasslands condition, soil moisture, and other values while allowing larger livestock yields.

Cattle grazing on grasslands.
Courtesy: National Resources Conservation Service.

Creosote-dominated landscape in New Mexico resulting from historic overgrazing.
Courtesy U.S. Bureau of Land Management

Same area five years later, restored to healthy grassland through Bureau of Land Management's Restore New Mexico project.
Courtesy U.S. Bureau of Land Management.

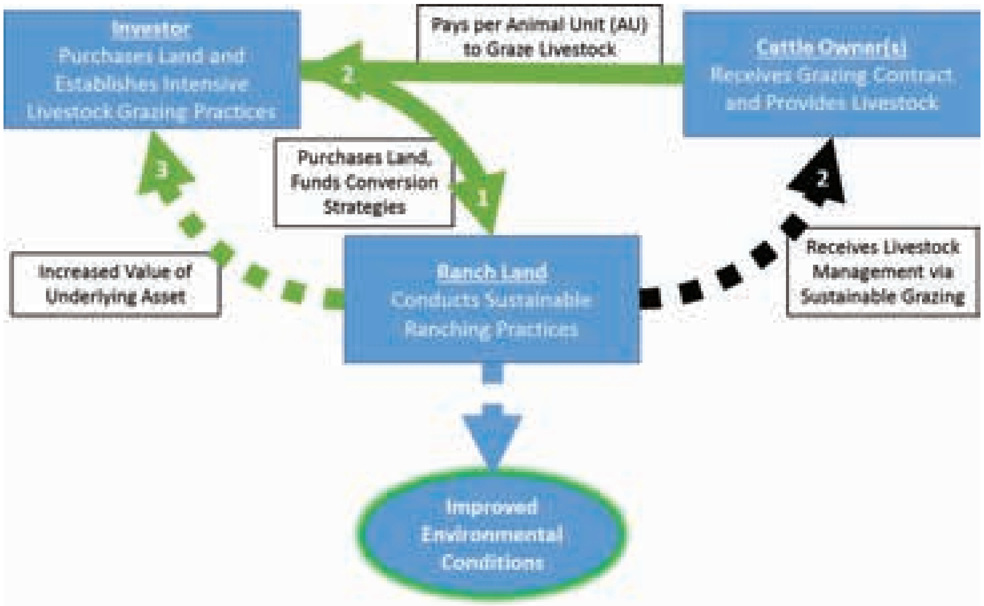


Figure 7. Structure of Holistic Management of Working Ranch Lands via Cattle Ownership

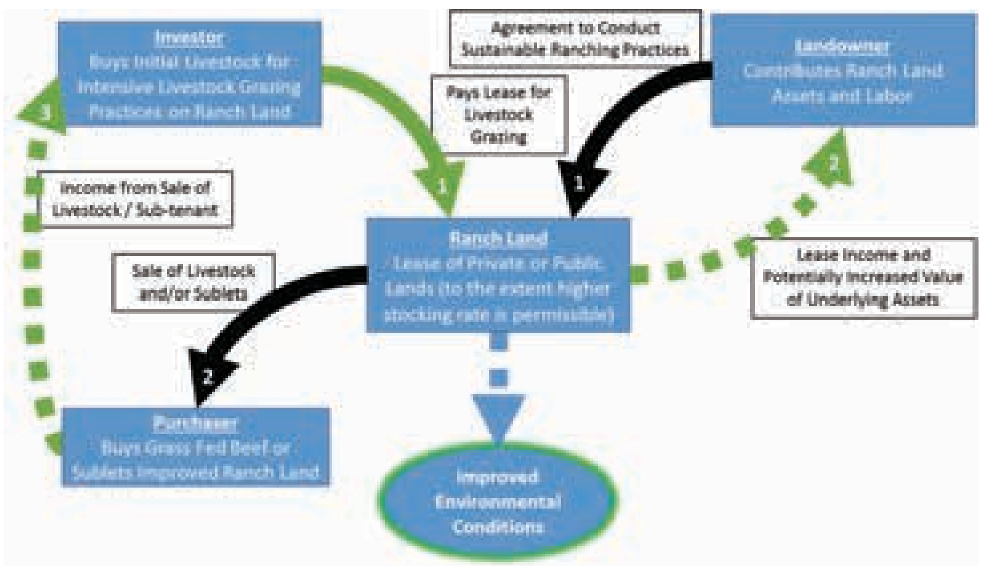


Figure 8. Structure of Holistic Management of Working Ranch Lands via Land Ownership

This financial vehicle is structured to make investments in improving grasslands condition and soil health through changes to the management of working ranch lands. This vehicle seeks to provide capital for ranches to convert to sustainable ranching practices on both private lands and public leased lands through a joint venture between an investor and an existing ranch owner/operator, or alternatively through the direct purchase of underutilized ranch lands and/or cattle herds. Investor returns would be generated from increased quantity and quality of livestock outputs in connection with improved forage and livestock capacity on restored lands (and in the case of direct purchase, the appreciation of underlying land assets). Improvements in grassland condition and soil health would be expected to produce both direct and indirect environmental and economic benefits through contributions to watershed yield, decreases in pollutant loading, and the appreciation on underlying land values. Additionally, the joint venture strategy could help to facilitate the entry of young farmers into the livestock industry or help keep existing owner-operators on their land.

4. Maximizing Agricultural Water Efficiency

Financing Crop Conversion, Enhanced Farm Management, and Infrastructure Upgrades

As in other parts of the West, agriculture accounts for approximately 70% of the developed water use in the Colorado River Basin, and the water rights held by agricultural water users tend be those with the highest legal priorities. Agricultural water use varies widely in both efficiency and relative economic value, and much of the Basin 's irrigation infrastructure is also significantly dated and inefficient. For example, outside of the high-value production agriculture that takes place in many of the Lower Basin states, flood irrigation – often supported by leaky earthen ditches – remains the predominant method of irrigation in most of the Basin..

This has made lower-value agricultural uses an obvious target for future water transfers to meet urban and industrial demands, as well as a source of water to support higher-value permanent croplands. However, even in areas producing lower-value outputs, agricultural lands and farm economies have critical economic, political, and cultural significance in many parts of the Basin, setting up important tensions among and between agricultural communities and urban water users. In particular, "buy and dry" strategies that have taken existing agricultural lands out of production to free up water have been extremely controversial due to their long-term impacts on local economies. However, alternative approaches—such as the conversion of existing farmland to the production of less water-intensive (and in many cases higher-value) crops, the use of deficit irrigation techniques on compatible crops, together with the introduction of water use efficiency improvements and approaches such as land leveling, drip irrigation, use of cover crops, and conservation tillage techniques—create potential opportunities to improve agricultural outputs in both returns per acre and returns per unit of water. At the same time, these more sustainable approaches to agriculture can potentially reduce the consumptive use of water by agricultural uses without changing the amount of land in production, generating water savings that could be transferred to other uses.

Crop (in thousands of acres)	AZ	CA	CO	NV	NM	UT	WY
Total Forage (harvested)	325	1,670	1,297	531	343	762	1,054
Total Forage (irrigated)	323	1,347	969	510	303	677	772
% of total forage irrigated	99%	81%	75%	96%	88%	89%	73%
Alfalfa hay (harvested)	272	874	654	344	222	566	547
Alfalfa hay (irrigated)	271	832	561	344	222	566	547
% of alfalfa hay irrigated	100%	95%	86%	100%	100%	100%	100%
Other tame hay (harvested)	44	670	688	181	104	166	498
Other tame hay (irrigated)	42	377	380	168	72	89	218
% of tame hay irrigated	95%	56%	55%	93%	69%	54%	44%
Wheat (harvested)	103	492	2,182	18	87	138	132
Wheat (irrigated)	103	383	126	18	37	45	17
% of wheat irrigated	100%	78%	6%	100%	43%	33%	13%
Total Harvested (forage, alfalfa, hay, wheat)	**744**	**3,706**	**4,821**	**1,074**	**756**	**1,632**	**2,231**
Total Irrigated (forage, alfalfa, hay, wheat)	**739**	**2,939**	**2,036**	**1,040**	**634**	**1,377**	**1,554**
% of total irrigated	**99%**	**79%**	**42%**	**97%**	**84%**	**84%**	**70%**

Table 4 Colorado River Basin Major Crops and Acreages (Note: Crop data is state-wide: both within and beyond the Colorado River Basin)

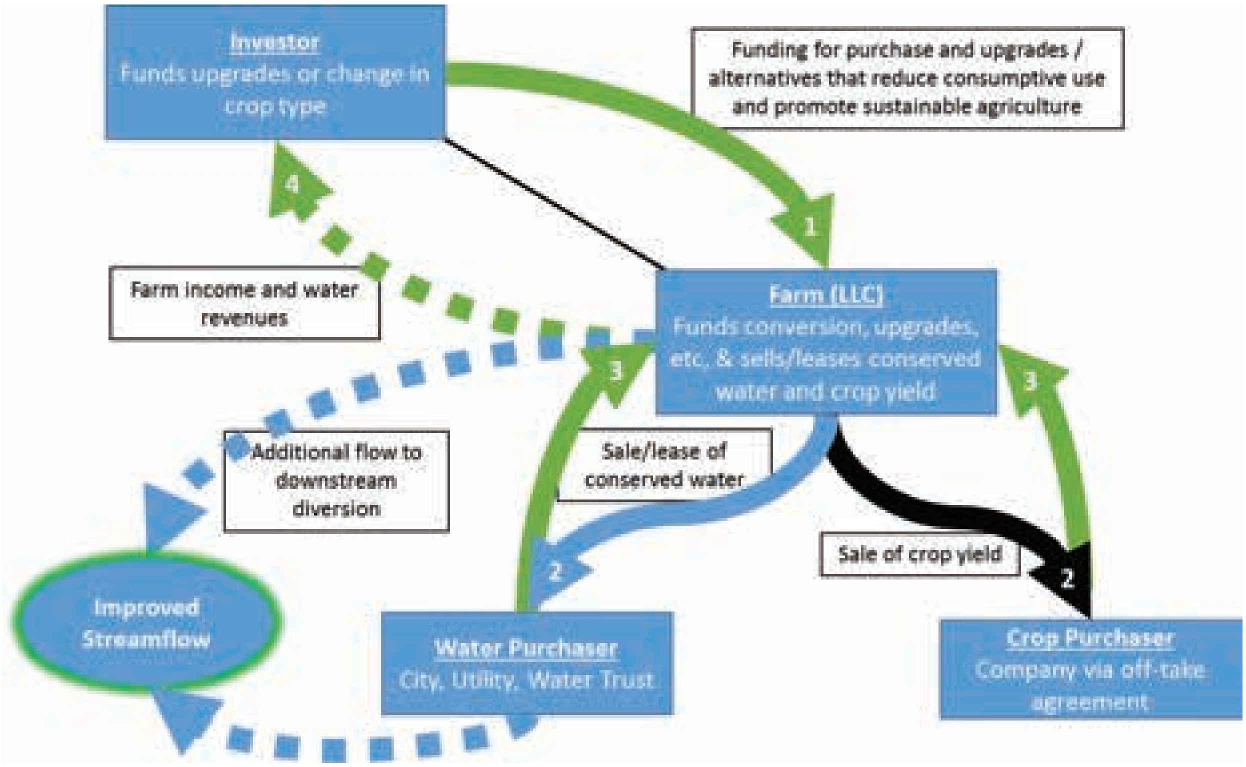


Figure 9. Structure of the Crop Conversion and Infrastructure Upgrade Direct Investment Model.

Given the challenges that many farmers will face in financing these types of improvements, there appears to be significant potential for the deployment of private capital solutions to finance improvements in agricultural water use, combining specific crop conversions towards lower water use, more drought-tolerant crops with irrigation infrastructure upgrades and enhanced land management techniques to increase overall efficiency. Repayment of these investments could be generated by a combination of enhanced farm revenues, potentially supported by off-take or long-term supply contracts for specialized crops that are not already widely produced in the region, and the monetization of water savings via the sale or lease of conserved water to downstream users.

A variety of potential deal structures could potentially support this approach, including direct investment strategies involving the direct purchase and upgrade of farmland by an investor (who could then capture the upside of both enhanced farm and water revenues, as well as the appreciation of the farmland assets), or a joint venture investment model in which an existing farmer and investor work together to achieve those outcomes through the contribution of farmland and labor (farmer) and needed capital (investor), and share in the resulting revenues. At the farm level, these types of investments could also be structured to facilitate the entry of young farmers as partners in the investment, allowing them to finance their acquisition of farmland in areas with aging farm populations (where the costs of an outright farm purchase by a young farmer are effectively out of reach). Similar joint venture investments could also be undertaken at the level of the irrigation district between a district and an investor, with the district organizing investments at the individual farm level to achieve those outcomes.

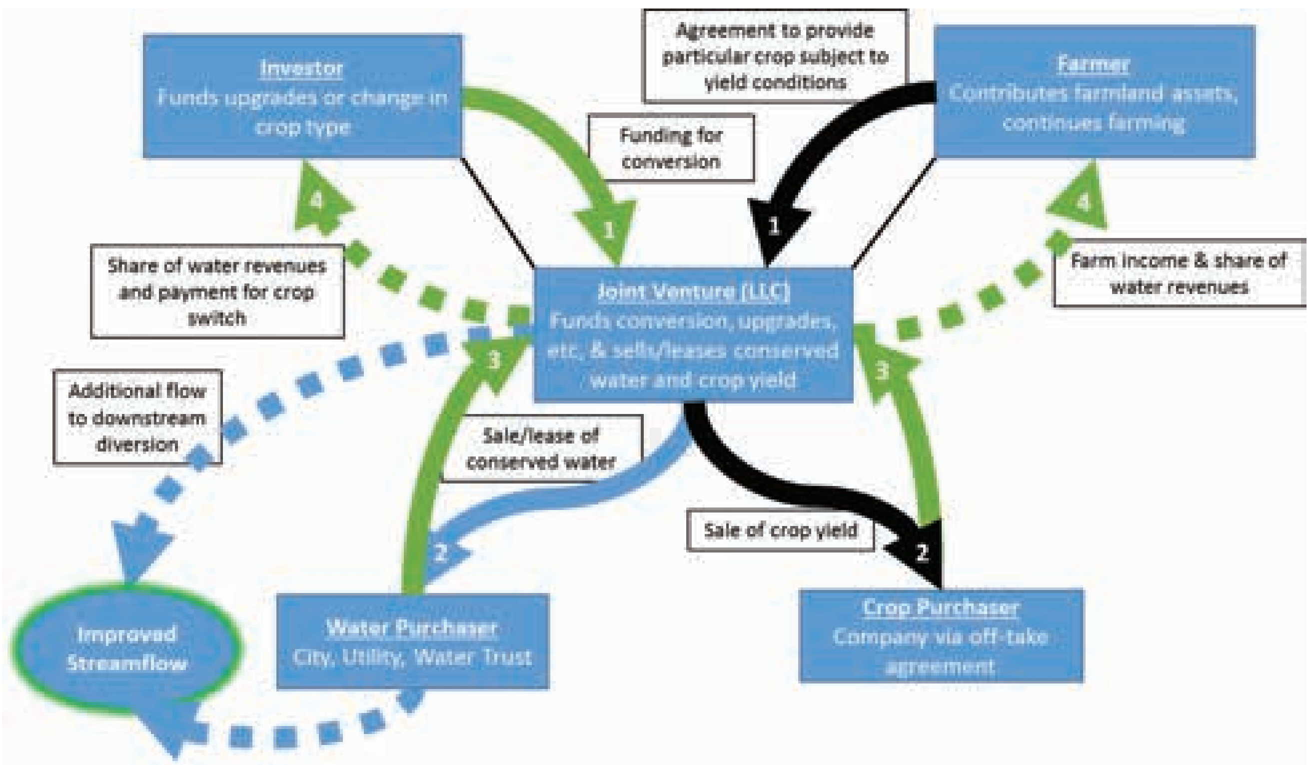


Figure 10. Structure of the Crop Conversion and Infrastructure Upgrade Joint Venture Model.

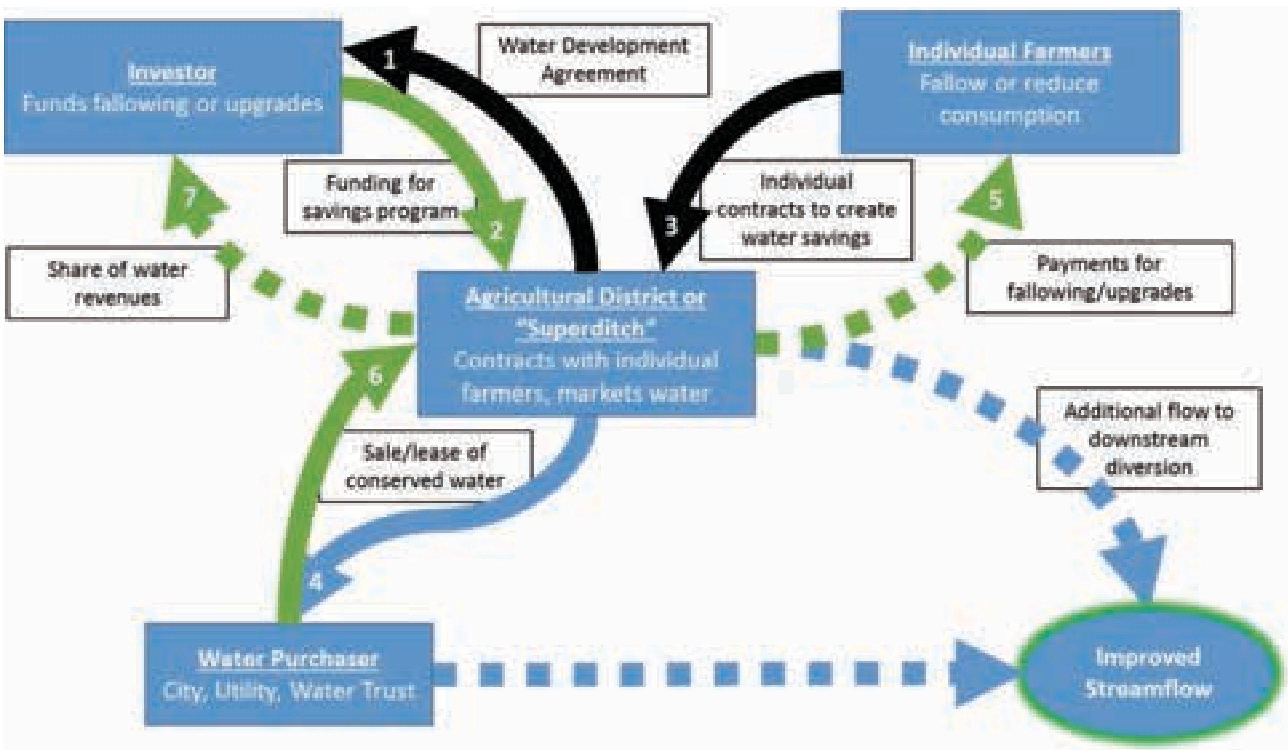


Figure 11. Structure of the District-Level Crop Conversion and Infrastructure Upgrade Water Development Agreement Investment Model

5. Sharing Water Supply Risk

Brokering Commodity-Indexed Dry-Year Options

As discussed above, water users in the Colorado River Basin are facing significantly increased risks of shortage over the coming decades as the long-term effects of legal overallocation, physical overuse of water, and growing changes in hydrology manifest throughout the Colorado River Basin. Recent forecast modeling has made it increasingly clear that, even with significant system-level investments in the management of shortage risks, water users in the Colorado River Basin must be prepared to deal with substantially increased levels of uncertainty and risks of water shortages that cannot be fully controlled. Under the current priority system for the allocation of shortage risks, this issue disproportionately impacts "low-priority" users whose water rights or delivery contracts are more recent in origin. Because of the history of development in the Basin, this frequently means that some of the greatest risks of shortage exposure fall to municipal and industrial users, as well as the Basin's more recent agricultural developments (such as agricultural districts served by the Central Arizona Project).

This leaves a variety of municipal and agricultural users potentially exposed to water supply shortfalls in areas that either (a) lack significant storage to buffer against drought events; (b) could experience sustained, below-average runoff that exhausts local storage; and/or (c) lack substantial redundancy in their water supply portfolios (or that have redundant supplies which could also be threatened). This growing uncertainty means that water users with "hardened" demands -- such as municipal users without significant new opportunities for near-term water conservation, water-intensive industry, or permanent crop producers that have a low tolerance for water supply interruption -- must be prepared to take actions and make investments that will reduce the physical, ecological, and/or economic fragility of their water supply systems in the face of future disruptions in water supply.

Downtown Phoenix Arizona
Source: Stocksy

Furrow irrigation using siphon tubes, Colorado.
Photo courtesy USDA Natural Resources Conservation Service.

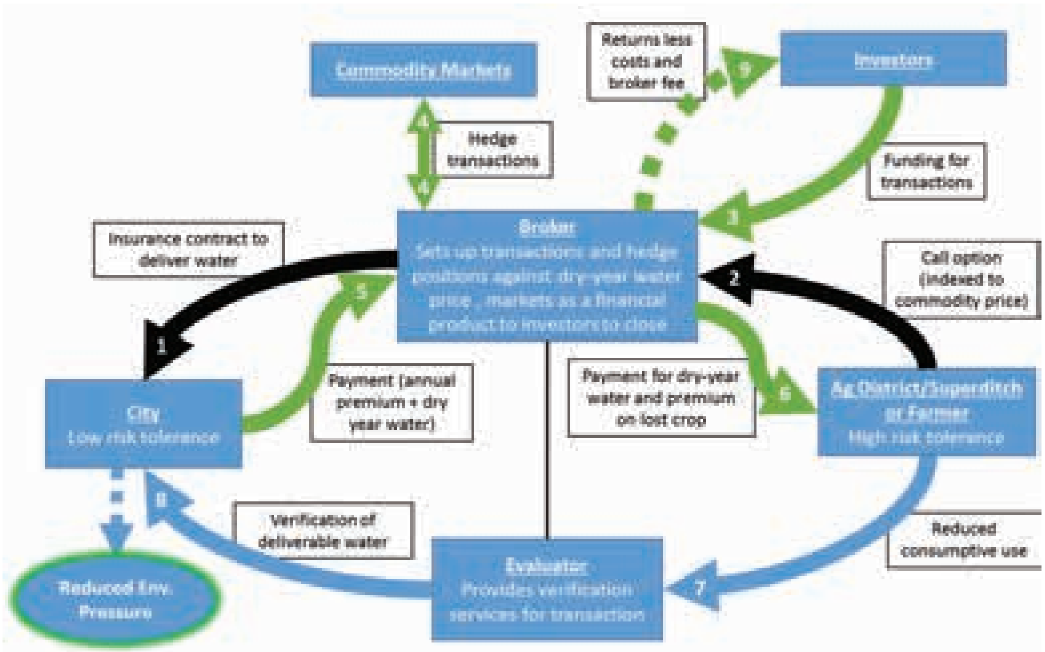


Figure 12. Structure of Commodity-Indexed Dry-Year Option.

So called "dry year options" provide a mechanism for water sharing in which a user with low tolerance for water supply disruption, such as a municipality or permanent crop farmer (the "option buyer"), pays a user with a higher tolerance for this disruption, such as a forage crop or row crop farmer (the "option seller") to utilize or share their water supply during shortage conditions. While these agreements can be attractive to both parties if they achieve water supply certainty for the option buyer while guaranteeing the option seller a higher price for the water than could have been realized growing crops, these agreements have been difficult to implement in practice -- in part because they typically shift all of the economic risks associated with these agreements to one party.

Managing this uncertainty provides a potential role for private investment to facilitate these types of agreements between parties by utilizing a more creative approach to hydrologic and economic risk sharing, referred to here as a "commodity-indexed dry year option." This proposed approach would utilize a dry year option agreement in which the price that would be paid to the option seller (in the event of a shortage to the option buyer) is indexed to the commodity prices associated with the crops that could be grown on that property, blended with a commodity price hedge mechanism. Under an agreement between the option buyer, the option seller, and a third-party investor, the option buyer agrees to pay the investor a known price to maintain the option and/or to pay for the water when the option is exercised, while the investor agrees to pay the option seller the commodity-indexed price for the water when it is exercised (plus some premium to maintain or exercise the option). The investor would then purchase commodity call option contracts in relevant indexed commodities to hedge upside commodity price risks, and, depending on the interests of the farmer, buy put option contracts in relevant indexed commodities to hedge downside commodity price risks.

This approach allows for simultaneous mitigation of physical hydrologic risk and water pricing risk to a municipal, agricultural, or industrial water user with low tolerance for water supply variability, while also limiting overall economic risks to an agricultural user with a higher tolerance for water supply variability. By facilitating the pre-negotiation of economically manageable water sharing arrangements and managing risks to both users, this tool could also work to limit the ecological risks and pressures that would otherwise be associated with sudden, catastrophic shortfalls to low-tolerance users -- who might otherwise be forced to exploit ecologically-important or otherwise unsustainable water supplies in the absence of other options.

6. Municipal Water Conservation

Using Pay-for-Performance to Address Non-Revenue Water

Implementation of municipal conservation efforts will be an important component of addressing supply and demand imbalances on the Colorado River, and in controlling the impact of increasing municipal water needs on the Basin's ecosystems and infrastructure (municipal use is projected to be the largest source of water supply demand growth in the Basin). However, conservation efforts can create their own unique set of challenges for municipal water suppliers, such as "demand hardening" that reduces system resiliency and reductions in the availability of effluent supplies used to supply secondary users. Most significantly, however, in many cases investments in conservation efforts tend to be "revenue negative" to the municipal provider itself, since reductions in customer water use will typically reduce revenue to the utility without generating proportionate reductions in operating costs, or result in stranded costs or issues with oversized infrastructure. Although these issues should not prevent investments in municipal conservation, they can make it difficult to design a privately-funded investment model for water conservation that would be attractive to municipal providers.

One obvious "no-regrets" form of conservation investment relates to the management of "system loss" – essentially, water losses within municipal water systems that occur as a result of leaks and water line breaks, unmapped infrastructure (particularly in older and rapid-growth areas), and unmetered connections – also referred to as "non-revenue water." The fact that non-revenue water is never received at a metered connection results in utilities having to divert and treat more water than they can sell. This means that controlling system loss is almost always revenue-positive to the water supplier, and can be used to reduce municipal diversions, groundwater pumping (even in closed-loop systems) and water treatment loads and costs -- all while increasing or maintaining system revenues.

Water system losses can be very significant; for example, a national survey of major U.S. metropolitan water providers showed loss rates as high as 30% for some suppliers. Major Basin municipalities have demonstrated that these losses can be controlled through proper investment, and as a whole have already achieved relatively low loss rates in comparison to most U.S. cities. However, control over system losses is generally more problematic for smaller, less-capitalized water suppliers, such as small- to mid-size municipalities as well as many private water providers, since they are less likely to have reserves that allow them to invest in infrastructure replacement on an ongoing basis. Many smaller municipalities also lack ready access to municipal bond markets and other traditional financing approaches to finance large-scale system upgrades, relying much more directly on annual cash flows from rate-based income to provide capital for system improvements and repairs.

This proposed investment would assist capital-constrained municipal water providers (either public or private) in reducing their water utility system losses using a pay-for-performance mechanism, thereby reducing net municipal water diversions and reducing future pressures on water resources in the local watershed from new growth. The investor, either independently or in a joint venture with a technology provider/ technical partner, would finance up front investments in system loss reduction. (These improvements could include the installation of various types of new leak detection and system monitoring technologies, the conduct of a comprehensive system audit to identify sources of non-revenue water, and the completion of needed infrastructure upgrades and repairs.) The investor and/or technical partner would then receive an agreed-upon return from the water provider based on the actual efficiency performance of those investments in reducing system losses on a per-unit or costs-saved basis. Because the performance payments would be

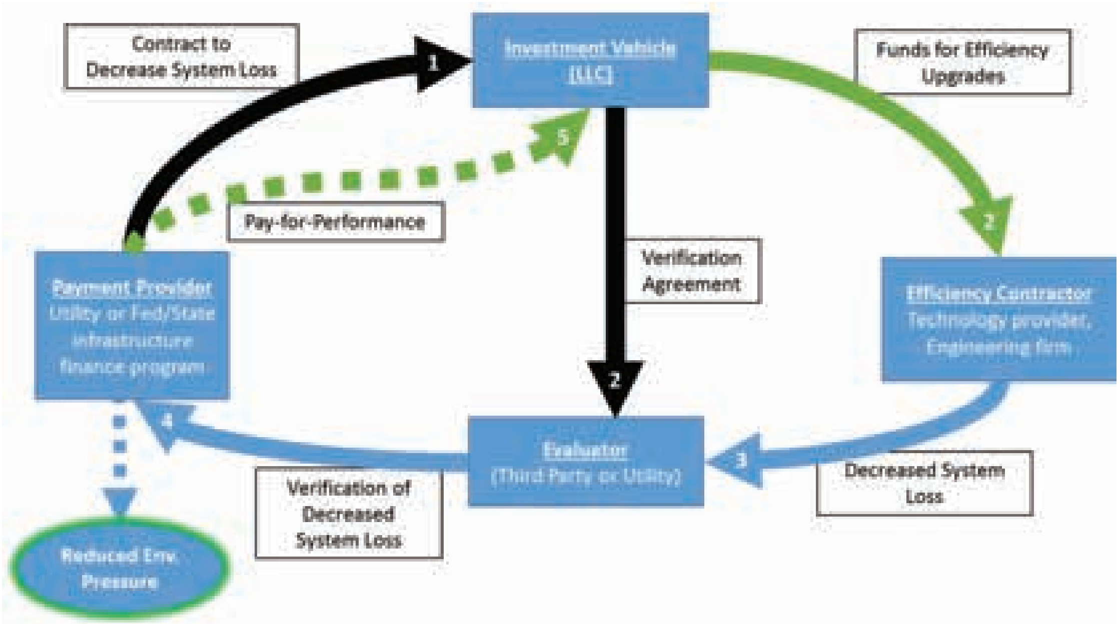


Figure 13. Structure of Investor-Only Model for System Loss Pay-for-Performance.

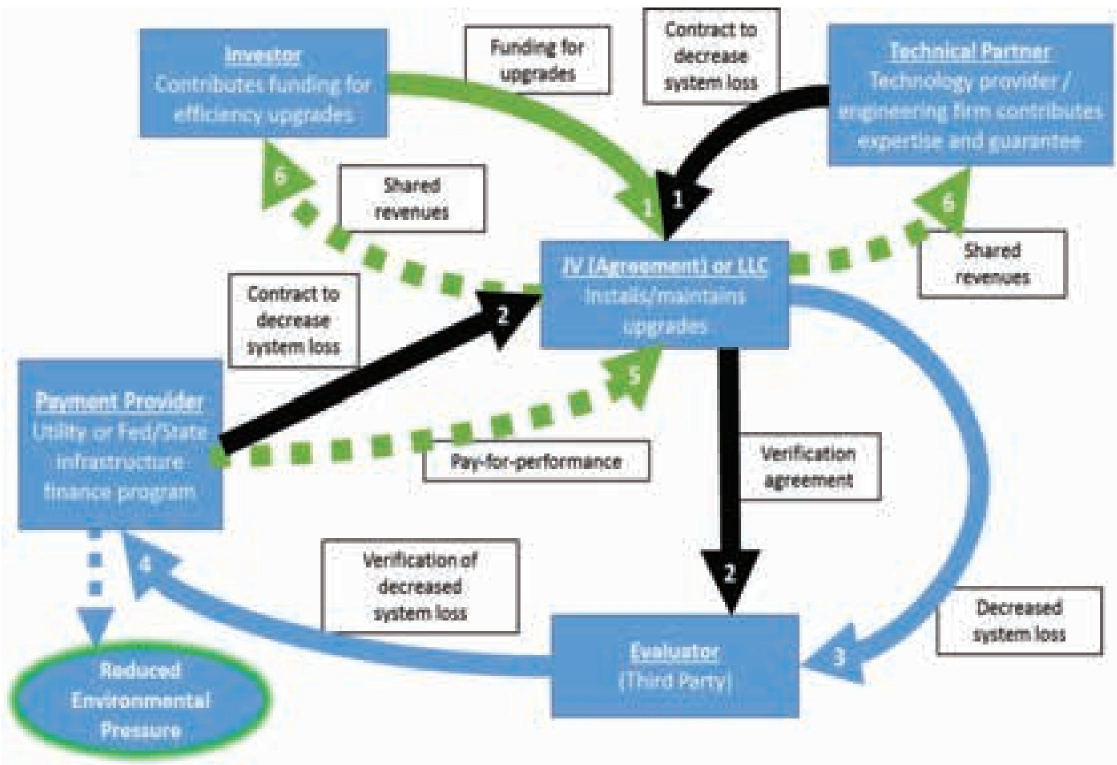


Figure 14. Structure of Joint Venture Model for System Loss Pay-for-Performance.

supported out of the revenue savings and enhancements the utility receives as a result of the efficiency upgrades, the water provider could thus achieve the reduction in system loss at no actual cost (or even see net increases in revenue) while shifting the risks of nonperformance to the third party investor/partner.

7. Financing Sustainable Water Infrastructure

Municipal Green Bonds with Environmental and Sustainability Conditions

Although the physical unavailability of water will clearly be a factor in the future of economic development for many communities, in many of the West's cities, towns, and rural areas, the bigger issue will be how to pay for the infrastructure, water rights, and new institutions needed to manage scarce supplies. As supply and demand imbalances continue to grow throughout the Colorado River Basin, many communities are facing significant infrastructure needs associated with access to and delivery of sustainable and reliable water supplies in the face of growing scarcity and water risk – including needs for consolidation and repair of aging or poorly-planned infrastructure, reuse and conservation projects, water supply enhancements, control of groundwater depletion and investments in recharge activities, and environmental mitigation and green infrastructure alternatives. Over the next 20 years, total infrastructure needs for drinking water facilities in the six Colorado River Basin states, excluding California, was estimated by U.S. EPA at $25.5 billion as of 2011; California alone had an estimated $45.5 billion need for infrastructure investments. At the same time, federal and state-level funding for water infrastructure – once a mainstay of Western development – has been declining since the 1980s.

These challenges appear to be particularly acute in small- to medium-sized growing communities in the West. While larger cities have ready access to capital via traditional municipal bond financing (and for the most part do not project significant future increases in water demand), some of the most significant water resource problems are developing in areas of the Basin with the least ability to pay for their own water supply and infrastructure needs. Rapid growth in these areas has often created significant accumulated deficits in water infrastructure, as well as widespread dependence on unsustainable groundwater "mining" that is depleting local aquifers and generating significant environmental issues. Facing a legacy of accumulated pre-recession fiscal and infrastructure debt, limited local revenues, and frequently local resistance to rate and tax increases, these same communities are frequently unable to access traditional bond financing on attractive terms to pay for solutions -- or are pushed to invest in cheaper, less sustainable infrastructure because they cannot afford to invest in more sustainable or desirable alternatives.

Given the vast backlog of infrastructure needs and significant projected growth in water demands in these communities, it is critical that new municipal water infrastructure be built with an appropriate focus on environmental impacts and opportunities. The failure to address infrastructure needs, as well as the manner in which these investments are made, can create significant environmental problems from water pollution, the depletion of stream flows from diversions to augment water supplies, long-term destruction of streams and riparian areas due to reliance on unsustainable groundwater pumping, and the risk of future emergency interventions to address water supply shortfalls that could override important environmental considerations. Similarly, failures to invest in proper environmental mitigation or to install green infrastructure options can represent huge missed opportunities and commit communities to long-term, less-sustainable paths to growth.

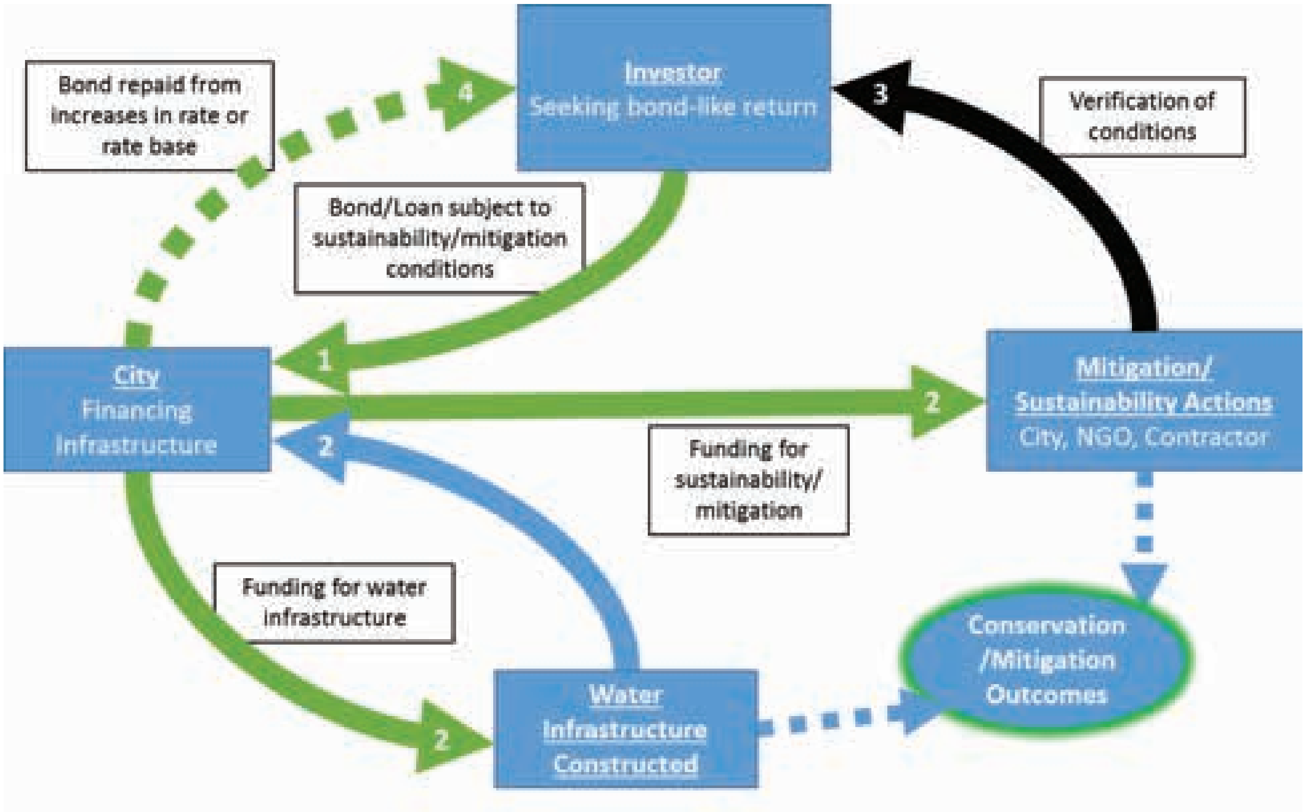


Figure 15. Structure of Green Bond with Sustainability Conditions.

There is a clear opportunity to utilize private capital to bridge these infrastructure funding gaps and help to encourage the development of environmentally-beneficial municipal infrastructure, implementation of sustainability policies, and/or implementation of enhanced environmental mitigation requirements. The suggested approach would utilize a modified version of a traditional municipal "project" or "double-barrel" bond, combining applicable characteristics of (i) green-labeled municipal bonds, but with actual environmental conditions;[5] (ii) project bonds in regard to the focus on an individual project and ring-fenced repayment; and (iii) double-barrel bonds by featuring an enhanced credit quality as a result of ratepayer funding or general obligation backing from multiple, cooperating entities. This type of arrangement would provide investor financing to build needed municipal water infrastructure, but with the implementation of sustainability measures as express conditions on access to financing (such as control of local groundwater overdraft or coordination among jurisdictions on regional water management), environmentally-beneficial projects (such as above-the-minimum mitigation activities or the construction of environmentally-beneficial infrastructure) and other environmental/social commitments. These conditions, oversight mechanisms, and the agreements associated with each could also be structured to help guarantee the repayment of the bond, e.g., by engaging multiple jurisdictions in responsibility for infrastructure or ensuring the long-term sustainability of new growth needed to repay the bond.

5 Current green bond issuances are generally self-labeled by issuers and underwriters. While the underlying projects supported by these debt fundraisings are often environmentally less harmful than traditional "gray" infrastructure alternatives, the net environmental benefit of many of these projects is essentially nonexistent, as they are essentially traditional infrastructure projects that would have been built anyway.

8. Next Generation Water Trusts

Facilitating Water Trade and Controlling Watershed Risks

As discussed above, environmental values have few recognized "rights" to water in the Colorado River Basin; where flow requirements do exist, they rarely extend beyond the bare minimum necessary to prevent the extinction of a particular endangered species, and do not necessarily protect any broader range of environmental and/or recreational values that may be associated with flows in that particular reach. One institution that has recently emerged in many Western states to address ecological water needs is the "water trust"; typically a 501(c)(3) non-profit organization organized in a manner similar to the more familiar "land trust" (although in some states, water trusts are housed in state water agencies). Water trusts are typically used to acquire water rights via outright purchases, leases, dry-year options, donations, or investments in water conservation in partnership with traditional users, with the rights dedicated to maintain minimum flows for the benefit of fish, vegetation, and wildlife, particularly during low-flow periods when those flows might otherwise be jeopardized.

Although water trusts have been successful in some areas, they face significant limitations in many parts of the West due to their typical reliance on an external regulatory driver (such as the Endangered Species Act) that generates ongoing requirements for flow mitigation, an ongoing public revenue stream (such as hydropower revenue) to fund mitigation activities, and/or robust water market enabling conditions (i.e. instream flow transfer laws, short-term leasing, groundwater controls, etc.). The absence of these enabling conditions in many parts of the West has significantly limited the scale of water trust activities, particularly in areas where the only source of funding is the limited support available from philanthropic sources.

Most water trusts are focused on the maintenance and protection of a single dimension of value in the watershed – environmental flows. However, many areas face a growing suite of "system-level" risks resulting from growth in water demand, legal overallocation, groundwater pumping, climate risks, and other factors that threaten not only environmental values, but also important economic values related to farming, energy, industry, and municipal use. Many of these users may have few options to respond to supply shortfalls that could result from these system-level risks, and cannot expect more traditional, capital-intensive approaches like the construction of new publicly-financed dams, canals, or groundwater wells to resolve them. In many areas, therefore, there is a growing need for new, locally-governed and controlled institutions that can engage proactively to increase water flexibility in the face of changes in water availability, help users adapt year-to-year, and manage growing systemic risks. For example, in overallocated systems, having a portion of the water use in the system dedicated to uses that can be flexibly turned "on" or "off" without causing economic or ecological disruption, and/or dedicated to ensuring flows needed to support economic and environmental uses with substantially "hardened demand" (e.g. municipal users, permanent crops, and fish) could be key to improving system resiliency for the benefit of human and environmental users alike.

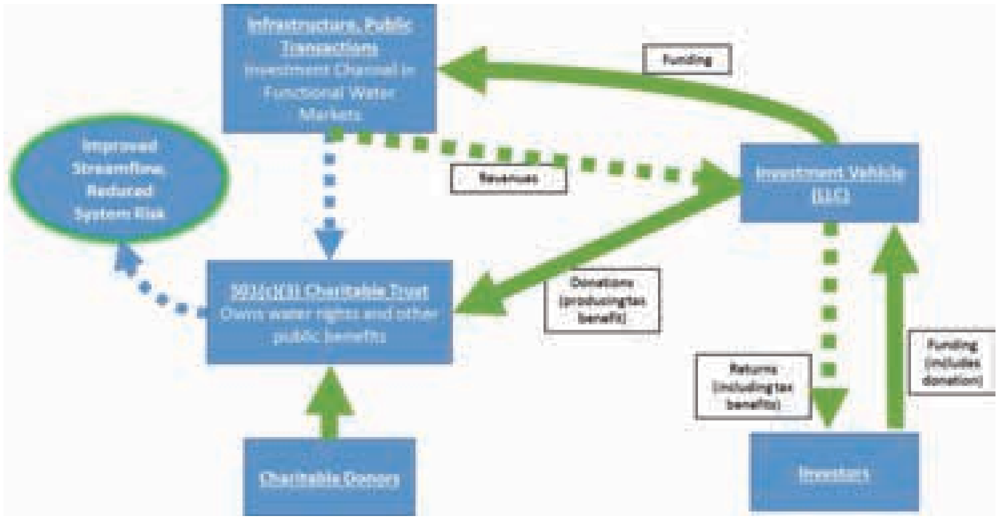


Figure 16. Structure of Proposed Investment-Friendly Water Trust.

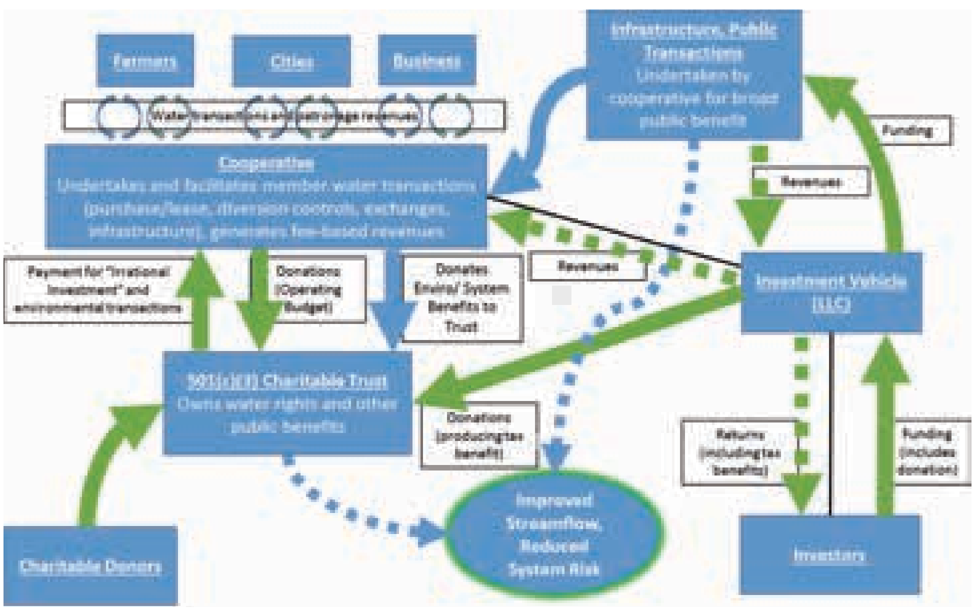


Figure 17. Structure of Proposed Cooperative Trust.

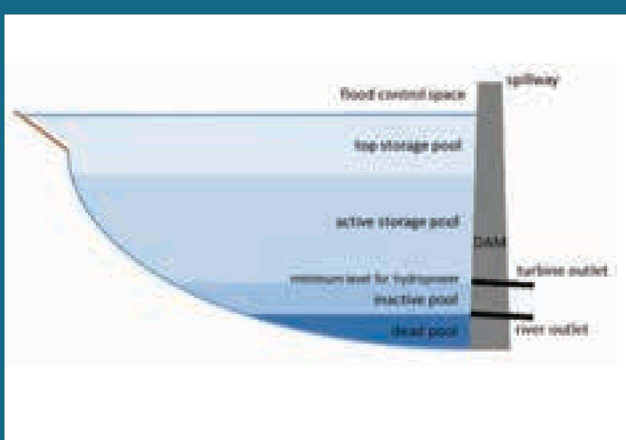
This investment vehicle proposes to achieve specific reductions in ecosystem and economic risks that would be achieved through a broad-purpose, next-generation "water trust" that would make specific investments in water resources and water infrastructure to reduce risks to both human and environmental users. In environments where substantial market enabling conditions already exist, this could be undertaken via the "investment-friendly" water trust structure, which would use a combination of secured loans and linked charitable donations to invest in water resources that would be repaid through revenue streams generated via the strategic deployment of trust assets. In areas without these conditions, the alternative "cooperative trust" structure would function as both a "market maker" to facilitate water transactions within a local watershed and as an "investment-friendly" water trust to finance, create and capture the public benefits needed to reduce human and environmental risks. These approaches would build on the successes of existing western water trust and water bank institutions, but broaden their potential scale and geographic scope by opening an investment-driven strategy that manages a greater range of system risks and generates corresponding revenues, while providing beneficial "market-maker" functions in geographies with limited trading opportunities.

9. Water Storage Trading

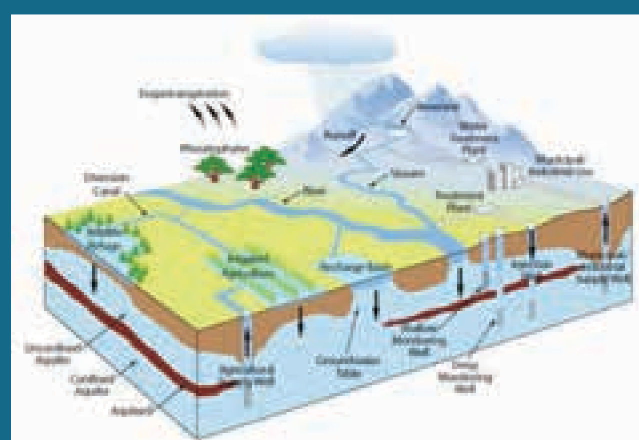
Creating Markets to Improve Groundwater and Surface Water Management

Reservoir storage has been a critical component of the management and delivery of reliable water supplies in the context of an arid and unpredictable Colorado River Basin. Similarly, groundwater pumping has played an equally significant if not even greater role in the development of the West, allowing access to stored water in underground aquifers in areas where surface water supplies would otherwise have been inadequate. In fact, many Basin cities and towns, agricultural users, industry, and other uses are either partially or completely dependent on groundwater for their survival. However, a combination of overuse of water and growing hydrologic variability is threatening both of these storage systems, with surface water reservoirs being driven to historic lows that threaten significant shortages, and groundwater use rapidly depleting or even exhausting critical groundwater reserves and threatening a number of the Basin's remaining perennial stream systems.

Many of these issues relate to the fact that under current approaches and rules, there are perverse incentives associated with use of both surface water storage and groundwater storage. For example, rights to the use of water from many surface water reservoirs are operated on a "use-it-or-lose-it" basis, with unused water defaulting to another user, or counting against a user's ability to capture and store water the following year – creating few incentives to conserve water in the reservoir during dry periods. Groundwater storage rules based on "reasonable use" and similar doctrines that permit open access to groundwater resources create even more damaging perverse incentives, driving substantial over-pumping and long-term groundwater declines that can damage surface water resources and erode vital groundwater reserves that could otherwise help to mitigate against future drought and shortage risks.



Distribution of reservoir water allocations; a proposed trading approach would allow users to "carry over" unused water as storage credits within a new "top storage" pool; this water could be traded to other users (and spills first in the event that the space is needed for flood control).



Example of a more sophisticated approach to aquifer management that reflects the active maintenance of multiple values associated with an aquifer through controls on groundwater use, monitoring activities, and active recharge through injection wells, recharge basins, and use of "natural recharge infrastructure" via wetlands and stream flow. Image courtesy of California Department of Water Resources.

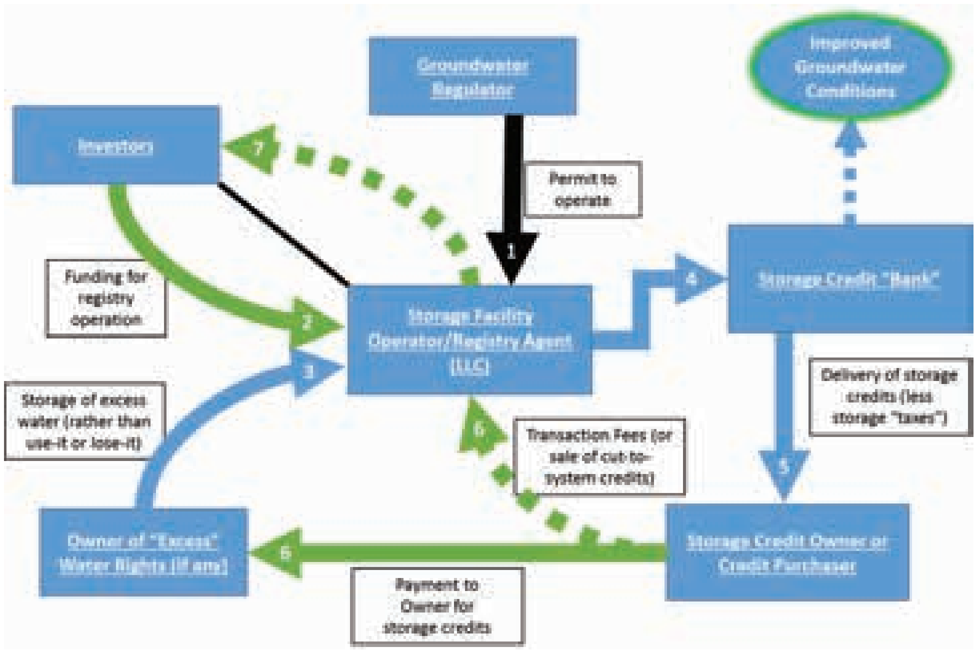


Figure 18. Structure of Underground Storage Trading Mechanism

Changing these rules to enable simple trading can help to protect reservoir levels during dry periods to hedge against the risks of serious shortages, and create incentives to recharge and maintain groundwater in storage in a manner that will protect strategic groundwater reserves and connected surface water systems. For example, allowing individual water entitlement holders to "carry over" their unused water in surface water reservoirs from season-to-season and year-to-year (typically as so-called "top storage") allows users to make investments in additional conservation efforts and keep water in storage to ensure that they will have a full allocation during a subsequent year. Enabling simple trading of these carryover storage "credits" between users can also vastly expand potential water trading opportunities and help to establish rational pricing for water, while incentivizing conservation activity by allowing users to conserve, store, and trade seasonally available water year-to-year or over multiple years. In environments where states or local jurisdictions have acted to close off open-access doctrines, create water rights in groundwater, and/or create "offset" programs where new groundwater pumping must be justified based on reductions in other existing withdrawals, similar opportunities to trade in groundwater rights and storage credits can help to incentivize storage activity and rationalize groundwater use. Several existing "water banks" (public, private, and non-profit) provide these types of services in certain jurisdictions, allowing surface water trading, groundwater trading, or both.

However, these institutions have only developed in a few places, in part because the operation of such a "water exchange" or "water bank" can be outside of the typical capacities and responsibilities of already overburdened reservoir operators and groundwater regulators. To provide for the broader deployment of storage trading solutions in western reservoirs and groundwater basins, this investment tool would utilize private capital to develop, implement, and operate storage trading facilities in both surface water reservoirs and aquifers (in environments where federal, state, or local regulations and policies have created the essential enabling conditions for storage trading). By allowing for the development and trade in storage credits among water users, storage facilities would provide a variety of physical and price hedging options and tools to water users to manage physical risks and control speculation, as well as insurance-type arrangements to cover water users and/or critical ecological values. This would be done while providing a return to the storage facility operator and underlying investors via transaction fees and a "tax" on storage transactions, together with the direct marketing of storage credits and services developed in the facility. By managing risks to water users, this tool can limit the ecological risks and pressures that would otherwise be associated with sudden catastrophic supply shortfalls, incentivize changes in water withdrawals in a manner that will protect stream flows, and develop water supplies that can be used to meet ecological needs.

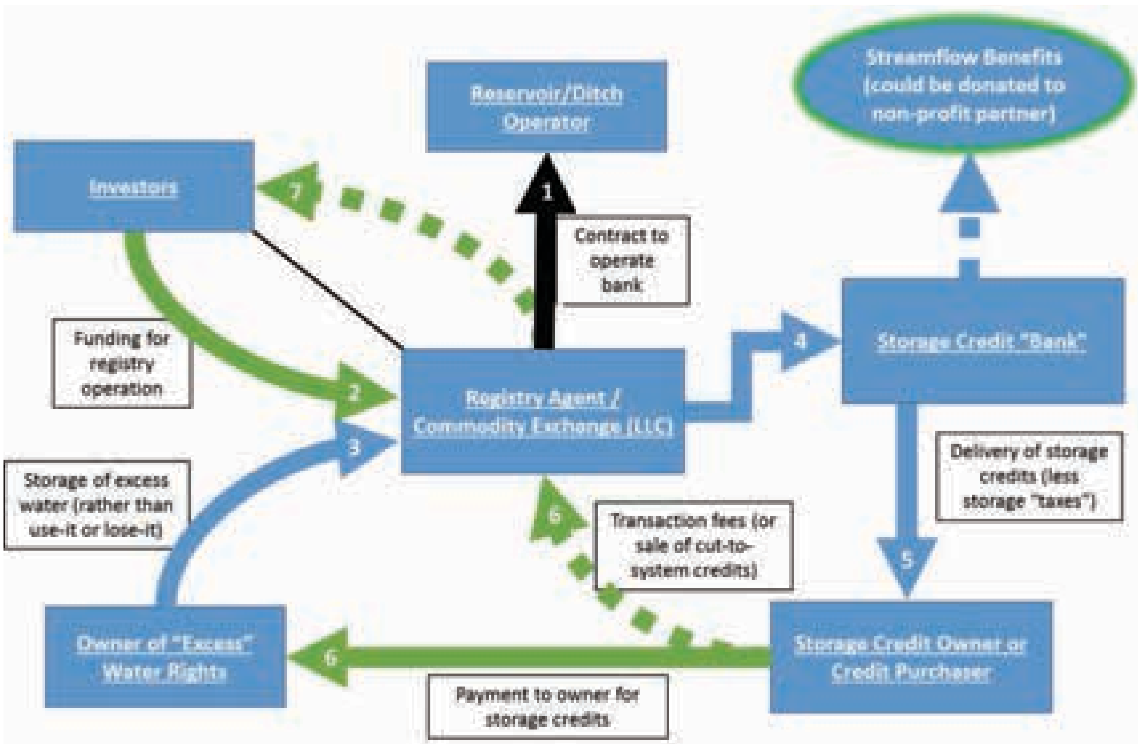
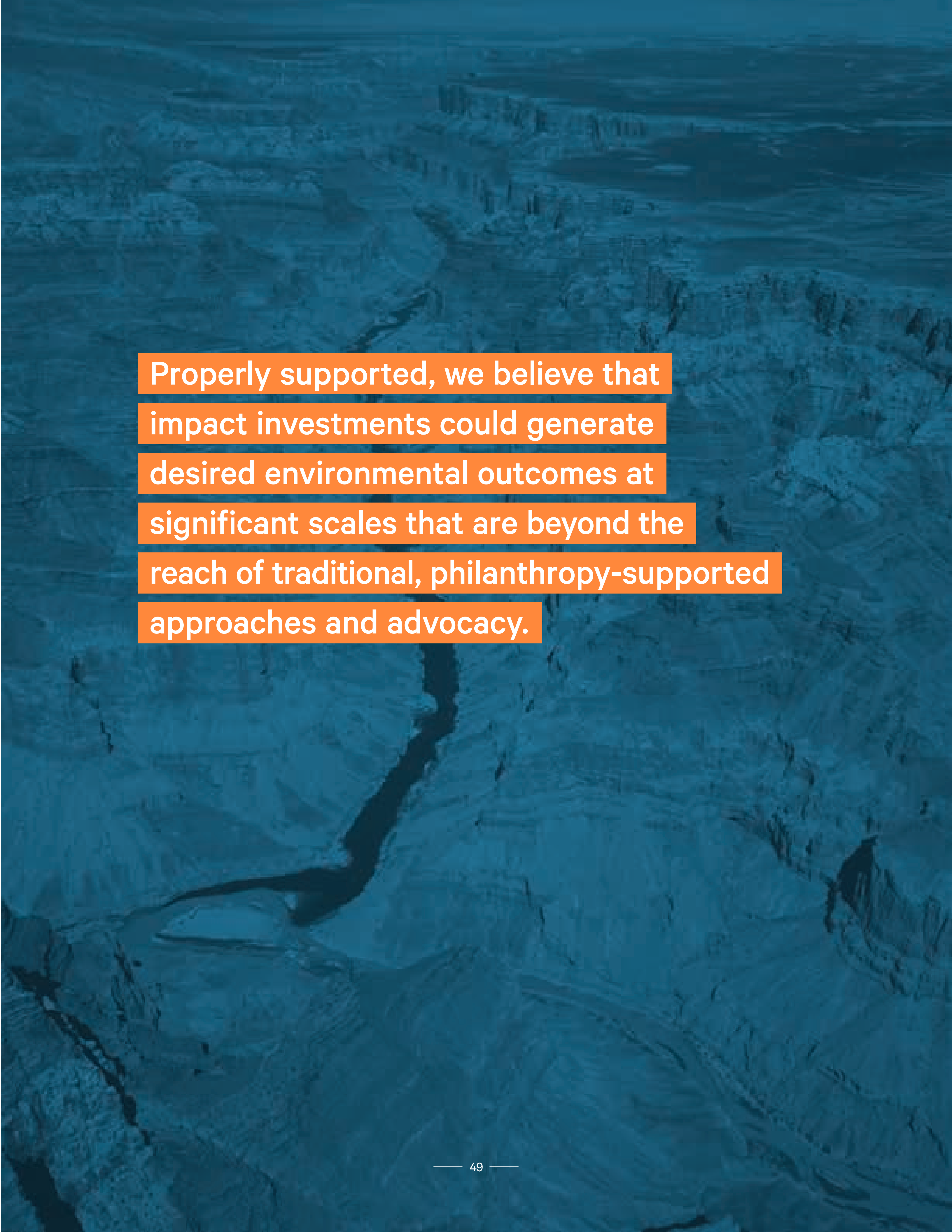


Figure 19. Structure of Reservoir Storage Trading Mechanism.



Properly supported, we believe that impact investments could generate desired environmental outcomes at significant scales that are beyond the reach of traditional, philanthropy-supported approaches and advocacy.

Relative Assessment of Key Metrics for Private Capital Investors and NGO Partners

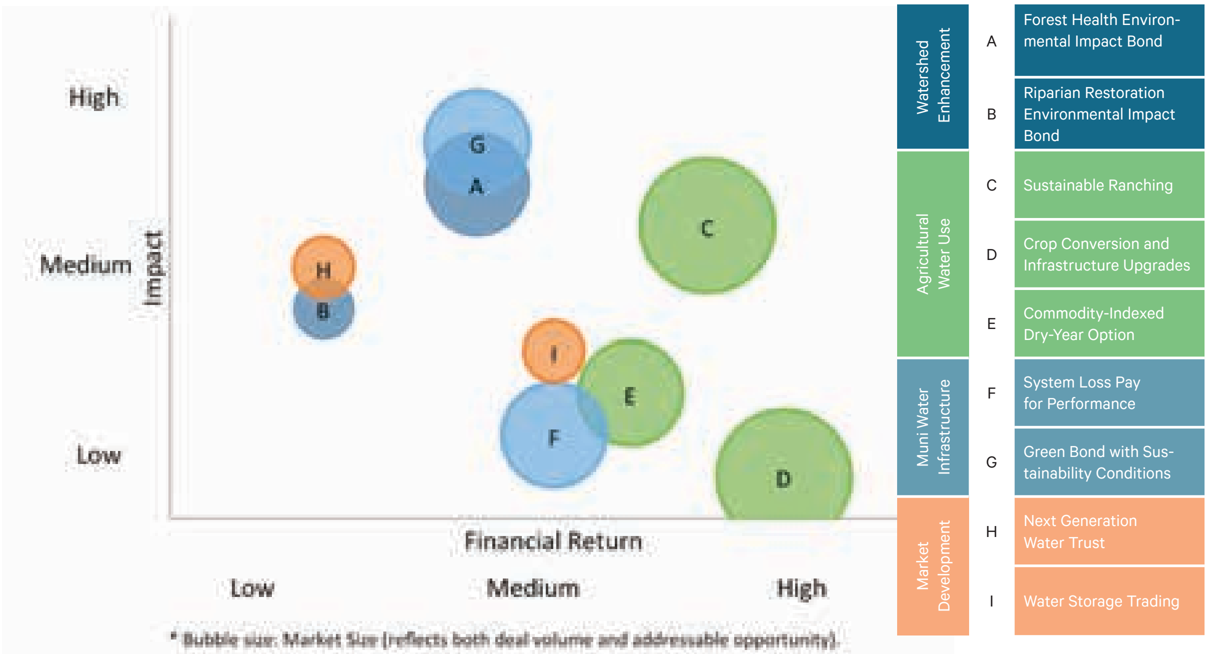


Figure 20. Private capital investor key metrics chart showing relative expected characteristics of each blueprint in terms of expected environmental benefits/impact, potential financial returns, and anticipated market size. Y axis: Expected Impact, X axis: Financial Return, Bubble size: Market Size of Opportunity.

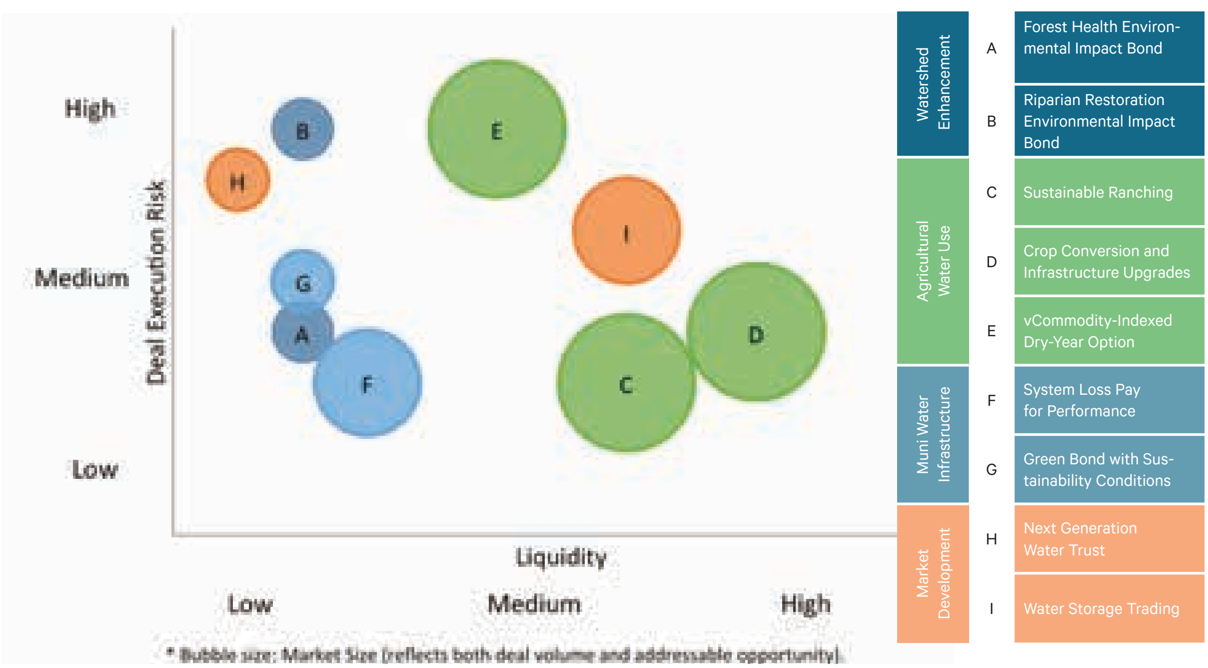


Figure 21. Private capital investor key metrics chart showing relative expected characteristics of each blueprint in terms of difficulty and risk in execution, expected level of liquidity, and potential financial returns. Y axis: Deal Execution Risk, X axis: Investor Liquidity, Bubble size: Potential Financial Return.

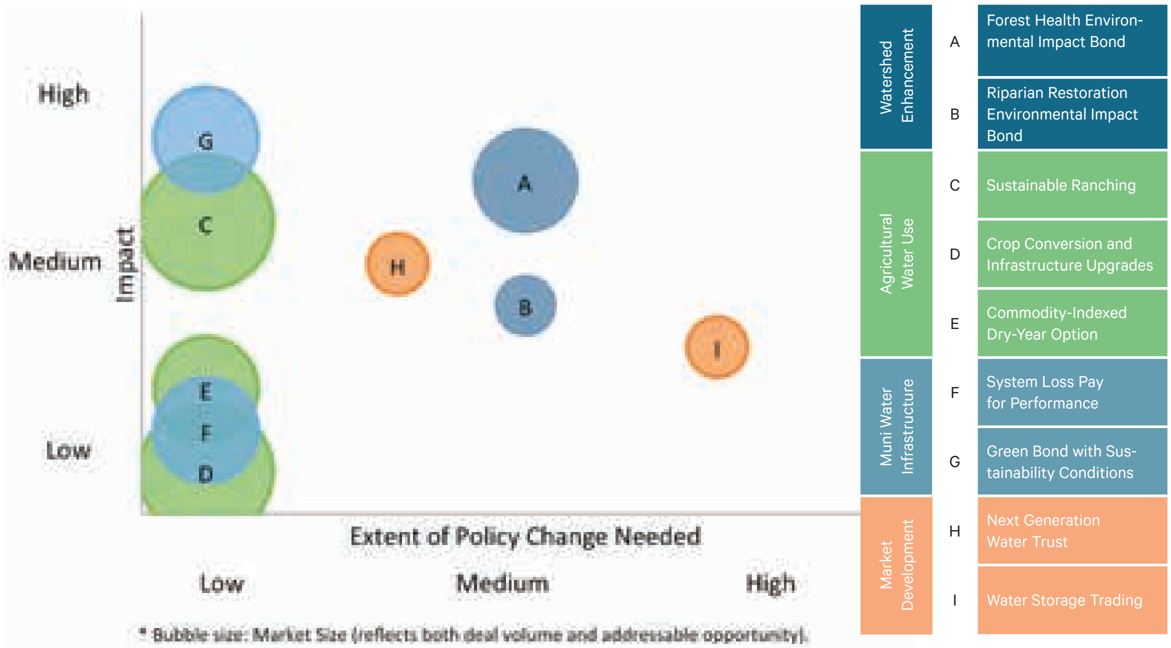


Figure 22. NGO partner key metrics chart showing relative expected characteristics of each blueprint in terms of expected environmental benefits/impact, the degree to which policy changes involving public participants and/or regulators are anticipated to be needed in order to create enabling conditions (if any), and anticipated market size . Y axis: Expected Impact, X axis: Policy Change Needed, Bubble size: Market Size Opportunity.

Key Recommendations for Capacity-Building

In most cases, the identification of specific investment opportunities will require substantial upfront investigation, as well as the availability and engagement of local capacity and knowledge on the ground, such as local NGOs or other parties that are capable of both identifying local opportunities that could fit within the identified blueprints and assessing the unique economic, user, and environmental risks and issues that could be addressed transactionally. In most cases, because of the lack of transparent data and information with regard to potential opportunities, the absence of existing market-enabling conditions that would allow for relatively simple transactions with low transaction costs, and the absence of regulatory requirements that could drive appropriate environmental outcomes in the absence of outside guidance, it is unrealistic to expect that investment opportunities and transactions will be developed organically by investors themselves.

It will also be critical to gather together or define environmental objectives in a particular region as clearly as possible in order to provide guidance for future investment design (for example, flow targets in particular stream reaches such as those provided by TNC's pending "Flow Road Map"), as well as clear criteria for the design of monitoring efforts and/or more specific environmental, social, economic, or other targets that may be built into a particular investment. These types of investments in planning, modeling, and goal-setting will be critical to ensure that impact investments produce outcomes that are both desirable and compatible with larger strategic goals for the region. This implies both continued support for NGOs and other partners on the ground to continue planning and traditional conservation advocacy work, as well as some level of “training” and coordination between entities seeking to set up deals and local NGOs to recognize opportunities and take advantage of established local relationships and trust needed to allow an investment to move forward.

Once opportunities are identified, many transactions will also require substantial due diligence in terms of legal and regulatory requirements, appraisals, engineering feasibility studies, and similar activities, and investment in outreach and discussions with potential parties to a transaction in order to set up transactions to the point where a pro forma term sheet or offering memorandum could be presented to potential investors. Although this process could potentially become independently-supported via the eventual creation of an organized fund around particular strategies, it will almost certainly be necessary to undertake one or more pilot transactions as a proof of concept and to establish a reliable deal “pipeline” before this would be feasible. In addition, a number of proposed investment structures may require, or could at least substantially benefit from, formation of “watershed conservation funds” or similar public funding mechanisms (once a demonstrated proof of concept has been secured) that could support investments in activities that produce generalized, distributed benefits in a watershed instead of creating value for particular single users.

> Developing and supporting capacity in the form of a deal-finding and deal-arranger team(s) will be essential to facilitating large-scale private impact investment.

Given the attendant costs, uncertainties, and potentially significant timelines required to identify potential opportunities, undertake required due diligence, establish environmental criteria, and develop the deal terms for particular investments, it is unrealistic to expect many investments to occur (or to expect that investments will align with environmental interests and goals) without up-front support from either public or charitable sources willing to provide concessionary or low-return capital for this purpose. As such, developing and supporting capacity in the form of a deal-finding and deal-arranger team or teams that could operate in the Basin will, in our view, be essential to facilitating any large-scale private impact investment activity. For example, establishing a deal team(s) that included a partner(s) that can interface with local NGOs and organizations, a technical consultant to undertake required modeling, mapping, and monitoring, legal support to diligence and structure transactions, and financial professionals that can ground-truth potential investments and bring (and sell) opportunities to the financial markets could be a way to rapidly identify and catalyze a series of like-kind investments and establish a reliable deal pipeline. One potentially efficient approach to funding this type of team would be to support its work with a program-related investment style “revolving fund” that could be used to pay the costs of deal-finding and deal-development over time, with the costs of successful transactions repaid into the fund from the “arranger fees” charged into the transaction. [5]

Finally, a basic objective of a larger impact investment program in the Basin can--and should--be to demonstrate the value of certain types of transactions in a manner that will contribute to longer-term policy reforms. The demonstration of impact transactions represents a potentially powerful tool for shaping the eventual development of water markets in the Basin in a way that will both honor and facilitate the achievement of broader environmental and social goals. In addition, given that substantial reforms of water management are likely to take decades to accomplish, pilot demonstration transactions may provide the best way to “lead the way” toward those larger reforms, providing an alternative to the pursuit of large-scale, difficult reforms in isolation through traditional policy advocacy.

However, continued investment in policy advocacy toward several important near-term reforms—such as changes in legal rules to enable short-term water transactions, the establishment of market-exchange platforms to facilitate water trading (such as water bank and trusts), continued efforts to control groundwater open-access issues that undermine the development of water markets, and investments in monitoring and information collection in data-poor environments—will also help to further expand opportunities for investment in the Basin. There appears to be strong current interest among federal leadership and agency staff in promoting strategies that will help bring private capital to bear on water management issues in the West, which suggests the potential for public-private collaboration related to proposed investment blueprints, policy reform and/or funding needs, and specific impact investment opportunities that could jump-start demonstration-scale impact investments in various parts of the Basin.

There is strong potential for impact investment in the Basin - but for these investments to be practically deployed, and to ensure the achievement of environmental benefits that could be derived from them, there will clearly need to be significant upfront investments in deal development and ground-level capacity. However, addressing those needs would also provide a powerful means for the Walton Family Foundation and other charitable actors to amplify relatively small investments of charitable money into large-scale impacts funded by outside private capital. Properly supported, we believe that such impact investment is positioned to generate desired environmental outcomes at significant scales that are presently beyond the reach of traditional, philanthropy-supported approaches and advocacy. Success at this level could also create momentum for regulatory reforms, and could powerfully shape the development of water markets as they begin to emerge in the Basin.

5 It may also make sense to invest in some level of centralized opportunity exchange, such as the West Coast Infrastructure Exchange used to generate a pipeline for public infrastructure projects in California, Oregon, Washington and the province of British Columbia.

I.
Introduction

I. Introduction

This report summarizes the findings of a joint investigation by Encourage Capital, LLC and Squire Patton Boggs (US) LLP ("SPB"), undertaken in collaboration with the Walton Family Foundation ("WFF"), to explore a suite of potential new investment tools and approaches related to water resources that could provide innovative approaches to financing solutions to water resource issues in western watersheds and communities, while also generating correlative environmental benefits. Through this investigation, which has included an evaluation of current restrictions on water trade, identification of user groups and interests that could drive future transactions, and exploration of potential solution sets that could be financed by various types of private capital, Encourage Capital and SPB have together identified a number of potential water-based investments that we believe could be successfully deployed in various contexts within the Colorado River Basin (and potentially more broadly in the West). Some of these concepts represent a proposed retasking of existing investment tools and approaches that have been successfully deployed in other natural resource contexts; others represent what we believe to be essentially unique approaches that combine or improvise on investment structures that have not previously been used in natural resource management.

Figure I-1 Headwaters stream, Utah. Image credit: Peter W. Culp.

In this report, we provide nine detailed "investment blueprints" that describe the most promising of the proposed tools that we considered as part of this investigation. These proposed tools are intended to be suitable for use as generic models for the development and investigation of specific investment opportunities on the ground. These include a description of general settings and contexts in which these tools could be deployed; the specific challenge(s) that each tool is designed to address; relevant regulatory and legal issues related to the use or deployment of the tools; and the key stakeholders or participants involved in developing and deploying the tools (including potential public, private, or NGO partners). For each tool, we provide a description and explanation of the specific structure of the investment and the expected environmental benefit that could be obtained from the tool's application, together with a ge neric case study example demonstrating the tool's application and a financial model demonstrating the potential revenue or return profile of the investment.

As discussed further below, this investigation has also suggested the importance of several specific "enabling conditions" for the successful development and deployment of these and other investment tools in the Colorado River Basin and elsewhere. We therefore provide several key recommendations related to capacity-building as well as a few specific policy objectives that could and should be pursued by WFF and other interests that are seeking to promote the use of environmentally beneficial, privately capitalized water investments in the future.

II.
Water in the Colorado River Basin

II. Water in the Colorado River Basin

The Colorado River Basin covers more than 246,000 square miles, spanning seven U.S. states and two Mexican states. The Colorado River itself stretches some 1,450 miles from its headwaters in the Rocky Mountains to its Delta at the head of the Gulf of California (Figure II-1). Historically, the Colorado was a wildly unpredictable, muddy river that was prone to severe drought and intense seasonal flooding and that supported an astonishing array of native fish and aquatic species—including 30 species of fish found nowhere else on Earth. Its Delta was a vast wetland lagoon that served as a critical stopover point for migratory birds on the Pacific Flyway, and supported a rich estuarine habitat and a major fishery in the Gulf of California.

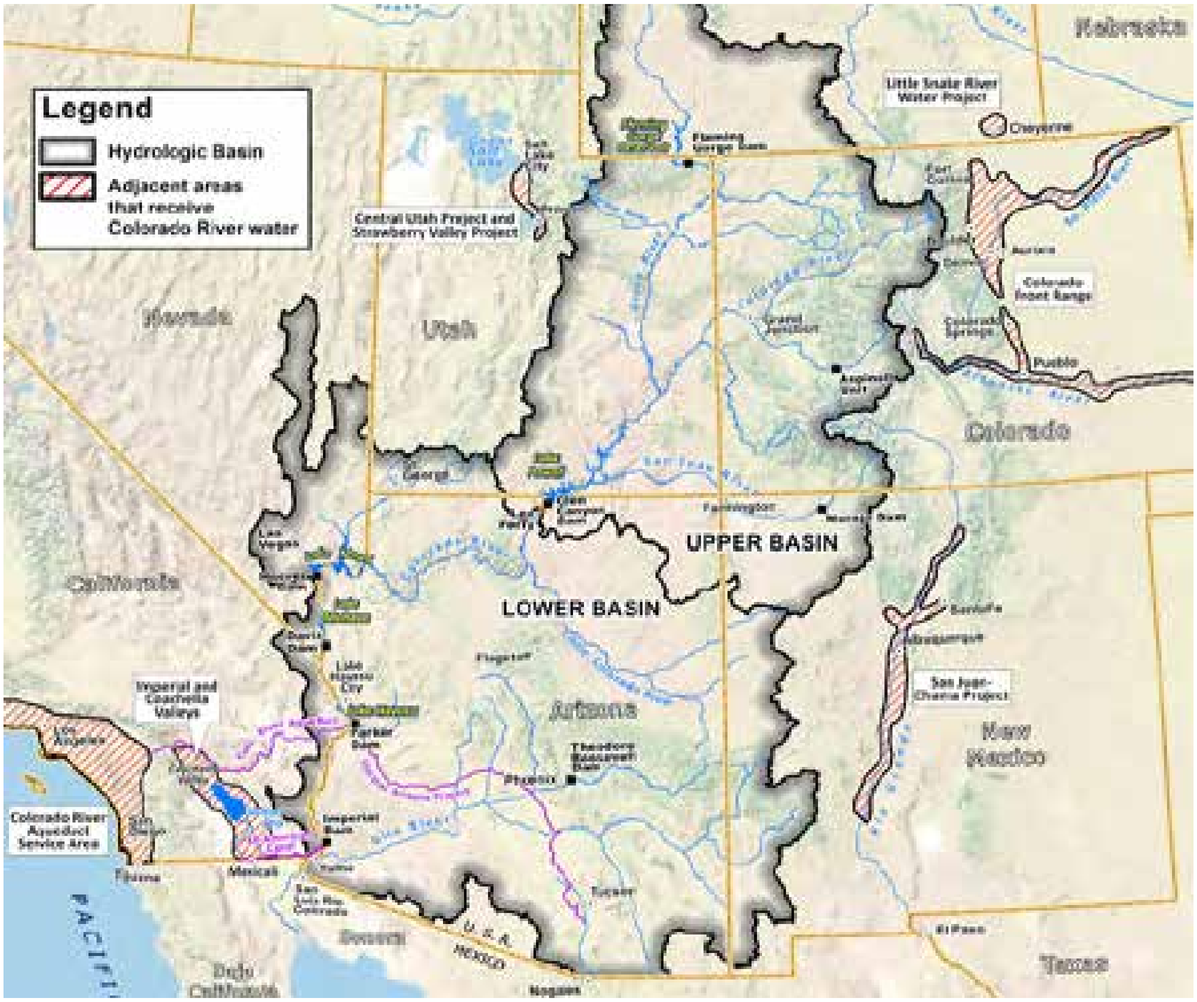


Figure II-1. The Colorado River Basin. Source: U.S. Bureau of Reclamation (2012).

Through more than nine decades of large-scale public and private investment, the once-wild Colorado River has been transformed into the most heavily regulated river system in the world, harnessed by dozens of major dams and diversion projects. These include more than a dozen diversions from the River's headwaters in the Rocky Mountains back across the Continental Divide to supply Colorado's Front Range; the Colorado River Aqueduct, supplying water to Southern California; the Central Arizona Project, supplying water to central Arizona; the Yuma Gravity Main, supplying water to the Yuma, Arizona, region; the All-American Canal, supplying the Imperial Valley region; and the Canal Reforma, supplying water to the Mexicali Valley; together with thousands of smaller diversions and uses. This enormous infrastructure now supports more than 35 million people, 4 million acres of irrigated agriculture, and an estimated 20% of U.S. national GDP. Taken together, the municipal, agricultural, industrial, and environmental uses supported by these dams and diversions consume essentially 100% of the River's natural flow. Nearly every drop of water is accounted for, and the River itself has not reliably reached its former Delta at the head of the Gulf of California since the 1960s.

Through more than nine decades of large-scale public and private investment, the once-wild Colorado River has been transformed into the most heavily regulated river system in the world

These transformations have wrought immense environmental changes in the Basin that have had widespread implications for the survival of native species and the health of the Basin's ecosystems, as well as the ability of the River to provide essential ecosystem services such as flood control, water filtration, and nutrient transfer. Currently, of the Basin's 30 endemic warm-water fish species, four are extinct, 12 are listed as endangered, and another four are threatened. In spite of this, however, the Colorado River and its tributaries continue to be home to significant biodiversity values. The River also supports many tourism- and recreation-based economies, ranging from whitewater rafting, fly fishing, and kayaking to hiking, camping, and many other non-consumptive activities.

The broad range of issues that are now facing the Colorado River and its managers also mean that the River provides a unique opportunity to explore challenges related to water resource management. The Basin exhibits an extraordinarily broad diversity of water management systems that are common to many western states, ranging from the individual diversions and small-scale farming operations that predominate in the Basin's higher elevations to the massive dam and canal infrastructure, vast cities, and expansive production agriculture in the Basin's lower reaches. Water users in the Basin are also facing a series of key water-related challenges that are shared in varying degrees by users throughout the West. As such, the Basin and its individual users provide a useful macrocosm as well as a microcosm of water issues throughout the West, such that many of the solutions identified and proposed in this report will be potentially transferable throughout the western United States.

A. The Law of the River

At the highest level, the waters of the Colorado River are governed by what is loosely described as the "Law of the River," an array of statutes, court decisions and decrees, contracts, interstate compacts, regulations, and treaties generated by a century of ongoing dispute over the allocation of Colorado River water. On the U.S. side of the border with Mexico, the Law of the River encompasses at least four different legal regimes: U.S. federal law; state law; various federal, state, and private contracts; and international law. Major components of the Law of the River are summarized in Table II-1.

These primary provisions of the Law of the River, together with dozens of other smaller agreements, contracts, regulations, and other provisions, drive the operation of the major system's reservoirs and major diversions. This primary system infrastructure is operated and controlled by a variety of state and federal actors, however, most of the Basin's reservoirs are operated by the U.S. Bureau of Reclamation ("Reclamation"), which also functions as the River's "water master" for the Lower Basin (administering the federal delivery contracts under the Boulder Canyon Project Act of 1928, or "BCPA").

Table II-1. The Law of the River

The Colorado River Compact (1922):

An interstate compact among the states of Arizona, California, Nevada, Wyoming, Colorado, Utah, and New Mexico that was ratified by Congress. The Compact divided the U.S. portion of the Colorado River Basin into two sections, with the dividing line at Lee's Ferry, Arizona. The "Upper Basin" consists of Colorado, Wyoming, Utah, New Mexico, and a small section of Arizona, while California, the remainder of Arizona, and Nevada constitute the "Lower Basin." The Compact allocated to each Basin the right to an annual "beneficial consumptive use" of 7.5 million acre-feet[1] (maf) of Colorado River water. The Lower Basin has the right to an additional 1 maf per year beyond these initial allocations through development of Lower Basin tributary water. The Compact also recognized a potential allocation of water for Mexico (to be taken from surplus flows, or else equally from the Upper and Lower Basin allocations)

The Boulder Canyon Project Act (1928)("BCPA"):

The BCPA authorized the construction of Hoover Dam and the All-American Canal, beginning an era of massive federal water projects that transformed the Lower Colorado into its present, highly controlled state, and authorized the Lower Basin states to enter into a compact to apportion Lower Basin water along specific guidelines. The BCPA also established the Secretary of the Interior as the "watermaster" for the Lower Colorado, authorizing the Secretary to enter into permanent water delivery contracts with users in the Lower Basin.

The Treaty of 1944:

In 1944, the U.S. and Mexico signed a treaty obligating the U.S. to deliver at least 1.5 maf per year to Mexico, and up to 1.7 maf in surplus years. The Treaty of 1944 also established the International Boundary and Water Commission (IBWC) to assist in the management of trans-border resources. Composed of a United States section (under the U.S. Department of State) and a corresponding Mexican section, IBWC has authority over the boundary sections of the Rio Grande and Colorado Rivers, projects that are related to treaty compliance, the settlement of disputes with regard to the Treaty, and the negotiation of further agreements regarding international waters.

The Upper Colorado Basin Compact (1948):

The Upper Basin states divided their share of river water in a second compact, signed in 1948. Under this agreement, each state receives a specific share of the 7.5 maf allotted to the Upper Basin: Colorado, 51.75%; New Mexico, 11.25%; Utah, 23%; Wyoming, 14%; and Arizona, 50,000 acre-feet (af) (a small part of northern Arizona lies within the Upper Basin). State law largely regulates appropriations within each Upper Basin state.

1 acre foot = 325,851 gallons, or enough water to cover 1 acre of land (approximately 1 American football field) in 1 foot of water.

Colorado River Basin Project Act (1968)("CRBPA"):

This legislation authorized the Central Arizona Project canal ("CAP"), fulfilling Arizona's long-standing desire to utilize a portion of its allocation in the central part of the state. In exchange for the authorization of the CAP, CRBPA established a priority for all of California's 4.4 maf apportionment and other pre-1968 rights in times of shortage. As a result, CAP and other "similar users" are the first water users to have their deliveries reduced in the event of a Lower Basin shortage. CRBPA additionally creates an obligation for the United States to augment the Colorado River supply to meet Mexican Treaty obligations, and authorized the Secretary of the Interior to develop "Long Range Operating Criteria" to govern the operation of the U.S. reservoir system.

Long Range Operating Criteria (1970):

The Long-Range Operating Criteria specify required release volumes from Glen Canyon Dam and the factors to be considered when deviating from them in times of surplus or shortage on the River. Based on the Operating Criteria, the Secretary develops an Annual Operating Plan ("AOP") to govern reservoir operations each year. The annual target release at Glen Canyon is 8.23 maf, and the Secretary can only exceed this volume under "surplus" or flood conditions that justify the release of additional water into the Lower Basin.

Colorado River Accounting Surface (1990s-present):

Under the governing principles of the BCPA and the Arizona v. California Decree, Lower Basin groundwater associated with the flow of the mainstem Colorado River may only be delivered pursuant to a Colorado River delivery contract (while groundwater originating from a different source, such as mountain front recharge or tributary inflows, is regulated under state law). To accommodate this division, the "Colorado River Accounting Surface" delineates a "river aquifer" that extends laterally away from the Colorado River floodplain; wells drawing from the river aquifer require a federal delivery contract.

Quantification Settlement Agreement (2002)("QSA"):

The QSA was negotiated to amend the 1931 California Seven-Party Agreement, which established the relative priorities between the various California water users. Under the Seven-Party Agreement, Metropolitan Water District (MWD) and San Diego County Water Authority (SDCWA) had the lowest priority to water, standing to lose half of their overall allocation in the event that California was restricted to its 4.4 maf apportionment. The QSA changed this through a series of "quantifications" of higher-priority agricultural users and water transfers, allowing California's major interests' use to "fit" within California's 4.4 maf apportionment without endangering urban water supplies.

2007 Shortage Guidelines (2007)("Shortage Guidelines"):

The 2007 Shortage Guidelines defined for the first time how the major system reservoirs would be operated in the face of declining reservoir levels and shortage risks. The new guidelines essentially provide for Lakes Mead and Powell to be operated more like a single, supermassive reservoir, such that in the event of extended dry conditions, they will be drawn down together towards zero - protecting against both Lower Basin shortages and the potential for a Compact "call" (a situation in which Upper Basin users must curtail their uses in order to meet required deliveries to the Lower Basin under the 1922 Compact). The new guidelines also provide parameters for the implementation of "shortage" deliveries in the Lower Basin (i.e., how and when deliveries are cut back) and create a storage mechanism to incentivize reduced use in the Lower Basin and protect reservoir levels (see discussion of the ICS program, below).

Minute No. 319 (2012):

Minute No. 319, the most recent of the major Colorado River agreements, interprets and expands key elements of the U.S.-Mexico Treaty. The Minute embraces a series of agreements, operational measures, and cooperative projects that are being undertaken by the United States and Mexico during a 5-year period through 2017, to be replaced by a longer term agreement by that time. The agreement is based on a principle of shared burden and benefit, and includes provisions for reductions in Mexican deliveries during shortage conditions and increased deliveries during surplus, provisions allowing Mexico to store conserved water in U.S. reservoirs, binational conservation investments and water exchanges, and a joint commitment to provide water to the Delta ecosystem.

Nevertheless, all seven of the U.S. Basin states – California, Arizona, and Nevada, which comprise the Lower Basin, and Colorado, Utah, Wyoming, and New Mexico, which comprise the Upper Basin – also play a significant role in Colorado River management, typically though their state water resources administrative agencies. In addition, many of the largest agricultural and municipal water delivery agencies play a substantial and visible role in Colorado River policymaking. For example, the Metropolitan Water District of Southern California (which delivers Colorado River water to the Los Angeles and San Diego metropolitan areas), the Imperial Irrigation District (serving Imperial Valley agriculture), the Central Arizona Project (serving Central Arizona municipalities and agriculture), the Southern Nevada Water Authority (serving the Las Vegas metropolitan area), the Colorado River District (serving many of Colorado's West Slope agricultural users), and Denver Water are all typically represented directly in negotiations and discussions among Reclamation, the seven Basin States, and Mexico.

Within the Colorado River's primary system infrastructure, Lake Powell operates as the primary Upper Basin storage reservoir and Lake Mead as the primary Lower Basin storage reservoir. Although both reservoirs have broader authorized purposes—including system augmentation and flow normalization, flood control, recreation, and electrical generation—the core storage operations of both reservoirs are conducted in deference to the 1922 Colorado River Compact, as reflected in the Long Range Operating Criteria. In essence, Lake Powell's Upper Basin storage function is to ensure that there is always adequate water retained in live storage to meet delivery obligations to the Lower Basin, and to limit the risk of a Compact "call" in which Upper Basin uses might need to be curtailed in order to meet delivery obligations under the 1922 Compact. Lake Mead's storage function is to provide water to meet the annual Mexico delivery obligation and, as often as possible, deliver a full 7.5 maf (or more) to Lower Basin users, capturing any excess flow from the Upper Basin.

The politics surrounding the Law of the River have long been dominated by efforts both to protect the entitlements of the various Basin States and their major water users under these rules, and to block transfers of water from one user to another. These efforts have been largely motivated by fears that if transfers were allowed, the larger, wealthier users (particularly California) would eventually acquire most rights to the flow of the Colorado, leaving other states with inadequate water for future economic development. Consistent with the resulting "use it or lose it" philosophy that has taken hold in the Basin, the Law of the River contains numerous provisions that block transfers of water.

Figure II-2 Lake Powell, which functions as the primary Upper Basin storage reservoir. Image courtesy U.S. Bureau of Reclamation.

For example, neither the Colorado River Compact nor the Upper Colorado River Compact provide mechanisms by which water can be moved from one Basin to the other Basin, or from one Upper Basin state to another Upper Basin state. Similarly, the division of the River in the Lower Basin under the Boulder Canyon Project Act, the Arizona v. California Decree, and the various federal delivery contracts managed by Reclamation do not provide mechanisms by which water can be transferred from one Lower Basin state to another (although some recent changes to the Law of the River have allowed for certain limited interstate banking, as described further below). Mirroring this domestic regime, the 1944 Treaty does not provide a mechanism by which water entitlements can be moved from the United States to Mexico, or vice versa, although the recent Minute 319 agreement has authorized a first-ever "water exchange" between U.S. and Mexican water users, based on investments in water conservation in the Mexicali Valley.

These provisions effectively operate to block most types of potential international, inter-Basin, interstate, and, in many cases, intra-state transfers of Colorado River water among water users. In addition, transfers from users within irrigation districts, which are generally the largest users of water on the Colorado, are usually governed by district charters, bylaws, and special provisions of state law. These rules typically provide agricultural districts with veto power over transfers outside the boundaries of the district. Transfers from federal irrigation projects also face additional restrictions unique to federal Reclamation law, including provisions of project-authorizing legislation. Finally, the U.S. Secretary of Interior's overarching authority over contracts for water deliveries in the Lower Basin (exercised through the Bureau of Reclamation) provides the Secretary with oversight on all proposed water transfers of Colorado River water.

Throughout the Colorado River Basin, irrigated agriculture still accounts for nearly 70% of all water use.

Throughout the Basin, irrigated agriculture – which drove the initial settlement and development of much of the Colorado River – still accounts for nearly 70% of all water use. The continued significance of Basin agriculture as both a source of U.S. food production and its importance to the economies of many rural areas should not be understated; nevertheless, continued growth and development over the past century have brought many new demands to bear on the River, such that agriculture now accounts for a comparatively small amount of the overall economic activity in the Basin. This growing disparity between water use and economic outcomes has generated significant tension for many agricultural water interests, whose social and economic future depends largely on a continued commitment to maintain farms in production rather than as "water farms" operated for the benefit of remote municipal, industrial, or environmental interests. The combination of priority-based appropriative legal entitlements and increasing political and economic tension has also helped to maintain the aforementioned "use-it-or-lose-it" methodology for water use among many Basin water users, and has even created perverse incentives to continue less-than-efficient water use in some areas in order to ensure that water rights are maintained and protected in the face of future potential shortfalls and pressures. This defensive posture also extends between the Basin states themselves and between the Upper and Lower Basins, with political leaders effectively obliged to "defend" their states' water rights against encroachment by other states, or to defend their Basin's "birthright" against the entitlements of the other Basin.

Despite these substantial barriers, the recent evolution of the Law of the River reflects an ongoing power shift away from the traditionally dominant agricultural interests toward the increasingly powerful urban interests in the Basin, as well as an important power shift within agricultural uses away from traditional, small-scale farming towards the large-scale production agriculture that now dominates in some key portions of the Basin. With growing pressures to shift water use to meet the needs of changing agricultural economies and growing urban areas, and heightened risks of shortfalls that could impact urban communities and cause substantial economic disruptions in production agriculture (like those being experienced in central California), future shifts in the allocation and management of water resources in the Basin are all but inevitable. Recent discussions among the Basin States and the Basin's major water users reflect an increasing understanding of and willingness to confront these issues and to pursue creative solutions. Regardless, proposals to transfer water rights within and between the Basin states—as well as internationally—will require significant sensitivity to the complex political and legal issues surrounding the Colorado River. The implementation of such proposals will require patient, thoughtful, and determined participation in the ongoing discussions regarding the allocation of Colorado River water.

B. State-Level Water Management in the Colorado River Basin

Although federal law and interstate compacts govern many important aspects of the management of the mainstem Colorado River, throughout the Basin (as elsewhere in the West) most intrastate water management is driven by state laws governing the appropriation of surface water and the use of groundwater. In the Upper Basin, for example, state laws largely govern allocation of Colorado River water available to users under the 1922 Compact and the Upper Basin Compact. In the Lower Basin, by contrast, federal statutes and regulations, the Arizona v. California decree, and the various federal delivery contracts primarily govern the allocation of mainstem Colorado River water out of Lake Mead (together with associated groundwater), while state law generally governs the allocation of water and groundwater associated with the tributaries of the Colorado River.

It is important to recognize that the management of water in the West, not to mention the legal and institutional regimes that govern it, is extraordinarily diverse. Unlike many other environmental issues and natural resources, water has traditionally been treated in the United States as a matter of state, not federal, law. As such water management institutions, approaches, and laws vary significantly across western states. Although many of these institutions, approaches, and laws are similar from state to state, certain important differences cannot be ignored – and these legal requirements powerfully shape both the potential for and the design of potential water transactions in the West.

1. Surface Water Management

For purposes of the management of surface water, nearly all western states follow the law of prior appropriation—in essence, a rule of "first in time, first in right."[1] Under the prior appropriation system, the first user to divert water from a stream and put it to beneficial use obtains a right to continue such diversions with a priority senior to all subsequent diverters. A junior appropriator may only exercise her water rights to the extent that all senior rights have been satisfied first—even if this means that she must forgo her use of water. It is important to note, however, that in most western states, the waters of the state belong to the public.[2] As such, although water rights are typically recognized as property rights, the ownership of a water right is in fact ownership of the right to the use of water, rather than the ownership of the water itself. As a result of the legal recognition of older, Spanish law–based rights developed before the Mexican War, some states also recognize a separate type of communally-held rights, known as "pueblo rights." California has the most complex regime for the management of surface water, representing a hybrid of prior appropriation doctrine, riparian doctrine (a legal framework common to the eastern U.S.), and pueblo rights.

Water rights are normally established by the filing of claims with a state agency or court, and in many parts of the West such rights have been subject to previous court proceedings that have "decreed" those rights to a greater or lesser extent, frequently in numerous, overlapping court cases that establish the relative rights of individual parties or groups of parties with regard to each other. To provide for more comprehensive adjudication and quantification of these rights, most western states have established a process of general stream adjudication ("GSA") to adjudicate, quantify, and prioritize claims to a given stream or river system. In some states, such as Colorado, water rights have been extensively adjudicated, and most of its streams and rivers have clearly defined water rights that can be administered through the courts. Other states, such as Arizona, have made little progress on adjudication; that state's largest general stream adjudication, the Gila River Adjudication, has been under way for more than four decades and has as yet failed to conclusively adjudicate any rights at all.[3] Where rights are unadjudicated—which is frequently the case, particularly on smaller river tributaries—this can lead to substantial legal and practical uncertainty and confusion regarding the relative quantity, priority, and validity of surface water rights, and can also present substantial barriers to enforcement.

Critically, water rights are almost universally treated as being "appurtenant" to a specific place of use and a designated type of use, such that in most of the West, they cannot be treated as a "commodity" held independently of the lands and uses to which they are applied. However, most western states authorize transfers of surface water rights through a "sever-and-transfer" procedure. The volume of water that can be transferred is typically limited to the amount of provable "consumptive use" associated with the historic use of the water right, as opposed to the much larger amount of water that is normally diverted to satisfy that right, since return flows to a river (via surface returns or underground returns) legally belong to other downstream appropriators. In addition, a critical limitation on surface water transferability in many states is the "salvaged water doctrine," which in many cases disallows claims to water that is conserved through improvements in efficiency.[4]

1 Arizona Cooper Co. v. Gillespie, 100 P. 465, 469-70 (Ariz. Terr. 1909), aff'd 230 U.S. 46 (1913).

2 See Ariz. Rev. Stat. §45-141.

3 Joseph M. Feller, The Adjudication That Ate Arizona Water Law, 49 Ariz. L. Rev. 405, 425 (2007).

4 The leading case on salvaged versus developed water (and a legal precedent followed in many states throughout the West) is Southeastern Colorado Water Conservancy District v. Shelton Farms, Inc. 529 P.2d 1321 (Colo. 1974). The case involved a claimant who removed phreatophytes (long-rooted plants that absorb moisture from the water table and are frequently found in areas of standing surface or subsurface water in floodplains and riparian corridors) from land in Colorado and then claimed the right to use the surface water that was "saved" by removing these plants. The court found that the claimant could not claim the saved water, since (a) the loss of the water to the phreatophytes did not constitute a beneficial use and (b) the water would have remained in the stream but for the interference, and thus the water legally belonged to the next junior appropriator.

Table II-2: Summary of Sever-and-Transfer Requirements and Procedures in the Colorado River Basin States

	Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming
Legal System	Prior Appropriation	Hybrid (Prior Appropriation, Riparian, Pueblo)	Prior Appropriation	Prior Appropriation	Prior Appropriation	Prior Appropriation	Prior Appropriation
Administrative Agencies	Arizona Department of Water Resources	State Water Resources Control Board within the California Environmental Protection Agency	Colorado Division of Water Resources within the Colorado Department of Natural Resources	Nevada Division of Water Resources within the Department of Conservation & Natural Resources	New Mexico State Engineer; Ditch & Irrigation District Water Banks	Utah Division of Water Rights within the Department of Natural Resources	Wyoming State Board of Control
Change in Point of Div. Allowed	Yes	Yes	Yes	Yes	Yes	Yes	No
Change in Place of Use Allowed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Change in Purpose Allowed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Procedure	Administrative application for sever-and-transfer filed with Arizona Department of Water Resources	Filing of petition with State Water Resources Control Board	Change of use application filed with water clerk; review by Colorado's water courts	Administrative application made to the state engineer of the Nevada Division of Water Resources	Transfer application filed with state engineer	Administrative application reviewed by state engineer	Petition filed with the Wyoming State Board of Control
Third Party Protections	No injury to existing rights; irrigation districts in same watershed have veto power over transfer	No injury to existing rights; may not unreasonably impact fish & wildlife and other beneficial instream uses; transfer may not affect groundwater pumping	No injury to existing rights; must provide information on impact of change to fish and wildlife and proposed mitigation	No injury to existing rights; interbasin transfers must be determined environmentally sound by state engineer	No injury to existing rights; must not be contrary to conservation of water within the state; must not be detrimental to public welfare; transfer involving acequia or community ditch must be approved by same	No injury to existing rights without just compensation; state engineer also to consider impact to public welfare, whether transfer made for speculation purposes, and if applicant has financial ability to complete project	No injury to existing rights; transfer may not increase the rate or amount of historic diversion; or increase consumptive use; may not decrease flows; economic losses to the community from transfer to be considered

The sever and transfer process, which normally involves a public hearing and opportunities for third-party objections, typically requires proof of the historic establishment and use of the right, quantification of actual consumptive use, and a third-party impact evaluation to determine if the transfer would harm other water users. These requirements can create significant transaction costs and can be difficult or even practically impossible to meet in the context of uncertain adjudication and/or poorly documented historic rights. In some cases, the transferring party to a transaction must also obtain the consent of any irrigation districts, water users' associations, or similar entities in the affected watershed,[5] although water rights can frequently be transferred within district boundaries with only the consent of the governing water district. Table II-2 provides a summary of the framework for surface water rights transfers in the various Colorado River Basin States.

Table II-3: Summary of Temporary Transfer Rules in Colorado River Basin States

Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming
No statutory mechanism	Temporary transfers limited to 1-year period, but are not subject to regular change reporting and monitoring procedures; transferor may not increase groundwater consumption to offset	Allowed through interruptible supply contracts or dry-year options; short term substitute water supply plans; rotational crop fallowing programs	Temporary transfers limited to a 1-year period; transfer must be in the public interest and cannot impair existing users rights; special exceptions allowed for water for livestock under drought conditions and to establish vegetative cover for wildfire prevention	Temporary transfers limited to a 1-year period for no more than 3 af per year; must not permanently impair the vested rights of others	Temporary transfers limited to a 1-year period; must not impair existing water rights	Temporary transfer limited to 2 years for highway construction or repair, railroad roadbed construction or repair, or drilling or producing operations; must be no injury to other water users; transfers can only occur within the extent of historic consum ptive use amounts

5 A.R.S. § 45-172(A)(5).

Table II-4: Instream Flow Rights in the Colorado River Basin States

	Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming
Instream Flow Statute	Yes	Yes	Yes	Yes	No. ISF laws come from A.G. Op. No. 98-01	Yes	Yes
Appropriation Permitted	Yes, application must be accompanied by at least 5 years of continuous streamflow measurement data	Yes, but may not unreasonably affect existing water rights or enlarge underlying water right	Yes, subject to senior decreed water rights	Yes.	Yes, subject to state engineer approval	Yes, but cannot impair existing water rights or enlarge underlying right; Division filed rights must be legislatively appropriated and limited to up to 1 year; nonprofit filed rights for a fixed time change of 1 to 10 years and approved by state engineer and Division of Wildlife Resources	Yes, but rights limited to stream segments specified by Wyoming State Board of Control; may not injure existing rights holders
Transfer of Existing Rights Permitted	Yes, sever and transfer allowed for recreation and wildlife purposes	Yes	Yes	Yes, temporary conversion of agricultural water rights to instream flow may occur for up to 3 years	Yes, provided there is a streamflow measuring device to monitor	Yes	Yes
Who Can Hold Right	Any person, the state, or a political subdivision thereof, but only state or political subdivision can hold instream flow based on transfer of existing water rights	Any person entitled to the use of water	Colorado Water Conservation Board only legal holder	Existing agricultural water right holder	Unclear. Op. No. 98-01 silent as to who can hold instream flow rights	Division of Wildlife Resources; Division of Parks & Recreation; nonprofit groups supporting fishing opportunities	Any person may appropriate and divert for instream flow as long as within 1-mile upstream of Wyoming state line; mainstem of North Platte River; Big Horn Lake; or Flaming Gorge or Palisades reservoir

Some states explicitly authorize short-term leasing or other "temporary" transfers of surface water rights from one user to another (Table II-3). This is commonly authorized by a special statute, and provides for an expedited transfer of a water right on a short-term basis, provided that certain conditions are met. This framework can be extremely useful in crafting more flexible approaches to the use of surface water, as well as in pursuing "water sharing" agreements in which a senior right holder can authorize the temporary use of water by a more junior user (such as in the dry-year option agreements described later in this report).

In addition, most western states now permit, by statute, some form of "in-stream flow rights"—essentially, rights to have water held in a natural watercourse for in-stream flow over a particular reach of a stream. These rights are distinct from a typical "appropriative right," which is premised on diverting water and putting it to a beneficial use at a specific location.[6] There are important differences in the way in-stream flow rights can be held in each state, which affect who can hold the right, how it can be acquired, and whether and how existing water rights can be transferred for in-stream use (Table II-4). For example, in many states, in-stream rights can be held only by a state agency or a political subdivision.

2. Groundwater Management

State law approaches to the management of groundwater differ significantly from state to state (Table II-5). A number of states recognize the prior appropriation doctrine with regard to both groundwater and surface water, such that individual groundwater users must prove appropriative rights to use groundwater. Other states, however, only loosely regulate groundwater use, typically following the "reasonable use" doctrine, which essentially permits open access to groundwater resources and does not recognize rights in groundwater, making it difficult or impossible to structure transactions involving groundwater. The latter system can also generate ongoing issues with regard to transactions in surface water due to (a) open-access effects on water pricing and (b) uncertainty as a result of the potential for groundwater use to undermine surface water rights.

In states that fail to recognize appropriative rights to groundwater, the dividing line between surface water and groundwater is also not always clear and can be extremely problematic. For example, Arizona recognizes a "third category" of water, known as "subflow," as a result of Arizona law's historical failure to recognize the inherent interconnections between surface water resources (subject to prior appropriation) and groundwater resources (subject to reasonable use doctrine). "Subflow" is a legal category of groundwater that is treated as appropriable surface water by virtue of being closely associated with a surface stream,[7] but it has been extraordinarily difficult to define in practice.

Although Arizona has little to no regulation of groundwater in many parts of the state, it also has one of the best-developed statutory systems for the management of groundwater pursuant to the 1980 Groundwater Management Act ("GMA"). The GMA establishes substantial controls over groundwater in a few Arizona groundwater basins, known as Active Management Areas ("AMAs"), through a system of groundwater rights and related controls on water use. As discussed further in Section V(D)(2)(b), this type of statutory framework can allow for a number of different types of transactions involving groundwater rights.

6 Cf. Phelps Dodge Corporation v. Arizona Department of Water Resources, CV 05-0321 (Ariz. Ct. App. 2005).

7 In re the General Adjudication of All Rights to Use Water in the Gila River System and Source 857 P.2d 1236, 1241 (Ariz. 1993) (hereinafter Gila II).

Table II-5: State Law Regimes for Groundwater Management

	Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming
Legal System	Reasonable Use	Groundwater managed through overlying right, appropriative rights, and prescriptive right, with reasonable use superior to appropriative use	Prior Appropriation; Groundwater regulated by category – designated groundwater & non-designated groundwater	Prior Appropriation	Prior Appropriation	Prior Appropriation	Prior Appropriation
Conjunctive Management of Groundwater & Surface Water	No	No	Yes, for some non-designated groundwater (i.e. tributary groundwater)	No; regulated separately, but managed conjunctively in practice	Yes	Yes	Groundwater subject to regulation & correlation with surface water right if determined to be connected
Special Provisions	Groundwater use managed in defined Active Management Areas (AMAs) and Irrigation Non-Expansion Areas (INAs); underground storage for groundwater recharge allowed and administered by ADWR	Certain uses are prohibited by state law (e.g. golf courses); conjunctive use pilot projects underway; program in place to loan funds to local governments for recharge purposes	Underground storage allowed; transfers of groundwater out of state prohibited; transfers of designated groundwater outside the basin also prohibited	Underground storage and recovery for future use allowed, provided a permit is obtained	Depletion of groundwater may be offset by increasing surface flows; permit is required for mine dewatering; permit required for groundwater transfer out of state; permit required for underground storage	Interstate transfers of groundwater allowed under certain conditions; groundwater recharge projects allowed if permit obtained;	Some groundwater managed in control areas to slow development & protect senior rights; interstate transfers of groundwater must be approved by legislature

3. Colorado River Delivery Contracts

In the Upper Basin, rights to the use of Colorado River water are generally governed by the provisions of state law under prior appropriation rules, subject to the overall limitations of the Upper Basin Compact. As noted above, the Compact allocates a specific share of the water available under the 1922 Colorado River Compact to each Upper Basin state. In the event of a shortfall or "call" under the 1922 Compact that would require curtailment of Upper Basin users (which has never occurred to date), each state must reduce its use proportionately, with shortages allocated to individual users based on the priorities associated with their individual appropriative rights.

In the Lower Basin, by contrast, state law prior-appropriation systems only govern the use of water on Colorado River tributaries (such as the Little Colorado River, the Virgin River, and the Bill Williams River; and the Salt River, Verde River, and Gila River systems). Entitlements to Colorado River mainstem water are instead administered by the federal government, through permanent Reclamation delivery contracts issued pursuant to the Boulder Canyon Project Act of 1928.

These contracts are issued to users within each Lower Basin state pursuant to the basic allocations established in the BCPA (4.4 maf to California, 2.8 maf to Arizona, and 0.3 maf to Nevada), and are further governed by a complex series of priorities established in those contracts or separate agreements among the users in those states. As noted above, the Colorado River Basin Project Act also assigns a lower priority to post-1968 users in Arizona and Nevada, as compared to all users in California, so Arizona and Nevada are subject to the first impacts of any shortage on the Lower Colorado (with approximately 90% of any shortage allocated to the Central Arizona Project).

Colorado River delivery contracts are, at least theoretically, transferable among contractors in the same state, subject to approval by the U.S. Bureau of Reclamation (which also triggers relevant federal environmental reviews). However, these transfers are also subject to state oversight, and are additionally subject to the requirements of other overarching agreements governing Lower Basin water use. For example, in California, any transfer of Colorado River entitlements is necessarily subject to the complex strictures of the Quantification Settlement Agreement, which addresses the division of Colorado River water among most of the major contractors in that state. In Arizona, entitlements are subject to the requirements of the Arizona Department of Water Resources' Arizona Colorado River Transfer Policy, which defines additional state-level procedures for Colorado River transfers.

The majority of Lower Basin Colorado River water use is associated with large-scale delivery contracts that are held by major agricultural districts (such as the Imperial Irrigation District and the Wellton Mohawk Irrigation and Drainage District, as well as by water delivery systems such as the Central Arizona Project. Individual users within these systems do not have individual entitlements, but rather receive a portion of the water delivered to those districts. As such, transfers of water involving those districts are subject to additional district-specific approvals and procedures.

The Intentionally Created Surplus ("ICS") mechanism, discussed in greater detail in Section V(D)(2)(a), provides the most flexible mechanism for the (temporary) carryover and transfer of water among Lower Basin contractors in the same state. The ICS program permits conserved Colorado River water (and certain other types of water) to be held as a storage credit in the Colorado River system reservoirs for future delivery. These activities can be undertaken to generate credits for the benefit of another party, which allows ICS to be used to "transfer" water between users.

Although the Law of the River generally operates to prohibit interstate transfers of Colorado River entitlements, some changes over the past 15 years have authorized certain types of interstate banking and storage activities on a limited scale. Most notably, the Intentionally Created Unused Apportionment rules, discussed in Section V(D)(2)(a), allow for limited interstate "banking" activities between Lower Basin contractors. In addition, developing mechanisms for controlling system risks, such as the pilot System Conservation Agreement, are designed to permit investments in conservation, fallowing, and similar activities to generate water for "system" benefit that do not belong to any particular user.

Under the reserved rights doctrine, tribes have been able to establish claims for expansive water rights in many rivers, streams, and groundwater basins in many parts of the West.

4. Federal Reserved Rights and Tribal Rights

One important additional category of water is the "federal reserved right." These water rights, which are deemed to be reserved by the United States when setting aside federal reservations in order to fulfill the purposes of those reservations, attach to federal Indian reservations[8] as well as to other federal enclaves, including national recreation areas, national wildlife refuges, and national forests.[9] The rights are typically delineated and enforced as part of state court general stream adjudications.[10] The amount and scope of a federal reserved right is determined based on the specific primary purpose of the federal reservation, and is limited to the amount of water necessary to fulfill that purpose.[11] The application of reserved rights doctrine to groundwater is not yet settled (although most, but not all, lower courts that have considered this issue have held that there is such a right).[12] Federal groundwater rights can be recognized and enforced even in environments where state law does not otherwise recognize rights to groundwater.[13]

The most significant federal reserved rights in the West are those held by Native American tribes. Early court decisions, established a standard for quantifying the water rights associated with Indian reservations based on the amount of "practically irrigable acreage" on those reservations. More recent state court decisions have used somewhat broader standards; for example, in Gila V the Arizona Supreme Court held that the purpose of a federal Indian reservation is to serve as a "permanent home and abiding place to the Native American people living there."[14]

Lake Mead, which functions as the primary Lower Basin storage reservoir. Image courtesy U.S. Bureau of Reclamation.

8 Winters v. United States, 207 U.S. 564, 576-77 (1908).
9 Id. at 601.
10 372 U.S. 609 (1963). See also Alexander Wood, Watering Down Federal Court Jurisdiction: What Role Do Federal Courts Play in Deciding Water Rights?, 23 J. Envtl. L. & Litig. 242, 252 (2008), citing United States v. District Court in and for the County of Eagle, 401 U.S. 520, 523-24 1971); Colorado River Water Conservation Dist. v. U.S., 424 U.S. 800, 809 (1976) (state court has jurisdiction over Indian water rights under the amendment).
11 Cappaert at 138, 141; see also 438 U.S. 696, 702 (1978).
12 See Gila III at 747. As an example of a state that has not recognized such a right, the Wyoming Supreme Court has declined to extend recognition of federal reserved rights to groundwater. Big Horn I, 753 P.2d 76 at 99.
13 Gila III at 419.
14 Gila V, 35 P.2d at 76 (internal citations omitted).

Regardless, under the reserved rights doctrine, tribes have been able to establish claims for expansive water rights in many rivers, streams, and groundwater basins in the Colorado River Basin and elsewhere in the West. In the Lower Basin, tribal rights to Colorado River water (recognized in the Arizona v. California decision) are administered by Reclamation pursuant to Colorado River delivery contracts.

Figure II-4 Lake Powell, which functions as the primary Upper Basin storage reservoir. Image courtesy U.S. Bureau of Reclamation.

5. Other Special Cases – Effluent, Developed Water, Diffuse Water, and Stormwater

Many western states recognize municipal effluent (i.e., treated municipal wastewater) as an effectively separate category of water that is the legal property of the entity generating it. As such, although effluent may be returned to a surface stream and may potentially be appropriated by others, this does not defeat the owner's ability to put effluent to a different use in the future. This effectively allows an owner of effluent to dispose of it by contract with a third party, irrespective of other water rights.

Effluent reuse plays an increasingly important role in many municipal water supply systems, particularly as a replacement supply for uses that would otherwise have depended on surface water or groundwater, such as golf courses, cooling systems, or public parks and turf facilities. Although direct potable reuse of effluent is not currently undertaken in the West, effluent is also increasingly being used indirectly as a municipal water supply through the recharge of groundwater.

One other distinct additional category of water, generally referred to as "diffuse surface water" (or sometimes, and more confusingly, "mere surface water" or simply "surface water"), arises out of the definition of "appropriable water" under the prior appropriation system in some states. "Appropriable water" is typically limited to waters flowing in natural channels, as well as lakes, ponds and springs.[15] As a result, before surface water originating from precipitation or from an underground source reaches a "natural channel" (typically, a watercourse with defined beds and banks), that water may be deemed to be non-appropriable,[16] and can be captured by the landowner.[17] Where "diffuse surface water" is collected and concentrated deliberately—such as via a stormwater collection system—it can then potentially be treated as "developed water" that is distinct from other surface water. Developed water is also non-appropriable; in essence, such water is "that which has been added to the supply of a natural stream and which never would have come into the particular stream system in the absence of the effort of the developers.[18]" (This must be carefully distinguished from "salvaged water," which is generally considered to be appropriable in many states, as noted above.) Under these general principles, water developed through urban stormwater collection systems, typically referred to as "enhanced urban runoff," can be treated as "diffuse" water that can be captured and developed independently of the relatively rigid appropriation system. This is an important distinction, since it can potentially be used to create a new source of water even in a stream system that is legally over-allocated. In some cases, this developed water can also be "wheeled" through natural channels for use elsewhere.

15 A.R.S. § 45-141(A).

16 Doney v. Beatty, 220 P.2d 77 (Mont. 1950); Southern Pacific Co. v. Proebstel, 150 P.2d 81 (Ariz. 1944); Kirkpatrick v. Butler, 483 P.2d 790 (Ariz. Ct. App. 1971); 93 C.J.S. Waters § 112, 170a (1956)

17 See, e.g., Reese v. Qualtrough, 156 P. 955, 960 (Utah 1916) (upstream defendant was not required to permit diffused surface water arising from springs on defendant's lands to flow unabated to downstream plaintiff's fish ponds).

18 Arizona Public Service, 773 P.2d at 995 (citing Southeastern Colorado, discussed immediately infra); see also Fourzan v. Curtis, 29 P.2d 722 (Ariz. 1934).

III.
Changing Water Supply, Demand, and Risk in the Colorado River Basin

III. Changing Water Supply, Demand, and Risk in the Colorado River Basin

A recent report undertaken by researchers from Ceres and several universities provides an analysis of the distribution of watershed "stress" across the United States. Unsurprisingly, the vast majority of these stressed watersheds were located in the comparatively arid states of the West. The study found that even under existing conditions, in nearly 10% of western watersheds, existing demands for freshwater resources exceeded the average available supply over a 10-year period (Figure III-1).

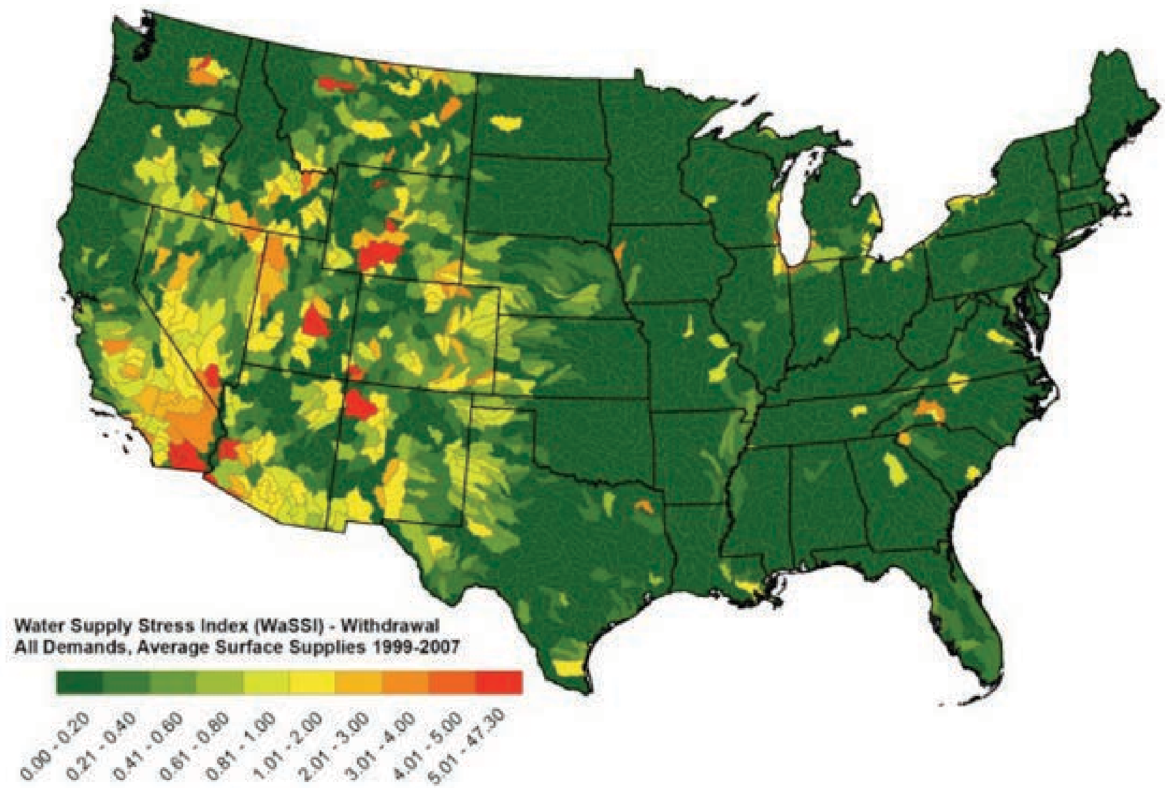


Figure III-1. Surface Water Stress in the United States. Map shows withdrawal and water supply index (WaSSI) data for demands and average water supplies from 1999-2007. Areas in red are potentially more vulnerable to changes in water supply. Source: K Averyt, et al., "Sectoral Contributions to Surface Water Stress in the Coterminous United States," Environmental Research Letters 8, no. 3 (Sept. 1, 2013).

Notably, many of the watersheds under the greatest relative levels of present-day stress are located within the Colorado River Basin. Perhaps more tellingly, however, the study also noted that a far greater number of watersheds experienced significant or extreme stress during the lowest-flow years during the 10-year period of analysis. Indeed, the vast majority of Colorado River Basin subwatersheds demonstrated high levels of stress during low-flow periods, and some even during the highest-flow periods.

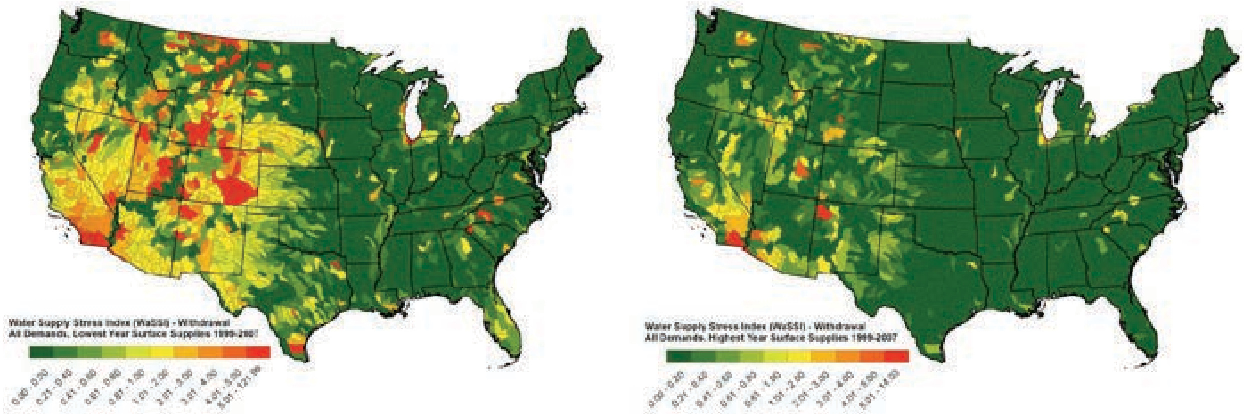


Figure III-2. Surface Water Stress – Low and High Flow Periods. Map shows differences in watershed stress between the driest (left) and wettest (right) years from 1999-2007. Source: K Averyt, et al., “Sectoral Contributions to Surface Water Stress in the Coterminous United States,” Environmental Research Letters 8, no. 3 (Sept. 1, 2013).

As shown in Figure III-3, these stresses are projected to increase significantly in the Colorado River Basin over the coming decades in response to declining overall water supply and projected growth in water demand. This means that most parts of the Colorado River Basin face growing imbalances between supply and demand that will require significant investments in controlling water demand, the development of new supplies, and transfers of water resources from existing to new users.

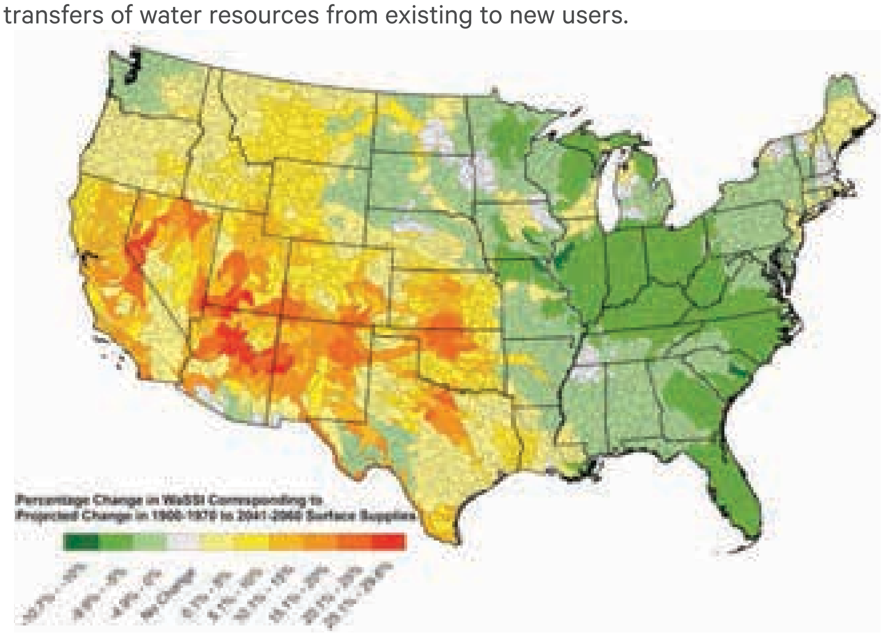


Figure III-3. Projected Increase in Surface Water Stress. Map shows projected increases in surface water stress in watersheds over the next 4-5 decades. Source: K Averyt, et al., “Sectoral Contributions to Surface Water Stress in the Coterminous United States,” Environmental Research Letters 8, no. 3 (Sept. 1, 2013).

Even more significant are the increasing problems of variability, uncertainty, and risk for water planning and infrastructure that these large-scale changes and challenges now pose for water users in the Basin. Growing out of the Reclamation Era in the early 1900s, water development in the Colorado River Basin (and elsewhere in the West) has typically been built around highly centralized, federally-or state-subsidized infrastructure projects that made possible the large-scale storage, diversion, and transportation of water on an unprecedented scale. Similarly, virtually all western water institutions and infrastructure have been designed—at their core—to dampen or protect against natural variability and disparity in the distribution of water supplies. Networks of large-scale dams, canals, and pipelines transformed highly variable rivers into stable supplies, and brought water from wetter areas to supply drier ones. However, this infrastructure was built to manage the natural variability in supply that had been observed during a fairly short period of record. Improved understanding of past hydrology and modeling of the impacts of climate change have led to an understanding that we can expect to see far larger variations in supply in the future—variations that will likely exceed the capacity of our existing infrastructure to manage, and which could threaten both human and environmental users alike.

The division of Colorado River water under the Colorado River Compact and the Treaty of 1944 is responsible for a central problem of the Law of the River: it apportions more water than actually exists.

A. Supply/Demand Imbalance – The Colorado River "Math Problem"

The division of Colorado River water under the Colorado River Compact and the Treaty of 1944 is responsible for a central problem of the Law of the River: it apportions more water than actually exists. Taken together, the Compact and the Treaty jointly allocate at least 16.5 maf of the water between the Upper Basin, the Lower Basin, and Mexico. When the Compact was signed in 1922, the annual flow of the river past Lee's Ferry (the dividing line between the Upper and Lower Basins) was estimated at 16.8 maf, based on flows from 1896 to 1921. Another study, based on 1906 to 1921 flows, computed the average at 18.1 maf. Unfortunately, modern tree-ring studies have demonstrated that the 20-year period of record that was used to estimate historic Colorado River flows for purposes of the Compact was among the wettest periods in the past several thousand years (Figure III-4), such that the long-term average supply that can be expected from the River is significantly lower than the figure allocated by the Law of the River.

Until recently, this historic overestimation of available resources had not generated any serious problems, in large part because the Upper Basin has never used its full apportionment under the 1922 Compact. This Upper Basin underutilization allowed significant quantities of surplus water to reach the Lower Basin each year. Until the late 1990s, Arizona had also never used its full apportionment, nor had the Lower Basin's Indian tribes, in part due to a lack of funding for tribal water development (recently, the tribes used only around 770,000 af each year out of a total allotment of 917,552 af).[1] This collective underutilization had, until very recently, allowed California to consistently access surplus Colorado River water to meet its growing demand. While California is only entitled to receive 4.4 maf of Colorado River water in normal years, its historic use exceeded 5 maf until as recently as 2001.

1 In addition, some Indian tribes have not yet settled or otherwise determined their rights to the Colorado River.

However, demand for water in the Colorado River Basin has been rapidly increasing. Starting in 1996, Arizona began diverting its full entitlement to Colorado River water, effectively completing the "build out" of Lower Basin Colorado River entitlements, and forcing rapid reductions in use in California to fit within its 4.4 maf legal entitlement. Upper Basin use has also been gradually increasing, and tribal water use is also expected to increase steadily over the next few decades. As a result of this increasing demand, as of 2003 human water use in the Colorado River has consistently exceeded the naturally available supply—in other words, as a practical matter, there is simply no more "surplus" water to grow into in either of the two Basins (Figure III-4).

Under the present rules of the Law of the River, this now-complete utilization of Colorado River resources can be expected to play out quite differently in the Upper and Lower Basins. In large part, the differences in potential Upper and Lower Basin outcomes relate to the different ways in which the Colorado River's larger "math problem" plays out in each Basin under the relative priorities under the Law of the River, which distribute risks differently between the Basins and among the users in each Basin.

In addition to the quantification described above, the 1922 Colorado River Compact established an inherent priority system for water deliveries as between the Upper and Lower Basin. Under Article III(D) of the Compact, the Upper Basin is obligated to deliver to the Lower Basin "an aggregate of 75 maf for any period of ten consecutive years," with this delivery having a higher priority than any use occurring in the Upper Basin. This provision gives the Lower Basin's 7.5 maf allocation the highest priority. Since the River is now understood to yield less at Lee's Ferry than the 15 maf provided to the two Basins under the Compact, this provision effectively allocates the resulting shortfall to the Upper Basin.

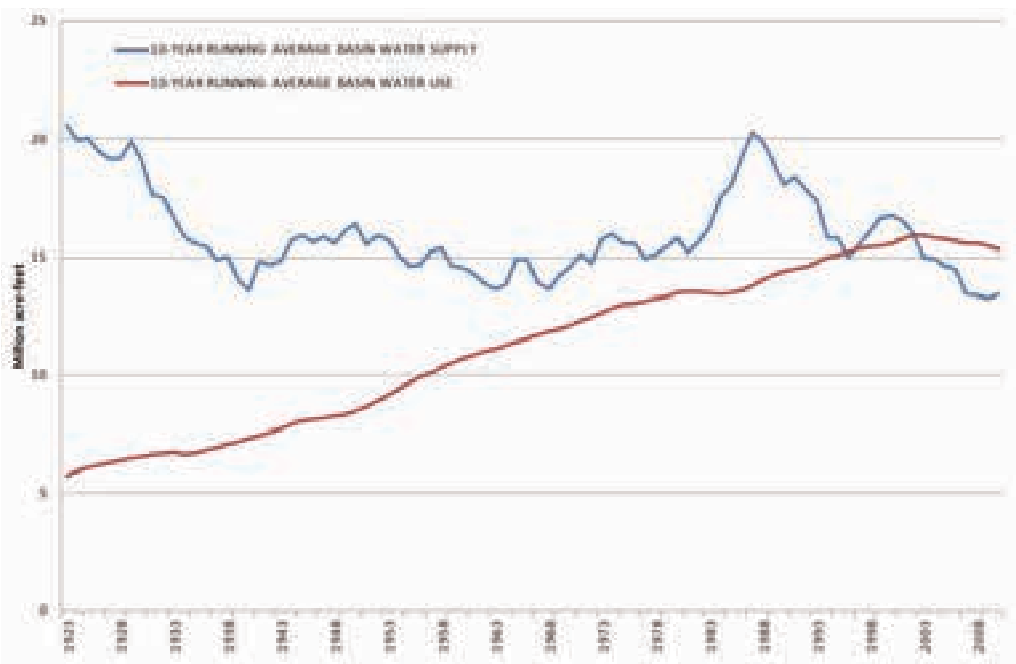


Figure III-4. Historic Basin-Wide Supply and Demand. 10-year running averages for water supply (blue) and water demand (red) in the Colorado River Basin. As of 2003, water demand has exceeded naturally available supply (and the historical average supply) every year. Source: U.S. Bureau of Reclamation (2012).

As the Law of the River is presently administered, the Upper and Lower Basin split the Treaty obligation to deliver water to Mexico. Under Article III(c) of the Compact, the Upper and Lower Basin agreed that the water for Mexico would first be taken from amounts above the water allocated under the Compact, but in the event that there was not enough water for this to occur, "the burden of such deficiency shall be equally borne by the Upper Basin and the Lower Basin." Because the River does not typically generate enough water to provide the water owed to Mexico out of flows in excess of the 15 maf allocated to the Upper and Lower Basins under the Compact, this has resulted operationally in an obligation for the Upper Basin to release an average of 8.23 maf each year out of Lake Powell for use in the Lower Basin: 7.5 maf, plus one-half of of the 1.5 maf to Mexico (750,000 af), less 20,000 af to account for the average inflow of the Paria River, which discharges to the Colorado River right above the dividing line at Lee's Ferry.

Figure III-5: "Bathtub ring" resulting from lowered water levels at Lake Mead. Image courtesy of U.S. Bureau of Reclamation.

As such, for the Upper Basin, the "math problem" effectively limits Upper Basin water development to the amount of water that is actually available each year, on average, after these delivery obligations to the Lower Basin and to Mexico are met—a figure closer to 5.5 maf than the Compact entitlement of 7.5 maf. This also means that the Upper Basin bears the primary risk of reductions in Basin yield in the future, as a result of drought, climate change, and other factors affecting supply. In the face of both the decreased mean yield and growing variability that is projected for the future of the Basin, this could translate to significantly reduced amounts of water and greatly increased annual shortage risk to individual users in the Upper Basin, as well as significant risk that the Upper Basin would be unable to meet its Compact delivery obligations, which could result in a "call" under the Colorado River Compact that would cause forced reductions in Upper Basin use.

For the Lower Basin, the "math problem" plays out as an increasing risk of shortages, largely due to the overuse of water available to it under the Compact. As noted above, the 1928 Boulder Canyon Project Act ("BCPA") operates to allocate the Lower Basin's 7.5 maf of "beneficial consumptive use" among the users in the Lower Basin States pursuant to federal delivery contracts: with a total allocation of 4.4 maf to users in California, 2.8 maf to Arizona, and 0.3 maf to Nevada. However, the BCPA fully allocates the Lower Basin's 7.5 maf for "consumptive use" by Lower Basin contractors. As such, the BPCA essentially assumes that the substantial other Lower Basin system demands—such as reservoir evaporation at Lake Mead and other reservoirs, phreatophyte use, the Lower Basin half of the Mexico obligation, and deliveries to Mexico that do not count against the Treaty—all have to be met either from Lower Basin tributary inflows (which are fairly small) or from excess releases out of the Upper Basin.

In practice, this results in an approximate 1.2 maf "deficit" in Lake Mead each year (the difference between Lower Basin demands and the water available under

3 The Upper Basin disputes whether it has an obligation to deliver half of Mexico's water under the Compact, arguing that the Lower Basin has actually developed more water than it was allowed to under a disputed provision in Article III(b) of the Compact, which gave the Lower Basin the right to "increase its beneficial consumptive use of such waters by one million acre-feet per annum" via the development of water out of Lower Basin tributaries (such as the Salt/Gila system in Arizona). This issue remains unresolved, although River operations currently reflect the Lower Basin perspective on this issue.

4 Under both the Compact and the BPCA, consumptive use means diversions less returns to the river (actual consumption of the supply).

the Compact and from Lower Basin tributary inflows). Therefore, in any year that the Upper Basin does not deliver 8.23 maf to the Lower Basin plus the amount of the deficit (i.e., around 9.43 maf), Lake Mead storage will decline. As such, for the Lower Basin, the "math problem" translates to inevitable shortages when excess flows out of the Upper Basin decrease.

In the event that Lake Mead cannot deliver the full amount of water needed to meet Lower Basin entitlements, a complex priority system established by the Arizona v. California Decree, federal delivery contracts, and the Colorado River Basin Project Act of 1968 takes hold. This priority system allocates essentially all the initial Lower Basin shortage risk to Arizona priority 4 contractors (approximately 1.5 maf of water to the Central Arizona Project, plus 167,000 af of on-river contractors) as well as a handful of Nevada contractors, effectively establishing these uses as a "buffer" against Lower Basin shortages. As noted above, the 2007 Shortage Guidelines defined a set of mandatory "shortage triggers" that begin cutting back these lower-priority Lower Basin users as Lake Mead levels decline.

B. Changing Supply and Demand in the Basin

In December 2012, the U.S. Bureau of Reclamation and the seven Colorado River Basin States completed the Colorado River Basin Water Supply and Demand Study ("Basin Study"), reflecting more than two years of collaborative effort among federal and state agencies, tribes, nongovernmental organizations ("NGOs"), and scientists. The Study is the most comprehensive analysis of river system supply and demand ever undertaken in any river system. It evaluates a variety of different agricultural, municipal, and industrial demand scenarios in each state, and then matches them against a series of future water-supply scenarios, including scenarios built from 29 different downscaled global climate models.

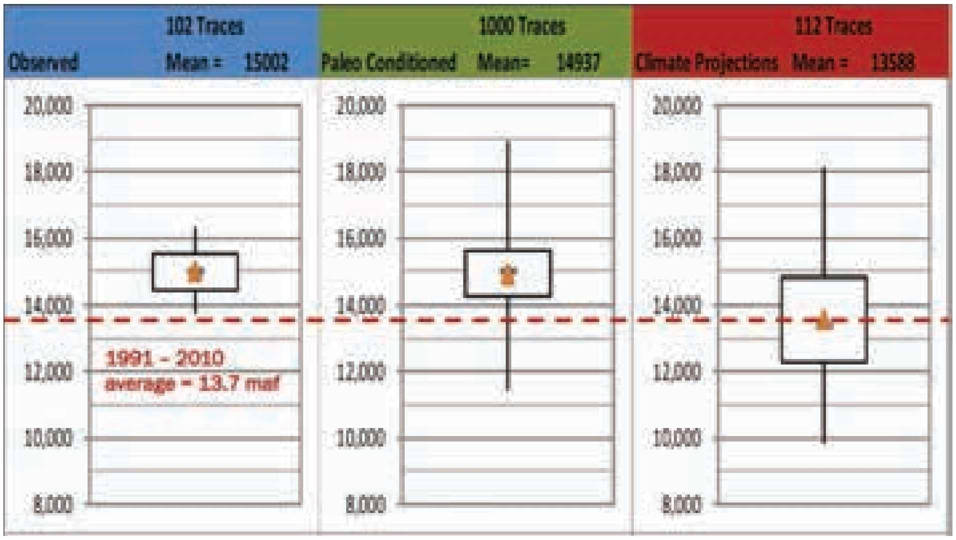


Figure III-5. Water Supply Projections for the Colorado River Basin. Chart showing differences between recent 100-year water supply available in the Colorado River Basin (Observed, left side) and potential future water supply based on (a) reconstructed historic flows from tree ring studies (Paleo, center), and (b) climate modeling (Climate Projections, right), in thousands of acre-feet. The rectangular box represents the range of annual water supply that would be observed in the 25th to 75th percentile years (i.e. the average flow years), while the whiskers above and below show potential deviations from the average in extreme years. The range of variation in water supply in the future is significantly greater than that seen in recent historic records. Note also that the average supply projected in the climate scenarios is equivalent to the recent average supply (1991-2010) observed during current drought conditions, suggesting that current conditions may provide a preview of future conditions. Source: U.S. Bureau of Reclamation (2012).

As depicted in Figure III-5, on the water supply side, the Study suggests that Basin users can expect both a net reduction in streamflow and increasing variability over the coming decades. A comparison of recent, historic measured streamflow in the Basin (based on 102 historic traces) against reconstructed paleo flow data (derived from tree-ring studies in the Basin) suggests that the mean flow of the Colorado River at Lee's Ferry can potentially be expected to decline from its recent average of 15.0 maf to a longer-term average of 14.7 to 14.9 maf. More importantly, however, these data suggest that recent average variability in flow, as well as recent extremes in flow, have been far lower than observed historically – in other words, future flow variability can be expected to be far wider than what we have seen in the past.

Once climate change impacts are considered, future mean flows in the River are projected to be equivalent to those observed during the past 20 years of record, at around 13.6 maf. In addition, future average variability in flow is projected to be far wider than observed in either the recent record or the paleo record, as are future extremes in flow. This would translate to a significant overall decline in water availability in the Basin, as well as to greatly increased year-to-year variation, with potential for both larger droughts and larger flood events over coming decades. This modeling also suggests that these climate change impacts are unlikely to be distributed equally in the Colorado River Basin. While climate projections suggested that an overall 9% decline in yield could be expected, particular watersheds or subwatersheds are likely to be disproportionately affected, with some watersheds experiencing far greater declines, while others might experience net increases in hydrologic yields.

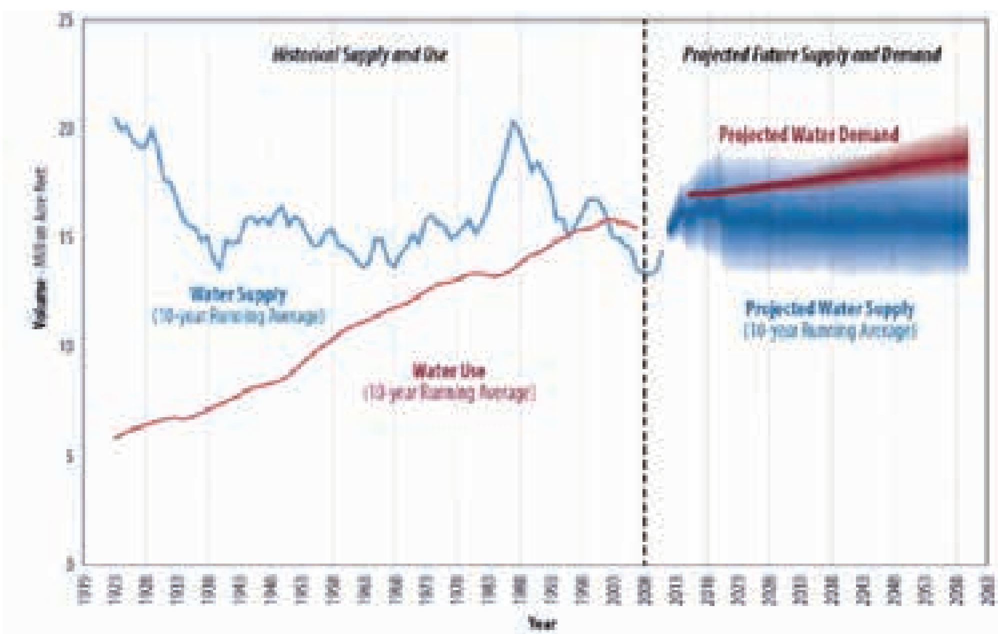
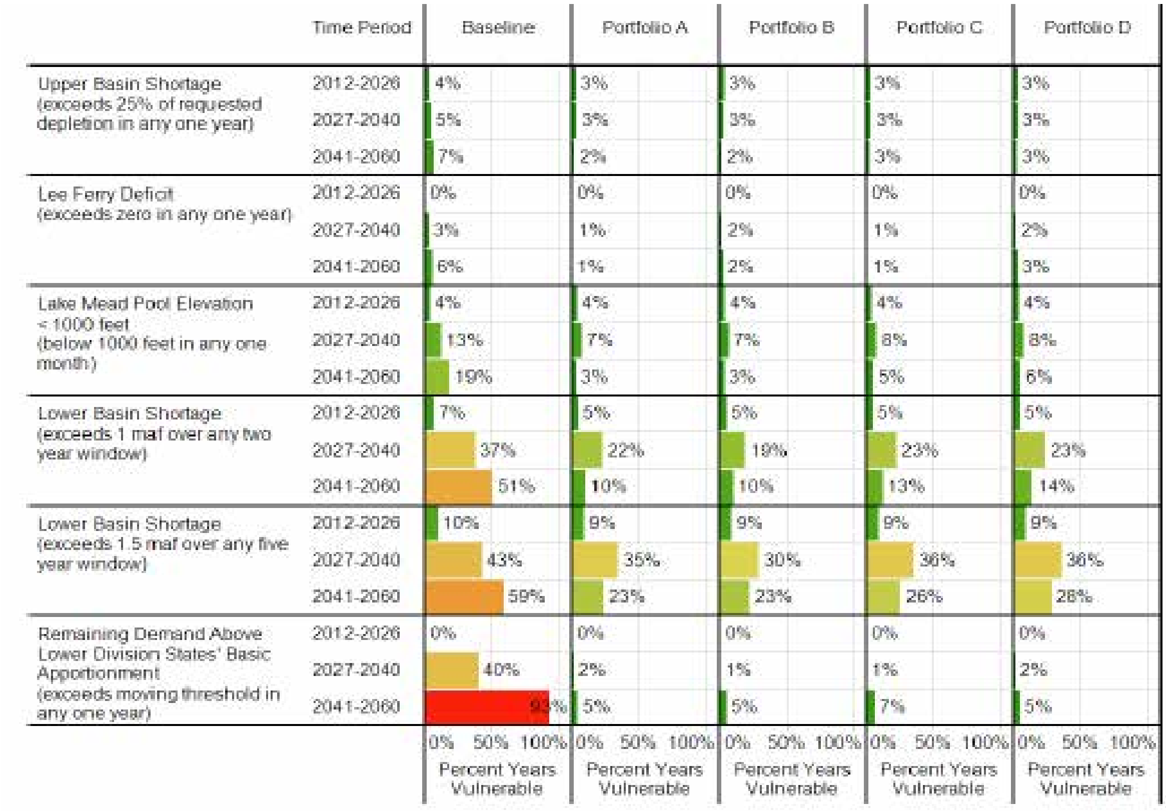


Figure III-6. Historic Basin-Wide Supply and Demand. 10-year running averages for water supply (blue) and water demand (red) in the Colorado River Basin, continuing forward from the graph in Figure III-5. Shading represents probability (darker areas represent higher probabilities). Projected future demand continues to grow under all scenarios, exceeding available supply by as much as 50% in some scenarios. Source: U.S. Bureau of Reclamation (2012).

On the water demand side, the Study considered several scenarios for growth in water demand in the Basin, based on projections developed for each state. These scenarios included a range of future outcomes, varying from "business as usual" projections based on relatively modest increases in water conservation and continued population growth in the Basin, to "slow growth" and "enhanced environment" scenarios in which slower rates of future growth and/or increased levels of conservation effort work to limit future increases in water demand. These scenarios show a significant variation in future projected demand, ranging from only small increases in future water demand to significant potential increases by the 2060s (Figure III-6).

Taken together, the results from the Basin Study demonstrate that without further proactive steps, including increased levels of agricultural and municipal conservation, the long-term projected imbalance in future supply and demand in the Basin could grow to an average of around 3.2 maf over the next five decades (approximately 20% of current Basinwide demands). The worst-case scenario suggests a potential imbalance of over 8 maf (greater than 50% of current demands). To address these imbalances, the Study also evaluated approximately 160 stakeholder-proposed solutions, including conservation programs, reuse of reclaimed water, and desalination of ocean or brackish water.



	Time Period	Baseline	Portfolio A	Portfolio B	Portfolio C	Portfolio D
Upper Basin Shortage (exceeds 25% of requested depletion in any one year)	2012-2026	4%	3%	3%	3%	3%
	2027-2040	5%	3%	3%	3%	3%
	2041-2060	7%	2%	2%	3%	3%
Lee Ferry Deficit (exceeds zero in any one year)	2012-2026	0%	0%	0%	0%	0%
	2027-2040	3%	1%	2%	1%	2%
	2041-2060	6%	1%	2%	1%	3%
Lake Mead Pool Elevation < 1000 feet (below 1000 feet in any one month)	2012-2026	4%	4%	4%	4%	4%
	2027-2040	13%	7%	7%	8%	8%
	2041-2060	19%	3%	3%	5%	6%
Lower Basin Shortage (exceeds 1 maf over any two year window)	2012-2026	7%	5%	5%	5%	5%
	2027-2040	37%	22%	19%	23%	23%
	2041-2060	51%	10%	10%	13%	14%
Lower Basin Shortage (exceeds 1.5 maf over any five year window)	2012-2026	10%	9%	9%	9%	9%
	2027-2040	43%	35%	30%	36%	36%
	2041-2060	59%	23%	23%	26%	26%
Remaining Demand Above Lower Division States' Basic Apportionment (exceeds moving threshold in any one year)	2012-2026	0%	0%	0%	0%	0%
	2027-2040	40%	2%	1%	1%	2%
	2041-2060	93%	5%	5%	7%	5%
		0% 50% 100% Percent Years Vulnerable	0% 50% 100% Percent Years Vulnerable	0% 50% 100% Percent Years Vulnerable	0% 50% 100% Percent Years Vulnerable	0% 50% 100% Percent Years Vulnerable

Figure III-7(a). Projected Increases in System Vulnerability – Water Deliveries. See description in Figure III-9(b).

Most of these scenarios imply substantially increasing costs for water in the future that will far exceed the costs to which water users have grown accustomed. Perhaps more significantly, however, the Basin Study also suggests that regardless of which actions are taken to manage these imbalances, the future vulnerabilities that will be faced by the River system's users—including risks of water supply shortages, reservoir declines, and critical reductions in streamflows—cannot all be eliminated. Even with all the available solutions that were considered in the Study implemented (at an annual cost of $3.5 to $4.5 billion), the significant vulnerabilities faced by the River's users as a result of increased annual variations, overall declines in supply, and growing demands can at best only be reduced. For example, the risks of critical events like shortages to major water users, reservoirs being lowered below key hydropower thresholds, and the loss of streamflows that are essential to environmental and recreational uses could still approach 50% annually within a few decades (Figure III-7(a) and III-7(b)).

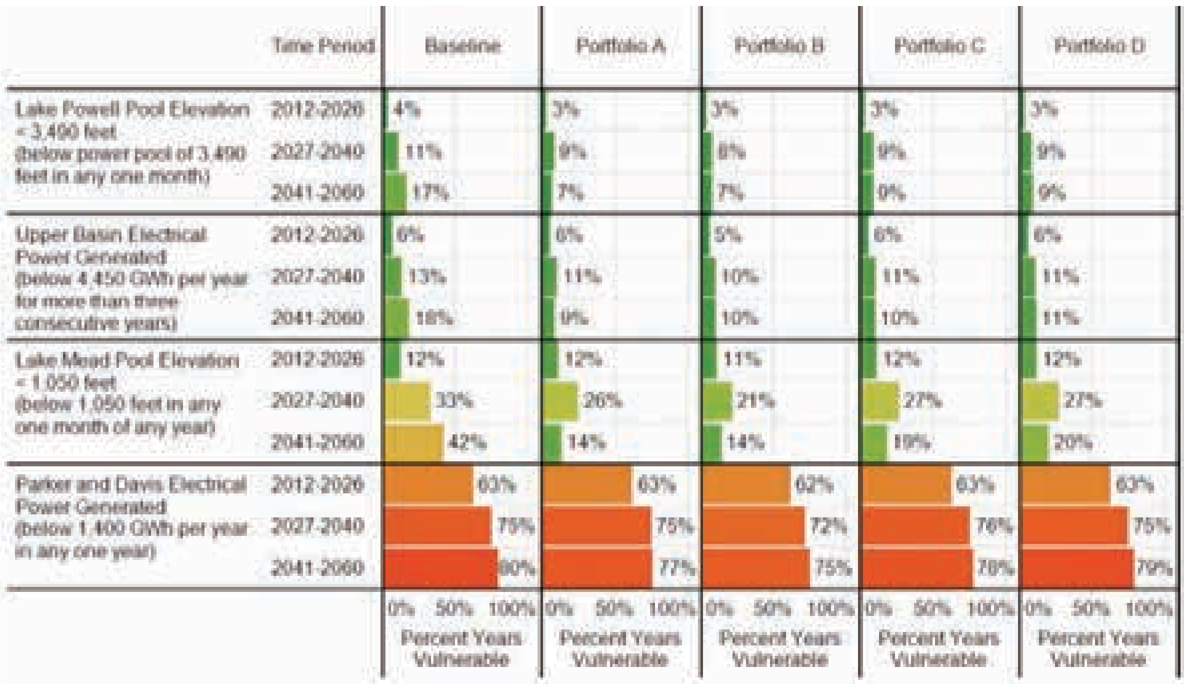


Figure III-7(b). Projected Increases in System Vulnerability – Power Generation. The charts above provide projected risks of one or more undesirable events occurring in terms of water deliveries or power generation under five scenarios: a baseline scenario representing the future changes in water supply predicted in the Basin Study and growth in water demand without major interventions to reduce risk (baseline); and for portfolios (a), (b),(c), and (d) the same risk projections assuming that various portfolios of solutions evaluated in the Basin Study are applied to reduce risk. As noted in the charts, in the absence of interventions risks become significant for both water and power delivery metrics; interventions reduce (but do not eliminate) these risks. Source: U.S. Bureau of Reclamation (2012).

5 Notably, the Study also does not fully consider the impacts of other important changes in the landscape that could further exacerbate uncertainty, including recently recognized issues associated with invasive species, dust on snow, and the loss of primary forest cover in large areas of the Upper Basin, as well as increases in agricultural water use that could be associated with longer growing seasons (which could increase by as much as a month in the coming decades).

As a result, the Basin Study makes clear that even with significant future public investments in the management of shortage risks, future water planning for water use in the Colorado River Basin must be premised on substantially increased levels of uncertainty and scarcity in water resources. This growing uncertainty means that the Basin's users must begin moving deliberately to reduce the physical, ecological, and economic fragility of critical systems in the face of growing water risk—and must ensure that planning for urban, agricultural, and ecological needs anticipate the potential for more extreme conditions in the future. This, in turn, means designing systems of water use to be able to both survive and thrive in the face of variability and inevitable disruption in water supplies.

C. Current Shortage Risks in the Basin

The current reservoir conditions in the Basin are essentially providing a preview of what this increased risk will look like in the future. The past 15 years of drought conditions have driven system storage to its lowest level since Lake Powell first began to fill, with less than 50% of storage capacity in the system (Figure III-8). At the end of 2014, Lake Mead stood at around 40% capacity and just 11 feet above its first shortage trigger, while Lake Powell stood at less than 45% of capacity.

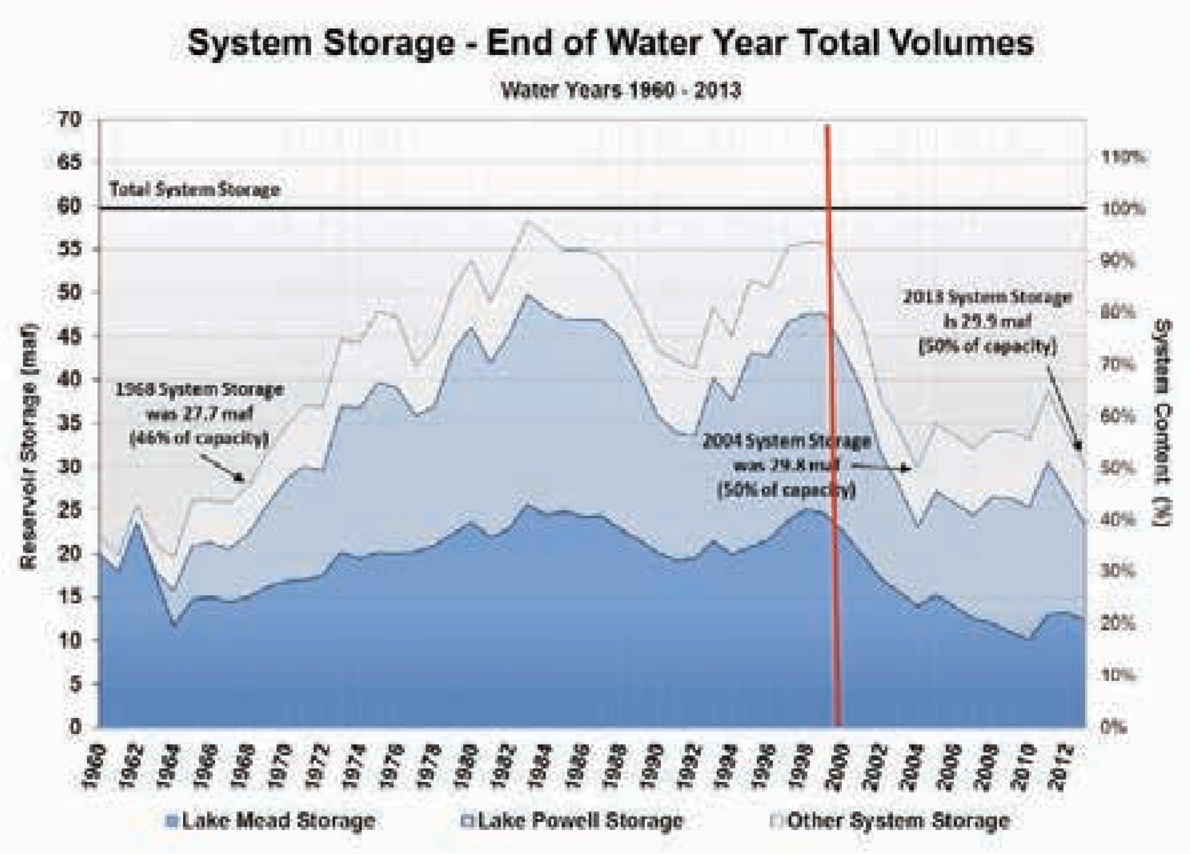


Figure III-8. System Reservoir Storage in the Colorado River Basin. The graph shows total volumes of water in storage in the primary Colorado River system reservoirs. By 2013, system storage had declined to a point equivalent to storage in 1968, prior to the construction of the Glen Canyon Dam (i.e. Lake Powell). Source: U.S. Bureau of Reclamation (2014).

With system storage reduced to this level, shortage risks have become acute as a result of the interplay of the structural deficits and overallocations reflected in the system. Under the present low-reservoir conditions, the probability of excess releases from the Upper Basin is very low, since it will likely take several "wet years" to recover system storage to the point where excess releases are likely to occur. Importantly, however, the probability of returning to and maintaining higher reservoir conditions is also dropping every year, as a result of ongoing changes in hydrology (e.g. climate change impacts, dust on snow, and invasive species) and of rules that require more water to be held back in Lake Powell to support Upper Basin use of water and to ensure continued hydropower production at Glen Canyon Dam. Essentially, Lake Powell releases extra water to the Lower Basin only when its elevation is higher than a defined point, known as the "equalization line." Under the Law of the River, this line is moved a little higher each year to ensure the reservoir can continue to protect Upper Basin users as they increase their demand for water upstream. As the reservoir level drops, it takes more and larger wet years to push the reservoir storage high enough to exceed the equalization line.

Table III-1. Lake Mead Shortage Triggers and Volumes

Lake Mead Jan 1, Elevation*	Arizona Reduction	Nevada Reduction	Mexico Reduction
1075'	320,000 AF	13,000 AF	50,000 AF
1050'	400,000 AF	17,000 AF	70,000 AF
1025'	480,000 AF	20,000 AF	125,000 AF

*For purposes of implementing the shortage triggers, the predicted elevation of Lake Mead on January 1 is projected as of August in the preceding year. Source: Central Arizona Project.

As Lake Mead continues to fall, it can also drag Lake Powell down with it, requiring larger so-called "balancing" releases (which attempt to balance the contents of the reservoirs when one is significantly above the other) that exceed 8.23 maf when levels in Mead drop too low compared to levels in Powell. These "balancing" releases help to slow the decline of Lake Mead, but unless Lake Powell then receives enough extra water to prevent its own levels from declining, Lake Mead will inevitably fall again in a subsequent year when the lakes balance in the other direction, following a "one-step-forward, two-steps-back" pattern toward the bottom.

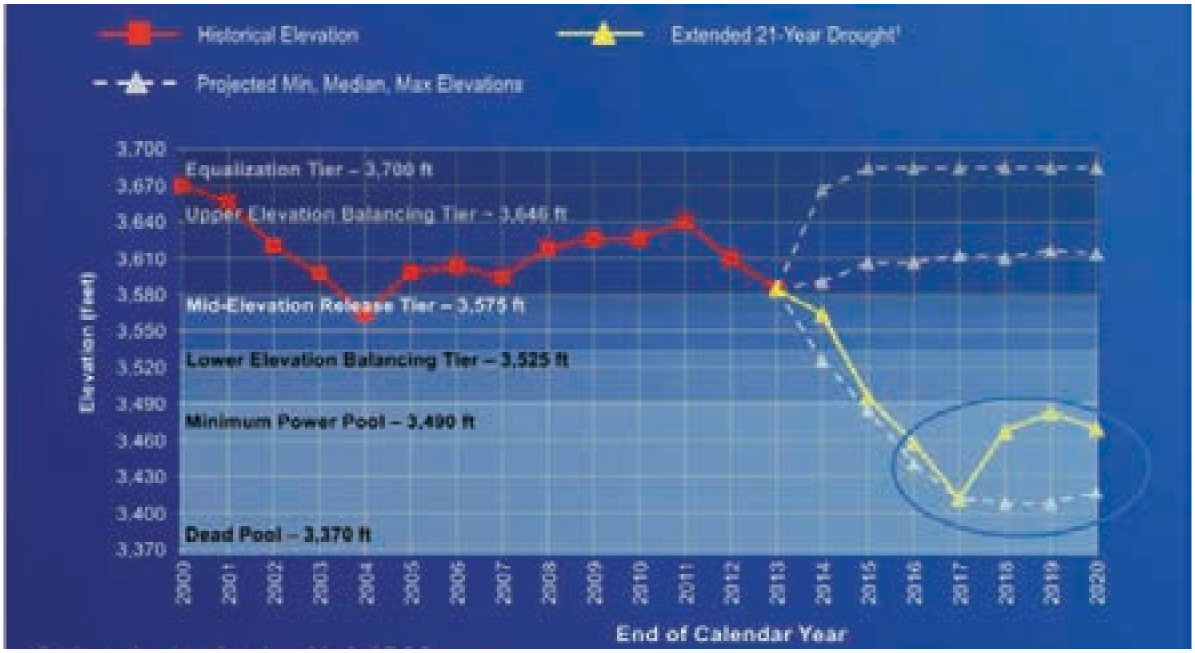


Figure III-9. Projected Future Conditions in Lake Powell. The three grey dotted lines show projections for 75% (wet), 50%(average), and 25%(dry) hydrologies. Note that in approximately 50% of scenarios, the lake will either not recover or will continue to trend downward. The yellow line provides a projection of reservoir levels if the next 10 years were to repeat the relatively dry hydrology of the past 10 years. Source: Bureau of Reclamation, 2013.

Under the 2007 Guidelines and the terms of the recent Minute 319 agreement between the United States and Mexico, once Lake Mead falls below an elevation of 1,075 feet, a series of increasing shortages are applied to users in Arizona, Nevada, and Mexico,[6] which then increase if the lake declines further (see Table III-1). Note, however, that these shortage amounts are not enough to overcome the Lower Basin deficit; they only reduce it. As such, Lower Basin shortages serve only to slow, not arrest, Lake Mead's decline under low-inflow conditions.

The Lower Basin is thus trapped in the equivalent of a classic gambler's fallacy—having lost a lot of money to the house, it must continue to gamble to recover its stake, even as the house holds a greater and greater advantage each year.

Even when the current drought ends, future projections of reservoir conditions show an increasingly low probability that Lake Powell levels will be maintained at levels that provide for regular releases of excess water from the lake that would replace this ongoing deficit in Lake Mead. As noted in Figure III-12, even under average conditions Lake Powell would be expected to operate at levels below the "equalization line" for the foreseeable future. As discussed above, this line also grows higher each year, even as Basin-wide yields are projected to decline. The Lower Basin is thus trapped in the equivalent of a classic gambler's fallacy—having lost a lot of money to the house, it must continue to gamble to recover its stake, even as the house holds a greater and greater advantage each year.

6 Under the terms of the Minute 319 agreement, Mexico can "pre-store" water in Lake Mead and use its accumulated storage to offset those shortages.

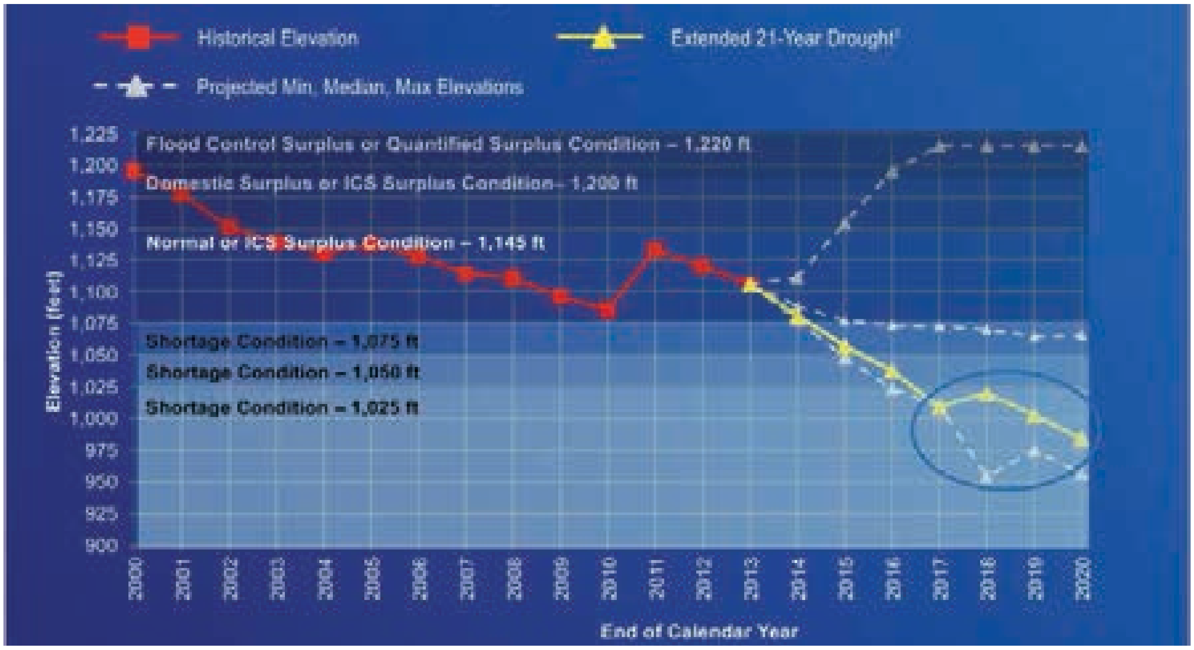


Figure III-10. Projected Future Conditions in Lake Mead. The three grey dotted lines show projections for 75% (wet), 50%(average), and 25%(dry) hydrologies. Note that in more than 50% of scenarios, the lake will either not recover from its current depleted condition or will continue to trend downward. The yellow line provides a projection of reservoir levels if the next 10 years were to repeat the relatively dry hydrology of the past 10 years. Source: Bureau of Reclamation, 2013.

Under the best-case scenario, assuming that the system returns to its relatively recent, wetter-than-average hydrology, Lower Basin shortage risks will continue to increase (eventually approaching 50% or greater annually). This progression toward a "permanent shortage" is readily apparent in the Bureau of Reclamation's future modeling. Should the Basin's future hydrology return to its long-term, lower average—or the even-lower numbers that could result from landscape-level changes and/or climate change—not only would frequent shortages become the norm, but the risk of large-scale, catastrophic shortage would become all but inevitable.

Figure III-10, which shows projected future conditions in Lake Mead, also suggests just how quickly shortages can manifest in the event of ongoing drought conditions. The yellow line on this figure reflects a projection of what would happen if the next 10 years of flow were to simply repeat the past 10 years of drought-type flows.

There is now widespread business recognition of water-related risk, not only among obvious users, such as utilities, developers, and the mining industry, but also among other water-intensive businesses that either have or are contemplating significant operations in the West.

As this projection makes clear, Lake Mead could rapidly decline to a point below 1,000' in the absence of significant intervention. The 1000' elevation has been universally identified as a point which the Lake Mead reservoir should never be allowed to reach; at that elevation, declining water levels would have cut off the existing municipal intakes to Las Vegas (jeopardizing the ability of the Southern Nevada Water Authority to meet municipal demands), and would have eliminated virtually all hydropower production from Hoover Dam. Further, it would potentially trigger large, uncontrolled shortages in the Lower Basin that could cut off lower-priority entitlements (such as the Central

Arizona Project and many on-river communities) and cause deep reductions in higher-priority entitlements (such as those held by the Metropolitan Water District of Southern California).

Importantly, the shortage volumes and triggers that were agreed to in the 2007 Guidelines to avoid reaching this level are not even sufficient to visibly alter the downward trajectory of the reservoir under these conditions. Modeling suggests that, at the present reservoir levels, reductions in use equivalent to perhaps 800,000 af/year in the Lower Basin, and an additional 200,000 af/year in the Upper Basin, will be needed to reduce the risk of Lake Mead from dropping to elevation 1,000', and Lake Powell from falling below its minimum power pool, to the same level of risk that the Basin States had deemed acceptable when the 2007 Guidelines were developed.

D. Other Critical Water Risks and Needs

Similar to what we see at the system scale in the Basin, there will clearly be a need for simple water reallocations over time within each of the Basin states to support ongoing changes in demand and priorities. All the Basin States are experiencing significant changes in terms of population growth, economic trends, urbanization, awareness of the value of ecosystem services and ecological values, and the impacts of climate disruption. Each factor will fundamentally alter how water is allocated among users, how that water will be used, and how differing communities and users will be exposed to shortage risks.

As population increases in the region and development expands, more of the landscapes that contribute to watershed health will be transformed and degraded.

As urban growth continues apace, many existing municipalities and urbanizing areas are simply outstripping their allocated water supply, in some cases by significant amounts. As noted in the Basin Study, urban demand growth is projected to comprise the vast majority of new water demand in the Basin over the coming decades, and is thus the most obvious driver for the future reallocation of water resources between existing users (although continued investments in conservation and changes in land use patterns may serve to limit or offset demand growth in many areas). However, where significant supply-and-demand imbalances arise in response to growth, in most cases it will only be possible to address those issues by undertaking new investments in water infrastructure or by water supply acquisitions.

Risks to urban water supplies often imply significant risks to industry as well. There is now widespread business recognition of water-related risk, not only among obvious users, such as utilities, developers, and the mining industry, but also among other water-intensive businesses that either have or are contemplating significant operations in the West. A recent quote from JP Morgan captures the sentiment of the business sector's recognition of water shortage risks: the firm encourages investors to "assess the reliance of their portfolios on water resources and their vulnerability to problems of water availability and pollution." [7]

Water shortages can also create a variety of ancillary economic risks. For example, significant water shortages tend to make headlines that may generate a high level of uncertainty for real estate markets, particularly in the wake of recent housing market woes. Likewise, as the Central Valley of California has recently experienced, water shortages can wreak havoc with agricultural markets and can precipitate the involuntary fallowing of thousands of acres of productive croplands.

7 Brooke Barton, "Water Scarcity Means Business for Companies & Investors," Mother Nature Network (content provided by MillerCoors). www.mnn.com/food/beverages/sponsorstory/water-scarcity-means-business-for-companies-investors.

In addition to the attendant economic impacts, water shortage conditions can also generate substantial perceptual, regulatory, and political risks. The perceptual and political risks surrounding water shortage can spook investors, reduce interest in water markets, and worsen the adaptive capacity of western communities and watersheds.[8] Many of these risks are inherently cross-cutting, affecting all sectors, from municipal to agricultural to environmental. Given the River users' significance to the U.S. economy – representing approximately 20% of U.S. GDP, these are national, not just regional, problems.

Although many agricultural users enjoy high-priority rights, agricultural interests also face potential challenges from water shortages. Where agricultural interests are exposed to shortage risks, shortages can quickly damage or bankrupt economically marginal farming operations; many of the Basin's farmers, even those growing high-value crops, are highly dependent on annual farming returns and cannot easily weather significant or prolonged water shortages. Permanent crop farmers—of almond, citrus, and other tree-based crops—can be particularly vulnerable, since even a brief shortage can result in the loss of crops that will take decades to replace. Where shortages are deep or sustained, they can have disastrous economic consequences not just for farmers but also for the communities that depend on farming operations. The ongoing drought in California, which has resulted in the fallowing of more than 500,000 acres of Central Valley farmland and billions of dollars in economic losses in one of the West's richest agricultural regions, provides a prime example of the broad potential economic and social consequences of water shortages.

Figure III-11 Razorback Sucker, an endangered Colorado River fish. Image courtesy of U.S. Bureau of Reclamation.

These concerns are compounded by another significant issue facing water users in the Basin: the continued, unsustainable use of groundwater resources in many areas. The overexploitation of aquifers, proceeding under "reasonable use" doctrine and similar open-access policies, has caused widespread groundwater depletion in many parts of the Basin. Recent NASA studies, which used satellite remote sensing technology to evaluate the impact of drought and overuse on groundwater supplies, concluded that, overall, the Colorado River Basin had lost some 65 cubic kilometers of freshwater storage over the past decade (approximately 53 maf); nearly 75% of this net water loss to the system occurred as a result of the overexploitation of underground water resources. This overexploitation is rapidly eroding the substantial safety buffer against long-term drought that was provided by aquifer storage. In some areas, aquifers have already reached critical levels. Groundwater overdraft in Central California has caused massive land subsidence in the Central Valley and has left dozens of communities with little or no water supplies in the midst of the ongoing drought. Correcting this problem not only will require major changes to groundwater regulation in many parts of the Basin, but will also require both reductions in local water use and the reallocation of existing, sustainable surface water supplies to offset current groundwater use.

8 However, it can be a double-edged sword, where perceptions of scarcity can precipitate policy reform that expands opportunities for reallocation to reflect current values. In the 1970s, the mere hint of water scarcity and lack of a regulatory framework to address it in Arizona caused the real estate market to bottom out, and ultimately led to the adoption of the 1980 Groundwater Code in a state that had previously resisted any such water management schemes.

E. Overview of Environmental Challenges in the Basin

Some of the most fundamental challenges facing the Basin relate to the future of ecosystem values, in no small part because the Law of the River recognizes few water allocations to support environmental values in the system. With essentially all available water supplies allocated for human use, where flow-dependent environmental values continue to exist in the Basin, environmental uses tend to persist either as a byproduct of the "run of the river" (e.g. because they are located upstream of another use or diversion and thus are guaranteed to receive water whenever water flows to the downstream use) or because they are dependent on the "waste" stream from an upstream user, such as municipal effluent, agricultural drainage, or the like. Throughout the Basin, many wetlands and riparian ecosystems survive on unused agricultural outflows, canal leakage, and flood releases that allow water to escape from the otherwise highly regulated reservoir system. (For example, virtually all remaining wetland habitat in the Colorado River Delta ecosystem is dependent on agricultural drainage from the Yuma, Arizona or Mexicali, Baja California agricultural valley.)

As continued growth and development in the Colorado River Basin increase the pressure on water resources and force reallocation of water between users, and as the efficiency of agricultural uses and reservoir system operations continue to increase, many of these environmental values will face growing jeopardy. As environmental pressures increase, so will legal uncertainties for water users, who may be forced to change water uses in order to accommodate protection of environmental values that are currently unrecognized in the entitlement system.

The diminishment of in-stream flows to support aquatic and riparian habitats, while by far the most significant environmental threat to Colorado River systems, are also tied to other environmental challenges. Low flows exacerbate issues with water quality created by more than a century of mineral exploitation and urban development, while invasive species supplant native vegetation and capture water needed by other environmental uses. As population increases in the region and development expands, more of the landscapes that contribute to watershed health will be transformed and degraded, even as climate changes affecting precipitation and drought patterns impact future streamflow and further jeopardize the health of landscapes along the Colorado's tributaries and headwaters.

The convergence of all these factors—growth and resource exploitation and their attending impacts, invasive species, a changing climate, and overallocation of flows—magnifies the challenge to protecting the critical ecological values of the Colorado River Basin. A summary of some of the major environmental challenges in the Basin is provided in Table III-2 (following page); further discussion of some of the more significant issues in the Basin is provided in the sections that follow.

1. Reduction of Flows and Altered Flow Regimes

Sustaining surface water flows and groundwater tables supporting river ecosystems is one of the most pressing environmental challenges in the Basin. The capture of close to 100% of existing flows in the Colorado Basin through a series of dams, diversions, canals, and other major water control infrastructure has created a situation in many of the Basin's stream reaches in which water flows may be significantly reduced or absent during all or key portions of the year.

Table III–2. Common Environmental Water Issues in the Colorado River Basin

Serious
Concern
OK
N/A

	Delta	Mead to Imperial	Lower Basin Tributaries	Mainstem to Mead	Collector Tributaries	High-Order Tributaries	Headwaters
Forest Health issues	N/A	N/A	Serious	OK	OK	Concern	Serious
Poor Grassland Health	N/A	N/A	Serious	N/A	Concern	Concern	Serious
Invasive Riparian Vegetation	Serious	Serious	Serious	Serious	Serious	Concern	Concern
Habitat Destruction Due to Channelization	Serious	Serious	N/A	N/A	OK	Concern	OK
Invasive/Non-Native Aquatic species (Fish, Mollusks)	N/A	Serious	Serious	Serious	Serious	Concern	Concern
Dust on Snow	N/A	N/A	N/A	N/A	N/A	Concern	Serious
Fish Barriers due to Dams and Ag. diversions	N/A	N/A	N/A	N/A	Concern	Concern	Serious
Depleted Stream Flows due to Excess Water Use	Serious	Concern	Serious	Concern	OK	Concern	Serious
Depleted Stream Flow from Groundwater Pumping	Serious	OK	Serious	OK	OK	Concern	Serious
Out-of-Basin Diversions	Concern	Concern	OK	OK	Concern	Serious	Serious
Changes in Stream Flow due to Dam Operations	Serious	Serious	Concern	Serious	Serious	Concern	OK
Changes in Water Temperature	Serious	Serious	Concern	Serious	Serious	OK	OK
Shortage Risks Due to Local Run-off Shortfalls	OK	OK	Serious	OK	OK	Concern	Serious
Shortage Risks due to Structural Deficit	Serious	Serious	OK	OK	OK	OK	OK
High Salinity	Serious	Concern	Concern	OK	OK	OK	OK

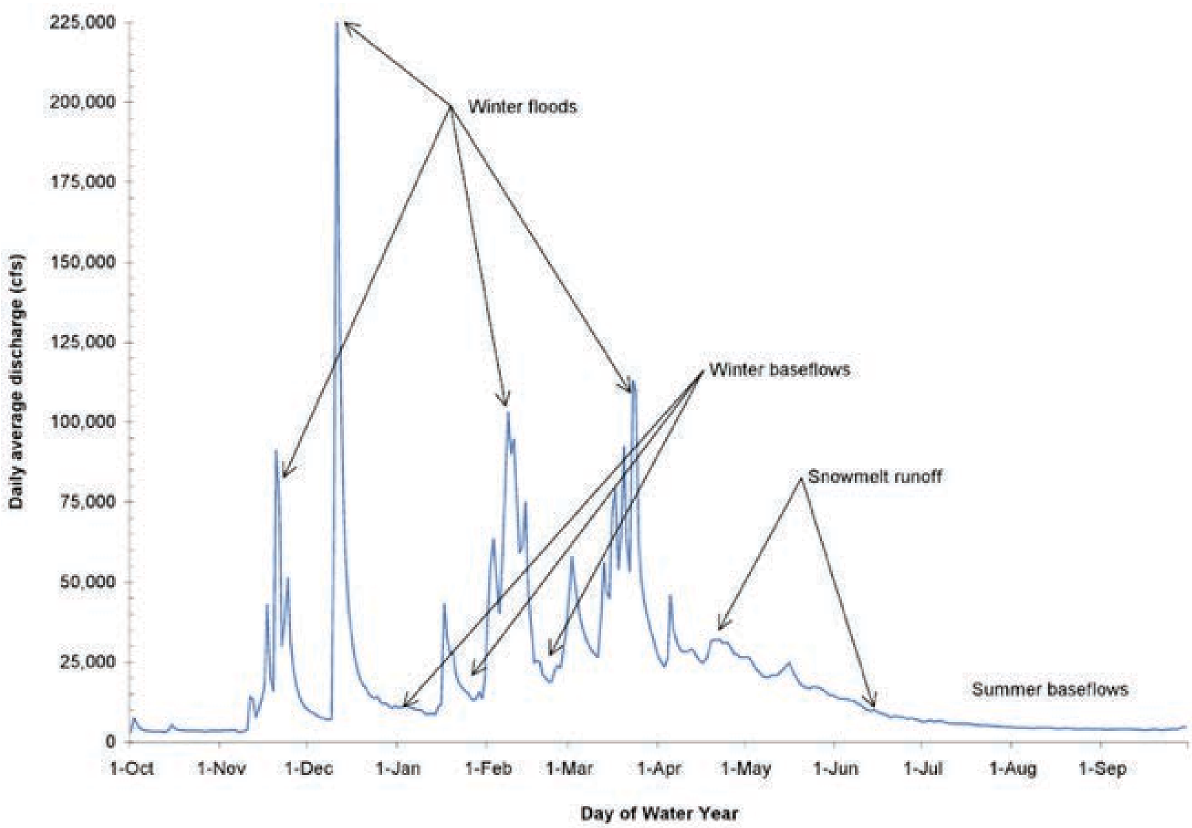


Figure III-12. Natural Stream Hydrograph. Natural stream hydrograph in the Sacramento Watershed on a stream without a dam or diversion. Source: Sacramento River Basin Report Card and Technical Report, Sacramento River Watershed Program (April 2010).

For example, agricultural diversions may remove most or all of the water from a stream reach during periods of peak irrigation activity, and these diversions may also coincide with drier summer months during which natural flows are at their lowest point. Figure III-12 provides an example of a typical natural stream hydrograph, showing higher peak flows associated with spring runoff, and low summer flows corresponding with the driest portion of the year. During drought conditions, such as those currently experienced in the Colorado River Basin, diversions may result in a completely dry stream channel unless water is required to be maintained in channel to meet the needs of senior, downstream appropriators.

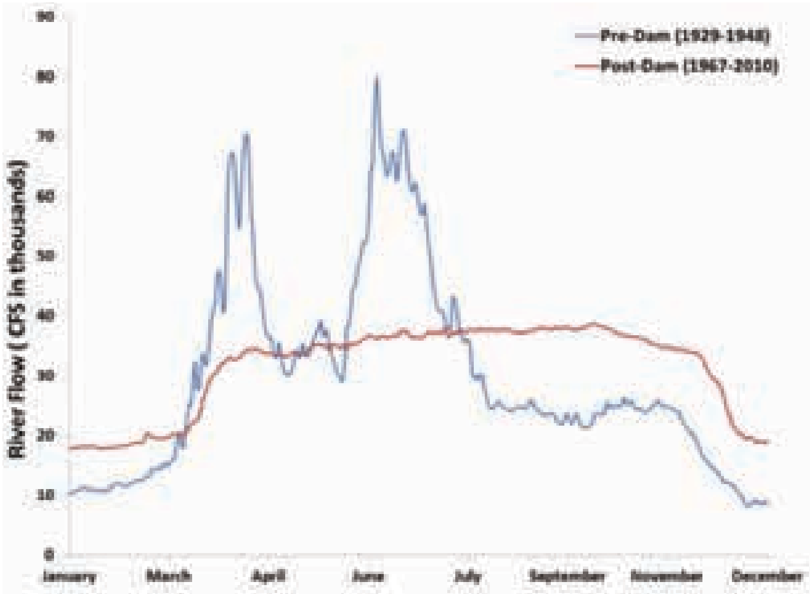


Figure III-13. Altered Stream Hydrograph. Hydrograph of the Missouri River hydrograph pre- and post-dam construction, showing effects of dam operations on the timing and volume of natural stream flows. Source: NRDC (2014).

Dam operations, by contrast, may reduce or completely eliminate natural flooding and variations in streamflow by capturing flood flows and releasing water at a more predictable rate over the course of the year, while creating substantially reduced water temperatures below the dam (Figure III-13). Hydropower operations, particularly where dams are used to meet peaking demand, may also create significant variations in flow on a daily basis, given how water releases will track variations in electrical demand over the course of the day or the week (Figure III-14).

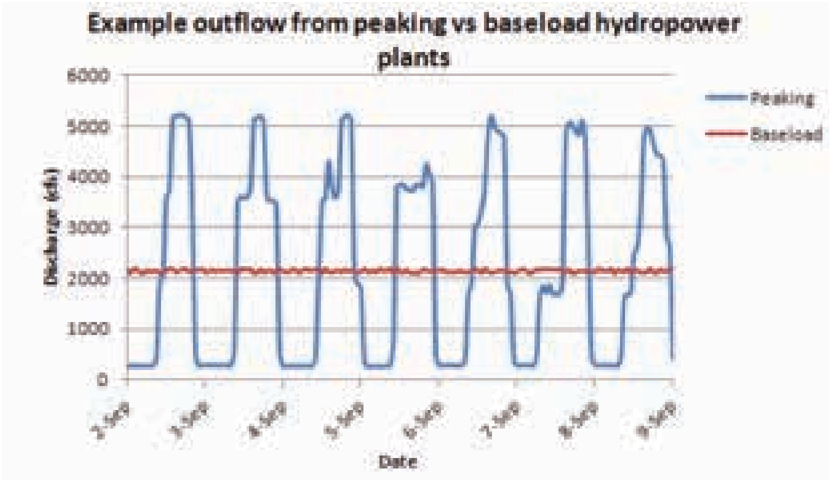


Figure III-14. Daily Hydrograph Downstream of Hydropower Dam. Hydrograph showing character of dam discharges when hydropower dam is engaged in peaking power production versus baseload production. Source: Oregon State University (2014).

in unfavorable changes in flow levels, flow timing, and stream temperatures. Waters that were once flood-prone, relatively warm, and sediment rich become steady, cold releases from dams that trap sediment behind them that once flowed down river. The lack of sediment can prevent the natural formation of sandbars, riffles, and backwater habitats critical to many species. These poor streamflow conditions inhibit recruitment of native fish, can create conditions that favor the success of nonnative aquatic species that favor colder water temperatures or different spawning habitat, or can even cause outright loss of fish populations in particular stream reaches. Variable streamflow conditions may also cause the loss of riparian vegetation or significant long-term changes to riparian areas, including the spread of undesirable invasive species, such as the tamarisk tree.[9]

In extreme cases, heavy diversions from particular watersheds to support agricultural and municipal expansion, together with widespread groundwater overexploitation, has led to the complete drying up of many perennial rivers and streams that once emptied into the Colorado River. The Gila River, for example, was once one of the Colorado's largest tributaries. That river, which extends across 600 miles of New Mexico and Central Arizona to drain into the Colorado River, now only flows intermittently in most stretches, and no longer connects to the Colorado River.[10] Diversion of surface flows and groundwater pumping near the river to support irrigated agriculture in Arizona has reduced the Gila River to a fraction of its former flows. The same is true of Arizona's Salt and Verde River watersheds, which drain into the Gila, where upstream diversions for irrigation and municipal/residential use have severely curtailed flows, leaving little water remaining to support wildlife habitat and aquatic ecosystems.[11]

These issues have arisen not only as a consequence of the diversion and overuse of water within the Colorado River Basin, but also because environmental values were largely omitted from consideration when water supplies were initially developed in the Basin. At the time that fundamental water allocation and management frameworks were developed, the environment was not recognized as a legitimate, beneficial use qualifying under doctrines of prior appropriation in the West. Given the widespread lack of water rights to support ecological values, there have been few legal means to prevent the degradation and de-watering of western streams over the past century. As discussed in Section III(A), in the Colorado River Basin, the combination of historic legal overallocation; urban population growth; increased demand for water for agricultural and industrial use; a tightly controlled system of dams, diversions, and canals; and recent declines in watershed yields throughout the Basin have ensured that there is little to no water left to support environmental values.

At the time that fundamental water allocation and management frameworks were developed, the environment was not recognized as a legitimate, beneficial use qualifying under doctrines of prior appropriation in the West.

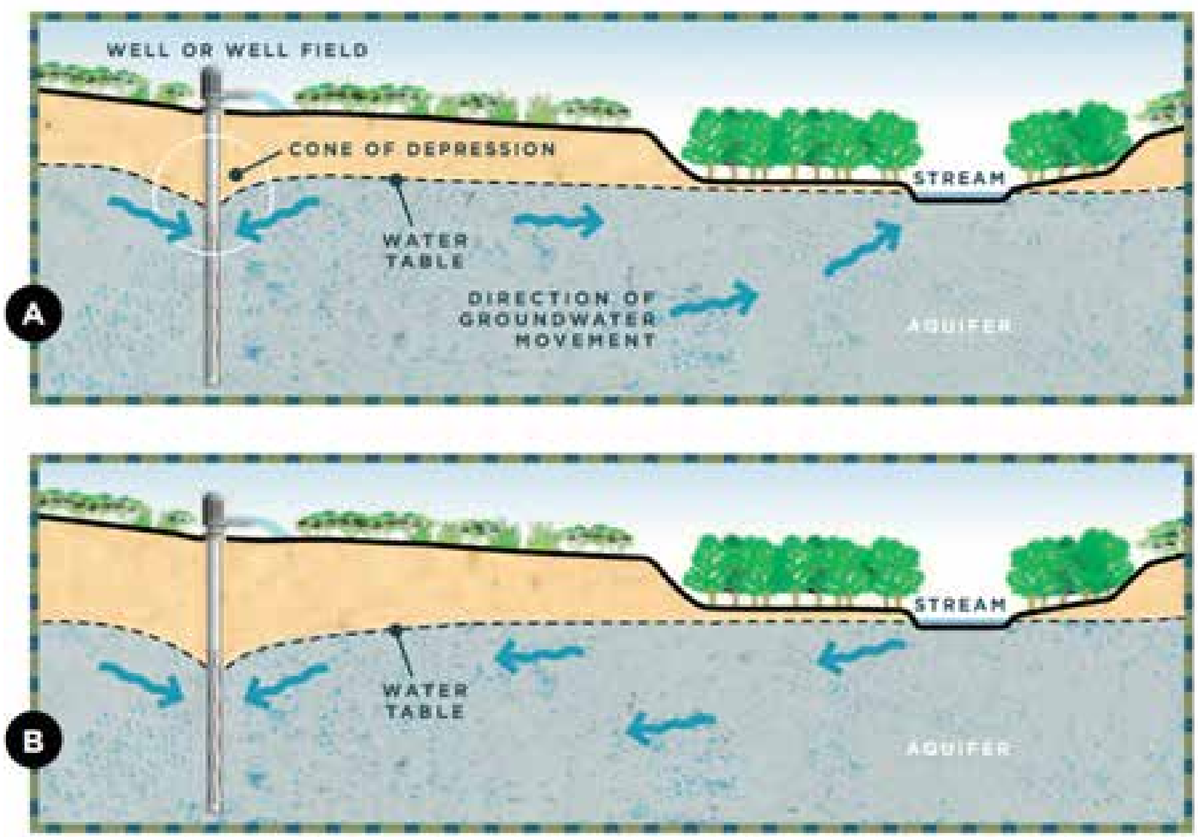
As a result, in most parts of the Colorado River Basin environmental values have little or no recognized "entitlement" to water. Where these entitlements do exist, they are typically associated with either (a) federal or state wildlife preserves, which may have individual water rights necessary to their operation, or (b) regulatory mandates derived from the Endangered Species Act, which may require that diversions and dam operations be undertaken in

9 Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment, December 2009.
10 "Celebrating Arizona Rivers: August 2012: The Gila River." River of the Month Series by EDF, Sierra Club, Grand Canyon Trust, Sonoran Institute, and Western Resource Advocates.
11 Ibid.

particular ways to avoid impacts to endangered species. However, these flow mandates rarely extend beyond the bare minimum necessary for a particular species of interest, and are typically insufficient to protect a broader range of environmental and/or recreational values that may be associated with flows in that particular reach.

2. Groundwater Depletion

Flows to support river ecosystems are also decreased by groundwater-surface water interactions, which are not always well accounted for in the legal frameworks surrounding water rights. Essentially, even where a surface water diversion is not occurring directly, the pumping of groundwater in the vicinity of a surface stream can reduce streamflows (either immediately or on a cumulative basis over time) in a manner similar to an outright surface diversion. Groundwater withdrawals from wells result in the formation of a "cone of depression" in the underground aquifer; once formed, such a cone will capture water that would otherwise reach the surface stream (such as mountain-front recharge or recharge from local precipitation), thus depleting base flows for the river. In areas where groundwater pumping is widespread, regional cones of depression can form as a result of the accumulated impacts of numerous wells operating in a groundwater aquifer. Once a cone of depression intercepts a floodplain aquifer, it can also pull water directly from the surface stream, which directly reduces surface water flows. If this continues for long enough, it can result in an actual disconnection between the river and the groundwater table, transforming a perennial stream to an intermittent or ephemeral one (Figure III-15).



(continued on next page)

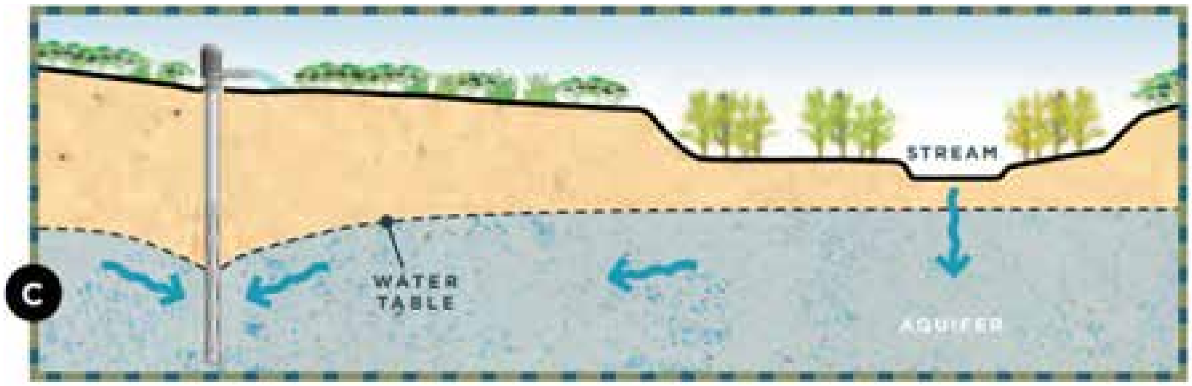


Figure III-15. Impacts of Groundwater Withdrawals on Surface Stream. The diagrams above provide a conceptual representation of the effect of near-stream groundwater pumping over time. With only modest groundwater pumping (A), the well's cone of depression captures only local groundwater, which reduces the amount of groundwater ultimately reaching the stream. With heavier pumping (B), the well's cone of depression intercepts the floodplain aquifer and begins pulling water away from the stream. The stream changes from a gaining stream to a losing stream. As pumping continues in excess of inflow from upgradient areas (C), the water table declines, disconnecting the stream from the aquifer and causing the stream to go dry. Source: Sustainable Water Management: Guidelines for Meeting the Needs of People and Nature in the Arid West, Sonoran Institute (2007).

While groundwater withdrawals do not always result in immediate impacts, they will eventually and inevitably do so unless efforts are undertaken to mitigate those impacts. Moreover, the impacts of groundwater withdrawals can also accumulate over time, creating a net deficit in an aquifer that can take decades, centuries, or even thousands of years to recover.

3. Water Quality Impacts

Water quality issues are another critical concern in the Colorado River Basin. A century of mineral exploitation in the West has led to significant heavy metal contamination due to leaching of tailings piles into the region's river systems. Agricultural activities have impaired many rivers with herbicide and pesticide runoff, as well as through irrigation practices that leach naturally occurring salts and other minerals into watercourses. The resulting high salt content in surface flows negatively impact aquatic wildlife and vegetation, as well as downstream crops and drinking water quality. Stormwater runoff from urban areas and other industrial activities has also contributed to the toxin loading of waterways.

Salinity impacts to water quality represent one of the most significant challenges in the Colorado River Basin. As the Colorado River system is used and reused by cities, agriculture, and industry on its journey downstream, its growing salinity generates critical impacts on water infrastructure, crop success, and drinking water quality, particularly at the "bottom" of the system. Throughout the Basin, salt is naturally leached out of soils as rainwater washes over rocks and minerals and flows into rivers; however, agricultural activity has vastly increased salinity loading, as agricultural drainage from irrigated crop lands also washes significant levels of salts into watersheds along the Colorado River. Even with extensive salinity controls in place, the River is estimated to transport some 9 million metric tons of dissolved salt downstream each year. By the time that the River reaches the Lower Basin, salinity levels in the River are 10 or more times higher than water in many of the Basin's headwater reaches.[12] The Bureau of Reclamation estimates the cost of damages resulting from high salinity levels in river water at approximately $500 to $750 million per year.[13] Salinity levels at the bottom of the system also represent a substantial ecological challenge, as return flows from agriculture drive salinity to levels that exceed the tolerance of native species, damaging riparian habitat. In fully or partially closed wetland systems like California's Salton Sea and Mexico's Cienega de Santa Clara wetland, salinity can ultimately reach levels higher than that of the ocean, rendering wetland areas incapable of supporting life.

4. Landscape Transformation

A combination of factors resulting from unsustainable land use controls—grazing, farming, and forestry practices; the introduction and spread of invasive species; and early impacts from changing climate—has led to the deterioration of landscape health throughout the Basin. These changes in the landscape also have significant implications for water availability in the Colorado River.

As discussed in detail in Section V(A)(1) below, the interactions between climate change, land use management decisions, and river health are particularly pronounced in forested headwaters regions, where the history of fire suppression, combined with prolonged drought and expansion of pine bark beetle infestations, has dramatically increased the risk of catastrophic wildfire. Decades of fire suppression in the West, where forests are adapted to a regime of periodic fire, together with many decades of logging of old-growth timber, have led to overgrowth of young, small-diameter trees, reducing watershed yields significantly over time when compared to the healthy, mature forests of the past. Overgrown forests, combined with severe, prolonged drought and an epidemic of pine beetle-killed trees, create heavily-stressed forest ecosystems that are particularly vulnerable to catastrophic wildfire. Wildfire, in turn, has created significant problems with erosion and sedimentation of water supplies, damaging water infrastructure and impacting water quality.

Even with extensive salinity controls in place, the River is estimated to transport some 9 million metric tons of dissolved salt downstream each year. By the time that the River reaches the Lower Basin, salinity levels in the River are 10 or more times higher than water in many of the Basin's headwater reaches.

Grassland ecosystems throughout the Basin are also facing significant alteration resulting from a legacy of unsustainable grazing practices, ongoing drought, encroachment of woody plants and shrubs (particularly in mesquite and pinyon-juniper dominated ecosystems), and the impact of invasive species. The majority of grasslands in the Colorado River Basin have been significantly degraded by a century or more of livestock overgrazing, which, when combined with drought conditions, has led to landscape-scale deterioration in many of the grasslands that served as important recharge areas for the Colorado River and its tributaries. As a consequence of natural fire suppression and overgrazing of grasses and forbs, many grassland ecosystems

12 U.S. Geological Survey, Salinization of the Upper Colorado River – Fingerprinting Geologic Salt Sources, Scientific Investigations Report No. 2009-5072.

13 USBR Colorado River Water Salinity Control Program, www.usbr.gov/projects/Project.jsp?proj_Name=Colorado+River+Basin+Salinity+Control+Project.

have increasingly become dominated by woody shrubs and small trees. Livestock tend to avoid these plants, and thus grazing pressure tends to accelerate their spread, with significant impacts to watershed health. Juniper-dominated rangelands, for example, have been shown to reduce streamflow in arid and semiarid landscapes. Similarly, the rapid spread of mesquite trees across previously healthy grasslands in the Lower Basin has had demonstrable impacts on groundwater tables and streamflows.

Figure III-16 Wind erosion on degraded rangeland during drought conditions, New Mexico. Photo courtesy USDA Natural Resources Conservation Service.

5. Invasive Species

Globally, it is estimated that nearly 80% of endangered species are threatened by competition or predation by introduced invasive species. In the Colorado River and its tributaries, this is a significant concern for native fish species, which are often outcompeted by nonnative fish, such as pike, bass, and catfish, many of which have been deliberately introduced into the Basin by state game and fish agencies. Other deliberately or accidentally introduced species, including aquatic animals, insects, various types of water plants, and others, have had a variety of other impacts on riparian and aquatic systems in the Basin that significantly alter the dynamics of its ecosystems. Many of these also have significant impacts on water management. For example, the quagga mussel, recently introduced into the Basin by watercraft that carried the mussel all the way from the Great Lakes, now results in millions of dollars of costs annually to clear clogged intakes, pipelines, and other water infrastructure.

Invasive species have had equally significant impacts on the Basin's landscapes. As noted above, grasslands in the headwaters of many of the Basin's main tributaries have also been dramatically transformed by the spread of invasive species, such as buffelgrass, cheatgrass, brome grass, and many others. Invasives can quickly outcompete native grasses, altering the fire regimes, soil conservation, drought tolerance of the system, and hydrologic function of grasslands.

Table III-3: Categorizing Potential Environmental Benefits from Water Investments

Category	Description
Watershed Health Improvement	There are a number of improvements that can be made in watershed health and function, including the following: • Increased watershed yield • Improved forest health • Improved grassland health • Improved soil health • Enhanced riparian habitat
Increase in Instream Flow	Increases in instream flow benefits may come from a variety of paths, including: • Increased flow volume/distance • Improved flow timing • Maintenance of minimum levels of flow during critical periods
Improved Groundwater Levels	Improved health and levels of groundwater aquifers can be achieved through: • Reduced groundwater pumping • Improved groundwater conditions (via recharge)
Water Quality Enhancement	Water quality enhancements can be created through a number of means – from watershed health improvements to improved infrastructure and treatment
Reduced Risk & Increased Flexibility	System risk reductions can take many forms, such as reduced environmental risk, reduced economic risks to water users, or preventing the need for future regulatory enforcement actions. This category also includes benefits from increased flexibility in the system. • Reduced regulatory risk • Reduced economic risk to agriculture • Reduced catastrophic/ecological risk • Improved market conditions
Reduced Pressure on Environment	This category captures those actions that reduce the pressure of human needs on the environment, and includes: • Reduced amounts of water diverted • Reduced risk of new diversions • Reduced pressure on environmental water supplies

From a water management perspective, however, perhaps the most pernicious invasive species problems are those associated with invasive riparian vegetation. As discussed in Section V(A)(2), tamarisk infestation is among the worst offenders, both damaging the riparian ecosystems of the Basin and significantly reducing watershed yields over time. As a result of altered flow regimes that have made it difficult for native species to reproduce, streamside habitats have become increasingly vulnerable to invasive species such as tamarisk—a vulnerability that is only growing in the face of climate change. In many river stretches throughout the West, tamarisk has outcompeted native riparian vegetation to form thick, brushy stands that capture significant volumes of water and alter soil chemistry to increase salts and alkalinity to levels that native species cannot tolerate.

6. Climate Change

There is accumulating evidence that the impacts of climate change can already be detected in the Colorado River Basin, with recent decades exhibiting significantly increased average temperatures; intensified drought conditions; changes in landscape-scale vegetation; and altered precipitation patterns, evaporation rates, and the timing of runoff from Basin headwaters. Changes in the timing and nature of precipitation, with increased winter precipitation falling as rain rather than snow in the high country, have led to problems with streamflow timing that affects aquatic habitats and riparian vegetation. The decrease in snowpack has led to less runoff during the spring and summer months, which has lowered streamflow during the hottest months of the year, when aquatic systems are most stressed. Low streamflow combined with intense groundwater pumping and surface water diversions has led to the loss of a large percentage of native fish and aquatic species in the Basin.

Perhaps the most significant risk that climate change risks pose for the Basin's ecological health and functionality relates to the "bottleneck" problem that can affect natural systems under periods of profound stress and disruption. An ecological bottleneck is a population crash (whether in terms of individual species, or whole species assemblages forming functional ecosystems) precipitated by a catastrophic event or events. Many in the scientific community regard climate change and human-driven conversion of landscapes as significant global bottleneck events. In such conditions, when ecological systems are unlikely to continue functioning in their historic capacities, the most fundamental economic and ecological priority is to ensure that core functions, habitats, and species survive a "bottleneck" event. If they do not, the changes to ecosystems and loss of species diversity that result may well prove to be irreversible.

7. Potential Environmental Benefits from Water Investments

The environmental challenges discussed above are essentially commonplace in watersheds throughout the West, where overallocation of surface flows and excess diversions from rivers and streams, groundwater depletion, and a variety of landscape-scale changes are creating fundamental threats to the critical ecosystem service values of watersheds, as well as to recreational, wildlife, and economic benefits associated with healthy, free-flowing river systems.

The water investments discussed in this report have the potential to address a variety of these complex environmental challenges, from ensuring thriving, ecologically-functional landscapes in river headwaters, to protecting adequate levels of in-stream flow, to the reduction in environmental pressure from agricultural and municipal diversions, to the restoration of degraded riparian habitat. For organizational purposes, these can be grouped into 6 primary categories of environmental benefit: watershed enhancement, improving instream flow, improved groundwater conditions, water quality enhancement, reducing water supply risk and increasing flexibility, and reducing environmental pressure. Table III-3 provides a breakdown of the various types of environmental outcomes that we have identified within these general categories.

Each of the proposed investments has the potential to affect a different set of environmental outcomes. As discussed in further detail in the blueprint descriptions in Section V, the ability of a particular investment to achieve an outcome will frequently depend on the specific contractual or other conditions imposed on the investment. In addition, the outcomes of specific investments may differ based on their relative location within the system; for example, investments in agricultural efficiency that transfer water for use further downstream will have different potential benefits for in-stream flows than a similar investment undertaken along an off-stream canal. Table III-4 (next page) provides a summary of the potential benefits that could be associated with each of the investment tools (and their variations) described in this report.

Table III-4: Potential Environmental Benefits from Water Investment Tools

Category of Environmental Benefit	Environmental Metric	Forest Health Treatments	Tamarisk Removal & Restoration	Regenerative Agriculture	Joint Venture Crop Conversion (Off-stream Use)	Joint Venture Crop Conversion (On-stream Use)	Commodity-Indexed Dry Year Option (Off-stream Use)	Commodity-Indexed Dry Year Option (On-stream Use)	System Loss Pay for Performance	Green Bond with Sustainability Conditions	Next Generation Water Trust – Investment-Friendly Trust Model	Next Generation Water Trust – Cooperative Trust Model	Reservoir Storage Trading	Underground Storage Trading
Watershed Health Improvement	Increased Watershed Yield	Increase	Increase	Maintain	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Improved Forest Health	Increase	Maintain	Maintain	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Improved Grassland Health	Maintain	Maintain	Increase	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Improved Soil Health	Increase	Maintain	Increase	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Enhanced Riparian Habitat	Maintain	Improve	Improve	N/A	N/A	N/A	N/A	N/A	Improve	Improve	Improve	N/A	N/A
Increase in Instream Flow	Increased Flow Volume/Distance	Increase	Increase	N/A	N/A	Increase	N/A	Increase	N/A	Increase	Increase	Increase	Increase	N/A
	Improved Flow Timing	N/A	N/A	N/A	N/A	Increase	N/A	N/A	N/A	Increase	Increase	Increase	N/A	N/A
	Maintain Minimum Flow Regime	Enhance	Enhance	Enhance	Maintain	Enhance	Maintain	Enhance	Maintain	Enhance	Enhance	Enhance	Enhance	Maintain
Improved Groundwater Levels	Reduced Groundwater Pumping	N/A	N/A	N/A	Reduce	N/A	Reduce	N/A	Reduce	Reduce	N/A	N/A	N/A	N/A
	Improved Groundwater Health (via recharge)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Improve	N/A	N/A	N/A	Improve
Water Quality Enhancements		Increase	Increase	Increase	N/A	N/A	N/A	N/A	N/A	Increase	Increase	Increase	N/A	N/A
Reduced Risk & Increased Flexibility	Reduced Regulatory Risk	N/A	N/A	N/A	N/A	N/A	Reduce	Reduce	N/A	Reduce	Reduce	Reduce	N/A	N/A
	Reduced Economic Risk to Agriculture	N/A	N/A	N/A	Reduce	Reduce	Reduce	Reduce	N/A	N/A	N/A	N/A	Reduce	N/A
	Reduced Catastrophic/ Ecological Risk	N/A	N/A	N/A	N/A	N/A	Reduce	Reduce	N/A	Reduce	Reduce	Reduce	Reduce	Reduce
	Improved Market Conditions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Improve	Improve	Improve
Reduced Pressure on Environment	Reduced Diversions	N/A	N/A	Reduce	Reduce	Reduce	Reduce	Reduce	Reduce	N/A	N/A	N/A	N/A	N/A
	Reduced Risk of New Diversions	N/A	N/A	N/A	Reduce	Reduce	Reduce	Reduce	Reduce	Reduce	N/A	N/A	N/A	N/A
	Reduced Pressure on Environmental Water Supplies	N/A	N/A	N/A	Reduce	Reduce	Reduce	Reduce	Reduce	Reduce	N/A	N/A	N/A	N/A

IV. Water Stress, Water Markets, and the Case for Impact Investment

IV. Water Stress, Water Markets, and the Case for Impact Investment

Taken together, the growing challenges facing human and environmental uses in the Colorado River Basin point to an increasing need for water uses to be adjusted more flexibly to serve changing conditions, values, and demands. In light of this fact, there is perhaps an even greater need for new institutions to emerge to increase flexibility and adaptive capacity in the system, help users adjust to changing conditions from year to year, and manage growing risks associated with deep levels of uncertainty in water supply. Understanding and developing successful strategies for the reallocation of water resources – where possible on a voluntary, compensated basis—and the management of growing water risk will be key to ensuring sustainable, long-term water resource management in the region.

This pressure has already led to a series of important policy developments over the past decade, including the adoption of the 2007 Interim Shortage Guidelines by the Basin States and the Bureau of Reclamation, the Minute 319 agreement between the U.S. and Mexico, and a number of "contingency planning" measures under discussion or implementation in the Upper and Lower Basins, such as the proposed Upper Basin Water Bank and the demonstration Colorado River System Conservation Program, discussed further in Section V(D) below. However, the recognition of the need for greater flexibility and adaptability has also led to a significant increase in interest among water managers, policymakers, and academics alike in the potential use of market mechanisms and natural infrastructure solutions to develop greater flexibility in water use, and to protect critical economic and ecosystem values at a variety of scales in the face of growing hydrologic variability.

Understanding and developing successful strategies for the reallocation of water resources and the management of growing water risk will be key to ensuring sustainable, long-term water resource management in the region.

A. Markets and Investing in Other Natural Resource Contexts

At a global scale, there is a growing interest in the use of market-based mechanisms to manage a variety of natural resource issues, and to ensure that the value of ecosystem services[1] to economies and societies are adequately captured in the marketplace. Traditionally, natural resources have been viewed primarily as a commodity or have been subject to open-access problems. Similarly, until relatively recently, most ecological functions had largely been taken for granted because nature seemed vast compared to the impact and footprint of human activities. However, as the role of natural resources in supporting economic prosperity is increasingly recognized, successful markets have been created around a variety of these resources and ecological processes.

Cap-and-trade structures were among the first natural resource management marketplaces to emerge in the United States, focusing on the control of air pollutants such as sulfur dioxide, NOx, SOx, and other pollutants implicated in acid rain and health

1 Ecosystem services consist of the range of biological and physical processes that support human health and well-being, including soil formation, water filtration and flood control, carbon sequestration, provision of food and fiber, the "genetic library" hosted in the biological diversity of species, and the recreational opportunities and aesthetic values provided by intact, functional ecosystems.

impacts. The implementation of the U.S. Environmental Protection Act's cap-and-trade program enforced with industrial sources for sulfur dioxide, for example, continues to stand as one of the most successful markets developed to control and reduce levels of air pollution.

Other markets for ecosystem functions have also been created under regulatory structures that require participation in a marketplace for compensatory mitigation purposes. These include mitigation markets under the Clean Water Act, where development activities that affect wetlands are required to offset those impacts through construction of replacement wetlands or purchase of credits for eligible wetlands mitigation banks. A similar structure exists under the Endangered Species Act, creating an emerging conservation banking market for endangered species habitat preservation. Other, newer markets, such as those developed for carbon offsets to reduce CO2 pollution implicated in climate change, are predominantly voluntary in nature (though states like California do have regulatory markets for carbon).

As the role of natural resources in supporting economic prosperity is increasingly recognized, successful markets have been created around a variety of natural resources and ecological processes.

Market tools incorporating catch limits and catch-shares in fisheries regulation provide another example of efforts to transform the unmanaged, open-commons, "frontier-style" exploitation of natural resources into a system of marketable rights that can be traded, leased, and otherwise controlled. The catch-share system relies on fisheries quotas and catch limits, which are often managed through ITQs (individual transferable quotas) and TURF (territorial user rights fisheries) structures that control access to a particular fish stock or to a given fishing ground. After decades of overfishing and crashing fish stocks, the system of catch limits and, more recently, tradeable catch-shares, that has been adopted has worked to transform the industry and incentivize stewardship.

Low-carbon fuel standards (LCFS) are another regulatory approach to market transformation, where rules are enacted to require oil refineries and fuel providers to ratchet down the carbon content of their fuels over time to meet requirements for lowering greenhouse gas emissions. Currently, California, British Columbia, and the European Union are the only jurisdictions that have adopted LCFS to reduce the carbon intensity of their vehicle emissions. As a top-down approach, LCFS are thus related to other regulatory driven structures that drive the establishment of a market designed to achieve a particular outcome for natural resource management.

Other market-type structures used to achieve environmental outcomes are the Clean Air Act's "bubble policy" and the concept of "netting" under EPA's new source review rules. The concept of bubbles was established as a means of regulating air emissions from a point source, such as a factory, that considers multiple emissions coming from the source as if they were a single aggregated whole. Under this regulatory structure, the point source can choose many different control methods, at various costs and effectiveness, to manage its emission efforts in a manner that can achieve control requirements for pollutants on an overall basis. While these tend to be neutral in overall environmental impacts (i.e. the industry can still pollute up to its legal limit), the strategy has resulted in significant flexibility and cost savings on control measures over the typical application of the

Clean Air Act to every pollutant discharged by every emitting unit at the source.

Netting allows an industry to avoid additional new source review or significant deterioration requirements that apply if a facility is expanding operations. It accomplishes this by allowing the source to offset any additional emissions associated with growth through the reduction of emissions in another area of the facility. This keeps the net emissions at or below their prior levels, but also allows significant flexibility in the approach to emissions reduction by the source itself. Netting and the bubble policy under the Clean Air Act are both programs that created a regulatory-driven framework to allow emissions trading to occur, at least internally within single facilities. They served as conceptual building blocks for a market where transfer of rights to pollute are allowed, and have led to the development of more complex trading systems to achieve clean-air goals, such as the cap-and-trade successes of sulfur dioxide and other harmful pollutants.

In the land use planning and open space conservation context, natural resource management goals have been advanced through the use of transferable development rights. A TDR program is typically established by a local government planning agency, with identified "sending" areas where development is restricted to achieve conservation goals. Landowners in the "sending" area are allowed to sell the development rights connected to their land, and then to transfer those rights to another parcel in a designated "receiving" area where higher levels of development density and intensity are allowed. However, a common implementation constraint to TDR programs is the reluctance of communities to allow higher intensities of development within their boundaries. As the programs also tend to be complex and expensive to administer, they often rely on significant government facilitation to effectively negotiate and carry out transactions.

Figure IV-1 Image courtesy National Oceanic and Atmosperic Administration.

A critical factor in the success of the majority of nontraditional natural resource markets involving essential ecosystem services has been the establishment of a regulatory environment that forces participation in the market. The markets for purely voluntary transactions in ecosystem services, such as those for carbon offsets, tend to be much smaller, less developed, and driven largely by value-based decision-making and philanthropic intent. However, even though many of these markets are relatively new and immature, they are proving to serve a vital role in encouraging recognition of the importance of natural values to the global economy, in experimenting with innovative approaches for measuring the value of those resources, and in establishing structures that enable greater market participation in their management and in promoting their sustainable use.

Unsurprisingly, as ecosystem services markets continue to expand and grow in sophistication and impact on a larger scale, commensurate interest has arisen in the development of "water markets" as a way to manage reallocation, address ecosystem services, and control risks to human and environmental water users in the context of water management. Consistent with this growing interest, much of the recent attention to water investment in the Colorado River Basin and the broader West has been focused on the need to promote the development of "water markets" that would allow water to be more readily traded between buyers and sellers—essentially, allowing water to be treated in a manner similar to other commodities.[2]

Unlike many natural resources, however, water is already heavily regulated and governed (or is deliberately unregulated and ungoverned) by a well-developed system of water rights and laws, environmental controls, and governance institutions. In addition, water is somewhat different from many other natural resources in both its essential character, its role in the economy, and its social and political significance, making the transfer of water between uses both practically, legally, and environmentally complex. As discussed further below, these differences will require potentially different approaches to thinking about water "markets," and more importantly, to the design of meaningful impact investments in water.

B. Trends in Water Investment in the Basin

Historically, much of the water development and water infrastructure of the West—including the vast network of dams, delivery canals, irrigation projects, and other projects—has been constructed with and subsidized by enormous investments of public resources, largely composed of federal and state tax dollars and low-interest government loans. For example, the Reclamation Act of 1902 began an era of massive federal public works projects for water storage, transfer, and irrigation to manage water in the West and established a vast federal fund to help finance the billions of dollars invested in those projects.[3]

Private investment, particularly in the form of traditional tax-exempt bond financing, has long played a central role in water management in the Basin.

Private investment, particularly in the form of traditional tax-exempt bond financing, has long played a central role in water management in the Basin. At the state level, the California State Water Project, effectively the single largest state-built and financed water infrastructure project in the nation, was largely paid for by large-scale bonding measures repaid by project beneficiaries, with remaining costs

2 Peter W. Culp, Robert J. Glennon, and Gary Libecap, Shopping for Water: How the Market Can Mitigate Water Shortages in the American West, Hamilton Project (2014).

3. "Water in the West", Bureau of Reclamation Historic Dams, Irrigation Projects, and Powerplants, www.nps.gov/nr/travel/ReclamationDamsIrrigationProjectsAndPowerplants/Water_In_The_West.html.

covered through California state general fund appropriations and federal funding for flood control.[4] The vast majority of municipal water delivery systems and many other water infrastructure projects have similarly been built via bond financing. Municipal bonds to underwrite water projects are anticipated to be used by utilities to meet infrastructure needs in more than 70% of the nation's cities.

However, the potential role for private capital in meeting these needs is growing as federal and state funding sources for water-related infrastructure and other needs have been steadily declining since the 1980s.[5] At least in the current political environment, less and less federal money has been available for financing the large-scale infrastructure projects that have characterized water development in the past. At the same time, legislative appropriations to support the agencies responsible for managing water supplies are at an all-time low in many areas, contracting the scope of government activities and capacity to support water resource management. This issue is particularly acute at the state level throughout the Intermountain West, where strong antigovernment sentiment has driven some state legislatures to engage in a long-term campaign to cut taxes and reduce expenditures—even where that jeopardizes resources necessary for sustainable economic growth.

In this respect, although the physical scarcity of water will clearly be a defining element of the future of economic development and ecosystem protection in the Colorado River Basin, the most pressing issue in many cases will not necessarily relate to the unavailability of water resources, but rather how to pay for the infrastructure, water rights, and institutions needed to manage and distribute scarce supplies more sustainably. Addressing this issue will likely require new, more creative approaches to private financing to supplement traditional bond financing approaches.

In some areas of the Basin—particularly the Basin's large urban centers in Los Angeles, Denver, Phoenix, and Las Vegas, which have historically had relatively robust economic growth and strong municipal balance sheets—it will continue to be possible to finance water and water infrastructure needs through more traditional means. However, it is important to note that in many parts of the West, the most significant water resource problems are developing in areas with the least ability to pay for water supply and infrastructure needs. Rapid growth has left many small and medium-size urban areas and developing rural areas facing significant accumulated infrastructure deficits, significant debt loads or marginal tax bases that may impair access to traditional bond financing, and rapidly aging infrastructure. These conditions are frequently set within a political context which makes it difficult for city governments to raise tax or rate revenues. Farming communities have also become increasingly marginal when it comes to water security; the development of agriculture in most parts of the Basin was enabled by significant state and federal public works, but with these sources of funding increasingly constrained, agricultural communities must cope with less and less support to finance the rehabilitation or improvement of infrastructure and the deployment of new management techniques. To date, relatively few examples have arisen of direct private investments to help finance water solutions in these environments.

Direct private investment in the development of water resources to support and serve changing

4 California State Water Project Overview, California Department of Water Resources, www.water.ca.gov/swp/index.cfm, 2015.
5 Corps of Engineers Water Resources Infrastructure: Deterioration, Investment or Divestment? 2012. USACE, Committee of US Army Corps of Engineers Water Resources, Science, Engineering, and Planning.

demands has also been limited. At least in part, this reflects the relatively inhospitable environment for the trading of water in the western United States. As noted in Section III above, both the Law of the River and the state-level regimes for surface water and groundwater management create significant barriers to water trade. While limited "water markets" have developed in a few areas of the West and the Colorado River Basin, in most areas, aside from a few isolated transactions, very little active water trading takes place. Outside of a few local markets in water, water transactions frequently face significant legal and political obstacles, as well as a "water culture" that opposes treatment of water as a "commodity." All of this has tended to discourage private investment in water resources.

In many parts of the West, the most significant water resource problems are developing in areas with the least ability to pay for water supply and infrastructure needs

Where private investment has occurred, to date, it is fair to conclude that the record of direct water investing in the West has been at best mixed. Significant investments in water—particularly in the form of investments in agricultural lands with associated water rights—have certainly taken place, and a significant number of investment entities are presently engaged in the purchase and management of agricultural lands with the expectation of repurposing the associated water rights for future urban or other higher-value uses. The growing and ever-more-publicized disparities between supply and demand and the significant disconnects in water pricing between agricultural and urban users have also led to increasing interest in water resources among the investment community, attracting everyone from T. Boone Pickens to Merrill Lynch in the search for opportunities to profit from meeting the demand created by growth and increasing water scarcity.

The experience of many investors suggests that the most successful investments in agricultural land and water in recent years have generally been built on strategies that provide an acceptable near-term IRR based on returns from agricultural production, with a potential upside associated with repurposing water and realizing the increased value of water resource assets associated with those lands over the longer term. A basic (and readily defensible) thesis of these investments is that the growing

Figure IV-2 Colorado River Aqueduct headworks at Lake Havasu, diverting water from the Colorado River to the Metropolitan Water District of Southern California. Photo credit: Peter W. Culp and ever-more-publicized disparities and disconnects in water pricing between historic agricultural users and growing, recent urban users (which in some places has urban users paying hundred or even thousands of times more money for water) will inevitably drive transactions to occur in spite of current legal or practical obstacles. However, it is also important to recognize that many of these types of investments have failed in the face of unrealistic expectations around investment return, the time and costs associated with meeting regulatory requirements, and/or the failure to appreciate the political, legal, and cultural nuances and sensitivities surrounding water resource management.

In addition, it is important to recognize that many of these successful investments have been in the form of relatively straightforward buy-low, sell-high transactions in which investors have inserted themselves as a bridge—or in other cases, just as intermediaries—between a historic agricultural user and a future urban buyer. While these types of investments may well provide opportunities for investment returns, their actual value as a water management tool and associated public benefit is often murky. At best, they provide a vehicle to drive transfers from agricultural to urban use to address existing and projected supply/demand imbalance in the urban sector; however, this addresses only a narrow band of growing issues, and may create associated environmental problems. Challenges associated with the long-term sustainability of agricultural communities, the financing of needed water supply and water infrastructure in growth communities, the numerous environmental challenges facing Basin users as a result of altered stream flows, groundwater depletion, and declining landscape health, and other critical needs are unlikely to be addressed through these investments, and may actually be worsened by them. At present, few examples exist of private-sector approaches to these broader issues in the Basin.[6]

C. Directions for Water Investment

The challenge of securing the next generation of water investment will thus be to design tools that are capable of attracting private investment at appropriate scale and generate reasonable investment returns, while accomplishing broader public, environmental, and systemic goals. These tools will need to accomplish more than simple reallocation of water resources from low-to-high value uses – they will need to contribute to the management of growing systemic risk across sectors in the Basin, and they will also need to reflect a different kind of thinking about the management of water. As noted above, like many western water management systems, the Colorado River system has long been dominated by centrally-managed water infrastructure planned around a "stationarity" principle,[7] with water management based on rigid, priority-driven allocations, and risk management (where risks are managed) largely through centralized, publicly-funded infrastructure such as storage dams, canals, and other infrastructure. However, this system is proving to be relatively slow-moving and fragile in the face of a hydrology that departs from historical experience.

6 The blueprints in Section V of this report provide some existing examples of successful (and less successful) private sector approaches to these broader issues.

7 "Stationarity" has been defined in the journal Science as "the idea that natural systems fluctuate within an unchanging envelope of variability." This concept has largely been disproved as the impacts of climate change have become more pronounced, and water management experts have recognized that past conditions can no longer be a reasonable predictor of the future. As noted in a 2009 article by Robin Kundis Craig titled "'Stationarity Is Dead' – Long Live Transformation: Five Principles for Climate Change Adaptation Law," most water management expertise now acknowledge that "'stationarity 'can no longer serve as a central, default assumption in water resource risk assessment and planning.'"

Finding meaningful financing solutions to address environmental issues in the Basin will be equally difficult, and just as critical. As discussed in Section III(E) above, the Basin faces a bevy of significant and growing environmental issues in connection with water management due to historic overallocation and exploitation, groundwater declines, altered streamflows, and invasive species. In this regard, it is important to note that the environmental benefits of private sector water investments—even in environments where more robust water markets exist—have been equally mixed. Simple reallocation of water rights from lower- to higher-value uses may indeed create environmental benefits—for example, if water is transferred from upstream to downstream use (boosting in-stream flow along the way). Similarly, transactions that help to rationalize water pricing may help to encourage water conservation, reducing overall human demands on watersheds. However, these types of transactions are equally likely to create environmental harms—through inter-Basin transfers that reduce water in-stream, transfers from downstream to upstream uses, and the loss of return flows and waste flows that presently sustain environmental values associated with current agricultural uses.

The challenge of securing the next generation of water investment will be to design tools that are capable of attracting private investment at appropriate scale and generate reasonable investment returns,while accomplishing broader public, environmental, and systemic goals.

The Colorado River Basin faces a bevy of significant and growing environmental issues in connection with water management due to historic overallocation and exploitation, groundwater declines, altered streamflows, and invasive species.

Transactions in water have given life to at least one new important environmental institution in the West: the water trust. At present, most existing western water trusts focus on the acquisition of water rights and/or leasing of water to maintain or enhance in-stream flows for the benefit of environmental resources. In keeping with this purpose, they have tended to rely heavily on a combination of philanthropic support and government-sponsored funding streams for their operations. The latter are typically associated with existing regulatory programs, such as the Endangered Species Act, that require dedication of flows to the environment in connection with public or private mitigation obligations. Yet, in the absence of regulatory drivers that require expenditures on mitigation, and thus participation in that market, it has generally proved difficult to secure large-scale government or charitable funding for market-based approaches to securing environmental benefits. Similarly, even where they have been successfully deployed, these solutions generally address only a narrow band of environmental needs—maintaining in-stream flow—while leaving the broader range of environmental challenges to be addressed through traditional public and charitable funding approaches.

It is notable that, consistent with the original stationarity principle that dominated the design of Western water institutions, the Basin's water problems frequently tend to be framed as a problem of simple allocation—typically as a supply/demand imbalance "gap." This perspective has led to a focus on market transactions to allow reallocation over time, since markets are good at resolving such imbalances. Still, it is important to note that in many cases this approach is also based on a vital, unstated underlying assumption, which is that if these transactions can occur, it will then somehow move the system into a new, more sustainable "static" state.

As discussed in Section III, however, emerging impacts from climate change, landscape change, and the like are creating conditions in which the Basin's natural systems can be expected to behave in ever-more-unpredictable ways. The destabilizing effects of changing precipitation patterns, landscape changes in vegetation, dust on snow (leading to earlier snowmelt and sublimation, where snowpack skips the liquid phase entirely and the water vaporizes directly into the atmosphere), and increasing temperatures are creating ever-increasing risks of significant, even catastrophic, physical water shortages in systems with already low levels of practical elasticity.

In keeping with the pervasive "stationarity principle," there has also been a tendency for water managers, and in many cases environmental advocates, to think about environmental problems and solutions as "static" in nature. It is important to note that most of the environmental laws that drive mandates designed to mitigate environmental harms were set up to defend a presumed status quo in natural systems—essentially, trying to preserve (or restore) a natural ecosystem and its associated species as it exists today, or as it existed in the past. However, efforts to return disrupted ecosystems to a former state are unlikely to succeed under conditions of climate change as the ecosystems that our laws and conservation efforts are designed to preserve are effectively shifting out from under us.

In this context, the widespread focus on simple reallocation of water between users is missing both a fundamental, emerging threat to water managers and the environment, and a key opportunity for investment. Market mechanisms and investment-driven transactions can obviously provide a tool for reallocation of scarce resources, particularly as these needs outstrip the capacity of traditional public and philanthropic resources to address. However, larger scale, systemic risks are also threatening to create "bottleneck" problems that could potentially overwhelm individual efforts to control water risk, and produce catastrophic results for both economic and ecosystem values. Private investment and the broader deployment of market-based approaches could also play a key role in the management of these challenges.

In other contexts, market tools have also been used to develop sophisticated risk management and distribution strategies, such as hedging, insurance, and the creative use of options. Given the importance of risk management in the future of the Basin, adapting and modifying these types of risk management tools to address water management and ecosystem risks represents both a key need and a significant investment opportunity. Positioning investments in water in a manner that supports, rather than exacerbates, the management of uncertainty in the system may be equally critical to limiting the risks to water investments generally. Several of the proposed risk management tools that will be discussed in this report are specifically targeted at reducing particular types of economic, hydrologic, and/or ecosystem risks.

Because of the close interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk could also provide an important opportunity to integrate economic and ecosystem values.

Perhaps most critically, because of the close interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk could also provide an important opportunity to integrate economic and ecosystem values. Long-term, sustainable solutions that will assist in addressing systemic risks can and should be cross-cutting, and will need to function at an increasingly large scale in order to address the magnitude of the challenges. Given the interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk in the face of unprecedented and unpredictable changes will need to treat these problems together, unlike many of the existing legal systems for water allocation, such as the prior appropriation doctrine, which either ignored environmental values in the process of legal allocation or managed them primarily through after-the-fact regulatory constraints. This opportunity is illustrated clearly by fisheries management strategies, which in many cases have managed to align economic drivers with both ecosystem needs and respect for the limitations of those ecosystems, thereby creating substantial economic and ecosystem benefits through the same mechanism.

The impact of particular investment strategies on the management of system risks can thus be an important filter on proposed solutions for maintaining ecosystem health and productivity, as well as a tool for recognizing and responding to the critical interface between water and other market and nonmarket institutions. By addressing risk in water management and priorities for human use, while at the same time addressing the risks to continued provision of important ecosystem services by natural systems and more robustly integrating economic and ecological systems, investors can gain a powerful tool to transform markets in a manner that will ensure long-term returns as well as attain sustainability goals for both human society and the natural world.

Figure IV-3 “Bathtub ring” resulting from lowered water levels at Lake Mead. Image courtesy of U.S. Bureau of Reclamation.

D. Thinking Beyond "Water Markets"

As noted above, interest is growing in the concept of developing "water markets" as a way to manage reallocation, address ecosystem services, and control risks to human and environmental water users in the context of water management (similar to the market structures that have been developed in fisheries, pollution, and other natural resource contexts). At the outset, it should be noted that the term "water market" has come to stand for a broad variety of activities that do not seem to clearly fit within any single definition. In economic terms, a "market" is generally understood to be a structure, institution, or physical or nominal "medium" where buyers and sellers can regularly connect to exchange goods, services, or information for money or barter. In this sense, a "water market" can likely best be understood as a set of practical conditions, legal rules, and associated institutions that allow the owners or beneficiaries of water rights and uses to buy, sell, trade, or exchange them within a particular hydrologic system or associated system of water infrastructure.

Interest is growing in the concept of developing "water markets" as a way to manage reallocation, address ecosystem services, and control risks to human and environmental water users.

At the most basic level, for a market to function, willing buyers and sellers must exist and be able to interact with each other to facilitate the trade in the resources, goods, or services in question. Markets also require the establishment of physical, economic, or legal conditions and incentives to allow and drive transfers to occur, and are fundamentally premised on practical conditions and rules that establish terms for transactions. As discussed further in Section II, above, all seven of the Colorado River Basin states provide for legal mechanisms by which water can, at least theoretically, be moved from one use to another within a particular hydrologic system. However, many water transactions, even in areas where the conditions for water transactions are better developed and more mature, face significant legal, political, and regulatory hurdles, including historic water rights laws that create uncertainty in the nature of property ownership in water (i.e. unadjudicated, uncertain rights and forfeiture rules), and third-party impacts doctrines that limit transferability. Taken together with the legal character of the "water rights" that govern the ownership and control of water in western watersheds, these barriers tend to impair one or more of the essential characteristics of property rights necessary for market transactions, as well as many other identified "enabling conditions" for market function.

In this sense, most western states already have a "water market"—albeit, as discussed below, one that is highly illiquid and that erects substantial barriers to, or expressly prohibits, many types of transactions as a result of a series of physical, political, and legal barriers to water trade. It is also critical to recognize that water transactions that propose to make changes in historic uses also almost inevitably confront a broad water culture in the West that has been built around access to water via subsidized, large-scale public water infrastructure, and that regards current and future access to local water supplies as a "birthright" that is essential to future economic prosperity. This culture tends to exhibit a pervasive hostility toward entities (particularly outsiders) that are engaged in "speculation" and could threaten future access to resources. As a result, water trade in the Basin has generally tended to favor transactions involving large, politically powerful, and generally public entities. In this mode, over the past decade or more, a fairly large number of market-style "transactions" involving water have occurred between agricultural, municipal, and industrial water users.

For example, California's 2003 Quantification Settlement Agreement involved several large-scale water transfers between agricultural and urban users, as well as substantial investments in infrastructure to generate transferable conserved water. Similarly, the substantial Indian water rights settlements authorized via the Arizona Water Settlements Act involved numerous exchanges, trades, and water lease authorizations among various water users and Arizona Native American tribes. However, aside from these larger-scale transactions and a handful of robust "water markets" that have developed in a few localized areas, very little active water trading is now occurring in the Colorado River Basin among most water users, even in the face of highly varied supply and demand conditions and significant disconnects in pricing.

This does not mean, however, that market forces are not acting on water rights and pricing; indeed, many current water issues relate to the interface of water institutions (and the various policies, pricing, and subsidies that are built into those institutions) with broader national and global markets. For example, U.S. trade policy and associated trade deficits have created conditions that are leading to the increasingly large-scale "export of water" in the form of water-intensive crops, such as alfalfa, to Japan, Saudi Arabia, China, and other countries to support their growing dairy industries.[8] In irrigation districts with priority rights and subsidized infrastructure supplying water, and with trade policies in place promoting the transfer of agricultural production in exchange for other goods, such water-intensive crop production of forage to supply foreign cattle production can be viable—even in the face of water shortages that may result in billions of dollars of damage to local and regional municipal providers and their economies.

Similar perverse outcomes and incentives resulting from interactions with broader market forces can be found throughout western water management. These include: subsidies and property tax rules that drive the continuation of economically marginal lands in farming; perverse pricing and regulatory incentives that promote development of ex-urban, water-intensive sprawl over relatively water-efficient urban infill; and open-access policies that promote the growth of unsustainable groundwater pumping to support residential and industrial development, undermining billions of dollars in public and private investment in surface water rights. Establishing water markets could help to mitigate these issues by rationalizing water pricing and associated economics to promote better water management outcomes.

Given the current barriers to market function, a great deal of recent literature related to water investment has focused on the need for policy reforms, incentives, and other "enabling conditions" that would facilitate broader water investment by creating more market-style conditions for water trade. For example, NatureVest and The Nature Conservancy have both developed well-researched sets of "enabling conditions" to allow for successful market-based investments. These enabling conditions focus on the need for water resources to be assigned a definable and measurable value, with a transparent record of transactions, low cost of operations, scalability, and defined growth drivers.

To provide for these conditions, NatureVest argues that a series of regulatory and practical elements must be present. For water to have a definable market value, for example, it requires a transparent price that can be measurable, at least where the resource can be separated or "unbundled" from land and other assets. Regulations governing those water resources, regardless of whether they be surface water or groundwater, must be aligned and stable, such that expectations for participating in a market can reasonably be realized. There must be a system of tracking transactions shifting water from user to user that is transparent and that provides a historical data record that can inform future transfers between market participants. Further, to best achieve long-term resource management goals, there must also be a strong link between environmental values and resource capacity and pricing. To ensure reasonable costs of operation of the market, a reliable, standardized system regulating water transactions that is structured in a manner to capture economies of scale must be established. Lastly, for a market to be created and grow, there must be certain drivers acting that will prompt a tangible need for transfer transactions to achieve efficiency in use—such as prolonged drought and shortage risks, rapid urban growth and demand outstripping available supplies, and other factors leading to demand/supply imbalances.

It is important to recognize that the elimination of barriers to water trade, by itself, will not necessarily improve environmental, economic, or systemic outcomes.

Based on these and other proposals to improve the tradability of water resources, trading opportunities are gradually broadening in the Basin. Some states, for example, now expressly permit short- or long-term leasing of water rights. In other states, forbearance or dry-year option agreements (where one user agrees to temporarily forbear use for the benefit of another), creative sever-and-transfer arrangements or changes in points of diversion, the construction and operation of shared infrastructure within districts, or local or regional water settlements may provide substitute means to accomplish similar outcomes. Water banks and trusts can provide increased flexibility and allow for the protection of instream flows; land use controls, interjurisdictional agreements, and settlements can help to provide basic controls needed to facilitate transactions. Even on the heavily-controlled mainstem of the Colorado River, recent agreements among the Basin states now permit some limited mechanisms for interstate storage and release of water among Lower Basin states, as well as the storage and transfer of conserved water among water users in individual states; a recent agreement, known as Minute 319, has even authorized a first-ever "water exchange" between U.S. and Mexican water users, based on investments in water conservation in the Mexicali Valley.

However, it is important to recognize that the elimination of barriers to water trade, by itself, will not necessarily improve environmental, economic, or systemic outcomes. Some economists treat markets as a "natural" phenomenon that result from human economic activity, which, in its most unfettered form, is a "free market." In practice, however, this ignores the basic fact that markets are fundamentally premised on a set of practical conditions and/or legal rules that establish the terms and conditions under which transactions can take place. Traditional markets have historically focused around commodities that could be easily identified, defined, and therefore traded among willing buyers and sellers. In this sense, a "water market" refers to the definition laid out above—a set of practical conditions, legal rules, and associated institutions that allow the owners or beneficiaries of water rights and

8 Peter Culp and Robert Glennon, "Parched in the West but Shipping Water to China, Bale by Bale," Wall Street Journal. October 5, 2012.

uses to buy, sell, trade, and exchange them within a particular hydrologic system or associated system of water infrastructure. Given this fact, however, it is critical to recognize that the character of the rules that govern a "water market"—and whom and what they favor—tends to strongly influence both the potential for and the larger physical, environmental, and hydrologic outcomes that can be associated with market transactions.

We suggest that the present lack of ready transferability of water market structures actually represents a potentially important opportunity to advance the interests of ecosystem protection and other public values through structured investments

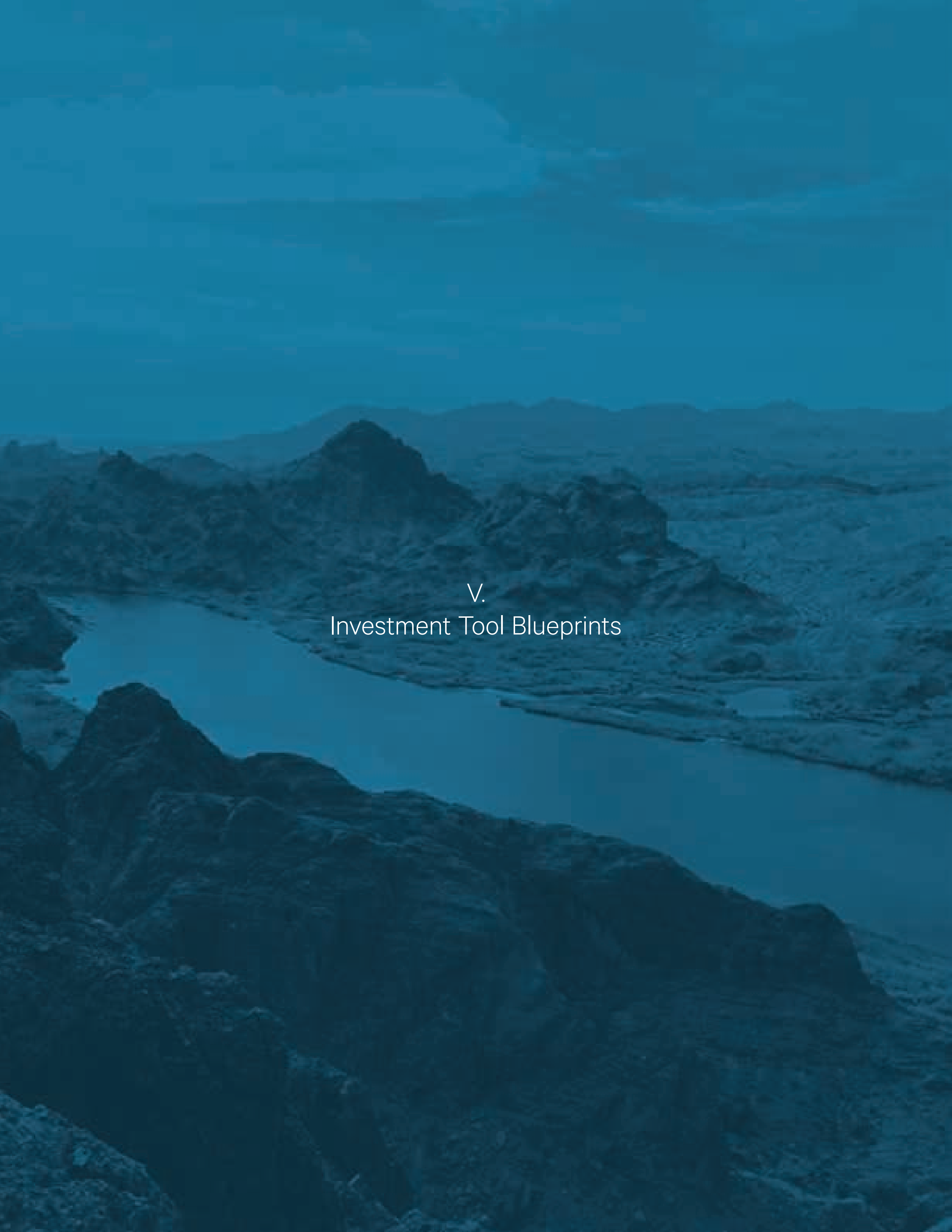
Regardless, given the legal character of most types of "water rights" in the Basin and the complex laws and regulations that govern the ownership and control of water across states and water management districts, relatively complete market "enabling conditions" are actually present in only a few areas within the Colorado River Basin. Under the logic of the prevailing literature on water markets, this might suggest that substantial reforms would need to precede significant investment in water resources. Indeed, in most cases, creating relatively robust water markets via large-scale reform is likely to take decades and would necessarily involve major, controversial policy reforms involving a broad range of opposed interests. However, while the advancement of policy reform to address market barriers is doubtless an important long-term priority, this focus on the lack of enabling conditions also tends to distract from the many opportunities for private capital to aid water resource management in the absence of readily recognizable "market" environments.

While the advancement of policy reforms to address market barriers is doubtless an important long-term priority, a focus on the lack of enabling conditions tends to distract from the many opportunities for private capital to aid water resource management in the absence of readily recognizable "market" environments.

Given the uncertainty attendant to what future water markets will look like, we suggest that the present lack of ready transferability of water market structures actually represents a potentially important opportunity to advance the interests of ecosystem protection and other public values through structured investments. Simply enabling water transfers via ready-made water markets will by no means guarantee environmentally beneficial outcomes from investment, particularly given the potential costs of addressing environmental needs and the lack of public funding to meet those needs, the lack of political and economic leverage among environmental interests, and a tendency for major reforms to be driven by urgent crisis conditions that may lead to less-than-environmentally-optimal allocations of resources. Put simply, there is no need to have the conditions in place for the full and ready transferability of water resources in order to develop investable structures that can facilitate water transactions and generate ecosystem benefits.

As discussed in regard to each of the investment tools described in Section V, there are a range of potential workarounds to the absence of market-enabling conditions that can be employed—at least in the context of the impact-oriented investments described in this report—to permit investments to occur and, where necessary, enable some level of water "trade." In fact, in the context of a highly restricted "market," impact investments appear more likely to succeed than strict arm's-length investment transactions in facilitating water transactions, since they by their very nature provide the potential for broader public benefits that can justify needed regulatory relief and/or more readily satisfy regulatory requirements related to environmental protection, avoidance of unacceptable economic and third-party impacts, and other considerations.

One consequence of the absence of a ready market, however, is that the deployment of these tools will in most cases require additional investigation on the ground to identify appropriate and high-value opportunities, assess the unique economic, user, and environmental risks associated with those opportunities, and evaluate specific "customer" interests that could be addressed transactionally. As such, and as discussed further in Section VI, most of the tools proposed in this report will require some level of initial investment by concessionary or other low-return capital to facilitate transactions. However, by piloting innovative approaches that resolve both human and environmental water needs, there is an opportunity to use such investments to guide the development of future water transactions that serve multiple interests and link management of economic and ecosystem risks, and powerfully shape water markets if and when they begin to emerge in the Basin. Such transactions will also demonstrate the value of and provide momentum for regulatory reforms to make similar transactions possible on a broader basis.



V.
Investment Tool Blueprints

V. Investment Tool Blueprints

The sections below describe eleven investment tools and approaches that were selected for more detailed investigation, following a preliminary analysis of dozens of different potential concepts in terms of real-world applicability, investment potential, legal requirements and complications, tax and securities issues, marketability and potential for investor interest, and other factors. The selected tools were identified as having strong potential to address a variety of environmental and/or water resource challenges in various geographic and legal settings, and also having potential for implementation (in at least some settings in the Basin) within existing legal and physical constraints.

The information provided in each description is intended to be suitable for use as a generic blueprint for the development and investigation of future investments in the area, and/or for development into a prospectus in connection with a specific opportunity that might be identified in the future. To this end, background information describing relevant scientific information, the specific types of environmental and water resource challenges and resulting benefits that the tool could be used to address and create, relevant regulatory and legal issues, and key potential stakeholders are provided, together with a description of the proposed structure of the investment, the types of investors who might be targeted for participation, and other key design components and external conditions that may need to be in place for implementation. For each tool, the report also provides a generic case study demonstrating how the tool might be applied, together with a financial model demonstrating the revenue/return profile of the investment with reference to the case study examples.

As discussed further below, these eleven tools have been grouped into four broad general categories: tools related to (a) watershed enhancement; (b) agricultural water use; (c) municipal water use; and (d) market development, and are described in nine individual blueprints (two of the eleven described tools represent variations on the same essential structure, and are therefore presented together).

V(A). Watershed Enhancement

Investment Blueprints

A. Watershed Enhancement

As detailed in Section III, human water demands in a growing number of western watersheds are approaching or exceeding available water supplies, even as landscape-level changes—such as invasive species, declining forest health, increased evaporation and evapotranspiration as a result of increasing temperatures in the Basin, and growing climatic variability—are driving significant net reductions in water supply over time.

While the majority of the investment tools described in this report focus on the management of demand or strategies involving the sharing or transfer of existing supplies, one obvious approach to addressing supply-demand imbalances is, of course, to seek to increase underlying water supplies. Among the 160-plus solutions evaluated by Reclamation in the Colorado River Basin Study, four primary options were considered for increasing supply: (1) importing water from other basins; (2) building desalination plants to treat seawater and brackish groundwater; (3) developing additional local supplies (in areas where this was feasible); and (4), as relevant here, undertaking watershed management programs to improve watershed yields.[1]

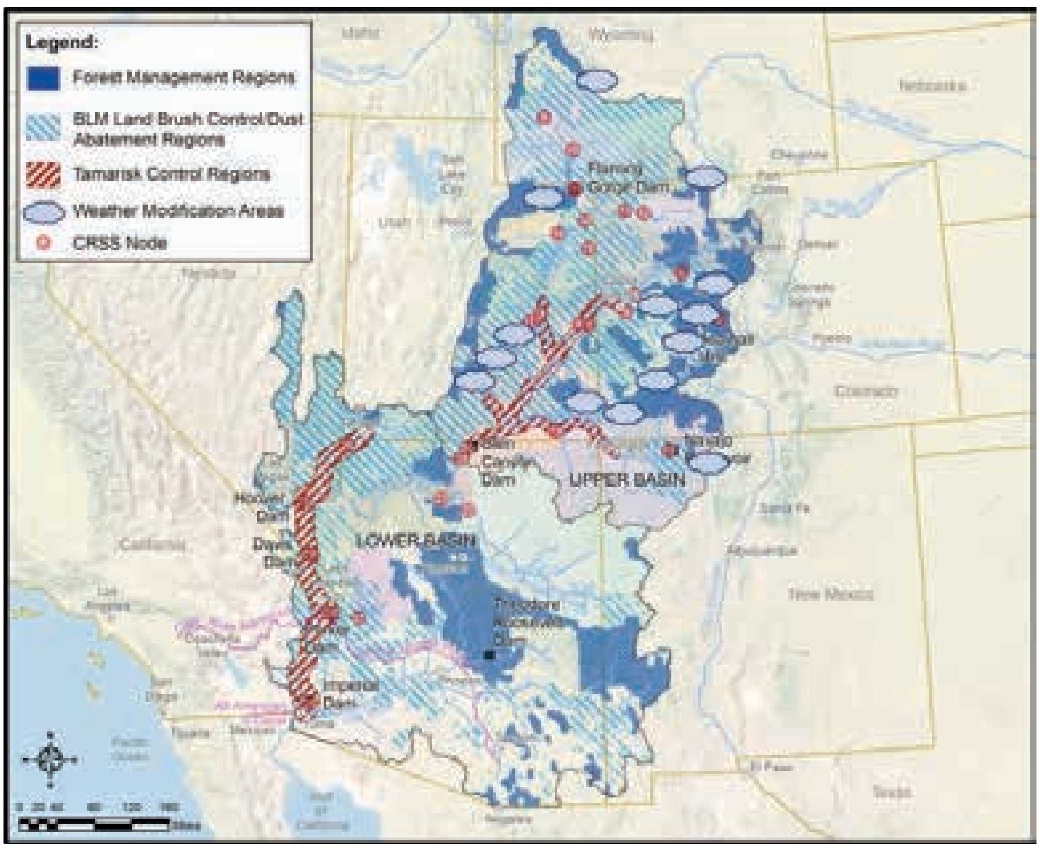


Figure V(A)-1. Potential Focal Areas for Investments in Watershed Enhancement. Map showing areas with high potential for watershed enhancement activities. Source: Bureau of Reclamation, Colorado River Basin Supply and Demand Study Technical Report F: Appendix F8 – Option Characterization – Watershed Management (2012).

1 Bureau of Reclamation, Colorado River Basin Water Supply and Demand Study, December 2012.

The vast majority of water supply enhancement options that have been investigated in the Basin, both in the Basin Study and elsewhere, have been found to be either physically or legally impractical and/or economically infeasible. Essentially, with most of the low-hanging fruit already plucked over the past century of large-scale public investments in water and water infrastructure, most potential "new" water supplies are either too costly to develop in comparison to other feasible options (such as reallocation of existing supplies or investments in conservation) or too controversial to develop because of the impacts they would impose on other watersheds. However, it is important to note that the Basin Study ultimately concluded that both desalination and watershed management efforts did represent potentially cost-effective means to address supply/demand imbalance issues (at least in some areas).

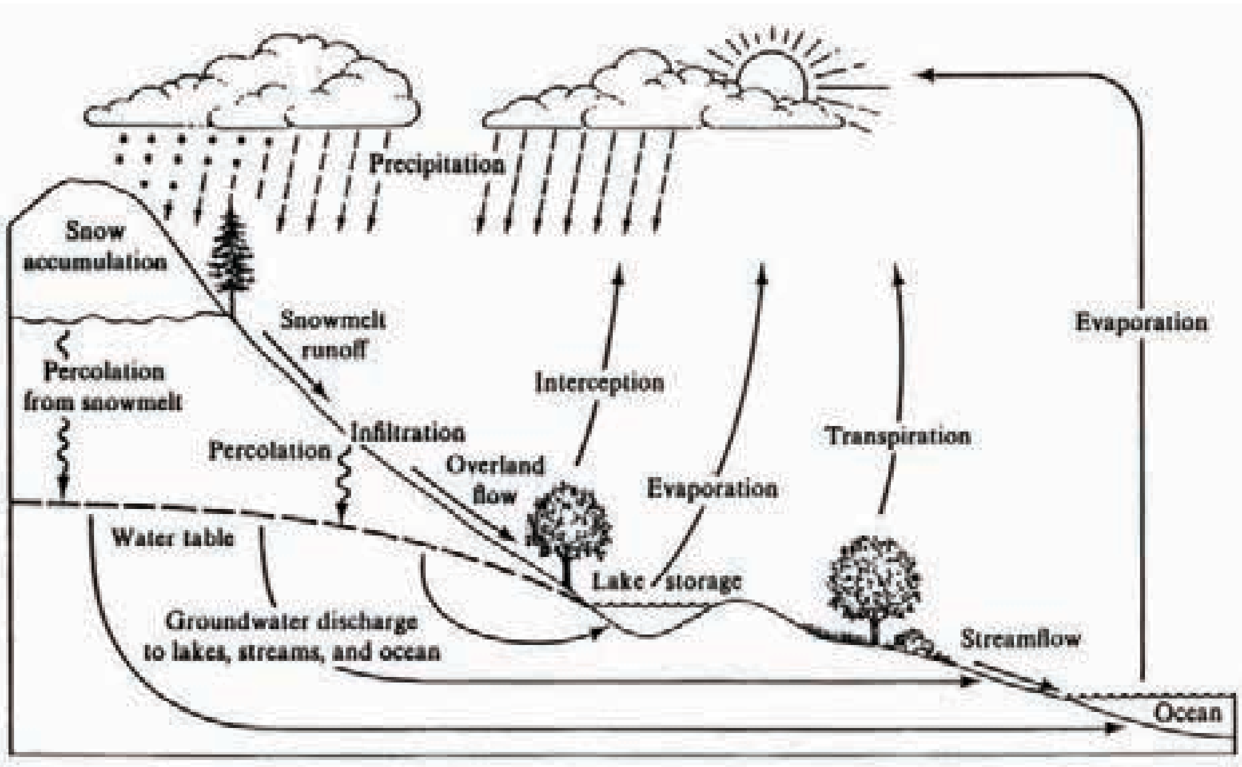


Figure V(A)-2. Watershed Hydrologic Cycle. Hydrologic cycle within a watershed highlighting evaporation and transpiration losses. Source: Dunne & Leopold (1978) Water in Environmental Planning.

In particular, investments in watershed management and restoration activities offer the potential to produce measurable increases in water supply (at least at a watershed scale), while also achieving important environmental goals related to the preservation and enhancement of wildlife habitat, ecosystem integrity and resiliency in the face of climate change, and restoration of badly disturbed ecosystems disrupted by more than a century of intensive human activity. The 2012 Basin Study identified a series of key focal areas in which to conduct watershed management work. As noted in Figure V(A)-1, these activities could be undertaken on a widespread basis in the Colorado River Basin, creating both local and downstream benefits in many watersheds and subwatersheds.

The potential for watershed management and restoration efforts to yield increases in water supply primarily relates to the differences in how water is used and consumed in an ecosystem under different conditions, and how that ecosystem use affects both the amount and timing of runoff patterns in a watershed. See Figure V(A)-2.

At the most basic level, all ecosystems use and consume water through evaporation and transpiration processes, or evapotranspiration (ET). Evaporation refers to direct conversion into vapor of water from soil, snow, and water surfaces; the evaporation rate relates to a variety of geographic and climatic factors, including temperature, elevation, and the intensity of solar exposure, as well as landscape-related variables such as soil type, soil cover, and surface shading from plant species. Transpiration, by contrast, is a physical plant process in which water is lost during photosynthesis; transpiration rates vary widely based on plant type and relevant metabolic processes, the density of plant cover, temperature, the length of the growing season, and other factors (factors which may also influence or interact with evaporation rates, such as the amount of surface shading).

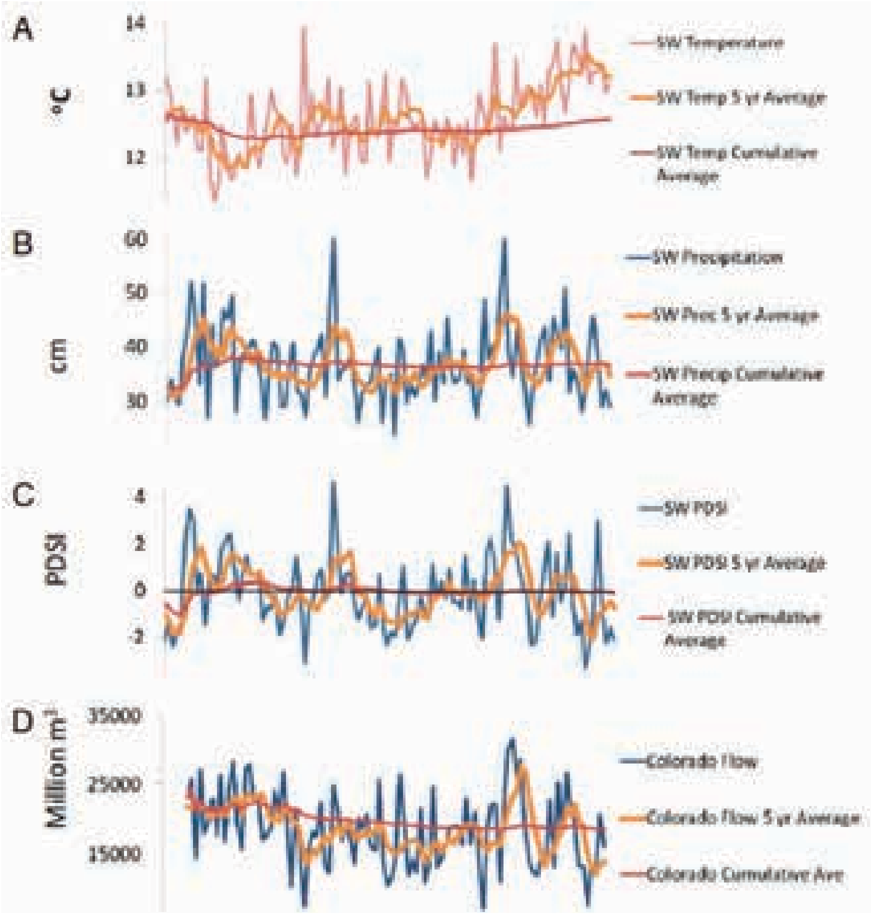


Figure V(A)-3. Annual Averages of Key Characteristics - Colorado River Basin. Annual averages for key characteristics in the southwest United States (California, Nevada, Arizona, New Mexico, Utah). Including:(A) Annual average temperature; (B) annual average precipitation; (C) annual average Palmer Drought Severity Index; (D) naturalized discharge of the Colorado River at Lees Ferry, AZ. Source: Glen MacDonald and B.L. Turner, "Water, Climate Change and Sustainability in the Southwest," Proceedings of the National Academy of Sciences of the United States of America, 107, no. 50 (Dec. 14, 2010): 21256-62.

The vast majority of precipitation that falls on a watershed is generally consumed in ET—typically, as much as 95% or even more. In desert systems, as much as 98% of already-scarce precipitation may be consumed as ET before reaching a groundwater aquifer or surface stream. However, as noted above, the different plant types and plant densities that may be present in a particular watershed can greatly impact both net transpiration and evaporation rates. As a result, changes in vegetation patterns at the landscape scale can have dramatic impacts on watershed yields.

Over the past century, the Colorado River Basin has experienced substantial, measurable decreases in watershed yield. Much of this change can be attributed to changes in precipitation and annual snowpack levels, together with increasing temperatures in the Basin (Figure V(A)-3). However, watershed health is also an increasingly material factor in this decline.

With the exception of changes in snowpack conditions, increasing temperatures, and the impacts associated with dust on snow, declines in forest health and the continued spread of invasive plant species are two of the most significant drivers of decreasing watershed yield in the Colorado River Basin. The watershed management approaches reflected in these investment tools would improve the health of Basin watersheds and subwatersheds by improving forest management in conjunction with efforts to reduce the risk of high-severity wildfires, and by restoring riparian areas through the eradication of invasive species and restoration of native vegetation.

SECTION V(A)(1):

Watershed Management Environmental Impact Bond:
Enhancing Watershed Health via Forest Management and Wildfire Reduction

Summary

This investment vehicle is structured to monetize public cost savings and generate water savings from forest management treatments applied in preventative wildfire management programs. These programs are expected to support natural water infrastructure, enhance water supply and security, and prevent watershed destruction resulting from catastrophic wildfires. Reducing high severity wildfires and employing these treatments not only increases the amount of available water in the system for high-priority use (whether that use be environmental, municipal, agricultural, hydropower or other) but also supports the natural habitat that allocates water efficiently within forest ecosystems and watersheds. Through a pay-for-performance–based Environmental Impact Bond ("EIB"), this financial instrument will seek to catalyze private capital to create these benefits.

1. Background

In the absence of human interference, North American forests historically burned at regular intervals, removing downed and small diameter trees, disposing of accumulated forest litter, and returning nutrients to the soil. When European settlers arrived, they quickly imposed a strategy of near-total fire suppression throughout the American West that carried well into the twentieth century. As a result, virtually all Western U.S. forests—including those of the Colorado River Basin—are now blanketed with excess vegetation and, in many cases, overcrowding of mature trees (See Figure V(A)(1)-1(a) and (b)). According to recent research by The Nature Conservancy (TNC), the Arizona Rural Policy Institute, and other investigators, preventative fuel-reduction forest treatments, including thinning and preventative controlled burns, can improve forest health, reduce fire risk, and potentially "harvest" more water from headwater forests to benefit watersheds and increase watershed yields.[1]

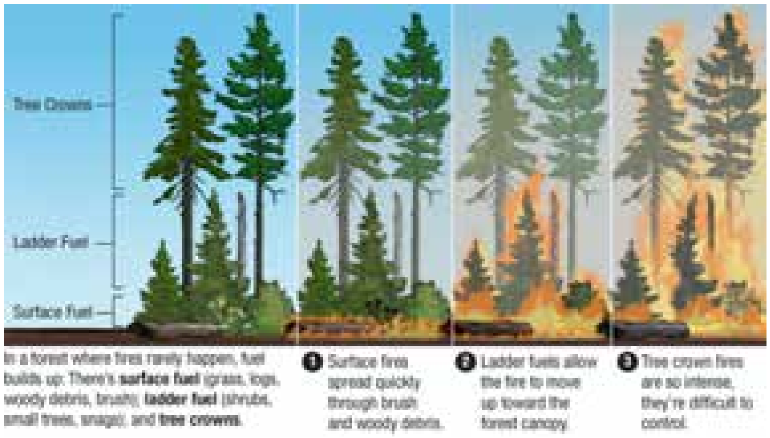


Figure V(A)(1)-1(a). See description in Figure V(A)(1)-1 (b) below.

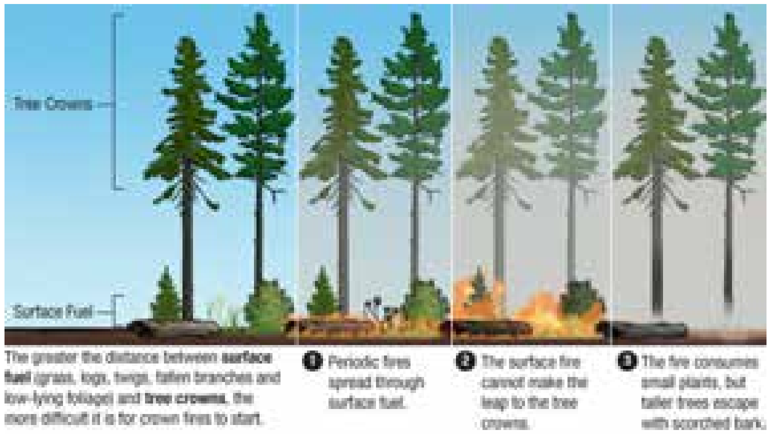


Figure V(A)(1)-1(b). Forest Fire Behavior Pre- and Post- Treatment. Forest fire behavior in areas where fires have been suppressed and there has been little to no active forest thinning (Figure (a), top), compared to areas that have had periodic forest fires and/or active thinning (Figure (b), bottom). Credit: Adam Cole, Nelson Hsu/NPR, http://www.npr.org/2012/08/23/159373770/the-new-normal-for-wildfires-forest-killing-megablazes

1 "Healthy Forests & Water Security: New Research Links Forest Thinning to Water Runoff Gains," The Nature Conservancy; "Flagstaff Watershed Protection Project Cost Avoidance Study," Arizona Rural Policy Institute, October 2014.

Forest overcrowding as a result of total fire suppression strategies leads to an abundance of "thirsty" trees that put undue pressure on the water table and local water sources. This net water deficit results from less runoff into headwater streams in the upper portions of a watershed and reduced stream flow overall in both drought and pluvial (above-average precipitation) periods. Other effects of abnormally high tree density include decreased soil water content and heightened evapotranspiration losses, which diminish soil moisture, limit groundwater recharge, and reduce surface water runoff. Because overgrown forests "drink" more than healthy forests, thinning these forests eases this competition for water—potentially by up to 20% or more (Figure V(A)(1)-2).[2]

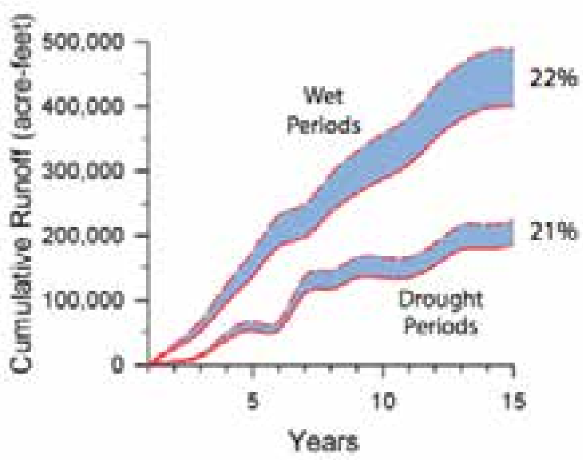


Figure V(A)(1)-2. Water Gains From Forest Thinning. Blue areas show a greater than 20% increase in runoff over time from thinned forests (dashed red line) versus unthinned forests (solid red line). Water gains during drought periods (bottom) are around 21%, while gains during wet periods are around 22%. Source: The Nature Conservancy.

A recent study by TNC examined half a million acres of forestland to evaluate statistical changes in runoff as a result of forest treatments. Unsurprisingly, yearly gains in water runoff varied considerably depending upon the amount of winter precipitation and snowpack. However, over the course of a longer, 15-year thinning treatment period, cumulative runoff increases ranged from 20% to 26%, producing the most benefits for flows in headwater streams and recharge to headwaters aquifers, with more modest benefits to downstream users.[3] Another similar study published in October 2014 found that thinning was able to yield a stand-level evapotranspiration reduction of 12% over a four year period.[4] Given the vast forested regions in the Colorado River Basin's headwaters—the source of most of the Basin's water—the increased runoff that could result from forest thinning could improve watershed yields in the Colorado River Basin. This additional water could recharge local aquifers, enhance or maintain baseflows in upper watersheds, and increase net runoff into headwater streams, helping to reduce both existing and future projected stream flow declines due to overuse, drought, and global warming.

In addition to its above-described impact on water availability, forest overgrowth poses an acute wildfire risk. The growing problem of wildfire and damaged watersheds is not a recent phenomenon, and has been well documented for decades (See Figure V(A)(1)-3). A 1999 U.S. Government Accountability Office report noted that "the most extensive and serious problem related to the health of national forests in the interior West is the over-accumulation of vegetation, which has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildfires."[5]

2 Ibid

3 Ibid

4 "Effects of Climate Variability and Accelerated Forest Thinning on Watershed-Scale Runoff in Southwestern USA Ponderosa Pine Forests," PLOS, October 2014.

5 "A Cohesive Strategy Is Needed to Address Catastrophic Wildfire Threats," RCED-99-65, published April 2, 1999, publicly released April 16, 1999, www.gao.gov/products/GAO/RCED-99-65.

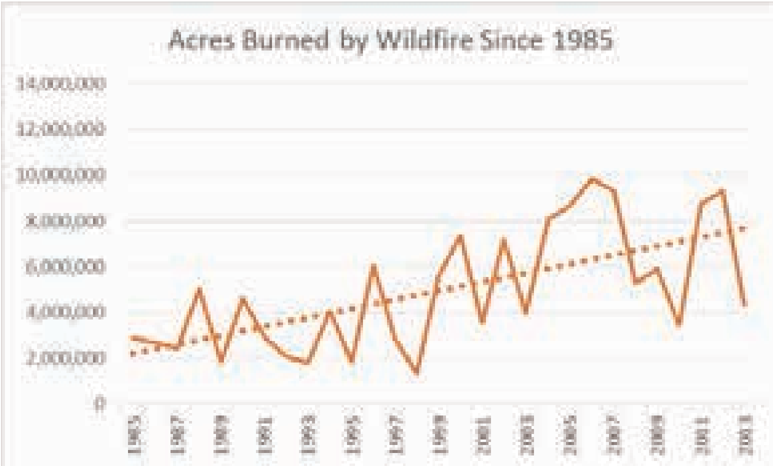


Figure V(A)(1)-3. Acres Burned by Wildfire. Acres of land burned by wildfires in the U.S. (solid line) with corresponding trend line (dotted line). Source: "Federal Firefighting Costs," National Interagency Fire Center, accessed December 14, 2014 www.nifc.gov/fireInfo/fireInfo_documents/SuppCosts.pdf

When a wildfire ignites in an overcrowded forest setting, there is significant potential for a high-intensity, dangerous burn due to the presence of excess fuels, instead of the low-intensity, creeping ground-level burns that predominated in natural forest cycles before European settlement. The heat of a high-intensity wildfire can readily overwhelm otherwise fire-resistant trees' natural defenses and propel fires vertically into the forest canopy. These canopy fires, also called "crown" fires, spread much faster and over greater distances through the forest and kill large numbers of mature trees, destroying large tracts of forest and damaging watersheds.

In addition to fire suppression, the National Academy of Sciences has identified ongoing impacts from climate change and the resultant changes in the hydrologic cycle as playing a large role in increased fire activity in the West.[6] According to a study published in the journal Geophysical Research Letters, in the region stretching from Nebraska to California, the number of large wildfires has increased at an average rate of 7 per year from 1984 to 2011, and the total area burned by these fires increased at an average rate of 90,000 acres annually.[7] In 2014 alone the United States saw 41,790 wildfires, impacting an area of over 3 million acres—an area equivalent to the size of Connecticut.[8]

As detailed above, damage from severe wildfires is twofold: damage to the forest from the fire itself and indirect damage resulting from the effects of fire on ecosystem services. High-intensity fires can result in 97% tree mortality over large areas of forest, destroying most of the ecosystem services that these forests provide,[9] such as wildlife habitat, carbon sequestration, and recreational value. The loss of trees also compromises the integrity of tree root systems, which are fundamental in preventing soil erosion.[10] Taken together, this leads to substantial erosion and reduced snowmelt retention, which jeopardizes sustainable water supplies to downstream rivers and their users.

6 O. Pechony and D. T. Shindell, Driving forces of global wildfires over the past millennium and the forthcoming century, Proceedings of the National Academy of Sciences of the United States of America, November 9, 2010, vol. 107, no. 45.
7 Sandra Postel, "Wildfires in the Western U.S. Are on the Rise, Posing Threats to Drinking Water," National Geographic, April 29, 2014.
8 National Interagency Fire Center, http://www.nifc.gov/fireInfo/nfn.htm.

Figure V(A)(1)-4. Severe wildfire moving into forest canopy. Source: National Oceanic and Atmospheric Administration.

Following a severe wildfire, floods often occur in areas downstream of burns, potentially causing damage many miles from the fire itself. Because severe wildfires essentially burn soil to the point that it is hydrophobic (the point at which it will no longer absorb water), runoff and erosion after intense fires on steep hillsides can increase peak runoff by up to 100 times the average flow.[11] These flows carry ash and mud that can threaten homes, businesses, government buildings, and reservoirs, and the sedimentation caused directly by the wildfires themselves, spew ash, charred soil, and other fire debris into streams, rivers, and water systems.[12]

This watershed damage can pose a particularly significant issue where the watershed is a source of drinking water. For example, following the 2011 Las Conchas Fire, which burned 151,000 acres of northern New Mexico, heavy rains pushed tree trunks, boulders, and blackened soil down the Jemez Mountain canyons and into the Rio Grande River. To avoid the high costs of treating this sediment-laden river water, the Albuquerque drinking water utility was forced to cut its intake from the Rio Grande by half, tapping more precious groundwater to make up the deficit.[13] In another example, the 2002 Hayman Fire in Colorado deposited more than one million cubic yards of sediment into the Strontia Springs Reservoir, a primary drinking water source for the city of Denver; cleanup costs ultimately totaled more than $40 million.[14] These examples demonstrate that forest management treatments applied in preventative wildfire management programs could not only alleviate pressure on water supplies, but could also reduce the risk for loss of critical watershed habitat and ancillary costs that may result from wildfire and post-wildfire flooding events.

2. Existing Approaches

Current efforts to reduce wildfire risk through thinning programs and other treatments are generally proving to be individually successful but, given current limitations on labor capacity within public agencies and on the public funding needed to take these efforts to scale, current approaches are generally not increasing ecological resiliency overall. Because climate change–induced drought conditions in the West have increased the length of the fire season by 75–80 days, wildfires have become more severe and fast spreading.[15] As a result of these larger fires and a longer fire season, wildfires cost more money to suppress and their effects are increasingly detrimental to the environment (Figure V(A)(1)-5).

9 Ibid.

10 J. Restaino and D. Peterson (2013), Wildfire and fuel treatment effects on forest carbon dynamics in the western United States, Forest Ecology and Management 303 (2013): 46–60.

11 "Flagstaff Watershed Protection Project Cost Avoidance Study," Arizona Rural Policy Institute, October 2014.

12 Ibid.

13 Sandra Postel, "Wildfires in the Western U.S. Are on the Rise, Posing Threats to Drinking Water," National Geographic, April 29, 2014.

14 Meeting Water Needs through Investing in Nature, Nature.org, www.nature.org/ourinitiatives/regions/northamerica/unitedstates/texas/tx-es-conference-13.pdf.

15 A. L. Westerling et al. (2006), Warming and earlier spring increase Western U.S. forest wildfire activity, Science, vol. 313, no. 578: 940–43.

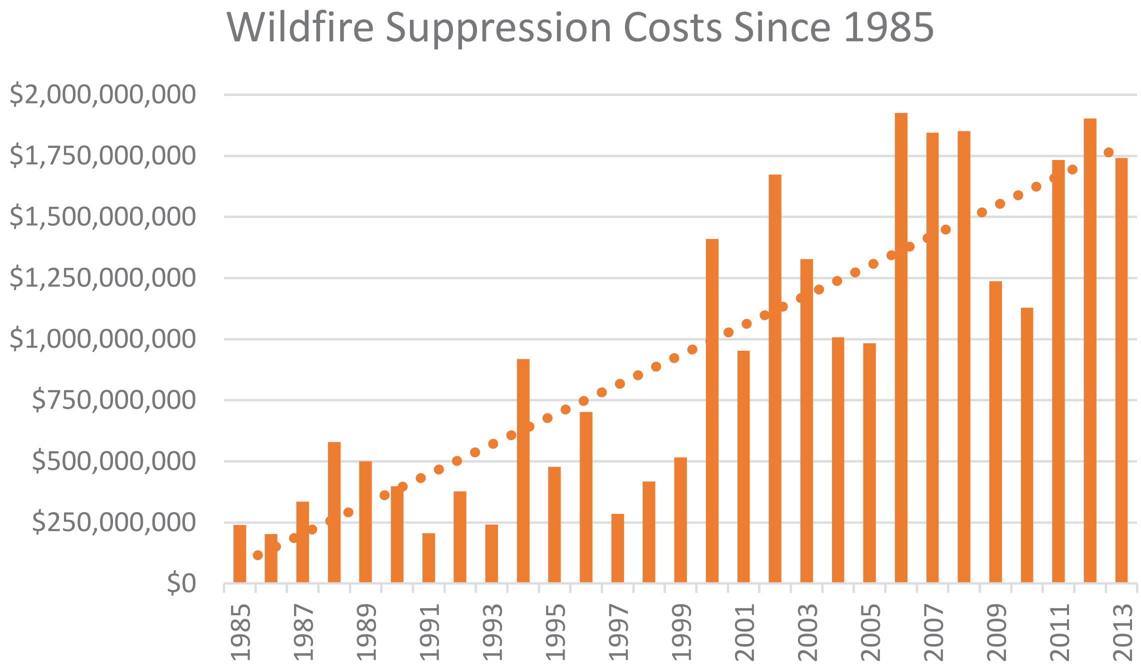


Figure V(A)(1)-5. Wildfire suppression costs (bars) and associated trend line (dotted line). Source: "Federal Firefighting Costs," National Interagency Fire Center, accessed December 14, 2014, www.nifc.gov/fireInfo/fireInfo_documents/SuppCosts.pdf.

Researchers have produced an abundance of literature on fire risk, fire behavior, and burn severity. Foresters have also used this data to analyze a range of forest treatments, generally involving a combination of thinning vegetation and intentionally setting controlled wildfires. As a result, statistical models can, to a high degree, accurately predict the wildfire risk of a given forest before and after treatment. However, despite a firm understanding of the need and economic value of forest and watershed protection in the West, preventative treatments remain significantly underfunded.

Despite the U.S. Forest Service's desire to engage in forest thinning and other management practices to proactively reduce severe wildfire threat in forests throughout the West, annual reactive firefighting costs continually exceed annual budgets, such that forest managers are forced to use funding that would otherwise be available for preventative treatments to cover fire suppression. For example, the U.S. Forest Service has experienced a shortfall in fire suppression funding in all but four years since 2000, and has been forced to "borrow" funding from other programs—including funding for preventative restoration. Over the past two years, more than $1 billion has been transferred out of nonsuppression programs, and the U.S. Forest Service also predicts it will exceed its suppression budget by $615 million for 2014.[16] This cycle of borrowing forest management funds to fight fires significantly reduces the level of investment in proactive management. In this respect, there could be a significant role for private capital to play in providing for the large, up-front investments that would be needed to bring these efforts to an appropriate scale in critical watersheds and move beyond the predominantly reactive wildfire management strategies that are currently in place.

16 FY15 U.S. Senate Emergency Supplemental Appropriations Bill.

While the costs of restoration treatments can be high, these preventative restoration costs are considerably lower than those typically associated with wildfire remediation, which include suppression, rehabilitating damaged landscapes and watersheds, cleanup from flash floods and sediment and debris flows, and reconstructing destroyed buildings and infrastructure. With proper capitalization, these financial savings can be captured, saving the government and end-users money and protecting a watershed's sustainable water supply.

In the forest management context, an EIB could help to break the current cycle of borrowing funds for forest management and watershed restoration to fight high-intensity wildfires, and instead catalyze the use of capital for preventative treatments that improve forests' health and resiliency.

There are some existing examples of successful local funding efforts to address these issues. One example is the Flagstaff Watershed Protection Project. In 2012, Flagstaff, AZ voted to fund a $10 million watershed protection project through the sale of municipal bonds – a funding effort that was supported by 74% of local voters.[17] These funds are currently being used to treat over 10,000 acres of National Forest in two watersheds critical to Flagstaff with fuel-reduction forest treatments (thinning and prescribed burning) in order to mitigate the risks of catastrophic wildfire and post-flood impacts.[18] The Flagstaff Watershed Protection Project Cost Avoidance Study estimates the potential financial damages mitigated by the implementation of this $10 million project range from $573 million to $1.2 billion.

Another recent example has developed in response to the 2002 Hayman Fire described above. In an effort to avoid a repeat of this disaster and the significant repair bills resulting from wildfire damage to its drinking water sources, Denver Water, the local water utility, is investing $16.5 million in thinning ponderosa pine stands and helping to rehabilitate the watershed.[19]

Similar investments have also been undertaken in Santa Fe, NM to safeguard against wildfires in the Santa Fe National Forest. In this instance, work performed in this region is supported by the Rio Grande Water Fund, which will finance large-scale watershed restoration. The Fund is backed by a number of businesses, including Lowe's, PNM (the state's largest electricity provider) and Wells Fargo.

3. Proposed Solution—Performance-Based Environmental Impact Bond

This proposed Environmental Impact Bond[20] (EIB) is intended as a means of breaking the cycle of underfunding for watershed health initiatives. In the forest management context, an EIB could help to break the current cycle of borrowing funds for forest management and watershed restoration to fight high-intensity wildfires, and instead catalyze the use of capital for preventative treatments that improve forests' health and resiliency. This treatment would help to potentially increase watershed yields while reducing the risk of severe wildfires, controlling their impact on water security, and avoiding the significant damage and remediation costs that would otherwise be incurred by end-users and the environment more broadly.

17 "Flagstaff Watershed Protection Project Cost Avoidance Study," Arizona Rural Policy Institute, October 2014.
18 Ibid.
19 Sandra Postel, "Wildfires in the Western U.S. Are on the Rise, Posing Threats to Drinking Water," National Geographic, April 29, 2014.
20 Although we refer to this investment as a "bond" in order to be consistent with the popular labeling used for similar SIB structures, EIBs and SIBs are more accurately described as pay-for-performance structures

Origins of Environmental Impact Bond

The EIB concept is adapted from the recently introduced Social Impact Bond (SIB) model, a financial instrument that introduces private capital into public projects that seek to generate positive social benefits, and provides a financial return for investors through government savings.

The first-ever SIB was implemented in 2010 at HM Prison Peterborough in the U.K., when 17 foundations committed £5 million to fund rehabilitative interventions for 1,000 male offenders sentenced to less than 12 months in the hopes of reducing recidivism rates.[21] A study by QinetiQ and the University of Leicester in August 2014 showed an 8.4% decrease in reoffending compared to a national comparison group. While the first phase of the investment did not reduce the number of reconvictions at the magnitude to trigger payments to investors (the contractual goal was 10%), investors will still receive a return on their capital in 2016 if there is an average fall in reconviction rates of at least 7.5%.[22]

By privatizing the risk of altering treatment practices, investors can increase effective forest management efforts and watershed yields for public benefit, with the potential to realize both environmental and financial returns.

This same SIB concept was later deployed at New York City's Rikers Island prison by Goldman Sachs Urban Investment Group, which announced the launch of the United States' first SIB in August 2012. The City of New York, MDRC, Bloomberg Philanthropies, the Osborne Association, and Goldman Sachs participated in the deal, making it a public-private partnership that leveraged private sector capital, philanthropic support, and nonprofit expertise to solve an ongoing community challenge related to youth offenders. The $9.6 million loan to MDRC, a provider of social services, supported a cognitive behavioral therapy program to reduce recidivism among teenagers incarcerated on Rikers Island. Bloomberg provided a $7.2 million grant to support the effort, guaranteeing part of Goldman's loan and paying MDRC for the pilot and intermediary costs. MDRC then contracted with the Osborne Association and Friends of Island Academy, two nonprofit service providers that delivered the intervention to detained youth.

In the same way the SIB structure privatizes financial risk in the service of providing a social benefit, an EIB would enable nonprofit entities, government agencies, and private investors alike to use a pay-for-performance structure to support environmental initiatives related to forest health, as detailed below.

21 Susannah Birkwood, Peterborough prison social impact bond pilot fails to hit target to trigger repayments, Third Sector, August 7, 2014, www.thirdsector.co.uk/peterborough-prison-social-impact-bond-pilot-fails-hit-target-trigger-repayments/finance/article/1307031.
22 Darrick Jolliffe and Carol Hedderman, Peterborough Social Impact Bond: Final Report on Cohort 1 Analysis, August, 7, 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/341684/peterborough-social-impact-bond-report.pdf.

STRUCTURE AND DESCRIPTION OF PROPOSED EIB FOR FOREST MANAGEMENT AND WILDFIRE REDUCTION

An EIB for forest treatments that aim to reduce severe wildfires would facilitate the shift of existing forest management activities from the reactive fire suppression approach that is currently employed to a proactive fire prevention approach in an attempt to mitigate forest fire intensity/frequency and create the ancillary benefit of increasing average water yields from a particular watershed. By privatizing the risk of altering treatment practices in this way, investors can increase effective forest management efforts and watershed yields for public benefit, with the potential to realize both environmental and financial returns. Specifically, the outcomes of such an investment could lead to long-term reduced cost for government agencies concerned with flood and fire risk, an increase in water quantity and quality for water utilities dependent on at-risk watersheds, and in some cases, employment opportunities in areas where current forest management staffing is limited.

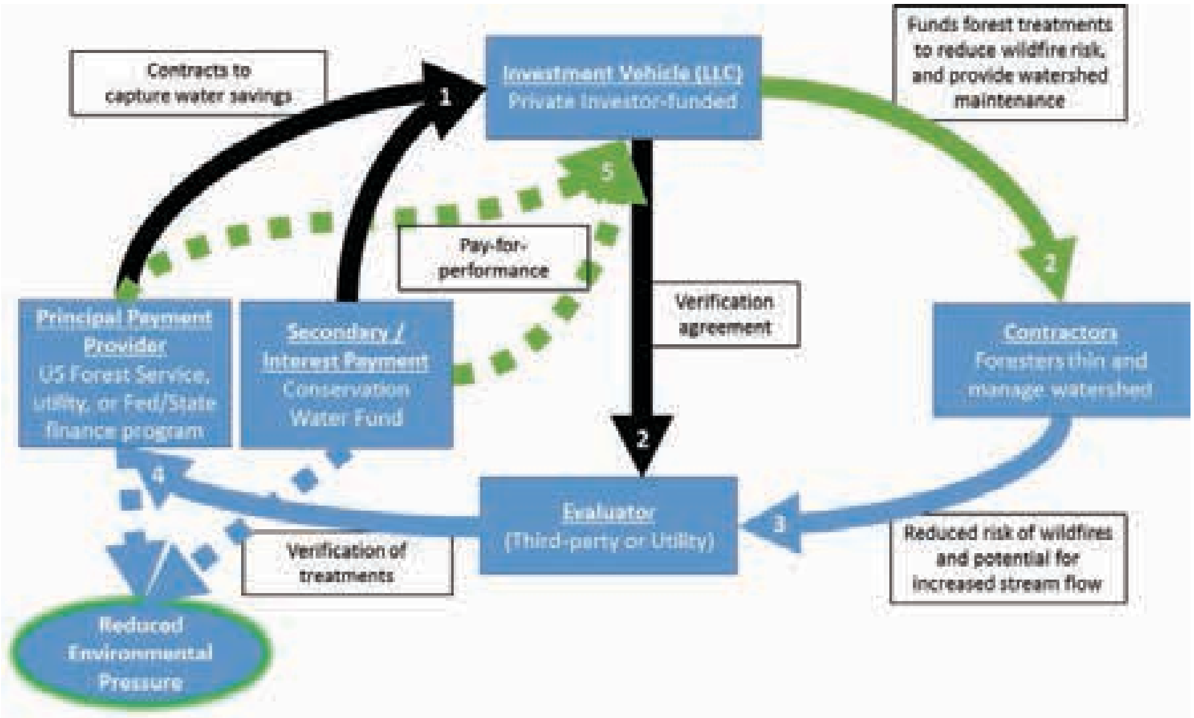


Figure V(A)(1)-6. Structure of Forest Management and Wildfire Reduction Environmental Impact Bond

HYPOTHETICAL CASE STUDY EXAMPLE

As described above, investors would fund forest management treatments through a special-purpose limited liability corporation ("LLC") that contracts with forest management crews to perform thinning and controlled burn scenarios within a given watershed. Like many watersheds in the Colorado River Basin, the target watershed exhibits poor existing forest health conditions and an increased fire risk and/or high burn rates. Fire suppression and restoration costs may have been incurred in the target watershed in the past, but little to no recent funding has been allocated for prevention through forest management techniques.

The LLC contracts with the U.S. Forest Service (USFS) as the primary payment provider. USFS has access to funding to undertake forest restoration activities, but lacks the budget appropriation and personnel to interrupt the perverse cycle of funding annual fire suppression rather than preventative treatments. While this type of long-term financing arrangement has not been completed in the past, initial discussions with USFS have indicated the Grants & Agreements division may be most appropriate unit for contracting. The targeted watershed would likely also provide water supplies and/or drinking water to a number of downstream water users that would benefit from reduced costs associated with the mitiga-

23 For tax purposes, the private investor would be expected to have compensation income at ordinary rates. The investor would also have ordinary income from the sale of forest products. The private investor's costs with respect to permitting and planning activities likely must be capitalized and deducted over the life of the contract. The tax treatment of incurred forest treatment costs (i.e. whether costs associated with thinning and selling forest products must be capitalized, deducted, or treated as selling expenses at the time of a sale) could potentially be complex and will have to be evaluated by the investor.

tion of severe wildfire impacts and/or increased water yield. Therefore, in addition to the USFS repayment funding, specific downstream users (such as major municipalities or utilities) and interested parties with environmental objectives, such as a local environmental NGO, would jointly create a "Conservation Water Fund". This Fund would help support the forest health treatments, with the contribution amount determined by an evaluation of projected avoided disaster recovery costs and estimated increased quantity and quality of water yield from the watershed.

Any water savings realized as a result of forest treatment practices would be ancillary to the avoided wildfire suppression costs, and the increased water yield would essentially provide a "system benefit" that is not easily quantified in any particular year or readily captured by or attributable to any individual user. For these reasons, the payments from the Watershed Conservation Fund would not be "buying" the resulting water savings for the benefit of specific users, and as modeled below, these payments would likely only represent a small fraction of the actual economic gain in water value to downstream users. However, those payments would facilitate the larger investments in improving watershed conditions that would create systemic water benefits (and could be tied to the performance of treatments to appropriate standards as they occur to ensure that the Watershed Conservation Fund users were not bearing inappropriate levels of risk). As such, the Watershed Conservation Fund contributions could be a critical funding component to investors by providing a modest "current yield" on the underlying, debt-like financial instrument that would in turn support an attractive internal rate of return on the investor's capital over the life of the investment, while the longer-term compensation from USFS based on demonstrated wildfire suppression savings would generate the majority of the actual costs and investor returns.

After the treatments take place, a third party verifier would assess the treatments and collect data on the watershed before and after the treatments, as well as collect data before and after any fire and flooding events in the region. Once the contracted objectives are met and evaluated by the third party verifier, the USFS would repay the investors (conceivably from budget allocated for future fire suppression) for the cost of work completed and the agreed upon financial return to the investors, while the Watershed Conservation Fund would provide interim payments to investors for increased environmental benefits and increased yield in the watershed.

HYPOTHETICAL TRANSACTION

1. An investment vehicle is formed as an LLC by private investors to undertake the EIB investment. An initial feasibility study is then conducted on a specific watershed to assess potential fire and flooding risk reduction approaches, associated potential watershed yield enhancement, estimated treatment costs, and estimated fire suppression savings.[23]

2. The USFS, functioning as the primary payment provider, provides a contract to the LLC to repay funds associated with planning, permitting, and forest health treatments that will result in decreased wildfire risk and associated suppression costs in the watershed, as well as any agreed upon financial return in excess of costs incurred.

25 This notional financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual project on an actual watershed. The hypothetical transaction is fictitious and only intended to provide some key line items interested parties might consider in assessing the potential for a transaction. Among other omissions, no tax considerations have been included in this notional financial model.

3. In order to reduce the effective cost to USFS and increase the potential for an attractive financial return to investors, downstream water users, including municipalities, utilities, and/or other nonprofit organizations establish and contribute to a Watershed Conservation Fund that commits to cover a portion of the investor return, based on estimated watershed yield enhancements and the performance of treatments to appropriate standards.

4. Working in cooperation with USFS and the Watershed Conservation Fund, the LLC undertakes the development of a treatment plan for the watershed, identifying specific treatment sites and approaches, timelines, target compliance metrics, and monitoring strategies (e.g., GPS mapping, aerial imagery, stream flow monitoring, etc.). Relevant public involvement and permitting requirements are also identified and followed, and required permits are secured.

5. Private investors fund forest treatments, monitoring activities, and watershed maintenance through the LLC as described previously, and contractors and restoration crews implement treatments, documenting areas to be monitored.

6. An independent evaluator (as identified in the contract with the LLC, USFS and Watershed Conservation Fund) analyzes the treated areas and monitoring data to determine completion of stated objectives, such as maintenance or enhancement of species diversity, reduced fuel loading, characteristics of subsequent wildfire burns, runoff characteristics, and other relevant forest health measures.

7. If the evaluator determines that objectives have been met based on contractual terms, then USFS and the Watershed Conservation Fund pay the investors back for work completed and any potential financial incentives as negotiated in the contract. If the terms are not met (or not completely met), investors lose their invested money (or a portion of it) in the same way they would if they had invested in a failed business.

4. Financial Model[24]

To further demonstrate how a market-based financial tool can be used for environmental benefit, the tables below detail hypothetical cash flows for a 10-year financing vehicle funding a forest thinning effort aimed at improving forest health and related fire risk, while potentially benefiting stream flow. The financial model is intended to be illustrative, since the costs and benefits associated with forest treatment projects are highly variable; further site-level diligence would be required for any targeted region.

25 A. A. Ager et al. (2007), Modeling wildfire risk to northern spotted owl habitat in Central Oregon, USA, Forest Ecology and Management 246 (1): 45–56. See also M. A. Finney et al. (2007), Simulation of Long-Term Landscape-Level Fuel Treatment Effects on Large Wildfires, International Journal of Wildland Fire 16: 712–27.
26 Ibid.

In the notional scenario modeled below, an investor would provide upfront payments to conduct restoration treatments and watershed maintenance as explained above, while the beneficiary—in the examples above, a government agency such as USFS and/or downstream water users—would promise to repay the investor on the condition that the restoration and maintenance occurs to positive environmental benefit. The investor would be further incentivized through interest payments on the cost outlay for forest treatments, and the beneficiary would conceivably be willing to pay the investor an additional amount reflecting a portion of the net cost savings realized (e.g., a portion of the cost of fire suppression typically paid for that same area over the 10-year period, or a portion of the cost of a replacement water supply equivalent to the average increase in water yield).

For the purposes of this model, to determine the extent of treatment necessary to reduce the risk of wildfire, research suggests that thinning approximately 30% of a watershed can significantly reduce the burn probability for the entire watershed, while the minimum treatment area required to measurably reduce risk from high-severity fires would be about 10–20%.[25] Further, treatment rates of up to 30% were found to have a maximum effectiveness in reducing fire risk for approximately two decades.[26] In addition, given the nature of the pay-for-performance structure, as well as the need to incentivize private capital investors to incur upfront costs as discussed above, it is assumed that the primary investment payment provider (e.g., USFS) would be willing to pay investors both a range of the initial capital invested, based on the demonstrated success of the forest treatment strategy (in this case, 2x), plus an modest interim annual interest payment for the upfront costs incurred (in this case, 1%, provided by the Watershed Conservation Fund in exchange for the enhancements to watershed health, net water yield, etc.). Given the potential range of payment outcomes, which would be detailed in the contractual agreements before implementation, the payment providers could set aside a total pool of capital for a "sinking fund" that would accrue interest and be used to pay disbursements to the investor determined by certain levels of success.

In the example below, it is assumed that the initial permitting and design of the strategy would take one year, and that the treatment costs would be incurred in years 2 through 6. While the benefits of the potential restoration project could be seen for 20 years or more, the investor repayment schedule is intended to return capital to the investor upon initial success (i.e. upon completion of the agreed-upon treatment work), paying back 50% of the target return in year 6 (1x invested capital, or effectively the "principal repayment"). It would provide payment for the potential continued performance of the treatments by releasing the remaining 50% of the target return in year 10.

Actual watershed savings may vary widely, particularly depending on the type of forest and geographic characteristics of the target watershed. For illustrative purposes, assuming 37.5% of a 100,000 acre watershed is treated, with a weighted average annual increase of 1.25 inches/acre of water yield, the total potential water increase in the target watershed form forest treatments is assumed to be in the range of 10,000 af.

Figure V(A)(1)-7. Assumptions and model drivers for the forest management and wildfire reduction EIB

Treatment Funding Parameters	
Total Acres of Targeted Watershed	100,000
Percentage of Land Treated[1]	37.5%
Acres Treated in Targeted Watershed	37,500
Treatment Cost per Acre[1]	$427
Treatment Oversight Costs (Annual)	$150,000
Total Treatment Cost	**$16,750,000**

[1] Treatment percentage and costs based on Mokelumne Watershed Avoided Cost Analysis. Treatment Costs can range from $130 to $2,200 acre. The initial estimate for illustrative purposes assumes a $16MM project on a 100,000 acre watershed.

Estimated Administrative Costs	
Project Management / Arrangement Fee[2]	$1,500,000
Legal and Permitting (Year 1)	$500,000
Verifier (Annual)	$50,000
Total Administrative Costs	**$2,450,000**

[2] Assumes $750,000 paid up front for arranger fee and the remainder paid out over the life of the project.

Timing and Structure of Funding	
Years of Permitting and Design	1
Years of Prevention Treatment	5
Total Life of Project / Maturity of Loan	10
Annual Interest Payment to Investor	1%
Total Principal Repayment (Success Payment)	1.5x
Principal Payment (Treatment Complete)	1.0x
Principal Payment (Maturity)	0.5x

Sources and Uses	
Sources	
EIB Funding Proceeds	$19,200,000
Uses	
Total Treatment Cost	$16,750,000
Total Administrative Costs	$2,450,000

Measured Outcome for Watershed Enhancement Fund	
Avoided Wildfire Suppression Costs per Acre[3]	$750
Full Avoided Wildfire Suppression Costs	$75,000,000
Costs Discounted for Burn Probability	80%
Avoided Watershed Suppression Costs	$60,000,000
Timber/Biomass Value for Full Watershed	$26,000,000
Timber/Biomass Revenue From Treatment Area/Year	$1,950,000
Timber/Biomass Revenue /Acre[3]	$260
Potential Avoided Cost/Acre (incl. admin & biomass)	**$518**

[3] Illustrative values based on Mokelumne Watershed Avoided Cost Analysis.

Total Project Costs	$20,970,000
Pot. Gov't Savings (80% Suppression Cost)	$39,030,000

Returns for Investor	
Multiple of Invested Capital (MOIC)	1.6x
Internal Rate of Return (IRR)	6.9%
Total Investor Return	$30,720,000
Discount Rate (Assume Government Issuer)	3.0%
Net Present Value of Project	$5,660,798

Potential Water Benefits

Potential Increase in Water by Thinning[4]

	Acres	Avg. Increase	Wt. Avg Inches
Sub-Alpine (Upper Basin)	6.8	2	0.93
Mixed Conifer (Lower Basin)	0.4	1.5	0.04
Ponderosa Pine (Upper Basin)	1.5	0.55	0.06
Ponderosa Pine (Lower Basin)	6	0.55	0.22
Total	*14.7*		*1.25*

Potential Increase in Targeted Watershed (inches)	124,660
Potential Increase over Targeted Watershed (A/F)	**10,388**
Implied Water Price for Funding Interest ($/AF)	$18
Implied Water Price for Funding EIB ($/AF)	$2,957

[4] Runoff value varies widely based on elevation, specific type of vegetation, slope of landscape, canopy cover and density, and by amount and type of thinning conducted. Yield figures are for illustrative purposes and were informed by Alden Hibbert's "Managing Vegetation to Increase Flow in the Colorado River Basin" paper.

Figure V(A)(1)-8. Illustrative cash flows for the forest management and wildfire reduction EIB

Year:	0	1	2	3	4	5	6	7	8	9	10	11-20
Potential Income												
Existing Carbon/Biomass[1]		$0	$1,950,000	$1,950,000	$1,950,000	$1,950,000	$1,950,000	$0	$0	$0	$0	$9,750,000
Total Income		$0	$1,950,000	$1,950,000	$1,950,000	$1,950,000	$1,950,000	$0	$0	$0	$0	$9,750,000

[1] *Assumed value from sale of biomass and/or carbon offset credits in years when treatments are conducted.*

Operating Expenses												
Arranger and Project Management Fees		$750,000	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$833,333
Legal and Permitting		500,000	0	0	0	0	0	0	0	0	0	
Verifier Fees		0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Treatment Costs[2]		0	3,350,000	3,350,000	3,350,000	3,350,000	3,350,000	0	0	0	0	$16,750,000
Total Expenses		$1,250,000	$3,483,333	$3,483,333	$3,483,333	$3,483,333	$3,483,333	$133,333	$133,333	$133,333	$133,333	$17,583,333

[1] *Assumes Treatment Costs incurred over 5 year period every 10 years, but investor captial called immediately.*

Repayment Schedule to Investor												
Total Potential Payment Due	$28,800,000						66.7%				33.3%	
Payment for Performance							$19,200,000				$9,600,000	
Interest on Principal (Current Yield)		$192,000	$192,000	$192,000	$192,000	$192,000	$192,000	$192,000	$192,000	$192,000	$192,000	
Watershed Enhancement Sinking Fund (20 year benefit)												
Fund Balance	$33,075,112	$33,075,112	$33,544,614	$34,023,506	$34,511,976	$35,010,216	$35,518,420	$16,836,789	$16,981,525	$17,129,155	$17,279,738	($0)
Interest Income	2.0%	661,502	670,892	680,470	690,240	700,204	710,368	336,736	339,630	342,583	345,595	
Disbursements to Investor		(192,000)	(192,000)	(192,000)	(192,000)	(192,000)	(19,392,000)	(192,000)	(192,000)	(192,000)	(9,792,000)	
Investor Returns												
Returns on Invested Capital	($19,200,000)	$192,000	$192,000	$192,000	$192,000	$192,000	$19,392,000	$192,000	$192,000	$192,000	$9,792,000	
Discounted Returns for NPV	(19,200,000)	186,408	180,978	175,707	170,590	165,621	16,240,494	156,114	151,567	147,152	7,286,168	

MOIC:	1.6x
IRR:	6.9%
NPV:	$5,660,798

Figure V(A)(1)-9. Investment scenarios for the forest management and wildfire reduction EIB

Model Sensitivities

Potential Avoided Cost /Acre (incl. admin & biomass)

Treatment $/A \ Suppression $/Acre	$450	$600	$750	$900	$1,050
$275	$370	$520	$670	$820	$970
$350	$295	$445	$595	$745	$895
$425	$220	$370	$520	$670	$820
$500	$145	$295	$445	$595	$745
$575	$70	$220	$370	$520	$670

Investor Internal Rate of Return (10 Years)

Interest Rate \ Total Principal Repayment Multiple	1.00x	1.25x	1.50x	1.75x	2.00x
0.0%	0.0%	3.4%	5.8%	7.7%	9.3%
0.5%	0.8%	4.0%	6.3%	8.2%	9.7%
1.0%	1.6%	4.6%	6.9%	8.7%	10.2%
1.5%	2.4%	5.2%	7.4%	9.1%	10.6%
2.0%	3.1%	5.9%	7.9%	9.6%	11.1%

Potential Government Savings in Watershed

Biomass Value \ Suppression $/Acre	$450	$600	$750	$900	$1,050
$200	$12,780,000	$24,780,000	$36,780,000	$48,780,000	$60,780,000
$230	$13,905,000	$25,905,000	$37,905,000	$49,905,000	$61,905,000
$260	$15,030,000	$27,030,000	$39,030,000	$51,030,000	$63,030,000
$290	$16,155,000	$28,155,000	$40,155,000	$52,155,000	$64,155,000
$320	$17,280,000	$29,280,000	$41,280,000	$53,280,000	$65,280,000

Investor Multiple on Invested Capital (10 years)

Interest Rate \ Total Principal Repayment Multiple	1.00x	1.25x	1.50x	1.75x	2.00x
0.0%	1.00x	1.25x	1.50x	1.75x	2.00x
0.5%	1.05x	1.30x	1.55x	1.80x	2.05x
1.0%	1.10x	1.35x	1.60x	1.85x	2.10x
1.5%	1.15x	1.40x	1.65x	1.90x	2.15x
2.0%	1.20x	1.45x	1.70x	1.95x	2.20x

Total Project Costs (incl. admin & biomass)

PFP Multiple \ Treatment Costs $/Acre	$275	$350	$425	$500	$575
1.0x	$5,113,750	$8,207,500	$11,301,250	$14,395,000	$17,488,750
1.5x	$11,870,000	$16,370,000	$20,870,000	$25,370,000	$29,870,000
2.0x	$18,626,250	$24,532,500	$30,438,750	$36,345,000	$42,251,250
2.5x	$25,382,500	$32,695,000	$40,007,500	$47,320,000	$54,632,500
3.0x	$32,138,750	$40,857,500	$49,576,250	$58,295,000	$67,013,750

Investor Net Present Value of Investment (10 Years. 3% discount rate)

Interest Rate \ Total Principal Repayment Multiple	1.00x	1.25x	1.50x	1.75x	2.00x
0.0%	($3,120,302)	$451,349	$4,022,999	$7,594,650	$11,166,301
0.5%	($2,301,403)	$1,270,248	$4,841,899	$8,413,549	$11,985,200
1.0%	($1,482,503)	$2,089,147	$5,660,798	$9,232,449	$12,804,100
1.5%	($663,604)	$2,908,047	$6,479,698	$10,051,348	$13,622,999
2.0%	$155,296	$3,726,946	$7,298,597	$10,870,248	$14,441,899

Implied Water Trust Price/AF to Cover Project Costs

In. Runoff/Acre \ Treatment Only $/Acre	$275	$350	$425	$500	$575
0.75	$3,459	$4,179	$4,899	$5,619	$6,339
1.00	$2,594	$3,134	$3,674	$4,214	$4,754
1.25	$2,076	$2,508	$2,940	$3,372	$3,804
1.50	$1,730	$2,090	$2,450	$2,810	$3,170
1.75	$1,483	$1,791	$2,100	$2,408	$2,717

SECTION V(A)(2):

Watershed Management Environmental Impact Bond:
Enhancing Watershed Health via Riparian Restoration

Summary

This investment vehicle is structured to monetize public cost savings and water savings from riparian restoration programs. These initiatives are intended to support natural water infrastructure, enhance water supply and security, and prevent watershed destruction as a result of invasive species infestation. Reducing invasive species and restoring native habitat would not only increase the amount of available water in the system for high-priority uses (whether they be environmental, municipal, agricultural, hydropower, other), but would also support natural habitat that allocates water efficiently. Through a pay-for-performance Environmental Impact Bond ("EIB"), this financial instrument will seek to catalyze private capital to benefit sustainable water supplies.

1. Background

Prior to the nineteenth century, native cottonwood and willow trees lined rivers throughout the Colorado River Basin, and supported an abundant community of resident and migratory birds, fish, amphibians, rodents, reptiles, and mammals. However, as discussed in Section I of this report, human intervention in the Basin has dramatically impacted natural riparian habitat. Direct alterations to natural flow patterns, along with indirect alterations, such as human-induced climate change, have dramatically decreased

species diversity and natural wildlife abundance in the Colorado River Basin. Among the most dramatic examples of the consequences of these alterations is the once-vast Colorado River Delta ecosystem, which has lost more than 90% of its former areal extent, with the few remaining areas of the Delta now badly degraded.[1] Further up the watershed, in the Lower Colorado River Basin alone there are now 26 endangered, threatened, or sensitive species.[2]

Figure V(A)(2)-1. Healthy cottonwood-willow forest on Gila River. Credit: National Geographic, Sandra Postel.

Figure V(A)(2)-2. Tamarisk tree. Credit: National Park Service.

Much of the environmental degradation in the Basin can be linked either directly or indirectly to the extensive changes to the hydrologic regime—resulting from the creation of dams and diversions—on both the Colorado River mainstem and tributaries. Beyond those changes, however, the growing presence of invasive species—and, in particular, the impacts of a widespread infestation by tamarisk (*Tamarix ramosissima*, also known as saltcedar)—has been a critical feature of the ecological and hydrological impacts throughout the Basin.

Tamarisk is an invasive shrub or tree that establishes near water sources. Since the introduction of tamarisk in the mid-nineteenth century, it has become one of the dominant riparian plant species in the Basin. Tamarisk was originally brought from Eurasia as an ornamental and used in Eastern U.S. gardens, but as settlers moved west across the country, landowners planted tamarisk both in an attempt to prevent stream bank erosion and to provide a source of shade and windbreak. Tamarisk quickly spread on its own along riparian corridors, and over time, the extensive diversion of rivers for irrigation, the increased grazing pressure, and overall climatic conditions furthered the establishment of tamarisk over native species.

1 Francisco Zamora-Arroyo et al., Conservation Priorities in the Colorado River Delta Mexico and the United States (Sonoran Institute, Environmental Defense Fund, University of Arizona, Pronatura Noroeste Direccion de Conservacion Sonora, Centro de Investigacion en Alimentacion y Desarrollo, and World Wildlife Fund - Gulf of California Program, 2005).

2 Bureau of Reclamation, Lower Colorado River Multi-Species Conservation Program, December 30, 2013, www.lcrmscp.gov/general_program.html.

Tamarisk has also proven to be extremely resilient to harsh conditions, and tends to rapidly outcompete native species in environments where natural flood cycles have been disrupted. For example, total tamarisk-infested acres across the West increased at 3–4% per year from 1900 through 2000.[3] As of 2010, tamarisk covered approximately 364,000 hectares (900,000 acres) in the western U.S., and the tree is now the second most abundant plant on western river corridors (Figure V(A)(2)-5).[4]

Since habitat structure is important to many species that use riparian areas, the impact to wildlife tends to vary with the level of tamarisk infestation. In areas with lighter infestation, tamarisk can still contribute to maintaining diverse vegetation structure among native species like cottonwoods and willows. In heavily infested areas, by contrast, tamarisk can create monotypic stands with little to no diversity in vegetation structure. Vegetation structure is often the most important factor for bird survival; and as a result, the transition to monotypic tamarisk stands reduces the number of bird species able to use the river corridor. The direct impact of tamarisk on reptiles, mammals, and fish is less well known, but, generally, tamarisk invasions have changed the historic structure and nature of river corridors, reducing available natural habitat for these species as well.

Figure V(A)(2)-3. Tamarisk (foreground) crowding out native cottonwood trees (taller trees in background). Credit: Colorado State University.

Figure V(A)(2)-4. Dry river channel of the Colorado River Delta. Credit: Environmental Defense Fund.

In addition to the direct effects of tamarisk on riparian species, the tree also changes the channel morphology of rivers and streams over time. Tamarisk was originally introduced to stabilize banks, and its root systems have proven to be effective at trapping and holding sediment in many sites. However, as a consequence of this stabilizing effect, tamarisk also limits the natural meandering of river systems, narrows river and stream channels, and decreases the extent of overbank flooding—the same conditions that are essential to native plant regeneration. This destructive cycle favors future tamarisk establishment and regeneration, fueling continued channel narrowing that further exacerbates the problem. These changes in vegetation structure and channel morphology can also impact the interaction between surface water and groundwater systems, as tamarisk tap shallow groundwater sources in the floodplain aquifer at far greater distances from the channel than would be observed with native vegetation, ultimately lowering water tables and effectively reducing the contributions of floodplain aquifers to surface flow.

3 Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment, December 2009.

4 Patrick B. Shafroth, Curtis A. Brown, and David M. Merritt, "Saltcedar and Russian Olive Control Demonstration Act Science Assessment: U.S. Geological Survey Scientific Investigations Report 2009-5247," U.S. Geological Survey, 2010.

Figure V(A)(2)-5. Tamarisk Infestation in the Colorado River Basin. Extent of tamarisk in the Basin as of 2009. Note that the Mexican portion of the Colorado River Delta is not included in the map coverage, but is also heavily infested. Source: Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment.

Finally, tamarisk is also suspected to contribute to increased salinity in surface water. Tamarisk is more salt tolerant than many native species, and the tree actively redistributes salts from deep in the soil to the surface, increasing local soil salinity to the further detriment of native species, which cannot establish in the resulting salty soils.[5] Removing tamarisk limits the redistribution of salt from deep in the soil profile, and thus tends to reduce the salinity of runoff into tributary streams and ultimately the Colorado River. As discussed in Section III of this report, management of salinity is a key concern in the Colorado River Basin, as the combination of natural salt sources and the effects of the use and reuse of water for irrigation as it moves downstream in the Basin cause significant increases in salinity, particularly in the Lower Basin. In response, the Colorado River Basin Salinity Control Program,[6] which was developed to improve water quality in the Colorado River, has been undertaking a

5 Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment, December 2009.

6 High salinity levels both impact crop production (in terms of crop yields and the types of crops that can be grown) and cause damage to municipal water infrastructure and household pipes and fixtures. Studies suggest that salinity damage in the Basin ranges between $500 and $750 million annually. The 1974 Colorado River Basin Salinity Control Act, Public Law 93-320, and subsequent amendments in 1984 and 1995 provide authority to the U.S. Department of Interior, acting through the Bureau of Reclamation, to implement a Basin-wide salinity control program. Salinity control projects can be undertaken by Reclamation directly or via grants, contracts, agreements, and other mechanisms. Many of these projects are undertaken on private lands. Reclamation works with the Bureau of Land Management and the U.S. Department of Agriculture on salinity control measures. USDA's Environmental Quality Incentives Program, for example, provides cost-share assistance to landowners who undertake salinity controls.

variety of projects to reduce salinity, including controls on natural salt sources and improvements to irrigation infrastructure in parts of the Upper Basin.[7] Tamarisk removal has also been identified as a potential salinity reduction project, although no studies to date have documented the specific amount of reduction that can be achieved through such removal.

Given the water supply and demand imbalance facing water users throughout the Colorado River Basin (as discussed in Section III(A) of this report), in addition to the obvious benefits to wildlife that could result from restoration activities, one of the most significant benefits of tamarisk removal could be the potential to save water for downstream environmental and economic benefit. As discussed below, the removal of tamarisk and restoration of native habitat could provide water savings in the form of net reductions in phreatophyte use along river and stream corridors and through changes in the quantity and quality of groundwater—both of which can increase instream flows and the amount of water potentially available for downstream use.

In general, tamarisk consume the same amount of water on a per-acre basis as other phreatophytic tree communities such as native cottonwoods and willows.[8] These species, or species that establish in areas with moderate to high access to water, also initially have evapotranspiration (ET) rates that are comparable to tamarisk at a similar stage of maturity. As a result, upon initial planting of replacement cottonwoods and willows in riparian areas, there may be a 5 to 15 year period during which ET rates are lower than that of established, mature tamarisk stands, although net ET rates generally equilibrate as the replacement stands mature. However, there can also be significant immediate and sustained water savings from removing tamarisk on the upper terraces of river systems, where, unlike native cottonwoods and willows, tamarisk tend to establish during floods. In these areas, the fast spreading and extensive root structure of the tamarisk (unlike native cottonwoods and willows) outcompetes mesquite, sagebrush, and other native upland species, and significantly alters the natural habitat. Native upland species (i.e. mesquite and sagebrush) use on average 50–75% less water than tamarisk.[9] As a result, significant net water savings can accrue from tamarisk removal and restoration of native species provided that upland areas and riparian corridors are treated at the same time as areas on the river banks.[10] Figure V(A)(2)-6 depicts the ecological difference between a tamarisk monoculture on the right and a native riverside habitat on the left.

7 However, it is worth noting that as a result of salinity control efforts, there are now important tradeoffs between salinity control and the management of the net water "deficit" in the Lower Basin. This is primarily due to Minute No. 242 to the Treaty of 1944 between the U.S. and Mexico, which establishes a water quality standard for deliveries to Mexico (Minute No. 242, Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River [1973]). To meet these standards, the U.S. presently bypasses saline drainage water from Yuma-area agriculture through the Main Outlet Drain Extension ("MODE") canal to the present-day Cienega de Santa Clara wetland. This water is accounted for as a "loss" to users in the U.S. As salinity levels in the river have dropped, Reclamation has had to further restrict pumping of drainage water from Yuma into the Colorado River and/or increase Treaty bypass water through the MODE in order to continue to comply with the water quality standard in Minute 242, such that further salinity reductions in the river can potentially translate into increases in the net "structural deficit" in Lake Mead.

8. Nabil Shafike, Salim Bawazir, and James Cleverly. "Native versus Invasive: Plant Water Use in the Middle Rio Grande Basin." Southwest Hydrology Volume 6 Number 6 (2007): 28-30.

9 Tamarisk Coalition, Independent Peer Review of Tamarisk and Russian Olive Evapotranspiration Colorado River Basin (Tamarisk Coalition: Grand Junction, Colorado, USA, 2009).

10 Shafroth, P.B., Brown, C.A., and Merritt, D.M., eds., 2010, Saltcedar and Russian olive control demonstration act science assessment: U.S. Geological Survey Scientific Investigations Report 2009–5247, 143 p.

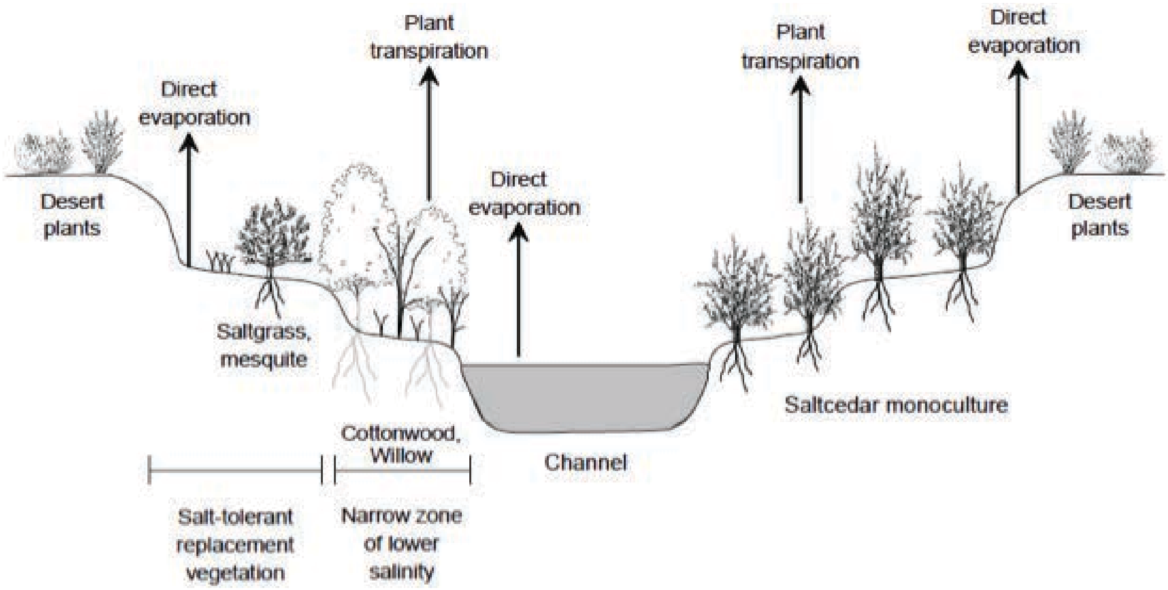


Figure V(A)(2)-6. Cross-section diagram of river habitat before and after restoration. The highest water savings from tamarisk removal will occur in areas of transition from tamarisk monoculture in upper terrace areas (see upper right terrace in diagram) to saltgrass and mesquite (upper left terrace). Source: Shafroth, Brown, and Merritt (USGS 2009).

Tamarisk has also proven to be a relatively fire-adapted species, which provides it with a competitive advantage in terms of resiliency over native species, which may perish entirely in wildfires. Moreover, in high severity fires, dense stands of tamarisk can serve as a bridge for wildfires to cross floodplain terraces to upland plains, where without this dense vegetation wildfires may otherwise be more moderate in severity and size. The right side of Figure V(A)(2)-6 above illustrates this potential linkage for wildfires.

Studies of changes in ET rates based on tamarisk removal and revegetation efforts have determined that tamarisk removal can save between 0 and 1.5 af of water per acre of treatment.[11] Based on this range, a conservative, but reasonable, net expected water savings is 0.54 af per acre per year for each acre of restored habitat.[12] There are still uncertainties regarding the extent to which water savings will manifest as either direct increased instream flows or as higher groundwater tables in floodplain aquifers, which could in turn contribute to increased baseflow contributions to surface streams. A recent study conducted by the Metropolitan Water District of Southern California and Utah State University, for example, found that in a region where tamarisk were removed, groundwater rose as tamarisk-related ET decreased. (Figure V(A)(2)-7).[13] Additional studies are being conducted at sites along the Lower Colorado River to provide additional proof of concept case studies.

11 Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment, December 2009.

12 Ibid.

13 Tom Ryan and Chris Harris, Assessing the Potential Impact of Invasive Species Water Use on the Lower Colorado River, October 2014.

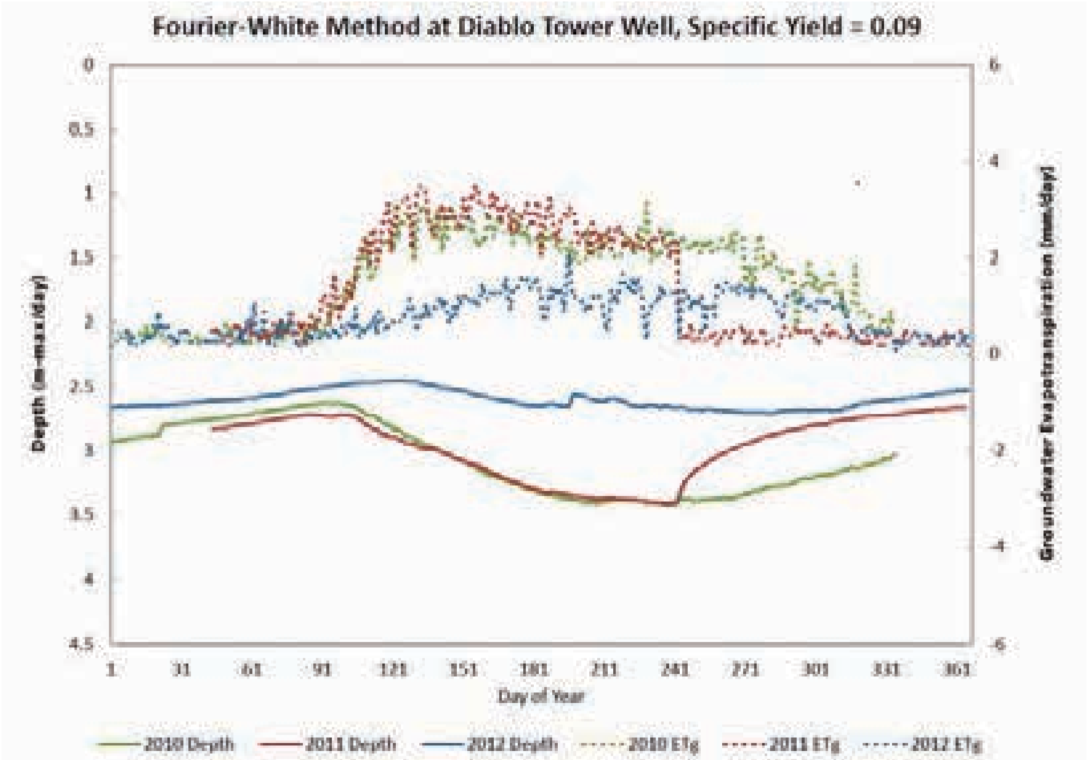


Figure V(A)(2)-7. Evapotranspiration (dotted lines) and groundwater depth (solid lines) at a tamarisk removal site in the Lower Colorado River Basin. Source: Ryan and Harris (2014).

A number of tamarisk removal strategies are currently being employed throughout the Basin. Mechanical control is perhaps the most obvious strategy for tamarisk removal. It involves using hand or machine tools to remove, reduce, or disturb plant biomass to kill the tamarisk.[14] While this is a relatively effective strategy, particularly when optimizing locations for removal, it can be comparatively slow, and full removal can cost as much as $1,976 per hectare ($800 per acre) before accounting for treatment to reduce the risk of reoccurrences.[15] More recent commentary from the Tamarisk Coalition, a non-profit organization that has been leading tamarisk control and riparian restoration efforts in many parts of the Basin, estimates the baseline costs to be $1,000 to $1,500 per acre, fluctuating primarily as a result of tamarisk density in the given area and specific removal method employed.

Several EPA-approved chemical herbicides have also been used to successfully defoliate and kill tamarisk, but this method is generally effective only at certain times of the year. Moreover, this method carries the risk of contaminating nearby water systems, particularly in the case of aerial spraying.[16] There are also a number of experiments with integrated approaches to tamarisk removal, such as the "cut-stump" method, combining both mechanical and herbicidal elements, which can result in tamarisk control rates of 60–80% under optimal conditions. The cost of employing the cut-stump method starts at approximately $988–$1,976 per hectare ($400–$800 per acre), excluding revegetation and monitoring costs.[17]

14 Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment, December 2009.

15 P. B. Shafroth, C. A. Brown, and D. M. Merritt, D.M., eds. (2010), Saltcedar and Russian Olive Control Demonstration Act Science Assessment, U.S. Geological Survey Scientific Investigations Report 2009–5247.

16 P. B. Shafroth, C. A. Brown, and D. M. Merritt, D.M., eds. (2010), Saltcedar and Russian Olive Control Demonstration Act Science Assessment, U.S. Geological Survey Scientific Investigations Report 2009–5247.

17 Ibid.

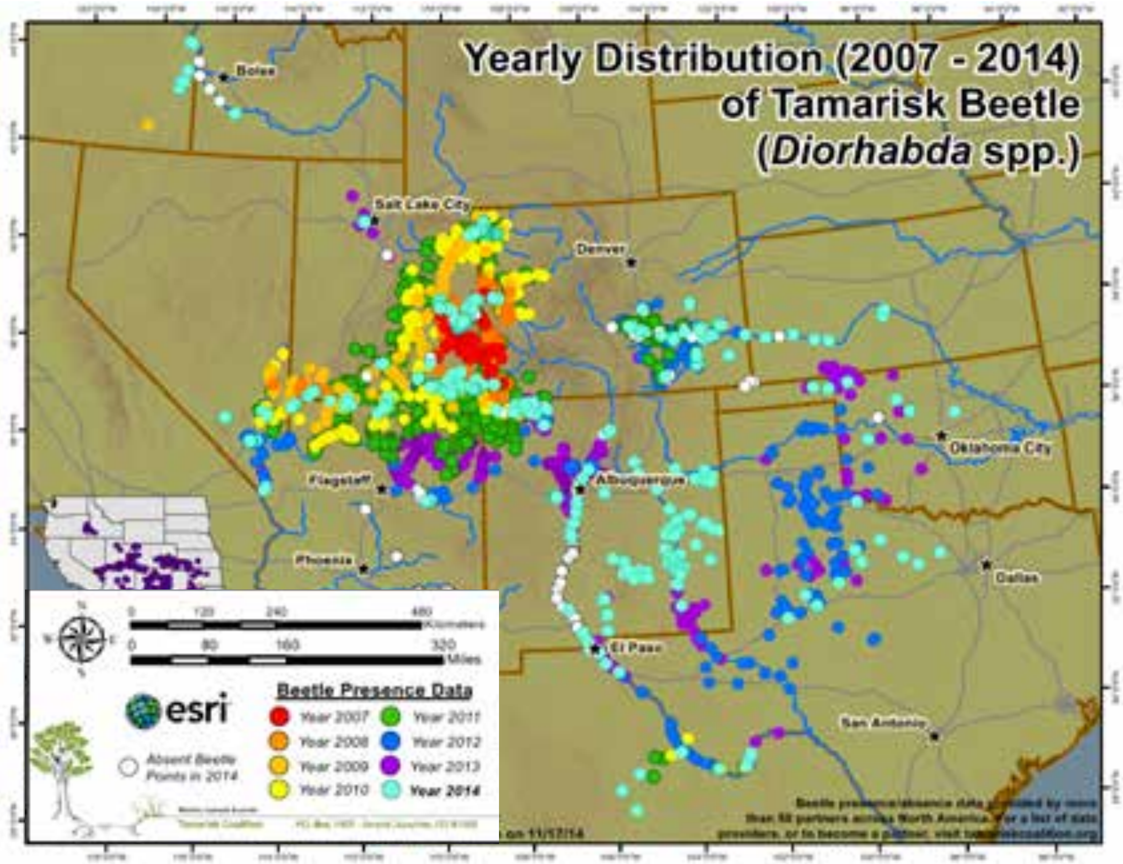


Figure V(A)(2)-8. Recent extent of tamarisk leaf beetle colonization in the Western U.S. Source: Tamarisk Coalition, November 17, 2014, www.tamariskcoalition.org/programs/tamarisk-beetle.

In addition to these methods, tamarisk beetles (Diorhabda spp.) are proving to be effective biocontrol agents in that they offer a low-maintenance strategy with a long duration.[18] This beetle was introduced from Asia to consume tamarisk leaves, depleting the tree's root energy reserves until the tamarisk is eventually exhausted and the plant dies.[19] At one study site in Nevada in 2006, 65% of the tamarisk died after five successive years of plant defoliation from a tamarisk beetle infestation.[20] Still, there are a number of concerns with tamarisk biological control—most notably the impact on native species, such as the endangered Southwestern Willow Flycatcher (a riparian bird species)—when tamarisk trees are killed and not immediately replaced by native habitat. In areas where tamarisk infestation is extensive, beetle kills can cause "brownouts" that effectively eliminate all available riparian habitat for such species. These kills can also create important concerns with biomass disposal once an infestation creates a "brownout" in a particular region. The removal of the root system without adequate revegetation can result in the discharge of large amounts of woody debris that heighten flooding risks, and the remaining dead tree biomass can also increase fire risk in a treated area.

18 Ibid.
19 Ibid.
20 Ibid.

Irrespective of these concerns, tamarisk beetles are now spreading in an essentially uncontrolled fashion in the Colorado River Basin (Figure V(A)(2)-8). As of the end of 2014, tamarisk beetles had colonized most of the Colorado River watershed from its northern headwaters downstream past Bullhead City, AZ, and are expected to shortly colonize major tributaries such as the Gila River watershed as well. This continued spread of the beetle is likely to require increased expenditures by various public agencies as part of both flood and fire control efforts to "clean up" dead and dying vegetation associated with beetle kills. However, this will also generate an opportunity to engage in a more comprehensive, post-beetle restoration and maintenance approach that could reduce the net cost-per-acre of initial treatment by taking advantage of the reductions in tamarisk density and the associated stress on surviving trees that accompany beetle infestation. This potential cost reduction would benefit not only public agencies responsible for flood and fire control efforts, but also agencies focused on watershed protection, wildlife protection, and water supply/demand management.

There appears to be potential to both improve overall watershed health and save significant quantities of water if riparian restoration efforts are prioritized, planned, and monitored appropriately at scale.

Regardless of the method employed, the impact of invasive species removal and restoration on ET rates is highly dependent on specific plant physiological conditions, as well as on the target restoration site conditions, including: (i) the level of infestation, (ii) the amount of water available, (iii) the character of surrounding vegetation, and (iv) geographic characteristics such as longitude and latitude coordinates, elevation, and exposure. These site-specific differences impact ET rates and must be taken into account when determining the potential amount of water saved through any restoration project.[21]

While tamarisk likely constitutes the most widespread woody invasive in the Basin (and in most other rivers in the Western U.S.), other invasive species now also dominate riparian corridors, including Russian olive, Siberian elm, giant reed, and "tree of heaven," as well as a large number of herbaceous weeds like kochia, Chico brush, cheat grass and Russian knapweed. Research on ET rates for other invasive species is limited, but Russian olive is documented to have ET rates similar to tamarisk and cottonwoods,[22] and the wildlife and stream flow impacts of Russian olive, which are found at higher elevations, are similar to those of tamarisk. Riparian restoration efforts to remove multiple invasive species are likely to generate both the highest ratio of water savings to treated areas, as well as the greatest potential environmental benefits and savings to public agencies.

Given these conditions, there appears to be potential to both improve overall watershed health and save significant quantities of water if riparian restoration efforts are prioritized, planned, and monitored appropriately at scale.[23] Using the previously discussed estimate of 0.54 af of water recovery per acre of restored habitat, approximately 135,000 af of water could hypothetically be saved each year in the Colorado River Basin if all estimated 250,000 acres of tamarisk infestation in the Colorado River Basin were removed and restored with native vegetation.[24]

21 Tamarisk Coalition, Independent Peer Review of Tamarisk and Russian Olive Evapotranspiration Colorado River Basin.

22 Nabil Shafike and Salim Bawazir, Southwest Hydrology, December 2007.

23 Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment.

24 Bureau of Reclamation, Colorado River Basin Supply and Demand Study Technical Report F: Appendix F8 - Option Characterization - Watershed Management, December 2012.

However, it is critical to note that any potential net water savings vary from site to site and will inherently be distributed, which will make measurement and monitoring of water benefits at specific sites particularly difficult. Moreover, as described in Section II (B) of this report, in most states within the U.S., water savings from riparian restoration efforts will be legally treated as "salvage" water that cannot be appropriated by a specific user. As such, similar to water savings resulting from forest health improvements, water benefits from riparian restoration will necessarily be "system benefits" that are not readily captured by or attributable to a specific user. That said, there will clearly be identifiable beneficiaries of flow improvements in specific watershed reaches due to the application of priority rules surrounding access to water (e.g. lower-priority downstream users may benefit from a reduced risk of losing water supplies during dry periods).

Similar to the funding sources for wildfire risk-reduction programs as discussed in Section V(A)(1), funding for the efforts to remove invasive species will, in most cases, need to be provided from public sources or via cooperative arrangements, like the Colorado River System Conservation Program or the Colorado River Basin Salinity Control Program, that are willing to pay for system-level benefits as a means of realizing long-term cost savings and distributed watershed benefits, rather than from funding by individual users. Similar to the wildfire risk reduction program, this could also benefit from the creation of a "Watershed Conservation Fund" involving contributions from downstream beneficiaries. Government agencies concerned with flood and fire risk throughout the Basin, such as the U.S. Army and flood control districts, could also be involved given the repercussions of tamarisk beetle spread and the benefits of tamarisk removal and restoration strategies. A potential exception to the requirement for all system-level funding for such efforts might be in smaller closed-system tributaries with a limited number of large, downstream users. In these cases, funding could potentially be derived from a few large downstream users who could expect to receive the vast majority of benefits associated with increased watershed yield. In addition, where river corridors pass through or near cities and towns, local communities may be in a position to contribute to these efforts as a result of direct benefits in terms of river access, recreational value, and aesthetic considerations.

2. Existing Approaches

Current riparian restoration practices are proving to be individually successful at a local and regional partnership level. However, given the capacity and public funding that would be needed to take these efforts to scale, these practices are generally not increasing ecological resiliency overall, nor are they generating meaningful benefits in increasing watershed yields. As discussed below, achieving and maintaining broader ecological goals and enhanced watershed yields would require watershed-wide invasives removal, restoration, and maintenance efforts. In this respect, there could be a significant role for private capital to play in providing for the large, up-front investments that would be needed to raise these efforts to an appropriate scale to create value over the long term. Although incentive structures for investors are yet to be tested, as discussed in Section IV, opportunities for private capital across the return spectrum—from concessionary/philanthropic involvement interested in environmental and social benefit to near-commercial returns for project-related financing—could potentially be pursued in partnership with commitments from larger public agencies as discussed below.

Figure V(A)(2)-9. Watershed partnerships focusing on removal of tamarisk and Russian olive trees and on riverside habitat restoration. Tamarisk Coalition, "Partnerships and Networking" (2013) www.tamariskcoalition.org/programs/partnerships-networking.

There are a number of efforts underway in the Colorado River Basin to restore riverside habitat by removing tamarisk and other invasive species, and reestablishing native plants through either passive or active revegetation. While these efforts started as piecemeal, site-by-site projects, more recent watershed-wide planning efforts have also been developed in the Basin on a regional basis. The Tamarisk Coalition and the Walton Family Foundation have been two key players in facilitating the transition to watershed-scale planning. Currently, 11 partnerships in the Basin either focus solely on, or conduct some portion of, invasive species removal and restoration (Figure V(A)(2)-9). Building from the success of individual regional projects, these larger partnership efforts aim to develop holistic restoration plans that prioritize work, leverage funding, plan scientifically for sound removal, manage biomass reduction and revegetation projects, ensure compliance with relevant regulations, monitor effectiveness of the implementation and maintain project sites.[25]

Many municipalities are building support for restoration efforts by highlighting the benefits of job creation and increased access to the river corridor, in addition to other benefits. For example, the Desert Rivers Collaborative in Grand Junction, CO has been investing in tamarisk control along a trail system that runs along the Colorado River through the Grand Valley. This partnership has garnered community volunteers, created restoration jobs, and engaged local conservation corps, while improving both recreational access and habitat resiliency. The city of Grand Junction is now building a concert venue adjacent to the river, and local businesses are developing property next to restoration sites and the trails system.[26] However, while these and other efforts have proven to be regionally effective at undertaking riparian restoration, scaling up removal and restoration efforts to generate system wide benefits in the Basin would require substantially greater levels of funding and effort, as well as significant coordination, implementation, monitoring, and maintenance efforts.

Scaling up removal and restoration efforts to generate system wide benefits in the Basin would require substantially greater levels of funding and effort, as well as significant coordination, implementation, monitoring, and maintenance efforts.

As previously mentioned, the cost of riparian restoration varies based on planning needs, site accessibility, type and severity of invasive infestation, control method, revegetation requirements, compliance and permitting requirements, and site-specific monitoring and maintenance requirements. Since costs vary widely, work has been done to assess the costs of previous restoration projects to determine whether specific cost elements are decreasing as institutional knowledge increases. Most studies, however, have not drawn defensible conclusions as a result of a lack of data and of the varying methods used for tracking costs. Regardless, it seems clear that traditional funding mechanisms will not be able to accomplish the magnitude of work required for a complete solution.[27]

Substantial additional financing streams are needed to bring existing riparian restoration efforts to scale if the trend of invasive tamarisk growth is to be reversed, and to ensure that comprehensive restoration efforts are undertaken in affected watersheds to control or eliminate upstream seed sources that will drive future reinfestation. Achieving this increase in scale will likely require linking restoration actions to broader watershed benefits, including approaches to estimate and track system-scale water savings from watershed management actions.

3. Proposed Solution – Performance-Based Environmental Impact Bond

The proposed Environmental Impact Bond (EIB) is intended as a proposed means of breaking through the regional funding barriers discussed above for watershed-scale restoration initiatives. An EIB could help to overcome current problems associated with small-scale restoration efforts, and could instead drive the availability of capital toward ecologically scaled riparian restoration efforts across the Basin by using the existing regional partnerships. Although achieving this scale would require commitment of larger amounts of public funding, undertaking these efforts at scale could help to potentially increase watershed yields while reducing further invasive species spread by supporting the regrowth of natural habitat.

26 Tamarisk Coalition, 2014, www.tamariskcoalition.org/programs/desert-rivers-collaborative.

27 Tim Carlson, Patrick Hickey, and Clark Tate, Sustainable Funding Options for a Comprehensive Riparian Restoration Initiative in the Colorado River Basin, Tamarisk Coalition, February 25, 2011.

ORIGINS OF ENVIRONMENTAL IMPACT BOND

As discussed in Section V(A)(1) on the proposed forest management and wildfire reduction EIB, the EIB concept is adapted from the Social Impact Bond (SIB) model. SIBs are financial instruments that introduce private capital into public projects that seek to produce positive social impact and reduce long-term government spending. Those government savings then provide a financial return for investors willing to take the risk of successful implementation of the public project. Similar to SIBs, which privatize financial risk in the service of providing a social benefit, this proposed EIB would provide a means for nonprofit entities, government agencies, and private investors to employ a pay-for-performance structure to support environmental initiatives related to riparian restoration.

STRUCTURE AND DESCRIPTION OF PROPOSED EIB FOR INVASIVE SPECIES REMOVAL AND RIPARIAN RESTORATION

The EIB for invasive species removal and riparian restoration would utilize a pay-for-performance mechanism tied to a Basin-wide public water supply enhancement funding source (a Watershed Conservation Fund, as described below). This effort would be funded by public agencies with the intention of generating increased "system water" and wildlife benefits, as well as reducing long-term cost for government agencies concerned with flood and fire risk in the aftermath of tamarisk beetle "brown-outs." In essence, the EIB would provide an investment channel for private investors and/or foundations to provide up-front funding for large-scale riparian restoration efforts, in exchange for compensatory payments from the Watershed Conservation Fund if restoration projects achieve predetermined objectives.

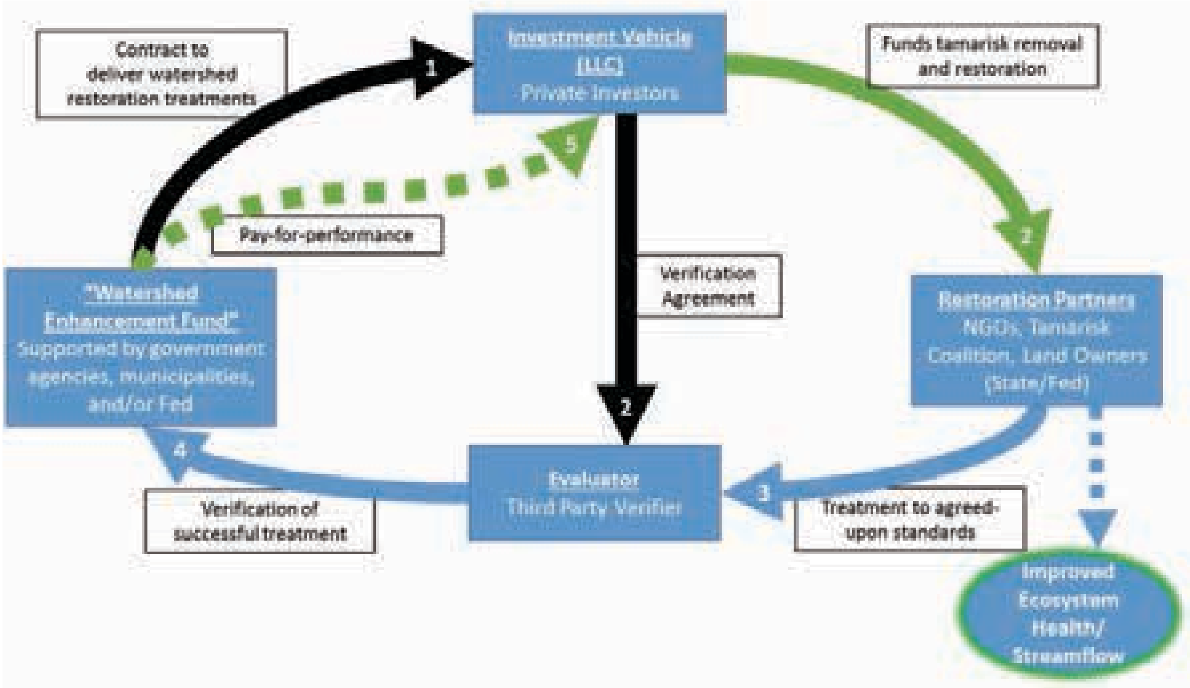


Figure V(A)(2)-10. Structure of the Riparian Restoration Environmental Impact Bond

HYPOTHETICAL CASE STUDY EXAMPLE

A target watershed for the EIB would exhibit extensive tamarisk and/or Russian olive infestation, including infestations at critical points along the river corridor that provide public river access and other benefits. Ideally, the watershed would have already experienced a tamarisk beetle infestation (i.e. brown-out), and also might be one where pilot projects have been undertaken in the past, but where previous restoration efforts have not been conducted at sufficient scale. Watersheds that contribute significant amounts of water to downstream users, who would thus enjoy potentially measurable benefits from enhanced watershed yield,) would be particularly attractive sites for such efforts.

As part of the proposal, system-level stewards such as the U.S. Bureau of Reclamation or other government agencies with exposure to costs associated with system-level flood and fire, along with potential support from specific downstream users (such as major municipalities or water utilities), charitable funders, and potential local beneficiaries, such as local municipalities and recreation interests, would create a “Watershed Conservation Fund”. This Fund would contract with an investment vehicle entity (likely a limited liability company, or LLC) that would be established and funded by private investors to arrange and fund restoration treatments on a per-acre basis. The Watershed Conservation Fund would make compensation payments for successful restoration on a per acre-basis, with the payment amounts reflecting a combination of reduced public costs associated with flood and fire risk, wildlife and endangered species benefit, recreation value, and ongoing water yield–based research showing net water savings associated with invasive species removal and restoration of native vegetation. Although downstream users would likely receive only indirect benefits from increases in watershed yield, they would be expected to contribute to the Watershed Conservation Fund due to the relatively low cost-per-af of riparian restoration in comparison to other options for increasing system water supplies. Local municipalities and recreational companies would likely also benefit from improved river access and associated recreation opportunities. Area communities could also commit interested volunteers and/or provide labor in connection with local employment programs to address temporary labor needs and reduce the net costs of restoration activities. It should be noted that the potential for creation and operation of such a Fund at scale would benefit significantly from the adoption of an effective "system conservation" program within the Basin that helped to ensure that investments in system benefits accrue to the benefit of the system and are not immediately recaptured by intervening users. Although this mechanism does not yet exist within the Law of the River, the pilot Colorado River System Conservation Program being undertaken by Reclamation and the four major municipal water suppliers in the Basin (discussed in Section V(D)(1)) is taking a meaningful first step in this direction, and could provide a vehicle for addressing those issues if it is brought to a larger scale once it moves past the demonstration phase.

HYPOTHETICAL TRANSACTION

1. A Watershed Conservation Fund (Fund) is established as a cooperative project among the Bureau of Reclamation (Reclamation) and various Basin interests seeking to reduce risk associated with drought conditions and/or flood and fire damage in brown-out regions. To support federal funds provided by Reclamation, various entities—such as municipalities, utilities, charitable funders, and other interested parties—would also contribute to the Fund in lump sum, or based on a relatively low cost per af for increased system-level water supply, as defined through site-level research by a third-party verifier. These contributions from interested parties would: lead to increased system-level water supplies in order to reduce risks associated with overallocation; ensure the availability of water for specific municipal, agricultural, or environmental needs; and/or improve local conditions for recreation or other amenity-based uses such as fishing, boating, rafting, etc.

2. An investment vehicle, likely structured as a limited liability corporation (LLC), is formed with private investors as members in order to facilitate the funds flow for removal and restoration practices, as well as accept and distribute financial return to the private investors from the Watershed Conservation Fund. An initial feasibility study is conducted by the LLC in cooperation with existing regional restoration partnerships to assess potential restoration approaches and sites, estimated treatment costs, associated potential watershed yield enhancement, and other community benefits in order to initiate the project and set the performance hurdles for the EIB investor return (discussed below).[28]

3. Based on funding available, the Watershed Conservation Fund provides a contract to the LLC[29] to pay interest and repay funds associated with successful planning, permitting, and restoration treatments via tamarisk/invasives removal and restoration of native vegetation in the watershed. Essentially these act as interest and a "principal repayment" to private investors upon completion of initial treatments (e.g. year 5) to agreed-upon standards. This interest and principal payment is based on the application of planned treatments on a per-acre or per project basis, with an additional "incentive payment" (a multiple of the invested private capital, or specific return hurdle) included in the contract between the Watershed Conservation Fund and the LLC based on potential treatment success across the watershed as evaluated against stated objectives (see below). In order to reduce the effective cost to the Watershed Conservation Fund, local parties could commit to cover a portion of these overall costs and/or in-kind services based on anticipated local benefits.

4. Working in cooperation with existing regional restoration partnerships, the LLC undertakes the development of a treatment plan for the target watershed; identifies specific treatment sites, approaches, milestones, and timelines; and specifies target compliance metrics and monitoring strategies (e.g. GPS mapping, aerial imagery, transects, and stream flow monitoring) with an independent, third-party verifier. Relevant public involvement and permitting requirements are identified and followed, and all required permits are secured.

5. The LLC provides funding for restoration treatments, monitoring activities, and watershed maintenance in anticipation of potential future distributions from the Watershed Conservation Fund (discussed above) upon successful completion of restoration work in accordance with the prearranged contract (e.g. interest, principal, and incentive payments). Investors also create a long-term monitoring and maintenance fund to maintain the treated areas over time.

6. Contractors and/or restoration crews are funded and managed by the LLC to implement treatments, with volunteer resources and other local resources used wherever possible to minimize costs. Treated areas are documented and monitored.

7. A third-party evaluator analyzes the treated areas to determine completion of stated objectives, such as successful removal of tamarisk and other invasives, replanting and subsequent survival of native plant species, and areal extent of riparian and upland habitat treated.

29 Depending on the requirements of applicable procurement rules and/or funding requirements, this might need to be undertaken pursuant to an RFP or similar competitive process.

28 For tax purposes, the private investor would be expected to have compensation income at ordinary rates. The private investor's costs with respect to obtaining contract rights (e.g. permitting and planning) likely must be capitalized and deducted over the life of the contract. The tax treatment of incurred restoration costs (i.e. whether costs associated with restoration activities must be capitalized or deducted) could potentially be complex and will have to be evaluated by the private investor.

8. If the third-party evaluator determines that objectives have been met upon the initial completion of the removal and restoration process based on contractual terms, the investors are paid back for work completed out of the Watershed Conservation Fund. If the terms are not met (or are not completely met), investors lose their invested money (or a portion of that money) in the same way they would if they had invested in a failed business.

9. After a predetermined period of time (e.g. after year 10), if the third-party evaluator determines that the watershed restoration work has exceeded expectations as defined by the initial site-level diligence and performance standards established in the contract between the Watershed Conservation Fund and the LLC, in terms of demonstrated watershed yield enhancements, increased "system water", avoided costs from flood and fire damage, etc., the Watershed Conservation Fund would pay the LLC a performance payment (e.g. a multiple of invested capital, or financial return hurdle rate). This payment would include repayment of long-term maintenance and monitoring funding secured from private investors.

10. Should the third-party evaluator determine that the watershed restoration work over that period of time (i.e. 10 years) falls short of performance standard expectations as defined in the initial contract between the Watershed Conservation Fund and the LLC, the Watershed Conservation Fund does not pay the LLC an additional financial return and residual funds in the Watershed Conservation Fund and the funds allocated to long-term monitoring and maintenance can be redirected for other uses.

4. Financial Model[30]

To further demonstrate how a market-based financial tool can be used for environmental benefit, the illustrations below detail hypothetical cash flows for a 10-year financing vehicle for a tamarisk removal and riparian restoration effort in a brown-out region of the Colorado River Basin, aimed at improving riparian health while potentially benefiting stream flow.

Since specific stream flow benefits are expected to be difficult to measure, in this example, as outlined above, a private investor/funder would provide upfront payments to conduct restoration treatments and watershed maintenance through a limited liability company, while the beneficiary, a "Watershed Conservation Fund", would promise to repay the private funders on the completion of initial restoration and maintenance. Although water savings would not be measured directly, some stream flow benefits from restoration activities would be assumed, provided that the restoration standard is achieved; as such, hypothetical costs per af of water savings are shown in the model output tables below. The private investor/funder could be further incentivized through interim interest payments on the advanced funds, while the beneficiary would conceivably be willing to pay the private investor/funder an additional amount reflecting a portion of the net cost savings realized (e.g. hypothetically, the average cost of a replacement water supply equivalent to the af of water saved).

The financial model is only intended to be illustrative, since the costs and benefits associated with removal and restoration at particular brown-out sites are highly variable, and further site-level diligence would be required for any targeted region. For purposes of this model, input data is derived from the 2012 Colorado River Basin Water Supply and Demand Study, which is based on a technical report informed by work of the Tamarisk Coalition. As noted above, however, given the rapid spread of tamarisk leaf beetles, a strategy targeted at post-beetle "cleanup" and restoration could prove to be more cost effective than traditional treatment methods in the report, and a post beetle brownout could serve to reduce the net costs-per-acre and hypothetical costs-per-af reflected in this model below.

The Basin Study indicated total tamarisk acreage in the Basin to be at least 250,000 acres as of 2009.[31] The illustrative model shown in the tables below assumes that one or two tributary-level watersheds, encompassing approximately 15,000 acres of total watershed acreage, would be addressed in the EIB. Further, given that the density of nonnative infestation varies by sub-watershed, and that the target site would include dead or dying biomass from a tamarisk beetle infestation, the model below assumes a 50%, or moderate, level of invasive species infestation, equating to 7,500 acres to treat.

One likely scenario for targeting and implementing watershed restoration strategies would be to work with current NGO-driven partnerships that are already in existence on the watershed and sub-watershed level and that have both established on-the-ground relationships and demonstrated initial progress. The model below also assumes that a combination of hand control and mechanical remov-

30 This notional financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual restoration project on an actual watershed. This hypothetical transaction is fictitious and only intended to provide some key line items interested parties might consider in assessing the potential for a transaction. Among other omissions, no tax considerations have been included in this notional financial model.

31 Bureau of Reclamation, Colorado River Basin Supply and Demand Study Technical Report F: Appendix F8 - Option Characterization- Watershed Management, December 2012, 8.

al strategies will be utilized, as well as some level of volunteer support, given past practices though the current partnerships in place. To calculate the total costs associated with treatment and restoration (i.e. removal, resprout treatment, biomass reduction, revegetation, monitoring plan survival, plant replacement, and weed control), it is imperative to note that these costs are highly variable and that actual costs for labor and removal strategies can widely differ from the assumptions used here. Nevertheless, a combination of estimated costs shown below indicates that approximately $12 million of treatment (excluding interest and transaction costs) would be required for the hypothetical case study of 15,000 acres of watershed, assuming 50% of the acreage is infested with tamarisk.

Given the nature of the pay-for-performance structure, as well as the need to incentivize private capital investors to incur the upfront costs, it is assumed that the Watershed Conservation Fund would be willing to pay investors both a range of the initial capital invested, based on the actual success of the riparian restoration strategy implemented (in this case, 2x), plus an modest interim annual interest payment for the upfront costs incurred (in this case, 1%). Given the potential range of payment outcomes, which would be detailed in the contractual agreements before implementation, the Watershed Conservation Fund could set aside a total pool of capital for a "sinking fund" that would accrue interest and be used to pay disbursements to the investor determined by certain levels of success.

In the example below, it is assumed that the initial permitting and design of the strategy would take two years, and that 90% of the treatment costs would be incurred in year 3 through year 6, with the remaining 10% (primarily maintenance and monitoring work) to be incurred in year 7 through year 10. While the benefits of the potential restoration project could be seen for 20 years or more, the investor repayment schedule is intended to return capital to the investor upon initial success (i.e., upon completion of the agreed-upon restoration work), paying back 50% of the target return in year 6 (1x invested capital, or effectively the "principal repayment"), and providing payment for the potential continued performance of the restoration work by releasing the remaining 50% of the target return in year 10[32]

Actual watershed savings may vary widely, particularly depending on the replacement vegetation chosen once invasive removal is complete. For illustrative purposes, assuming the previously mentioned annual 0.54 af increase in water for each acre in the hypothetical watershed shown below, the water benefits over a 20-year period could be more than 160,000 af in this example. Moreover, if this level of water savings were actually achieved under the hypothetical cost and repayment scenario outlined below, the implied "price" of water saved by the Watershed Restoration Fund could be around $200 per af.

32 One approach to extending the benefits of a restoration project could be to incorporate the establishment of a "spend-down" trust fund for maintenance of the restored areas over a longer period of time. This would potentially allow the investor to recover costs earlier (e.g. upon completion of the primary restoration effort, provided that the maintenance program was established and the associated trust fund was fully capitalized), which could reduce the program's net cost while guaranteeing a longer maintenance period.

Figure V(A)(2)-11. Assumptions and model drivers for the invasive species removal and riparian restoration EIB

Treatment Funding Parameters	
Watershed Acres for Treatment with Partnerships[1]	15,000
% of Watershed with Invasives	50%
Acres of Tamarisk Treated in Watersheds	7,500
Restoration Costs of Brown-out Region w/Moderate Canopy Cover[2]	
% Hand Control w/Herbicide @ $4,500/acre	15%
% Mechanical Mulching w/Herbicide @ $1,300/acre	85%
	$13,350,000
Volunteer Labor Cost Reduction/acre	$150
Total Cost of Treatment	**$12,225,000**

[1] *Assumes treatment projects with existing watershed partnerships.*
[2] *Complete Restoration Costs include resprout treatment, biomass removal, revegetation, monitoring plan survival, plant replacement, and weed control. Volunteer labor could reduce these cost estimates.*

Estimated Administrative Costs	
Project Management / Arranger Fee	$1,500,000
Legal (e.g. NEPA, 404 Permit, Section 7)	$500,000
Permitting / Design of Specific Strategy	$400,000
Third-Party Verifier Costs	$500,000
Total Administrative Costs	**$2,900,000**

Timing and Structure of Funding	
Life of Project Treatment (total cost over # years)	10
Years for Legal, Permitting and Planning	2
Years for Treatment and Monitoring	8
Annual Interest Payment on Investor Funding	1%
Total Principal Repayment (Success Payment)	1.5x
Principal Payment (Treatment Complete)	1.0x
Principal Payment (Maturity)	0.5x

Sources and Uses	
Sources	
Total Funding Needed	$15,125,000
Uses	
Total Costs for Complete Restoration	$12,225,000
Total Administrative Costs	$2,900,000

Measured Outcome for Watershed Enhancement Fund	
Benefits	
AF Increase post-Treatment / Acre	0.54
AF Increase in Watershed	8,100
Years of Benefit from 10 Year Treatment Project	20
Total AF Saved from Treatment	162,000
Cost of Long-term Maintenance and Monitoring	$3,056,250
Total Project Costs	$27,256,250
Implied Price per AF (includes long-term monitoring)	**$168**

Returns for Investor	
Multiple of Invested Capital (MOIC)	1.6x
Internal Rate of Return (IRR)	6.9%
Total Return (Incl. Interest)	$24,200,000
Discount Rate (Assume Government Issuer)	3.0%
Net Present Value	$4,459,353

Figure V(A)(2)-12. Illustrative cash flows for the invasive species removal and riparian restoration EIB

Year:	0	1	2	3	4	5	6	7	8	9	10	11-20
Operating Expenses												
Arranger and Project Mgmt Fees		$750,000	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$83,333	$833,333
Legal		250,000	250,000	0	0	0	0	0	0	0	0	
Permitting and Design		200,000	200,000	0	0	0	0	0	0	0	0	
Treatment Costs[1]		0	0	2,750,625	2,750,625	2,750,625	2,750,625	305,625	305,625	305,625	305,625	3,056,250
Third-Party Verifier Costs		0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Total Operating Expenses		$1,200,000	$583,333	$2,883,958	$2,883,958	$2,883,958	$2,883,958	$438,958	$438,958	$438,958	$438,958	$3,889,583

[1] *Assumes 90% of Total Treatment Costs are incurred in years 3-6 for removal and revegetation, and 10% of Total Treatment Costs are incurred in years 7-10 for monitoring and maintenance. For years 10-20, o project management and monitoring & maintenance expenses are assumed to be incurred. Conservatively assumes all investor capital drawn initially.*

	0	1	2	3	4	5	6	7	8	9	10	11-20
Repayment Schedule to Investor												
Total Potential Payment Due	$22,687,500						66.7%				33.3%	
Payment for Performance							$15,125,000				$7,562,500	
Interest on Principal (Current Yield)		$151,250	$151,250	$151,250	$151,250	$151,250	$151,250	$151,250	$151,250	$151,250	$151,250	
Watershed Enhancement Sinking Fund (20 year benefit)												
Fund Balance	$24,183,880	$24,183,880	$24,516,308	$24,855,384	$25,201,242	$25,554,017	$25,913,847	$11,155,874	$11,227,741	$11,301,046	$11,375,817	($0)
Interest Income 2.0%		483,678	490,326	497,108	504,025	511,080	518,277	223,117	224,555	226,021	227,516	
Disbursements to Investor		(151,250)	(151,250)	(151,250)	(151,250)	(151,250)	(15,276,250)	(151,250)	(151,250)	(151,250)	(7,713,750)	
Investor Returns												
Returns on Invested Capital	($15,125,000)	$151,250	$151,250	$151,250	$151,250	$151,250	$15,276,250	$151,250	$151,250	$151,250	$7,713,750	
Discounted Returns for NPV	(15,125,000)	146,845	142,568	138,415	134,384	130,470	12,793,619	122,980	119,398	115,921	5,739,754	

MOIC:	1.6x
IRR:	6.9%
NPV:	$4,459,353

Figure V(A)(2)-13. Investment scenarios for the invasive species removal and riparian restoration EIB

Model Sensitivities

Total Cost for Treatment (assuming moderate 50% coverage of invasives)

Vol Labr Reduc	Watershed Acres: 10,000	12,500	15,000	17,500	20,000
$50	$8,650,000	$10,812,500	$12,975,000	$15,137,500	$17,300,000
$100	$8,400,000	$10,500,000	$12,600,000	$14,700,000	$16,800,000
$150	$8,150,000	$10,187,500	$12,225,000	$14,262,500	$16,300,000
$200	$7,900,000	$9,875,000	$11,850,000	$13,825,000	$15,800,000
$250	$7,650,000	$9,562,500	$11,475,000	$13,387,500	$15,300,000

Investor Internal Rate of Return (10 years)

Interest Rate	Principal Payment (multiple): 1.0x	1.5x	2.0x	2.5x	3.0x
0.0%	0.0%	5.8%	9.3%	11.9%	13.9%
0.5%	0.8%	6.3%	9.7%	12.3%	14.3%
1.0%	1.6%	6.9%	10.2%	12.7%	14.7%
1.5%	2.4%	7.4%	10.6%	13.1%	15.0%
2.0%	3.1%	7.9%	11.1%	13.5%	15.4%

Total Costs - Paid to Investor and Long-Term Monitoring (7,500 acres treated)

Interest Rate	Principal Payment (multiple): 1.0x	1.5x	2.0x	2.5x	3.0x
0.0%	$18,181,250	$25,743,750	$33,306,250	$40,868,750	$48,431,250
0.5%	$18,937,500	$26,500,000	$34,062,500	$41,625,000	$49,187,500
1.0%	$19,693,750	$27,256,250	$34,818,750	$42,381,250	$49,943,750
1.5%	$20,450,000	$28,012,500	$35,575,000	$43,137,500	$50,700,000
2.0%	$21,206,250	$28,768,750	$36,331,250	$43,893,750	$51,456,250

Investor Multiple of Invested Capital (10 years)

Interest Rate	Principal Payment (multiple): 1.0x	1.5x	2.0x	2.5x	3.0x
0.0%	1.00x	1.50x	2.00x	2.50x	3.00x
0.5%	1.05x	1.55x	2.05x	2.55x	3.05x
1.0%	1.10x	1.60x	2.10x	2.60x	3.10x
1.5%	1.15x	1.65x	2.15x	2.65x	3.15x
2.0%	1.20x	1.70x	2.20x	2.70x	3.20x

Cost per AF for Project of 15,000 Watershed Acres (0.54 AF/Acre Treated)

Int Rate Paid	Principal Payment Multiple: 1.0x	1.5x	2.0x	2.5x	3.0x
0.0%	$112	$159	$206	$252	$299
0.5%	$117	$164	$210	$257	$304
1.0%	$122	$168	$215	$262	$308
1.5%	$126	$173	$220	$266	$313
2.0%	$131	$178	$224	$271	$318

Investor Net Present Value (10 years, 3% discount rate)

Interest Rate	Principal Payment (multiple): 1.0x	1.5x	2.0x	2.5x	3.0x
0.0%	($2,458,051)	$3,169,160	$8,796,370	$14,423,580	$20,050,790
0.5%	($1,812,954)	$3,814,256	$9,441,466	$15,068,677	$20,695,887
1.0%	($1,167,857)	$4,459,353	$10,086,563	$15,713,773	$21,340,983
1.5%	($522,761)	$5,104,449	$10,731,660	$16,358,870	$21,986,080
2.0%	$122,336	$5,749,546	$11,376,756	$17,003,966	$22,631,177

V(B). Agricultural Water Use

Investment Blueprints

B. Agricultural Water Use

Although Native Americans have diverted water for agricultural purposes in the Colorado River Basin for hundreds of years (in some places at significant scales, such as the massive irrigation projects of the Pima-Maricopa peoples in the Phoenix area), one of the first European efforts at large-scale agricultural development in the Basin was initiated by Brigham Young, who led his Mormon followers across the Wasatch Mountains of Utah in 1846.[1] Determined to settle and farm the valley of the Great Salt Lake, the Mormons built a dam across City Creek and began to develop agriculture and irrigation projects in areas that many deemed to be barren wasteland. In 1857, the US Army began to establish outposts in order to maintain a federal presence in the West, and in 1868, William Carter, who established Fort Bridger in the Green River Basin, imported Texas Longhorns to supply the troops with food.[2] Not long thereafter, New Mexico ranchers drove cattle into Brown's Park, Colorado, and cattle ranching flourished over the next decade, reaching 1.5 million head in Wyoming during the mid 1880's.[3] Growth in livestock use followed a similar trajectory in much of the Southwest; by the end of the late 1880's, New Mexico, along with much of northern and southern Arizona also supported millions of cattle – many of which were descended from cattle abandoned by the Coronado expedition during its search for the Seven Cities of Gold more than two hundred years earlier.[4]

Along with the pioneers of the Salt Lake City irrigation developments, other settlers, such as Jack Swilling – the founder of modern-day Phoenix, AZ—built dams and diversions to support mining practices and subsistence-level agriculture for the growing populations and livestock herds that followed the Homestead Act of 1862 into the western frontier. From the 1860's through the 1880's, hundreds of private irrigation companies were set up to support irrigation infrastructure projects, and while some of these private companies did not survive for more than a few years, others flourished. The development model was replicated and led to the many major agricultural diversion projects and cooperatives that are still in place today.[5] Projects like these established major Colorado River diversions such as those serving the Imperial Valley and the Palo Verde Irrigation District in California.[6]

1 Colorado River Water Users Association, Agriculture, www.crwua.org/colorado-river/uses/agriculture.

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid.

6 Ibid.

Table V(B)-1. Irrigated Acreage in the Colorado River Basin, by State, 2007[7]

	Source			
Acres (1000s)	USBR[a]	Census	USGS[b]	State
Wyoming	304	342	171	335
Colorado	754	643	695	822
Utah	368	322	321	351
(Upper)	343			332[c]
(Lower)	25			18
New Mexico	80[d]	102	103	108
(Upper)	80	78	80	80
(Lower)	[d]	24	23	28
Arizona	716[e]	876	949	n/r[f]
(Upper)	0.5			0.4
(Lower)	182[g]			502
Nevada	19[b]	33	21	n/r[f]
California	549	504[h]	504[i]	587
(Mainstem)	97			96
(SS basin)	452	452		490
U.S. Total	2,791[d]	2,820	2,765	2,704[d]
Mexico	494	501		
(Headwaters)		2		
(Delta)	494	499		
Total	3,286	3,321		

The Reclamation Act of 1902 vastly expanded these early, privately-funded efforts and promoted the rapid development and settlement of the West through federally-subsidized irrigation projects supporting small-scale family farms. The Reclamation Act and its numerous amendments and extensions provided federal funds for the construction of water storage and distribution facilities, such as dams, canals, tunnels, and reservoirs throughout the West.[8]

7 "Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin." The Pacific Institute, Michael Cohen, Juliet Christian-Smith, and John Berggren. May 2013.

8 Colorado River Water Users Association, Agriculture, www.crwua.org/colorado-river/uses/agriculture.

Today, of the Colorado River water that is diverted for human purposes, over 70% is directed toward agricultural use.[9] Due to arid conditions and lack of rainfall in the Basin, irrigation is used to provide water for more than 90% of land used to harvest crops and support livestock.[10] Overall, approximately 3.5 million acres within the Basin, as well as approximately 2.5 million acres in areas outside the Basin but that are nevertheless served by Colorado River water, are employed for crop production, requiring extensive volumes of water from the Colorado River.[11] Agriculture is also a significant user of groundwater, with approximately half of all agricultural water consumption in the Basin relying on sources other than the River itself.[12]

Agricultural users in the Basin today produce a diverse range of crops, ranging from relatively low-value crops such as alfalfa, hay, wheat, and cotton, to high-end citrus, vegetable, and lettuce crops.[13] Livestock production is also a significant contributor to Colorado River water use, ranging from the smaller-scale cow-calf operations that predominate in the Upper Basin to the large-scale feedlots and dairies of the Lower Basin; once the production of livestock feed is taken into account, livestock production is the largest user of water in the Basin. Taken together, the states located within the Colorado River Basin are responsible for 15% of total crops and 13% of total livestock produced in the United States.[14] However, the region's contribution to certain crops, such as winter lettuce and vegetables, is even more significant; for example, during the winter months, the Yuma, Arizona, region produces as much as 90% of the nation's supply of lettuce, as well as substantial international exports. The value of those crops and livestock in 2012 was approximately $37 billion and $24 billion, respectively.[15] Table V(B)-2 provides an overview of the farm production values associated with the various U.S. Basin states.

Taken together, the states located within the Colorado River Basin are responsible for 15% of total crops and 13% of total livestock produced in the United States.

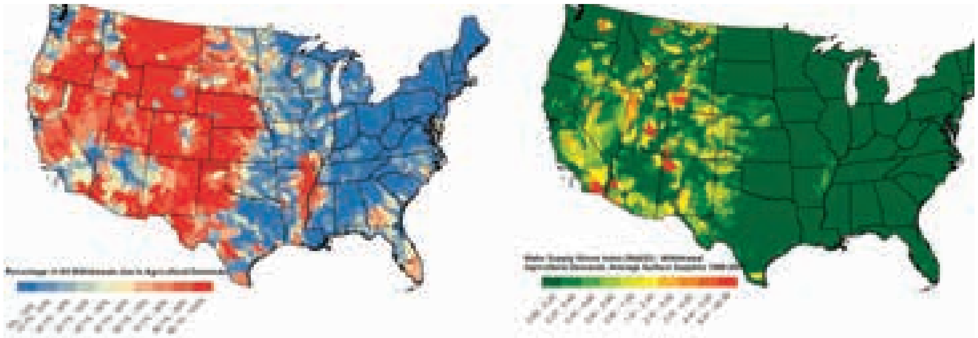


Figure V(B)-1. Contribution of Irrigated Agriculture to Watershed Stress. As shown in the maps, irrigation represents the majority of water withdrawals in the western United States, and is the also the primary driver of watershed stress in the Colorado River Basin (compare to Figure III-1 in Section III of this report). Source: K Averyt, et al., "Sectoral Contributions to Surface Water Stress in the Coterminous United States," Environmental Research Letters 8, no. 3 (September 1, 2013).

9 The Colorado River Basin: An Overview, The Colorado College, August 2011. Web, January 13, 2015, 1.

10 Aaron Thiel, "Climate Change Impacts on Agriculture in the Colorado River Basin," UWM Center for Water Policy, n.d. Web, January 13, 2015.

11 Ibid.

12 Tim James et al., The Economic Importance of the Colorado River to the Basin Region. Rep. L William Seidman Research Institute, W. P. Carey School of Business, Arizona State University, December 18, 2014. Web.

13 The Colorado River Basin: An Overview, The Colorado College, August 2011. Web, January 13, 2015, 4.

14 Aaron Thiel, Climate Change Impacts on Agriculture in the Colorado River Basin, UWM Center for Water Policy, n.d. Web, January 13, 2015.

15 U.S. Department of Agriculture (USDA), 2014. 2012 Census of Agriculture: United States Summary and State Data. Government report AC-12-A-51. Washington D.C.: U.S. Department of Agriculture. www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_US_State_Level/usv1.pdf.

As the table suggests, very significant differences are seen in the use of water in agriculture between the Upper and Lower Basins. In the Colorado River headwaters region, agricultural production is dominated primarily by ranching and crop production for forage, such as alfalfa, hay, and other feed crops for livestock. In the central area of the Basin, some production agriculture appears, but most operations are small scale. In the Lower Basin, by contrast, agriculture is dominated by large-scale production agriculture, producing a wide range of domestic and export food crops. Critically, however, it is important to note that the majority of water in the Colorado River Basin is still used to grow grass (or feed) for livestock – among the lowest-value agricultural uses. This has led some observers to note that the Colorado River Basin has "a grass problem" rather than a water problem."

As noted in Figure V(B)-1, because of the significance of its water use in comparison to other sectors, agricultural water use is in fact the primary contributor to existing watershed stress in the Basin. Given its sheer scale, reductions in agricultural water use—whether through the retirement of marginal agricultural lands or the implementation of agricultural water conservation or other consumptive use reduction techniques—will thus clearly have to be the primary target for changes in water use needed to meet emerging demands in the Basin, increased flexibility in water use to improve system resiliency, and reduced overall water use in the face of drought and climate change.

State	Estimated Irrigated Acres (2008)	Total Farm Production (farm gate value, 2011 $)[a]	Production Value Ranking		
			First	Second	Third
Arizona	876,158	$4,372,000,000	Dairy	Vegetables, beef	Cotton, grains, nursery plants
California	8,016,159	$43,544,000,000	Dairy	Fruits, nuts, vegetables/melon crops	Beef, nursery plants, hay
Colorado	2,867,957	$7,076,000,000	Beef	Corn, Dairy	Wheat, hay
Nevada	691,030	$680,000,000	Beef	Hay	Dairy, vegetables
New Mexico	830,048	$4,106,000,000	Beef	Dairy	Hay, fruit, cotton
Utah	1,134,144	$1,607,000,000	Dairy	Beef	Hogs, hay, grains
Wyoming	1,550,723	$1,450,000,000	Beef	Hay	Other

Table V(B)-2 Source: Pacific Northwest Project 2013. Note that since these are state-level production figures, not all values are derived from the use of Colorado River water or in-Basin groundwater supplies.

Nevertheless, agricultural activity plays a critical role in the Basin's economy and holds substantial political power and influence over water policy. Taken together, agricultural enterprises in the Basin states are estimated to generate approximately $60 billion in economic activity each year,[16] much of this in rural or semi-rural areas where agriculture may be the primary contributor to local economies.[17] As noted above, by virtue of prior appropriation, agricultural users tend to have large, high-priority, and long-established water rights, frequently exercised through large agricultural districts with significant economic and political power. Agricultural water use also plays important cultural, aesthetic, and political roles in the Basin, and is linked to open space and the integrity of rural landscapes,[18] cultural components such as recreational hunting and tourism, as well as to ecosystem values (which tend to be undervalued in market value assessments).[19]

Agricultural water use plays an important cultural, aesthetic, and political role in the Basin, and is also closely linked to open space values and the integrity of rural landscapes, related cultural values such as recreational hunting and tourism, and to many ecosystem values.

Given these realities, there is an understandably strong aversion to shifting water out of agricultural use, and particular resistance to so-called "buy-and-dry" approaches that take farmland permanently out of production to facilitate the transfer of water for use elsewhere. Setting aside the strong cultural values and political resistance to the transfer of water from agriculture, these transfers can create significant social and economic risks to farm communities as a result of diminished agricultural production, including loss of employment opportunities, stranded costs for the maintenance of common water infrastructure, and indirect impacts on food processing, farm equipment dealers, and the like.

Also, as discussed further in Section VI(B)(3) below, a great deal of the water held by the agricultural sector exists within irrigation districts. Since any transfer of water resources outside the irrigation district will typically require the cooperation of the district, this substantially complicates efforts to undertake water transfers, particularly where they are politically unpopular. To combat these issues, a handful of investment firms have been leading large-scale investments in agricultural lands – particularly in the Lower Basin states – that could, if taken to sufficient scale, begin to force changes in the Law of the River and various state and local policies sufficient to facilitate larger-scale transfers. There are clear opportunities available to partner with these interests to drive needed political and policy changes.

However, there are also very significant opportunities to redirect water from the agricultural sector through increased efficiency and changes in crop production that could help to avoid or minimize these political confrontations. Throughout the West, it would require only small reductions in the overall use of water in the agricultural sector to make substantial water supplies potentially available for other uses, including reductions in overall use that would provide improvements to system resilience. Traditional irrigation

16 Ibid.

17 Tim James et al. The Economic Importance of the Colorado River to the Basin Region. Rep. L William Seidman Research Institute, W. P. Carey School of Business, Arizona State University, December 18, 2014. Web, January 22, 2015.

18 Scott Swinton et al. "Ecosystem Services and Agriculture: Cultivating Agricultural Ecosystems for Diverse Benefits," Ecological Economics 64 (2007): 245–52. Science Direct. Web, January 14, 2015, 247.

19 Ibid.

methods, which are still employed in many parts of the West, typically consist of simple earthen ditches that divert water from rivers, with manually-operated canal gates along the length of the ditch that can be opened to flood fields. A significant portion of the diverted water in these systems is typically lost in conveyance along the canal, while flood irrigation may result in even larger losses to evaporation, while much of the water percolates into the ground instead of reaching crops. While much of this percolated water may return to the river, along the way it leaches salts and other pollutants from the soil, contributing to water quality degradation. Despite its relative inefficiency, flood irrigation is still used on almost half of the 60 million irrigated acres in the United States, and the technique remains widespread throughout the Basin.

Flood irrigation is still used on almost half of the 60 million irrigated acres in the United States, and the technique remains widespread throughout the Basin.

More-modern irrigation techniques, such as drip irrigation systems, micro-sprinklers, and deficit irrigation,[20] can substantially reduce agricultural water use, and can also improve crop yield.[21] Drip irrigation, which releases water slowly and directly to the roots of the plant, ensures that water is being transported and utilized efficiently and also reduces runoff and evaporation.[22] Commonly used in orchards, micro-sprinklers uniformly disperse water at a relatively low intensity throughout soil.[23] This method can allow farmers to decrease their water consumption (or at least the efficiency of water uptake by crops) and reliance on manual labor and harmful fertilizers. Deficit irrigation involves reducing water usage on crops during their most stress-tolerant growth stages.[25] This technique has proven to be successful in maintaining output levels of crops such as alfalfa, which can tolerate water shortages during certain periods in its development.[26]

Not surprisingly, the farming areas that have tended to achieve the greatest efficiency gains are typically those supporting the highest value crops (such as the lettuce fields of Yuma or the citrus and nuts of central California), where higher farm incomes can support investments in new technologies, or where regulatory requirements have mandated specific levels of farm efficiency, such as Central Arizona. Many areas of the Basin have made only minimal investments in efficiency, making agricultural water use a logical target for investment so as to free up water for transfer to other uses. Still, it is important to recognize that under the legal rules governing water use in the Colorado River Basin (and elsewhere in the West), not all agricultural conservation activity will generate legally transferable water.

These rules not only provide little incentive for farmers to become more efficient (and in many cases these perverse rules explain the lack of investment in water efficiency),[27] but can also substantially complicate investments and make the financing of agricultural improvements (such as investments in water conservation technologies or crop switching) difficult to achieve. Table V(B)-3 provides a brief overview of the major "components" of a typical irrigation water

20 Aaron Thiel, Climate Change Impacts on Agriculture in the Colorado River Basin, UWM Center for Water Policy, n.d. Web, January 13, 2015.
21 Ibid.
22 "Drip Irrigation for the Home Garden," Sustainable Landscaping, Healthy Landscapes, n.d. Web, January 13, 2015.
23 R. Godin and I. Broner, "Micro-Sprinkler Irrigation for Orchards," Colorado State University Extension, November 2013. Web, January 13, 2015.
24 Ibid.
25 Aaron Thiel, Climate Change Impacts on Agriculture in the Colorado River Basin,
26 UWM Center for Water Policy, n.d. Web, January 13, 2015.
27 Ibid.

Table V(B)-2. Four Discrete Components of an Irrigation Water Right

Component	Description	Legal Character
1. Diversion	This component of the right incorporates the total amount of water diverted from the river or the aquifer, including not just the water actually consumed, but also the extra water diverted to cover losses due to system inefficiency and the water that is ultimately returned to the stream.	Also referred to as a "diversion right." Many water rights are quantified only in terms of diversions, although the transferable portion of the right is far lower.
2. Consumptive Use	This component of the water right incorporates the water actually taken up by the crop as a combination of crop transpiration and evaporation (evapotranspiration, or "ET"). The season-long ET, less effective local precipitation, is the consumptive use. In most cases, upgrading irrigation practices will increase the efficiency of water use by reducing losses, but will not necessarily reduce consumptive use (and might increase it). Reduction in consumptive use will typically require one or more of the following: 1. Decrease in irrigated acres 2. Change in crop selection to a lower water-use crop 3. Reduction in the length of the growing season 4. Change in growing season (e.g., summer to winter) 5. Deficit irrigation (forced ET reduction) 6. Reduction in evaporative loss from the field surface (e.g. conservation tillage, mulching, drip irrigation).	The "consumptive use" typically defines the transferable portion of the right.
3. Losses	This component includes all of the water lost as part of the diversion, transmission, delivery, and use of water in irrigation, including evaporation from areas not under crop, consumptive use by non-crop plants, such as weeds and riparian plants along irrigation canals, and deep percolation that does not return to the stream.	To the extent these losses are reduced, the savings are typically considered to be "salvage water."
4. Returns	This component includes all water that returns to the stream following diversion and use, including water that simply flows through a diversion canal and back out (canal returns), surface runoff and drainage from fields, and percolation returns to the river from groundwater.	These returns are subject to appropriation by downstream users.

right; as noted in the table, only the third component of the right is typically legally transferable under prior appropriation rules. As a result, it may be difficult (and in some cases impossible) to monetize efficiency improvements that affect water use with regard to the other components of the right.

It is also important to note that where these savings can be captured, non-consumptive water savings in agriculture may reduce the water available to downstream users – including environmental users—unless the saved water is itself transferred for use further downstream. A prime example of this phenomenon can be found in the perverse relationship between the water transfers that have been undertaken from the farms of California's Imperial Valley and the health of the Salton Sea – an enormous inland body of water, created in 1905-1906 in connection with a monumental engineering accident, that is sustained almost entirely by return flows from Imperial Valley agriculture. The Sea, which has no outlet aside from evaporation, has transformed over the past century from a relatively fresh body of water to a toxic soup of concentrated salts and agricultural chemicals that now functions as a major "population sink" for migratory birds. Over the past decades, significant investments in water efficiency in the Imperial Valley (largely undertaken in connection with the water transfers authorized in the QSA) to reduce transmission losses and the efficiency of on-farm use have resulted in reductions in agricultural drainage, and with it, significant reductions in inflow to the Sea. Although a temporary mitigation program is in place, these reductions will ultimately cause the Sea to shrink significantly and grow even more toxic for migratory birds, as well as expose hundreds of square miles of toxic sediments and create "toxic dust" storms.

Substitution of current, higher-water use crops with more drought-tolerant crops on farms in the Basin could allow for both larger crop yield and reduced water consumption – without removing land from production.

However, one approach to increasing agricultural efficiency that can effectively reduce consumptive use – thus potentially avoiding both the legal and practical issues associated with reductions in non-consumptive use – is crop switching. Substitution of current, higher-water use crops with more drought-tolerant crops on farms in the Colorado River Basin could allow for both larger crop yield and reduced water consumption – without removing land from production.[28] There are a variety of potential substitution crops that require significantly less water to produce than typical high-water-use crops such as alfalfa, cotton, wheat, and sudan grass; some can also tolerate higher salinity levels. In each case, these crops offer both the potential for water savings and reduced risk of lower farm outputs during times of drought.[29] For example, the guayule rubber plant, which has been cultivated for centuries by southwestern and Mexican Indian tribes, shows great promise for farmers in Arizona.[30] The guayule plant is low maintenance and requires relatively little water to grow, allowing it to thrive in Arizona's arid climate.[31] Once guayule is established as a domesticated crop, it could offer numerous benefits for farmers as a substitute for more water-intensive crops.[32]

28 Nathan Lee Alice Plant, Agricultural Water Use in the Colorado River Basin: Conservation and Efficiency Tools for a Water Friendly Future. Rep. N.p., n.d. Web, January 14, 2015.

29 Ibid.

30 "Native Crops: Commercial Uses for Prickly Pear and Guayule," The Arizona Experience, December 4, 2012. Web, January 14, 2015.

31 Ibid.

32 Ibid.

As another alternative, the adoption of more sustainable approaches to agriculture—such as the innovative solutions offered by regenerative agriculture and agroforestry—can not only result in water savings, but also can help to restore wildlife habitat, improve soil quality, and offer watershed protection.[33] Regenerative agriculture includes methods such as intensive livestock farming, which creates healthier and more permeable soil by grazing livestock in concentrated areas for short periods, then rotating them to other areas; the use of cover crops, which are planted either during or outside the regular growing season and provide numerous environmental benefits;[34] and agroforestry, which involves planting trees and shrubs along with crops or livestock to improve ecosystem quality.[35 36]

The blueprints below focus on several approaches to improving agricultural practices and reducing water use that avoid traditional "buy-and-dry" approaches, but that nonetheless appear suitable for investment. The first two blueprints, which focus on direct and joint venture investment in ranching and farming operations to promote regenerative agriculture and crop switching, are designed to produce benefits to farming economies while also producing clearly articulable and direct environmental benefits. The third blueprint, which proposes an alternative approach to the design of dry-year option agreements, is designed to improve the relationship between farms and cities in connection with potential shortage conditions, and also to create a more economically rational structure for addressing systemic water risk.

33 "Environmental Impacts of Farming," WWF Global. N.p., n.d. Web, January 13, 2015.

34 "What Are Cover Crops?" Midwest Cover Crops Council. N.p., n.d. Web, January 11, 2015.

35 "What Is Agroforestry? Association for Temperate Agroforestry. N.p., n.d. Web, January 14, 2015.

36 Ben Falk, "Build Healthy Soil Through Regenerative Grazing," Mother Earth News. N.p., September 2014. Web, January 14, 2015.

SECTION V(B)(1):

Holistic Management of Working Ranch Lands:
Improving Soil and Grasslands Health for Environmental Benefit

Summary

This investment vehicle is structured to make investments in improving grasslands condition and soil health through changes to the management of working ranch lands. More specifically, this strategy seeks to provide investment capital for ranches to convert to more sustainable and resilient ranching practices on both private lands and public leased lands, through partnerships between investors and existing ranch owners/operators. Investor returns could be generated from increased quantity and quality of livestock outputs, while improvements in grassland condition and soil health would be expected to produce both direct and indirect environmental and economic benefits through contributions to watershed yield, decreases in pollutant loading, and the appreciation of underlying land values. These objectives could be combined with public environmental support programs that are already in place, such as carbon banking, mitigation banking and nutrient loading, to help leverage public capital for environmental benefit, or the objectives could be approached directly with private party participants. Additionally, a joint venture strategy with attractive incentives could help to facilitate the entry of young farmers into the livestock industry or keep existing owner-operators on their land.

1. Background

The full cycle of livestock production (including the growing of livestock feed) represents by far the largest single source of water use in the Colorado River Basin. Taken as a whole, the seven Colorado River Basin states account for around 13% of total U.S. livestock production.[1] While livestock and associated feed production in these states is not solely dependent on water from the Colorado River, agricultural production, collectively, is responsible for an estimated 70% of all water use in the Colorado River Basin.[2] While the direct use of water by livestock (for drinking water, cooling water, and similar uses) represents a relatively small proportion of total water use, the indirect use of water by livestock via the production of feed is substantial. For example, in the Upper Colorado River Basin, approximately 90% of all water use is dedicated to agricultural production; of the 1.6 million irrigated acres in the Upper Basin, an estimated 88% is used to produce feed for livestock.[3]

Livestock production also influences the ecology and hydrology of the Colorado River Basin in a more subtle and widespread fashion as a result of its impacts on grasslands, riparian areas, and other areas in the Basin. Grazing occurs throughout the Basin -- not just in the comparatively wet Upper Basin States where cattle ranching is probably the most iconic. For example, of the 99 million acres of land located in the comparatively arid Lower Basin, approximately 82 million acres are utilized for rangeland or pasture.[4] Also, while a great deal of grazing is concentrated on private lands, across the Western U.S. approximately 73% of publicly-owned land (an area of around 270 million acres) is currently grazed under lease agreements issued by the Bureau of Land Management and the U.S. Forest Service, predominantly by large livestock operators.[5]

Figure V(B)(1)-1. Cattle grazing on grasslands.
Courtesy: National Resources Conservation Service.

1 Colorado River Basin Water Supply and Demand Study, Report of U.S. Department of the Interior, Bureau of Reclamation, December 2012.
2 Basin Report: Colorado River, Bureau of Reclamation, April, 2011, http://www.usbr.gov/climate/SECURE/factsheets/colorado.html.
3 Water Development, Extraction, and Diversion, http://cpluhna.nau.edu/Change/waterdevelopment6.htm. November, 2014.
4 Ibid.
5 Fact Sheet on the BLM's Management of Livestock Grazing. http://www.blm.gov/wo/st/en/prog/grazing.html. November, 2014.

Both historic grazing uses and more recent practices have had complex effects on the ecosystems of the Colorado River Basin. Where grasslands are maintained in good condition, grazing and the deposition of manure are a critical part of the ecosystem, helping to build soil, improve water infiltration, and increase nutrient cycling. However, over- and under-grazing by cattle, and in some areas of the Basin, sheep, has caused extensive changes in the landscape over time.

Both historic grazing uses and more recent practices have had complex effects on the ecosystems of the Colorado River Basin.

Cattle and sheep were introduced into the southern portions of the Basin around the year 1540, when Francisco Vásquez de Coronado, accompanied by cavalry, foot soldiers, slaves, pack animals, and huge herds of cows, pigs, and sheep, set out from Mexico City in search of the mythical kingdom of Cibola and the Seven Cities of Gold. The wild herds that descended from these animals became the foundation for a booming frontier sheep and cattle industry in what is now Sonora, Mexico and Southern Arizona.[6]

Cattle were also introduced into the central parts of the Colorado River Basin during the early 1880s, as the arrival of the railroads made the growing Eastern markets available to cattle ranchers and investors. For example, the arrival of the Atlantic and Pacific Railroad and the stockyards at Holbrook in northern Arizona gave birth to the massive Aztec Land and Cattle Company, which relocated thousands of cattle from Texas (where overgrazing and drought had destroyed Texas range lands and left thousands of cattle starving). Aztec acquired more than 1 million acres of private grazing land from the railroad, which due to its "checkboard" nature left the company in control of some 2 million acres of high-quality private and public range land in Northern Arizona.[7] Similarly, the Wyoming cattle industry was born in 1857, when the movement of the U.S. Army into Utah as part of the ongoing dispute between the federal government and Mormon settlers presented the opportunity for William Carter -- a Fort Bridger merchant who served in various roles as judge, cattle baron, and beef and lumber supplier to the Army – to import the first 900 head of cattle into the area. Just 25 years later, there were at least 1.5 million cattle in Wyoming.[8]

The impacts of over- and under-grazing began to manifest early in the history of the Basin, and in some cases in dramatic fashion. For example, in Southern Arizona, a severe drought that struck the region in the early 1890s led to the loss of between 50% and 75% of the cattle in the territory as a result of starvation -- but not before the herds denuded the landscape of virtually all vegetation. Rain and flooding events that followed the drought in 1893 resulted in widespread damage throughout southern Arizona, cutting deep arroyos in stream and river beds, stripping away vast amounts of topsoil, and instantly converting the once-rich grass savannahs surrounding Tucson into the comparatively barren, creosote-scrub desert ecosystem that exists there today.[10]

Similar disasters befell the ranching industry in other parts of the Basin. The harsh winter of 1886-1887 destroyed herds throughout Wyoming and Colorado in the Upper Basin, and range crowding in the 1890s

6 C. Luther Propst, Peter W. Culp, Searching for Cibola: Community-Based Environmental Restoration in the Colorado River Watershed, 42 ARIZ. L. REV. (2000).

7 Abruzzi, W. S. 1995. The Social and Ecological Consequences of Early Cattle Ranching in the Little Colorado River Basin. Human Ecology 23: 75-98

8 Colorado River Water Users Association, River Uses: Agriculture, available at: http://www.crwua.org/colorado-river/uses/agriculture

9 Gerald R Noonan, The overgrazing of Arizona rangelands. Science Quest Technical Paper 2 (October 20, 2011).

10 C. Luther Propst, Peter W. Culp, Searching for Cibola: Community-Based Environmental Restoration in the Colorado River Watershed, 42 ARIZ. L. REV. (2000).

and 1900s on much of the Colorado Plateau – by both cattle and sheep – caused widespread damage to grasslands and native forests. One commentator noted that the forest floor in mid-elevation areas and highlands was rendered "as bare and compact as a roadbed," and the natural fire ecology was drastically altered (see discussion of other fire-related forest impacts in Section V(A)(1)).[11] Today, almost 120 years after one company's oversized herds destroyed portions of the northern Arizona range, wiping out local grasslands and leaving the country badly eroded by deep ravines and gullies, the rangeland in the area is estimated to be able to support only one-third to one-half of the number of grazing animals that it could prior to the introduction of livestock in the 1880s.[12]

Figure V(B)(1)-2. Riparian area along Custer Creek, Montana, damaged by historic overgrazing; in process of restoration by Haughian Ranch through improved grazing management.

Courtesy Scott Kaiser, Montana Department of Natural Resources and Conservation

Even where over- and under-grazing are less dramatic in nature, it can still significantly affect the composition of plant communities over time. These plant communities are affected by the selective grazing pressures that animals put on specific types of grasses and other edible plants, competitive advantages conferred to undesirable or inedible plants that grazing animals will not eat, damage to plant communities from trampling, and dispersal of seeds through mechanical movement or the consumption and deposition of seeds in manure. In additional to plant communities, native wildlife communities can also be affected by habitat losses or changes, direct displacement, and disease, invasive species may spread into disturbed areas, and fire regimes can be changed in a manner that further erodes both grassland and forest health.

Taken as a whole, historical ranching practices and resulting landscape changes have now altered most of the grassland ecosystems of the Basin on both public and private lands. Very few examples of relatively unaltered, native grasslands remain anywhere in the Basin; many grasslands have disappeared altogether or are now devoid of vegetation, and most remaining grassland areas are unhealthy. Assessments of public lands, for example, have found that less than one third of lands leased for grazing were in good condition, with most lands in only fair to poor condition. In most areas, soil quality has declined and vegetative communities have also changed significantly, with many desirable grass species replaced with invasives, juniper trees, and less productive species. Grazing also has significant implications for the health of riparian habitats in the Basin; the same combinations of food, water, and shade that make these areas significant for wildlife also attract livestock. Damage to riparian habitat from overgrazing and trampling, sedimentation and siltation from erosion, together with the permanent destruction of riparian areas and streams from downcutting and arroyo formation, are widespread problems through-

11 Christopher J. Huggard and Arthur Gomez, Forests Under Fire: A Century of Ecosystem Mismanagement in the Southwest, University of Arizona Press, 187 (2001)(quoting Professor J.W. Toumey, Our Forest Reservations, Popular Science Monthly (June 1901))

12 Abruzzi, W. S. 1995. The Social and Ecological Consequences of Early Cattle Ranching in the Little Colorado River Basin. Human Ecology 23: 75-98.

out the Basin. The water quality of many rivers and streams is also negatively impacted by the presence of livestock, most notably by the deposition of manure in and along stream channels.[13]

Assessing the impacts of livestock on watershed yield is difficult to quantify precisely, but livestock ranching practices are widely understood to have led to increased desertification of grasslands, changes in surface runoff, and a general lack of ground cover, which plays an important part in the hydrologic cycle associated with soil health.[14] Many experts, such as Allan Savory, argue that the desertification and associated problems that are sometimes attributed to cattle are not necessarily due to the cattle themselves, but rather to the nature of existing ranching practices. Regardless, at the simplest level, the loss of grass cover leads to soil erosion and reduces infiltration rates, which cuts down on the amount of precipitation that becomes groundwater. This erosion, together with lowered water tables resulting from declines in infiltration and the downcutting of ravines and arroyos, then reduces the soil's overall ability to hold water.[15] This, in turn, leads to further loss of plant diversity and ground cover, which causes soil hardening, further increasing erosion and sedimentation of streams. Lowered water tables can also ultimately destroy wetlands, cienegas, and springs.

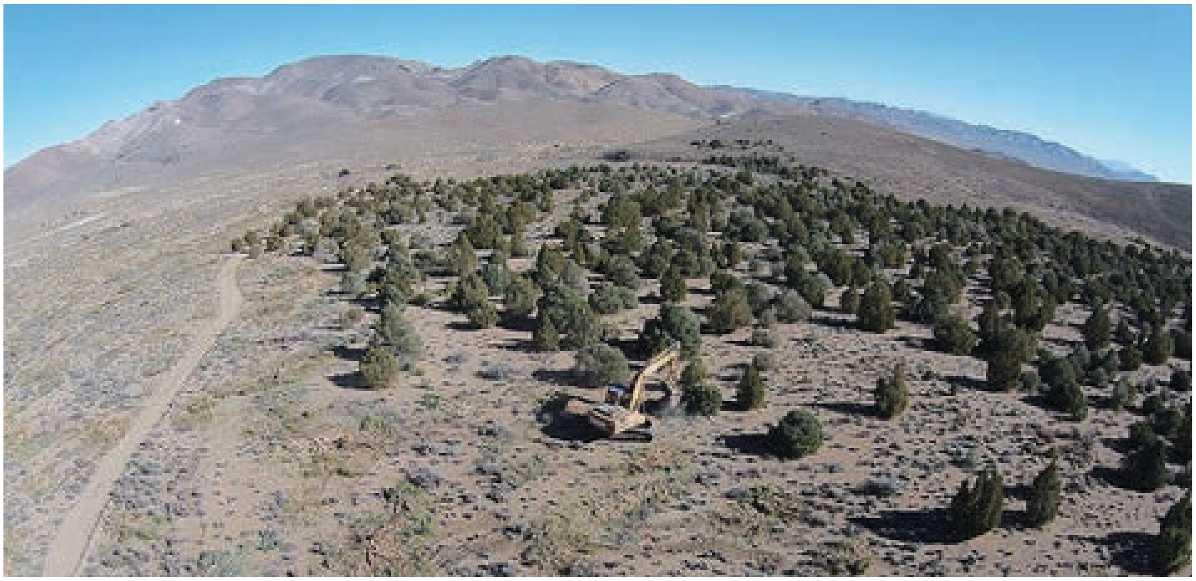


Figure V(B)(1)-3. Treatment of encroaching pinon-juniper forest on BLM grazing lands in Nevada.

As previously mentioned, grazing can also accelerate the spread of juniper and other tree species (such as mesquite) into former grassland areas. This is largely a result of preferential grazing by livestock, which removes edible plants but leaves behind woody shrubs, which then prevent grassland recovery through shading of the ground and competition for water. One study shows that anywhere between 9 and 35 juniper trees per acre are enough to consume all available moisture in an area receiving 13 inches

13 U. S. Department of the Interior, "Water Quality in the Upper Colorado River Basin". 1996-1998.

14 Keith T. Weber and Bhushan S. Gokhale, Effect of Grazing Treatment on Soil Moisture in Semiarid Rangelands, 161–74. Final Report: "Forecasting Rangeland Condition with GIS in Southeastern Idaho." N.p.: 2010. Print, 162. See also R. A. O'Brien et al., 2003. "Indicators of Rangeland Health and Functionality in the Intermountain West." U.S. Department of Agriculture, Rocky Mountain Research Station, General Technical Report RMRS-GTR-104.

15 Zeedyk, B. and J. Jansens. 2004. An introduction to erosion control. The Quivira Coalition, Santa Fe, New Mexico USA. Sponholtz, C. 2005. Agro-ecological Restoration. M.A. Thesis, Prescott College, Prescott, Arizona.

of precipitation per year;[16] when conditions are dry, species like juniper and mesquite can also draw water from tap roots deep below the surface (160 feet or more), further lowering groundwater levels. Once established, these tree species also further lower the penetration of water into soils, contributing to runoff and erosion. [17]

Unsustainable grazing practices and poor grassland health are also contributing to the emerging issue of "dust on snow." Recent studies that have evaluated the impact of human-caused dust deposits on mountain snow packs in the Upper Colorado River Basin suggest that the amount of dust falling in the Rocky Mountains has increased by 500% to 600% since the mid to late 1800s, when grazing and agriculture began to disturb fragile (but previously stable) desert soils. These dust deposits make the snowpack darker, reducing the ability of the snow to reflect sunlight; this causes snow to melt faster and earlier in the season. This in turn increases evaporation and "sublimation" rates (where snow evaporates directly into the atmosphere) and causes earlier growth of vegetation, which consumes more water over the course of the year. These impacts are estimated to have resulted in an approximate 5% reduction in average runoff – a total loss of around 35 billion cubic feet of water (approximately 800,000 af) from the Colorado River each year as compared to pre-settlement levels.[18] Study researchers have suggested that better management of livestock grazing could help to reduce the severity of dust on snow impacts in the Basin.[19]

Improvements in livestock production practices could be a significant contributor to increasing watershed health and maintaining sustainable water supplies.

These impacts on Basin water supplies are, of course, mostly indirect. As such, investments in improving range management and grasslands health have not generally been a focus of water management efforts, and like the watershed enhancement strategies discussed in Section V(A), are not likely to produce increases in water supply for the Basin's human or environmental users that can be legally developed or captured by individual downstream users. Nevertheless, given the broad implications that grazing and livestock production have for grasslands, riparian areas, soil conditions, and the larger hydrologic cycle in the Basin, improvements in livestock production practices could be a significant contributor to increasing watershed health and maintaining sustainable water supplies.[20] Many groups, such as the Fox Ranch, Dixon Water Foundation, Quivira Coalition, and Ladder Ranch are investing in improved livestock management and grazing practices to capture some of these broader environmental benefits.

2. Existing Approaches

Many approaches to improved ranch land management have been pursued in the Colorado River Basin and elsewhere in the West. These include: investments in better range planning, enforcement of limitations (and in some cases expansion) on the number of grazing animals, better monitoring of soil and grassland conditions, employment of conservation easements to control land use and protect intact landscapes, fencing to avoid impacts to sensitive ri-

16 Deboodt, T.L., M.P. Fisher, J.C. Buckhouse, and J. Swansen. 2009. Monitoring Hydrological changes due to western juniper removal, a paired watershed approach. The Grazier May 2009: 5-12. Oregon State University, Corvallis Oregon.
17 Jacobs, B.F., R.G. Gatewood, and C.D. Allen. 2002. Watershed restoration in degraded piñon-juniper woodlands: A paired watershed study 1996-1998. Final report to: USGS-BRD Research/NPS-Natural Resource Preservation Program. Bandelier National Monument, Los Alamos New Mexico
18 Painter, T. H., J. Deems, J. Belnap, A. Hamlet, C. C. Landry, and B. Udall (2010), Response of Colorado River runoff to dust radiative forcing in snow, Proceedings of the National Academy of Sciences, in press.
19 Andy Soos, The Dusty Colorado River, Environmental News Network, September 22, 2010.
20. (NEXT PAGE)

parian areas, and control of invasive species. Many of these approaches entail needed long-term reductions in range use, the elimination of grazing in sensitive landscapes, or affirmative investments in restoration of streams and other habitat areas to manage impacts associated with past over- and under-grazing, erosion, and similar issues.

There is an extensive literature regarding methods to improve the management of range lands in the Western United States. Taken together, range management issues present complexities, challenges and opportunities that are probably at least equal to those connected to water management in the Colorado River Basin -- and as such are well beyond the scope of this report. However, some emerging range management strategies suggest that there could be significant potential for private investment in emerging "regenerative agriculture" techniques. Essentially, these are targeted approaches to livestock production that can increase net yields across rangelands over time and simultaneously improve grassland conditions. The intensive rotational grazing and technique discussed below is an example of an emerging approach to enhanced range management that could be the subject of a private impact investment model.

Figure V(B)(1)-4. Creosote-dominated landscape in New Mexico resulting from historic overgrazing.

Courtesy U.S. Bureau of Land Management

Figure V(B)(1)-5. Same area Figure V(B)(1)-4, five years later, restored to healthy grassland through Bureau of Land Management's Restore New Mexico project.
Courtesy U.S. Bureau of Land Management.

On some ranch lands, so-called intensive rotational livestock grazing may be utilized as a form of regenerative agriculture, with numerous environmental benefits. This technique, which grew out of the 1980s-era "Savory method"[21] (which was designed to imitate the movement of wild animals), requires that a high concentration of livestock graze intensively on a confined plot of land for a short period, but then don't return to that plot until the grasses have time to fully regenerate.[22] Essentially, these livestock graze on tall grasses until the grasses are almost, but not entirely, grazed down, and as a result of this pruning (and the trampling of dead grasses

21 Allan Savory, The Savory Grazing Method or Holistic Resource Management, Rangelands 5(4) (1983).

22 Ben Falk, "Build Healthy Soil Through Regenerative Grazing," Mother Earth News. N.p., September 2014. Web, January 22, 2015. 20 One example of an effort to address watershed health through improvements in range management is the Pasture Project of the Upper Mississippi River Basin, created to address water quality issues of the Mississippi River and the Gulf of Mexico. The project attempts to facilitate the transition to sustainable practices and increase the total number of farmland acres that adopt sustainable farming techniques, such as managed livestock grazing and cover crop use, in a way that offers both environmental and economic benefits for participants. As a result of the Pasture Project, landowners and farmers adopted grass-based animal agriculture and nutrient management strategies that increased soil health and improved water use. "Pasture Project," Wallace Center. N.p., n.d. Web, January 23, 2015. www.wallacecenter.org/pastureproject.

and woody plants), the plants' roots die back and organic matter remains within the soil.[23] Following the intensive grazing period, animal manure is left behind, providing nitrogen and other organic matter to enrich the soil.[24] Sod that is churned up by the livestock allows rainwater to transport recently accumulated nitrogen, as well as microbes present within the manure to seep deeper into the soil, increasing nutrient content.[25]

Because intensive livestock grazing opens the soil, nutrients and biological microbes are less likely to leave the landscape along with runoff, so seeds are able to sit deeper in the topsoil.[26] Because grasses are not completely grazed down, they grow back quickly before the livestock returns, and the roots grow back even longer than before, allowing nutrients to permeate deeper into the soil.[27] Further, because grasses are left with living roots, the symbiotic relationships between those roots and soil fungi critical to water retention and soil moisture, notably myccorhizae, are able to persist.[28]

On some ranch lands, so-called intensive rotational livestock grazing may be utilized as a form of regenerative agriculture, with numerous environmental benefits.

These improvements in soil health present a substantial commercial opportunity for ranchers, allowing for more income from the same amount of available land. Nutrient- and microbe-rich soil is better able to support grass growth, enabling farmers to produce grass-fed beef. Grass-fed beef, currently only about 1% of the domestic U.S. beef market, can command a premium price over conventional beef, and the grass-fed category is anticipated to grow dramatically over the next five to eight years.[29]

The Fox Ranch, a commercial cattle ranch and nature preserve in Colorado, is being utilized as an experiment to examine the potential benefits of intensive rotational livestock grazing.[30] Nathan Andrews, a cattle farmer on the ranch, observed that intensive rotational livestock grazing resulted in higher levels of grass production.[31] In years of drought, Andrews was also able to grow the size of his herd, while other ranchers struggled, showing how the strategy can be valuable even during the most adverse conditions.[32] Allan Savory, a major proponent of regenerative grazing, stresses the importance of the interaction between cattle and soil in enriching soil quality and overall health of the land.[33]

The Dixon Water Foundation, which runs four demonstration ranches in Texas that face similar water challenges as those in the Colorado Basin, also employs an intensive rotational livestock grazing approach. All of its cows graze in a particular pasture for a brief period of time, after which they are moved to another pasture to allow grass to fully regrow. The Foundation reports that this approach to grazing "stimulates grass root growth, creating more vigorous plants and enhancing soil quality and biodiversity." Specifically with regard to soil quality, research from New Mexico University's

23 Ibid.
24 Ibid.
25 Ibid.
26 Ibid.
27 Ibid.
28 A. De Vliegher and L. Carlier, Eds. "Permanent and Temporary Grassland Plan, Environment and Economy." Grassland Science in Europe Volume 12. (2007) 247-258, Print.
29 Allen Williams and Rod Ofte, "Organic Grass-fed Beef Success", The Pasture Project, 2015.
30 "Ecologists Turn to Planned Grazing to Revive Grassland Soil," NPR, August 5, 2013. Web, January 22, 2015.
31 Ibid.
32 Ibid.
33 Ibid.

Institute for Sustainable Agricultural Research (ISAR) has demonstrated that intensive production can yield "biomass growth greater than 7,200 grams/m2/year or approximately three times the production of natural systems with no nutrient amendments."[34] These improvements in root growth and soil in turn allow more rainwater to penetrate the ground, reducing erosion and replenishing local rivers and aquifers.[35]

Similar to the Fox and Dixon Water ranches, the Ladder Ranch, a 135-year old family farm in Wyoming, employs a range of holistic management techniques to capture both commercial and environmental benefits. As owner and rancher Pat O'Toole says, "We were always taught to keep one eye on the livestock and one eye on the landscape. One does not do well without the responsible management of the other." In additional to intensive rotational grazing, the O'Tooles also plant cover crops on their farmland, partner with land trusts to place acreage under conservation easement, and voluntarily reduce their irrigation diversions during low flow periods to maintain sufficient water in local fisheries (despite possessing senior water rights)[36] The O'Tooles credit their integrated fishery and irrigation system as enabling them to run both a viable agricultural operation and an outdoor recreation business, which caters to fishing, birding, hunting, cycling, and tourism.

An academic study conducted on intensive rotational livestock grazing in southeastern Idaho grasslands also verified that livestock management had a significant effect on soil moisture, which is a major determining factor of land productivity.[38] Range land in that region is reliant on ground cover, which enables the land to properly capture, store, and release water.[39] While the study did not find a significant difference in ground cover when comparing intensive livestock grazing with a rest-rotation condition where cattle grazed for long periods at a low intensity, it did determine that soil moisture levels were significantly higher when cattle were grazed at a high density for short periods.[40] Further, intensive rotational grazing increases levels of organic biomass in soil as discussed previously, which has been linked to water benefits. Allen Williams, a grass-fed beef expert in the U.S. and a core team member of the Wallace Center's Pasture Project to promote the expansion of grass-fed livestock in the Upper Mississippi River Basin[41], has commented on controlling water runoff through increased organic matter in soil. Allen has found in one particular instance that 2% organic matter in soil held 32,000 gallons of water, or 21% of a heavy rainfall, 5% organic matter in soil held 80,000 gallons of water, or 53% of a heavy rainfall, and 8% organic matter in soil held 128,000 gallons of water, or 85% of a heavy rainfall.

Beyond the potential for improvements in soil moisture and grassland health, there is evidence that intensive rotational livestock grazing and resulting improvements in soil health via increased organic matter could create the conditions necessary for meaningful carbon sequestration and climate change mitigation.

34 David C. Johnson, Joe Ellington, and Wes Eaton, Carbon Sequestration: A Practical Approach, New Mexico University Institute for Sustainable Agricultural Research, Web, June 12, 2015.

35 "Sustainable Land Management," The Dixon Water Foundation. June 9, 2015.

36 Daniel Fullmer, Kate Greenberg, and Dan Keppen, Innovations in Agricultural Stewardship: Stories of Conservation and Drought Resilience in the Arid West, National Young Farmers Coalition and Family Farm Alliance, May 17, 2015. Web, June 9, 2015.

37 "Colorado Freshwater Forum: Exploring Colorado's Solutions to a National Challenge", the Johnson Foundation, October 18, 2011. Web, June 9, 2015.

38 Keith T. Weber and Bhushan S. Gokhale, Effect of Grazing Treatment on Soil Moisture in Semiarid Rangelands, 161–74. Final Report: "Forecasting Rangeland Condition with GIS in Southeastern Idaho." N.p.: 2010. Print, 162.

39 Ibid.

40 Ibid.

41 "The Pasture Project", the Wallace Center at Winrock International, Web, June 18, 2015.

The New Mexico-based Quivira Coalition has proposed that employing these sustainable practices (including: planned grazing systems, active restoration of riparian, riverine and wetland zones, removal of woody vegetation, conservation of open space, implementation of no-till farming practices, and management of land for long-term resilience) could yield healthy soil better able to grow green plants and therefore better able to store atmospheric carbon. In fact, Quivira cites research by Dr. Peter Smith of the University of Aberdeen, Scotland suggesting that "carbon accrual on optimally grazed lands is often greater than on ungrazed or overgrazed land."[42] Research from ISAR shows that production through intensive rotational livestock grazing could have the ability to absorb current total carbon emissions resulting from human activity if year-round, intensive rotational grazing was adopted on 17% of the world's arable cropland.[43] This research suggests that, properly designed, grasslands restoration efforts might ultimately support the development of marketable carbon credits, in addition to the other potential revenue streams discussed below.

3. Proposed Solution

In this broader context, a private capital solution for financing improvements in ranch management that would incentivize or facilitate the transition of individual ranch operations towards more sustainable practices (such as intensive rotational grazing) could help to drive larger improvements in range land health that could produce a variety of hydrological and ecological benefits in the Colorado River Basin.[44]

Given that much of the ranch land in the Colorado River Basin is leased by large cattle owners from private and government entities, such as the Bureau of Land Management or state land boards, one potential strategy for introducing sustainable ranch land management would be through joint-venture driven intensive rotational grazing to prove soil health and environmental benefits on working ranch lands. For example, a "cattle ownership" strategy could involve investing in a cattle herd for an ongoing cow/calf operation whereby the investor would slowly increase the stocking rate to the extent the rotational grazing practices are successfully driving an increase in forage and capacity to hold livestock. This strategy would keep ranch land in operation, and also allow for increased land rental rates to benefit both government entities and private ranch land owners. The return for the investor in this cattle ownership strategy would include selling higher quantity and quality of grass-fed beef, for example.

42 Courtney White, The Carbon Ranch: Fighting Climate Change One Acre at a Time, Quivira Coalition, December 2010. Web, June 9, 2015.
43 David C. Johnson, Joe Ellington, and Wes Eaton, Carbon Sequestration: A Practical Approach, New Mexico University Institute for Sustainable Agricultural Research, Web, June 12, 2015.
44 As noted above, although improvements in grassland health can be expected to produce benefits to water supply and water quality at the Basin scale, these benefits would almost certainly be indirect and distributed in nature (e.g., improvements in groundwater conditions and decreases in dust on snow events, leading to incremental increases in base flow). As such, similar to the issues surrounding the financing of forest health and tamarisk control measures in Section V(A)(1) and (2), we do not believe that these improvements could be financed based on expected water benefits; instead, these improvements would need to be undertaken based on returns that could be generated from increases in ranch outputs independent of any benefits to the Basin at large.

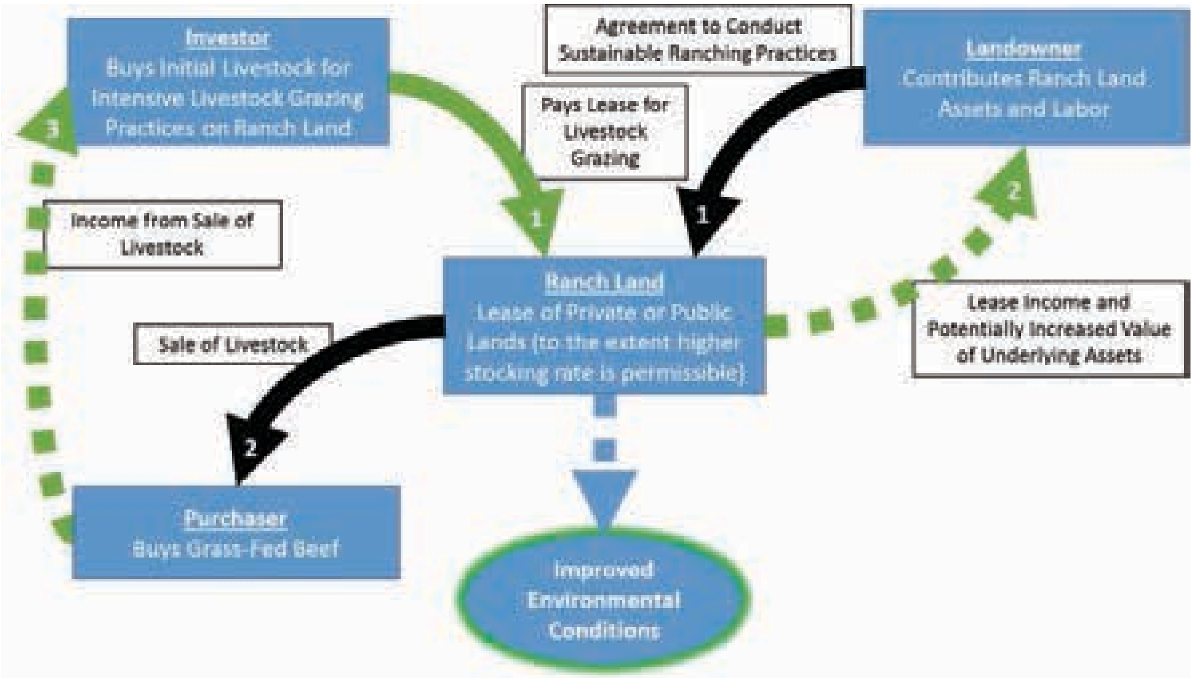


Figure V(B)(1)-6. Structure of Holistic Management of Working Ranch Lands via Cattle Ownership

Another option for initiating sustainable ranch land management would be through the direct purchase of underutilized ranch lands. This "land ownership" strategy would be best suited for the aging farm/ranch population that is not interested in maintaining ownership of land into the future, but that would prefer to see land utilized for agricultural use rather than for municipal or industrial development. Under this strategy, an investor with a goal to increase soil and grasslands health (and with it, net livestock yield) would purchase land and implement intensive rotational grazing practices, funding the conversion to revised ranching practices - including any capital costs associated with planning, upgraded ranch machinery and monitoring equipment, changes in fencing, water infrastructure, and training/educational costs - while a separate cattle owner would contribute the livestock and agree to pay for the use of the ranch land on an animal unit (AU) basis. The financial return from this land ownership strategy would include the rental income from increased stocking rates of animal units, as well as appreciation on the underlying land or asset value. This strategy could also potentially work under a profit-sharing or joint-venture arrangement, and could facilitate the entry of young farmers or cattle owners who do not have the financial capacity to initiate ranching operations of their own.

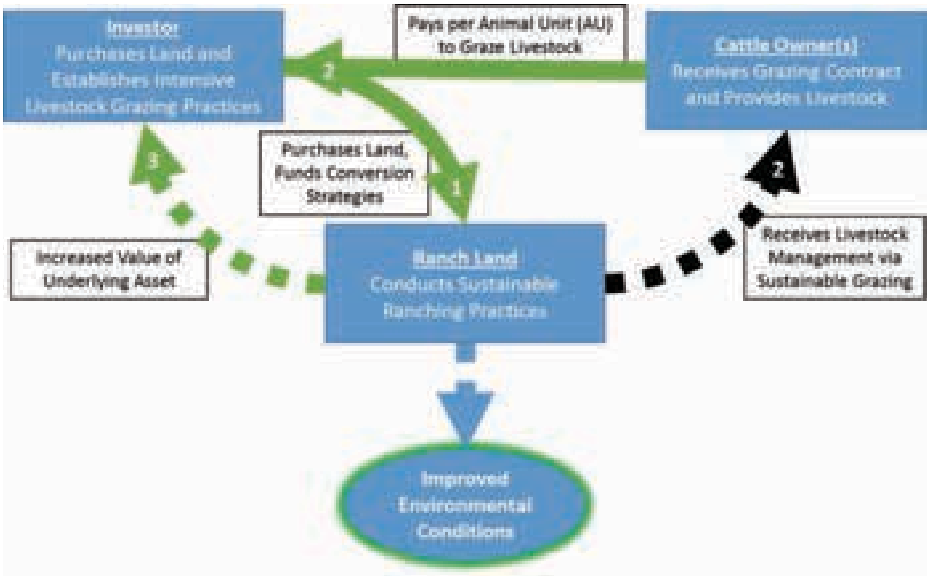


Figure V(B)(1)-7. Structure of Holistic Management of Working Ranch Lands via Land Ownership

HYPOTHETICAL CASE STUDY EXAMPLES[45]

In the "cattle ownership" scenario described above, it is assumed that an investor or joint venture would fund the purchase of an initial stock of weaned feeder calves (a.k.a. feeders), as well as brood cows (mother cattle) and bulls that would be used for breeding on leased ranch land. The number of cattle purchased in each of these categories would depend on the initial stocking rate of the land for supporting grass-fed cattle. The stocking rate, or carrying capacity, is defined as the number of animal units a ranch can support at a given time without deteriorating the land. Research in other arid grassland regions in the U.S. has shown that stocking rates can increase significantly—up to three times—when ranchers combine strategies to maintain soil microbial health with intensive rotational grazing.[46] Ideal ranches on which to pursue this cattle ownership strategy include those where the owner may wish to keep land in production (versus selling the land for municipal or industrial development), but may not necessarily want to incur the operating costs and risks associated with ownership of a cattle herd. Certain government leased lands through the Bureau of Land Management (BLM) and the U.S. Forest Service may also be attractive for this strategy depending on the willingness of federal agencies to explore flexibility in stocking rates in connection with range health improvements. The extensive portfolio of state-owned trust lands (used to generate money to fund public education and other public institutions) would also be potentially suitable; many of these lands are also leased for grazing use. In the cattle ownership scenario, the investor would be responsible for the animal health and supplemental feed costs required for the cow/calf operation, and the land owner would maintain the land for rotational livestock grazing and on-farm expenses related to land management. The investor would anticipate financial return on the growth of the herd and premium beef prices for grass-fed beef, and the land owner would receive lease payments in addition to the potential for increased land value by virtue of the more sustainable ranching practices conducted on the land.

45 Under both case study examples the parties may wish to form a joint venture to share in both the upfront cost and the profits resulting from the sustainable ranching practices.

46 Allen Williams and Rod Ofte, "Organic Grass-fed Beef Success", The Pasture Project, 2015

In the "land ownership" scenario, an investor would directly purchase or joint venture to purchase land that could be converted to more sustainable ranching practices. As with the cattle ownership scenario discussed above, the land and cattle owners would agree on target stocking rates for the animal units, and the cattle owner would lease the land at a predetermined rate per animal unit. The cattle owner would then cover livestock herd-specific costs, with the land owner managing the day-to-day ranch operations (including any water and operational improvements). The financial return to the investor would be current yield via lease payments from the cattle owner as the stocking rates increase over time, and potentially through the appreciation on the underlying land asset value as a result of sustainable ranching practices being conducted on the land.

HYPOTHETICAL TRANSACTION - CATTLE OWNERSHIP

Multigenerational "Rancher A" owns 10,000 acres of ranch land in the Colorado River Basin, together with associated federal grazing leases. Rancher A historically focused on raising beef cattle (cow/calf operation) in order to sell his feeder calves to beef producers with grain-based feed lots. The ranch now conducts flood irrigation on a portion of the ranch for hay, and the remainder of the ranch land is semiarid grassland.

The pasture is in poor condition due to past ranching practices, so "Investor B" approaches Rancher A to inquire about his willingness to adopt regenerative agricultural practices in order to improve the health of the soil across the ranch land. Rancher A is interested in transitioning to these practices, but he has not adopted these techniques on account of the required investment and maintenance for a large grass-fed rotational grazing operation. Additionally, Rancher A would like to maintain ownership of his land and continue to operate the ranch, but is willing to accept a lease arrangement with a cattle owner on a per animal unit basis to help defray the costs of implementing more sustainable ranching methods.

THE TRANSACTION COULD DEVELOP AS FOLLOWS:

1. Rancher A and Investor B enter into a contract whereby Investor B will buy feeder calves, and brood cows and bulls to begin a cow/calf operation in order to meet an agreed upon stocking rate for grass-fed animal units on the land of Rancher A. Investor B will also pay for the upfront planning and infrastructure costs associated with rotational grazing practices on the land of Rancher A.

2. Rancher A agrees to initiate sustainable ranching practices with the cattle purchased by Investor B, and Rancher A will provide all labor and ranch management in exchange for lease payments from Investor B on a per animal unit basis.

3. Investor B then contracts with Purchaser C to sell premium grass-fed beef while monitoring closely the animal units and target stocking rate. Investor B could also sublet any unused land / animal units so long as sustainable ranching practices are maintained and animal units are below the max agreed upon stocking rate.

4. Rancher A and Investor B see increased profits under this revised ranch land management

scenario resulting from increased stocking rates and associated sales of premium grass-fed beef, and as Investor B pays a lease rate to Rancher A based on total AU.

5. Rancher A is left with restored higher-value ranch land with greater output and profitability per acre, as well as better quality soil for future farming and ranching practices.

HYPOTHETICAL TRANSACTION - LAND OWNERSHIP

"Investor C" purchases 10,000 acres of ranch land in the Colorado River Basin, together with associated federal and state land grazing leases. The previous land owner focused on beef cattle (cow/calf operation) in order to sell feeder calves to beef producers with grain-based feed lots. The ranch now conducts flood irrigation on a portion of the ranch for hay, and the remainder of the ranch land is underutilized semiarid grassland.

The pasture is in poor condition due to past ranching practices, so "Investor C" approaches another cattle owner interested in selling premium grass-fed beef through regenerative agricultural practices in an attempt to improve the health of the soil across the ranch land. The cattle owner might be interested in transitioning to these practices, but does not have the knowledge or land base necessary. Investor C is willing to pay to operate the ranch on a daily basis in exchange for lease payments from cattle owners that pay on a per animal unit basis.

THE TRANSACTION COULD DEVELOP AS FOLLOWS:

1. Investor C purchases ranch land with the intention of initiating a sustainable grass-fed beef operation through leases with cattle owners who are also in support of regenerative agriculture.

2. Investor C agrees to operate the ranch on a daily basis (through a ranch management team) providing labor and management services in exchange for lease payments from cattle owners on a per animal unit basis.

3. Investor C funds the initial feasibility study and planning to convert the ranch land to rotational grazing practices, and monitors closely the animal units and target stocking rate. The ranch management team also collects soil health data in accordance with the sustainable management practices employed.

4. The cattle owners would expect financial return from a successful cow/calf operation selling premium grass-fed beef, and Investor C would expect a financial return from increased stocking rates and associated rents paid based on total AU, as well as increased underlying asset value as a result of restored higher-value ranch land with greater output and profitability per acre. Investor C would likely also benefit from better quality soil for purposes of future farming and ranching activities.

4. Financial Models[47]

In order to demonstrate how the hypothetical case studies described above could translate into a market-based financial tool, the illustrations below detail hypothetical cash flows for a 10-year financing vehicle aimed at improving grasslands health while generating a financial return. As previously mentioned, specific water benefits are expected to be difficult to measure in this example; therefore, a potential investor/funder would be incentivized through current yield of lease payments or agricultural outputs (grass-fed beef in these hypothetical transactions) and potentially through long term appreciation of land assets, as opposed to expecting any monetization of water-related benefits.

The financial model is intended to be for illustrative purposes only, since the costs and benefits associated with agricultural practices are highly variable; further site-level diligence would be required for any potential transaction. For purposes of this model, input data was derived from discussions with various grass-fed beef producers; however, the collective data is not representative of an actual strategy that any one source is attempting to pursue. Assumptions have also been made around the exit value in the hypothetical case studies that result in highly variable internal rate of return calculations. In addition to site-level diligence for the potential transactions as outlined above, financial diligence should also be conducted to produce reasonable assumptions around costs of maintaining a grass-fed beef operation in any particular location, as these can vary from site to site.

In the examples below, it is assumed that the initial site assessment and design of the strategy would take one year, and that the project manager would be involved over the life of the project. While the benefits of the potential restoration project could be seen for 20 years or more, the hypothetical cash flow models outlined below focus on a 10 year investment cycle (exiting land or selling all remaining cattle at the end of year 10). The specific costs and potential benefits associated with water use and hydrologic outcomes are not highlighted here given the variability of outcomes and the broad array of potential environmental benefits on which one could focus.

Figure V(B)(1)-8. Assumptions and Model Drivers for Cattle Ownership

Project Funding Parameters	
Acres for Ranching	10,000
Cattle Ownership (1) or Land Ownership (0)	1
Initial Stocking (20% Feeder, 80% Broods & Bulls)	$5,889,901
Initial Year Health Costs for Livestock	$200,000
Initial Year Grazing/Hay Costs for Livestock	$1,952,188
Purchase: Price/Acre	$750
Purchase: Capital Required	$0
Feasibility Study and Planning	$25,000
New Fencing and Infrastructure Costs ($20/Acre)	$200,000
Initial Investment in Project	$8,267,088

Estimated Administrative Costs	
Arranger / Project Management Fee (Life of Project)	$1,500,000
Legal and Administrative Fees (Year 1)	$500,000
Total Administrative Costs	$2,000,000

Timing and Structure of Funding	
Years to Conduct Initial Upgrades	1
Life of Project / Exit Year (years)	10

Investment Returns	
Investor % of Profit/Loss (Capital Returned)	100%
Rancher % of Profit/Loss (Capital Returned)	0%
Multiple of Invested Capital (MOIC)	3.9x
Internal Rate of Return (IRR)	22.3%
Discount Rate	5.0%
Net Present Value of Project	$17,774,694

Sources and Uses	
Sources	
Investor Funding	$10,267,088
Uses	
Initial Investment in Project	$8,267,088
Total Administrative Costs	$2,000,000
	$10,267,088

Expenses and Measured Outcome		
Initial Base Animal Equivalents (AU) /Acre	0.5	
Max AU/Acre with Managed Rotational Grazing	1.0	
Years to Reach Max AU/Acre	8	
Lbs per AU	1,000	
Cattle Operation		
AU: Cow/Calf	1.2	
AU: Bull	1.0	
AU: 1-2 Yr Old Heifer	0.7	
AU: 0-1 Yr Old Heifer	0.4	
AU: Calf	0.0	
AU: Feeder Finishers	0.7	
Cows/Bull Ratio	30	
Adults/Feeder starting ratio	80%	
% of Broods having a healthy calf / Yr.	75%	
% of Broods Culled	20%	
% of Bulls Culled/Replaced	33%	
% Mortality of Female Adults	3%	
% Mortality of Youths	5%	
Livestock Price (per animal)	Purchase Cost	Sale Price in Terminal Year
Broods Cow	$1,500	$650
Bull	$2,000	$700
1-2 Yr Old Heifer	$700	$600
0-1 Yr Old Heifer	$500	$450
Feeder	$650	$600
Home-born Calf		$400
Ranch Operations, 2% annual inflation		
Annual Animal Health Costs/AU	$40	
Days/Year Animals Grazed	180	
Days/Year Animals on Hay	185	
Contract Grazing Costs ($/AU/Day)	$1.00	
Hay Needed (lbs./AU/Day)	26	
Purchased Hay Costs / Bale (800lb)	$35	
Purchased Hay Cost / lb. in 800 lb bale	$0.04	
AU Transportation for Processing ($/AU)	$50	
Ratio On the Hoof to Hanging Weight	60%	
Grass Fed Beef Finished $/lb., (incl. $0.80/lb. processing)	$5.20	
Annual Grassfed Beef Price Escalator	2.0%	
Land Purchase w/Lease to Cattle Owner		
Annual Fence/Water Maintenance Costs ($/Acre)	$5	
Cost Rancher Management /1,000 Acres	$30,000	
Fuel and Utility Vehicle Cost/1,000 Acres	$8,000	
Other (admin office, repairs, etc.) Cost/1,000 Acres	$3,000	
Agroforestry (Windbreaks, Riparian Buffers, etc) ($/Acre)	$5	

Figure V(B)(1)-9. Assumptions and Model Drivers for Land Ownership

Project Funding Parameters	
Acres for Ranching	10,000
Cattle Ownership **(1)** **or** Land Ownership **(0)**	0
Initial Stocking (20% Feeder, 80% Broods & Bulls)	$0
Initial Year Health Costs for Livestock	$0
Initial Year Grazing/Hay Costs for Livestock	$0
Purchase: Price/Acre	$750
Purchase: Capital Required	$7,500,000
Feasibility Study and Planning	$25,000
New Fencing and Infrastructure Costs ($20/Acre)	$200,000
Initial Investment in Project	$7,725,000

Estimated Administrative Costs	
Arranger / Project Management Fee (Life of Project)	$1,500,000
Legal and Administrative Fees (Year 1)	$500,000
Total Administrative Costs	$2,000,000

Timing and Structure of Funding	
Years to Conduct Initial Upgrades	1
Life of Project / Exit Year (years)	10

Investment Returns	
Investor % of Profit/Loss (Capital Returned)	100%
Rancher % of Profit/Loss (Capital Returned)	0%
Multiple of Invested Capital (MOIC)	1.7x
Internal Rate of Return (IRR)	6.2%
Discount Rate	5.0%
Net Present Value of Project	$942,550

Sources and Uses	
Sources	
Investor Funding	$9,725,000
Uses	
Initial Investment in Project	$7,725,000
Total Administrative Costs	$2,000,000
	$9,725,000

Expenses and Measured Outcome		
Initial Base Animal Equivalents (AU) /Acre	0.5	
Max AU/Acre with Managed Rotational Grazing	1.0	
Years to Reach Max AU/Acre	8	
Lbs per AU	1,000	
Cattle Operation		
AU: Cow/Calf	1.2	
AU: Bull	1.0	
AU: 1-2 Yr Old Heifer	0.7	
AU: 0-1 Yr Old Heifer	0.4	
AU: Calf	0.0	
AU: Feeder Finishers	0.7	
Cows/Bull Ratio	30	
Adults/Feeder starting ratio	80%	
% of Broods having a healthy calf / Yr.	75%	
% of Broods Culled	20%	
% of Bulls Culled/Replaced	33%	
% Mortality of Female Adults	3%	
% Mortality of Youths	5%	
Livestock Price (per animal)	Purchase Cost	Sale Price in Terminal Year
Broods Cow	$1,500	$650
Bull	$2,000	$700
1-2 Yr Old Heifer	$700	$600
0-1 Yr Old Heifer	$500	$450
Feeder	$650	$600
Home-born Calf		$400
Ranch Operations, 2% annual inflation		
Annual Animal Health Costs/AU	$40	
Days/Year Animals Grazed	180	
Days/Year Animals on Hay	185	
Contract Grazing Costs ($/AU/Day)	$1.00	
Hay Needed (lbs./AU/Day)	26	
Purchased Hay Costs / Bale (800lb)	$35	
Purchased Hay Cost / lb. in 800 lb bale	$0.04	
AU Transportation for Processing ($/AU)	$50	
Ratio On the Hoof to Hanging Weight	60%	
Grass Fed Beef Finished $/lb., (incl. $0.80/lb. processing)	$5.20	
Annual Grassfed Beef Price Escalator	2.0%	
Land Purchase w/Lease to Cattle Owner		
Annual Fence/Water Maintenance Costs ($/Acre)	$5	
Cost Rancher Management /1,000 Acres	$30,000	
Fuel and Utility Vehicle Cost/1,000 Acres	$8,000	
Other (admin office, repairs, etc.) Cost/1,000 Acres	$3,000	
Agroforestry (Windbreaks, Riparian Buffers, etc) ($/Acre)	$5	

Figure V(B)(1)-10. Illustrative Cash Flows for Holistic Management of Working Lands via Cattle Ownership

Year:		0	1	2	3	4	5	6	7	8	9	10	Exit	
Herd Schedule													AU Sold	
Brood increase			*20%*	*12%*	*8%*	*6%*	*4%*	*4%*	*4%*	*4%*	*0%*	*0%*		
Brood Cows		2,524	3,029	3,393	3,664	3,884	4,039	4,201	4,369	4,544	4,544	4,544	5,452	
1-2 Yr Old Heifers		790	697	780	843	893	929	966	1,005	1,045	1,045	1,045	697	
0-1 Yr Old Heifers		805	819	885	938	976	1,015	1,055	1,097	1,097	1,097	1,097	488	
Calves		1,893	2,272	2,545	2,748	2,913	3,030	3,151	3,277	3,408	3,408	3,408	0	
Bulls		87	101	113	122	129	135	140	146	151	151	151	151	
Home-born Feeders				1,339	2,269	2,516	2,712	2,849	2,963	3,082	3,249	3,317	2,211	
Bought Feeder Finisher Steers		1,500	1,500	784	0	0	0	0	0	0	0	0	0	
Actual Carrying Capacity		5,000	5,565	6,513	7,010	7,496	7,860	8,194	8,521	8,843	8,954	9,000		
Actual AU/acre		0.50	0.56	0.65	0.70	0.75	0.79	0.82	0.85	0.88	0.90	0.90		
% carrying capacity increase			*11.3%*	*17.0%*	*7.6%*	*6.9%*	*4.9%*	*4.2%*	*4.0%*	*3.8%*	*1.3%*	*0.5%*		
Revenue														Live Animal Sale
AU Sold			1,188	1,750	1,870	2,039	2,165	2,271	2,361	2,456	2,522	2,567		7,533,687
Lbs. Grass-fed Beef Sold			1,187,836	1,749,646	1,870,391	2,038,593	2,164,766	2,270,502	2,361,322	2,455,775	2,521,555	2,567,210		
Lbs. Grass-fed Beef Hanging Wt.			712,702	1,049,787	1,122,235	1,223,156	1,298,860	1,362,301	1,416,793	1,473,465	1,512,933	1,540,326		
Price of Beef (w/escalator)			$5.20	$5.30	$5.41	$5.52	$5.63	$5.74	$5.86	$5.97	$6.09	$6.21		
Grass fed Beef Revenue			$3,706,049	$5,568,072	$6,071,380	$6,749,719	$7,310,823	$7,821,271	$8,296,804	$8,801,250	$9,217,738	$9,572,329		
Lease Revenue (AU*Grazing Price*Days Grazed)			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Total Revenue			$3,706,049	$5,568,072	$6,071,380	$6,749,719	$7,310,823	$7,821,271	$8,296,804	$8,801,250	$9,217,738	$9,572,329		
Operating Expenses														
Animal Health Costs			$222,587	$260,521	$280,417	$299,857	$314,402	$327,744	$340,854	$353,707	$358,165	$359,991		
Grazing Costs / Lease Pmt			1,001,643	1,172,346	1,261,876	1,349,355	1,414,809	1,474,847	1,533,841	1,591,683	1,611,742	1,619,960		
Hay Costs			1,171,018	1,370,586	1,475,256	1,577,527	1,654,049	1,724,240	1,793,209	1,860,833	1,884,283	1,893,890		
Additional Cow Purchase			757,500	546,000	408,000	330,000	234,000	243,000	253,500	262,500	0	0		
Additional Bull Purchase			30,000	26,000	20,000	16,000	12,000	12,000	12,000	12,000	0	0		
Bull Replacement Cost			66,643	74,640	80,611	85,448	88,866	92,421	96,117	99,962	99,962	99,962		
Transportation for Processing			59,392	87,482	93,520	101,930	108,238	113,525	118,066	122,789	126,078	128,361		
Total Costs for Cattle Operation			**$3,308,783**	**$3,537,576**	**$3,619,680**	**$3,760,117**	**$3,826,364**	**$3,987,777**	**$4,147,588**	**$4,303,474**	**$4,080,229**	**$4,102,164**		
Operating Costs for Scenario			$3,308,783	$3,537,576	$3,619,680	$3,760,117	$3,826,364	$3,987,777	$4,147,588	$4,303,474	$4,080,229	$4,102,164		
Program Management Costs			150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000		
Legal			500,000	0	0	0	0	0	0	0	0	0		
Total Expenses			$3,958,783	$3,687,576	$3,769,680	$3,910,117	$3,976,364	$4,137,777	$4,297,588	$4,453,474	$4,230,229	$4,252,164		
Operating Income			($252,734)	$1,880,496	$2,301,699	$2,839,602	$3,334,459	$3,683,495	$3,999,217	$4,347,776	$4,987,509	$5,320,165		
Income Share[1]														
Investor --- 100%, 100%	100%	100%	($252,734)	$1,880,496	$2,301,699	$2,839,602	$3,334,459	$3,683,495	$3,999,217	$4,347,776	$4,987,509	$5,320,165		
Farmer/Landowner --- 0%, 0%				$0	$0	$0	$0	$0	$0	$0	$0	$0		

[1] Investor to receive 100% of operating profits until year after investment capital is returned; each year thereafter is split 100%/0% with the farmer/landowner.

		0	1	2	3	4	5	6	7	8	9	10	Exit	
														Annual Land Price Appreciation
														2.0%
Investor Returns													In-Flows	Exit Value
Returns on Invested Capital		($10,267,088)	($252,734)	$1,880,496	$2,301,699	$2,839,602	$3,334,459	$3,683,495	$3,999,217	$4,347,776	$4,987,509	$12,853,852	$39,975,371	$7,533,687
Discounted Returns for NPV		($10,267,088)	($240,699)	$1,705,665	$1,988,295	$2,336,148	$2,612,636	$2,748,680	$2,842,169	$2,942,746	$3,214,992	$7,891,150	$28,041,782	
											MOIC:	3.9x		
											IRR:	22.3%		
											NPV:	$17,774,694		

igure V(B)(1)-11. Illustrative Cash Flows for Holistic Management of Working Lands via Land Ownership

Year:	0	1	2	3	4	5	6	7	8	9	10	Exit	
Herd Schedule												AU Sold	
Brood increase		*20%*	*12%*	*8%*	*6%*	*4%*	*4%*	*4%*	*4%*	*0%*	*0%*		
Brood Cows	2,524	3,029	3,393	3,664	3,884	4,039	4,201	4,369	4,544	4,544	4,544	5,452	
1-2 Yr Old Heifers	790	697	780	843	893	929	966	1,005	1,045	1,045	1,045	697	
0-1 Yr Old Heifers	805	819	885	938	976	1,015	1,055	1,097	1,097	1,097	1,097	488	
Calves	1,893	2,272	2,545	2,748	2,913	3,030	3,151	3,277	3,408	3,408	3,408	0	
Bulls	87	101	113	122	129	135	140	146	151	151	151	151	
Home-born Feeders			1,339	2,269	2,516	2,712	2,849	2,963	3,082	3,249	3,317	2,211	
Bought Feeder Finisher Steers	1,500	1,500	784	0	0	0	0	0	0	0	0	0	
Actual Carrying Capacity	5,000	5,565	6,513	7,010	7,496	7,860	8,194	8,521	8,843	8,954	9,000		
Actual AU/acre	0.50	0.56	0.65	0.70	0.75	0.79	0.82	0.85	0.88	0.90	0.90		
% carrying capacity increase		*11.3%*	*17.0%*	*7.6%*	*6.9%*	*4.9%*	*4.2%*	*4.0%*	*3.8%*	*1.3%*	*0.5%*		
Revenue													Live Animal Sale
Lease Revenue (AU*Grazing Price*Days Grazed)		$1,001,643	$1,172,346	$1,261,876	$1,349,355	$1,414,809	$1,474,847	$1,533,841	$1,591,683	$1,611,742	$1,619,960		
Total Revenue		$1,001,643	$1,172,346	$1,261,876	$1,349,355	$1,414,809	$1,474,847	$1,533,841	$1,591,683	$1,611,742	$1,619,960		
Operating Expenses													
Fence Maintenance Costs		$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000		
Agroforestry		50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000		
Rancher Mgmt.		300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000		
Fuel/Utility Vehicles		80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000		
Other (Admin)		30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000		
Total Costs for Own Land Operation		**$510,000**	**$510,000**	**$510,000**	**$510,000**	**$510,000**	**$510,000**	**$510,000**	**$510,000**	**$510,000**	**$510,000**		
Operating Costs for Scenario		$510,000	$510,000	$510,000	$510,000	$510,000	$510,000	$510,000	$510,000	$510,000	$510,000		
Program Management Costs		150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000		
Legal		500,000	0	0	0	0	0	0	0	0	0		
Total Expenses		$1,160,000	$660,000	$660,000	$660,000	$660,000	$660,000	$660,000	$660,000	$660,000	$660,000		
Operating Income		($158,357)	$512,346	$601,876	$689,355	$754,809	$814,847	$873,841	$931,683	$951,742	$959,960		
Income Share[1]													
Investor --- 100%, 100% 100%	100%	($158,357)	$512,346	$601,876	$689,355	$754,809	$814,847	$873,841	$931,683	$951,742	$959,960		
Farmer/Landowner --- 0%, 0%			$0	$0	$0	$0	$0	$0	$0	$0	$0		

[1] Investor to receive 100% of operating profits until year after investment capital is returned; each year thereafter is split 100%/0% with the farmer/landowner.

	0	1	2	3	4	5	6	7	8	9	10		Annual Land Price Appreciation 2.0%
Investor Returns												In-Flows	Exit Value
Returns on Invested Capital	($9,725,000)	($158,357)	$512,346	$601,876	$689,355	$754,809	$814,847	$873,841	$931,683	$951,742	$10,102,418	$16,074,560	$9,142,458
Discounted Returns for NPV	($9,725,000)	($150,816)	$464,713	$519,923	$567,134	$591,412	$608,052	$621,023	$630,600	$613,501	$6,202,008	$10,667,550	

MOIC:	1.7x
IRR:	6.2%
NPV:	$942,550

SECTION V(B)(2):

Maximizing Agricultural Water Efficiency:
Financing Crop Conversion, Enhanced Farm Management, and Infrastructure Upgrades

Summary

This financial vehicle is structured to make investments that lead to improved soil health and reduced water use in the agriculture sector. As was noted in Section II of this report, agriculture is one of the largest users of water in the Colorado River Basin, but it is also one of the most important economic activities in the Basin. The challenge is to develop strategies that reduce the use of agricultural water without damaging local agricultural economies. Specifically, this strategy can be seen as an alternative to the more controversial "buy and dry" approaches which retire agricultural uses in order to provide the basis for water transfers from agriculture to other uses; instead of retiring lands, this vehicle seeks to provide capital for farms and ranches in order to finance the transition to more sustainable farming practices. Investor returns could be generated from increased quantity and quality of agriculture outputs, decreased water use (with potential for monetization of saved water if achieved at scale in the geographies that support transfer), decreased use of chemical fertilizers and pesticides, and the appreciation on the underlying land values. This strategy could be pursued via a direct purchase of land, or through joint-venture partnerships with existing land owners. Additionally, the joint venture strategy could either facilitate the entry of young farmers into the agricultural industry or keep existing owner-operators on their land.

1. Background

The use of water in the agricultural sector presently varies widely in both efficiency and relative economic value within the Colorado River Basin. Of the roughly 3.5 million acres of irrigated land dedicated to agriculture within the Colorado River Basin (representing approximately 70% of all water use), approximately 2 million acres are dedicated in some way to livestock, either as irrigated pasture or for forage crops (not to mention the tens of millions of acres dedicated to livestock grazing).[1] Although these uses tend to have very high priority water rights (as in many cases they were established far earlier than later agricultural, municipal, and industrial uses – the extreme drought currently facing the American West suggests that the production of irrigated forage crops may not be the highest and best use of dwindling domestic water reserves – particularly as many high-value water users are moving to invest millions if not billions of dollars in new supply or to increase the reliability of existing water supplies. However, as noted throughout this report, the legal regimes governing water allocation have created systems of water rights that are deeply entrenched, and which make changes in water use difficult. For individual farmers, the economic incentives around water use have in many cases created perverse "use it or lose it" frameworks that encourage inefficient water use, or which require the use of water on marginal lands and/or to produce relatively low-value crops even in the face of shortage conditions.

Under the reserved rights doctrine, tribes have been able to establish claims for expansive water rights in many rivers, streams, and groundwater basins in many parts of the West.

Figure V(B)(2)-1. Production of alfalfa, a common forage crop, and one of the largest agricultural uses of Colorado River water in both the Upper and Lower Basins. Image courtesy of U.S. Bureau of Reclamation.

Although legal frameworks contribute to these incentives, many reflect the realities imposed by farm commodities markets, particularly in the absence of market-driven pricing for water itself. For example, a considerable portion of the low-value forage crops grown in the American West (see Table V(B)(2)- 1 below) are actually now grown for export outside of the United States. U.S. exports of alfalfa hay to China, for instance, increased more than eightfold from 2009 to 2013, reaching nearly 785,000 tons,[2] adding to existing exports to Saudi Arabia, Japan, and other countries. These exports support dairy industries in these countries, which generally lack available land for forage production – either due to lack of arable land (e.g. Saudi Arabia) or due to the fact that their land base is dedicated to growing higher-value crops (e.g. China). Although these exports appear perplexing in the light of growing domestic water

1 Glen D. Schaible and Marcel P. Aillery, 2012. Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands, EIB-99, U.S. Department of Agriculture, Economic Research Service. www.ers.usda.gov/media/884158/eib99.pdf.
2 "China's Hard Line on Biotech Burns U.S. Hay." The Wall Street Journal. Jesse Newman. Web, December 15, 2014.

demand and risk, the effective transportation subsidies resulting from U.S. trade deficits (particularly with China) have reduced costs to the point where it is cheaper to ship hay from Southern California farms to China than it is to ship hay to dairy farms elsewhere in California. As a result, the associated increase in demand for alfalfa export, for example, have doubled prices in the last three years to more than $300 per ton – creating attractive near-term potential returns for farmers.

Figure V(B)(2)-2. Flood irrigation, Arizona.
Photo courtesy USDA Natural Resources Conservation Service.

Better alignment of economic incentives could allow investments in improved farming practices, such as switching summer crop planting to cool seasonal crops, planting lower water consumptive crops with short growing seasons, or planting higher value rotational crops with fewer seasons that would produce both greater domestic economic returns and utilize water far more efficiently.[3] However, given the relatively low price paid for water by many agricultural users with priority water rights (in some cases just a few dollars per af), the lack of ready access to capital to invest in farm improvements, and the lack of access to markets that would open up other options, the economic incentives for individual farmers tend to point away from those investments, while increased alfalfa production (or other low-value crops) may present attractive near-term potential returns. In keeping with these practical realities, the conditions described above have recently fueled the conversion of more and more land in some portions of the Colorado River Basin to grow water-intensive alfalfa for export[4] even as drought conditions threaten high-value crops and the availability of water to urban users.

Outside of the high-value production agriculture that takes place in many of the Lower Basin districts, flood irrigation – supported by earthen ditches and manually-operated diversions – remains the predominant method of irrigation in most of the Basin. In many areas, relatively inefficient irrigation practices are accompanied by farming practices that have tended to degrade soil health over time and that have contributed to water pollution and other environmental issues.

3 Colorado Agricultural Water Alliance. Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures. 2008.
4 "U.S. Farmers Making Hay with Alfalfa Exports to China." Los Angeles Times. David Pierson. Web, June 8, 2014.

Crop (in thousands of acres)	AZ	CA	CO	NV	NM	UT	WY
Total Forage (harvested)	325	1,670	1,297	531	343	762	1,054
Total Forage (irrigated)	323	1,347	969	510	303	677	772
% of total forage irrigated	99%	81%	75%	96%	88%	89%	73%
Alfalfa hay (harvested)	272	874	654	344	222	566	547
Alfalfa hay (irrigated)	271	832	561	344	222	566	547
% of alfalfa hay irrigated	100%	95%	86%	100%	100%	100%	100%
Other tame hay (harvested)	44	670	688	181	104	166	498
Other tame hay (irrigated)	42	377	380	168	72	89	218
% of tame hay irrigated	95%	56%	55%	93%	69%	54%	44%
Wheat (harvested)	103	492	2,182	18	87	138	132
Wheat (irrigated)	103	383	126	18	37	45	17
% of wheat irrigated	100%	78%	6%	100%	43%	33%	13%
Total Harvested (forage, alfalfa, hay, wheat)	744	3,706	4,821	1,074	756	1,632	2,231
Total Irrigated (forage, alfalfa, hay, wheat)	739	2,939	2,036	1,040	634	1,377	1,554
% of total irrigated	99%	79%	42%	97%	84%	84%	70%

Table V(B)(2)-1. Colorado River Basin Major Crops and Acreages (Note: Crop data is state-wide: both within and beyond the Colorado River Basin) [5]

Given the sheer scale of agricultural water use and the relatively low economic returns associated with some of this water use, agricultural water users have become the most obvious -- and inevitable -- targets for future water transfers to meet changing urban and industrial demands, for restoring flow to depleted streams, or to protect higher-value agricultural uses (e.g. permanent crops) facing potential drought and shortage threats. However, previously, in many parts of the American West crop and livestock outputs from these lands account for a significant portion of local economic output, and are also associated with important cultural and social values. The strong economic and political tensions that this creates suggest that there is significant value in the exploration of alternatives to "buy and dry" strategies that fallow existing agricultural lands in order to provide water for transfer to other uses. Although these fallowing programs have in many cases provided obvious economic benefits to individual farmers and downstream users, these benefits are not always widely distributed in the community, and these practices raise questions about the "best" use for water and the long-term impacts of these changes on jobs, community character, and local economies.

In many parts of the American West crop and livestock outputs from agricultural lands account for a significant portion of local economic output, and are also associated with important cultural and social values.

There are in fact a series of well-documented alternatives to fallowing that could yield improvements in agricultural outputs and generate water savings from existing agricultural lands that could be transferred to other uses – essentially allowing lands to stay in agricultural production while generating the water needed to support changing needs and values. Some of these approaches to land management, coupled with appropriate economic incentives, could provide a basis for private investment that could lead to more sustainable water use, improved soil health, and even facilitate the cultural transition to a new generation of farmers.

5 Source: U.S. Department of Agriculture, USDA Agricultural Census, 2012.

2. Existing Approaches

There are various potential approaches to reducing water use in agriculture, targeting phases of the overall "water budget" for irrigated land. As discussed below, the water budget across an irrigation system (Figure V(B)(2)-4) can be viewed in three levels: (i) diversion, (ii) consumption, and (iii) non-consumptive use.

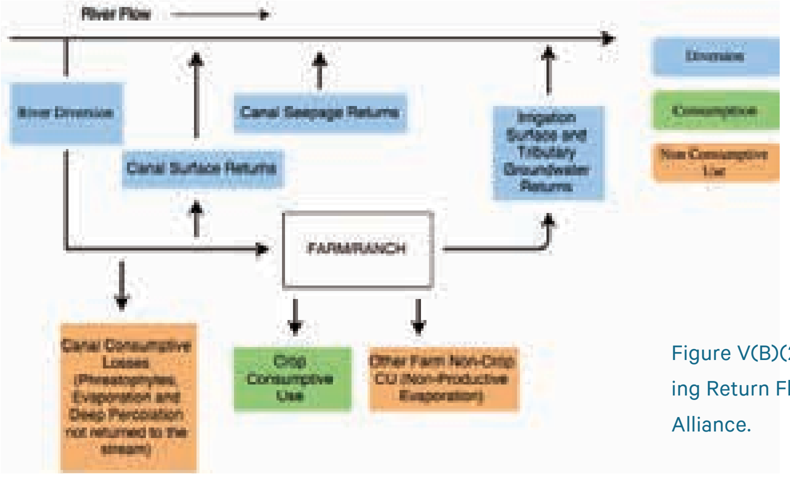


Figure V(B)(2)-4. Irrigation System Schematic Including Return Flows. Source: Colorado Agricultural Water Alliance.

INCREASING WATER USE EFFICIENCY

Most of the potential investments that can be made in increasing water use "efficiency" in agriculture relate to the first and third levels of the water budget discussed above. "Diversion," the first level of the water budget for irrigation, relates to the amount of water diverted from a primary source (e.g. a river or aquifer). The amount of this diversion includes the crop's consumptive use, as discussed below, but also the additional water required to deliver that consumptive use and compensate for system inefficiency. This system inefficiency could come in the form of non-beneficial evaporative losses, return flows that pass on to downstream users (i.e., water included in another users water budget), deep percolation, and surface runoff.[6] Many non-beneficial evaporative losses, canal leakage and percolation, and surface runoff can be targeted through lining canal ditches (both on- and off-farm) with non-permeable surfaces, such as concrete. This lining process also reduces unwanted phreatophytes around the delivery system that consume water for non-beneficial use.

Estimated Efficiencies and Costs for Irrigation Methods

Type of Irrigation	Range of Application Efficiency	Average Capital Cost/ Acre	Average Annual Cost/ Acre
Flood	30-50%	--	--
Furrow	40-60%	$37	$30
Gated Pipe	~60%	$178	$51
Center Pivot Circle	~85%	$433	$64
Center Pivot with Corner	~85%	$568	$80
Subsurface Drip Irrigation	~90%	$1,000	$120

Table V(B)(2)-2. Comparison of Irrigation Methods. Source: Colorado Agricultural Water Alliance.

6 Colorado Agricultural Water Alliance. Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures. 2008.

Irrigation infrastructure upgrades, such as investments in modern diversion structures that allow adjustments to stream diversions based on actual irrigation needs, the conversion of flood irrigation ditches to center pivot sprinklers, or other more precise forms of irrigation, are other primary methods farmers can use to achieve higher water delivery efficiency (Table V(B)(2)-2) in over to increase efficiency at the diversion level of the water budget. In addition to infrastructure and labor costs for upgrading irrigation equipment, land leveling may also help to maximize the benefits of irrigation infrastructure upgrades. This upgrade process can ensure that a uniform release of water across a field equates to a uniform application of water at the plant level. Land leveling can also be helpful both in balancing nutrient distribution through crop cycles and in gravity-fed irrigation systems.

"Non-consumptive use", the third level of the water budget for irrigation, relates to water that is lost at the field level, including deep percolation and the growth of vegetation not for crop harvest. As shown in Table V(B)(2)-2, the type of irrigation equipment and the method of delivery employed can have a significant impact on application efficiency and alter the amount of non-consumptive use of water. Subsurface drip irrigation, for example, ensures that water is being transported and utilized efficiently, reducing runoff and evaporation by releasing water slowly near the root of the plant.[7] Also, commonly used in orchards, micro-sprinklers can uniformly disperse water at a relatively low intensity throughout the soil, reducing deep percolation.

Similar to direct conservation investments, investments that increase control over non-consumptive use water losses can also create ancillary economic and environmental benefits in addition to net water savings.

Similar to direct conservation investments, investments that increase control over these non-consumptive use water losses can also create ancillary economic and environmental benefits in addition to net water savings. For example, two underutilized approaches to reducing non-consumptive use water losses are "conservation tillage" and the use of "cover crops", each discussed in further detail in the paragraphs that follow.

CONSERVATION TILLAGE

Conservation tillage is a practice often used in arid regions in order to retain soil moisture and better utilize water by leaving up to one-third of the ground surface covered by crop residue at planting time.[8] The ability of the soil to retain water is enhanced through this practice by reducing soil evaporation and increasing infiltration of precipitation and irrigated water. During the growing season, plant residue acts as a buffer against solar evaporation, while less frequent topsoil turnover also reduces soil erosion from wind and water, preserving the crops and potentially increasing yield.[9] Typically, the highest potential for benefit from conservation tillage occurs when it is integrated with high irrigation efficiency (e.g. micro sprinklers), as proper management of crop residue allows for greater infiltration of water into the soil.

Research shows that, as of 2008, roughly 41% of U.S. cropland was farmed using conservation tillage practices.[10] Data collection from these practices on water and soil health has only recently started, but in addition to labor, time, and machinery cost savings from

7 "Drip Irrigation for the Home Garden." Sustainable Landscaping. Healthy Landscapes, n.d. Web, January 13, 2015.
8 "Agricultural Water Use in the Colorado River Basin: Conservation and Efficiency Tools for a Water Friendly Future," The Colorado College State of the Rockies Report Card, n.p. Web, January 11, 2015. PDF.
9 Ibid.
10 David R. Huggins and John P. Reganold, "No-Till: the Quiet Revolution", Scientific American, 2008.

conservation tillage techniques, New Mexico State University conducted a survey that identified $27.71/acre in savings from fuel and oil as a result of conservation tillage.[11] Similarly, Colorado State University's Conservation Tillage Demonstration and Outreach Project found that conservation tillage could lead to a 17% reduction in costs per acre.[12]

COVER CROPS / CROP MIX

The planting of cover crops is a soil nutrient management strategy utilized to improve soil health, provide for erosion control, and prevent the growth of unwanted plants.[13] Some cover crops, such as oilseed or radishes, possess hardened roots that help infiltrate into compact subsoil during a process called bio-drilling.[14] After these crops die, the crops grown for harvest can benefit both from the paths previously created by cover crop roots, as well as from improved nutrient supply coming from the decaying cover crops.[15] Dakota Lakes Research Farm, owned by South Dakota State University, has demonstrated the multifaceted benefits of cover crop use, noting specifically the importance of cover crops in providing competition for weeds and enhancing nutrient cycling.[16]

Cover crops generate a number of economic benefits for farmers, including reduced fertilizer costs (if the cover crop used is a nitrogen-fixing plant which can transfer nitrogen from the atmosphere into the soil), reduced herbicide cost (due to weed growth reduction by diminishing the supply of water and nutrients available for weeds), and lower likelihood of crop damage caused by disease in reducing hosts for microbial organisms.[17] Additionally, the nutrient cycling, additional organic matter, and more efficient infiltration of surface water provided by cover crops all serve to enrich the soil and increase farmers' output.[18] As with conservation tillage, cover crops can also provide a means of soil erosion control as they hold soil in place and offer protection from harmful weather conditions, and they preserve moisture within the soil, thereby lessening the damaging effects of drought.[19]

LIMITATIONS ON TRANSFERABILITY

It is important to note, that (as explained in Section V(B) of this report), increased water efficiency does not necessarily equal reduced consumptive use, since water "lost" as a result of inefficiency during transmission or as a result of overwatering, may well return to the stream anyway through direct return flows or subsurface underflows. As such, some approaches to increasing agricultural water efficiency will not necessarily generate legally transferable water savings. Generally, conserved water in agriculture can only generate transferable water to the extent that conservation results in an actual reduction in consumptive use. In addition, the success of a particular irrigation infrastructure upgrade is dependent upon the management of the "system" and the specific circumstances of each user.[20] In some cases, increased on-farm water use efficiency as a result of irrigation infrastructure upgrades can actually

11 R. D. Baker and B. Rouppet, "Conservation Farming in New Mexico," New Mexico State University and USDA (1996).

12 J. Driscoll, "Economics: Conservation Tillage Demonstration and Outreach Project," Colorado State University, accessed August 10, 2012, http://conservationtillage.colostate.edu/Economics.html.

13 Barbara Pleasant, "Use Cover Crops to Improve Soil," Mother Earth News. N.p., October–November 2009. Web, January 22, 2015.

14 Ibid.

15 Ibid.

16 Ibid.

17 Ibid.

18 Ibid.

19 Barbara Pleasant, "Use Cover Crops to Improve Soil," Mother Earth News. N.p., October–November 2009. Web, January 22, 2015.

increase consumptive use, particularly where crop yields can be increased through more effective water delivery at the field level, such as by improving the uniformity of water application over an entire field. While this approach increases crop yield in areas that were previously underirrigated, the net result of such increased efficiency can be an increase in the total consumption of water over the entire field.[21]

Economic Comparison of Drip and Furrow Irrigation Methods

Economic Activity Evaluated for Each Scenario	Drip Irrigation Percentage as Compared to the Same Furrow-Irrigated Farm Model, 2000
Yield	25%
Chemicals	-18%
Fertilizer	-26%
Capital	47%
Fixed Costs	19%
Seed Costs	-20%

Table V(B)(2)-3. Drip Irrigation for Row Crops: Economic comparison of drip and furrow irrigation methods. New Mexico State University (2001).

These issues on transferability effectively limit the ability to finance investments in efficiency improvements through the monetization of conserved water. However, while higher efficiency irrigation methods are more costly to implement than existing flood and furrow irrigation methods, these forms of precise irrigation, and the associated preparations, can pay for themselves in other ways, such as by enabling farmers to decrease both their water consumption and their reliance on manual labor and harmful chemical fertilizers.[22] There are also a number of other delivery efficiency gains that can be achieved through on- and off-farm water conservation activities, such as canal lining, erosion mitigation, and on-farm water reuse that could not only help increase yield to the farmer but could also reduce conveyance losses for higher economic return and greater environmental benefits.

As a result, increased costs can potentially be offset through cost savings from reduced surface water diversions or groundwater pumping requirements, or through ancillary benefits that may accrue in terms of both on-farm outcomes and external factors. For example, on-farm irrigation infrastructure upgrades can improve on current methods of water delivery and application by leaching less water through the soil, improving soil quality, and increasing crop yields per unit of input.[23] In addition to reducing evaporative losses, Table V(B)(2)-3 indicates that water applied in a more precise manner leads to decreased erosion and runoff, which in turn reduces the amount of beneficial nutrients removed from the topsoil.[24] However, in many cases, we believe that financing these improvements may make the most sense in connection with larger reductions in consumptive use – such as the crop switching approaches described in the sections that follow; pursued together, these improvements and crop switching can both increase yields and farm revenues while cutting consumptive use.

REDUCTIONS IN CONSUMPTIVE USE

"Consumptive use" relates principally to the second level of the water budget for irrigation, and varies

20 Ibid.

21 Colorado Agricultural Water Alliance. Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures. 2008.

22 R. Godin and I. Broner. "Micro-Sprinkler Irrigation for Orchards." Colorado State University Extension. Colorado State University, November 2013. Web, January 13 2015.

23 "Agricultural Water Use in the Colorado River Basin: Conservation and Efficiency Tools for a Water Friendly Future," The Colorado College State of the Rockies Report Card, n.p. Web, January 11, 2015. PDF.

24 Ibid

based on the amount of water a particular crop requires for consumption to support growth and maintenance (both for biomass and for evapotranspiration). Clearly, the simplest approach to a reduction in actual consumptive use in agriculture is simple fallowing of agricultural lands (on either a temporary or permanent basis); however, an alternative approach that can create legally recognizable reductions in consumptive use and potentially "transferable" water – and create meaningful environmental benefits through reductions in diversions, control of pollution, and other improvements – is the conversion of agricultural lands to high-value, lower water-use crops. For example, shifts from rotational row crops (such as grains and soybeans) to permanent tree crops (such as citrus or nut trees) can provide much, much higher potential income for the equivalent amount of water used given the relatively high price paid for permanent crop outputs. To be successful, a conversion strategy needs to clearly demonstrate the anticipated reduction in consumptive use of water over various crop cycles (e.g., planting almond trees in place of alfalfa will not necessarily provide for a reduction in consumptive use of water, and may actually be a poor approach for environmental benefit). However, there is growing demand for crop types that may fit within a strategy of crop conversion for environmental benefit.

CROP CONVERSION

Throughout the American West, the crops that farmers selected to grow in particular areas have been driven by a combination of market demands and prices, the availability of local processing and packing facilities, water availability, general soil conditions, and specific local economic conditions. However, crop selection over time has not necessarily followed the highest and best use of water, nor has it been reformed over time in response to changing physical, economic, and hydrological conditions. The relatively slow rate of change in the use of irrigated lands in some areas can be the a result of a combination of factors, including a lack of local processing and packing facilities for alternative crops, a lack of information and education in farm practices, misaligned economic incentives (including crop subsidies), cultural resistance to change, and the lack of access to capital or cash flows needs to fund infrastructure investments, crop conversions, and other adaptations.

It is important to note that commodity prices for most crops grown in the Colorado River Basin are volatile, and their input costs and water requirements also vary based on local soil, climate, and other variables, such that site-specific analysis and calculations will necessarily need to be undertaken to evaluate the economics and water savings potential on different farms and in different regions. However, a 2013 study performed by the Pacific Institute provides an analysis of potential water savings for specific crop changes in the Lower Basin. This report indicated that switching from growing one acre of cotton to growing one acre of wheat would save almost 1.3 af of water per acre each year.[25] Other scenarios in the report analyzed replacing alfalfa, which indicated even more drastic water saving possibilities: planting sorghum in place of alfalfa could save 1.9 af per acre, planting cotton could save 2.8 af per acre, and planting wheat could save up to 4 af of water per acre per year when replacing alfalfa.[26]

25 "Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin." The Pacific Institute, Michael Cohen, Juliet Christian-Smith, and John Berggren. May 2013.

26 S. C. de Vries et al. 2010. "Resource use efficiency and environmental performance of nine major biofuel crops, processed by first-generation conversion techniques." Biomass and Bioenergy 34: 588–601; "Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin." The Pacific Institute, Michael Cohen, Juliet Christian-Smith, and John Berggren. May 2013.

Figure V(B)(2)-5. Cotton crop. Cotton production has historically been among the largest agricultural uses of Colorado River water in the Lower Basin states. Image courtesy of the U.S. Bureau of Reclamation.

Importantly, the comparative consumptive use between various crops can mostly be explained by the season in which the crops are grown, and the length of that growing season for a particular crop (Figure V(B)(2)-4).[27] Field crops (any crop other than fruits and vegetables), for example, are generally high-water-use crops, but they have relatively low variable costs as compared to vegetables.[28] Some row crops, such as winter wheat, grow best in cool seasons, thus requiring less water for evapotranspiration than crops grown in high heat.

In many cases, switching to more drought-tolerant or "stress-tolerant" crops can also allow for the implementation of deficit irrigation practices (as described below) and optimum irrigation scheduling, cutting down on water usage during periods of a crop's life cycle when it is most tolerant of drought.[29] In addition to reducing the risks of lower output during times of drought, many low-water use crops can also typically tolerate higher salinity levels, such that they can be deployed in a variety of soil types and water quality environments.[30]

27 Ibid.

28 B. Colby and G. B. Frisvold, 2011. Adaptation and Resilience: The Economics of Climate, Water, and Energy Challenges in the American Southwest, Washington, D.C.: Earthscan Press.

29 C. Kirda, Deficit Irrigation Scheduling Based on Plant Growth Stages Showing Water Stress Tolerance. Natural Resources Management and Environment Department, n.d. Web, January 22, 2015.

30 Ibid.

Growing Season and Consumptive Use			
Crop Type	Growing Season		Consumption (Inches) / Season
	Average Dates	Days	
Alfalfa	3/20 - 10/10	204	35
Sugarbeets	4/25 - 10/10	168	30
Corn/Grain	5/5 - 10/5	153	25
Soybeans	5/25 - 10/5	133	16
Spring Grains	4/1 - 7/25	115	15
Dry Beans	6/1 - 9/5	96	19

Table V(B)(2)-4. Growing Season and Consumptive Use for Crops in Holyoak, Colorado. Source: Colorado Agricultural Water Alliance.

Although potentially generating greater yields per acre and/or increases in yield per af of water consumed, changes in crop types can also generate important tradeoffs, some of which may not be desirable. For example, as described previously, permanent tree crops require a consistent supply of water, which hardens water demand and limits the opportunity for making alternative uses of water in other seasons, while locking in land uses for long periods of time. Certain crops are also capital-intensive, requiring significant investments and opportunity costs to plant and grow trees to the point where they will provide economic returns. In addition, the changeover and planting seasons for permanent crops require longer lead times for supply and demand management, which can be difficult in times of drought and drive farmers to rely on unsustainable groundwater pumping for water supplies (as recently witnessed in California).

REGULATED DEFICIT IRRIGATION

A related strategy to reduce net consumptive use in agriculture is so-called “deficit irrigation.” Regulated deficit irrigation is a holistic land management technique that reduces water usage during periods of a crop’s life cycle when it is most tolerant of drought.[31] Despite reducing the volume of water supplied, when timed appropriately, deficit irrigation often does not have a large impact on crop yield.[32] This strategy does require knowledge of the transpiration deficiency level allowable in the particular crop to avoid a significant yield decrease, as well as knowledge of how output levels will respond to reduced water consumption.[33] The crops that have proven to be most successful with the use of deficit irrigation are those that have a short growing season and are generally more tolerant of drought, such as cotton, maize, wheat, and sunflowers.[34] In some cases, deficit irrigation has increased certain aspects of crop quality, including higher protein content in wheat, improved sucrose concentration in sugar beets, and longer and sturdier fibers in cotton.[35]

ORGANIC FARMING

As part of a larger strategy of crop conversion and efficiency improvements, some farm operations may have opportunities to convert into specialty forms of production, such as organic farming, as a means to increase net farm revenues on each acre. Organic agricultural practices, which utilize natural ecosystem management in place of artificial agricultural inputs, can offer extensive environmental and economic benefits. Within the category, agricultural strategies such as crop rotation and use of organic fertilizers are essential for improving soil structure and maintaining nutrient and energy content.[36] Organic farming also reduces water

31 C. Kirda, Deficit Irrigation Scheduling Based on Plant Growth Stages Showing Water Stress Tolerance, Natural Resources Management and Environment Department, n.d. Web, January 22, 2015.

32 Ibid.

33 Ibid.

34 Ibid.

35 Ibid.

36 “Organic Agriculture: What Are the Environmental Benefits of Organic Agriculture?” Food and Agricultural Organization of the United Nations. N.p., n.d. Web, January 21, 2015.

pollution resulting from pesticides and synthetic fertilizers, and helps to restore areas afflicted by groundwater pollution.[39] The organic certification requirements in the U.S. prohibit the use of GMOs and promote natural biodiversity, and also sequester larger amounts of carbon in soil which helps mitigate the effects of global warming. While farmers may benefit economically from the price premiums commanded by organic food (ranging from +50% to +200%), organic food currently comprises only 4.4% of all food sales in the United States. However, demand for organic food is currently growing at a rate of 14% per year, while the supply of cropland utilized to produce organic food is growing at only 8% per year.[40]

In addition to organic farming, the market is seeing a proliferation of other specialty certifications. Whole Foods grocery stores recently unveiled its "Responsibly Grown" certification, which rewards producers for contributions to water conservation, improved soil health, pest management, and farmworker welfare, among other metrics.[41] This standard is too new to assess in terms of environmental and financial impact, but it suggests growing opportunity and demand for farms shifting to more sustainable practices.

CHALLENGES WITH IMPLEMENTING CONVERSION AND EFFICIENCY INVESTMENTS

Depending on the individual characteristics of a farm in the Colorado River Basin, it may well be beneficial for a farmer to consider crop conversion, invest in irrigation efficiency improvements, or explore alternative agricultural practices such as conservation tillage, use of cover crops, etc. However, while these strategies can produce obvious benefits to conserving water, increasing yields, and reducing input costs, many farmers and ranchers may simply be unaware of certain of these practices, have not been presented with the right financing structure to implement these changes or make them financially feasible, or lack the motivation to initiate changes.

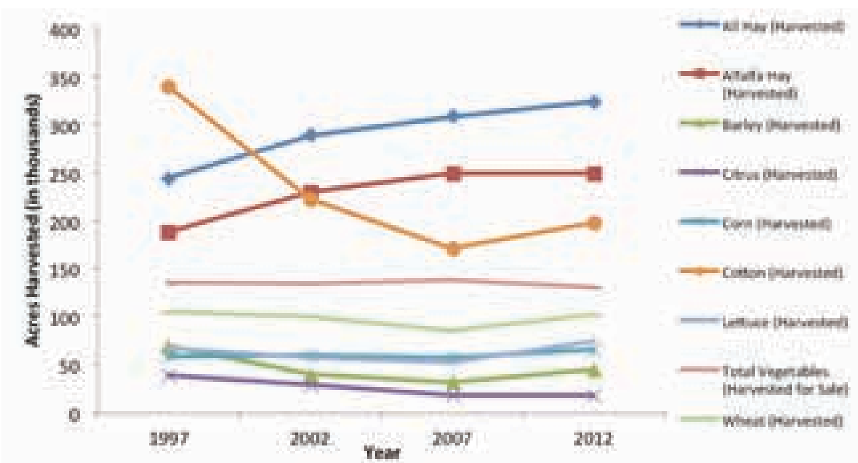


Figure V(B)(2)-6. Major Arizona Crops and Acreages, 1997-2012. Source: USDA Agricultural Census, 1997 and 2012. Note: All data points are total acres harvested, with the exception of citrus from 1997 and 2002, which refer to total acres planted.

37 Ibid.

38 Ibid.

39 Farmland LP. Rep. Vital Farmland REIT, LLC, November 18, 2014. PDF, January 22, 2015, 12.

40 Ibid.

41 "Get to Know Responsibly Grown" Whole Foods Markets. Web, June 15, 2015

42 "A Case Study in Efficiency - Agriculture and Water Us in the Yuma, Arizona Area". Yuma County Agriculture Water Coalition. February 2015.

43 Ibid.

In some areas of the Colorado River Basin, extensive irrigation infrastructure upgrades have already been undertaken in both the efficiency of water delivery systems at diversion and the efficiency of on-farm use. Irrigation districts in the Yuma, Arizona region provide a prime example of these investments, which over time have allowed net yields to increase substantially even as overall water use declined.[42] Interestingly, in the Yuma area, these improvements have for the most part been undertaken in the absence of significant regulatory drivers requiring increased efficiency, instead reflecting the pursuit of improved farm-level and district-level economics (although these efforts were aided or incentivized in many cases by federal programs designed to manage salinity, soils, and other issues).[43] Central Arizona agricultural users, concentrated in the agricultural districts surrounding the Central Arizona Project canal, have also demonstrated similar improvements in efficiency over time, driven by affirmative regulatory requirements pursuant to the 1980 Arizona Groundwater Management Act, which sets specific efficiency requirements and establishes best management practices for irrigated lands in the central portions of the state.

However, these same types of investments have not occurred in all parts of both the Upper and Lower Basins where, in many cases, relatively inefficient, high-water use methods of irrigation continue to be routinely employed. Hay crops, for example, are quickly maturing crops that are relatively resilient to overwatering, creating few incentives to carefully regulate water use. With ample water and favorable weather, alfalfa hay can be harvested up to 12 times per year in certain regions.[44] In the Upper Basin over 55% of the crop mix is characterized as hay crops and another 37% as irrigated pasture.[45] With these relatively low-value but high-yield crop types, there is little incentive for a farmer attempting to maximize yield to apply less water, even when efficient irrigation methods are employed. Similar considerations may disincentivize crop conversions, which can require significant up-front costs as well as corresponding investments in changes to irrigation infrastructure.

External economic incentives may offer an important stimulus for change. A number of government programs have been implemented to spur investment in irrigation efficiency and connect private capital with rural investment opportunities. For example, the U.S. Department of Agriculture (USDA) Rural Opportunity Investment Initiative (ROI) is attempting to leverage private sector financing to provide funding to vital rural infrastructure projects such as “hospitals, schools and other educational facilities, rural water

44 Ibid.

45 “Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin.” The Pacific Institute, Michael Cohen, Juliet Christian-Smith, and John Berggren. May 2013.

and wastewater systems, energy projects, broadband expansion, local and regional food systems, and other rural infrastructure".[46] While programs like this do hold high potential for addressing funding needs in critical infrastructure, the application process takes time to navigate, and site-specific funding may be insufficient to implement changes across an entire farm or agricultural district. Moreover, given the broad infrastructure agenda of this particular program (i.e. from hospitals to waste water) the funding allocated is less likely to be tailored to meet specific farmers' needs, whereas focused private investors who work directly with a farmer can offer more flexible funding strategies.

3. Proposed Solution

In this broader context, a private capital solution for financing improvements in agricultural water use that combines (a) specific crop conversions towards lower water use, drought-tolerant crops, (b) irrigation infrastructure upgrades to increase overall efficiency and (c), where appropriate, the introduction of enhanced land management techniques (such as cover cropping and conservation tillage) could help to reduce the consumptive use of water in many parts of the Colorado River Basin. These investments could create meaningful alternatives to fallowing as a source of water savings, improving farm yields and water use without causing reductions in the land area used for agriculture.[47] Just as importantly, such changes could also serve to better align incentives among water users in the Basin.

In some cases, the growth in revenue that could be derived from increased crop yields, the cost savings from efficiency improvements and reduced infrastructure/pumping costs, and/or the higher farm gate revenues associated with higher-value, lower-water use crops may be independently sufficient to justify the capital investments in infrastructure and crop switching required to undertake conversions. However, the opportunity to monetize resulting water savings via the sale or lease of saved water to another user could be a key source of income to help repay those investments and generate financial return that would be attractive to private investors. In addition, the negotiation of off-take agreements for converted crops, combined with necessary upstream investments in processing capability or other value-chains for alternative crops, could help to reduce the risks associated with crop conversions by "locking in" the revenue associated with future farming operations.

Figure V(B)(2)-7. Irrigated fields near Yuma, Arizona.
Image courtesy of U.S. Bureau of Reclamation.

46 www.whitehouse.gov/the-press-office/2015/01/16/fact-sheet-increasing-investment-us-roads-ports-and-drinking-water-syste. May 2013.
47 Nathan Lee and Alice Plant. Agricultural Water Use in the Colorado River Basin: Conservation and Efficiency Tools for a Water Friendly Future. Rep. N.p., n.d. Web, January 14, 2015.

This latter approach to off-take agreements appears to be particularly promising with regard to the production of specialized crops that are not already widely produced in the region, and for which the negotiation of long-term supply contracts or similar arrangements could be attractive to a buyer. For example, a particular type of rubber plant, guayule, appears to have great promise for farmers in Arizona.[48] The guayule plant, in addition to being relatively low maintenance, requires less water than citrus fruits and many row crops, which allows it to thrive in Arizona's arid climate.[49] While guayule has been cultivated for centuries by southwestern and Mexican Indian tribes, the plant yields a form of rubber that does not contain the specific proteins that trigger latex allergies, and the rubber is therefore experiencing increasing demand today by large manufacturers of consumer goods. Equally promising for farmers in the region is that guayule yields per plant, when combined with land leveling and precision irrigation practices, are consistent and highly predictable. This predictability could allow for the negotiation of long-term, low-risk or shared-risk supply contracts with buyers that are in need of stable, predictable supplies of raw materials.

Predictability could allow for the negotiation of long-term, low-risk or shared-risk supply contracts with buyers that are in need of stable, predictable supplies of raw materials.

Regardless of the approach, making these agricultural conversion solutions work will typically require a multi-dimensional, holistic approach to addressing farm and land management practices, rather than simply looking to invest in changes to single variables, such as reducing acres under cultivation or increasing net farm yields. For environmental benefit, water use targets and crop types should be defined based on estimates of future water demand and pricing associated with potential transfers of water savings to new users, local soil types, drought risks, and other variables, and the direction of water transfers could create either environmentally-beneficial or environmentally-damaging results (for example, while transfers of water to users downstream will increase stream flows, transfers to users upstreams will diminish instream flows and can change the timing of those flows). Efficiency upgrades should also be matched to the site-specific opportunities and potential benefits and savings (environmental and otherwise) associated with reductions in diversions. Economic incentives will need to be carefully aligned in order to attract private capital to the financing vehicle, and a flexible deal structure will be critical to addressing the needs of farmers who wish to maintain an ownership stake in their land. The models below suggest three potential arrangements under which investors and farmers can work together to achieve these broader results.

48 "Native Crops: Commercial Uses for Prickly Pear and Guayule." Native Crops: Commercial Uses for Prickly Pear and Guayule. The Arizona Experience, December 4, 2012. Web, January 14, 2015.
49 Ibid.

1. DIRECT INVESTMENT MODEL[50]

A direct investment strategy would involve the direct purchase of farmland by an investor, with a goal to reduce water diversion and consumption through upgrading irrigation infrastructure, changing land management practices, and converting farms to lower-water-use (and in some cases higher-value) crops. The investor would also seek to negotiate off-take agreements to better predict and secure revenues and costs, and financial returns would be generated from increased quantity and quality of farm outputs, decreased water use (with potential for monetization of saved water), and the appreciation of the underlying land and other assets (through higher margin outputs and quality of land upon exit). This strategy could also incorporate financing strategies, such as an "earn-out," that would facilitate the entry of young farmers and ranchers into the agricultural industry who have proven to be willing and capable managers, but who lack the capital to pursue farm purchases or conversion strategies by themselves.

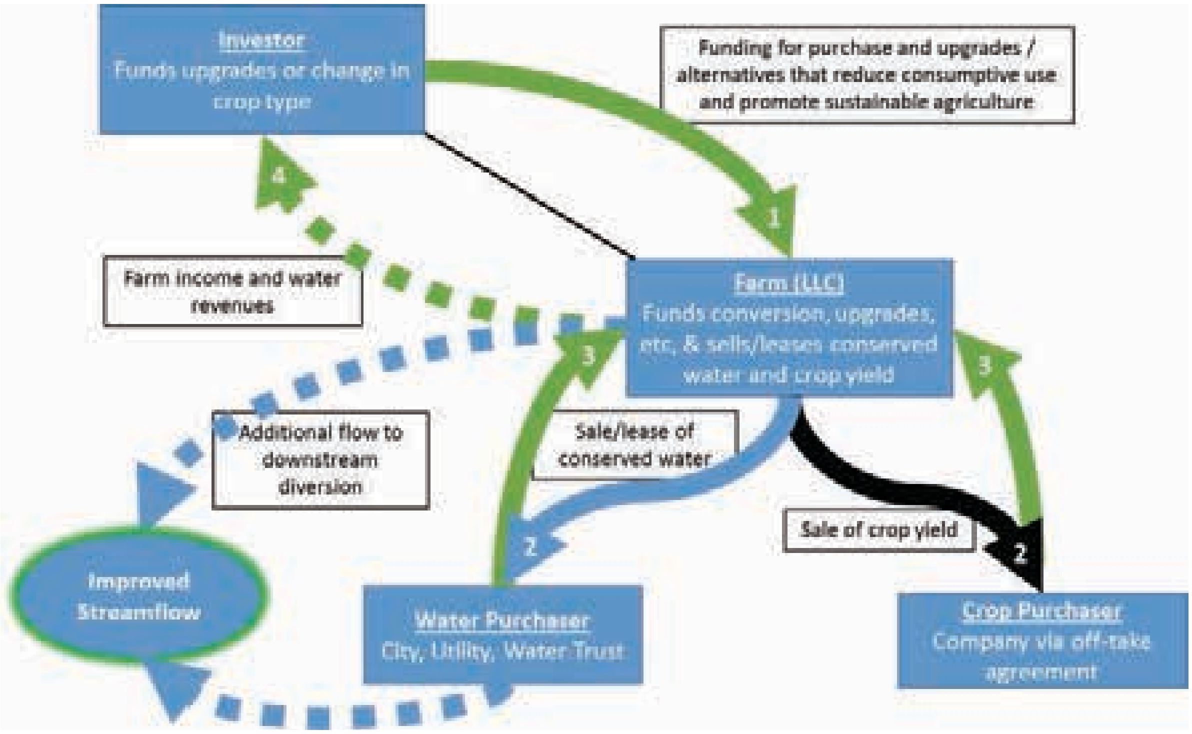


Figure V(B)(2)-8. Structure of the Crop Conversion and Infrastructure Upgrade Direct Investment Model.

50 For tax purposes, the private investor would be expected to have ordinary income from the sale of the water and the sale of the crops. The cost of infrastructure/farm upgrades likely will have to be capitalized and deducted over their useful life. The costs associated with farming activity will be recovered in the same manner as any other costs of crop production.

2. JOINT VENTURE INVESTMENT MODEL [51]

In contrast to the direct investment approach, a joint venture investment model would provide for a joint venture (JV) to be formed by an investor and the farmer/landowner with the goal of reducing water diversion and consumption through upgrading irrigation infrastructure, enhancing land management, and converting the existing farm to lower-water-use crops. Working together, the investor and the farmer would also seek to negotiate off-take agreements to better predict and secure revenues and costs. In this scenario, the investor would fund both on-farm infrastructure upgrades and the conversion to lower-water-use crops though a joint venture with the farmer. The farmer, in turn, would contribute land assets, alter farming practices, and provide labor. The financial return from the joint venture to both parties is a percentage of profits from the increased quantity and quality of farm or ranch outputs, decreased water use (with potential for monetization of saved water), and appreciated underlying land or asset value (which is likely to remain with the farmer).

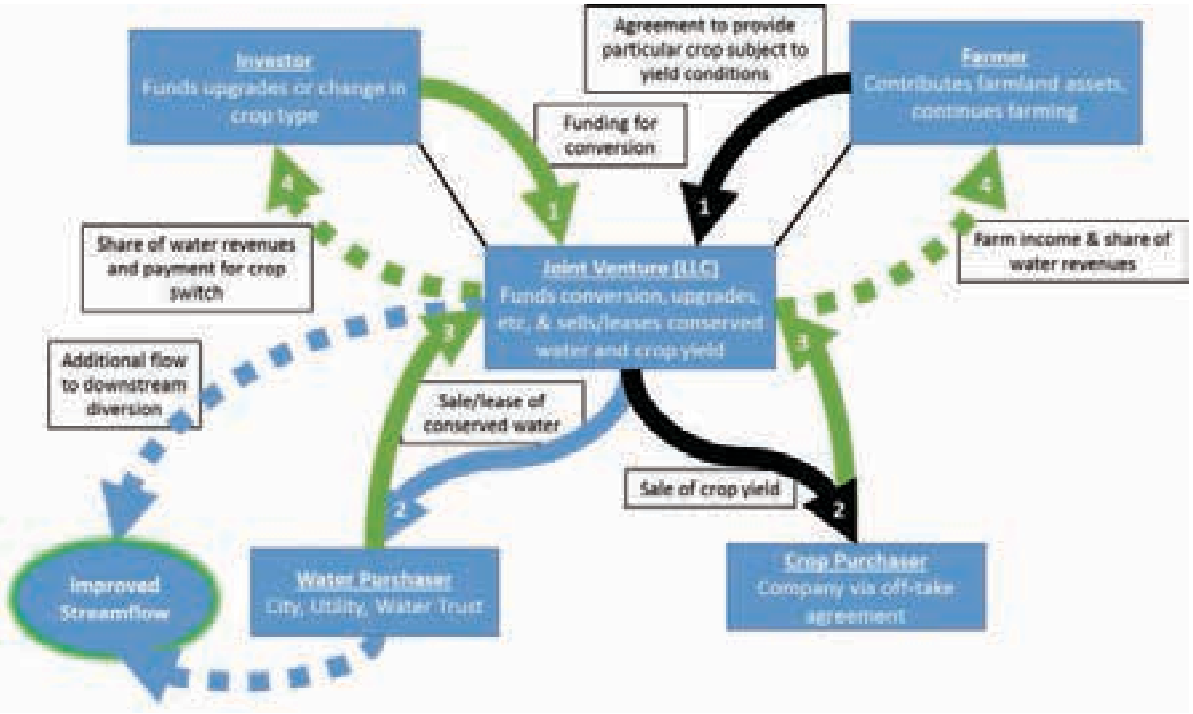


Figure V(B)(2)-9. Structure of the Crop Conversion and Infrastructure Upgrade Joint Venture Model.

51 Unless it elects to be a "corporation," the joint venture entity would likely be treated as a partnership for federal income tax purposes and generally for state income tax purposes. For federal income tax purposes (and generally for state income tax purposes) the income from a water sale or lease with another user for federal income tax purposes would thus not be taxed at the entity level but rather would flow through to the investor and farmer (based on their sharing agreement) and would be taxed at ordinary rates. The lease of the farmland to the entity would be taxed at ordinary rates.

3. WATER DEVELOPMENT AGREEMENT INVESTMENT MODEL (FOR DIRECT PURCHASE OR JOINT VENTURE)[52]

As discussed further in Section II of this report, the majority of agricultural water use in many areas of the Colorado River Basin occurs within irrigation districts and other forms of agricultural districts, as water rights and uses are held and controlled by these districts on behalf of individual farmers. This specific strategy would allow for investments in crop switching and/or efficiency at the district level through a "Water Development Agreement" to be negotiated between investors and an agricultural district. The purpose of the agreement would be to finance infrastructure upgrades and contract with farm owners (or purchase land outright) in order to reduce consumptive water use. The investor would fund the water savings program in exchange for the potential of a financial return, most likely in the form of a share of revenues that would be generated by the agricultural district via the monetization of resulting water savings through a lease or sale of water to a specific purchaser. The agricultural district would upgrade infrastructure and contract with individual farmers to reduce water consumption (e.g., through crop switching investments). The agricultural district would then sell or lease the saved water to another water user (such as a municipality) and return a portion of the revenue to the investor to generate investment return.

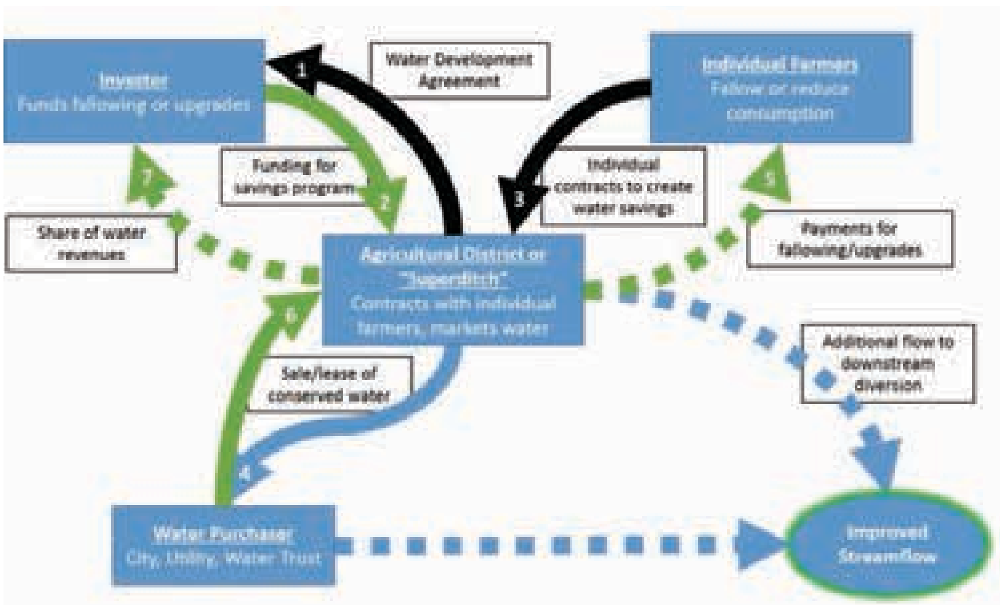


Figure V(B)(2)-10. Structure of the Crop Conversion and Infrastructure Upgrade Water Development Agreement Investment Model.

52 For tax purposes, the amount paid by the private investor to the agricultural district likely would have to be capitalized and amortized over the life of the contract. The payments received by the private investor from the sale or lease of the water would be ordinary income to the private investor. The arrangement between the agricultural district and the private investor could be construed as a "partnership" for federal and state income tax purposes; since this would be very complicated to implement, the documentation would need to be carefully drafted to avoid such a characterization. The agricultural district's payments to individual farmers for the farmland upgrades would likely be treated as income to the farmer(s) unless such amounts are treated as a non-taxable contribution to the capital of the farmer entity. For such a payment to be a non-taxable, non-shareholder capital contribution, the farmer entity would have to be a corporation, payment would have to be made for the upgrades rather than for fallowing, and the payment would have to meet certain other requirements. If the payment made by the agricultural district to the farmer is taxable, the cost of the upgrades would be deductible by the farmer over the useful life of those upgrades under the Internal Revenue Code.

HYPOTHETICAL CASE STUDY EXAMPLE

Several variations on this type of agricultural investment are reflected in the schematics above. However, the hypothetical case study below highlights just one of these possible scenarios (a joint-venture arrangement) to show how infrastructure investment and crop switching could generate interest from private capital investors and create meaningful environmental impact.

Multigenerational family Farmer A owns 5,000 acres of farmland and is looking to retire. His farm has traditionally focused on alfalfa farming utilizing flood irrigation, undertaken through a relatively inefficient and primitive system of unlined ditches. While Farmer A is looking to spend less time on the farm, he would like to maintain ownership of the land and occasionally “get his hands dirty” in the day-to-day operations. The farm is supplied with water through a shared local ditch company that serves several farms in the area and has high-priority water rights.

Farmer A is aware that Permanent Cropper C, who is expanding operations on adjacent lands on the ditch, is looking to acquire land and/or water rights in order to meet the needs associated with her growing citrus orchards. Municipality E, which diverts water for urban use at a point substantially further downstream from Farmer A and Permanent Cropper C, is also looking to obtain water rights to support growing water demands over the longer term. Farmer A has no intention of selling his land, however, and would only cut his current water use if he could ensure there was enough farm income to support his lifestyle into retirement.

Farmer A is relatively indifferent as to the particular crop grown on his land (or crop cycle), but likes the idea of irrigation upgrades since his neighbors have increased their cuttings of alfalfa as a result of switching out of flood irrigation, and he knows that new infrastructure will increase the underlying value of his farm asset.

Investor B approaches Farmer A, Permanent Cropper C, and Municipality E, believing that there is an opportunity to upgrade Farmer A’s farm to a subsurface drip irrigation system and convert the harvest to durum wheat, while generating water savings. A portion of the potential water savings could be temporarily (or permanently) used by Permanent Cropper C to support their expanded citrus production, and a portion of the water savings could be sold or transferred to Municipality E over the longer term.

Investments in canal lining, land leveling, and changes in land management techniques, such as the introduction of cover crops (in this case, black-eyed peas), would also significantly increase overall water use efficiency and allow for reduced diversions and associated costs. While Investor B is flexible in her approach to finance this upgrade and conversion, she has no previous experience in farming and would like to utilize Farmer A’s expertise to help ensure that the potential investment results in a profitable outcome for all parties.

HYPOTHETICAL TRANSACTION

1. Farmer A and Investor B enter into a joint venture agreement whereby Investor B will pay for on-farm irrigation infrastructure upgrades and the crop conversion expenses in exchange for a share of annual farm profits and revenue from the lease/sale of water savings.
2. Farmer A agrees to initiate the planning and construction of canal lining and installation of subsurface drip irrigation to replace his existing ditches and flood irrigation infrastructure, and also to convert his fields from alfalfa to durum wheat.
3. The joint-venture entity then contracts with Permanent Cropper C to lease a portion of the resulting water savings (as compared to Farmer A's prior five-year average diversion), and enters into a long-term supply contract with Bread Company D to buy the crop of wheat for a number of upcoming harvests.
4. Over the years to follow, the joint-venture entity demonstrates that these investments for water efficiency have resulted in a demonstrable net reduction in consumptive use, and permanently sells the corresponding portion of their water rights to Permanent Cropper C and Municipality E. As a result of these investments and transfers, the amount of water diverted into the ditch to serve Farmer A is significantly reduced, increasing the amount of water flowing instream down to the diversion point for Municipality E and creating corresponding environmental benefits.
5. Farmer A and Investor B share the profits of the farm that result from crop output and water not diverted as a result of crop switching and irrigation efficiency upgrades.
6. After the exit of Investor B, Farmer A is left with higher value farmland through upgraded irrigation infrastructure, higher output / profitability per acre, and higher quality soil.

4. Financial Model[53]

The illustrations below detail hypothetical cash flows for a 10-year financing vehicle to make this type of agricultural investment, while creating environmental benefits to stream flows and soil health. The arrangement contemplated in Figure V(B)(2)- 11 and Figure V(B)(2)- 13 shows a hypothetical transaction for an investor buying land per the structure listed above, and Figure V(B)(2)- 12 and Figure V(B)(2)- 14 below show a joint-venture arrangement between an investor and land owner per the structure listed above.

The financial model is intended to be for illustrative purposes only, as the costs and benefits associated with agricultural practices are highly variable; further site-level diligence would be required for investment in any targeted region. For purposes of this model however, input data is derived from specific farm-level sources and data points for an operation in Yuma, AZ.

In the examples below, it is assumed that the initial design and farm conversion (and associated costs) would take approximately one year to implement. The water savings would also need to be proved over a number of years before they could be sold, although a temporary transfer mechanism (lease or forbearance agreement) might provide a limited interim opportunity for discounted-rate monetization of the saved water (until the precise quantity of savings and transferable consumptive use is identified). While the benefits of the project could be seen sooner (or later) than the 10 year time horizon, the investor repayment schedule in the joint venture operation is intended to return capital to the investor by splitting the annual farm income 70% to the investor and 30% to the farmer until the investor reaches 100% repayment of his invested capital (at which point the split is assumed to be 50%/50% going forward). For purposes of the mode, it is also assumed that any permanent water rights transfer would also return capital to the investor on a split of 30% to the investor and 70% to the farmer.

53 This notional financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual project on an actual farm. The hypothetical transaction is fictitious and is only intended to provide some key line items interested parties might consider in assessing the potential for a transaction. Among other omissions, inflation, depreciation and tax considerations have not been diligenced for this notional financial model.

Figure V(B)(2)-11. Assumptions for Crop Conversion and Infrastructure Upgrades Model (Buy Land)

Project Funding Parameters	
Scenario: Buy Land (1) or Joint Venture (0)	1
Acres of Land Contracted/Purchased	5,000
Upgrade Cost / Acre (drainage, pumps, leveling)[1]	$1,000
Feasibility Study and Planning	$150,000
Initial Cost for Project Upgrades	$5,150,000
Price per Acre[2]	$3,000
Land Purchase (Buy Scenario Only)	$15,000,000

[1] Colorado Agricultural Water Alliance estimate for subsurface drip irrigation.
[2] Based off Yuma, AZ (http://www.landandfarm.com).

Estimated Administrative Costs	
Project Management Fee (Life of Project)	$1,500,000
Legal and Administrative Fees (Over 2 Years)	$500,000
Total Administrative Costs	$2,000,000

Timing and Structure of Funding	
Years to Conduct Initial Upgrades	1
Initial Year of Water Savings[3]	2
Years to Prove Water Savings for Sale[4]	5
Life of Project / Exit Year (years)	10

[3] Assumes water savings generated in year after upgrades complete.
[4] Water rights sold only after proven reduction in water use.

Investment Returns	
Land Value Appreciation (Buy Scenario Only)	10%
Multiple of Invested Capital (MOIC)	2.4x
Internal Rate of Return (IRR)	12.1%
Discount Rate	5.0%
Net Present Value of Project	$14,492,678

Sources and Uses	
Sources	
Investor Funding	$22,150,000
Uses	
Initial Cost for Project Upgrades	$5,150,000
Land Purchase (Buy Scenario Only)	$15,000,000
Total Administrative Costs	$2,000,000
	$22,150,000

Expenses and Income (Annual)	
Wheat Farming Costs / Acre (equip, seed, etc.)[5]	$215
Black-eyed Peas Cover Crop / Acre (equip, seed, etc.)[5]	$180
Irrigation Maintenance Costs / Acre[1]	$120
Annual Crop/Water Costs	$2,575,000

[5] Based off Yuma Area Ag Council Data (http://www.yaac.net).

Labor (only in Buy Land Scenario)	
Full-time Equivalent / 1,000 Acres	1.75
Daily Pay Rate / Full-time Equivalent ($10/hour)	$80
Annual Labor Costs	$255,500
Farming Income	
Wheat Revenue / Acre (Cooler Months)[5]	$438
Black-eyed Pea Revenue / Acre (30% Reduced Value)[5]	$270
Annual Farm Income[6]	$3,535,000

[6] Does not account for potential increased yield from drip irrigation.

Water Analysis	
AF Cost to Farmer for Diverted Water	$25
Water Diversion Required for Flood Irrigation	45,833
Net Efficiency from Flood Irrigation[1]	40.0%
Alfalfa Irrigation Required (5.5 AF/Acre)[5]	27,500
Wheat and Black-eyed Pea Cover (3.5 AF/Acre)[5]	17,500
Loss Rate with Subsurface Drip[1]	10.0%
Water Diversion Required for Wheat and Peas	19,444
Reduction in Required Water Diversion	26,389
Direct Reduction in Crop Consumption	10,000
AF Price Paid by Permanent Cropper for Lease	$100
Annual Water Revenue from Lease	$1,000,000
Water Savings Sold[7]	10,000
Water Sale Price for Permanent Right	$3,500
Water Revenue at Sale	$35,000,000

[7] Assumes sale of 100% of reduced consumption.

Figure V(B)(2)-12. Assumptions for Crop Conversion and Infrastructure Upgrades Model (Joint Venture)

Project Funding Parameters	
Scenario: Buy Land (1) or Joint Venture (0)	0
Acres of Land Contracted/Purchased	5,000
Upgrade Cost / Acre (drainage, pumps, leveling)[1]	$1,000
Feasibility Study and Planning	$150,000
Initial Cost for Project Upgrades	$5,150,000
Price per Acre[2]	$3,000
Land Purchase (Buy Scenario Only)	$0

[1] Colorado Agricultural Water Alliance estimate for subsurface drip irrigation.
[2] Based off Yuma, AZ (http://www.landandfarm.com).

Estimated Administrative Costs	
Project Management Fee (Life of Project)	$1,500,000
Legal and Administrative Fees (Over 2 Years)	$500,000
Total Administrative Costs	$2,000,000

Timing and Structure of Funding	
Years to Conduct Initial Upgrades	1
Initial Year of Water Savings[3]	2
Years to Prove Water Savings for Sale[4]	5
Life of Project / Exit Year (years)	10

[3] Assumes water savings generated in year after upgrades complete.
[4] Water rights sold only after proven reduction in water use.

Investment Returns	
Land Value Appreciation (Buy Scenario Only)	10%
Multiple of Invested Capital (MOIC)	1.9x
Internal Rate of Return (IRR)	10.0%
Discount Rate	5.0%
Net Present Value of Project	$2,544,968

Sources and Uses	
Sources	
Investor Funding	$7,150,000
Uses	
Initial Cost for Project Upgrades	$5,150,000
Land Purchase (Buy Scenario Only)	$0
Total Administrative Costs	$2,000,000
	$7,150,000

Expenses and Income (Annual)	
Wheat Farming Costs / Acre (equip, seed, etc.)[5]	$215
Black-eyed Peas Cover Crop / Acre (equip, seed, etc.)[5]	$180
Irrigation Maintenance Costs / Acre[1]	$120
Annual Crop/Water Costs	$2,575,000

[5] Based off Yuma Area Ag Council Data (http://www.yaac.net).

Labor (only in Buy Land Scenario)	
Full-time Equivalent / 1,000 Acres	1.75
Daily Pay Rate / Full-time Equivalent ($10/hour)	$80
Annual Labor Costs	$255,500
Farming Income	
Wheat Revenue / Acre (Cooler Months)[5]	$438
Black-eyed Pea Revenue / Acre (30% Reduced Value)[5]	$270
Annual Farm Income[6]	$3,535,000

[6] Does not account for potential increased yield from drip irrigation.

Water Analysis	
AF Cost to Farmer for Diverted Water	$25
Water Diversion Required for Flood Irrigation	45,833
Net Efficiency from Flood Irrigation[1]	40.0%
Alfalfa Irrigation Required (5.5 AF/Acre)[5]	27,500
Wheat and Black-eyed Pea Cover (3.5 AF/Acre)[5]	17,500
Loss Rate with Subsurface Drip[1]	10.0%
Water Diversion Required for Wheat and Peas	19,444
Reduction in Required Water Diversion	26,389
Direct Reduction in Crop Consumption	10,000
AF Price Paid by Permanent Cropper for Lease	$100
Annual Water Revenue from Lease	$1,000,000
Water Savings Sold[7]	10,000
Water Sale Price for Permanent Right	$3,500
Water Revenue at Sale	$35,000,000

[7] Assumes sale of 100% of reduced consumption.

Figure V(B)(2)-13. Illustrative cash flows for Crop Conversion and Infrastructure Upgrade (Buy Land)

Year:	0	1	2	3	4	5	6	7	8	9	10
Income											
Crop Revenue		$0	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000
Lease of Water Savings		0	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	0	0	0	0
Sale of Water Savings (Permanent Right)[1]		0	0	0	0	0	0	35,000,000	0	0	0
Total Income		$0	$4,535,000	$4,535,000	$4,535,000	$4,535,000	$4,535,000	$38,535,000	$3,535,000	$3,535,000	$3,535,000

[1] Assumes permanent water right can be sold after five years of demonstrated reduced consumption.

	0	1	2	3	4	5	6	7	8	9	10
Operating Expenses											
Labor (Buy Land Scenario)[2]		$0	$255,500	$255,500	$255,500	$255,500	$255,500	$255,500	$255,500	$255,500	$255,500
Annual Water Diversion		0	1,145,833	1,145,833	1,145,833	1,145,833	1,145,833	486,111	486,111	486,111	486,111
Annual Crop Input		0	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000
Program Management		150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Legal		250,000	250,000	0	0	0	0	0	0	0	0
Upgrade & Conversion		5,150,000	0	0	0	0	0	0	0	0	0
Land Purchase		15,000,000	0	0	0	0	0	0	0	0	0
Total Expenses		$20,550,000	$4,376,333	$4,126,333	$4,126,333	$4,126,333	$4,126,333	$3,466,611	$3,466,611	$3,466,611	$3,466,611

[2] Expects labor costs to be contributed by the farmer/landowner in the Joint Venture Scenario.

	0	1	2	3	4	5	6	7	8	9	10
Operating Income		($20,550,000)	$158,667	$408,667	$408,667	$408,667	$408,667	$35,068,389	$68,389	$68,389	$68,389
Income Share (JV Scenario Only)[3]											
Investor --- 70%, 50% 70%	50%		$111,067	$286,067	$286,067	$286,067	$286,067	$47,872	$34,194	$34,194	$34,194
Farmer/Landowner --- 30%, 50%			$47,600	$122,600	$122,600	$122,600	$122,600	$20,517	$34,194	$34,194	$34,194

[3] Investor to receive 85% of operating profits until year after investment capital is return; each year thereafter is split 50%/50% with the farmer/landowner.

	0	1	2	3	4	5	6	7	8	9	10
Sale of Permanent Water Share (JV Scenario Only)[4]											
Investor --- 30% 30%			$0	$0	$0	$0	$0	$10,500,000	$0	$0	$0
Farmer/Landowner --- 70%			$0	$0	$0	$0	$0	$24,500,000	$0	$0	$0

[4] Assumes farmer/landowner keeps 70% of sale of permanent water rights and keeps irrigation infrastructure funded by the investor in exchange for 30% of income from sale of permanent water rights.

Investor Returns	0	1	2	3	4	5	6	7	8	9	10	In-Flows	Exit Value
Returns on Invested Capital	($22,150,000)	$0	$158,667	$408,667	$408,667	$408,667	$408,667	$35,068,389	$68,389	$68,389	$16,568,389	$53,566,889	$16,500,000
Discounted Returns for NPV	($22,150,000)	$0	$143,915	$353,022	$336,211	$320,201	$304,953	$24,922,449	$46,288	$44,084	$10,171,554	$36,642,678	

MOIC:	2.4x
IRR:	12.1%
NPV:	$14,492,678

Figure V(B)(2)-14. Illustrative cash flows for Crop Conversion and Infrastructure Upgrade (Joint Venture)

Year:		0	1	2	3	4	5	6	7	8	9	10		
Income														
Crop Revenue			$0	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000	$3,535,000		
Lease of Water Savings			0	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	0	0	0	0		
Sale of Water Savings (Permanent Right)[1]			0	0	0	0	0	0	35,000,000	0	0	0		
Total Income			$0	$4,535,000	$4,535,000	$4,535,000	$4,535,000	$4,535,000	$38,535,000	$3,535,000	$3,535,000	$3,535,000		
[1] Assumes permanent water right can be sold after five years of demonstrated reduced consumption.														
Operating Expenses														
Labor (Buy Land Scenario)[2]			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Annual Water Diversion			0	1,145,833	1,145,833	1,145,833	1,145,833	1,145,833	486,111	486,111	486,111	486,111		
Annual Crop Input			0	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000	2,575,000		
Program Management			150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000		
Legal			250,000	250,000	0	0	0	0	0	0	0	0		
Upgrade & Conversion			5,150,000	0	0	0	0	0	0	0	0	0		
Land Purchase			0	0	0	0	0	0	0	0	0	0		
Total Expenses			$5,550,000	$4,120,833	$3,870,833	$3,870,833	$3,870,833	$3,870,833	$3,211,111	$3,211,111	$3,211,111	$3,211,111		
[2] Expects labor costs to be contributed by the farmer/landowner in the Joint Venture Scenario.														
Operating Income			($5,550,000)	$414,167	$664,167	$664,167	$664,167	$664,167	$35,323,889	$323,889	$323,889	$323,889		
Income Share (JV Scenario Only)[3]														
Investor --- 70%, 50%	70%	50%		$289,917	$464,917	$464,917	$464,917	$464,917	$226,722	$161,944	$161,944	$161,944		
Farmer/Landowner --- 30%, 50%				$124,250	$199,250	$199,250	$199,250	$199,250	$97,167	$161,944	$161,944	$161,944		
[3] Investor to receive 85% of operating profits until year after investment capital is return; each year thereafter is split 50%/50% with the farmer/landowner.														
Sale of Permanent Water Share (JV Scenario Only)[4]														
Investor --- 30%	30%			$0	$0	$0	$0	$0	$10,500,000	$0	$0	$0		
Farmer/Landowner --- 70%				$0	$0	$0	$0	$0	$24,500,000	$0	$0	$0		
[4] Assumes farmer/landowner keeps 70% of sale of permanent water rights and keeps irrigation infrastructure funded by the investor in exchange for 30% of income from sale of permanent water rights.														
Investor Returns													In-Flows	Exit Value
Returns on Invested Capital		($7,150,000)	$0	$289,917	$464,917	$464,917	$464,917	$464,917	$10,726,722	$161,944	$161,944	$161,944	$13,362,139	$0
Discounted Returns for NPV		($7,150,000)	$0	$262,963	$401,612	$382,488	$364,274	$346,928	$7,623,281	$109,610	$104,391	$99,420	$9,694,968	

MOIC:	1.9x
IRR:	10.0%
NPV:	$2,544,968

SECTION V(B)(3):

Sharing Water Supply Risk:
Brokering Commodity-Indexed Dry-Year Options

Summary

This investment vehicle is structured to monetize reductions in water supply risk to water users with a low risk tolerance for interruption in water supplies, using a contingency-driven, price-hedged “dry-year option” agreement. This type of option agreement distributes or shifts the burden of hydrologic risks among and between water users with higher and lower tolerances for water supply interruption by providing for the sharing of higher-priority water rights during drought conditions, while also controlling related economic and pricing risks to both the buyer and seller through commodity price hedging. This creates an attractive option for a low-risk-tolerance water user with a need to reduce extraordinary water supply risks at a predictable cost, while ensuring that the seller of the option does not take inordinate economic risk by agreeing to share its higher-priority water right during adverse hydrological conditions. By managing risks to both users, this tool can also limit the ecological risks and system pressures that would otherwise be associated with sudden, catastrophic shortfalls to low-tolerance users that may otherwise be forced to fall back on ecologically-important water supplies or draw down critical reservoir or aquifer storage.

1. Background

As discussed in Section III, water users in the Colorado River Basin are facing significantly increased risks of shortage over the coming decades as the long-term effects of legal overallocation, physical overuse of water, and the growing changes in the Basin's hydrology begin to manifest throughout the Colorado River Basin. As the Colorado River Basin Study and Reclamation modeling make clear, even with significant investments in the management of shortage risks, water users in the Colorado River Basin must be prepared to deal with substantially increased levels of uncertainty and potential for water shortage that cannot be fully controlled. This growing uncertainty means that the Basin's users – or at least those who have a lower tolerance for water supply interruption – must be prepared to take actions and make investments that will secure replacement supplies in the event of future shortages.

Under the current priority system for the allocation of shortage risks, this issue disproportionately impacts "low-priority" users whose water rights or delivery contracts are more recent in origin. Because of the history of development in the Basin, this frequently means that the greatest risks of shortage exposure fall to municipal and industrial users, as well as a few more recent agricultural developments (such as agricultural districts served by the Central Arizona Project). Taken together, these risks affect users along significant portions of the Colorado River mainstem, as well as users on various tributary systems.

Water users in the Colorado River Basin are facing significantly increased risks of shortage over the coming decades as the long-term effects of legal overallocation, physical overuse of water, and the growing changes in the Basin's hydrology begin to manifest throughout the Colorado River Basin.

Figure V(B)(3)-1. Reservoir at Trinity Lake, California, nearly empty as a result of ongoing drought conditions.Photo courtesy of U.S. Geological Survey.

In the Upper Basin, low-priority users include both agricultural and municipal users (including some on the Front Range: central CO and southeastern WY) with potential exposure to future Colorado River Compact calls. In the Lower Basin, this includes the numerous lower priority municipal users with exposure to shortage risk driven by the structural deficit in Lake Mead, including Southern Nevada Water Authority (SNWA), municipal and agricultural customers on the Central Arizona Project (CAP), various municipal and agricultural on-river users in Arizona, and various municipal and agricultural users in Southern California with exposure to shortfalls on the State Water Project and Central Valley Project. On tributary systems, the nature and extent of shortage exposure varies depending on applicable legal priorities. However, there are numerous examples in both the Upper and Lower Basins of agricultural and/or municipal users that could face supply shortfalls on individual tributary systems that either (a) lack significant storage to buffer against drought events, or (b) experience sustained, below-average runoff that exhausts local storage. These risks can be particularly significant for municipal users, who generally have few options to reduce demand in the face of significant shortfalls aside from municipal conservation. It is generally impractical to simply cut off most municipal customers from supply in the event of a significant supply shortfall (although it may be possible to suspend some services, such as turf irrigation, during critical periods).

Although most municipalities strive to achieve some level of redundancy in water supply to avoid over-dependence on a single source, this is not always practical to achieve, and large-scale shortage conditions may threaten redundant supplies as well. For example, SNWA, which serves the Las Vegas metropolitan region, receives more than 90% of its water supply from the Colorado River and Lake Mead. While this single-source dependence creates obvious risks, there are in fact few other local options for water supply because the Las Vegas area has already fully exploited or over-exploited its local groundwater reserves. To address this issue, SNWA is seeking approvals for an expensive and highly controversial groundwater supply pipeline to import groundwater from other parts of Nevada, and is also deepening its intakes in Lake Mead at enormous expense to ensure access to at least partial supplies even if the reservoir declines to disastrously low levels.

Other Basin cities, such as the Phoenix metropolitan area and the Los Angeles metro area, actually have significant redundancies in supply. Phoenix sits atop a massive groundwater storage basin and has access to both the Colorado River (via the CAP) and the Salt River system (via the Salt River Project). The L.A. region has access to supplies from the Colorado River via the Colorado River Aqueduct, from the Sierras in northern and central California via the State Water Project and Central Valley Project, as well as supplies from the eastern side of the Sierras through pipelines from Mono Lake and the Owens Valley. However, a large-scale shortage can overwhelm even this level of redundancy. For example, the current California drought has impacted the availability of water from essentially every supply source to the L.A. region except for the Colorado River. Similarly, a large-scale shortage in Arizona could conceivably effect both the Colorado River and Salt River simultaneously; if such a shortage were sustained, groundwater reserves could quickly prove inadequate.

More importantly, existing system redundancies are not evenly available to the users in these areas. For example, the City of Phoenix has a highly resilient supply, but many outlying growth communities in the metro area, such as the City of Buckeye, have little or no redundancy in their systems. For users without redundant supplies, obtaining new redundant supplies is not always feasible, as other local supplies may already be spoken for or may be economically infeasible to obtain. In addition, it may not be particularly economical to obtain additional water supplies to guard against future shortfalls if those supplies are unlikely to be needed except in occasional drought years – effectively, the city would be required to incur high capital costs and pay to maintain the availability of supplies potentially for decades before they are actually needed.

In the absence of redundancy in underlying supply, water conservation efforts are the only real option to control municipal demand. Some water conservation actions, such as installation of high-efficiency fixtures in residential homes or grass “buy back” programs that replace turf and other high-water-use plants with xeriscaping, take time and substantial investment to implement, and thus cannot be implemented on short notice. For municipalities that have already made those conservation investments and have grown into their available supplies, they may additionally have "hardened demands" that are much more difficult to reduce further. Significant shortfalls can thus require politically unpopular, economically disruptive, or controversial actions like mandatory water rationing, bans on outdoor water use, and similar approaches.

A recent study of U.S. companies found that 84% of the surveyed companies believed that they would face water-related challenges by 2018, 86% are considering water in decisions with regard to where to locate, and 57% expect water issues to be a factor in their growth by 2018.

Risks to urban water supplies often imply significant risks to industrial users as well. There is now widespread business recognition of water-related risk from not only obvious users, such as utilities, developers, and the mining industry – but also among other water-intensive businesses that either have or are contemplating significant operations in the West.[1] A recent study of U.S. companies (representing a broad range of industry sectors) by the Pacific Institute and VOX Global found that 84% of the surveyed companies believed that they would face water-related challenges by 2018, 86% are considering water in decisions with regard to where to locate, and 57% expect water issues to be a factor in their growth by 2018.[2]

Although many agricultural users enjoy high priority water rights, these users nevertheless face significant potential challenges from water shortages. Where agricultural interests are exposed to shortage risks, shortages can quickly damage or bankrupt economically marginal or cash-flow dependent farming operations; many of the Basin's farmers, even those growing high-value crops, are highly dependent on annual farming returns and cannot easily weather significant water shortages. Permanent crop farmers – such as almond, citrus, and other tree-based crops – can be particularly vulnerable, since even a brief shortage can result in the loss of crops that will take decades to replace. Where shortages are deep or sustained, they can have disastrous economic consequences not just for farmers, but for the communities that depend on farming operations. Moreover, drought exposure can create additional side effects on feed and pesticide credit, crop insurance, and other factors that pose risk to farmers beyond the direct impact of water supply shortages.

Municipal and agricultural water supply risk also creates substantial ecological risks. As noted in Section III of this report, environmental values often lack entitlements in the system, and therefore frequently either persist as a side effect or "run of the river" value, or the environment is afforded a lower priority in state law. Given that environmental values and environmental water users tend to be poorly represented in traditional water management governance institutions, it may be relatively easy to "take" water from these sources in the event of considerable drought, particularly where municipal populations are affected. Additionally, a "humans vs. nature" competition can create significant political consequences for environmental values.

1 Barton, Brooke. "Water Scarcity Means Business for Companies & Investors" Mother Nature Network (content provided by MillerCoors). http://www.mnn.com/food/beverages/sponsorstory/water-scarcity-means-business-for-companies-investors.

2 Schulte et al., Bridging Concern With Action: Are U.S. Companies Prepared for Looming Water Challenges, Pacific Institute & Vox Global (April 2014).

For example, government officials have recently been conflicted between satisfying farmers' interests and saving the fish population along the Klamath River, which flows from Oregon, through Northern California, and into the Pacific Ocean.[3] The lack of rain has led to exceptionally low water levels in reservoirs, rivers and tributaries throughout California, and the lowest water levels each year are expected during August and September, when many salmon begin to travel upstream to lay eggs.[4] Farmers strenuously opposed the Bureau of Reclamation's decision to release water from the Trinity Dam into the Klamath River in 2013, despite the need for increased flows in order to maintain the salmon population.[5] A similar situation on the Klamath occurred in 2002 that resulted in the death of between 33,000 and 65,000 salmon before the fish could successfully reproduce, with significant long term consequences for future generations of salmon.[6] It is crucial to acknowledge the substantial ecological risks associated with "bottleneck" problems similar to those of the Klamath River, and further, to understand that significant and possibly irreversible ecological damage could occur in a single season if addressing environmental risks is not a priority in resource allocation.

Water shortages can also create a variety of ancillary economic risks. For example, significant water shortages tend to make headlines that may generate a high level of uncertainty for real estate markets, particularly in the wake of recent housing market woes. The perceptual and political risks surrounding water shortages can spook investors, damage business confidence, undermine municipal bond ratings, and worsen the adaptive capacity of western communities and watersheds.[7] Many of these risks are inherently cross-cutting – affecting all sectors, from municipal, to industrial, to agricultural and environmental, and can generate bitter political, social, and economic conflict.

Figure V(B)(3)-2. Folsom Lake, California, nearly empty as a result of California drought. Image courtesy U.S. Geological Survey.

3 Fimrite, Peter. "Fish vs. Farmers in Conflict over Klamath River." SFGate. N.p., 19 July 2013. Web. 23 Jan. 2015.

4 Ibid. 5 Ibid.

6 Ibid.

7 Of course, these same perceptions of scarcity can be the best driver for policy reform; the recent drought has led to some of the most significant changes in the Law of the River since the signing of the Colorado River Compact in 1922.

The ongoing drought in California, which has resulted in billions of dollars in economic losses in one of the West's richest agricultural regions, provides a prime example of the broad and cross-cutting economic, ecological and social consequences of water shortages, which are now affecting farmers, communities, environmental values, and larger economic markets alike. In addition to the attendant economic impacts, water shortage conditions can also generate substantial perceptual, regulatory, and political risks. Water delivery shortfalls from the California State Water Project (SWP) and the Central Valley Project (CVP) have heavily impacted Central Valley farmers, causing the fallowing of more than 500,000 acres of Central Valley farmland, including high-value fruit and nut production orchards. These shortfalls have triggered significant increases in water prices as farmers, desperate to preserve substantial investments in mature orchards and other permanent crops, try to obtain replacement supplies. It has also driven huge expansions in groundwater pumping throughout the Central Valley. These in turn have caused water tables to plummet, with literally dozens of communities seeing their wells go dry over the past few years.

All of this has created enormous pressure on local and national politicians, who have helped farmers ppressure on other California water users to alleviate shortfalls. Similar to the example of the Klamath, one of the immediate targets for this effort has been reducing protections for the Sacramento Bay-Delta ecosystem. Protection of endangered fish and other values in the Delta – including preventing the further intrusion of seawater, which due to overpumping has been drawn upstream from San Francisco Bay almost to Sacramento – restricts the amount of water that can be pumped into the SWP and CVP. As the Central California drought crisis has become acute, farmers have pushed for the relaxation of environmental restrictions on the Delta resource to allow additional pumping, jeopardizing one of the most important ecological resources in the state.

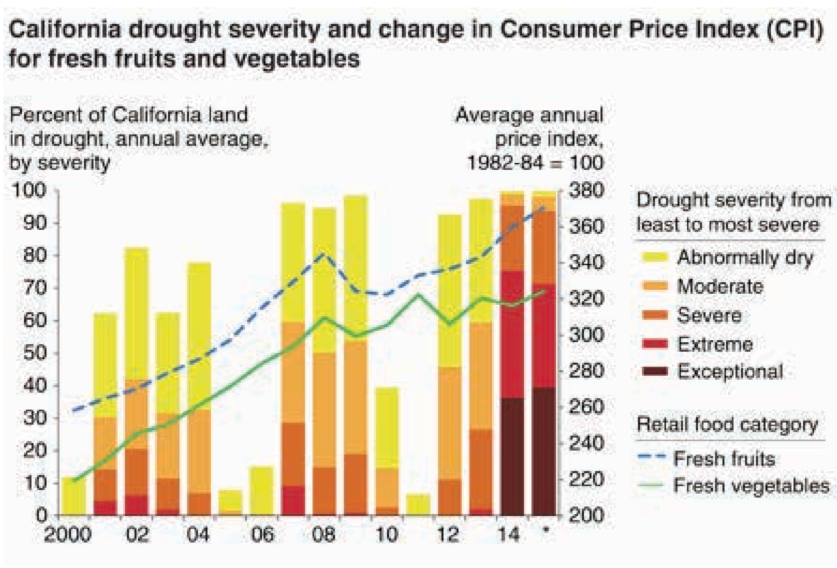


Figure V(B)(3)-3. Correlation between drought severity and fruit and vegetable prices in California. Source: USDA Economic Research Service.
*Average drought severity form Jan. - Mar. 2015. Average annual price index was calculated using USDA forecasts for fresh fruits and vegetables.
Source: USDA, Economic Research Service using data from the National Drought Mitigation Center and the U.S. Bureau of Labor Statistics.

Another target of this effort has been the Metropolitan Water District (MWD) (serving the greater Los Angeles region), which has been pressured to consume drought reserve supplies for the city in order to provide water for farms. This, in turn, has driven additional withdrawals of stored water from reservoirs already approaching critical levels – including Lake Mead, on a completely separate river system. By June of 2015, MWD anticipated that it would have withdrawn nearly its entire accumulated reserve of storage credits generated by past conservation activities from Lake Mead, equivalent to 5 feet of reservoir elevation. This leaves the lake now hovering at levels that could trigger shortages in Arizona and Nevada. This conflict only continues the cycle, as these lower water allocations are driving more expensive produce, such as berries, almonds, melons, and broccoli in California and across the United States. In response to these price signals, farmers continue to expand production of these higher revenue-generating crops, which has only served to increase water demand and the cost of water, thus further intensifying the conflict with environmental resources in the Delta, groundwater management, and urban water supply needs.[8] At the same time, these increasing water prices have also driven many family farms, some which have existed in the region for decades, out of business.[9]

2. Existing Approaches

Water trading can be used as a means of reducing the water-related risks described above, although it has proven difficult in the Western U.S. The Murray-Darling Basin (MDB) in Australia faces water scarcity similar to that in the American West,[10] and provides an example of the ways in which water-trading methods can be utilized to ensure more reliable allocations. To respond to the urgency of these scarcities, MDB implemented voluntary and cooperative water markets to encourage a more efficient allocation of water resources.[11] The benefits of this system include more reliable water supply for farmers of permanent crops who risk losing trees or orchards that they have invested in for many years, as well as higher prices for farmers who are able to reduce their water usage and sell their seasonal water allocations, offsetting lower levels of crop production and reduced irrigation.[12]

As noted earlier in this report, there are few environments in the Colorado River Basin where active water markets are currently possible. One key environment (although outside of the Basin) where limited water trading has been actively taking place is in Central California through the SWP/CVP infrastructure. To date, traded water in California represents a small fraction of the total available - most is arranged under multi-year contracts with state and federal agencies - but has been growing each year as demand increases and water users become desperate for supply. While annual water trades in the early 1980s were just over 100,000 af per year, closer to 700,000 af of water was traded in 2013, the last year for which reliable figures are available.[13] Interestingly, much of the new demand for "spot market" water is coming from cities that are trying to guarantee reliable water supplies year to

8 Daniel Sumner, Food Prices and the California Drought, UC Davis Center for Watershed Sciences, April 22, 2015, http://californiawater-blog.com/2015/04/22/food-prices-and-the-california-drought/.

9 Stephanie Strom, California's Thirsting Farmland, New York Times, April 20, 2014.

10 Grafton, R. Quentin, Gary D. Libecap, Eric C. Edwards, R.J. O'Brien, and Clay Landry. A Comparative Assessment of Water Markets: Insights from the Murray-Darling Basin of Australia and the Western US. Rep. N.p.2011.

11 Ibid.

12 Ibid.

13 Garance Burke, In Dry California, Water Fetching Record Prices, The Associate Press, July 2, 2014, www.bigstory.ap.org/article/dry-california-water-fetching-record-prices.

year.[14] The Front Range of Colorado, also outside the Basin, although served by Colorado River water, also hosts a limited water market through trading in water entitlements for the Colorado-Big Thompson project.

That said, simple water trading alone does not provide a solution for long-term supply protection, nor does it necessarily eliminate annual variability and risk, particularly since it leaves users exposed to significant pricing risks. Trading may also be more difficult for larger entities, such as municipalities, or users with hardened demands to adapt to given the lack of experience in water trading and the long timelines needed to undertake water transfers, particularly in the American West.

One strategy that has emerged to manage these kinds of risks on an individual user level over a multiple-year basis is the so called "dry-year option." An alternative to the outright transfer of water rights through sale or lease, "dry-year options" provide a means to arrange in advance to share water supplies between users with little flexibility in managing water demands, such as permanent crop farmers, municipalities, and industrial users, and those with more flexibility to accommodate changes in water availability, such as farmers who grow annual crops and can adjust the types of crops grown or the amount of land utilized for production. A dry-year option involves an agreement by which users with low tolerance for reduced water supply pay higher-tolerance users for an option that allows them the right to use the higher-tolerance user's water in the event of dry conditions.

A dry-year option involves an agreement in which a user with low tolerance for reduced water supply pays a higher-tolerance user for the right to use the higher-tolerance user's water in the event of dry conditions.

An early example of a dry-year option appeared in the Edwards Aquifer Authority, which implemented a pilot Irrigation Suspension Program (ISP) for the Edwards Aquifer region in Texas by paying a group of farmers not to irrigate during the 1997 cropping season. The program was designed to raise aquifer levels, increase springflow, and provide municipalities with relief in major drought periods. The Edwards Aquifer is critically important as it supplies virtually all the municipal and industrial water supply for the greater San Antonio region and supports a thriving irrigated agricultural economy, while supplying springflow to two large springs northeast of San Antonio. In turn, these springs are a significant source of recharge to the Guadalupe and Blanco rivers, where the water can be utilized for agricultural, municipal, recreational and industrial uses. During the ISP, irrigation was suspended on 9,669 acres of land at a cost of $2,350,000, which equated to roughly $99 per af of water. A continuing version of this program, called the Voluntary Irrigation Suspension Program Option ("VISPO"), exists today in the Edwards Aquifer, entering into five or ten year contracts with farmers for the option to suspend irrigation in dry years. In this instance, the VISPO pays a flat "stand-by" fee and then purchases water at a fixed forbearance price, subject to an annual price index.[15]

As shortage risks increase, there will be growing interest in these types of risk-sharing arrangements in the Colorado River Basin, particularly among lower priority municipal users that face potential supply shortfalls. As noted above, these users may have few options to control demand in the near term, and it may not be economical to obtain redundant supplies

14 Lisa M. Krieger, California Drought Puts Farmers in a Bidding War for Water, CAdrought.com, July 21, 2014, www.cadrought.com/california-drought-puts-farmers-bidding-war-water.

15 Voluntary Irrigation Suspension Program Option, Edwards Aquifer Authority, http://www.eahcp.org/index.php/flow_protection/vispo .

that will only be needed in extreme scenarios. In such a case, it is potentially far more attractive to obtain a dry-year option that allows access to supply when it is needed, while allowing a farmer to continue to use it in the years when it is not needed.

If these agreements could be made more accessible, there would also likely be significant agricultural demand for these types of arrangements among permanent crop farmers in the Basin given the extremely high costs and unpredictability of "spot" access to water. In 2014, for example, in the midst of the Central California drought crisis, unprecedented water auctions took place in which counties and individuals sold off their excess water to the highest bidder. In an indication of how desperate they were, farmers, fearing the loss of expensive permanent crops, outbid the city of Santa Barbara to gain access to 3,200 af of water that the Madera Irrigation District had auctioned off for the unheard-of price at the time of \$2,200/af.[16] This price was approximately ten times higher than the "normal" cost of water in the area, but reflected the "spot market" price being driven by demands at the time. A pre-negotiated dry-year option could have potentially been obtained in advance of the crisis at a fraction of that cost.

Protection of permanent crops will be an increasingly important issue in California. One important trend in California's recent agricultural history has been the increase in land devoted to growing almond trees. The amount of acreage dedicated to this crop has nearly doubled in the last 10 years – from 570,000 acres in the early 2000s to 940,000 acres in 2013 – and as demand for nut-heavy Mediterranean and Paleo diets has grown, prices for almonds have increased dramatically.[17] California almonds are now a \$5 billion per year crop (up from \$1.2 billion a decade earlier), due largely to rising demand and prices.[18] Seeing their fellow farmers' success has led even more farmers to plant almond trees, which take 4-5 years to produce their first crop and about 10 years to break even.[19] Unfortunately, almonds are also an incredibly water-intensive crop: each single almond requires approximately a gallon of water to produce. And since almonds are a tree crop, reducing water or cutting it off entirely will both reduce the yield and eventually kill the tree – giving the farmer little or no flexibility in the management of water demands in the face of drought. Although relatively few permanent crops are currently grown using Colorado River water, similar trends seem likely to manifest in areas with potential for such production (such as California and the Yuma and central regions of Arizona) in the future.

LIMITATIONS OF EXISTING APPROACHES

There are several significant limitations with the typical approach to dry-year options (and similar water-sharing agreements) that have limited the application of this solution in the Colorado River Basin and elsewhere in the West. Most importantly, risk-shifting from one user to another presents a challenge for most dry-year option agreements. As these agreements have typically been structured, the water user with a low risk tolerance – e.g. the permanent crop farmer or municipality – effectively shifts all of their water supply risk onto the water user with the higher risk tolerance – e.g., the row crop farmer or alfalfa

16 Sarah Goodyear, Got Spare Water? You Can Make Millions in California, Next City, July 7, 2014. , www.nextcity.org/daily/entry/drought-west-california-water-selling.

17 Eric Holthaus, The Thirsty West: 10 Percent of California's Water Goes to Almond Farming, Slate, May 14, 2014, www.slate.com/articles/technology/future_tense/2014/05/_10_percent_of_california_s_water_goes_to_almond_farming.html.

18 John Roach, That's Nuts: Almond Boom Strains California Water Supply, NBC News, June 13, 2014, www.nbcnews.com/business/markets/thats-nuts-almond-boom-strains-california-water-supply-n130586.

19 Peter Fimrite, California Drought: How Water Crisis is Worse for Almonds, SFGate, March 24, 2014, http://www.sfgate.com/science/article/California-drought-How-water-crisis-is-worse-for-5341382.php.

farmer, who agrees to give up water supply at some time in the future when drought conditions manifest.

While this risk shifting arrangement may be attractive to the municipality or permanent crop farmer, it is singularly unattractive to the row crop farmer/alfalfa farmer who is giving up the water supply, as the high risk tolerant farmer cannot really know what he is agreeing to give up at the time that the option is negotiated. For example, commodity prices for the crops he grows could be higher when the option is called, or he might have switched to a different crop in response to shifts in operating costs. Particularly if the high risk tolerant farmer is a sophisticated agricultural producer that is generating relatively high returns, the risk of guessing wrong on the price of water will render the option unattractive, or lead him to demand a much higher price for the option than might otherwise be objectively reasonable.

In the previous example, the high risk tolerant farmer's preference would clearly be for the other party to absorb the price risk created by the absorption of the hydrologic risk, and, for example, pay him whatever he could have earned farming with that water (plus an option premium) when the option has to be exercised. However, this in turn is likely to be unattractive to a municipality, which has to build the costs of reserve supplies into its regular rate structure and reserves, and is not in a position to adjust those rates on users easily in response to changing conditions. Instead, the municipal preference is to be able to exercise the option at a known cost (even if it is somewhat high) that can be built into those user rates. Similar interests to the municipality motivate the permanent crop farmer, who could use a dry-year option to hedge against higher water costs on spot markets in the future and ensure that her farming operation remains profitable and does not experience losses of permanent crops even during drought conditions. The permanent crop farmer, like the municipality, would also presumably prefer to have access to that water at a known price or price range that can be factored into the farm economics up-front.

The most recognized dry-year option is likely the fallowing easement structure followed by the Palo Verde Irrigation District ("PVID") in its agreement to provide water to the Metropolitan Water District ("MWD") in Southern California. The PVID-MWD agreement provides that PVID farmers will fallow up to 25% of farmland in exchange for payment up-front on a per-acre basis. That payment gives MWD the right to the water that would have been used on the fallowed land in order to provide water to municipal and industrial users in the MWD service area. The landowner also records an easement on the property that provides a legal basis for MWD to rely on the fallowing arrangement in the event farm ownership changes hands. In this case, MWD then agrees to pay a fixed price for the water in the year that the option is exercised. The program is slated to run for 35 years, and MWD is limited to requesting the maximum amount of fallowing for 10 of the 35 years.[20]

20 Ed Smith, PVID/MWD Land Management, Crop Rotation and Water Supply Program, Palo Verde Irrigation District.

Figure V(B)(3)-3. Aerial view of the Palo Verde Irrigation District (PVID). Image courtesy U.S. Bureau of Reclamation.

Since MWD controls when the option is exercised (even though the number of years is capped) effectively, the program shifts most of the economic and water supply risk to the PVID farmers. In keeping with this approach, the cost of the MWD/PVID option program was quite high. The fallowing program began with MWD offering approximately $3,000 per acre for land enrolled in the program – a figure that represented a significant fraction of the value of the underlying farmland against which the option was recorded. In addition, MWD agreed to make annual payments for the water itself when the option is exercised – initially at costs around $145 per af. While this works in light of MWD's resources and needs, such high up-front costs are unattractive to many municipal users, particularly smaller and mid-size communities without the ability to advance significant costs in support of a dry-year option.

A few creative approaches have been implemented to provide automatic adjustments or index dry-year options against other costs in order to partially rebalance risk-shifting between the optionor and the optionee. For example, the Super-Ditch agreement in Colorado allows for adjustments in the initial price of water based on utility costs, ensuring that the real "cost" of water to a municipal water provider will remain the same year-to-year.[21] The California SWP agreement ensures that costs are indexed to the San Joaquin Water Year Hydrologic Index based on local water supply conditions, such that water prices are set higher during dry conditions or lower during wet conditions. Finally, the Texas agreement on the Edwards Aquifer includes compensation for farmers who have agreed to potentially forbear their use of water to meet environmental demands. The agreement offers farmers a fixed price for their water,

21 Water Resource Advocates, Filling the Gap: Commonsense Solutions for Colorado's Front Range, May 2012.

which increases annually at a known rate. Farmers can also benefit from a higher interest rate for a longer option, but take higher risk of lost opportunity on increased crop prices.

However, a more creative mechanism could protect the low-tolerance user from both hydrological risk and at least a portion of pricing risk associated with higher water costs, while also protecting higher-tolerance users from opportunity costs associated with the exercise of the option and the price risks associated with changes in underlying commodity prices. This would give both parties what they are looking for: the farmer a guarantee of a payment equivalent to what they could earn farming, and the city or permanent crop farmer access to the water at a known price that can be built into rates or longer-term business planning.

OPTIONS, FUTURES CONTRACTS, AND COMMODITY PRICE HEDGES

Option and futures contracts are commonly employed as risk mitigation tools in financial settings to protect market participants against future changes in the availability or price of a particular commodity. Options create the right to purchase an asset at a future point in time on specified terms, shifting the risk from the buyer to the seller of the option in exchange for the price of the contract. Futures contracts involve a seller agreeing to supply a certain quantity of a commodity on specified terms, including an agreed upon future date and price. This agreement shifts the risk from the buyer to the seller of the futures contract. Options and futures protect both sellers and buyers by building in the opportunity for increased flexibility and hedging; essentially, each side gives up the possibility of securing the best price in exchange for a more secure transaction.

These types of transactions are by no means foreign to agricultural water users in the Basin. The output of agricultural crop and livestock producers in the Colorado River Basin is regularly impacted by numerous risks, including natural disasters, disease and pest outbreaks, hail and frost, flood and drought, changes in commodity prices, and water supply risks. Additionally, producers must consider risk related to fluctuations in international markets and currency exchange rates. In order to manage these risks at the farm level, most sophisticated farmers employ a variety of existing market-based tools to protect themselves, which extend above and beyond the protections offered to many farmers through assistance such as federal price supports and government insurance programs. Farmers often choose to diversify their sales among buyers to reduce risk, and they may also sell into private co-op pools or processing cooperatives in order to take advantage of increased efficiency. Farmers' usage of on-farm or centralized commodity storage allows them to hedge risks through time or across markets. They also may benefit from the negative correlation between yield and price, which acts as an income stabilizing mechanism (provided the yield reduction is not limited to that farmer), or option and futures contracts, which serve as a means for managing price risk.

OVERVIEW OF COMMODITY FUTURES HEDGING

A futures contract is an agreement between two parties that one will deliver a specific commodity at a certain time for a certain price. For people whose fortunes depend significantly on the value of commodity crops whose prices can fluctuate widely, it can be very comforting to both producer (seller) and customer (buyer) to accurately predict income and cost. This enables the farmer to plan exactly what his income will look like – or at least part of it – irrespective of future price movements. If the farmer can deliver the agreed amount of, say, wheat, on that given date, he knows exactly what he will be paid for it. This enables him to budget, plan, and predict his financial position accurately. A buyer, such as a bread producer, similarly can know that she will have a predictable cost for her raw materials, and can use this to plan her business as well. Of course, by choosing this predictability, each party is giving up the opportunity to capitalize on changing conditions that might move the "spot market" price in his or her favor. For example, if a short growing season reduces the amount of wheat available, driving up its price, the farmer relinquishes that upside, just as he avoids the risk of falling prices caused by a bumper crop or by reduced demand.

Futures contracts also can be traded without delivery; they are essentially a paper bet on the direction of markets, much as one might buy a future on the S&P 500 or on gold. This simply represents a bet on the direction of a commodity price. These are traded widely by people who have no interest in the underlying commodity product, but nonetheless win and lose bets based on the performance of corn, sugar, wheat, and other commodities. It is important to note that these are called commodities because they are identical. Commodities contracts will specify the type of wheat (Hard Red Winter Wheat) and its condition – all to ensure that what is being bought and sold is exactly the same as that commodity being traded elsewhere.

Hedging is a way of reducing risk by using the futures markets. For example, the farmer who expects to produce 1,000 bushels of Hard Red Winter Wheat and sells 1,000 futures for $5/bushel is essentially "locking in" or hedging his entire crop. He may choose to hedge only 25% and let the rest be purchased at the spot market price if he thinks that has the opportunity to be higher than the current futures price.

Hedging for an investor is somewhat different. He will neither deliver bushels of wheat, nor receive delivery of them, so he has no actual product to hedge against. Investors therefore hedge themselves in several different ways, two of which are particularly important:

- Call Option: The investor, assuming that the price of a commodity is likely to rise during a period of time, can buy a call option which means he pays for the right to buy a commodity at a specific strike price in the future. The price of that call option depends on several factors, including the current market price of the commodity, how long the option is good for and its volatility (i.e., how much and how frequently the price changes.) For example, a call option to buy a bushel of wheat for $5 in 3 months is going to cost more if wheat costs $7/bushel today than if it only costs $3/bushel today, since the option is more likely to have value, or be "in-the-money", based on the price today. Even a call option priced at the same market price as today may vary widely in its value, depending on how long the option is valid, and how volatile the commodity is. A call option good for 90 days on a commodity whose price is fluctuating widely will be more valuable than a call option on a commodity with steady pricing, since there is a higher likelihood that the option will, at some point, have more value (when the commodity price rises) and therefore could be resold to someone else for a higher price on the secondary market. An investor would buy a call option if he thinks that during the period the option is valid, the commodity price is likely to rise far enough above the strike price to cover his cost in purchasing the option.

- Put Option: Conversely, an investor who thinks that the price of a commodity is likely to fall during a period of time may consider buying a put option. This enables the buyer of the put option to, at a certain point in time, sell the commodity for a specified price, regardless of its market price. For example, if a bushel of wheat costs $5 today and an investor thinks it will go down in the next 90 days, he may buy a 3 month, $5 put option. Then, if he is correct and the spot market price for wheat falls to $3.50/bushel, he can in 90 days buy a bushel of wheat for $3.50 and know that he will be paid $5 for that bushel by the party who sold him the put option.

Each of these instruments requires a counter-party to sell the option and take the corresponding risk on the other side. The seller of a call option collects the price (premium) for the option, but faces an unlimited risk if the price of the commodity sky-rockets. Similarly, the seller of a put option collects the premium from the buyer, but faces downside risk all the way to a price of zero for the commodity.

However, nothing limits the seller of a call option with a strike price of $5 from also buying a call option with a strike price of $7. In this example, the investor's risk is limited to a scenario where the price exposure of the underlying commodity rises above $5 but stays below $7, and that risk is further reduced by the premium that the investor received for selling that $5 option. This can lead to various kinds of futures strategies and trades. However, the cost and availability of the option arrangements will depend on the breadth of interest in the product. Options that trade at significant volumes on standardized product descriptions are lower cost than custom-tailored contracts that are used to address a specific case.

3. Proposed Solution

A potentially more promising use of the dry-year option arrangement would be to provide for more complex hedging of both hydrological and economic risks across and among water user categories via the participation of a third party investor. This investor could arrange and/or take hedge positions in relevant commodity markets to equilibrate the risk for the parties involved. The proposed commodity-indexed dry-year option utilizes a traditional dry-year option agreement, but the price paid for water is indexed to a series of commodity prices with a commodity price hedge mechanism. This structure allows for simultaneous mitigation of physical hydrologic risk and pricing risk to a municipal, agricultural, or industrial water user with low tolerance for water supply variability, while also limiting overall economic risks to an agricultural user with a higher tolerance for water supply variability. The structure would involve a three-party agreement among a low-tolerance water user, such as a city, a high-tolerance water user, such as an annual crop farmer, as well as a third-party investor. The agreement could potentially be for a fixed term or open-ended.

The objective of this investment would be to create a tool that can be utilized by a user who has a very low tolerance for water risk, such as a city or farmer of permanent crops, as part of water supply planning, to guarantee water availability during drought and shortage conditions at a known price, or at least a known range of prices. The proposed solution would also be potentially attractive to a higher risk-tolerance user, such as an seasonal crop farmer, or collection of farmers in the case of a super ditch, by at least partially guaranteeing a level of economic return comparable to that farmer's expected value from that water, while minimizing opportunity cost on the underlying value of farm yields.

The solution can be used by the high risk tolerant user as part of a larger farm risk and commodity price hedging strategy, and also benefits the low risk tolerant user by fitting the costs of risk management into a relatively stable rate structure (or sale price calculation in the case of permanent crops), so that water made available will be priced within a foreseeable and controllable range. The ultimate goal is that the low risk tolerant user is able to purchase an option to secure access to water at a predictable cost, instead of taking a risk on the spot price of water (and therefore the potential price of the crop grown) going up as it has in recent California water auctions. The high risk tolerant participant of that option is then fairly compensated for the crop he would otherwise have grown with that water at the market rate for the commodity he would have grown. Specific commodities, such as cotton in Arizona, or perhaps a basket of commodities traded across the Basin, could be indexed based on the highest price, average price, or other pricing mechanisms, such that the city- or permanent crop farmer-buyer would be protected on the downside while the farmer who sold the option has upside protection in the fallowed season while the contract is in effect.

The proposed commodity-indexed dry-year option blends a dry-year option agreement in which the price paid for water is indexed to a series of commodity prices with a commodity price hedge mechanism -- allowing for simultaneous mitigation of physical hydrologic risk and pricing risk to a user with low tolerance for water supply variability, while also limiting economic risks to the user with a higher tolerance for water supply variability.

The payment and commodity price hedge arrangement would involve a payment stream from the low risk tolerant user to the third-party investor in exchange for the investor agreeing to structure and broker the deal. The investor would then purchase commodity call option contracts in relevant indexed commodities to hedge upside commodity price risks. Further, depending on the interests of the party selling the dry-year option (farmer), the investor could secure put option contracts in relevant indexed commodities to hedge downside commodity price risks for the farmer. The investor could then buy and sell put and call options to increase return, depending on individual risk tolerance.

Commodity hedges are listed for a number of commodities grown, produced, or dependent on crops produced in the Colorado River Basin that could potentially be used to hedge against relevant commodity price changes. This hedging could either be direct (e.g. a hedge against the price of cotton to protect against changes in cotton) or indirect (e.g. a hedge against the cost of dairy products, to protect against changes in alfalfa). These could be used to construct commodity-indexed dry-year options in a number of different environments in the Basin, although given the types of commodities against which hedging is available, they would be easiest to undertake in environments where there is existing large-scale production agriculture (e.g. the Lower Basin).

It is important to note, however, that key information needs to be gathered at the local level, depending on the region and specific crop grown, in order to engage in crop hedging practices with financial brokers. Based on recent conversations with brokers, given regulatory restrictions, trades need to be structured for farmers who want to mitigate their particular crop risk (e.g. the price of wheat on a certain number of tons grown), not with firms exposed to "capital" risk, which generally occurs further up the supply chain (e.g. a bread distributor who merely delivers bread made with wheat). Moreover, a sufficient volume of a crop must be available for market liquidity and to generate a reasonable return for the investor, given associated transaction fees. As such, initial dry-year option strategies will likely need to be deployed in pilot form with investors who are willing to structure a bespoke legal agreement and then hold crop hedges as they wish that may be only loosely associated with the particular crops grown by a farmer in the transaction.

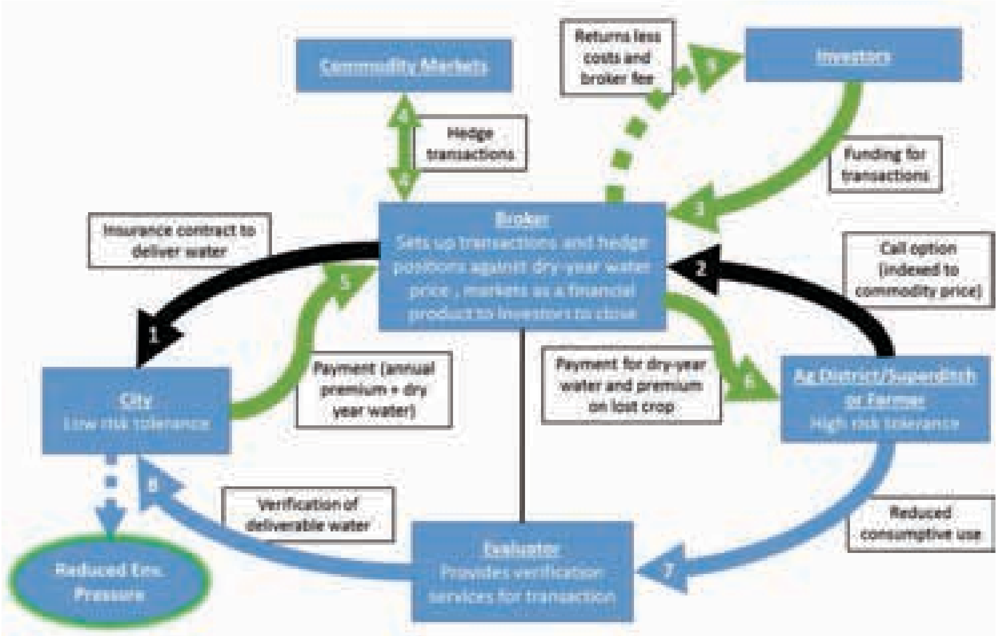


Figure V(B)(3)-4. Structure of Commodity-Indexed Dry-Year Option.

HYPOTHETICAL CASE STUDY EXAMPLE

City A is exposed to potential future water shortages on a major Reclamation-operated canal in the event that regional shortages exceed a certain level. There is a reasonable probability of this occurring from time to time in the future (10%-15%), and occasionally for extended periods (decades), which is well above the discount rate typically employed by City A in evaluating the cost-benefit associated with critical water supply infrastructure investments. City A has limited options for reserve supply due to insufficient/unavailable local groundwater sources or other replacement supplies. City A also has concerns with controlling future increases in water rates due to the political risks of a rate shock and potential impacts on economically disadvantaged residents. City A is therefore concerned about the potential impacts of perceived water risk on business investment, real estate markets, and credit markets, which have been heightened by recent media accounts announcing potential shortfalls, and which have led to questions about proposed municipal infrastructure bonds and refinancings.

Farmer B, who grows nut trees, is exposed to potential shortages on the same canal as City A.[22] Farmer B's trees represent a significant capital investment, as they cannot produce for approximately 5 years after replacement. The trees are expected to produce for 30 years after reaching maturity, and will require at least 10 years of production to fully amortize Farmer B's initial investment. They must be watered continuously and cannot absorb shortages lasting more than 1 week without losing the crop, or 2-3 weeks without killing the trees outright. Farmer B has a lower water right priority than City A, and is also concerned about the ability to obtain water to support the trees in the face of shortages, particularly because Farmer B's ability to pay for water is limited. Farmer B is also exposed to significant negative price risk in the commodity market, which tends to fluctuate in a manner that corresponds to hydrologic risk (i.e. the highest opportunity cost occurs during drought conditions, when other nut producers are also threatened or lose crops).

In the event that City A or Farmer B is cut off from supply, there will be inevitable pressure to increase diversions from the river of origin in order to limit damage. An increase in diversions, however, would threaten fish populations and other wildlife on the river.

Farmer C on the same canal has a higher-priority right to water that can be readily diverted to other users on the same canal, pursuant to an existing wheeling/transfer policy. Farmer C typically grows annual row crops, alternating with alfalfa and/or cotton crops depending on year-to-year market conditions. Farmer C's returns from farming vary widely, but recent returns have been significant due to high alfalfa prices. Farmer C is unwilling to undertake a permanent transfer, but would be willing to enter into a dry-year option agreement provided that he will earn a comparable amount each year not farming to what he could otherwise earn farming (including costs of the temporary fallowing of his land).

Investor D facilitates a transaction among these parties that will protect City A and Farmer B from water shortage exposure at a predictable price, and that will guarantee Farmer C a return comparable to what he might have expected to receive from farming plus an option premium based on the fair market value of farmland. The transaction developed by Investor D involves a dry-year option offered by Farmer C, a wheeling agreement allowing the temporary transfer of water from Farmer C to Farmer B, City A, or both, and several commodity price hedge transactions undertaken by Investor D. To facilitate the transaction, Investor D also partially funds environmental and other impact studies necessary to approve the wheeling agreement. In exchange, Investor D expects to realize a reasonable investment-grade return. Investor D includes a premium in the price he charges City A and Farmer B for taking on the work and risk of structuring the instrument.

22 "Farmer B" included here to further explain how the structure could work with multiple parties, but not a required participant for the dry-year option.

HYPOTHETICAL TRANSACTION [23]

1. Farmer C enters into a dry-year option agreement with Investor D, recorded as an easement against the farm property, in which Farmer C will forgo use of water on his lands whenever a local hydrologic index points toward a high probability of canal shortages in the following year (in which case he will automatically fallow in that following year unless otherwise directed), or when a shortage actually occurs during the current year (if fallowing is requested by City A and/or Farmer B), with the amount of his foregone use depending on whether City A, Farmer B, or both will experience shortages. In exchange for recording the easement, Farmer C is paid an upfront fee and is guaranteed additional payments when the option is exercised as follows:

    - In exchange for undertaking fallowing in any given year, Farmer C is entitled to a payment for the use of water on a per af basis that is equivalent to the net profit from those units of cotton, alfalfa, and/or historically grown row crops which could have been produced using that water based on historic average production figures and a regional farm-gate commodity price index, plus an option premium based on the fair market value of the agricultural land. The commodity price used is the highest price of the selected group in the year the option is exercised.
    - Farmer C is also entitled to the recovery of costs associated with the fallowing activity, e.g. costs of dust abatement, weed control, etc. In the event that Farmer C is required to abandon an existing crop prior to harvest, Farmer C is additionally entitled to a per-acre payment to recover costs incurred in planting, fertilizer, etc.

2. City A and Farmer B participate in the dry-year option arrangement, in which they agree to pay Investor D an initial fee plus an annual maintenance fee for maintaining the option in force each year. City A bears the bulk of these costs, as it will have the highest priority to water in the event of a catastrophic shortage as described below. City A and Farmer B also agree to pay a known price for the water if and when the dry-year option is exercised. The annual maintenance payment is built into City A's utility rates as a "drought protection fee," and City A maintains a strategic drought reserve fund sufficient to cover the cost of water in the event that the option is exercised. The transfer of water is pre-approved under the terms of a wheeling agreement with the canal operator and rules allowing temporary transfer of water rights.

23 This option could take the form of a recorded easement or covenant allowing the interruption of water use in the case of individual farm property, could be undertaken on a contractual basis where the counterparty was an irrigation district or other centralized provider that would be enrolling individual users, or a combination of the two (similar to the structure utilized in the MWD/PVID transaction described above).

3. Investor D makes the required payments to Farmer C paid by City A and Farmer B. To hedge against the potential that the price that must be paid to Farmer C for water is higher than what City A and Farmer B have agreed to pay at the time that the option is exercised, Investor D purchases sufficient quantities of option contracts in relevant indexed commodities to hedge upside commodity price risks, while selling futures contracts against those same options to hedge the downside risks associated with the options (if so directed by Farmer C). The baseline price negotiated is sufficient to cover Investor D's expected costs in facilitating the agreement and undertaking required hedging, while securing a reasonable investment-backed return under normal conditions.[24]

4. During a shortage that affects only Farmer B, Farmer C is required to undertake partial fallowing sufficient to allow Farmer B's supply. This completely hedges Farmer B's water supply risk in the event of a significant shortage, preventing the premature loss of his nut trees or loss of harvest. Farmer C is compensated for this partial fallowing by Investor D at the prevailing commodity prices plus the option premium, earning Farmer C a return higher than he could have otherwise obtained (given the option premium as a percentage of fair market value of agricultural land).

5. During a larger shortage that affects both Farmer B and City A, Farmer C is required to undertake complete fallowing, which completely hedges Farmer B but also City A's risks in that shortage such that it is guaranteed to receive its allocation (or as much as hydrologically possible). In the event of a catastrophic shortage that cuts City A to less than its allocation, City A has the first priority on the fallowed water until it has reach a significant portion of its allocation, even if this leaves Farmer B unable to meet his needs. This provides as much protection as possible to City A, while providing protection to Farmer B from all but the worst case scenarios.

24 For tax purposes, the broker or other intermediary would have ordinary income from the commission fees. The investor will most likely be treated as having purchased the contracts, and the purchase price for such contracts would be amortized over the life of the contract. The payments from the city (or other low-risk tolerant user) would be taxable to the investor upon receipt. Payments to the farmers would be taxable as ordinary income upon receipt.

4. Financial Model[25]

Figure V(B)(3)-6 Assumptions and model drivers for Agricultural Water Use – Dry-Year Option[26]

Project Funding Parameters		
Acres of Farm in Production for Farmer C		5,000
Fair Market Value (FMV) per Acre		$800
FMV of Farmland		$4,000,000
% of FMV for Annual Premium on Call Option		0.5%
Annual Premium Paid to Farmer C		$20,000
Acre feet Water Rights Held by Farmer C		10,000
Price Currently Paid for Water by Farmer C		$250
Crop Type Farmer C Grows (Choose in drop-down)		Alfalfa
Yield per Acre Given Crop Type	Tons:	5
Value of Crop Hedged Through Call Option		$5,250,000
% Bonus Payment on Exercise (e.g. Fallowing Costs)		3.0%
Bonus Payment when Dry-Year Option Exercised		$157,500
Transaction Cost per Call Option[1]		$80,000

[1] Transaction costs for options difficult to forecast without trader pricing.

Estimated Administrative Costs	
Project Management Fee to Investor (Over Life)	$1,750,000
Legal and Administrative (Up-front)	$500,000
Total Premiums Paid to Farmer	$200,000
Cost to Buy Call Options for Selected Crop(s)	$800,000
Total Administrative Costs	$3,250,000

Timing and Number of Call Options	
# Options (Varying by # of Years per # of Crops)	10
Life of Instrument (Years)	10
Anticipated # of Years Option is Exercised	3
Transaction Fee to Investor (% of Crop Hedge)	5.0%

Crops Grown and Standard Measurement (Source: USDA)

		Yield/Acre	$/Unit	$ to Hedge
Wheat	Bushels:	60.0	$5.50	$1,650,000
Soybeans	Bushels:	50.0	$9.50	$2,375,000
Cotton	Bales:	1.6	$325.00	$2,583,750
Corn	Bushels:	160.0	$3.70	$2,960,000
Alfalfa	Tons:	5.0	$210.00	$5,250,000

Sources and Uses		
Sources		
Investor Equity	85.0%	$3,164,125
PRI / Grant / Philanthropic Partner	15.0%	$558,375
Total Investor Funding Required		$3,722,500
Uses		
Bonus Payment when Dry-Year Option Exercised		$472,500
Total Administrative Costs		$3,250,000

Expenses and Measured Outcome (Annual)	
Farmer C Income	
Annual Fees to Farmer in Normal Year	$20,000
Total Fees to Farmer in Dry-Year	$7,927,500
City A Costs	
Annual Outlay (Amortized Proj Costs incl. Premium)	$325,000
Implied Water Price per AF (Annual Premium)	$33
Outlay when Dry Year Called (Excl. Farmer Premium)	$7,907,500
Implied Price per AF in Dry-Year	$791
Total Implied Price per AF in Dry Year (Excl. Admin Fee)	**$823**

Returns for Investor	
Multiple of Invested Capital (MOIC)	1.4x
Internal Rate of Return (IRR)	6.4%
Discount Rate	2.0%
Net Present Value of Project	$765,756

Sample List of Crops Available for Hedge	
Butter	Lumber
Cheese	Milks
Cocoa	Oats
Coffee	Palm oil
Corn	Rice
Cotton	Soybean
Dry whey	Soybean meal
Feeder cattle	Sugar
Lean hog	Wheat
Live cattle	

25 This financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual project. The hypothetical transaction is fictitious and is only intended to provide some key line items interested parties might consider in assessing the potential for a commodity-indexed dry-year option agreement. Among other omissions, inflation, depreciation and tax considerations have not been diligenced for this notional financial model.

26 Farmer B excluded in the Financial Model for simplicity. Farmer B would participate in a similar way as City A.

Figure V(B)(3)-7. Model Sensitivities for the Agricultural Water Use – Dry-Year Option

Model Sensitivities - City A

Annual Price per AF for Holding Dry-Year Options on 10,000 AF

# Options Held	Transaction Cost per Dry-Year Option Held: $50,000	$65,000	$80,000	$95,000	$110,000
10	$30	$31	$33	$34	$36
20	$35	$38	$41	$44	$47
30	$40	$44	$49	$53	$58
40	$45	$51	$57	$63	$69
50	$50	$57	$65	$72	$80

Price per AF for Exercising Dry-Year Option in 1 Year (Holding 10 Years of Options)

Crop Hedged	Transaction Cost per Dry-Year Option Held: $50,000	$65,000	$80,000	$95,000	$110,000
Wheat	$449	$451	$452	$454	$455
Soybeans	$524	$526	$527	$529	$530
Cotton	$546	$547	$549	$550	$552
Corn	$584	$586	$587	$589	$590
Alfalfa	$820	$822	$823	$825	$826

Model Sensitivities - Farmer C

Farmer Income in Year Dry-Year Option is Exercised (Full Fallowing Required)

Crop Hedged	Price Currently Paid for Water: $50	$150	$250	$350	$450
Wheat	$2,219,500	$3,219,500	$4,219,500	$5,219,500	$6,219,500
Soybeans	$2,966,250	$3,966,250	$4,966,250	$5,966,250	$6,966,250
Cotton	$3,181,263	$4,181,263	$5,181,263	$6,181,263	$7,181,263
Corn	$3,568,800	$4,568,800	$5,568,800	$6,568,800	$7,568,800
Alfalfa	$5,927,500	$6,927,500	$7,927,500	$8,927,500	$9,927,500

Model Sensitivities - Investor D

10 Yr Investor IRR, Excluding Upside from Option Trading - Alfalfa

Transaction Fee	Transaction Cost per Dry-Year Option Held: $50,000	$65,000	$80,000	$95,000	$110,000
3.0%	2.5%	1.7%	0.9%	0.2%	(0.5%)
4.0%	5.4%	4.6%	3.7%	3.0%	2.2%
5.0%	8.2%	7.3%	6.4%	5.5%	4.8%
6.0%	10.8%	9.8%	8.9%	8.0%	7.1%
7.0%	13.3%	12.2%	11.2%	10.3%	9.4%

27 Farmer B excluded in the Financial Model for simplicity. Farmer B would participate in a similar way as City A.

Figure V(B)(3)-8. Illustrative cash flows for the Agricultural Water Use – Dry-Year Option

Illustrative Cash Flow Analysis (Normal Years)

Year:	0	1	2	3	4	5	6	7	8	9	10
Income to Investor D											
Program Management Costs		175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000
Fee to Investor for Crop Hedge		262,500	262,500	262,500	262,500	262,500	262,500	262,500	262,500	262,500	262,500
Total Income		$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500
Operating Expenses (Paid by City A)											
Premium to Farmer		$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Legal Costs (Over 2 Years)		250,000	250,000	0	0	0	0	0	0	0	0
Total Expenses		$270,000	$270,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Interest Expense		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxes		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income		$167,500	$167,500	$417,500	$417,500	$417,500	$417,500	$417,500	$417,500	$417,500	$417,500

Investor D Returns (Equity)

Returns on Invested Capital	($3,164,125)	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500	$437,500
Discounted Returns for NPV	($3,164,125)	$428,922	$420,511	$412,266	$404,182	$396,257	$388,487	$380,870	$373,402	$366,080	$358,902

MOIC:	1.4x
IRR:	6.4%
NPV:	$765,756

28 Farmer B excluded in the Financial Model for simplicity. Farmer B would participate in a similar way as City A.

V(C). Municipal Use and Water Infrastructure

Investment Blueprints

C. Municipal Use and Water Infrastructure

Contrary to popular assumptions, urban and industrial uses of water actually represent a comparatively small fraction of overall water demand in the arid West. Taken as a whole, urban and industrial water use in the Western United States typically represents only 10% to 20% of overall demand in a watershed. The vast majority of water is used in agriculture.

This distribution of water amid agricultural, industrial, and urban uses is as much an artifact of the nature of western water rights as anything else. The natural consequence of prior appropriation was to grant the vast majority of water rights to the first water users who arrived on the landscape—in most cases, farmers. Through a combination of private and public investment, most of the West was initially developed in connection with irrigation projects, varying from small canal districts served by a single small diversion to vast enterprises supported by enormous dams, cheap hydropower, and integrated systems of canals and groundwater pumps. The West's cities and industry arrived later, often growing up in and around this existing agricultural infrastructure. Although many historically agricultural lands have since been converted to urban use, this use typically consumes considerably less water per acre than farming, and the majority of water rights and water use remains associated with those historically irrigated lands.

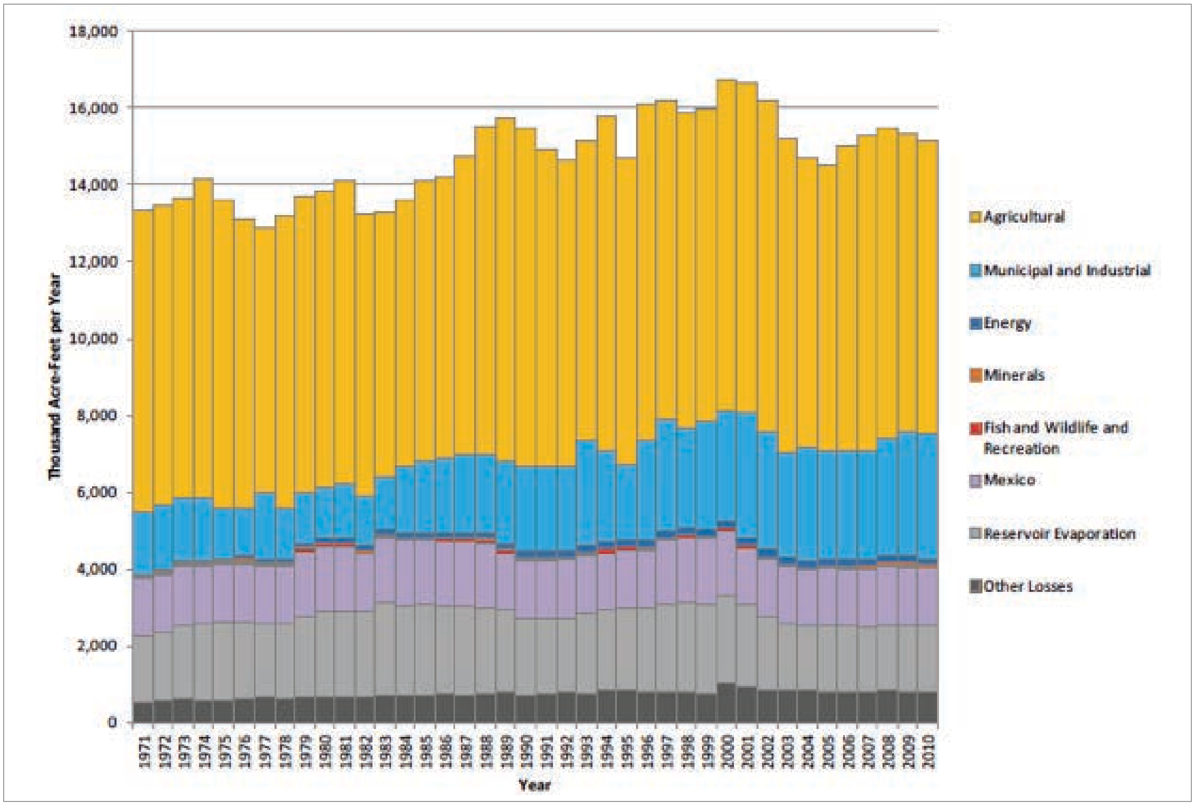


Figure V(C)-1. Historical Colorado River consumptive water use by sector. As show in the chart above, municipal and industrial demand has increased significantly over recent decades, whereas water use in the agricultural sector (and other categories) has remained fairly constant or has declined over time. Source: Basin Study (2012).

As noted in Section III of this report, however, municipal water demand in the Colorado River Basin is expected to increase significantly over the coming decades in the absence of significant investments in water conservation. The Colorado River Basin is home to some of the fastest growing urban and industrial centers in the United States, with growth rates exceeding the national average, and many existing urban areas and newly urbanizing areas are facing significant projected supply shortfalls in the face of this continued growth. This is not a new phenomenon; over recent decades, increases in the consumptive use of water in the Basin have been primarily driven by increases in municipal and industrial water use, whereas agricultural water use has remained relatively constant (Figure V(C)-1).[1]

Municipal water demand in the Colorado River Basin is expected to increase significantly over the coming decades in the absence of significant investments in water conservation.

As noted in the Basin Study, this growth in urban water demand is expected to continue to drive the vast majority of new water demand in the Colorado River Basin over the coming decades. In Basin Study scenarios, increased municipal and industrial demands comprised between 64% and 76% of projected future shortfalls in water supply within the Basin.[2] The Basin Study projected that the municipal and industrial demand for water will increase by approximately 27% by 2035 and between 33% and 38% by 2060, with increases in demand driven mostly by population growth. While increases in urban water conservation and efficiency measures are projected to offset some of the demand increase[3], concern remains that booming populations could drive demand increases that outpace these water savings. As shown in Figure V(C)-2, tribal water use, as well as water used in the energy and minerals sectors, is also projected to increase, though not as significantly as municipal water use.

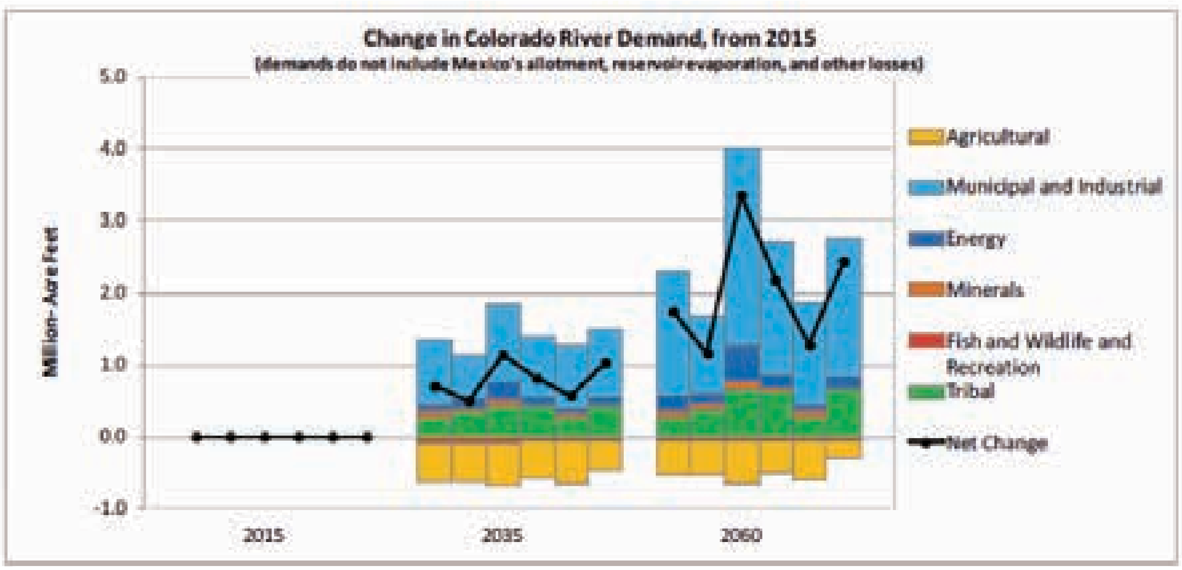


Figure V(C)-2. Projected Increases in Colorado River Consumptive Use (By Sector). As shown in the chart above, which provides five different potential scenarios for future demand in 2035 and 2060) growth in municipal and industrial demand is projected to be the largest single contributor to increased water demand (along with energy and tribal use), whereas agricultural use is expected to decline (although a large portion of tribal use is agricultural in nature, such that net agricultural use may remain roughly the same). Source: Basin Study (2012).

1 Colorado River Basin Water Supply and Demand Study: Executive Summary, Bureau of Reclamation, December 2012.

2 Ibid

3 Ibid

Meeting these demands is likely to require significant investments to increase municipal water supplies—including the transfer of water supplies from agriculture and the development of new water infrastructure. These efforts will also require significant investments in urban water conservation and other demand-reduction efforts to mitigate against increasing municipal water demand.

Increasing Municipal Supply

Given the significant disparities in the allocation of water between agricultural and urban users, water transfers from the agricultural sector to municipal water users will be an essential and inevitable component of meeting future municipal demand, in spite of concerns about impacts on agricultural economies. In light of the significant disparities in the economic value associated with those uses, there will be particular pressure for the transfer of water away from use in relatively low-value, high-water demand crop production (such as alfalfa farming). Many higher-value agricultural uses, by contrast, such as for vegetable and citrus production, may approach or exceed the economic value of water use to meet urban demands. Some of the tools discussed in previous sections of this report suggest approaches to such reallocation that could provide alternatives to controversial "buy-and-dry" strategies; in some cases, this reallocation will also occur as a matter of course as a result of the urbanization of existing farmland. However, in many cases, accomplishing these transfers would require new investments in water infrastructure to move water from its current place of use in agricultural districts to serve distant urban centers.

Another alternative source of municipal supply may include construction of facilities for the desalination of ocean or brackish water, particularly in areas that lack other local sources of fresh water and that will therefore need to rely on imported supplies from remote sources, such as Southern California. In such cases, desalination can provide a viable and reliable alternative supply. However, desalination is also comparatively expensive, is energy-intensive, and is potentially environmentally damaging without a concomitant significant investment in mitigation for released brine.[4]

One particularly promising option is reuse of municipal effluent, which allows the same water supply to be used multiple times before it is exhausted. Some areas of the West already recycle significant amounts of their municipal effluent, creating fully or at least partially "closed-loop" systems. While direct reuse of effluent for drinking water has proven controversial and has at least thus far been rejected in nearly all western communities, its use to replace water used in landscaping, industrial applications, and agriculture is increasingly common, as are "indirect reuse" approaches in which effluent is used to replace supplies diverted to urban use.

One example of a closed-loop system is the Las Vegas area, served by the Southern Nevada Water Authority. The system directs nearly all its municipal effluent into Las Vegas Wash, where it supports riparian habitat and then flows back into Lake Mead, where it is then reused by SNWA (Figure V(C)-3). As a result, SNWA physically diverts some 500,000 af per year from Lake Mead, but consumes only around 300,000 af. Similarly, in the Phoenix metropolitan area, most effluent is reused, either indirectly through recharge into local aquifers, thereby recharging drinking water supply aquifers, or directly by downstream water users. These downstream users include a nuclear power plant and historic farming areas, which previously used surface water out of the Gila and Salt Rivers that is now used in the urban area.

4 Importantly, desalination of brackish water sources, such as saline groundwater, is far less expensive than seawater desalination, although brine disposal remains a significant issue in both cases.

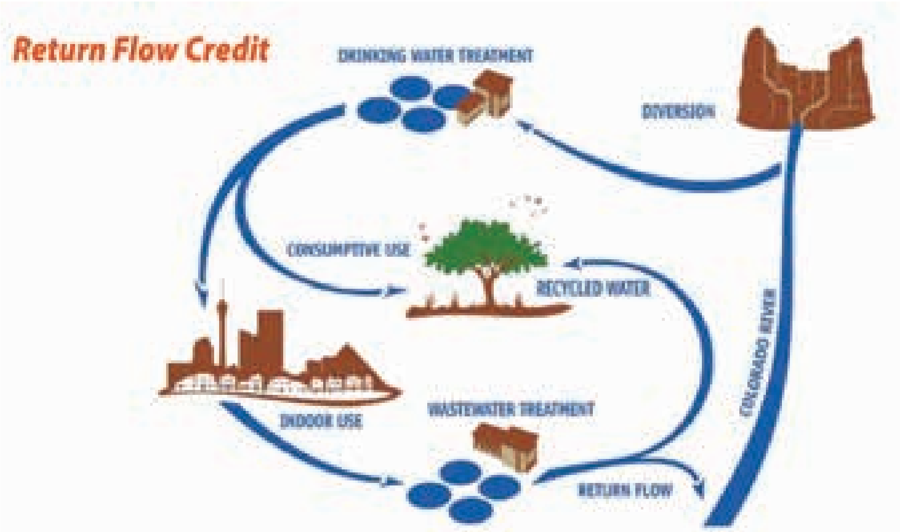


Figure V(C)-3. Southern Nevada Water Authority's Closed-Loop System. Source: Southern Nevada Regional Water Recycling Study, Southern Nevada Water Authority, Clean Water Coalition, and Black & Veatch (2009).

At significant scales, however, implementation of reuse can require significant investments in infrastructure. This is because it frequently requires the construction of a completely separate or parallel system of municipal water infrastructure, often through or under already heavily urbanized areas-- to deliver water to locations where it can be reused directly or be returned to the "headworks" of municipal water delivery systems for reintroduction (directly or indirectly) into the source or sources of supply. In the examples of Las Vegas and Arizona cited above, unique geographic advantages have made large-scale indirect reuse comparatively easy, although still expensive, to implement. In the case of Las Vegas, gravity works directly in favor of reuse, since treated effluent can flow downhill through an existing natural channel to Lake Mead, where the existing "headworks" of the municipal delivery system—enormous intakes and pumping stations—are already located. In Arizona's case, the presence of vast basin-fill aquifers that underlie the state's major cities allows effluent to be recharged to the same underground aquifers from which municipal water supply is withdrawn, replacing the water pumped from those aquifers through existing treatment infrastructure into the municipal system.

Unlike Arizona and Nevada, Southern California, which imports nearly two-thirds of its water supplies via pipelines from Northern California, the Owens Valley, and the Colorado River, currently reuses only a small fraction of its effluent, with the vast majority (around 95% at present) flowing from municipal treatment plants directly into the Pacific Ocean. Although there is increasing interest in developing systems for reuse, the costs of doing so will be high. This is for the simple reason that the existing municipal delivery system is designed to carry water from the large canals, reservoirs, and pipelines that convey water over and through the mountains that ring the Los Angeles and San Diego basins, and then distribute it (primarily via gravity) through ever-smaller delivery infrastructure to its points of use. From there, sewer systems then collect the resulting effluent and carry it (usually downhill via gravity) to large centralized treatment facilities, usually near the coast. As such, large-scale reuse would require the construction of complex new infrastructure capable of pumping treated effluent many miles back uphill to be reintroduced near the location of current municipal water treatment headworks. However, this approach is likely to be cheaper in many cases than other sources of "new" supply, such as seawater desalination.

Effluent also has great potential as an environmental water supply. In the West, there are many important riparian and river ecosystem corridors that are effluent-dependent systems with important ecological values. Even in the absence of direct or indirect reuse approaches, the deployment of effluent to support ecosystem function (and to replace water that has been withdrawn from ecosystems to support human uses) has potential in many other areas of the West. In many cases, indirect reuse strategies that allow effluent to move through natural systems as part of the reuse cycle have allowed effluent to support important environmental values. An example is the Las Vegas Wash, as described above.

Municipal use of water in the Basin varies widely, depending on land use controls, landscaping requirements, and the relative level of investment in water conservation techniques and technologies.

Demand Management

While supply augmentation options will be an important component of meeting growing municipal demand, there is also significant potential for improvement in municipal water conservation as a means to moderate or even eliminate the projected increases in municipal demand. Municipal use of water in the Basin varies widely, depending on land use controls, landscaping requirements, and the relative level of investment in water conservation techniques and technologies. Communities that have made significant investments in land use controls and water conservation efforts have achieved gallons-per-capita-per-day (GPCD) rates (a typical measure of urban water rates) on the order of 50–60 GPCD. Other communities—particularly those with low-intensity, large-lot land uses and decentralized water infrastructure—are more likely to have rates in the range of 200–300 GPCD. The Basin Study identified the potential to save between 600,000 and 1.2 million af of water by implementing or improving municipal water conservation programs across the Basin.[5]

However, there can be some important barriers to water conservation investments by municipal water suppliers for several key reasons. First, if the savings from water conservation are then used to support additional growth in the provider's service area, conservation efforts can lead to so-called "demand hardening." Although this issue can be significantly overstated and is rarely a justification to not engage in water conservation efforts, the reality is that to the extent conservation efforts allow larger and larger populations to depend on the same underlying water supply, the municipality's ability to conserve more in the face of water supply interruption tends to drop (since the easy investments in conservation will have already been made). This, in turn, can limit the ability of the provider to weather future shortages that may occur in response to droughts or temporary interruptions in supply, reducing resiliency in the community water system, and requiring corresponding investments in additional storage or redundant supplies to protect the "hardened" sectors in the event of a shortage.

Closed-loop systems involving extensive reuse of ef-

5 Colorado River Basin Water Supply and Demand Study: Technical Report F – Development of Options and Strategies, Bureau of Reclamation (December 2012).

fluent, like those discussed above, can also present important challenges to efforts to manage demand through water conservation. In closed-loop systems, the net water savings as a result of municipal conservation activities may be far lower than seems intuitive, or can even prove problematic in some circumstances. This relates to the fact that approximately 95% of water used indoors (e.g. in showers, toilets, food prep/dishwashing, cleaning) is typically returned to municipal sewer systems as graywater/blackwater for treatment, such that relatively little water is actually consumed as part of the indoor use cycle. There are some exceptions to this rule, such as where end users rely on septic systems, which typically are designed to evaporate and transpire effluent and return very little to groundwater, where users have extensive pipe leaks, or where users are deliberately consuming water (e.g. bottling plants, or cooling towers). However, virtually all outdoor water use—lawn and landscape watering, swimming pools, wash water—is consumptive and therefore cannot be recycled through the system. As a result, in municipal systems with substantial reuse, reductions in indoor water use can generate corresponding reductions in municipal effluent supply – supply that either serves as a source of supply for another user or is being recycled back into the municipal supply. If effluent supplies are unavailable, users dependent on that effluent may need to move to other supplies to replace the lost effluent, which effectively defeats the benefit of the water conservation activity from a mass-balance perspective. (Importantly, of course, conservation efforts that reduce water use for uses that do not return effluent through the sewer system, such as outdoor water use, do not generate these issues.)

Many municipal conservation measures can be revenue negative to a water provider, and can even create significant financial issues.

Most of the large, established urban uses in the Basin, including the cities of Los Angeles, Las Vegas, and Phoenix, have been experiencing overall declines in water demand as a result of urban water conservation efforts and growing effluent reuse programs.

Perhaps the most problematic aspect of municipal conservation measures is that many will be revenue negative to the water provider, and can even create significant financial issues. Municipal water suppliers are typically in the business of selling a "product"—water—to their customers, typically on a volumetric basis, and they earn virtually all their revenues from water rates. For both public and private (regulated) utilities, these rates essentially reflect the costs to the supplier of operating the system. If water use in the system drops, these costs may fall somewhat, but they will generally not drop in proportion to the amount of water conservation, since many costs borne by water companies are fixed (e.g. treatment facilities, physical infrastructure, repairs, and other maintenance costs). In addition, municipalities have typically built and sized water supply infrastructure such as water mains, sewer mains, pumping stations, and treatment facilities based on assumed GPCD rates for the populations to be served by those facilities. As GPCD rates decrease, this can leave the utility with stranded costs and oversize facilities that may not work properly, absent additional costs for retrofits. As such, when conservation efforts decrease water used, revenues from water sold drop, but costs do not; they may even increase. This can result in significant financial pressures—and for private water providers, reduced profit—and can require politically unpopular and counter-intuitive rate increases in response to conservation.

Regardless, it is important to note that most of the large, established urban users, including the cities of Los Angeles, Las Vegas, and Phoenix, have been experiencing overall declines in water demand as a result of urban water conservation efforts and growing effluent reuse programs. Phoenix, for example, now uses less water than it did in the mid-1990s, despite a significant increase in its population over the intervening period (Figure V(C)-4). Most growth in municipal demand is instead associated with rapidly growing satellite cities and ex-urban areas—areas that tend to have neither established water rights nor the level of financial resources needed to acquire water rights to support this growth or make significant investments in municipal conservation programs. As discussed in detail in Section V(C)(2), there is also a considerable and growing water infrastructure deficit throughout the Basin, one that is particularly acute in these same growth communities.

As the latecomers to the Basin, many growth communities also have the most significant exposure to future water risks, since they were not able to obtain access to the cheaper, safer, and more stable supplies developed in connection with major federal infrastructure projects (which are already held by established cities and agricultural users) and must instead rely on relatively low-priority water supplies and/or much more expensive alternatives. Even for established cities, many municipal water supplies are associated with lower-priority water rights, since large-scale agricultural use was already in place, and had appropriated most of the available water, before significant urban growth occurred in most of the Colorado River Basin. In many places, these lower-priority rights mean that urban users could be the first to see supplies cut back in the event of shortages, and are thus exposed to the greatest risk as shortage risks increase in the Basin.

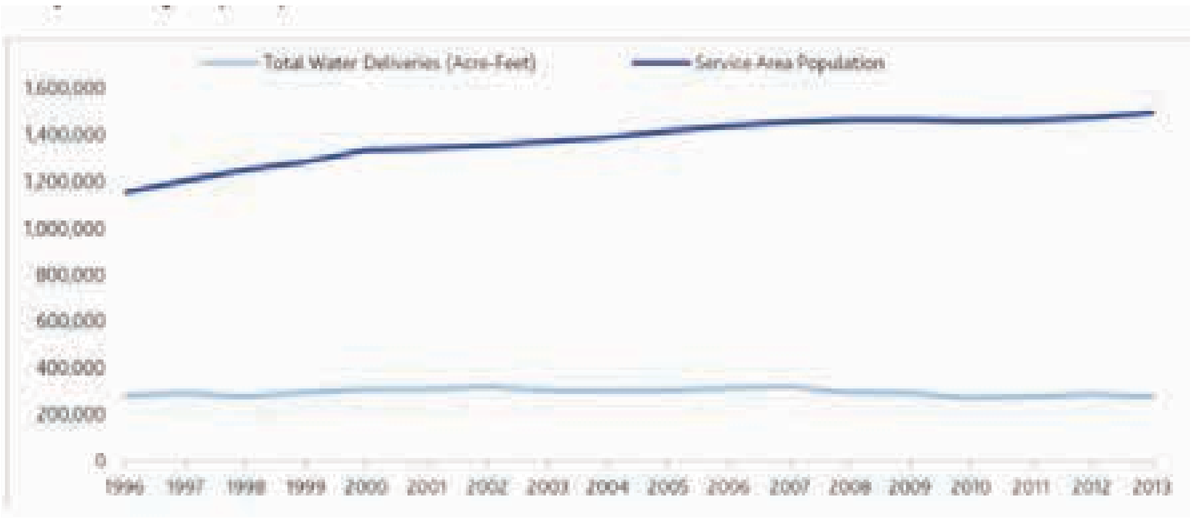


Figure V(C)-4. City of Phoenix Water Demand vs. Service Area Population. Based on City of Phoenix data. Chart from Moody's U.S. Public Finance "Issuer in Depth" November 2014 Report, Phoenix (AZ) Water Enterprise: Water System Prepared to Manage Current Drought with Diverse Sources and Substantial Volume, Moody's Investor Service, November 23, 2014.

The challenges posed by growing municipal water demand and the approaches to meeting those demands will have tremendous environmental significance in the Basin. Water transfers from agricultural to urban uses could potentially threaten environmental values associated with agricultural uses and associated return flows. New diversions for urban use, such as planned and proposed trans-basin diversions in the Upper Basin, could deplete many of the Basin's remaining healthy rivers and streams, or could further reduce or alter already disrupted streamflows in other parts of the Basin. Continued, unsustainable pumping of groundwater in infrastructure-challenged growth communities threatens some of the few remaining perennial river systems and riparian ecosystems in the Southwest. Continued, uncontrolled municipal demand growth will further drive increases in system risk resulting from overallocation and overuse. And depending on what infrastructure is constructed, and how it is constructed, municipal water infrastructure could either create significant environmental benefits or cause significant environmental harm.

The growing risk of shortage to urban users could generate equally significant—if not even more significant—environmental risks. Of all demand sectors, municipal water supply is the most difficult to manage in the face of shortage conditions. Exposing millions of people in urban areas to water shortfalls is an outcome that would be both dangerously unstable economically, as well as socially and politically unacceptable. As the risks of those shortfalls increase, the chance that they will ultimately overwhelm or eclipse other values in water management grows as well. Ensuring that these demands are adequately met will be a challenge, but if they are not met in a manner that leaves room for other values—such as watershed health, proper ecological functions, and healthy agricultural economies—the outlook for those other values is dim. Given these concerns, the management of municipal water demand, as well as the management of municipal water risk, is a critical component of protecting ecological values in the Basin.

Of all demand sectors, municipal water supply is the most difficult to manage in the face of shortage conditions. As a result, the management of municipal water demand, as well as the management of municipal water risk, is a critical component of protecting ecological values in the Basin.

The two blueprints that follow are intended to provide investment approaches for two key issues—municipal demand management and providing for sustainable approaches to the construction of new municipal water infrastructure—while generating direct environmental benefits and/or avoiding or minimizing environmental harms.

SECTION V(C)(1):

Investing in Municipal Water Conservation:
Using Pay-for-Performance to Address Non-Revenue Water

Summary

This investment vehicle is structured to monetize specific reductions in "system losses" experienced by municipal water suppliers via a pay-for-performance mechanism. This type of arrangement shifts both the risk and the up-front financial burden of investments to reduce or eliminate water main leaks, unaccounted-for uses, and other types of system losses in municipal water supply systems away from the municipal water supplier to a third-party investor, with the investor repaid from expected enhancements in revenues to the water supplier as a result of the reduction in system losses. This structure creates an attractive option for municipal water suppliers that lack substantial capital budgets to improve system efficiency at no net cost, while also potentially improving municipal water conservation performance in a manner that is revenue-positive, or at least revenue-neutral, to the supplier (unlike many other conservation strategies). By reducing overall municipal demand, this tool can limit the ecological risks and pressures that are otherwise associated with growing municipal water demand, particularly among cash-poor small to medium-size water suppliers.

1. Background

As noted in Section III of this report, implementation of municipal conservation efforts will be an important component of addressing supply and demand imbalances on the Colorado River, as well as controlling increasing municipal pressure on the Basin's ecosystems. However, conservation efforts can create their own unique set of challenges for municipal water suppliers. Over time, if conserved supplies are utilized to underwrite additional urban growth, conservation efforts can result in demand hardening that can reduce system resiliency; where conservation efforts are undertaken in fully or partially "closed-loop" systems with extensive effluent reuse, conservation efforts may cause reductions in effluent flow needed to service secondary uses, defeating water savings potential.

Perhaps most significantly, in many cases investments in conservation efforts will be "revenue negative" to the municipal provider itself, since reductions in customer water use will typically reduce revenue to the utility without generating proportionate reductions in operating costs. In addition, significant changes in customer use may generate stranded costs or issues with oversized infrastructure that further exacerbate these issues. Given the importance of municipal conservation to stretching scarce supplies and reducing system-level risk, as well as potential savings from reduced energy consumption and other costs, this should not necessarily deter expenditures by municipal providers on conservation efforts. The fact that such investments are potentially revenue negative to the provider does, however, make it more difficult to design a privately-funded investment model around such investments. Despite this difficulty, one area that appears to be an opportunity to capitalize on water savings without potentially damaging side effects for providers relates to the management of "system loss," or "non-revenue water."

The current water infrastructure across the U.S. is aging and is increasingly inadequate to support growing populations. According to the American Water Works Association (AWWA), approximately $1 trillion will need to be invested over the next 25 years to expand or replace existing aging water mains if current practices continue.[1] Moreover, the Environmental Protection Agency (EPA) estimates that, given current levels of investment, there is currently a $530 billion shortfall between actual and necessary levels of investment in water infrastructure, and that 60% of the total system costs are found in the distribution and transmission pipelines.[2]

While much of this required investment is expected to be the result of either population growth, combined sewer overflow systems that are capacity restrained, or primary water treatment and delivery systems, there exists a specific opportunity to focus on infrastructure related to water that is diverted and/or treated by the municipal water supplier but that does not actually arrive at a metered customer connection. This loss of treated water that is essentially unaccounted for, but is nevertheless costly to the municipal water provider, is typically referred to as "system loss" or "non-revenue water." Upgrading infrastructure to address system loss represents an estimated $97 billion opportunity in the U.S.[3]

1 Buried No Longer: Confronting America's Water Infrastructure Challenge, American Water Works Association, 2012.

2 A Cost Effective Approach to Increasing Investment in Water Infrastructure, American Water Works Association, Water Environment Federation, and Association of Metropolitan Water Agencies, n.d.

3 J. Thornton, R. Sturm, and G. Kunkel, Water Loss Control Manual, 2d ed.,, McGraw Hill, 2008.

<table>
<tr><th colspan="5">AWWA Water Loss Accounting</th></tr>
<tr><td rowspan="10">System Input Volume</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized</td><td>Metered</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Unmetered</td></tr>
<tr><td rowspan="2">Unbilled Authorized</td><td>Metered</td><td rowspan="8">NonRevenue Water (NRW)</td></tr>
<tr><td>Unmetered</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unathorized</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

Figure V(C)(1)-1. Water Loss Accounting for a Typical Municipal Water Supplier. Source: New Mexico Office of the State Engineer, Water Use and Conservation Bureau.

There are several sources of system loss, including leaks and water main breakage, conveyance and treatment losses in the primary supply system, unmapped infrastructure (particularly in older and rapid-growth areas), and unmetered connections and subsequent water use. Figure V(C)(1)-1 provides a typical example of water utilities' loss accounting. In total, water system losses can be very significant; a survey of major metropolitan water providers showed loss rates as high as 30% for some suppliers (see Figure V(C)(1)-2).

City	Water System Leakages (% of water lost 2000-2010)	City	Water System Leakages (% of water lost 2000-2010)
Atlanta	31.4%	Minneapolis	6.0%
Boston	9.0%	New York City	14.2%
Charlotte	11.0%	Orlando	10.0%
Chicago	2.0%	Philadelphia	26.5%
Cleveland	28.7%	Phoenix	6.6%
Dallas	9.1%	Pittsburgh	26.0%
Denver	5.0%	Sacramento	10.0%
Detroit	15.9%	San Francisco	8.8%
Houston	11.8%	Seattle	8.0%
Los Angeles	5.3%	St. Louis	3.0%
Miami	8.3%	Washington, DC	14.4%
City Average	12.8%		

Figure V(C)(1)-2. Source: http://grow-ingblue.com/case-studies/leakages-in-water-distribution-systems

The data reported here, of course, comes from large metropolitan areas that generally have the financial capacity and resources to identify the cause of losses, and therefore also tend to have the capability to implement changes and upgrades in infrastructure as needed (note the relatively low rates of reported loss in the major Basin communities – Denver, Los Angeles, and Phoenix – listed here). However, while statistics vary and reporting from smaller systems is typically poor, system losses are generally even more significant for smaller, less-capitalized water suppliers, such as those associated with small to midsize municipalities as well as many private water providers, who are less likely to maintain significant reserves that allow them to invest in infrastructure replacement and system loss monitoring on an ongoing basis. Based on anecdotal experience, loss rates for these types of providers can regularly be in the 20% range, with at least one privately-operated system that the authors are familiar with exhibiting loss rates closer to 40%.

These types of water providers also frequently have the most difficulty accessing funds to make system upgrades when they are needed. Many smaller municipalities lack ready access to municipal bond markets and other traditional financing approaches to undertake large-scale system upgrades, relying much more directly on annual cash flows from rate-based income to provide capital for system improvements and repairs. Significant upgrades may therefore require rate increases, which may be politically unpopular and face resistance from city councils. In addition, most private water providers (and in some cases municipal providers) are regulated by state public utilities commissions. These regulatory bodies typically restrict water rates to reflect actual cost-of-service plus a modest profit (in the case of a private provider), and in many cases these rates have to be set in advance and can only be revisited occasionally through a formal "rate case," which is generally an expensive undertaking. As a result, rates cannot necessarily be adjusted easily to meet unexpected costs or needed upgrades, and there are generally incentives to defer such costs until a wholesale rate adjustment can be justified.

Aside from authorized, but unbilled water deliveries (fire departments, municipal buildings, etc.) the specific opportunity for addressing system loss can be split into two primary categories as shown in Figure V(C)(1)-1: real losses and apparent losses. Real losses refer to physical system leaks and generally consist of leakage from transmission and distribution mains, leakage and overflows from the utilities' storage tanks, and leakage from service connections up to and including the meter. [4] Apparent losses refer to situations where water that should be included as revenue generating water actually appears as a loss due to unauthorized actions or calculation errors. Apparent losses consist of unauthorized consumption, customer metering inaccuracies, and systematic data-handling errors in the meter reading and billing processes.[5] Both real and apparent losses relate to unaccounted water that is treated and delivered but not appropriately billed for, which is referred to as "non-revenue water" for the water supplier.

The fact that non-revenue water is never received at a metered connection results in utilities having to divert and treat more water than they can actually sell. Therefore, controlling system loss is almost always revenue-positive to the water supplier (unlike most other forms of municipal water conservation). In addition, reducing system loss can also reduce pumping and diversion costs and water treatment loads and costs, without reducing revenues from wa-

4 Control and Mitigation of Drinking Water Losses in Distribution Systems, U.S. Environmental Protection Agency, EPA 816-R-10-019, Office of Water, November 2010.
5 Ibid.

ter deliveries, which further results in net revenue increases. Finally, reducing system loss does not result in demand hardening on the customer side, and it effectively reduces net municipal water use in both open and closed systems without impacting effluent production. As such, investing to reduce system loss is generally a "no-regrets" form of conservation investment.

2. Existing Approaches

A number of leak detection methods have been designed in an attempt to manage system loss. The EPA and the AWWA have both developed resources and tools to assist municipalities in addressing the problem. Historically, two main steps are needed to reduce system loss: (i) a detailed water audit to determine where water is leaving the system, and (ii) the development and implementation of a system loss intervention strategy.[6]

As previously discussed, real water loss occurs when water physically leaves the distribution system, while apparent water loss refers to the inability of the utility to bill for water delivered to the end customer. However, both real and apparent water losses can be addressed through leak detection and more-robust metering systems.[7] Many leak detection systems identify and prioritize leaks throughout the entire system by employing electronic lead (metal) sensors mounted on service lines to detect leaks and/or sensitive pressure transducers that watch for suspicious pressure fluctuations. Data from these sensors is then transmitted to a database that converts the data into a map that warns the system operator about leak locations and volumes. In addition to leak detection, upgrading meters can also provide significant savings by reducing both metering errors and the feasibility of theft of service. For example, the city of Kingsport, Tennessee, implemented a leak detection and meter system upgrade after a water audit revealed that the city was losing 1.2 billion gallons of water each year. After 26 months of a leak detection program, more than 116 leaks had been repaired, preventing the loss of some 1,200 gallons of water per minute (the equivalent of approximately 630 million gallons per year).[8]

While system loss investments have obvious net benefits, many of these upgrades for water utilities are capital-intensive to implement, and the water savings are not always completely certain. Common financing options for infrastructure improvements generally include raising taxes, issuing revenue bonds, or utilizing general funds from the municipal government (or in the case of private providers, incurring costs that may cut into profits). However, all these financing strategies are unpopular with the general public (or in the case of private providers, with company principals and shareholders), and therefore many municipalities and private water providers tend to delay investment in infrastructure improvements. Moreover, while budget-neutral performance contracting provides a politically feasible financing option,[9] the upgrades are still challenging to finance for small to midsize utilities when their capital and/or revenue is constrained. Given this reluctance, or even inability, to finance efficiency upgrades despite the obvious long-term benefits, system loss investment in small to midsize municipalities could be ideal for a pay-for-performance financing mechanism.

Importantly, however, the providers of system loss reduction technologies and related services are not necessarily in a position to provide their services directly on a pay-for-performance basis; typical business

6 Veronica Blette et al., "Water Loss Control: Tools, Policies and Successful Programs," October 15, 2014.

7 Craig Hannah, "Performance Contracting Finances Water Loss Reduction Program," Waterworld, October 2011.

8 Ibid.

9 Ibid.

models are premised upon direct payment from the water provider to cover the costs of the technology, together with capital and labor costs for installation, etc. In other words, the provider is in the business of selling the product and service, and cannot necessarily afford to take on significant risk associated with that business. For the reasons noted above, for practical purposes this may significantly delay the implementation of system loss reduction investments by small to midsize municipal providers and private providers, or may effectively place significant investments in system loss reduction technologies, monitoring equipment, and upgrades beyond their reach.

3. Proposed Solution

This proposed tool would link investments in water utility system loss management in a pay-for-performance mechanism with a third-party investor and/or a partner technology provider who would finance investments in system loss reduction up front, in exchange for an agreed-upon financial return. The return would be based on the actual efficiency performance of those investments in reducing system losses. The performance payments to the parties, which would cover initial costs as well as a modest financial return to incentivize private investment, would be supported out of the revenue savings and enhancements the utility receives as a result of the efficiency upgrades.

This pay-for-performance mechanism may be particularly attractive for capital-constrained or revenue-constrained municipal utilities as a means to reduce system losses and improve municipal water conservation performance. Furthermore, since the tool should allow those upgrades to fit within existing municipal water provider rate structures, the investment would be expected to be relatively uncontroversial. With successful implementation of efficiency upgrades, the pay-for-performance investment would essentially generate revenue-positive (or at least revenue-neutral) conservation savings to municipalities at no net increase in cost to the municipality (and potentially at significant net savings). Further, it should not increase stranded cost problems or contribute to the demand hardening issues discussed previously.

This pay-for-performance structure also shifts the risks of nonperformance to a third-party investor, such that the investment is a "win-win" for the municipal water provider. Further, given the pay-for-performance incentive structure, there exists an opportunity for partnerships between investors and emerging technology providers to undertake system loss reduction projects in municipal systems in ways that earn solid financial returns in exchange for the shared underwriting of associated installation and savings risks.

While the specific project funding will vary by project, partner negotiations, and scale required for implementation, it should be noted that a recently created government funding program (discussed further in Section V(C)(2), called the Water Infrastructure Finance and Innovation Authority (WIFIA), could help develop low-interest loans to promote investment in infrastructure in order to accelerate these types of pay-for-performance projec ts. Since bond issuances finance approximately 70% of all local infrastructure projects, reducing the interest on these bonds would significantly lower the long-term costs of financing efficiency upgrades both with and without pay-for-performance structures. WIFIA, modeled after a successful transportation infrastructure funding platform called TIFIA, will seek to decrease the overall costs of infrastructure improvements through funding by the U.S. Treasury.

The proposed investment structure would proceed under one of two potential models, as follows.

1. INVESTOR-ONLY MODEL

In the investor-only system loss pay-for-performance scenario, the utility (or the infrastructure financing program) enters into a contract with an investor to install system loss improvements in exchange for a fixed amount of return per unit of water saved, or for a percentage of revenue savings to the utility derived from those investments once completed. In this case, the investor would hire an efficiency contractor (such as a technology provider or an engineering firm) to install improvements, and the investor would front the costs of those improvements. Next, a third-party evaluator would measure the resulting water savings from the efficiency upgrades for the purposes of calculating financial returns to the investor, and the utility would pay the investor for the resulting savings. Because this payment would occur only after the municipality had realized actual reductions in up-front costs of treatment and delivery as compared to revenues and/or net increases in revenue through the capture of unmetered connections, these payments could potentially be made without any change to the municipality's current water rates.

In a case where no water savings occur, or where the savings are less than projected, the investor absorbs the costs of improvements as a loss. If water savings from efficiency upgrades are greater than projected, then the investor receives a greater financial return.[10]

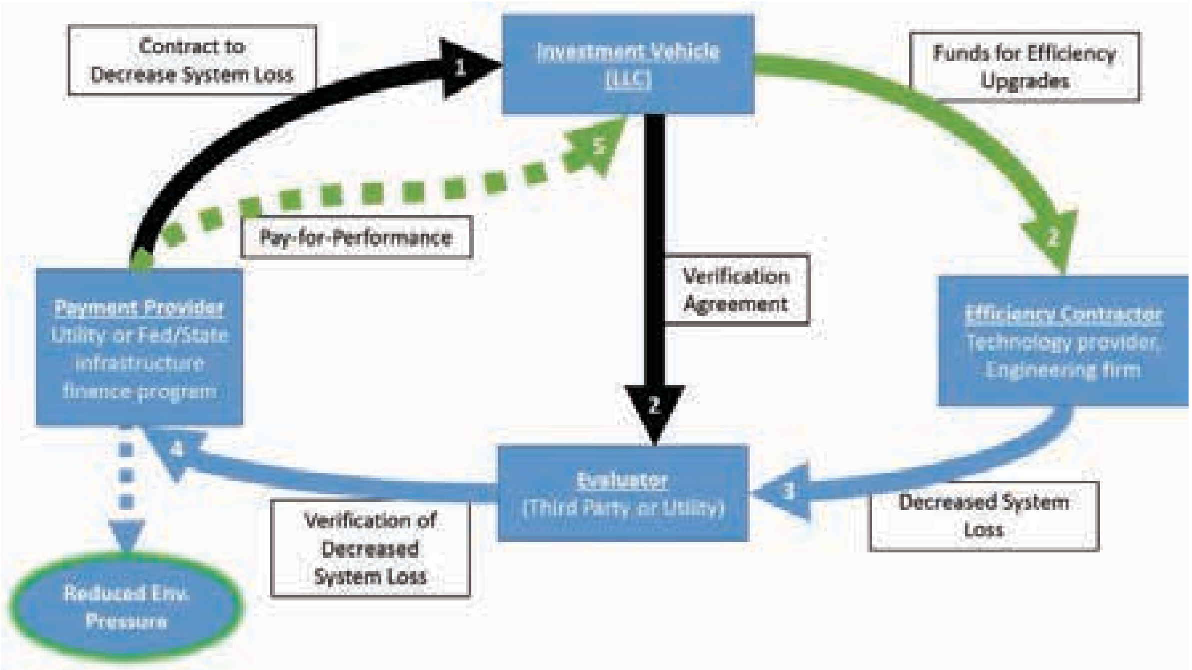


Figure V(C)(1)-3. Structure Of Investor-Only Model For System Loss Pay-For-Performance.

10 For tax purposes, the investor should be able to deduct his/her costs over the life of the contract with the water provider, and would have taxable income from the performance payments as they are paid.

2. JOINT VENTURE MODEL

In a joint venture system loss pay-for-performance scenario, the investor and a technical partner (a technology provider or an engineering firm) form a joint venture to install system loss improvements, whereby the investor provides capital, and the technology provider provides technical expertise and labor in undertaking engineering work. The utility (or the infrastructure financing program) then enters into a contract with the joint venture to install system loss improvements, either in exchange for a fixed amount of return per unit of water saved or for a percentage of revenue savings to the utility derived from those investments once completed. The technical partner then undertakes installation of improvements and technologies, and the investor fronts some or all of the capital costs of those improvements. Next, a third-party evaluator measures the resulting water savings from the efficiency upgrades for the purposes of calculating financial returns to the joint venture, and the utility pays the joint venture for any resulting savings. Because this payment would occur only after the municipality had realized actual reductions in up-front costs of treatment and delivery as compared to revenues and/or net increases in revenue through the capture of unmetered connections, these payments could potentially be made without any change to the municipality's current water rates. These payments would then pass through the joint venture back to the investor and the technical partner.

In a case where no water savings are achieved, or where the savings are less than projected, the joint venture absorbs the costs of improvements as a loss. If water savings from efficiency upgrades are greater than projected, then the joint venture receives a greater financial return to pass on to the investor and the technical partner.[11]

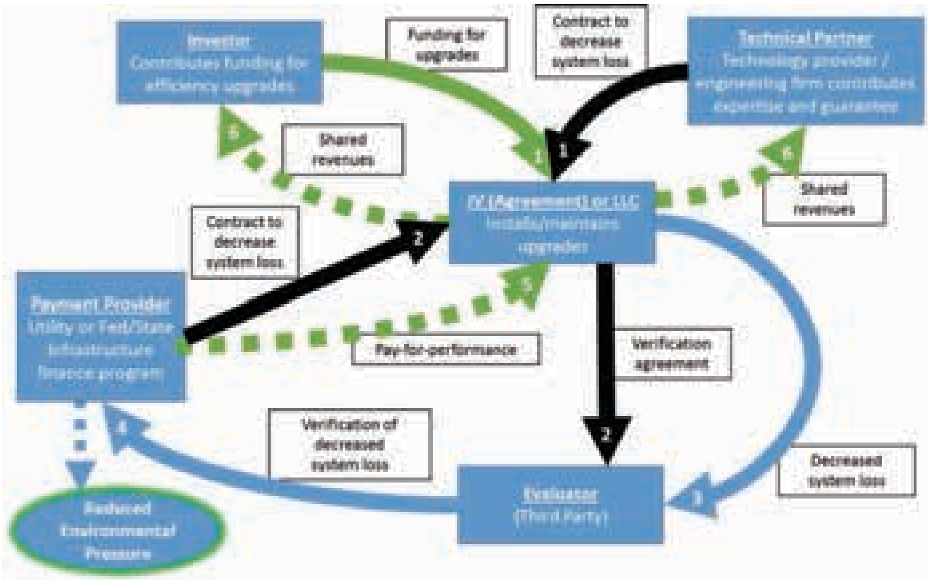


Figure V(C)(1)-4. Structure of Joint Venture Model for System Loss Pay-for-Performance.

11 *The joint venture entity, unless it elects to be a "corporation," would likely be treated as a partnership for federal income tax purposes and generally for state income tax purposes. The performance payments from the water provider for federal income tax purposes (and generally for state income tax purposes) would thus not be taxed at the entity level but rather would flow through to the investor and technology/engineering partner (based on their sharing agreement) and would be taxed at ordinary rates.*

HYPOTHETICAL CASE STUDY EXAMPLE

A medium-sized city-owned municipal water provider in City A projects significant growth in water demand over the coming decade. City A also grew quickly over the previous decade, and as a result has a hodgepodge of water supply infrastructure. This infrastructure includes older core water infrastructure that is aging and failing, new infrastructure in growth areas that is interconnected to the older supply system, and new water treatment systems that are coming online in support of expected growth. In addition, older and unmapped infrastructure in newly annexed areas that were previously served by small private water companies is now operated by the city's municipal water system. This latter infrastructure built for recently annexed divisions is poorly documented and is partially interconnected into the new water system and partially operated independently.

City A has experienced normal rates of conservation increases over time, leaving the municipal water provider with oversized infrastructure in certain new growth and some core areas. As a result the municipal water provider is revenue stressed. Internal audits have demonstrated that City A is experiencing approximately 10% overall system losses, with approximately 5% losses in the newly developed areas, 10% losses in the aging city core areas, and as much as 15% losses in the older infrastructure in the newly annexed areas. The losses in the newly annexed areas are believed to be the result of unmetered or unknown connections as well as extensive system leaks. Further, the municipal water provider has little capital to undertake system improvements, but is willing to do so. The City Council is unwilling to raise water rates to increase conservation efforts.

Technology Provider B has developed a proprietary water system mapping and leak detection technology that it hopes to deploy in municipal water systems around the world. Technology Provider B is particularly interested in deploying the new technology in City A and other similar environments, given the high system loss rates and associated savings its new technology could generate. Technology Provider B, however, lacks the funds to front the deployment costs of this new technology on its own, despite a high degree of confidence in the water savings to City A.

HYPOTHETICAL TRANSACTION

1. Investor C facilitates a transaction among City A and Technology Provider B, whereby Investor C enters into a joint venture with Technology Provider B for the installation of leak detection systems and water supply system mapping for the municipal water provider in City A.
2. The joint venture enters into a service contract with City A in which the joint venture will receive a percentage of the net revenue savings resulting from the installation of leak detection and monitoring equipment over the next 10 years.

3. Under the joint venture, Investor C fronts the hard costs for the leak detection installation and system mapping, with Technology Provider B providing the technology and most of the staffing costs. Implementation costs are to be repaid first, followed by a "hurdle" rate for the investor, with all other revenues split between Investor C, Technology Provider B, and City A.

4. Leak technology installation and system mapping are completed within five years, and Technology Provider B identifies more than 200 small to medium-size water main breaks and leaks for repair throughout the water supply system. Further, system mapping identifies a number of illegal or unmapped connections to the municipal water supply system, mostly in the newly annexed areas of City A.

5. A third-party evaluation shows that systemwide losses are reduced from 10% to 5%, and subsequent-year monitoring shows that these savings hold steady for the following four years of the contract. Investor A and Technology Provider B receive funds through the joint venture that are adequate to repay all costs, plus a return on Investor C's money.

6. As a result, City A is able to avoid acquisition of new water supplies necessary to meet projected growth in water demands, and is further able to serve all new-growth areas for the next decade using its existing water supply.

4. Financial Model[12]

To provide an illustrative example of the transaction described above, the Utah State University Buried Structures Laboratory Comprehensive Study on Water Main Break Rates ("Utah State Study") of April 2012 was used to help inform the hypothetical case study presented below, including relevant cost figures, leak statistics, and similar data. In addition, the AWWA 2014 Validated Water Audit Data was referenced so as to select a target municipality with appropriate loss data.

Some of the key assumptions and model outputs are included below. It is important to note, however, that the notional model presented here is intended for illustrative purposes only; additional research would obviously be required for any actual investment in a municipal water system, and the evaluation of potential returns and costs would require a case-specific investigation and thorough diligence.

12 This financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual project. The hypothetical transaction is fictitious and is only intended to provide some key line items interested parties might consider in assessing the potential for a system loss pay for performance vehicle. Among other omissions, inflation, depreciation and tax considerations have not been diligenced for this notional financial model.

SELECTED KEY ASSUMPTIONS[13]

- The Utah State Study included 188 survey participants that represent a total of 117,603 miles of pipe, or approximately 10% of the total length of water mains in the U.S.
- On average, 264 people are served per mile of pipe, regardless of utility size.
- 66% of all water mains are 8" or less in diameter, and the range of 10" to 14" make up another 18% of all installed water mains.
- The average supply pressure is 77 psi (pounds per square inch), with pressure fluctuations of less than 20 psi.
- Across all pipe types in all regions of the U.S., there are approximately 11 failures per 100 miles of pipe per year.
- Depending on the material, construction, and procedure chosen to fix a leak, each main break requires approximately 10 feet of pipe replacement, at an all-in cost of approximately $1,000 per foot.
- Costs of conducting an audit and a feasibility study, and then implementing the necessary leak detection technology and protocol, varies widely, according to the size and structure of a water system. A conservatively high estimate of $5 million for these costs was used in the hypothetical case study, based on a number of discussions held with engineering firms experienced in leak detection.

13 Steven Folkman, "Water Main Break Rates in the USA and Canada: A Comprehensive Study," Utah State University Buried Structures Laboratory, April 2012.

Figure V(C)(1)-5. Assumptions and Model Drivers for Municipal Water Use - System Loss Pay for Performance Vehicle

Project Funding Parameters	
Total Pipe Miles in the Municipality[1]	1,894
Failures per Mile[1]	0.11
Pipe Feet in Need of Upgrade (10 ft per Failure)[2]	2,083
Upgrade Cost per Foot of Pipe (Incl. Labor)[2]	$1,200
Audit, Feasibility, Metering and Technology[2]	$5,000,000
Total Cost for Infrastructure Upgrades	$7,500,000

Estimated Administrative Costs	
Project Management Fee[3]	$1,000,000
Legal and Administrative[3]	$1,000,000
Verifier (Annual)	$150,000
Total Administrative Costs	$2,150,000

Timing and Structure of Funding	
Years to Conduct Upgrades (Technology and Leaks)	5
Life of Project / Maturity of Loan (years)	10
First Year When Full Savings Achieved	6
Realized Savings in Initial Years	50%

Returns for Investor	
Multiple of Invested Capital (MOIC)	2.5x
Internal Rate of Return (IRR)	14.1%
Discount Rate	3.0%
Net Present Value (NPV) of Project	$9,917,415

[1] Based on midsize municipality per Utah State Study.
[2] Estimates provided system leak technology providers.
[3] Spread over first five years of the project.
[4] From AWWA 2014 Validated Water Audit.
[5] Based on a select midsize municipality.

Sources and Uses	
Sources	
Total Investor Funding Required for Upgrades	$9,650,000
Uses	
Total Cost for Infrastructure Upgrades	$7,500,000
Total Administrative Costs	$2,150,000

Measured Outcome (Annual)	
Total Acre Feet (AF) Processed by Municipality[4]	95,660
Conversion to Gallons	31,170,910,000
Starting System Loss[5]	10.0%
Actual Metered Delivery Before Infrastructure Upgrades	86,094
% System Loss After Upgrades	5.0%
Total Metered AF Delivery After Upgrades	90,877
Add'l AF Metered / Saved with Upgrades	4,783
Gross Amt Needed for Treatment (Steady Demand)	90,625
Reduction in Treatment Needs (Volume Savings)	5,035
Municipal Price Charged per AF[5]	$1,100
Municipal Price per Gallon (Implied)	$0.00338
Revenue Potential From Upgrades (Reduced Treatment)	$5,538,204

Hypothetical Proceeds to Partners (Annual)	
Joint Venture (JV) Partner: (1) = Yes, (0) = Direct	1
Initial % of Potential Revenue Due to Investor (Hurdle)	10%
Hurdle $ to Investor	$553,820
Distribution % of Project Cash Flow after Hurdle	
To Municipality	20%
To Engineer / Joint Venture Partner	5%
To Investor	75%

Figure V(C)(1)-6. Illustrative cash flows for the Municipal Water Use - System Loss Pay for Performance Vehicle (with JV Partner)

Year:	0	1	2	3	4	5	6	7	8	9	10	
Income												
Total Realized Water Savings		$2,769,102	$2,769,102	$2,769,102	$2,769,102	$2,769,102	$5,538,204	$5,538,204	$5,538,204	$5,538,204	$5,538,204	
Total Potential Income		$2,769,102	$2,769,102	$2,769,102	$2,769,102	$2,769,102	$5,538,204	$5,538,204	$5,538,204	$5,538,204	$5,538,204	
Operating Expenses												
Program Management Costs [1]		$200,000	$200,000	$200,000	$200,000	$200,000	$0	$0	$0	$0	$0	
Legal [2]		$500,000	$125,000	$125,000	$125,000	$125,000	$0	$0	$0	$0	$0	
Verifier		$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	
Implementation Costs		$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$0	$0	$0	$0	$0	
Total Expenses		$2,350,000	$1,975,000	$1,975,000	$1,975,000	$1,975,000	$150,000	$150,000	$150,000	$150,000	$150,000	
Potential Cash Flow from Project		$419,102	$794,102	$794,102	$794,102	$794,102	$5,388,204	$5,388,204	$5,388,204	$5,388,204	$5,388,204	

[1] *Program Management Costs are assumed to be incurred over the treatment period.*

[2] *Assumes 50% of Legal Cost are incurred in Year 1 with the remainder of legal costs experienced over the remainder of the treatment period.*

	0	1	2	3	4	5	6	7	8	9	10	Totals
Performance Waterfall												
Project Cash Flow		$419,102	$794,102	$794,102	$794,102	$794,102	$5,388,204	$5,388,204	$5,388,204	$5,388,204	$5,388,204	
Initial Cash Flow Due to Investor		$419,102	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	
Performance Over Hurdle		$0	$240,282	$240,282	$240,282	$240,282	$4,834,383	$4,834,383	$4,834,383	$4,834,383	$4,834,383	
JV Partner Upside		$0	$12,014	$12,014	$12,014	$12,014	$241,719	$241,719	$241,719	$241,719	$241,719	$1,256,652
Municipal Partner Upside		$0	$48,056	$48,056	$48,056	$48,056	$966,877	$966,877	$966,877	$966,877	$966,877	$5,026,609
Residual to Investor (After Hurdle)		$0	$180,211	$180,211	$180,211	$180,211	$3,625,788	$3,625,788	$3,625,788	$3,625,788	$3,625,788	
Investor Total Returns												
Returns on Invested Capital	($9,650,000)	$419,102	$734,032	$734,032	$734,032	$734,032	$4,179,608	$4,179,608	$4,179,608	$4,179,608	$4,179,608	$24,253,268
Discounted Returns for NPV	($9,650,000)	$406,895	$691,895	$671,743	$652,177	$633,182	$3,500,356	$3,398,404	$3,299,421	$3,203,321	$3,110,021	$19,567,415

MOIC:	2.5x
IRR:	14.1%
NPV:	$9,917,415

Figure V(C)(1)-7. Illustrative cash flows for the Municipal Water Use - System Loss Pay for Performance Vehicle (without JV Partner)

Year:	0	1	2	3	4	5	6	7	8	9	10	Totals
Income												
Total Realized Water Savings		$2,769,102	$2,769,102	$2,769,102	$2,769,102	$2,769,102	$5,538,204	$5,538,204	$5,538,204	$5,538,204	$5,538,204	
Total Potential Income		$2,769,102	$2,769,102	$2,769,102	$2,769,102	$2,769,102	$5,538,204	$5,538,204	$5,538,204	$5,538,204	$5,538,204	
Operating Expenses												
Program Management Costs [1]		$200,000	$200,000	$200,000	$200,000	$200,000	$0	$0	$0	$0	$0	
Legal [2]		$500,000	$125,000	$125,000	$125,000	$125,000	$0	$0	$0	$0	$0	
Verifier		$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	
Implementation Costs		$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$0	$0	$0	$0	$0	
Total Expenses		$2,350,000	$1,975,000	$1,975,000	$1,975,000	$1,975,000	$150,000	$150,000	$150,000	$150,000	$150,000	
Potential Cash Flow from Project		$419,102	$794,102	$794,102	$794,102	$794,102	$5,388,204	$5,388,204	$5,388,204	$5,388,204	$5,388,204	

[1] *Program Management Costs are assumed to be incurred over the treatment period.*

[2] *Assumes 50% of Legal Cost are incurred in Year 1 with the remainder of legal costs experienced over the remainder of the treatment period.*

	0	1	2	3	4	5	6	7	8	9	10	Totals
Performance Waterfall												
Project Cash Flow		$419,102	$794,102	$794,102	$794,102	$794,102	$5,388,204	$5,388,204	$5,388,204	$5,388,204	$5,388,204	
Initial Cash Flow Due to Investor		$419,102	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	$553,820	
Performance Over Hurdle		$0	$240,282	$240,282	$240,282	$240,282	$4,834,383	$4,834,383	$4,834,383	$4,834,383	$4,834,383	
JV Partner Upside		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Municipal Partner Upside		$0	$48,056	$48,056	$48,056	$48,056	$966,877	$966,877	$966,877	$966,877	$966,877	$5,026,609
Residual to Investor (After Hurdle)		$0	$192,225	$192,225	$192,225	$192,225	$3,867,507	$3,867,507	$3,867,507	$3,867,507	$3,867,507	
Investor Total Returns												
Returns on Invested Capital	($9,650,000)	$419,102	$746,046	$746,046	$746,046	$746,046	$4,421,327	$4,421,327	$4,421,327	$4,421,327	$4,421,327	$25,509,920
Discounted Returns for NPV	($9,650,000)	$406,895	$703,220	$682,737	$662,852	$643,545	$3,702,792	$3,594,944	$3,490,236	$3,388,579	$3,289,883	$20,565,683

MOIC:	2.6x
IRR:	14.9%
NPV:	$10,915,683

Figure V(C)(1)-8. Investment scenarios for the Municipal Water Use - System Loss Pay for Performance Vehicle

Model Sensitivities - Municipality Loss and Potential Gain, ~95,000 AF Water System

Potential Annual Municipal Revenue Due to Reduced Treatment (Loss to 5% Level)

Initial % Loss	Water Price Charged per AF: $500	$800	$1,100	$1,400	$1,700
10.0%	$2,517,365	$4,027,785	$5,538,204	$7,048,623	$8,559,042
15.0%	$5,034,731	$8,055,569	$11,076,408	$14,097,246	$17,118,084
20.0%	$7,552,096	$12,083,354	$16,614,611	$21,145,869	$25,677,127
25.0%	$10,069,461	$16,111,138	$22,152,815	$28,194,492	$34,236,169
30.0%	$12,586,827	$20,138,923	$27,691,019	$35,243,115	$42,795,211

Potential Revenue Gain for Municipality over 10 Yr. Period (Loss to 5% Level)

Initial % Loss	Water Price per AF: $500	$800	$1,100	$1,400	$1,700
10.0%	$2,115,629	$3,475,006	$5,026,609	$6,963,210	$8,926,755
15.0%	$4,412,371	$8,272,240	$12,199,330	$16,126,420	$20,053,510
20.0%	$7,617,725	$13,508,360	$19,398,995	$25,289,630	$31,180,265
25.0%	$10,890,300	$18,744,480	$26,598,660	$34,452,840	$42,307,019
30.0%	$14,162,875	$23,980,600	$33,798,325	$43,616,049	$53,433,774

Model Sensitivities - Returns to JV Partners

JV Partner: Total Return w/ 5% of Savings (Excl. Payment from Work Contract)

% Savings Rcv'd	Water Price per AF: $500	$800	$1,100	$1,400	$1,700
5.0%	$528,907	$868,752	$1,256,652	$1,740,802	$2,231,689
10.0%	$1,057,814	$1,737,503	$2,513,304	$3,481,605	$4,463,377
15.0%	$1,586,722	$2,606,255	$3,769,956	$5,222,407	$6,695,066
20.0%	$2,115,629	$3,475,006	$5,026,609	$6,963,210	$8,926,755
25.0%	$2,644,536	$4,343,758	$6,283,261	$8,704,012	$11,158,444

Investor IRR: 10 Years, ~95,000 AF Project w/10% Loss Rate Down to 5%

	Total Project Costs (excl. Admin & Legal): $6,666,667	$7,083,333	$7,500,000	$7,916,667	$8,333,333
Water Price/AF	Cost Per Foot In Replacement: $800	$1,000	$1,200	$1,400	$1,600
$500	(3.5%)	(4.5%)	(5.3%)	(6.1%)	(6.9%)
$800	7.7%	6.6%	5.5%	4.5%	3.5%
$1,100	16.6%	15.3%	14.1%	13.0%	11.9%
$1,400	24.0%	22.5%	21.1%	19.9%	18.7%
$1,700	30.8%	29.2%	27.6%	26.2%	24.8%

Model Sensitivities - Returns to JV Partners (Continued)

Investor MOIC: 10 Years, ~95,000 AF Project w/10% Loss Rate Down to 5%

		Total Project Costs (excl. Admin & Legal)				
		$6,666,667	$7,083,333	$7,500,000	$7,916,667	$8,333,333
		Cost Per Foot In Replacement				
		$800	$1,000	$1,200	$1,400	$1,600
Water Price/AF	$500	0.7x	0.6x	0.5x	0.5x	0.4x
	$800	1.8x	1.7x	1.5x	1.4x	1.3x
	$1,100	2.8x	2.7x	2.5x	2.4x	2.2x
	$1,400	3.8x	3.6x	3.4x	3.3x	3.1x
	$1,700	4.8x	4.6x	4.4x	4.1x	4.0x

Investor NPV: 10 Years, ~95,000 AF Project w/10% Loss Rate Down to 5%

		Total Project Costs (excl. Admin & Legal)				
		$6,666,667	$7,083,333	$7,500,000	$7,916,667	$8,333,333
		Cost Per Foot In Replacement				
		$800	$1,000	$1,200	$1,400	$1,600
Water Price/AF	$500	($4,435,162)	($5,233,471)	($6,031,780)	($6,830,089)	($7,628,398)
	$800	$3,647,827	$2,849,518	$2,051,210	$1,252,901	$454,592
	$1,100	$11,355,911	$10,640,540	$9,917,415	$9,194,291	$8,471,166
	$1,400	$18,747,173	$18,044,275	$17,341,376	$16,638,478	$15,935,579
	$1,700	$26,138,435	$25,435,537	$24,732,638	$24,029,740	$23,326,842

SECTION V(C)(2):

Financing Sustainable Water Infrastructure:
Municipal Green Bonds with Environmental and Sustainability Conditions

Summary

This investment vehicle seeks to utilize a long-term bond investment for the development of a specific piece of local or regional water supply infrastructure (or similar capital investment). In connection with the investment, which theoretically would be undertaken at a favorable rate, the bond issuer would commit to compliance with a series of conditions and an investor-driven oversight mechanism that might include environmental mitigation, commitments to sustainability in the use of local water supplies, and other conditions that would both result in a better environmental/social outcome and help guarantee the successful repayment of the bond.

1. Background

Although the physical unavailability of water will clearly be a factor in the future economic development for many Western communities, in many cases it will not be the most important water problem that those communities face. As noted in the background report, for many of the West's cities, towns, and rural areas, the bigger issue will be how to pay for the infrastructure, water rights, and new institutions needed to manage scarce supplies amid growing uncertainty and pressure on water resources. Over the next 20 years, total infrastructure needs for drinking water facilities in the six Colorado River Basin states, excluding California, was estimated by U.S. EPA at $25.5 billion as of 2011; California alone had an estimated $45.5 billion need for infrastructure investments.[1] Just for wastewater infrastructure, the investment need was estimated at $11.2 billion across the six states, and at $24.4 billion in California alone.

Even if federal and state subsidies were to continue to be available, the standard approach to managing water scarcity through traditional infrastructure—more dams, more wells, more diversions—is no longer feasible in many places, as existing water supplies are already overallocated.

Much of the water development and water infrastructure of the West—including the vast network of dams, delivery canals, irrigation projects, and other projects—has been constructed with, and subsidized by, enormous investments of public resources, largely composed of federal and state tax dollars, low-interest government loans, and traditional tax-exempt bond financing. These investments helped fuel the unprecedented growth of the American West, and made it possible to build cities and massive agricultural enterprises in locations where this would otherwise have proved impossible.

Some federal funding for water infrastructure and supply development continues to be available, but it has been declining steadily since the 1980s.[2] However, several state programs continue to provide support for water infrastructure development. For instance, there are still various state revolving funds that provide low-interest loans to local governments to finance water projects built with federal funding available under the Clean Water Act. Nevertheless, in the aftermath of the 2008 recession, less and less public money is available to finance large-scale infrastructure projects. Many state governments have been experiencing declining revenues and capacity for financing public infrastructure needs. Legislative appropriations to support state agencies responsible for managing water supplies are at an all-time low in many states, triggering significant downsizing of agency staff and the contraction of the scope of activities and programs to support water resource management

It is also important to note that in many places, even if federal and state subsidies were to continue to be available, the standard approach to managing water scarcity through traditional infrastructure—more dams, more wells, more diversions—is no longer feasible, as existing water supplies are already overallocated. Although there continue to be numerous examples of "magical thinking" about the costs and feasibility of new major infrastructure projects to rescue the Colorado River Basin and other water-challenged parts of the

1 EPA Drinking Water Needs Infrastructure Survey and Assessment, 2013.

2 "Corps of Engineers Water Resources Infrastructure: Deterioration, Investment or Divestment?" 2012. USACE, Committee of US Army Corps of Engineers Water Resources, Science, Engineering, and Planning.

West from water scarcity—such as the construction of enormous and expensive water pipelines from the Mississippi River or Columbia Basin, transportation of icebergs, or even cloud seeding enterprises—it is increasingly recognized that these kinds of projects are unlikely to materialize in the near-term.

As supply and demand imbalances continue to grow throughout the Colorado River Basin, many communities are facing significant infrastructure needs associated with access to and delivery of sustainable water supplies. In addition, the current stock of "gray" infrastructure will likely not be able to respond to the needs created by increasingly extreme weather patterns, which will require heightened levels of redundancy among existing water supplies.[3]

These challenges are amplified by failing, outdated, and underdeveloped municipal water infrastructure systems. American Society of Civil Engineers' (ASCE) most recent 2009 "report card" for water and wastewater infrastructure gave the U.S. as a whole a "D minus" grade.[4] According to the American Water Works Association (AWWA), approximately $1 trillion will need to be invested over the next 25 years to expand or replace existing aging water mains if current practices continue.[5] Even those infrastructure projects that were developed through large-scale federal and state investments—such as the large Reclamation dams, pipelines, canals, and other projects—are aging and in some cases falling into disrepair. The U.S. Army Corps of Engineers also cites a significant backlog in deferred maintenance and repair in its projects as a result of inadequate federal funding levels.

These problems and needs tend to fall into several key categories:

- Population growth or annexing of other municipalities creating challenges associated with expanded service areas, such as:
    - Decentralized and/or aging infrastructure requiring repair and consolidation, as well as older core infrastructure approaching the end of its useful life.
    - Consolidation and extension of municipal service infrastructure to serve an expanded service area.
    - Significant decentralization of water supply infrastructure.
    - Conversion of septic wastewater systems to sewered systems, integration of small water companies, and new growth infrastructure and matching infrastructure.
- Need for investment in demand reduction projects, such as gray-water infrastructure for reuse and turf conversion, which may serve as conservation mechanisms.
- Supply enhancement projects, including pipeline and diversion proposals, that create the need for new infrastructure and for infrastructure replacement.

3 Drinking Water Infrastructure: An Advocate's Guide, Report of American Rivers, July 2013. Web, December 16, 2014, 4.
4 "Failure to Act: The Economic Impact of Current Investment Trends in Water and Wastewater Infrastructure," American Society of Civil Engineers, 2011.
5 American Water Works Association, Buried No Longer: Confronting America's Water Infrastructure Challenge. Web. http://www.awwa.org/Portals/0/files/legreg/documents/BuriedNoLonger.pdf. January 2015.

- The need to address groundwater dependence and replace existing groundwater depletions via recharge activities, especially in regions and municipalities facing water scarcities.
- Environmental mitigation and amenities. Municipal infrastructure can be used to create affirmative environmental benefits, including tertiary treatment wetlands, near-stream recharge facilities, effluent dependent systems, green infrastructure in cities, storm water retention facilities and groundwater recharge.

These infrastructure issues are of course by no means confined to the Colorado River Basin; the Basin's infrastructure deficits are developing in the context of a broader national challenge related to municipal water infrastructure. Municipalities across the United States face water quantity and quality issues relating to infrastructure failures and the need for infrastructure development and upgrades. As cities continue to expand and populations continue to grow, improving water infrastructure becomes ever more critical to ensuring a readily available and high-quality water supply. The aged, broken, and often underdeveloped water infrastructure in the country is detrimental to surrounding urban and rural populations, stresses system stability, and erodes environmental health, as a result of recurring costly damage, the low quantity and poor quality of water delivered, and unprotected at-risk natural watersheds.[6]

As cities continue to expand and populations continue to grow, improving water infrastructure becomes ever more critical to ensuring a readily available and high-quality water supply.

As a result of changes in availability of state and federal financial support, the largest current source of investment capital for water infrastructure and supply security needs is the private sector. According to a National Association of Counties Report, between 2003 and 2013 county, state, and municipal bonds generated over $3.2 trillion in capital invested in infrastructure projects.[7] Meeting needs of communities with existing and future infrastructure deficits will require substantial investments in infrastructure upgrades and expansion, investments in the management of water demand, and investments in new water supply. Where growth has not been accompanied with investments in conservation and water supply redundancy, these same communities may be significantly exposed to drought risks.

ENVIRONMENTAL CHALLENGES

The failure to address municipal water infrastructure needs can create extremely significant environmental issues. Aging infrastructure can cause groundwater and surface water contamination. Additionally, low levels of conservation in aged infrastructure mean that municipalities continue to use more water than necessary, depleting stream flows. This depletion of primary sources has led to continued reliance on groundwater pumping, producing a vicious cycle of lowering water tables, threatened streams and riparian areas, and enormous underground "cones of depression" that reflect decades of accumulated groundwater deficits. Finally, municipalities exposed to shortage risks face sudden, catastrophic shortfalls, leaving large populations exposed to drought and

6 Hamida Kinge, What's on Tap: America's Failing Water Infrastructure, Americancity.org, n.d. Web, December 16, 2014, 33.
7 Emilia Istrate, "Municipal Bonds Build America: A County Perspective on the Changing Tax-Exempt Status of Municipal Bond Interest," National Association of Counties Policy Research Paper Series, issue 1, 2013.

requiring emergency interventions that may override environmental considerations altogether for practical or political reasons. Understandably, the sudden lack of sufficient water supply for millions of people can be incredibly dangerous to water-dependent environmental values.

The manner in which these infrastructure needs are addressed is also extremely significant environmentally, as new municipal infrastructure can cause huge environmental impacts. Drilling new wells can deplete groundwater aquifers and threaten streams and riparian areas. Such wells can create or add to existing cones of depression in aquifers and accumulated groundwater deficits. Additionally, changes in water use patterns and conservation may reduce effluent production, threatening downstream water users or effluent-dependent environmental values. Retirement of agricultural and other water uses to free up water to meet urban demands may threaten environmental values that rely on return flows or groundwater recharge created by those uses. Finally, new water supply infrastructure to divert, pump, or otherwise transport water from one place to another can lead to depleted stream flows, aquifer impacts, and myriad other harmful consequences.

The manner in which municipal infrastructure needs are addressed has tremendous environmental significance, as new municipal infrastructure can cause huge environmental impacts.

In this context, failures to install "green" infrastructure options can represent huge missed opportunities and commit communities to long-term, less-sustainable paths to growth. Given the vast backlog of municipal infrastructure projects and significant projected growth in municipal water demands, particularly among small- to medium-growth communities, it is critical to future environmental values in the Basin that new municipal infrastructure be built with an appropriate focus on environmental impacts and opportunities. The development and retrofit of municipal infrastructure in growth communities also represents a tremendous opportunity to shape the future of infrastructure development throughout the West in ways that could help to address the impacts of past poor practices, excessive diversions, and unsustainable groundwater mining and accumulated groundwater deficits. However, it will be almost impossible to convince communities with limited access to traditional financing--where even modest infrastructure projects will be difficult to finance and build--to construct more costly, environmentally-sensitive projects that may be considered "Cadillac" solutions.

Failures to install "green" infrastructure options can represent huge missed opportunities and commit communities to long-term, less-sustainable paths to growth.

Figure V(C)(2)-1. Tres Rios wetland project, a large effluent-dependent wetland supported by the 91st Avenue Wastewater Treatment Plan in Phoenix, Arizona.

This is both a problem and an opportunity. It is a problem because, left to their own devices, many growth communities can be expected to build environmentally damaging and unsustainable infrastructure. It is an opportunity because these same municipalities can have significant needs for new access to capital, so providing them with financing at favorable rates could serve as a powerful incentive to build more environmentally sustainable projects.

DIFFERENCES BETWEEN LARGE AND SMALL COMMUNITIES

In some areas of the Colorado River Basin—particularly the Basin's large urban centers—it will clearly continue to be feasible to finance water needs through traditional means. Las Vegas, Phoenix, Los Angeles, and Denver all have solid balance sheets at present, and the ability to bond for large infrastructure projects.[8] However, in many cases the most significant water resource problems are developing in areas of the Basin with the least ability to pay for their own water supply and infrastructure needs.

As noted earlier in this report, the Bureau of Reclamation's Colorado River Basin Water Supply and Demand study projected growing municipal demand for water under a variety of economic, developmental, and environmental scenarios. Under each parameter, the Bureau predicted that by the year 2060, agricultural demand in the Basin study area would decrease, while municipal and industrial demand was expected to increase.[10]

As a result of significant and increasing investments in municipal and industrial conservation efforts, however, essentially every major existing municipality in the Colorado River Basin has recently projected no net increase—or at most a minor net increase—in water demands over coming decades. As noted earlier in this report, Phoenix, Las Vegas, Denver, and Los Angeles have all experienced net declines in water use over the past two decades, despite massive increases in population over that period. As a result, many of the most acute infrastructure needs in the Basin are expected to be associated with smaller to midsize communities that, given expected unprecedented growth, are leading the water demand curve.

Particularly in those small- to medium-size communities, rapid growth has already created significant infrastructure deficits, compounding pre-existing problems with aging infrastructure. Where high growth is or has been occurring, these municipalities typically face significant accumulated deficits in infrastructure. Over the past decade or so, double-, triple-, and even quadruple-digit growth rates in some ex-urban communities have generated significant infrastructure shortfalls that translate into future shortfalls in water supply.

One increasingly widespread issue in these growth communities is unsustainable dependence on groundwater mining for water supply. Under the "reasonable use" doctrine, groundwater development in some areas of the Basin can either occur without real access to long-term sustainable supplies, or can be dependent on supplies that (over time) will generate significant environmental issues. Replacing current groundwater use with sustainable supplies will in many cases require large-scale investments in re-

8 It should be noted, however, that even for relatively fiscally healthy communities, investment capital for water infrastructure could be threatened by changes affecting municipal bond markets, and particularly changes associated with tax exemption. Proposed reforms at the federal level to repeal or cap the tax-exempt status for municipal bond interest could steer investors away from financing instruments that support large-scale public works projects, create higher borrowing costs for communities, and undermine one of the more significant tools for financing infrastructure.

9 Colorado River Basin Water Supply and Demand Study, Report of U.S. Department of the Interior, Bureau of Reclamation, December 2012.

10 Ibid.

gional water infrastructure to reduce existing demand, access new supplies, and/or mitigate the impacts of both past and present unsustainable use that have created significant accumulated deficits in local aquifers.

These same Basin communities, however, are also increasingly struggling under growing debt burdens. According to U.S. Census data, state and local government expenditures on interest from debt have reached levels of over $100 billion per year. Forbes has also noted that while payments on debt interest have grown significantly in recent years, investment in infrastructure has fallen when adjusted for inflation.[11] While the relative increase in the debt burden of local governments post-recession is not surprising, with revenues declining over the past years (and only recently beginning to rebound) and with increasing demands on government programs (particularly social safety nets), the fiscal health of state and local governments has come under increased political scrutiny. This may ultimately result in constraints on the borrowing capacity of local governments. For many such municipalities with small but growing populations, water-related infrastructure projects can be extremely costly and disruptive to the existing infrastructure.[12] They can even force these municipalities to rely on cheaper alternatives to procure water, despite the environmental repercussions or sustainability implications of their actions.[13]

Figure V(C)(2)-2.Groundwater recharge basin near Sierra Vista, AZ. The site is designed to recharge municipal effluent to benefit flow in the threatened San Pedro River. Photo credit: Peter W. Culp

These constraints are exacerbated by other limitations placed on local government financing options, in particular impact fee reforms that make it more difficult for county and municipal governments both to require new development to pay for itself and to fund the infrastructure needs generated by such development. As local governments have struggled in recent years to meet increasing demands for services under

11 Scott Hodge, For the Sake of Tax Reform, the Muni Bond Exemption (and Tax Deduction) Must Go, Forbes, March 21, 2013, www.forbes.com/sites/realspin/2013/03/21/for-the-sake-of-tax-reform-the-muni-bond-and-state-tax-exemptions-must-be-abolished/.
12 Hamida Kinge, What's on Tap: America's Failing Water Infrastructure, Americancity.org, n.d. Web, 16. December 2014, 33.
13 Ibid.

conditions of significant population growth and dramatic expansions of urban footprints, many communities have turned to impact fees as an efficient, politically palatable means of paying for those improvements. This strategy became especially widespread in the Southwest U.S., where strong taxpayer antipathy toward paying property taxes—or indeed taxes of any kind—forced communities with booming populations to seek to shift the cost of financing necessary infrastructure improvements to new development. However, as the use of impact fees rose, developers and members of the real estate industry began to push back on these costs, and led efforts to limit or repeal impact fees.

2. Existing Approaches

Although laws for municipal bonds vary from state to state, under laws currently applicable in most Basin states, municipalities can finance water-related projects via:

- Voter-approved general obligation bonds
- Voter-approved water system revenue bonds
- Non-voted water revenue obligations (not always available with unqualified bond counsel)
- Non-voted excise (sales) tax obligations (with the municipalities using water system revenues as an internal funding source, although the revenues are not usually pledged to the loan)
- Loans from state revolving funds established under the Clean Water and Drinking Water State Revolving Fund (SRF) program (e.g., Arizona's Water Infrastructure Finance Authority (WIFA) Program); voter approval requirements vary, but may be waived for smaller communities
- Community facilities districts or similar special taxing districts

Most municipal water systems have "net revenue" debt outstanding under one of the above means. It should also be noted that municipal bonds employed to fund public projects can either be taxable or tax exempt. Income generated by tax-exempt bonds is not affected by federal taxes, and is often also exempt from state and local income taxes. Although the majority of municipal bonds are tax exempt, the federal government has the ability to disallow tax exemption for bond-funded projects that do not substantially benefit the public. While tax exemption is an attractive lure for investors, taxable municipal bonds sometimes offer higher, risk-adjusted yields that are more similar to those of corporate bonds.

Another potential source of funding will be a new federal program adopted under the Water Resources Reform and Development Act (WRRDA) of 2014, which creates a new low-cost loan program for water infrastructure known as the Water Infrastructure Finance and Innovation Act (WIFIA), modeled on a highly successful transportation loan program: the Transportation Infrastructure Finance and Innovation Act (TIFIA). The WIFIA program will provide low-cost, long-term loans (based on U.S. Treasury rates) to lower the cost of water infrastructure projects and accelerate water infrastructure investment. The program can be used for clean water and drinking water projects as well as water resources projects, and is open to local governments and utilities, state infrastructure financing authorities, and private entities undertaking public projects. The program targets larger projects (over $20 million), which typically cannot secure financing through state revolving funds.[14]

GREEN BONDS

In funding water infrastructure system developments in the U.S., whether in the eastern or western regions, "green bonds" are discussed with increasing frequency as a potential financing mechanism. Green bonds are broadly defined as fixed-income financial instruments that fund projects that generate some form of environmental benefit.[15] These bonds are usually viewed as attractive investment opportunities, since many are tax exempt and can be supported by high-quality credit ratings, similar to traditional revenue-backed or general obligation municipal bonds.[16] While the degree of environmental benefit provided by any particular green bond is debatable, the market for such bonds, collectively, has expanded dramatically in recent years (Figure V(C)(2)-3. This growth in capital markets private-side financing for public infrastructure projects suggests that investors, issuers, and underwriters alike are showing high levels of interest in the asset class and the associated environmental issues.[17]

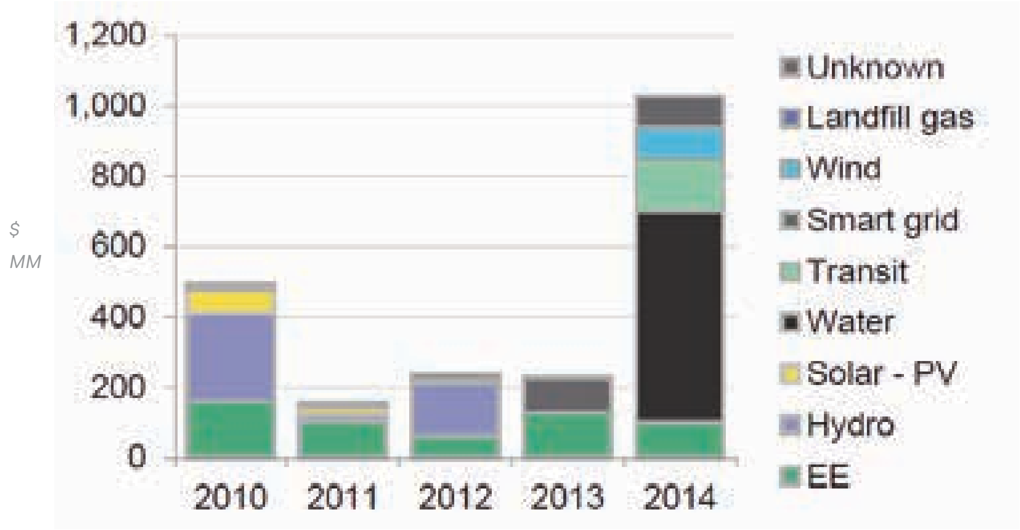


Figure V(C)(2)-3. U.S. State & Municipal Green Bond Issuance by Use of Proceeds ($MM). Source: Bloomberg New Energy Finance, December 2014.

14 President Signs Bill Creating New WIFIA Loan Program, Squire Patton Boggs LLP (June 2014).

15 Erin Carson and Eric Davis, State-Backed Green Bonds Emerge Following International Model, Issue brief, Enerknol, October 14, 2014. Web, 2.

16 "About World Bank Green Bonds," World Bank Green Bonds, World Bank Treasury, n.d. Web, December 10, 2014.

17 Bridget Boulle, Sean Kidney, and Padraig Oliver, Bonds and Climate Change: The State of the Market in 2014, Report of Climate Bonds Initiative, July 2014. Web, 10.

18 "Expanding Bond Market for Green Projects," JPMorgan Chase, n.d. Web, December 10, 2014.

Historically, green bonds were most commonly issued by supranational organizations, including the European Investment Bank (EIB), the International Finance Corporation (IFC), and the World Bank.[18] Today, green bonds are being issued with increasing frequency by municipalities and corporations, and via public-private partnerships.[19] The opportunity to use green bond funding is promising for projects that have the ability to generate cash flow as a means to repay the bond. Municipal bonds, for example, are often sold as serial bonds (rather than traditional or "term" bonds), to allow the issuer to match income with interest and principal repayment. Municipal serial bonds can also carry rate-reduction, or revenue-backed, repayment from a specific infrastructure project that is funded from debt proceeds. However, the terms of green bonds being marketed today are not meaningfully different from those of general obligation municipal bonds, whether they are generating environmental benefits or not. For this reason, smaller municipalities that most need improved water supply infrastructure, such as communities in the semiarid Colorado River Basin, cannot tap into traditional capital markets, despite measured environmental benefits that could be imposed on those regions when procuring supplemental water supply.

Moreover, current green bond issuances (Table V(C)(2)-1) are generally self-labeled as such by issuers and underwriters that classify as "green" what would be traditional general obligation municipal bond financings. While the underlying projects supported by these debt fundraisings are often environmentally less harmful than the alternatives, the net environmental benefit of many of these projects is essentially nonexistent, as these bonds are essentially funding traditional infrastructure projects that would have been built anyway. Similarly, while some green bonds include a second opinion regarding verification of the so-called "green" initiatives, typically no third-party monitoring is done to ensure that environmental objectives are met. Further, few of the stated green initiatives are ever tracked over time to see whether they met the environmental goals. For this reason, many environmentally-focused investors, NGOs, and foundations have not entered the current market of green bonds. Instead, they are opting to finance bespoke environmental initiatives, like facilitating water transfers by purchasing annual leases on water rights in critical areas.

Name of Issuer	Total Amount YTD ($USD)	Issue Month(s)	Maturity	Second Opinion
ANZ Bank	$ 440,697,536	June	2020	EY
Arizona State University	182,645,000	April	2036	No
Asian Development Bank	501,965,239	May, March	2018-2025	CICERO
Bank of America	600,000,000	May	2018	No
Berlin Hyp	546,284,501	May	2022	Oekom
Chicago Met Water	225,000,000	January	2044	No
City of St Paul	8,700,000	May	2034	No
City of Tacoma	21,095,000	March	2025	No
City of Venice, Florida	15,355,000	March	2035	No
Connecticut	250,000,000	May	2035	No

19 "Issuing Bodies," Climate Bonds Initiative, n.d. Web, December 10, 2014.

Name of Issuer	Total Amount YTD ($USD)	Issue Month(s)	Maturity	Second Opinion
Credit Agricole CIB	$ 21,974,120	February	2019-2020	Sustainalytics
DNB Bank	120,825,494	February	2020	DNV GL
EBRD	67,347,100	March, April, May	2017-2019	CICERO
EIB	1,795,018,439	January, February, March, April	2019-2026	No
Export-Import Bank of India	500,000,000	March	2020	No
Fortum Varme	286,132,268	May	2021-2022	CICERO
IFC	6,551,352	February, March	2017-2020	CICERO
Ile de France	546,284,501	April	2027	Vigeo
Indiana Finance Authority	239,715,000	February, March	2025-2035	No
Indiana University	58,960,000	January	2034	No
Iowa Finance Authority	321,530,000	February	2035	No
KBN	500,000,000	February	2025	CICERO
KfW	440,697,536	April	2020	CICERO
Massachusetts Development Authority	158,155,000	April	2045	No
Massachusetts State Clean Water	228,155,000	January	2028	No
Nelja Energia	54,628,450	June	2021	No
NIB	114,452,907	April	2020	CICERO
OPIC	88,750,000	January, March	2025-2033	No
Paprec	524,433,121	March	2022-2023	Vigeo
Rapid Holding	437,027,600	April	2020	No
Rikshem	80,117,035	May	2018	CICERO
San Francisco	32,025,000	May	2045	No
Stockholms Lans Landsting	206,015,233	May	2021	CICERO
TenneT Holdings	1,092,569,001	June	2021-2027	Oekom
TerraForm Power	800,000,000	January	2023	No
Transport for London	620,567,788	April	2025	DNV GL
Unibail Rodamco	546,284,501	April	2025	Vigeo
University of Virginia	97,735,000	April	2045	No
Vasakronan	45,781,163	February	2018	CICERO
Vestas	546,284,501	March	2022	No
Wallenstam	57,226,454	March	2019	DNV GL
World Bank	842,734,464	January, February, March, April, May	2020-2045	CICERO
Yes Bank	156,858,587	February	2025	No

Table V(C)(2)-1. U.S. Dollar Denominated Self-Labeled Green Bonds by Issuer, YTD August, 2015. Source: Climate Bonds Initiative, www.climatebonds.net/cbi/pub/data/bonds?items_per_page=All, Web, August 7, 2015.

As described previously, general obligation municipal bonds are frequently used to finance water-related infrastructure projects in major cities across the United States, and some of these are labeled as green bonds. For example, the city of Spokane, Washington, is using the proceeds of a $180MM green bond to finance projects that benefit the Spokane River as part of an effort to improve the city's water quality.[20] Similar to projects in Atlanta and on the Chattahoochee River, Spokane's green bond projects will address challenges related to a combination of sewer system overflow, wastewater treatment, and river contamination by untreated storm water runoff.[21] This Spokane Water Wastewater Utility bond is supported by the municipality's high-quality credit ratings, making it even more attractive to potential investors.[22]

Likewise, Chicago provides another example of the use of general obligation green bonds to finance water-related infrastructure improvements. In this case, the issue was managing flood risk; given Greater Chicago area's proximity to marshland, the city is especially susceptible to flooding.[23] In December 2014 the Metropolitan Water Reclamation District of Greater Chicago (MWRD) announced plans to issue a $225MM green bond to fund improvements in water-related infrastructure.[24] The water agency will direct bond proceeds toward creating and maintaining reservoirs and other mechanisms to control localized flooding, as well as to fund "some non-water related environmental projects" (yet to be determined).[25] Generally speaking, the benefits of these infrastructure projects are targeted to include both increased water recycling improvements and flood management capabilities.[26] While this municipal bond's "green" labeling and actual environmental impact are controversial and are being debated, its issuance also demonstrates continued investor demand for bonds that claim to finance projects addressing environmental issues.

The above examples illustrate green bonds used to fund relatively large water infrastructure projects backed by the full faith and credit of the issuing municipality. While the offerings have little focus on the infrastructure itself, or on the associated environmental outcomes, the general obligation of the municipality issuing the bond is a critical component to a successful issuance. With these large and growing municipalities comes a robust tax base that backs both the interest payments and the principal repayment of the bond, ensuring investors a secure and stable "bond-like" risk/return investment. In addition, the larger the size of the issuance, the more liquid a secondary trading market can be for any particular series of bonds, giving an asset manager the ability to quickly analyze and reallocate an investment portfolio as needed.

Currently, green bonds utilized for water-related projects comprise a relatively small portion of the total $3.7 trillion municipal bond universe,[27] especially after excluding the $300MM century bond that Washington, D.C., issued in July 2014. Still, the World Bank and several other organizations have issued water-related bonds that show promise for future green-bond–funded projects that aim to reduce climate-related impacts on water quantity and quality.[28] For example, a project executed between 2009 and 2015 in Tunisia employs

20 "Water Wastewater Utility Revenue Bonds Get High Ratings from Moody's, S&P," Spokane City, November 6, 2014. Web, December 18, 2014.

21 Ibid.

22 Ibid.

23 "Chicago Water Agency Plans $225 Million Green Bond, with More Expected," Environmental Finance, n.p., December 10, 2014. Web, December 18, 2014.

24 Ibid.

25 Ibid.

26 "Chicago Water Agency Plans $225 Million Green Bond, with More Expected," Environmental Finance, n.p., December 10, 2014. Web, December 18, 2014.

27 www.sec.gov/spotlight/municipalsecurities.shtml, Web, December 23, 2014.

28 Green Bond Sixth Annual Investor Update, Report of The World Bank, September 2014. Web, 3.

World Bank green bond funding to restructure damaged irrigation and drainage systems, as well as improve water management policies, with the goal of gaining increased efficiency in the use of irrigation to secure a more reliable water supply that's adaptable to future water scarcity challenges.[29] Similarly, NWB Bank, a Dutch financial services provider for the public sector, issued a $684MM green bond in September 2014,[30] whose proceeds are earmarked for projects focused on mitigating the effects of climate change, including improvement of flood protection and water management mechanisms.[31]

It is difficult to accurately size the overall market for green bonds because it is broadly defined and continuously expanding as they become a more prominent financing option. Climate Change Initiative's 2014 Bonds and Climate Change report projected that the "climate-themed bonds universe," which includes both labeled and unlabeled green and climate-themed bonds used to fund a wide variety of projects, totaled $503bn in June 2014.[32] This universe encompasses various types of bonds, including corporate self-labeled, green asset-backed securities, project bonds, sovereign and supranational bonds, and state and municipal bonds.[33] However, labeled green bonds comprised only $36bn of the total "climate-themed bonds universe."[34] The average bond size varies, depending on the category of the project being funded, ranging from $60MM for bonds funding waste and pollution projects to $466MM for bonds funding transportation projects.[35] Climate Change Initiative estimated the average size for green bonds that fund water-related projects to be $133.5MM in June 2014.[36] Trends suggest that the average size of green bonds will increase as the market progresses.[37]

Soon-to-be published research from the Harvard Kennedy School on the use of green bonds for land conservation highlights a series of eight questions to assess when a green bond may be appropriate. Applied to the water context, they are:

1. Does the issuer have a strong credit rating to make the bond palatable to investors? And/or is another party willing to backstop the bond?
2. Does the issuer include water management in its green bond criteria?
3. Is debt financing appropriate?
4. Does the scale of the bond issuance match the scale of the project?
5. Can returns from water benefits be clearly articulated and agreed upon in the market?
6. Is it possible to measure the project's impact, particularly if payments are tied to performance?
7. Is the policy and regulatory environment conducive?
8. Are the government and key stakeholders engaged and willing to collaborate?[38]

29 "Green Projects from Around the World," World Bank Green Bonds, World Bank Treasury, n.d. Web, December 10, 2014.
30 Q4 2014 Green Bonds Market Outlook, Report of Bloomberg New Energy Finance, October 10, 2014. Web, 19.
31 Ibid.
32 Bridget Boulle, Sean Kidney, and Padraig Oliver, Bonds and Climate Change: The State of the Market in 2014, Report of Climate Bonds Initiative, July 2014. Web, 4.
33 Q4 2014 Green Bonds Market Outlook, Report of Bloomberg New Energy Finance, October 10, 2014. Web, 3.
34 Bridget Boulle, Sean Kidney, and Padraig Oliver, Bonds and Climate Change: The State of the Market in 2014, Report of Climate Bonds Initiative, July 2014. Web, 4.
35 Ibid.
36 Ibid.
37 Hugh Wheelan and Daniel Brooksbank, eds., Green Bonds: The Future of Sustainability Financing, Report of Responsible-Investor/Bank of America Merrill Lynch, October 2014. Web, 37.
38 Carolyn Mansfield duPont, Jim Levitt, and Linda Bilmes, "Green Bond and Land Conservation: Navigating a New Funding Landscape", Harvard Kennedy School, manuscript in preparation.

In 2014 and further revised in March of 2015, JPMorgan Chase collaborated with several other banks to develop the Green Bond Principles (or the "Principles"), which outline criteria for improving transparency and investor confidence in the market.[39] The Principles are split into four components. The first discusses the use of proceeds of green bonds and recommends that projects funded by them should deliver well-defined environmental benefits that will be quantified and evaluated when possible.[40] The Principles also suggest a process for project evaluation and selection. They encourage the issuer to establish a system to place investments within the categories identified by the "use of proceeds" section and thoroughly review the environmental impacts of each project.[41]

A number of water supply infrastructure projects throughout the Colorado River Basin remain undeveloped largely as a result of the inability to obtain financing (or the perception that financing for potentially viable solutions is out of reach).

The Principles further provide recommendations for the management of proceeds, suggesting that the issuer carefully track proceeds and regularly and publically release information relating to the management process.[42] Finally, the Green Bond Principles advise issuers to consistently report on specific investments that were funded by green bond proceeds, including accurate measures of each investment's environmental impact.[43] These guidelines will serve both to hold issuers accountable for the projects they are funding and to better define and manage the growing market for green bonds, but do not set limitations or requirements for green bond issuance.

Another category of bonds worthy of mention are rate reduction bonds, since they show promise for structuring the growing green bond market. Rate reduction bonds, which originated in the 1990s when states began deregulating their electric utilities, are designed to securitize a pledged revenue stream by charging a fee to utilities consumers.[44] For utilities, it allows them to use future receivables to get money up front. As a technique it can provide numerous benefits, including increased flexibility and reduced costs for both ratepayers and the utility.[45] Securitized bonds also can potentially receive higher credit ratings than would normally be awarded when issued by lower-rated issuers.[46] Because a revenue-generating surcharge is denoted separately on ratepayers' bills, the securitization structure works most favorably when used to fund projects with clear public benefits, especially those with conservation conditions.[47]

Regardless of the structure, larger cities have proven the ability to independently issue green municipal bonds, but alternative bond structures are needed for smaller communities. Particularly in the Colorado River Basin, many critical water supply infrastructure projects, such as pipelines and aquifer recharge systems, are of a much smaller scale yet are nevertheless needed in cities that by themselves cannot match the creditworthiness of municipalities issuing traditional municipal green bonds. For this reason, a number of water supply infrastructure projects throughout the Colorado River Basin remain undeveloped largely as a result of the inability to obtain financing (or the perception that financing for potentially viable solutions is out of reach).

39 "Expanding Bond Market for Green Projects," JPMorgan Chase, n.d. Web, December 10, 2014.
40 Green Bond Principles, 2014. N.p., n.d. Web, January 13, 2014, 3.
41 Green Bond Principles, 2014. N.p., n.d. Web, January 13, 2014, 4.
42 Ibid.
43 Ibid.
44 Ibid.
45 Ibid.
46 Ibid.
47 Ibid.

IMPOSING BOND CONDITIONS

Although current examples of green bonds do not frequently contain express conditions requiring the achievement of particular environmental or sustainability goals, there is no reason that such conditions could not be built directly into the bond obligations. Most bonds contain a variety of conditions designed to improve the security of the bond for the bondholder. Where, as proposed here, a bond investment was premised upon the achievement of specific environmental objectives, conditions relevant to ensuring that those objectives were achieved could be built in to ensure the security of those obligations in a manner similar to conditions securing bond repayment.

One important restriction on those sorts of conditions will come into play where the municipality has pre-existing debt issued against its water infrastructure, which will typically contain conditions to protect existing bondholders from conditions imposed as part of a new debt issuance. For example, most bond documents contain rate-maintenance covenants and other customary system-related covenants. Most also mandate "Additional Bond Tests" that require minimum debt service coverage levels in order for additional obligations to be issued on parity with the outstanding debt. So long as those bond documents remain in place, new bonds would have only the rights and obligations available in the original bond resolution or bond indenture, and could not add additional duties or remedies available only to the new investors. However, it would be possible to issue new water system obligations as "subordinate lien" obligations, which can have a "new contract" with investors, though their payment priority would be junior to the outstanding obligations.

By contrast, if mitigation or sustainability projects could be brought on as separate from the existing "water system" (e.g. new infrastructure developed with an independent basis in rates), then a municipality would have greater flexibility. It would be free of its current borrowing documents and restrictions, could agree to more-tailored terms with a new lender or lenders, and could even incorporate some form of "project financing".

The enforcement of specific bond conditions is another important consideration. In most cases, water system bonds and other obligations have no mortgage liens on any system assets (other than certain equipment lease purchase obligations that are typically issued outside the formal revenue bond or obligation process). Therefore there is little statutory authority for municipalities to mortgage public property on the occurrence of a default, except in a lease-purchase financing where a lease may be terminated after a default. In some cases, bond resolutions may provide for an acceleration clause on the occurrence of a default, but in practical terms there is usually little practical way to realize upon an acceleration, given the rate increases that would be required. Appointment of a receiver for the system is another common remedy. Particularly in the case of a financing issued by multiple parties, careful thought needs to be given to the design of enforcement terms that can be practically pursued in the event of default on either financial or environmental conditions.

Some bond resolutions, especially for bonds sold to or loans made by banks, do provide for an increase in interest rate during the occurrence of an event of default, which has been the primary "hammer" for investors. If a sustainability bond were done within the context of a current "water system bond" context, punitive interest rates would seem to be the only practical enforcement remedy, unless the project being financed were undertaken via a government-imposed consent decree or other order. However, in the case of environmental and sustainability conditions, the investor could also potentially tie conditions together with the requirements of environmental permits and other authorizations required for the legal operation of water facilities, increasing the potential for enforcement.

3. Proposed Solution

Because obtaining funding for water projects with environmental benefits can be difficult for some municipalities via traditional fundraising channels, a more adaptable strategy should be implemented to develop and finance green solutions that address water scarcity in the Colorado River Basin.[48] This new strategy would capitalize on the following:

i. The growth and overall volume of green bond issuance to date (demand by signifying issuer, private investors, and underwriter for transactions with "green" labels);

ii. The backlog in municipal water infrastructure projects associated with small to mid-size communities;

iii. The existence of stalled or disregarded water supply infrastructure projects (or enhanced approaches to traditional projects) with the potential for positive environmental outcomes that lack a secure funding source;

iv. The general stability of municipal-backed infrastructure projects and the potential to "ring-fence" proceeds from projects engineered to increase water supply (traditional ratepayer financing with general obligation guarantees);

v. The ever-increasing need for environmentally-focused water supply projects in semiarid regions of the Colorado River Basin; and,

vi. The willingness of foundations and other impact-focused investors to purchase annual leases or permanent rights to water for environmental benefit.

Given the water supply infrastructure needs of mid-size municipalities and the investor demand associated with green initiatives explained above, there is a clear funding gap that could be bridged with a properly structured financial product. This product would be similar to "project" or "double-barrel" municipal bonds (whereby ratepayer proceeds from the water infrastructure project are pledged to the bond, and a credit enhancement exists as these debts are backstopped by a municipal guarantee). In essence, the product would combine the applicable characteristics of (i) green-labeled municipal bonds, but with actual environmental conditions; (ii) project bonds in regard to the focus on an individual project and ring-fenced repayment; and (iii) double-barrel bonds by featuring an enhanced credit quality as a result of ratepayer funding and a general obligation backing from a collection of municipal entities.

As outlined below, this financial product would primarily target water supply infrastructure needs in midsize communities of the Colorado River Basin. The objective of the product would be to facilitate the construction of currently stalled or disregarded projects (or planned projects with disregarded

48 Drinking Water Infrastructure: An Advocate's Guide, Report of American Rivers, July 2013. Web, December 16, 2014, 4.

enhancements that would improve environmental outcomes). The structure and demonstration of the product would also encourage the creation of additional projects that generate legitimate environmental benefits, while also being economically sustainable and transparent as to the use of proceeds.

This new form of double-barrel municipal bond financing would explicitly impose conditions that support sustainable and environmentally beneficial outcomes as key components of the terms of the loan. This “green conditionality” would also be assessed and monitored to evaluate issuer performance and to trigger default scenarios in the event of noncompliance. In each case, the environmental benefits or enhancements associated with the infrastructure would be guaranteed through legally binding conditions on the bond issuer and beneficiaries of the infrastructure. Where appropriate, to mitigate credit quality issues and ensure buy-in to collective water benefits, the product could be used to finance shared infrastructure among multiple jurisdictions, and also legally bind the beneficiaries of the water supply infrastructure to repay the debt under an inter-governmental agreement (“IGA”), such as a joint exercise of powers agreement (“JEPA”).

This environmental stipulation would hopefully attract the wave of investors interested in truly “green” projects, and could also be used to encourage needed coordination among water users (such as multiple municipalities) to develop larger, regional partnerships around shared water infrastructure through IGAs. These IGAs would also act as enhanced default-risk security for the investor, and would hold all beneficiaries accountable to generate sustainable, environmentally beneficial outcomes in the regions that suffer from a limited direct water supply.

Particularly with regard to small to midsize communities without easy access to traditional financing, these new green double-barrel debt products could provide a way to effectively drive implementation of environmentally beneficial municipal infrastructure, implementation of sustainability policies, and/or implementation of enhanced environmental mitigation requirements that would substantially exceed what could reasonably be expected to occur in those communities via traditional financing. These structures could also help municipalities move beyond the piecemeal or “Band-Aid” approaches to the construction and financing of needed water infrastructure.

It should be noted that, to the extent that an investor takes the position of a lender in a conventional municipal transaction (e.g. having no equity interest), transactions can also be potentially structured as a tax-exempt loan to a city. The key tax-exempt bond concept is whether more than 10% of the bond-financed property is deemed to be used in the “trade or business” of a nongovernmental entity; if not, it will potentially qualify for tax-exempt treatment.

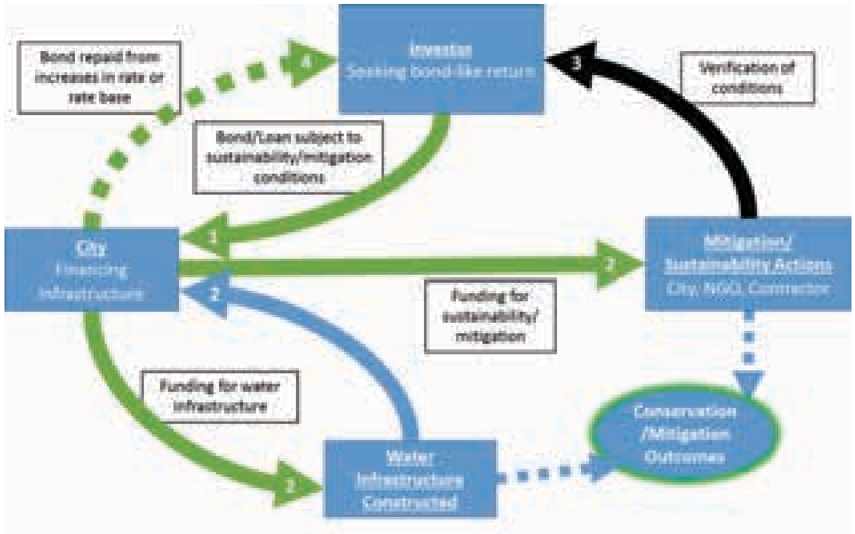


Figure V(C)(2)-4. Structure of Green Bond with Sustainability Conditions.

HYPOTHETICAL CASE STUDY EXAMPLE

A City is located along a small, perennial river system supported by a large basin-fill aquifer. The City has grown significantly in the past two decades, tripling its population over this period. Most of this development has occurred in the form of small subdivisions, some of which were initially supplied by private water companies that have been subsequently acquired by the City or that it is in the process of acquiring. The City is almost entirely supplied by groundwater wells drilled at various places, including some close to the river and numerous deeper wells drilled into the regional aquifer.

The City continues to experience rapid growth, although concerns about the sustainability of its water supply are becoming more acute. The City has also already accumulated significant debt to finance roads, schools, water treatment plants and distribution/collection systems, not to mention other infrastructure necessitated by its rapid growth. Numerous subdivisions are planned, and some have already been platted, along the edges of the City's growth areas. Towns, adjacent to the City (upstream and downstream) are also experiencing significant growth, as are unincorporated areas of the surrounding County. All this growth is expected to be groundwater dependent, and will require installation of yet more wells to service the growing populations. In addition to the municipal use, there is some groundwater-dependent farming in the surrounding areas that adds to the pressure on the water supply.

Groundwater pumping by the City, the Towns, and the development in surrounding areas, together with the farming operations, substantially exceeds local recharge and has resulted in the formation of a significant cone of soil depression as well as a substantial accumulated groundwater pumping deficit. As a result of these impacts, stream flows have already declined and are projected to decline further in the near future, possibly drying up the river completely within several decades. This will threaten important environmental and recreational values associated with the river, and will also harm downstream surface water claimants, who may be in a position to litigate against the City in the event that their rights are lost. Recognizing the long-term threats associated with groundwater pumping, the City and the adjacent Towns have launched and promoted voluntary water conservation programs, yet per-capita water use rates remain relatively high in the City and outlying areas.

A hydrological investigation and feasibility studies that the City undertook, with assistance from the U.S. Bureau of Reclamation, have suggested that the City could construct a new water supply pipeline to import water from a neighboring area that has available surface water supplies. This would provide water for some level of new growth and help to offset existing depletions of the regional aquifer. In addition, feasibility studies have suggested that the City could construct a near-stream recharge network, forward of the leading edge of the current cone of depression, in order to prevent the further expansion of the cone of depression and resultant damage to the stream. The recharge network could be supplied by a combination of effluent from the City's water treatment plant and stormwater harvested from the City's developed areas. This strategy would effectively "wall off" the floodplain aquifer of the river from the existing cone of depression, thus maintaining stream flows and preventing the cone of depression from intercepting the aquifer.

In this hypothetical case study example, the pipeline project will cost the City an estimated $50MM, and the recharge network is estimated to cost an additional $30MM. Installing the pipeline in isolation without the recharge network would potentially only serve to allow the City to grow further on its new supply, without addressing its existing groundwater deficit. Similarly, while the recharge network would serve to prevent impacts to the stream system, in the absence of efforts to successfully control existing groundwater overdrafts and remedy past accumulated groundwater deficits by reducing per-capita water use and capping future water demand in the City and/or outlying areas, it would only buy time for the City. Continued overdraft and expected future demand growth would eventually overwhelm the underground "buffer" that the recharge network would create.

HYPOTHETICAL TRANSACTION

1. The City, the Towns, and the County form a regional financing entity pursuant to a Joint Exercise of Powers Agreement ("JEPA") to construct and operate pipeline and recharge network infrastructure; the JEPA is capable of issuing tax-exempt bonds for infrastructure financing.

2. An investor seeking a bond-like return with environmental sustainability conditions offers to provide infrastructure financing to the JEPA entity as a green bond issuer. This financing is contingent on a contract that promises repayment in the form of interest and principal associated with rate payments generated from beneficiaries of the infrastructure (City, Towns, and County), backed by a general obligation shared among the JEPA entities, as well as meeting a set of sustainability performance criteria (described below) that will both benefit the river and help to ensure the repayment of the bond.

3. The investor and the JEPA entities negotiate a series of sustainability conditions that are incorporated into the funding agreement, including the following:

    a. Both the proposed pipeline and recharge network must be constructed and operated concurrently, with the costs of both and their associated repayment built into the rate structures charged to the various municipal customers of the City and the Towns. The County additionally agrees to commit a portion of property tax revenues from unincorporated areas to the bond repayment, equivalent to the net costs to municipal customers.

    b. The City and Towns each commit to supply water to the recharge network from municipal effluent and from integrated storm water development planning. In addition, they agree to shut down and relocate certain major wells currently located in the floodplain aquifer.

    c. The City and Towns each commit to affirmative conservation programs that will bring per-capita water use rates down to a level that will eliminate current groundwater deficits. The parties also agree to purchase or record conservation easements over the farmland in the area to reduce agricultural water use. In combination, these measures will bring aquifer withdrawals under control.

    d. The City, Towns, and County jointly agree to adopt and maintain a set of integrated land-use controls that will impose mandatory low-water-use criteria into building requirements in their respective jurisdictions. In addition, these land-use controls will incentivize future development to occur well away from the river by establishing a “buffer zone” in which densities are lowered unless water is supplied by nongroundwater sources. Higher densities are offered at greater distances from the river.

    e. The JEPA entities further agree to an offset program in which net groundwater use will be capped within their jurisdictions at levels that will maintain better-than-safe-yield withdrawal rates for the life of the bond.

4. Provided that the sustainability criteria are met, the investor agrees to provide a favorable interest rate for the financing that reflects the fact that (a) environmental benefits will be generated by the overall strategy, (b) there is significantly reduced water supply and regulatory risk due to the protection of the river, and (c) despite the debt burdens of the jurisdictions, there is far lower risk that the bond will not be repaid because local water supplies will be sustainable and will support continued growth. In the event criteria are not met by any party or parties, interest rates are raised against the offending party or parties, and other potential default criteria also go into effect.

5. The JEPA entity funds the construction of the pipeline and recharge network infrastructure, using the proceeds of the bond. The JEPA jurisdictions also adopt required sustainability and environmental conditions as specified by the terms of the agreement.

6. Contractors or environmental consultants verify that sustainability conditions are implemented and met, and continue to notify the investor group and green-bond issuer of compliance status.

7. Through the collection of rate payments and/or user fees, the JEPA entity pays back to the investor both principal and interest.

4. Financial Model[49]

The illustrations below detail hypothetical cash flows for a 20-year financing vehicle that could be used to construct a pipeline and recharge network to manage water supply issues and protect stream flow, while imposing associated environmental conditions. The ability to generate income from the project depends on municipal-specific variables, the success of the project, and the base of rate-payers.

Given the variety of conditions that may exist, the primary purpose of this hypothetical example is to inform, on an illustrative basis, the types of costs and investor returns that might associated with a green bond with environmental conditions. Of course, the outputs do not show either the specific environmental stipulations imposed on the issuer or the default rates that may prevail. These conditions are assumed to be met, and default scenarios would be included in the legal agreements associated with the debt offering. Moreover, the specific infrastructure costs are not detailed with any level of accuracy; therefore, the total project costs will vary from what is described in the example on the following page.

49 This financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual project. The hypothetical transaction is fictitious and is only intended to provide some key line items interested parties might consider in assessing the potential for a green bond. Among other omissions, inflation, depreciation and tax considerations have not been diligenced for this notional financial model.

Figure V(C)(2)-5. Assumptions and Structuring for Municipal Green Bond [50]

Funding Parameters (Hypothetical Example)	
New Pipeline for Water Delivery	$50,000,000
Aquifer Recharge Network	$30,000,000
Total Project-level Costs	**$80,000,000**

Administrative Costs	
Underwriter/Admin. Fee[1]	$1,500,000
Legal Fee[1]	$1,000,000
Verifier Fee[2]	$500,000
Total Administrative Costs	**$3,000,000**

Timing and Structure of Funding	
Life of Project / Loan Term (Years)	20
Annual Debt Service Target (Level Service)[3]	$5,840,000
Bond Denomination	$5,000
Project-level Costs Incurred (Years)	10

Sources and Uses	
Sources	
Par Issue Amount	$83,000,000
Uses	
Total Project-level Costs	$80,000,000
Total Administrative Costs	$3,000,000
	$83,000,000

Potential Measured Outcome (Annual)[4]	
AF Increase in Watershed (Once Complete)	2,000
Price per AF	$1,100
Value-add from Increased Water	$2,200,000
Increased Rate-Payer Funding	$500,000

[1] Assumed to be paid over the first three years.

[2] Assumed to be paid over the life of the debt instrument.

[3] Flexed to set total capital raised at par equal to total "Uses".

[4] Hypothetical estimates. Actuals vary widely depending on watershed and municipality.

50 For tax purposes, the private investor will have interest income at ordinary rates unless the bond qualifies as tax-exempt.

Figure V(C)(2)-6. Debt Issuance and Repayment for Serial Municipal Green Bond[51]

Debt Table for Standard Debt Service (Serial Bonds)				
Year	Principal	Coupon	Interest	Debt Service
1	$4,150,000	0.92%	$2,464,270	$6,614,270
2	$4,150,000	0.92%	$2,426,090	$6,576,090
3	$4,150,000	1.68%	$2,387,910	$6,537,910
4	$4,150,000	1.68%	$2,318,190	$6,468,190
5	$4,150,000	1.68%	$2,248,470	$6,398,470
6	$4,150,000	2.94%	$2,178,750	$6,328,750
7	$4,150,000	2.94%	$2,056,740	$6,206,740
8	$4,150,000	2.94%	$1,934,730	$6,084,730
9	$4,150,000	2.94%	$1,812,720	$5,962,720
10	$4,150,000	2.94%	$1,690,710	$5,840,710
11	$4,150,000	3.78%	$1,568,700	$5,718,700
12	$4,150,000	3.78%	$1,411,830	$5,561,830
13	$4,150,000	3.78%	$1,254,960	$5,404,960
14	$4,150,000	3.78%	$1,098,090	$5,248,090
15	$4,150,000	3.78%	$941,220	$5,091,220
16	$4,150,000	3.78%	$784,350	$4,934,350
17	$4,150,000	3.78%	$627,480	$4,777,480
18	$4,150,000	3.78%	$470,610	$4,620,610
19	$4,150,000	3.78%	$313,740	$4,463,740
20	$4,150,000	3.78%	$156,870	$4,306,870
	$83,000,000			**$113,146,430**

Debt Table for Level Debt Service (Serial Bonds)				
Year	Principal	Coupon	Interest	Debt Service
1	$3,255,000	0.92%	$2,582,814	$5,837,814
2	$3,285,000	0.92%	$2,552,868	$5,837,868
3	$3,315,000	1.68%	$2,522,646	$5,837,646
4	$3,370,000	1.68%	$2,466,954	$5,836,954
5	$3,425,000	1.68%	$2,410,338	$5,835,338
6	$3,485,000	2.94%	$2,352,798	$5,837,798
7	$3,585,000	2.94%	$2,250,339	$5,835,339
8	$3,695,000	2.94%	$2,144,940	$5,839,940
9	$3,800,000	2.94%	$2,036,307	$5,836,307
10	$3,915,000	2.94%	$1,924,587	$5,839,587
11	$4,030,000	3.78%	$1,809,486	$5,839,486
12	$4,180,000	3.78%	$1,657,152	$5,837,152
13	$4,340,000	3.78%	$1,499,148	$5,839,148
14	$4,500,000	3.78%	$1,335,096	$5,835,096
15	$4,675,000	3.78%	$1,164,996	$5,839,996
16	$4,850,000	3.78%	$988,281	$5,838,281
17	$5,030,000	3.78%	$804,951	$5,834,951
18	$5,220,000	3.78%	$614,817	$5,834,817
19	$5,420,000	3.78%	$417,501	$5,837,501
20	$5,625,000	3.78%	$212,625	$5,837,625
	$83,000,000			**$116,748,644**

Figure V(C)(2)-7. Traditional Muni Financing for Midsize Municipality with Poor Credit Rating

Standard Comparison Table at "Market" Interest Rate				
Year	Principal	Coupon	Interest	Debt Service
1	$4,150,000	8.00%	$6,640,000	$10,790,000
2	$4,150,000	8.00%	$6,308,000	$10,458,000
3	$4,150,000	8.00%	$5,976,000	$10,126,000
4	$4,150,000	8.00%	$5,644,000	$9,794,000
5	$4,150,000	8.00%	$5,312,000	$9,462,000
6	$4,150,000	8.00%	$4,980,000	$9,130,000
7	$4,150,000	8.00%	$4,648,000	$8,798,000
8	$4,150,000	8.00%	$4,316,000	$8,466,000
9	$4,150,000	8.00%	$3,984,000	$8,134,000
10	$4,150,000	8.00%	$3,652,000	$7,802,000
11	$4,150,000	8.00%	$3,320,000	$7,470,000
12	$4,150,000	8.00%	$2,988,000	$7,138,000
13	$4,150,000	8.00%	$2,656,000	$6,806,000
14	$4,150,000	8.00%	$2,324,000	$6,474,000
15	$4,150,000	8.00%	$1,992,000	$6,142,000
16	$4,150,000	8.00%	$1,660,000	$5,810,000
17	$4,150,000	8.00%	$1,328,000	$5,478,000
18	$4,150,000	8.00%	$996,000	$5,146,000
19	$4,150,000	8.00%	$664,000	$4,814,000
20	$4,150,000	8.00%	$332,000	$4,482,000
	$83,000,000			**$152,720,000**

51 Coupon rates based on ValuBond data for 'A' rated municipalities.

Figure V(C)(2)-8. Illustrative Cash Flow Profile

Year:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Potential Income Streams [1]																				
Ratepayer Increase	$0	$125,000	$250,000	$375,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000
Increased Water Sold	$0	$550,000	$1,100,000	$1,650,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000	$2,200,000
Total Potential Income	$0	$675,000	$1,350,000	$2,025,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000
Operating Expenses [2]																				
Underwriter/Admin. Fee	$500,000	$500,000	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Legal	$333,333	$333,333	$333,333	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Verifier	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000
Project-level Costs	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$8,000,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenses	$8,858,333	$8,858,333	$8,858,333	$8,025,000	$8,025,000	$8,025,000	$8,025,000	$8,025,000	$8,025,000	$8,025,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000
Interest Exp. (Standard)	$2,464,270	$2,426,090	$2,387,910	$2,318,190	$2,248,470	$2,178,750	$2,056,740	$1,934,730	$1,812,720	$1,690,710	$1,568,700	$1,411,830	$1,254,960	$1,098,090	$941,220	$784,350	$627,480	$470,610	$313,740	$156,870
Interest Exp. (Level)	$2,582,814	$2,552,868	$2,522,646	$2,466,954	$2,410,338	$2,352,798	$2,250,339	$2,144,940	$2,036,307	$1,924,587	$1,809,486	$1,657,152	$1,499,148	$1,335,096	$1,164,996	$988,281	$804,951	$614,817	$417,501	$212,625

[1] Assumes ratepayer increase and annual increase in water sold is phased in at 25% each of years 2 through 5 to account for timing of infrastructure being built.

[2] Underwriting and legal fees are expected to be amortized over a three year period while the project comes on-line.

V(D). Market Development

Investment Blueprints

D. Market Development

As discussed above, the establishment of a functional "water market" is not necessarily a precondition to structuring and implementing effective impact investments in water. Nevertheless, assuming that they are properly structured, water markets could potentially be used to create significant systemic and environmental benefits that could help to address a number of important water management issues

In many cases, the current barriers to water trade point to a need for an active "market maker" to make water transactions possible. To accomplish this transformation, a key role for impact investment could be to facilitate the creation of these "market makers"—effectively creating the market-driven institutions that could spur more rational allocation of water as a scarce resource, and which could also create mechanisms to achieve other critical outcomes relative to the restoration of ecological health and function. In some cases, creating the conditions for market transactions will require explicit regulatory and policy reform. However, in other cases, the "enabling conditions" for market-style transactions can potentially be created on a contractual basis—within various contexts and at various geographic and institutional scales—even in the absence of explicit statutory authorization or support for particular types of transactions (and in certain cases, even in the presence of explicit legal prohibitions).

water users in a relatively small basin or confined geography can essentially set up small-area agreements in which water rights can be traded more freely

For example, in the absence of complete adjudications that clearly define water rights and the requirements for trade, legal certainty with regard to water rights can still potentially be achieved via (1) practical, physical, or legal restrictions on the utilization of lands and/or water that prevent additional diversions or well installations, and/or (2) agreements among individual buyers and sellers and their representatives regarding the relative nature and extent of their water rights and claims. Under this approach, water users in a relatively small basin or confined geography can essentially set up small-area agreements in which water rights can be traded more freely. Indeed, in the limited circumstances where markets do exist in the Basin, they tend to be built around similar "micro-settlement" agreements that determine and define the rights as between a discrete group of users (such as the landowners within a single irrigation district), Indian water rights settlements (which in many cases have a defined set of rights and obligations—as well as the conditions for lease transactions—within a particular region), or around the trading of entitlements among the users of shared local or regional infrastructure.

These conditions can potentially be replicated elsewhere through voluntary agreements or through the creation of common infrastructure and institutions required to facilitate trade. For example, a multiparty agreement could be utilized to grant a particular infrastructure project, transfer agreement, or mitigation action that creates shared benefit "hold harmless" treatment in the context of a future adjudication. In this instance, a "micro-settlement" or "mini-settlement" could be entered into between one or more downstream appropriators and one or more upstream appropriators facing legal uncertainty, such as groundwater users. Through such a mechanism, the specific levels of use or the specific mitigation actions sketched out in the mini-settlement are deemed acceptable within the rights of the parties, and are agreed to go uncontested in an adjudication or in other settings. These type of agreements could be used to manage current uncertainties regarding the management of groundwater-surface water conflicts between users (by establishing agreed-on pumping limits), the management of surface water diversions, or the implementation of common institutional or physical infrastructure for shared benefit, such as a mitigation bank, groundwater recharge or reuse infrastructure, or short-term trading to facilitate in-stream flow leasing, seasonal fallowing, or other "harmless" transactions.

Another potential mechanism for facilitating limited water trading, particularly in the absence of adequate state-level regulation, is voluntary inter-jurisdictional coordination among local communities. The authorities available to local jurisdictions and land use authorities can offer a variety of options for local regulation and management of water resources. Although individual regulations and programs need to be carefully tailored to avoid conflicts with state law, the potential scope of local control over water through land use planning and zoning, conservation requirements, utility operation, infrastructure construction, financing, incentives, and other means can be quite broad. Local control can be employed within a jurisdiction to establish simple trading opportunities and platforms—for example, a land use density-trading program that ties voluntary upgrades in land use density to the accomplishment of water-related objectives. The city of Santa Fe's water demand offset program, which required new construction to offset the water that new development would use through reductions in existing demand (via underwriting water conservation measures, such as retrofitting existing homes with low-flow toilets, or through the purchase of water rights through a city-operated water bank), is an excellent example of such an approach.

Local control can be employed within a jurisdiction to establish simple trading opportunities and platforms

If these types of controls can be coordinated between jurisdictions, they could also create the potential for broader, regional trading programs. Most western states (including Arizona, California, Colorado, Nevada, New Mexico, and Oregon) have a statute authorizing the joint exercise of government powers. While the details vary by state, these statutes generally allow specified political subdivisions to enter into intergovernmental agreements ("IGAs"), a common type of which is referred to as a Joint Exercise of Powers Agreement ("JEPA"). These tools have previously allowed local governments to conduct a variety of regional planning and coordination efforts relating to infrastructure without the need to organize a separate governmental body, such as a special district. Generally, the statutes will specify which governmental entities are permitted to be parties to the agreement, how the agreement is formed, and what action is required to authorize such agreements on the political body's behalf. Through IGAs, governmental entities can contract for services and exercise powers common to the contracting parties, either by merely acting jointly or by creating a separate legal entity. These types of agreements can also be used to coordinate local regulations, such as land use controls, buffer zones, and other regulatory requirements on an interjurisdictional basis, and could thus be used to ensure coordinated management of groundwater use controls across jurisdictions even in the absence of a comprehensive state regulatory program.

The investment tools below suggest several mechanisms that could be developed to provide a "market-maker" function in various contexts in order to accomplish reallocation, change water use, or otherwise generate transferable water while generating direct ecosystem benefits—even in the absence of otherwise required market "enabling conditions." These mechanisms focus on two key institutions—first, the development of a "next-generation water trust" to improve on and expand the potential scope and reach of the existing western water trust institution, and, second, the establishment of storage trading platforms within above-ground reservoirs and in underground aquifers to create a variety of market-driven benefits in these contexts.

SECTION V(D)(1):

Next Generation Water Trusts:
Facilitating Water Trade and Controlling Watershed Risks

Summary

This investment vehicle is structured to monetize specific reductions in ecosystem and economic risks that would be achieved through a broad-purpose "water trust," or through an alternative "cooperative trust" structure. This structure would facilitate water transactions within a local watershed, and make specific public-benefit investments that reduce risks to human and environmental users. The structure is intended to build and improve upon existing, well-tested traditional "water trusts" that are currently operating in many parts of the West, but that are presently almost entirely reliant on public funding, charitable support, and the presence of water market institutions - conditions that are not available in many areas of the West.

I. Background

As detailed in Section III(E) of this report, a challenge common in many Colorado River Basin stream reaches and their associated vegetation, fish, and wildlife communities is the lack of water availability during all or key portions of the year. This lack of water typically results from upstream dams, diversions, and/or drought conditions that may change the volume(s) and/or the timing of in-stream flows on a periodic or permanent basis. Taken together, the combination of reduced and altered stream flow conditions can result in unfavorable changes in stream temperatures, extreme low-flow conditions, or even dried-out stream reaches.

These poor stream flow conditions inhibit recruitment of native fish, create conditions that favor the success of non-native aquatic species, or can even cause outright loss of fish populations in particular stream reaches. Degraded or highly altered stream flow conditions may also cause the loss of riparian vegetation or significant long-term changes to riparian areas, including the spread of undesirable invasive species, such as the tamarisk tree.[1]

In combination, these changes may not only result in overall declines in fish and wildlife populations, but in declines in overall ecosystem health as well. In addition to their environmental impacts, these ecosystem changes can also increase regulatory risks to water users due to the imposition of controls to protect currently endangered or threatened fish and wildlife, and cause the temporary or permanent loss of recreational opportunities and related economic values in affected areas.

As noted in Section III of the background report, these issues relate not only to the growing overuse of water within the Colorado River Basin, but also to the fact that environmental values have little or no recognized "entitlements" to water in the Colorado River Basin. Where these entitlements do exist, they are typically associated with a few federal or state wildlife preserves, which may have individual water rights necessary to their operation, or regulatory mandates derived from the Endangered Species Act, which may require that diversions and dam operations be undertaken in particular ways to avoid impacts to endangered species. However, these flow mandates rarely extend beyond the bare minimum necessary for a particular species of interest, and are typically insufficient to protect a broader range of environmental and/or recreational values that may be associated with flows in that particular reach.

These inherent environmental risks are compounded in many Colorado River Basin watersheds by a growing suite of "system-level" risks resulting from growth in water demand, legal overallocation, overuse of water resources and groundwater pumping, and groundwater-surface water interaction problems that threaten the continued reliability of stream flows and associated water deliveries to water users. These system-level risks are only compounded by current and projected changes in precipitation levels and patterns in response to climate change, and landscape-level changes, including declining forest health, invasive species, and dust on snow that are adding further pressure on an already overstressed system. Taken together, these challenges are leaving an increasing number of human and environmental water users exposed to water supply risk.

In many cases, these risks threaten important economic values related to farming, energy, industrial manufacturing, and municipal demand that have become reliant on stable, reliable water supplies delivered primarily by manmade infrastructure. Many

1 See discussion in Section V(A)(2) with regard to proposed Environmental Impact Bonds for riparian restoration.

of these water users have a relatively low risk tolerance, and a substantially hardened demand, with few options to quickly substitute supply or otherwise reduce demand in response to potential water delivery shortfalls. Once built in buffers such as reservoir storage and groundwater supplies are depleted, significant reductions in water use may become necessary in order to avoid continued, rapid, reservoir declines that could result in potentially catastrophic shortages that could severely impact municipal, agricultural, and industrial users.

Section III describes how these risks are playing out at the Basin-wide scale in terms of declines in Lakes Mead and Powell and the substantial shortage risks now facing users in the Lower Basin. However, at smaller scales these same issues are generating similar, or potentially even greater, risks to water users in tributary watersheds. In fact, the past decade of drought has seen many tributary watersheds and sub-watersheds experience extremely significant shortfalls that have jeopardized local agricultural, municipal, and industrial users. In the Upper Basin, shortages occur essentially every year in some part of the Basin due to hydrologic variability.

While most water users engage in drought planning and explore options to substitute local supply or reduce demand in the face of drought conditions, options are frequently limited when users are exposed to larger "system risks" that are beyond their immediate control. As recognition of these system risks in the larger Colorado River Basin has grown, Basin stakeholders have worked together to shape a number of important policy measures to begin managing risks, including the adoption of the 2007 Interim Shortage Guidelines and the negotiation of Minute 319 with Mexico. However, these efforts, which were led by the federal government and certain state officials, have largely focused on the management of risk at the larger, interstate scale; efforts to manage risks at smaller watershed or sub-watershed scales across the Basin have not received similar attention.

In light of these developments, there is a clear and growing need for new, locally-governed and controlled institutions that engage proactively in local demand management activities to increase flexibility, help users adapt year-to-year, and manage growing systemic risks. Moreover, in an environment where the larger human use of water resources on a natural system already exceeds even the historical average yield of natural systems, construction of new artificial "buffers" (such as new reservoir storage) will not necessarily help to reduce risk. These kinds of capital-intensive projects, traditionally financed with federal subsidy and support, are also far more difficult to support in today's economic environment, and tend to be far more environmentally controversial than in the past. This further highlights the growing need to focus on improving controls on the use of water itself in order to create greater flexibility in demand in the face of inevitable, continued disruption.

2. Existing Approaches

Traditionally, "system risks" have been managed publicly through traditional, hard-path approaches such as constructing new dams, canals, and water infrastructure, altering existing reservoir operations, or by other more traditional approaches to water management. In many cases, however, these system risk issues in the Colorado River Basin can no longer be addressed simply through traditional means. The emerging "system risks" in the Basin reflect not just natural variability, but larger problems of the supply-demand imbalance resulting from population increases. This is coupled with the fundamental disconnect between built infrastructure that is designed to transform variable natural water supplies into predictable, stable water supplies and a system that is experiencing increasing levels of variability that depart from historical experience.

In most cases, new reservoir storage will not serve to augment existing supply; as noted in Section III, there are now significant tradeoffs at work in the Colorado River Basin between reservoir evaporation loss and the resilience created by storage, even setting aside environmental problems created by further alteration of stream flows. New canals and diversions conflict with already over-allocated systems. Buy and dry approaches to transferring water create economic tradeoffs between agricultural communities and urban users. Drilling new wells only increases pressure on already over-tapped supplies. Increased conservation can stretch existing supplies further, but does not solve underlying problems with increasing variability of water supplies and will not necessarily translate into more water for the environment. And, while current approaches to mitigating these risks vary from place to place and institution to institution based on place-specific physical, economic, and ecological challenges, for the most part, historical responses have focused primarily on reducing risks to individual water users, and not the long-term impacts to ecological systems.

WATER TRUSTS IN THE WEST

One institution that has emerged in recent years in the West to address ecological water needs is the "water trust." Water trusts are typically used to acquire water rights via outright purchases, leases, dry-year options, donations, or investments in water conservation in partnership with traditional users. Water rights are then dedicated to maintain flows for the benefit of fish, vegetation, and wildlife, particularly during low-flow periods when those flows might otherwise be jeopardized. There are active water trusts now operating within a number of Western states.

The term "water trust" is used to describe a diverse set of organizations. Some water trusts are nonprofit NGOs, while others are housed within state water resource departments. The focus of water trusts also varies from working exclusively on water transactions for the environment to facilitating inclusion of water rights in conservation land acquisitions, while some water trusts have no express environmental goal whatsoever.

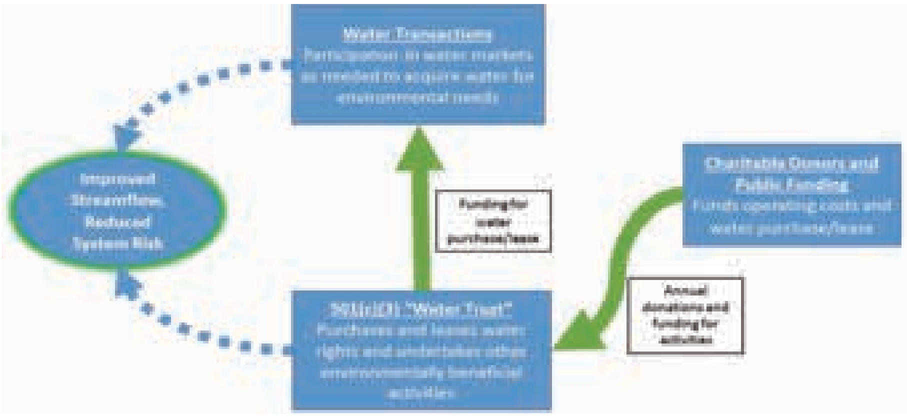


Figure V(D)(1)-1. Traditional Structure of a 501(c)(3) Water Trust.

Despite these variations, most water trusts that are not operated by a state agency are organized as 501(c)(3) non-profit organizations, essentially built around the traditional "land trust" model that has been widely used in the context of land conservation activities. A typical institutional structure for a water trust is shown in Figure V(D)(1)-1 above. It is also important to recognize that despite the use of the term "trust," essentially none of these organizations are set up as an actual "trust," rather, they generally rely on a typical non-profit governance mechanism to ensure that resources are used for the intended purposes.

A survey of existing Western water trusts demonstrates significant variation among these trusts and their activities; Table V(D)(1)-1 below provides an inventory and brief description of a number of existing Western water trusts. Much of this variation stems from the significant diversity among different states' regulation of water transactions and instream flow rights, including different approaches to the recognition and creation of instream flow rights, who can hold those rights, and the availability of temporary water transfer mechanisms. For the most part, this lack of uniformity, coupled with widespread restrictions on the interstate movement of water, has resulted in water trusts that operate largely within the borders of a given state. However, the web of regulatory constraints and opportunities has also spawned significant innovation as people work to develop institutional frameworks that support water transactions in these different contexts.

A significant limitation in the majority of existing water trusts is their reliance on an external regulatory driver (e.g. the Endangered Species Act) that generates requirements for mitigation and/or an associated public revenue stream (e.g. protections for salmon runs and hydropower revenues in the Pacific Northwest). These regular, predictable sources of funds enable these trusts to undertake market-based water rights transactions, and in particular, short-term water transactions (such as water leasing), on an ongoing basis. However, only some Western watersheds (and, as noted in Section II, very few areas of the Colorado River Basin) exhibit the enabling conditions for the types of market-based water transactions that many water trusts rely on, nor are meaningful external regulatory drivers available in all watersheds.

Water Trust	Description	Funding stream/strategy	ESA driver	Challenging market conditions	Requires conservation focus
Arizona Land and Water Trust	501(c)(3) under the management of a board of directors (BOD). The ALWT uses land acquisitions and conservation easements to secure water rights.	Secures funding through federal programs (Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS)), state programs (Arizona Game & Fish Department), county programs (Pima County Open Space Bond), and private foundations.		Yes	Yes

Water Trust	Description	Funding stream/strategy	ESA driver	Challeng-ing market conditions	Requires conserva-tion focus
Scott River Water Trust	501(c)(3) overseen by a BOD and advisory committee. The SRWT uses forbearance agreements with diverters to maintain instream flow in priority reaches.	Secures funding from federal and state programs as well as private foundations including the National Fish and Wildlife Foundation (NFWF).	Yes		Yes
Colorado Water Trust	501(c)(3) under the management of a BOD. The CWT facilitates transactions by acquiring water rights, sheparding them through water court and conveying decreed instream rights to the Colorado Water Conservation Board (CWCB).	Secures funding from state programs (CWCB, Colorado Parks and Wildlife), water conservation districts, hydropower entities, and private foundations.		Some	Yes
Park County Land and Water Trust Fund	County entity, board members appointed by county government. Main focus in water security for Park County. Acquires land and develops conservation easements in sensitive watersheds.	Receives a 1% sales tax from the county which is paired with state funding (Great Outdoors Colorado), Colorado Open Lands), as well as federal programs (NRCS, USFWS, U.S. Geological Survey (USGS)).		Some	
Clark Fork Coalition	501(c)(3) organization with a BOD. The CFC acquires and leases water rights, and develops diversion reduction agreements.	Secures funding from Bonneville Power Administration through NFWF and the Columbia Basin Water Transactions Program, as well as local, state, federal and private foundation sources.	Yes		Yes
Great Basin Land & Water	501(c)(3) incorporated in Nevada and based in California, with projects in Utah, Nevada, and Arizona. Acquires instream water rights as well as land acquisition.	Secures funding from state and local entities as well as the federal government.	Yes	Some	
Nevada Land Trust	501(c)(3) with a typical BOD. Acquires land with the goal of improving stream function and restoring riparian habitat.	Secures funding from local, state, and federal programs as well as partnerships with NGOs.		Some	

Water Trust	Description	Funding stream/strategy	ESA driver	Challeng-ing market conditions	Requires conserva-tion focus
Middle Rio Grande Endan-gered Species Collaborative	Formal collaborative between 17 local, state and federal entities. Acquires water and manages habitat restoration.	Federal funding with state and other non-federal match.	Yes	Some	Yes
Middle Rio Grande Conser-vancy District Water Bank	Legislatively created Con-servancy District, managed by BOD. Water can be leased from the Bank for a variety of uses.	Lease prices are set based on anticipated willingness to pay.		Some	
The Freshwater Trust	501(c)(3) managed by a BOD and an advisory council. Utilizes split-season leases, full-season leases, time limited transfers, point of diversion transfers and donations.	Most water transactions are funded by the Columbia Basin Water Transactions Program in addition to state, federal programs, founda-tions and earned revenue.	Yes		Yes
Deschutes River Conservancy	501(c)(3) managed by a BOD consisting of numer-ous stakeholders. The DRC leases water, promotes conserved water, and acquires water.	Most water transactions are funded by the Columbia Basin Water Transactions Program in addition to state, federal programs, founda-tions and consulting fees.	Yes		Yes
U.S. Bureau of Reclamation Klamath Basin Leasing Pro-gram	Run by USBR and autho-rizes short term leases throughout the basins to restore flows in dewatered stream reaches.	Funded by the federal government.	Yes		Yes
Trans Pecos Water and Land Trust	501(c)(3) managed by an eight-member BOD. The TP-WLT acts as an agent/facili-tator to acquire water rights to deposit in the state's water trust program or to dedicate to instream flow.	Secures funding from NFWF, USFWS, private foundations and state programs.			Yes
Washington Water Trust	Neutral, nonregulatory 501(c)(3) managed by a BOD. It works closely with Washington Department of Ecology to facilitate water right transfers that benefit and restore instream flow.	Funding from the Columbia Basin Water Transaction Program, state programs, private foundations and partnerships with NGOs and tribes.	Yes		Yes

Water Trust	Description	Funding stream/strategy	ESA driver	Challenging market conditions	Requires conservation focus
Walla Walla Watershed Management Partnership	Broadly, WWWMP assists right-holders with evaluating and pursuing options for sale, lease, or banking of water under the pilot program.	Funding from the Columbia Basin Water Transaction Program, state programs, and local entities.	Yes		Yes
Washington Water Project of Trout Unlimited	A project of Trout Unlimited, which is a 501(c)(3). The organization acts as a facilitator for instream acquisitions, then transfers to state trust program.	Trout Unlimited provides funding for program activities, with funding assistance from federal, state, local, and NGO entities.	Yes		Yes

Table V(D)(1)-1. Water Trusts in the Western United States.
Note: The table above is based on a survey of trust organizational types, enabling conditions, and transaction types covering 12 western states. Source: Squire Patton Boggs, Survey of Western Water Trusts, 2014.

Unlike in the Pacific Northwest, where the need to protect anadromous fish runs (i.e. salmon and steelhead) have driven significant, ongoing flow mitigation requirements and relatively stable revenue streams from hydropower operations, endangered species issues in the Colorado River Basin have not generated a similarly comprehensive set of flow mitigation requirements. Where flow requirements exist in the Basin, they tend to be focused on the rules governing the operation of single reservoirs, rather than on ensuring consistent, desirable flows throughout the mainstem, upstream tributaries, and headwaters areas. Moreover, while federal hydropower revenues are used in support of various environmental programs in the Basin (such as the Upper Basin Endangered Fish Recovery Program), in the absence of broad flow mitigation requirements, the Basin has not generated comparable scales of reliable, ongoing sources of public money that could be directed to support water trust-style transactions.[2]

Figure V(D)(1)-2. The Cienega de Santa Clara wetland in Mexico. Water from the Colorado River Delta water trust was used to augment flows to the wetland as part of a 2010 international agreement. Photo credit: Peter W. Culp.

2 Mike Jolliffe, "Considerations for Ecological Flow Transactions" (presented at the Water Markets Design Workshop, Bren School of Environmental Science and Management, UCSB, November 8, 2014); Amy Beaty, "Colorado Water Trust" (presented at the Water Markets Design Workshop, Bren School of Environmental Science and Management, UCSB, November 8, 2014).

A related limitation of the current water trust approach is that the need to maintain water in-stream for environmental purposes typically varies year-to-year based on the natural availability of water in the watershed. In response, many water trusts have preferred to lease water rights in particular years and at particular locations where augmented stream flows are necessary or desirable (such as during dry years), rather than purchase water rights outright for dedication to instream flow (since those rights may not contribute significantly to in-stream environmental values during normal or higher-flow years). Some economic studies have verified that this short-term leasing approach is in many cases more economically efficient at generating in-stream benefits than engaging in the long-term purchase and retirement of water rights to instream flow, and as noted in Section II, several states permit these temporary leases or allow for forbearance-driven approaches that lend themselves to the use of temporary transactions.

In the absence of a steady supply of public funding, most trusts currently rely on philanthropic sources of support. These non-profit resources for water trust funding are extremely limited in scope and scale, however, and of course vary in response to larger economic conditions. Given the limited resources available in the charitable sector, foundations and other philanthropic funders are hesitant to fund ongoing, revenue-intensive activities like water leasing – particularly given the relatively high cost and inherently short-term environmental benefits associated with these programs. As such, leasing activities are unlikely to prove to be sustainable for water trusts, at least at large scales, outside of environments like the Pacific Northwest where trusts can access large, stable sources of public revenue that are dedicated for this purpose.

Most existing trusts also rely upon the existence of substantially-complete market enabling conditions (i.e. instream flow transfer laws, short-term leasing rules, groundwater controls, etc.). Therefore, existing trusts function more commonly as “market participants” rather than as “market makers.” In many watersheds, however, the development and operation of a “market maker” institution will be a precondition to many types of traditional water trust-style transactions. For example, in many western watersheds, ongoing uncertainties related to incomplete stream adjudications, uncertainties regarding the scope of surface water rights (e.g. consumptive use vs. diversions), the bifurcated treatment of surface water rights and groundwater uses, the absence of existing “market” mechanisms, and the difficulty of undertaking instream flow transfers have burdened efforts to set up water trusts along the lines of the successful models used in other states and countries. Where these issues exist, a “market maker” institution will be needed to generate the sorts of transferable interests or instream flow guarantees at the scale needed to support trust operations.

A final, and perhaps the most important limitation of traditional water trusts, relates to scalability. Even at the scale that these trusts are presently operating, the largest water trusts are controlling only a tiny fraction of the water yield of particular basins. While these flows make an important or even critical difference to ecological values in high-order, small-flow tributaries, they would need to be significantly scaled up in both volume and geographic extent to produce watershed-level benefits in an environment like the Colorado River Basin – requiring investments that would likely far exceed the interest and ability of philanthropic sources to generate. This problem of scale was highlighted at a recent conference at UCSB that focused on environmental water market transactions.

SYSTEM RISK MANAGEMENT APPROACHES

It is also important to note that at present, the majority of water trusts in the U.S. are narrowly focused on the maintenance and protection of a single dimension of value in the watershed – environmental flows. This focus has limited both the demand for transactions to be undertaken by water trusts and the funding opportunities for those activities. While there is a growing interest in managing risks that affect a much broader range of municipal, agricultural, environmental, and hydropower generation values via system-level actions, current water trust institutions generally lack both the scale and mandate to address these broader issues.

In recent years, several examples of "collective" or cooperative efforts to manage system risk have arisen at the Basin-wide scale. For example, in 2014, four major municipal water suppliers in the Colorado River Basin (the Metropolitan Water District of Southern California, the Southern Nevada Water Authority, the Central Arizona Project, and Denver Water), in cooperation with the U.S. Bureau of Reclamation established a demonstration scale Colorado River System Conservation Program. Based on an $11 million contributed funds agreement, the program will pay for voluntary, compensated reductions in the consumptive use of Colorado River water that would result in net decreased depletions from the Colorado River mainstem.[3] These reductions are intended to include a variety of different approaches, including fallowing or deficit irrigation programs on irrigated agricultural lands, investments in enhanced municipal conservation, or reductions in industrial use.

Figure V(D)(1)-3. The Laguna Grande riparian restoration site in the Colorado River Delta, Mexico. Water needed for restoration activities at the site are provided by the Colorado River Delta Water Trust, a water trust operating in the Mexicali Valley of Mexico. Photo credit: Peter W. Culp.

Importantly, rather than resulting in a transfer of water from one party to another, conserved water from the program was explicitly intended to be retained in the Colorado River as "system water," which would not be credited or attributed to any particular Basin, state, or water user (essentially similar to water held by a traditional water trust for public benefit).[4] This "system water" would be held back in order to buttress the volume of water in storage at Lakes Powell and Mead, creating potential ancillary benefits to hydropower, environmental and recreational uses, and other flow-related values along the way. Although the funds provided for the program are relatively modest, they are intended to develop and test the viability of this "system conservation" approach as a tool to manage risks to water users in the Basin. The program will work in combination with other measures under consideration to mitigate and control declines in Lakes Powell and Mead, and help to avoid crossing critical thresholds in the system reservoirs.

Another example of a "system" risk management approach that has emerged in recent years is the development of water banks, a handful of which have been set up in Western states on a small scale. Water banking generally refers to a managed program in which the use of water rights by particular users – in the form of surface water, groundwater, or storage – can be restricted or reduced in exchange for some form of compensation. The resulting savings is then "banked", or pooled together, for re-delivery or use by other users, or to meet some sort of mitigation requirement or system-level need. Water banks can also serve functions such as (i) verifying the qualifications of water rights that can be banked and the quantity of water that is actually saved in a transaction that can be credited to the bank; (ii) establishing contract terms; (iii) facilitating regulatory compliance; and (iv) managing transactions and banked water to meet system reliability objectives. In this way, banks can be used to ensure the availability of supplies during dry years; maintain environmental flows to protect in-stream values; promote water conservation by establishing mechanisms to deposit conserved water in the bank; or ensure compliance with interstate agreements.

Given that water banking typically requires use of storage, it is usually most appropriate in systems where there is existing storage capacity available to facilitate the program. For this reason, water banking is also normally described within programs that function at a larger scale, not just water allocation initiatives that function within a single irrigation district. Banking arrangements also typically require

3 Bureau of Reclamation, "U.S. Department of the Interior and Western Municipal Water Suppliers Developing Water Conservation Projects as Part of a Landmark Collaborative Agreement," October 8, 2014, http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=48006.

4 Ibid.

some sort of agency or institution administering the water rights involved in the role of a broker (soliciting buyers and sellers) or a market maker (connecting buyers and sellers in a balanced fashion).

The proposed Upper Basin Water Bank provides an example of an effort to use water banking to drive a larger program of basin-wide demand management across all water use sectors. This bank, which would store and maintain a strategic water reserve in Lake Powell and possibly other Colorado River Storage Project (CRSP) reservoirs, would rely solely on the use of voluntary, market-based mechanisms to generate "deposits" of reduced consumptive use from irrigated agriculture. These mechanisms could include payments to irrigators to temporarily reduce consumptive use of Colorado River water, and the "saved" water could then be shepherded from its historic point of diversion to Lake Powell or into other CRSP reservoirs. While funding mechanisms are still under discussion, one possible source of payments would be contributions from existing water users that would otherwise be exposed to water risk. Once established, the bank could also benefit from other demand management efforts involving urban and industrial users. Taken together, the bank would function to increase the security and reliability of existing and potential new uses of Colorado River water in the Upper Basin in the face of increasing hydrological variability and drought potential, protect the power pool at Lake Powell and the lowest municipal intake at Lake Mead, avoid Colorado River Compact-related conflicts between the Upper and Lower Basins, and (potentially) help to ensure healthy flows in Upper Basin streams and rivers, particularly during low-flow conditions.

To date, however, efforts to manage system-level water risk have been largely reactive -- undertaking interventions to reduce demands or otherwise control risk only in response to impending critical conditions in reservoirs. Interventions are also subject to political realities, and many government institutions are unable to move quickly or effectively. For example, the System Conservation Program discussed previously took more than 18 months to negotiate and will create only a small fraction of the system water that Bureau of Reclamation models suggest are needed to meaningfully reduce the risk of shortages. The consequence of continued delay in making interventions can leave both municipal and agricultural users exposed to significantly greater levels of system risk that may be even more difficult to manage locally, and can also require substantially larger interventions in the future. In water systems with extensive storage, such as the Colorado River Basin, reservoir impacts are cumulative, such that waiting to intervene until storage levels have declined further can then require even greater cutbacks to prevent catastrophic shortages. In addition, while some system risk management approaches may eventually develop at larger scales in the Basin under federal and state leadership, they are not likely to translate into smaller scale projects, as local water issues cannot be expected to gather the same high level of attention that has driven federal or state interventions at the basin scale.

Existing approaches have also largely failed to address environmental risks, and these system risks create significant concerns of even greater instream flow disruptions in the future. As noted above, there are few recognized environmental "entitlements" present in watersheds, and also relatively few environmental controls on flows. Most environmental values in the system thus depend on flows whose scheduling and volume are driven by water deliveries for human use and hydropower generation, or, as in the Colorado River Delta, persist on system "waste," such as agricultural drains, accidental releases, or effluent, that are a byproduct of those uses.

As human users come under increasing stress in the face of shortages and drought, there are strong incentives and pressures to alter these flow regimes in order to ensure the continuation of human over environmental uses. For example, in the face of the ongoing drought in California, agricultural users in Central California have been pushing Congress to carve out exceptions to environmental laws that constrain the movement of water out of the California Sacramento-San Joaquin Bay Delta in order to ensure water deliveries through the Central Valley Project.[5] Even in the absence of efforts to curtail environmental protections, investments in increased efficiency undertaken in response to shortage conditions may reduce or eliminate current waste streams on which many ecological values rely. Taken together, these pressures can create major ecosystem water supply "bottlenecks" that can result in significant and potentially irreversible ecological damage in very short periods of time.

In this context, ensuring that at least a portion of the water available in the system is associated with uses that can be flexibly turned "on" or "off" in response to changing hydrological conditions – without causing substantial economic or ecological disruption, or requiring large-scale, heavy-handed government intervention – will be key to improving the long-term reliability of the natural water supply to the less risk-tolerant users in the watershed. Such flexibility could also be used to guarantee key environmental flows in various parts of the system.

3. Proposed Solution – Next Generation Water Trust

A "next generation" water trust would provide a mechanism to overcome some of these important limitations in both existing trust models and existing approaches to system risk management, and also catalyze capital towards making investments that would help to improve a range of ecosystem, economic, and social risks currently associated with water in Western watersheds. To accomplish this, the proposed "next generation" water trust would incorporate several additional layers of activity into the existing water trust model:

1. Increase the range of public values and associated system risks that the trust is designed to service through the deployment of portfolios of water assets, dry-year options, and/or system storage, such as:

    a. Engaging in transactions or deploying trust assets to maintain desired flow levels to downstream municipal or agricultural diversions during low-flow conditions, and/or to maintain instream flows for environmental values or recreational users;

    b. Purchasing rights in order to provide for ongoing "system ownership" of a portion of the total water rights and entitlements in the system to control overuse during periods of hydrologic variability and discourage the overdevelopment of system water resources;

    c. Engaging in transactions or forgoing use of trust-controlled water assets to protect

5 Felicity Barringer, "Water Source for Almonds in California May Run Dry," New York Times, December 27, 2014, http://www.nytimes.com/2014/12/28/us/water-source-for-almonds-in-california-may-run-dry.html?smprod=nytcore-iphone&smid=nytcore-iphone-share.

system storage or maintain target reservoir levels to provide protection to municipal and agricultural users and/or to protect hydropower generation;

d. Deploying trust assets to manage market-driven changes in water use (such as those driven by changes in agricultural commodity prices) through selective leasing or other use of trust-owned water, as needed to aid or resist commodity-driven crop shifts or ensure the availability of water to economically marginalized users.

2. Providing an "investment channel" for trust funding that would allow for the use of private capital, in the form of a combination of secured loans and linked charitable donations, in order to undertake water transactions for public benefit (such as water purchases, leases, or the construction of needed infrastructure). These loans would be repaid via a revenue stream back to the trust that would be associated with the deployment of trust assets, such as:

    a. Payment-for-water/ecosystem-services, such as payments from downstream users that will benefit from improved water reliability or the avoidance of specific environmental/regulatory risks;

    b. Providing a mechanism for payment-for-system-services by downstream users, such as funding for periodic demand reductions to protect reservoir levels similar to the existing Colorado River "System Conservation Program." This could include a financing strategy for spreading the cost of system reductions over multiple years so that the cost of occasional, high-cost demand reduction transactions could be paid by individual users over time via a small annual fee.

    c. Generating revenue through the lease of a portion of the water assets held by the Trust to other users during periods when water assets are not needed to guarantee protection for other values (such as during normal or high-flow years), or by leasing water assets until loans were repaid, and then redeploying the paid-off assets for Trust purposes over the long term;

    d. Generating revenue by exploiting the interest rate spreads between the cost of discounted capital available to the Trust via the "investment channel" and prevailing local market discount rates, which could allow the Trust to acquire more water using its borrowed money than would be needed to generate the revenues necessary for loan repayment.

3. In the absence of adequate local enabling conditions for water transactions, undertaking a "market-maker" function in a watershed or specific geography to facilitate water transactions (which in some cases could be essentially similar to the functions provided by a water bank) as described further below.

Depending on the character of local market con- ditions, we propose two alternative approaches to structuring the next generation water trust: an “investment-friendly” water trust, or a “cooperative trust.” Both approaches are detailed below.

A. Structure and Description of Proposed Investment-Friendly Trust [6]

The investment-friendly water trust model builds on the existing nonprofit water trust structure, but creates an associated “investment channel” that would allow for the use of private investment dollars to undertake a broader range of activities that could be supported by new funding streams. This approach would be appropriate for deployment in environments where there are already functional “water markets” allowing for the acquisition and deployment of water for instream flows and other needs.

This investment channel would consist of a vehicle for the receipt of low-interest loans by the trust to be used for the purchase of trust assets (which would be secured against those assets), with the principal and interest to be repaid via the deployment of trust assets during periods of non-use (such as the lease of water rights when not needed to secure environmental and system benefits) and fee-for-service activities undertaken by the trust in reducing system risks. Investment would be provided to the trust via a combination of a low-interest loan and accompanying charitable donation. The interest payments, principal payments, and tax benefits from the donation would pass back to the investor, generating a reasonable overall rate of return.

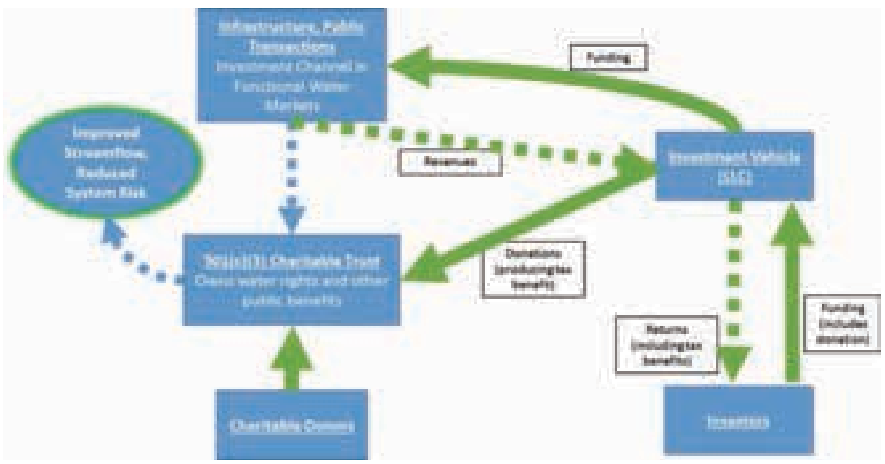


Figure V(D)(1)-4. Structure of Proposed Investment-Friendly Water Trust.

HYPOTHETICAL CASE STUDY EXAMPLE

An existing water trust develops a new “investment channel” to provide local “risk reduction” services for users in its watershed, with the intent of benefiting both water users and ecosystem values. The tributary watershed in which the trust operates consists of a series of farming enterprises, irrigation districts, and downstream municipalities, and water rights trading is feasible in the system where the trust operates.

6 The investment vehicle entity would likely “elect” to be treated as a partnership for federal income tax purposes and for state income tax purposes. The income deductions, including the charitable deductions for federal income tax purposes and generally for state income tax purposes, would thus not be taxed at the entity level but rather would flow through to the investors of in the entity (based on their sharing agreement). The entity would have ordinary income from the revenues received, and would be able to deduct costs over the life of the contract(s) associated with the “investment channel.” The payments made to the 501(c)(3) water trust would be intended to be charitable gifts, and the deductions would be intended to flow through the fund to its taxable investors. It would be advisable for the 501(c)(3) water trust to obtain an IRS ruling with regard to the qualification of its activities and donations.

Water transfers to instream use are also allowable in the watershed, but transactions are not presently occurring at significant volumes/scale, especially to meet ecological goals.

Streams in the watershed are subject to low-flow risks that jeopardize environmental values in-stream (e.g. fish runs), creating potential future regulatory risks, and affecting recreational/fishing values important to local tourism. Under very low-flow conditions, low flows can impact farm diversions for some users, and can also impact water available to the downstream municipalities in the event that reservoir levels fall. Continued drought and low stream flows have caused lowered reservoir levels, which have also impacted hydropower generation downstream.

HYPOTHETICAL TRANSACTION

1. An existing water trust expands its mission to undertake discrete "system risk reduction" services as part of its overall mission, and develops a new "investment channel" through which it will provide these services for both water users and ecosystem values.
2. The trust identifies certain specific investments that would provide those services, including the purchase of a substantial new block of water rights that can be alternatively put to use for instream flow, partially forborne during drought conditions to improve reservoir conditions, and potentially leased for irrigation use during periods when flow and/or reservoir augmentation is unnecessary. The trust also identifies an infrastructure program for the construction of automated headgates on several existing diversion canals that would allow for improved access to water for the canal users during low-flow conditions and reduce net diversions by those canals by diverting only what is needed to serve the users, increasing flow in-stream along a significant portion of the reach.
3. In agreements with downstream users, the water trust agrees to deploy its water rights in a manner that will guarantee the availability of certain flow amounts to irrigation districts and municipal diversions in exchange for annual payments to the water trust. These deliveries also guarantee the maintenance of instream flows in several threatened reaches during low-flow conditions. In addition, the water trust agrees to forbear a portion of its otherwise available deliveries from the hydropower reservoir when reservoir levels are low in exchange for the payment of a portion of hydropower revenues.
4. Private investors provide funding to the water trust through a combination of a charitable donation to the water trust and a low-interest loan, with the latter secured against the water assets to be acquired by the water trust.
5. The water trust uses this funding to acquire water rights and construct the new infrastructure, and utilizes the rights and infrastructure for risk reduction activities as agreed.

The water trust receives the agreed payments for risk reduction services, and uses these revenues to make the loan payments and fund its operations. During periods when the trust does not need to deploy its water assets in support of risk reduction, it leases the excess rights in order to generate additional revenues to repay loan principal. Once the loan is repaid, the water trust owns the purchased water assets free and clear.

6. The investor receives periodic interest payments, which in combination with tax benefits from the donation portion of investment, produce a reasonable rate of return until loan repayment is complete. In the event of default, water assets can be sold to achieve a partial or complete return on the loan principal.

B. Structure and Description of Proposed Cooperative Trust [7]

The second approach to a next generation water trust would utilize a similar "investment channel," but would also involve the creation of a multi-function "cooperative trust" in place of a simple water trust. The cooperative portion of the structure would serve as a market maker in the local watershed to facilitate third-party transactions, while the "trust" portion of the structure would fund and capture public benefit transactions to be retained in "trust" for the system as a whole.

This approach would be appropriate for deployment in environments where there are existing barriers to water transactions that could be resolved through the creation of a "market maker" institution that would facilitate transfers. For example, in a watershed where water rights are poorly defined, the cooperative trust could facilitate the entry of a "mini-settlement" among water users along a particular reach and senior downstream users, allowing transactions to take place between the users on that reach so long as the net depletions on the reach (as measured at an upstream "entry point" and downstream "compliance point") remained constant. In an area where users share one or more pieces of common infrastructure (such as an irrigation canal or a series of canals), but existing diversion structures were primitive in nature or not closely controlled, the cooperative trust could undertake the installation and maintenance of measuring devices and automated headgates to allow for changes in diversion amounts in response to transfers and verification of changes in water use, while increasing the volume of water instream below previously uncontrolled diversion points.

A cooperative trust could also be used to create a local "water bank" mechanism in the absence of clearly defined credits in water trading. For example, there are several examples of existing or proposed "groundwater mitigation banks" that would be used to control groundwater use in the vicinity of surface streams, structured around voluntary transactions

7 The investment vehicle entity likely would "elect" to be a partnership for federal income tax purposes and for state income tax purposes. The income deductions, including the charitable deductions for federal income tax purposes and generally for state income tax purposes, would thus not be taxed at the entity level but rather would flow through to the investors of in the entity (based on their sharing agreement). If the amount paid to the cooperative is not in the form of a loan, the entity would have ordinary income from the payments paid by the cooperative, and would be able to deduct costs over the life of the contract with the cooperative. If the amount paid to the cooperative is a loan, the entity would generally have ordinary income from the interest payments and would not have income from the principal payments. The payments made to the 501(c)(3) water trust would be intended to be charitable gifts, and the deductions would be intended to flow through the fund to its taxable investors. It would be advisable for the 501(c)(3) water trust to obtain an IRS ruling with regard to the qualification of its activities and donations. The cooperative would be intended to be a "cooperative" for purposes of the IRC, and, thus, generally could eliminate its income from the transactions with its members by distributing/allocating patronage dividends.

involving groundwater, surface water, and reuse to generate groundwater credits that could be transferred to offset new groundwater uses. A cooperative trust could provide the institutional brokering and trading functions necessary to facilitate the independent groundwater, surface water, and reuse transactions that would provide for the creation and verification of credits.

Based on a review of potential corporate legal structures, the initial recommendation is to use two separate but interrelated organizations for this structure:

- A cooperative that would function to facilitate water transactions, finance and operate infrastructure, and provide for community-level stakeholder governance, in which the 501(c)(3) trust (described below) would be a member together with other interested parties.
- A charitable trust that is qualified as a 501(c)(3) organization, which would be (1) the legal owner of surface water rights, (2) the benefited party for diversion agreements or water use restrictions undertaken to create instream flow, and (3) the provider of a potential financing tool for infrastructure.

THE COOPERATIVE

A cooperative is an autonomous association of individual or corporate persons who voluntarily cooperate for mutual social, economic, and cultural benefit. In this case, the cooperative would be established to function as the "market maker" – the broker and facilitator of water transactions among and between its members. The cooperative would also own and operate infrastructure necessary to undertake or facilitate those transactions, and would spin off environmental and other public benefits to the river that would be captured and owned by the 501(c)(3) trust (described below).

Cooperatives can include non-profit community organizations, business organizations that are owned by the people who use its services (a community cooperative), business organizations owned by the people who are employed there (a worker cooperative), or residents (housing cooperatives). Hybrid organizations include credit unions, multi-stakeholder cooperatives that bring together parties to deliver community needs, and organizations of cooperatives. At the time of this report, investigation was being conducted with the Internal Revenue Service to confirm that a water-based cooperative can properly qualify for cooperative status under U.S. tax laws; however, all initial indications are that it can.

Governance of a cooperative is typically democratic in nature, and would allow for direct stakeholder involvement and participation in managing the business of the cooperative. The 501(c)(3) trust would also be a member, and would participate in transactions wherever appropriate. Typically, as a member of a cooperative, you are buying and selling the commodity(ies) that are the focus of the cooperative through the cooperative organization. Each member earns "patronage" for the transactions conducted through the cooperative, based on the volume of transactions undertaken.

Although not entitled to non-profit treatment, the cooperative structure is highly tax-efficient, since to the extent that it receives and distributes patronage income, that patronage can be deducted against the income of the cooperative. The cooperative can also designate up to a set amount of its income as "retainage" that is reinvested into the cooperative and its operations that is not taxed. As such, a cooperative can maintain a zero net income provided that patronage distributions are made. In the case of a cooperative trust, the cooperative could also be set up to donate a portion of any net income to the 501(c)(3) trust organization.

THE CHARITABLE TRUST

The second entity would be established as a charitable trust, and would obtain a 501(c)(3) designation. As noted above, the primary purpose of this organization would be to generate, capture and hold environmental and other system-level benefits created through transactions with and through the cooperative, and hold those benefits in trust for the public. Unlike a traditional water trust, this would be established as an actual trust for the purpose of generating and holding environmental and system benefits for the public and the River, with a trustee or trustees (typically a specific individual, a class of individuals, or a financial institution) appointed by the trust instrument, and bound by fiduciary obligations to honor the purposes of the trust. Reformation of the trust or its purposes would require court intervention, while enforcement of the trust instrument would typically be the responsibility of the attorney general of the state, although a specific class of beneficiaries, such as the local public, could also be identified for enforcement purposes.

The 501(c)(3) trust's role in the structure would be to (1) help establish and maintain the cooperative as the market maker; (2) function as a market participant by undertaking traditional "water trust"-style deals through the cooperative; (3) intervene in the cooperative to facilitate or subsidize deals that are environmentally beneficial or that create other system benefits in exchange for the benefit (essentially, functioning as the "irrational investor" that can purchase the environmental/public benefits of otherwise uneconomic transactions); and, (4) hold in trust the environmental/public benefits generated through its activities for the public. For example, the 501(c)(3) could be the benefited party of diversion agreements, restrictions on groundwater or surface water use, conservation easements, and so forth, and would be the owner of any instream flow rights or other property assets with which environmental benefits are associated.

The 501(c)(3) trust would be a member of the cooperative (and could legally be a member without violating its tax status), as membership in the cooperative would be essential to its charitable purpose. The trust could receive donations from the cooperative through excess patronage revenue and spin-off environmental benefits generated through transactions. It would also be entitled to its share of patronage income, which would provide an additional revenue source for operations. Although this would normally qualify as trade or business income, if properly structured, the 501(c)(3) should be able to treat this income as integrally related to its charitable purpose. Importantly, after a functioning market was established, the trust would also not risk losing its ability to treat revenue as tax exempt due to its competition with other market participants since it would be functioning as an "irrational investor."

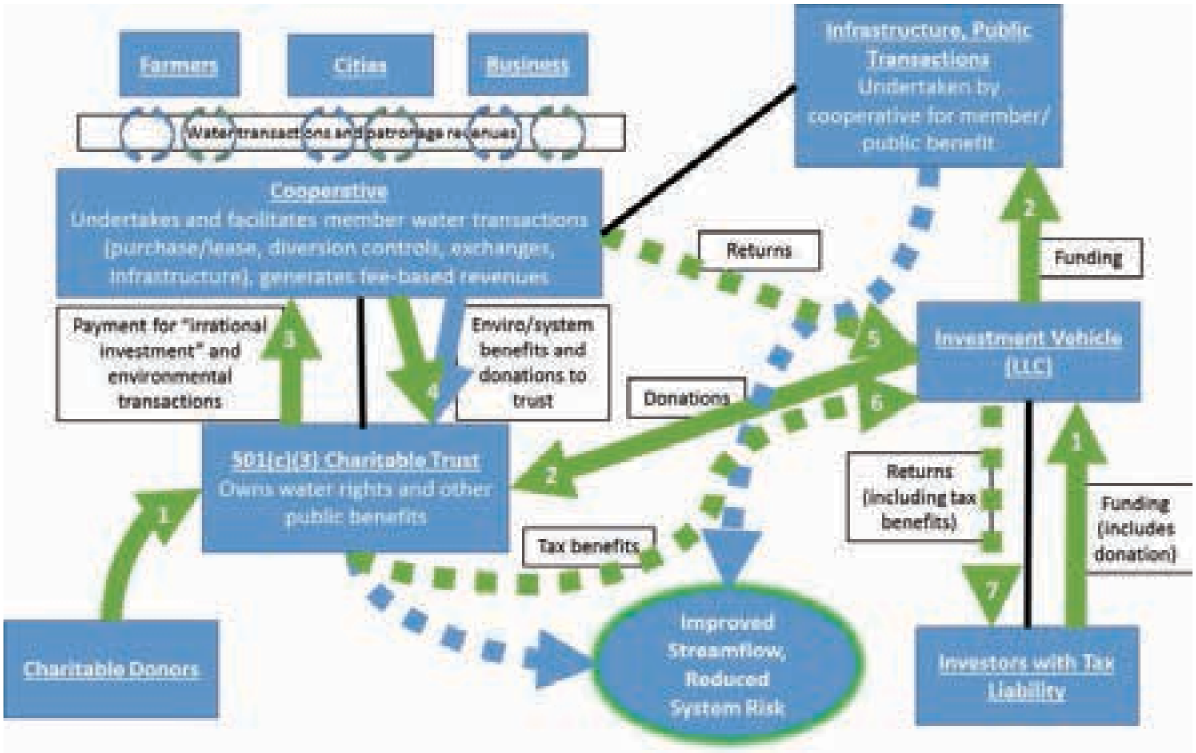


Figure V(D)(1)-5. Structure of Proposed Cooperative Trust.

HYPOTHETICAL CASE STUDY EXAMPLE

Like the previous example, the tributary watershed consists of a series of farming enterprises, irrigation districts, and downstream municipalities. However, the trading of water rights among users is not presently feasible on the system due to incomplete adjudication. Water transfers to instream use are theoretically feasible, but have not previously occurred.

Previous assessments of the potential for creating a water trust in the area determined that establishment of a traditional water trust would be difficult due to the lack of market enabling conditions.

HYPOTHETICAL TRANSACTION

1. An interested investor, such as a charitable foundation, and one or more local interests work together to form a new 501(c)(3) "water trust" entity which will be designed to provide discrete environmental benefits and "risk reduction" functions as part of its overall mission along a defined stream reach, and develop an "investment channel" through which it will provide these services for both water users and ecosystem values.

2. The trust identifies certain specific investments that would provide those services, including the purchase of a block of water rights that could be alternatively put to use for instream flow, partially forborne during drought conditions to improve reservoir conditions, or put to other uses when flow and/or reservoir augmentation is unnecessary. The trust also identifies an infrastructure program for the construction of monitoring and measurement equipment along the stream reach, as well as automated headgates on several existing diversion canals in that reach that would allow for improved access to water for the canal users during low-flow conditions and reduce net diversions by those canals by diverting only what is needed to serve the users, increasing flow in-stream along a significant portion of the reach. Finally, the trust explores the potential for entry of a "mini-settlement" with senior downstream appropriators to allow for transactions within the reach provided that monitoring and measurement demonstrates no net increase in depletions within the reach.

3. The water trust, together with local interests focused on undertaking water transactions, form a "water cooperative" that will serve as a market maker and function as a sister entity to the water trust. Membership in the cooperative creates the right to utilize the cooperative in order to undertake water transactions. Membership is solicited and is open to local farmers, cities, developers, etc.

4. The cooperative enters into the mini-settlement with downstream users. The cooperative, acting through an investment vehicle entity, established by the cooperative and the investor, undertakes construction of required new infrastructure, monitoring/measuring efforts, and the formation and operation of a registry/exchange/water bank/etc. to facilitate water transactions. The water trust assists with these efforts in exchange for contractual rights to the public benefits generated by these investments as described further below. The investor provides funding for these investments through the investment vehicle entity in the form of a combination of a low-interest loan to the cooperative and a charitable donation to underlying water trust.

5. The cooperative members undertake ongoing water transactions, with the cooperative receiving a "cut" of transactions in water, fees, or both. The cooperative also receives payments for specific services from its members, such as the operation of infrastructure and measuring equipment, and the provision of system risk reduction services via its relationship with the water trust. Cooperative revenues are used (in order of priority) to (1) pay cooperative operating expenses, (2) to repay the loan to the investment vehicle, (3) to pay the water trust for system risk reduction services and/or provide donations to the water trust to provide trust operating revenues, and (4) to redistribute excess revenues to members as patronage dividends.

6. The water trust participates in the cooperative as a transacting party and/or as an "irrational investor" that helps to underwrite transactions that create public benefits that would otherwise not occur, in exchange for ownership of those benefits (e.g. share of conserved water, contractual rights to enforce non-diversion, etc.). The water trust deploys these assets for environmental/system benefit through its underlying agreement with the cooperative, which provides payments to the trust for those services from its revenues.

7. The investor receives periodic interest payments, which, in combination with tax benefits from the donation portion of investment, produce a reasonable rate of return until loan repayment is complete. In the event of default, water assets can be sold to achieve a partial or complete return on the loan principal.

4. Financial Model[8]

To further demonstrate how an "investment channel" can be appended to either an existing water trust to create the investment-friendly water trust or the proposed cooperative trust structure, the tables below detail illustrative financial statements for a hypothetical 10-year financing of an investment-friendly water trust or a cooperative trust. The financial model for the investment channel is intended to be illustrative since the costs and benefits associated with the transactions are highly variable; further legal and site-specific diligence would be required before implementation.

In the scenario modeled below, an investor would provide upfront capital to fund the establishment of the investment channel, purchase permanent water rights, and conduct operations for benefit of the trust beneficiaries or members of the cooperative. It is assumed that the initial funding will be raised via low-interest debt and equity funds (which also consist of annual tax-deductible donations) in order to maintain trust operations. As discussed above, the trust would not only own water rights, but also fund investments for public benefit (e.g. automatic head gates to increase efficiency, maintain in stream flow levels, etc.), and would generate return for the investors (or patronage for the cooperative) from a portion of water lease revenues, transaction fees, service fees, etc.

8 This financial model should not be used as investment advice, or even taken as a diligence framework associated with an actual project. The hypothetical transaction is fictitious and is only intended to provide some key line items interested parties might consider in assessing the potential for a next generation water trust. Among other omissions, inflation, depreciation and tax considerations have not been diligenced for this notional financial model.

Figure V(D)(1)-6. Illustrative Financial Statements for the Investment Channel

Year:	0	1	2	3	4	5	6	7	8	9	10
Income Statement											
Revenue											
Muni Member Fees / Water Lease Revenue		$875,000	$875,000	$875,000	$875,000	$875,000	$875,000	$875,000	$875,000	$875,000	$875,000
Ag Member Fees / Water Lease Revenue		2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000
Transaction Fees		33,750	33,750	33,750	33,750	33,750	33,750	33,750	33,750	33,750	33,750
Total Revenue		$3,408,750	$3,408,750	$3,408,750	$3,408,750	$3,408,750	$3,408,750	$3,408,750	$3,408,750	$3,408,750	$3,408,750
Operating Expenses											
Trust Admin: Exec Team, Audit, Legal		$1,000,000	$1,020,000	$1,040,400	$1,061,208	$1,082,432	$1,104,081	$1,126,162	$1,148,686	$1,171,659	$1,195,093
Property Tax on Water/Land Assets		191,250	205,594	219,938	234,281	248,625	262,969	277,313	291,656	306,000	320,344
Enviro Restoration, Monitoring, Maintenance		300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Strategic Water Leases to Maintain Flow		50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Total Operating Expenses		$1,541,250	$1,575,594	$1,610,338	$1,645,489	$1,681,057	$1,717,050	$1,753,475	$1,790,342	$1,827,659	$1,865,436
Depreciation		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating Income		$1,867,500	$1,833,156	$1,798,413	$1,763,261	$1,727,693	$1,691,700	$1,655,275	$1,618,408	$1,581,091	$1,543,314
Gain/(Loss) on Sale of Water/Land		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Interest Income		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Interest Expense		$255,000	$231,000	$207,000	$183,000	$159,000	$135,000	$111,000	$87,000	$63,000	$39,000
Corporate Taxes		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income		$1,612,500	$1,602,156	$1,591,413	$1,580,261	$1,568,693	$1,556,700	$1,544,275	$1,531,408	$1,518,091	$1,504,314

Figure V(D)(1)-7. Illustrative Financial Statements for the Investment Channel

Year:	0	1	2	3	4	5	6	7	8	9	10
Balance Sheet											
Assets											
Cash	$7,000,000	$7,925,000	$7,666,844	$7,350,131	$6,974,455	$6,539,397	$6,044,535	$5,489,435	$4,873,656	$4,196,747	$458,248
Net Working Capital Growth	0	0	0	0	0	0	0	0	0	0	0
Net PPE (Owned Water Rights)	16,000,000	16,050,000	17,225,000	18,400,000	19,575,000	20,750,000	21,925,000	23,100,000	24,275,000	25,450,000	26,625,000
Total Assets	$23,000,000	$23,975,000	$24,891,844	$25,750,131	$26,549,455	$27,289,397	$27,969,535	$28,589,435	$29,148,656	$29,646,747	$27,083,248
Liabilities & S/H Equity											
Long-Term Debt	$8,000,000	$7,200,000	$6,400,000	$5,600,000	$4,800,000	$4,000,000	$3,200,000	$2,400,000	$1,600,000	$800,000	$0
PRI / Concessionary	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	0
Total Liabilities	$11,000,000	$10,200,000	$9,400,000	$8,600,000	$7,800,000	$7,000,000	$6,200,000	$5,400,000	$4,600,000	$3,800,000	$0
Equity/Member Capital	$12,000,000	$13,775,000	$15,491,844	$17,150,131	$18,749,455	$20,289,397	$21,769,535	$23,189,435	$24,548,656	$25,846,747	$27,083,248
Liabilities & S/H Equity	$23,000,000	$23,975,000	$24,891,844	$25,750,131	$26,549,455	$27,289,397	$27,969,535	$28,589,435	$29,148,656	$29,646,747	$27,083,248

Year:	0	1	2	3	4	5	6	7	8	9	10
Statement of Cash Flows											
Net Income		$1,612,500	$1,602,156	$1,591,413	$1,580,261	$1,568,693	$1,556,700	$1,544,275	$1,531,408	$1,518,091	$1,504,314
Depreciation		0	0	0	0	0	0	0	0	0	0
(Gain)/Loss on Sale of Water/Land		0	0	0	0	0	0	0	0	0	0
Changes in NWC	0	0	0	0	0	0	0	0	0	0	0
Cash Flow from Operations	$0	$1,612,500	$1,602,156	$1,591,413	$1,580,261	$1,568,693	$1,556,700	$1,544,275	$1,531,408	$1,518,091	$1,504,314
(Cap Ex) for Headgates / (Retainage)	$0	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)
(Purchase)/Sale of Water/Land	(15,000,000)	0	(1,125,000)	(1,125,000)	(1,125,000)	(1,125,000)	(1,125,000)	(1,125,000)	(1,125,000)	(1,125,000)	(1,125,000)
(Fees) for Initial Structuring	(1,000,000)	0	0	0	0	0	0	0	0	0	0
Cash Flow from Investing	($16,000,000)	($50,000)	($1,175,000)	($1,175,000)	($1,175,000)	($1,175,000)	($1,175,000)	($1,175,000)	($1,175,000)	($1,175,000)	($1,175,000)
Long-Term Debt	$8,000,000	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)
PRI / Low Interest Loan	3,000,000	0	0	0	0	0	0	0	0	0	(3,000,000)
Equity / Contributions Rcv'd	12,000,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000
(Dividend): Member Patronage	0	(637,500)	(685,313)	(733,125)	(780,938)	(828,750)	(876,563)	(924,375)	(972,188)	(1,020,000)	(1,067,813)
(Dividend): 501(c)3 Contribution	0	0	0	0	0	0	0	0	0	0	0
Cash Flow from Financing	$23,000,000	($637,500)	($685,313)	($733,125)	($780,938)	($828,750)	($876,563)	($924,375)	($972,188)	($1,020,000)	($4,067,813)
Cash at Beginning of Year	$0	$7,000,000	$7,925,000	$7,666,844	$7,350,131	$6,974,455	$6,539,397	$6,044,535	$5,489,435	$4,873,656	$4,196,747
Change in Cash	7,000,000	925,000	(258,156)	(316,713)	(375,677)	(435,057)	(494,862)	(555,100)	(615,779)	(676,909)	(3,738,499)
Cash at End of Year	$7,000,000	$7,925,000	$7,666,844	$7,350,131	$6,974,455	$6,539,397	$6,044,535	$5,489,435	$4,873,656	$4,196,747	$458,248

Figure V(D)(1)-8. Illustrative Debt Schedules for the Investment Channel

Year:	0	1	2	3	4	5	6	7	8	9	10
Debt Schedules											
Free Cash Flow		$1,562,500	$427,156	$416,413	$405,261	$393,693	$381,700	$369,275	$356,408	$343,091	$329,314
Debt Repayment		(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(3,800,000)
Change in Equity		162,500	114,688	66,875	19,063	(28,750)	(76,563)	(124,375)	(172,188)	(220,000)	(267,813)
Excess Cash on B/S		7,000,000	7,925,000	7,666,844	7,350,131	6,974,455	6,539,397	6,044,535	5,489,435	4,873,656	4,196,747
Cash Avail for Debt Repayment		$7,925,000	$7,666,844	$7,350,131	$6,974,455	$6,539,397	$6,044,535	$5,489,435	$4,873,656	$4,196,747	$458,248
Long-Term Debt											
Beginning Balance		$8,000,000	$7,200,000	$6,400,000	$5,600,000	$4,800,000	$4,000,000	$3,200,000	$2,400,000	$1,600,000	$800,000
Principal (Payments)		(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)	(800,000)
Increases		0	0	0	0	0	0	0	0	0	0
Ending Balance	$8,000,000	$7,200,000	$6,400,000	$5,600,000	$4,800,000	$4,000,000	$3,200,000	$2,400,000	$1,600,000	$800,000	$0
Interest Expense	3.0%	$240,000	$216,000	$192,000	$168,000	$144,000	$120,000	$96,000	$72,000	$48,000	$24,000
PRI / Concessionary											
Beginning Balance		$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000
Principal (Payments)		0	0	0	0	0	0	0	0	0	(3,000,000)
Increases		0	0	0	0	0	0	0	0	0	0
Ending Balance	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$0
Interest Expense	0.5%	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000

Figure V(D)(1)-9. Illustrative Ownership, Leasing and Return Schedules for the Investment Channel

Year:	0	1	2	3	4	5	6	7	8	9	10
Water Ownership / Leasing Schedule											
Annual: Rights Acq / (Sold) in AF		0	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250
Aggregate Rights Owned in AF	30,000	30,000	32,250	34,500	36,750	39,000	41,250	43,500	45,750	48,000	50,250
Implied Market Value (Avg. Price)		$6,375,000	$6,853,125	$7,331,250	$7,809,375	$8,287,500	$8,765,625	$9,243,750	$9,721,875	$10,200,000	$10,678,125
Min Enviro Low-Flow / Base Line	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Min Muni Rights (Leased) in AF		5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Min Ag Rights (Leased) in AF		20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Residual AF for Lease / Enviro Use		0	2,250	4,500	6,750	9,000	11,250	13,500	15,750	18,000	20,250
$ Value of Flow over Baseline (Lease Potential)		$0	$112,500	$225,000	$337,500	$450,000	$562,500	$675,000	$787,500	$900,000	$1,012,500
Pricing Assumptions											
Trust Purchase Price per AF	$500										
Muni Member Fee-Lease Price/AF	$175										
Ag Member Fee-Ag Lease Price/AF	$125										
Excess Flow Lease Price/AF	$50										
Output Totals over Period											
Total AF Avail for Environmental Use	151,250										
Automated Headgates Proj Spend	$500,000										
Aggregate Donations for Tax Shield	$20,000,000										
Hypothetical "Investor" Return (Includes Donation)											
Invested Capital & Yr. 10 Equity Value	($12,000,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	($800,000)	$26,283,248

MOIC:	1.4x
IRR:	3.9%

SECTION V(D)(2):

Water Storage Trading:
Facilitating Water Trade and Controlling Watershed Risks

Summary

This investment vehicle is structured to generate ongoing returns from the establishment and operation of a water storage trading facility utilizing existing physical reservoir storage or underground storage (aquifers) in water-limited systems. By allowing the development and trade in storage credits among water users, storage facilities would provide a variety of physical and price hedging options and tools to water users to manage physical risks and control speculation, as well as insurance-type arrangements to cover water users and/or critical ecological values. This would be done while providing a return to the storage facility operator and underlying investors via transaction fees and a "tax" on storage transactions, together with the direct marketing of storage credits and services developed in the facility. By creating tradable credits in water storage, this tool can help to create essential conditions for the development of a water market, assist with the development of economically rational pricing for water resources and resource reallocation, help to control risks to water users by increasing year-to-year flexibility in water use and limiting the ecological risks and pressures that would otherwise be associated with sudden catastrophic supply shortfalls, incentivize changes in water withdrawals in a manner that will protect stream flows, and develop water supplies that can be used to meet ecological needs.

1. Background

Water storage is critical to the management and delivery of water throughout the Western United States. With most of the Western U.S. receiving less than 20 inches of rainfall each year and prone to unpredictable and frequently extended drought conditions, the development of large-scale water storage to transform variable surface water sources into stable water supplies was key to the settlement of the West. As the virtual centerpiece of the Reclamation Era's drive to "make the desert bloom," the Colorado River Basin's water management system now boasts one of the most extensive storage systems in the world. There are now nearly 40 large and medium-sized dams in the Colorado River Basin (i.e. dams with a capacity greater than 50,000 af), in addition to 5 major diversion dams. These dams are capable of capturing more than 4 times the River's annual flow, converting the Colorado's highly variable flows into reliable, steady supplies and providing a significant buffer against drought.

As the virtual centerpiece of the Reclamation Era's drive to "make the desert bloom," the Colorado River Basin's water management system now boasts one of the most extensive storage systems in the world.

Figure V(D)(2)-1. Dams in the Colorado River Basin. Image courtesy Wikimedia Commons.

Groundwater pumping has played an equally significant role in the development of the West. Access to stored water in underground aquifers has made agriculture, industry, and urban development possible in areas where surface water supplies would otherwise have been inadequate. Throughout the West, major cities, agricultural districts, industrial users, and other critical uses are at least partially – and in many cases completely – dependent on continued access to groundwater for their survival. In many parts of the West, groundwater storage also represents the best potential reserve supply to buffer urban, agricultural, and industrial users from the increasing hydrologic variability anticipated from climate change. In the Colorado River Basin, this is particularly important in the Lower Basin, where most of the major cities and many agricultural districts are heavily dependent on groundwater for either primary or reserve supplies.

However, as described further in Section III of the background report, these above and below-ground reserves are increasingly threatened in the Colorado River Basin. Hydrologic variability that departs significantly from our recent historical experience has driven Colorado River reservoir storage to historic lows and threatens significant potential shortages for users throughout the Basin. Overpumping of groundwater is rapidly depleting or even exhausting critical groundwater reserves in many areas, jeopardizing many of the Lower Basin's few remaining perennial stream systems, and causing significant problems with land subsidence and other issues.

Many of these issues relate to the fact that under current approaches and rules, there are perverse incentives associated with use of both surface water storage and groundwater storage. Developing new approaches to the management of storage and associated systemic risk, including the use of market-driven approaches, could be a key part of the solution to water challenges in the Colorado River Basin, and represents a significant potential opportunity for the use of private investment.

SURFACE WATER STORAGE

Most Western watersheds experience significant flow variations both within a single year (e.g. high spring flow, extremely low summer flow) and across multiple years in response to drought and wet year conditions. Reservoir storage, therefore, has historically been used to mitigate variations in natural water supply as these variations can be controlled to produce stable, predictable supplies of water needed to support irrigated agriculture, municipal and industrial demands.

Figure V(D)(2)-2. Flaming Gorge Dam. Image courtesy U.S. Bureau of Reclamation.

As growth and development have increased demand for water, however, many existing reservoirs have become overtaxed with essentially all storage space and available water being used each year. As described in the background report, the Colorado River Basin is facing critical risks of shortages on many surface water systems. However, not all risk is hydrological in nature. At least some of this risk relates to rules governing the use of reservoirs that create perverse incentives and undermine the ability of reservoirs to "buffer" against drought conditions. The capacity of many reservoirs to manage systemic risk could potentially be improved by changing rules to incentivize lower levels of use during drought conditions.

Most large surface water reservoirs serve multiple functions in a watershed. In addition to providing for annual water storage to change the timing of flows (e.g. capturing high flows in the spring and converting them into stable flows throughout the year), reservoirs are used to control flood risks, maintain multiple years of reserve storage for water supply, guarantee minimum flow levels below the dam for instream values, and, in some cases, generate hydropower. Frequently, particular portions of reservoir storage space are allocated to these uses, with operational rules built on a risk analysis derived from the historic record. For example, a large portion of available reservoir storage may be dedicated to meeting water supply needs. At low levels, releases may be restricted to prevent shortages and preserve hydropower, while at higher levels, extra water may be deliberately released to free up reservoir space needed for flood control. A typical distribution of theses allocations is shown in Figure V(D)(2)-3.

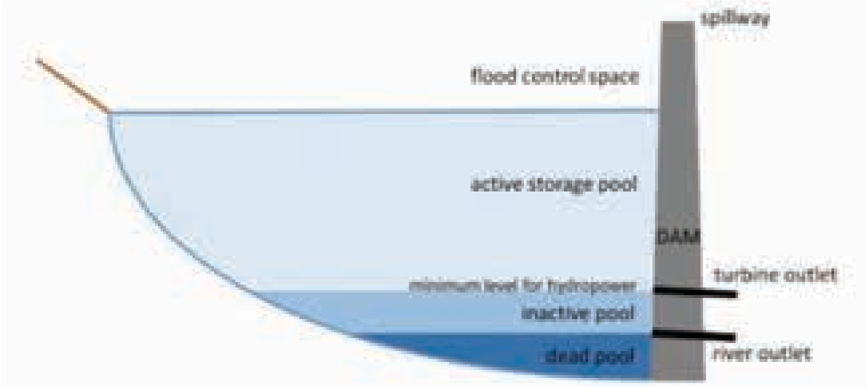


Figure V(D)(2)-3. Typical distribution of reservoir water allocation between active storage, inactive storage, and "dead pool," with a portion of the reservoir storage reserved for flood control purposes.

In a typical reservoir, the only portion of the reservoir that is normally utilized for water supply purposes is the "active storage" pool. Depending on the size of the reservoir, this pool may represent multiple years' worth of annual deliveries, providing a substantial buffer against drought conditions in the watershed. Typically, the rights to stored water are allocated to the users of the reservoir on an annual use basis, in which each reservoir user has a claim for the delivery of stored water, provided that sufficient storage is available in the "active storage" pool to satisfy that delivery.

In the event that a reservoir user does not utilize its allocated share of delivery, the delivery may be taken by another user, or it may simply be left in storage to meet future years' deliveries. In the event that storage levels fall too low, deliveries out of the reservoir will normally be restricted, typically either on a pro-rata basis (in which all users have the same priority, and share equally in a shortfall) or on a priority basis (in which some users will be cut off from deliveries before others).

The problem with this arrangement is that, by effectively allocating the unused delivery entitlement of any reservoir user to other reservoir users, it effectively creates a "use it or lose it" based allocation system, in which there is no incentive for a user to forego delivery of water from the reservoir. During dry conditions, this "use it or lose it" incentive may drive a reservoir into shortage conditions quite rapidly, since no individual user has an incentive to undertake conservation activities (or forgo use of low-value water), even if their withdrawals will potentially cause a shortfall in a subsequent year. If the reservoir level falls low enough – e.g. to the point where deliveries must be restricted to protect a minimum power pool; to the point where the waterline is no longer high enough to move water through the dam efficiently, or to the "dead pool" (the point where water cannot leave the reservoir at all, such that the water coming out of a dam is equivalent to the amount flowing into the reservoir from upstream) – then all users of the system will be exposed to shortfalls.

Another example of this type of disincentive is the "one fill rule," which is followed in some states. The one fill rule limits the volume of water stored each year to the capacity of the reservoir. Although this helps to protect junior users, the one fill rule has the additional consequence of discouraging carryover storage, making water administration and use less efficient. Under the one fill rule in Colorado, for example, "a water user may store water whenever the water is physically available, its water right is in-priority, and the decree for the water right has not been filled" in any given year. After the end of a seasonal year—generally running from November 1 to October 31—water left in a reservoir is considered carryover storage, and then counts against the next year's fill. As this effectively reallocates any carryover storage to users elsewhere in the river system, there is little incentive to conserve storage in the reservoir for future use.

In addition to operational hazards and shortage risks, reservoir shortfalls can create significant environmental issues. For example, when water levels are low within reservoir areas, riparian vegetation frequently spreads into the "delta" environments created as water levels recede, exposing rich sediments and creating prime wildlife habitat; however, this habitat is then lost when reservoir levels recover. This can create complex regulatory and ecosystem challenges, as exampled by the Salt River in Arizona, where frequent reservoir fluctuations have led to conflict between reservoir operations and the survival of endangered birds that utilize emergent habitat during low reservoir conditions. In areas below the reservoirs, fluctuations in deliveries directly impact in stream flow levels, timing of flow, and the associated dynamics, as further detailed in Section III of the background report. These fluctuations can directly impact fish and wildlife habitat, as well as indirectly alter stream flow temperatures and facilitate the spread of resilient invasive species.

Adding to these challenges is the fact that reservoir systems frequently support high-value, inflexible agricultural and urban uses that have grown up in dependence of a highly stable water supply. Interruption of that consistent supply can result in intense political and physical pressure to ensure the availability of water to protect high-value uses, even if this comes at the expense of important environmental values.

GROUNDWATER STORAGE

Prior to large-scale groundwater development, the expansion of agriculture, cities, and industry was limited to locations where access to reliable surface water supplies was possible – either in areas adjacent to rivers and streams, or in areas where water could be made accessible through the development of infrastructure to transport water – frequently in the form of large-scale, expensive public projects. Since surface water was comparatively scarce, the lack of water availability effectively put much of the Western landscape off-limits to significant development.

Following the advent of high-lift turbine pump technology in the 1930s, however, many regions suddenly found themselves with access to vast reserves of water in underground aquifers that could support agricultural enterprises and development in areas where surface water supplies would otherwise have been inadequate. This technology fueled an era of explosive growth in many areas that could not (and even now cannot) be reasonably supplied from surface water sources, based on the availability of a seemingly unlimited stored water supply in underground aquifers – in some cases water that had accumulated in storage over the course of hundreds of thousands of years. As a result, continued access to groundwater reserves is now critical to the survival or many parts of the West.

Continued access to groundwater reserves is now critical to the survival or many parts of the West.

For example, in Central Arizona, large-scale agricultural enterprises developed in areas where surface water supplies were not even remotely available. Prior to the emergence of large-scale groundwater pumping, agriculture in Central Arizona was only possible in a few areas, mostly areas adjacent to the Salt and Gila Rivers that had historically been farmed by Indian tribes. Similarly, large-scale urban development in the Phoenix and Tucson metropolitan areas became highly dependent on groundwater pumping. Although the Central Arizona Project was later constructed to deliver surface water to some of these areas, much of Central Arizona's urban and agricultural landscape still relies on groundwater for its water supply, although many users now use surface water "indirectly" by replacing the groundwater that they pump by recharging surface water into the aquifer.

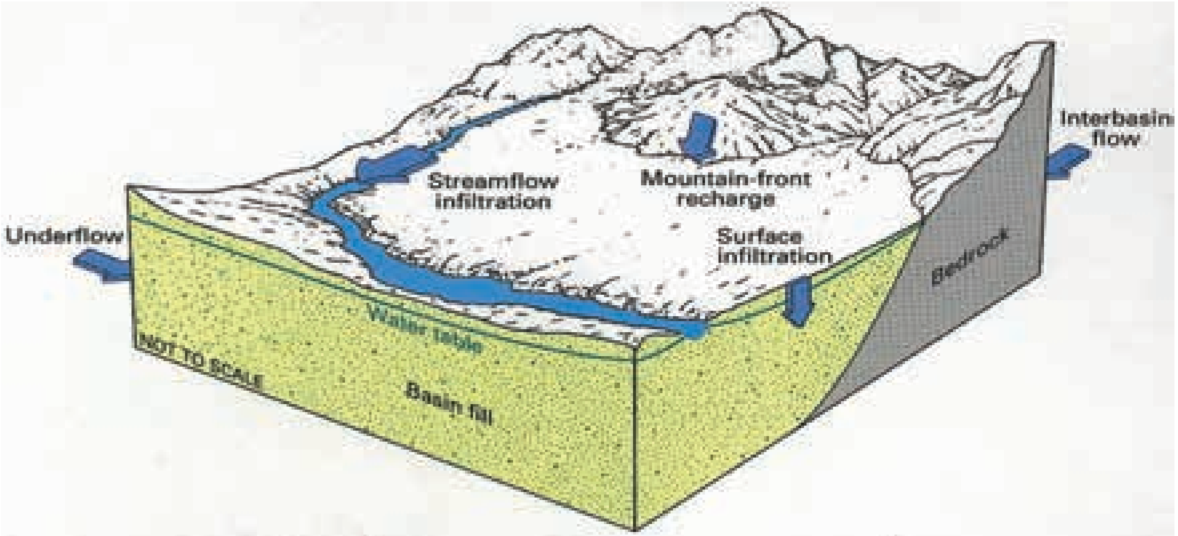


Figure V(D)(2)-4. Geology of a typical basin-fill aquifer, recharged by infiltration from streamflow into the basin, as well as mountain-front recharge and direct surface infiltration. Source: U.S. Geological Survey, Ground Water Atlas of the United States; Arizona, Colorado, New Mexico, Utah, HA 730-C.

There are two basic types of aquifers that are prevalent in the Colorado River Basin – "basin-fill" or alluvial aquifers, and fractured bedrock aquifers. Basin-fill aquifers, which result from the widespread "basin-range" geography in the Colorado River Basin, are comprised of mountain ranges separated by wide basins that are filled with sediments - sand, gravel, silt, and/or clay that has accumulated through erosion. This permeable and semi-permeable material is saturated with water that has infiltrated down from the surface (either as direct precipitation or as runoff from the surrounding mountain ranges), forming an aquifer – effectively like a large bathtub filled with sediment that is permeated with water. Water in these aquifers is generally more easily accessible than water in bedrock aquifers, although water from alluvial aquifers is also more likely to contain natural and/or man-made pollutants.

Fractured bedrock aquifers are comprised of networks of fractures, filled with water, that occur throughout the underlying bedrock and which can extend hundreds of feet down and cover vast areas. While water quality is in these aquifers is generally higher than in alluvial aquifers, bedrock aquifers are harder to access and may have complex interrelationships with surface water systems. For example, depending on how particular systems of fractures interconnect, the withdrawal of water from a fracture can potentially have impacts on springs, wells, or other surface features at substantial distances. As a result, modeling of the impacts of groundwater withdrawals from these systems can require substantial understanding of local geology.

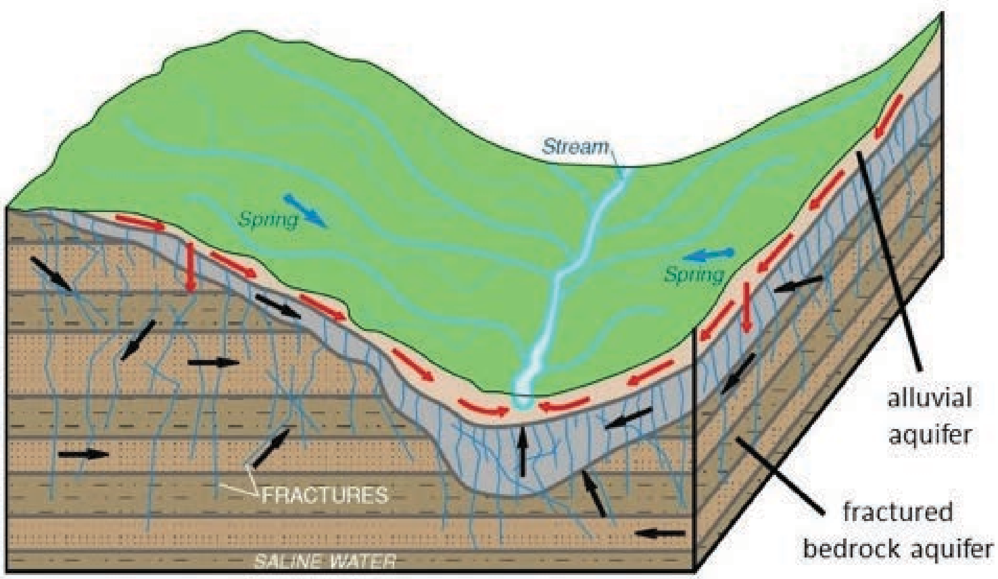


Figure V(D)(2)-5. Structure of a typical fractured bedrock aquifer, with discharges to springs and to the overlying alluvial aquifer (which supports a surface stream). Image courtesy of the U.S. Geological Survey

Surface water becomes groundwater through the process of infiltration. However, unlike surface water accumulation, which can recharge in days or weeks, groundwater aquifers consist of long-term accumulated water storage, sometimes developed over hundreds of thousands of years. Over time, aquifers naturally reach an "equilibrium" state in which the natural discharges from the aquifer – in the form of seeps, springs, and discharges to surface water streams – balance with the natural recharge to the aquifer from surface infiltration, mountain-front recharge, and discharges from underlying bedrock aquifers. As such, a critical rule is that in most cases, any withdrawal of groundwater from an aquifer – effectively, an artificial discharge from the aquifer – will inevitably translate into a reduction in natural discharge from that aquifer (although because of the transit times required for groundwater to move through the aquifer system, this

1 Glennon, Robert. 2002. Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters. Washington, DC: Island Press.

impact will necessarily be delayed, and may not manifest for days, weeks, months, years, or even centuries).

As a result, only a fraction of the total amount of stored groundwater in an aquifer truly qualifies as a "renewable resource." Once groundwater pumping from an aquifer becomes significant, reductions in discharge to surface water sources will eventually manifest, reducing available surface water to downstream users and to the environment. Once the rate of local groundwater pumping exceeds the rate of local recharge, the extraction of groundwater is effectively "mining" out historically accumulated water, and net losses in the accumulated aquifer storage will begin to occur. The groundwater deficits created by these net losses in storage accumulate over time; depending on the rate of recharge, it could take decades, centuries, or even thousands of years for aquifer storage to recover.

Depending on the rate of recharge, it could take decades, centuries, or even thousands of years for aquifer storage to recover from the impacts of current overuse.

This creates a secondary but equally critical problem in basin-fill aquifers known as subsidence. Essentially, as groundwater levels fall and water is removed from the underlying sediments, the removed water leaves behind the tiny pore spaces that it once occupied; under the force of gravity, the sediments will then compact to fill those spaces. This not only reduces the ability of the aquifer to store water again in the future, but can also lead to significant subsidence of overlying land. For example, in the San Joaquin Valley of California, excessive groundwater pumping throughout the 20th century caused the water table to plummet, which in turn caused the surface of the earth to subside more than twenty-five feet between 1925 and 1977.[1] Recently, the vastly accelerated rates of groundwater pumping that have occurred in response to the ongoing California drought have been causing ground-surface subsidence of as much as twelve inches per month.

Figure V(D)(2)-6. Iconic photo showing land subsidence in the San Joaquin Valley from 1925 to 1977 as a result of excessive groundwater pumping. The sign at the top of the pole indicates the land surface elevation in 1925. Image courtesy of U.S. Geological Survey.

2 Ponce, V. (2007). Sustainable Yield of Groundwater. San Diego State University.

The term "safe yield" is often used to reference the amount of water that can be withdrawn from an aquifer without causing a net loss of aquifer storage – effectively, a rate of extraction that does not exceed the rate of recharge. Any withdrawal above sustainable yield thus effectively constitutes "mining" – where withdrawals exceed natural recharge, net aquifer storage will decline. It should be noted, however, that achieving "safe yield" does not protect surface water resources; over time, if groundwater extractions equal natural recharge, natural discharges to springs and surface water bodies will effectively decline to zero. A different standard, "sustainable yield," reflects the amount of water that can be withdrawn without causing undesirable impacts to groundwater-fed surface water and groundwater-dependent ecosystems – essentially reserving a portion of the "safe yield" discharge to support natural systems (and the water users on those systems). While this varies depending on local geological and ecological conditions, sustainable yield rates are typically identified as being between 10% and 70% of an aquifer's recharge rate.[2]

As discussed earlier in the report, regardless of the overall rate of pumping in an aquifer, groundwater pumping can also create important localized impacts to surface water by reducing or eliminating base flow. Stream flow is comprised of a combination of runoff and base flow. Runoff is surface water running across the land from rainfall or snowmelt, while base flow results from the discharge of groundwater from an underlying or adjacent aquifer into the stream channel. Following a local or upstream precipitation event, the high streamflow will be primarily composed of runoff; by contrast, during dry conditions, a stream's running water is mostly comprised of base flow.

Groundwater pumping results in the formation of "cones of depression" around groundwater wells. These cones of depression capture groundwater that would have otherwise flowed to surface streams, reduce aquifer heads (the hydrologic pressure that causes groundwater discharge), and thus reduce flow in surface streams. If the cone of depression intercepts the floodplain aquifer of a surface stream, the well can begin to draw water directly out the stream, further reducing surface flows. Over time, this can lower the water levels in the floodplain aquifer to the point where the connection between the surface stream and the aquifer is lost; this will then quickly transform a perennial stream into a dry riverbed. These declining water levels will also quickly affect riparian vegetation, such as native cottonwood and willow trees, that depend upon shallow groundwater to survive.

Figure V(D)(2)-7. Destroyed riparian vegetation on agricultural land; courtesy of Wikimedia Commons.

As noted in Section II of the background report, only some of the states in the Basin recognize this basic interconnection between surface water and groundwater. Where it is recognized, groundwater extraction is typically still permissible so long as it does not interfere with a surface water right (which may allow significant depletion to occur). Other states apply only the "reasonable use" doctrine, which allows effectively unlimited access to groundwater for use on the surface, regardless of the impacts on other users.

As a result, many groundwater aquifers in the Western United States are being mined in an uncontrolled fashion by multiple users to provide water for day-to-day use. Depending on the size and characteristics of the aquifer, these impacts can occur across enormous geographic areas. Perhaps the best-known example of this is the exploitation of the massive Ogallala Aquifer, which underlies much of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. Unsustainable pumping of this aquifer has led to widespread groundwater declines whose impacts now extend from South Dakota to Texas.

Groundwater use at levels that damages surface streams, as well as serious groundwater overdraft that jeopardizes local or even regional groundwater aquifers, is essentially ubiquitous in the Colorado River Basin, particularly in rural and semi-rural areas where regulation has tended to advance more slowly (major cities have typically acted faster to protect their long-term interests). As noted in Section III of the report, a 2014 study produced jointly by the NASA Jet Propulsion Laboratory and the University of California, Irvine found that groundwater reserves in the Colorado River Basin have declined by 53 million af during the past 10 years – a volume equivalent to twice the capacity of Lake Mead. To put that figure in perspective, these groundwater depletions comprised 75% of the total loss in water storage in the Basin over that same timeframe.[3]

Many groundwater aquifers in the Western United States are being mined in an uncontrolled fashion by multiple users to provide water for day-to-day use.

2. Existing Approaches

There are a number of existing approaches to the management of these issues with regard to both surface water reservoirs and groundwater storage; a few of the most relevant approaches are discussed below.

RESERVOIR STORAGE TRADING

At a basic level, allowing individual water entitlement holders to "carry over" their unused water in surface water reservoirs from season-to-season can enable users to make better individual choices about the use of water from year-to-year. In addition, a system built on this mutual cooperation improves the ability to manage risks associated with dry cycles – e.g., during abnormally dry conditions, it allows users to make investments in additional conservation efforts and keep the water in storage to ensure that they will have a full allocation available during a subsequent year. This ability to carry over water can therefore discourage the counterproductive "use it or lose it" incentives as discussed earlier, and enhance operational flexibility.

The opportunity for carry-over credit is particularly attractive on smaller reservoirs, where allocating storage space in this manner can allow users to manage their own water supply risks. This strategy essentially provides users with greater certainty than if the reservoir operations were subject to fixed delivery rules. It lets users decide for themselves how to manage their personal available storage based on information about current water levels and projected inflows, while being at least partially insulated from the consequences of other parties' (poor) decisions. Also, with carryover storage available, if one party elects to conserve and another elects to use his/her full allocation in the face of drought, the party with carryover storage may still receive a full allocation if a shortage occurs later, while only the party who failed to conserve will be shorted.

A slightly more complex approach defines entitlements to delivery of water from storage (e.g. a shared reservoir) in terms of a share of the available active storage capacity, whereby each entitlement holder receives a share of inflows and outflows, reduced for evaporation and seepage loss. These entitlement holders would then collectively determine the releases from the dam that they need, allowing users to manage their own water supply and the associated risks of supply shortfalls across seasons.

An opportunity exists for a willing "market maker" to not only establish the rules for transactions, but also receive a percentage of the transaction costs in exchange for providing a well-functioning trading market.

Further, in the event that carryover credits are made transferable between reservoir users, these types of carryover and storage rules can vastly expand potential trading opportunities as water users would have the ability to store and trade seasonally available water on a year-to-year basis or potentially over multiple years. This market liquidity could also help encourage greater use of the storage mechanism, since parties can trade or sell accumulated credits and receive compensation for foregone use even if they do not later have a value-added use for the stored water themselves. This trading market would help establish pricing for water in the specific reservoir, which would largely be absent even if the water rights themselves could be transferred.

While adoption of such carry-over rules is a potentially easy way for reservoir operators – whether at the federal, state, or district level – to encourage water trading, the operation of a water exchange obviously falls outside of the typical interests and responsibilities of reservoir operators, who are generally set up to plan and operate under fixed delivery rules and hydropower schedules. Therefore, an opportunity exists for a willing "market maker" to not only establish the rules for transactions, but also receive a percentage of the transaction costs in exchange for providing a well-functioning trading market.

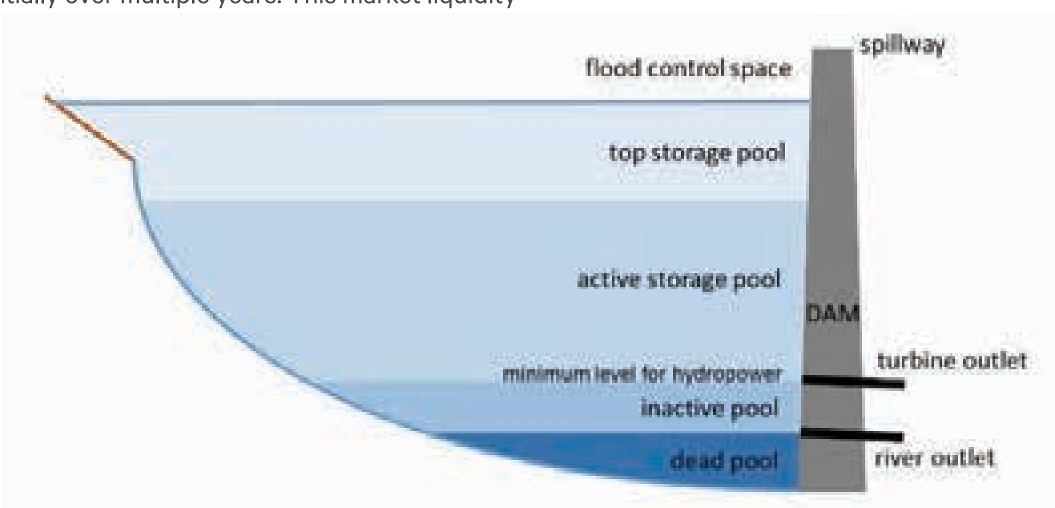


Figure V(D)(2)-8. Distribution of reservoir water allocation with "top storage" pool for carryover storage space.

There exist some examples of carryover storage in reservoirs; however, each reservoir is managed differently, and the priorities vary among key stakeholders. Implementation of any carryover mechanism requires a reservoir operator to allow at least a portion of available storage space to be used for temporary "carryover" storage. Typically, this can be treated as "top storage" within the reservoir – i.e. water that is held on top of the normal storage and/or that occupies space normally reserved for flood control. In the event of a flood, the "top storage" spills first, so this stored water can be lost. This prevents harm to other users that would otherwise occur if the active storage was utilized. However, since the water can be withdrawn prior to a flood event, and since demand for water tends to be low during flood conditions, this does not necessarily render top storage unattractive.

Figure V(D)(2)-9. Hoover Dam, the storage and hydropower dam that maintains the massive Lake Mead reservoir. Image courtesy of U.S. Bureau of Reclamation.

An excellent example of this type of storage program is the Intentionally Created Surplus (ICS) mechanism currently utilized in Lake Mead. However, this particular program does not presently allow for the active trading of storage credits.

INTENTIONALLY CREATED SURPLUS PROGRAM

The ICS Program is operated out of Lake Mead by the U.S. Bureau of Reclamation, pursuant to the provisions of the December 13, 2007 Record of Decision, Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead ("Interim Guidelines"), which establishes the rules for operation of the Lake Mead reservoir by Reclamation. The ICS mechanism allows a Colorado River contractor to "conserve" Colorado River water that would otherwise have been used in a particular year and retain it in Lake Mead storage for delivery in a subsequent year (to the same contractor or another contractor in the same state).

Under the ICS program, "surplus" Colorado River water, in the form of "ICS credits," may be created using a variety of water conservation or system augmentation measures that either (a) reduce the amount of Colorado River water that is currently in use or that (b) otherwise increase the amount of Colorado River water available for delivery to users within the United States. The resulting ICS credits can be stored in Lake Mead for future delivery, subject to certain "charges" to account for evaporation (3% per year) and to generate benefits for the reservoir system storage as a whole (via a one-time 2% "system charge"). ICS credits are effectively treated as a "top storage pool" that spills first during flood control releases if not previously withdrawn by the storing entity. Because ICS credits cannot be delivered during very low reservoir conditions (below elevation 1075 feet in Lake Mead), stored ICS credits thus serve to hold reservoir levels relatively higher and prevent shortages during dry conditions.

The Interim Guidelines define a detailed process by which ICS credits are to be created, accounted for, and delivered (subject to interstate forbearance and Reclamation approvals) that is beyond the scope of this report. In essence, however, there are four allowed types of ICS credits under the program: Extraordinary Conservation ICS, Tributary ICS, System Efficiency ICS, and Imported ICS. Extraordinary Conservation ICS, the category most relevant to this discussion, can be created through activities that result in the conservation of mainstream water that would have been otherwise consumptively used (or lost to the system) pursuant to a Colorado River delivery contract. A contractor may create extraordinary conservation ICS by fallowing land that is currently and historically irrigated, lining delivery or drainage canals, creating "new" water from a source outside the Colorado River system that allows mainstream river diversions to be proportionately reduced, and other mechanisms that the Lower Basin states may agree on pursuant to a master, multi-party Forbearance Agreement.[4] The total quantity of such ICS credits that can be generated in a single year is limited for each Lower Basin State. California contractors, for example, are restricted to a maximum creation or delivery of 400,000 af of ICS credits per year.[5]

To enable the ICS program, as part of the Interim Guidelines, water users in the Lower Basin States that would otherwise be entitled to the delivery of surplus water from Lake Mead agreed to forbear from the use of water used to generate ICS credits pursuant to a multi-party Forbearance Agreement[6] that identifies the

3 Castle, S., et. al. (2014). Groundwater depletion during drought threatens future water security of the Colorado River Basin. Geophysical Research Letters.

4 Interim Guidelines, p. 38.

5 Interim Guidelines, p. 41-42.

6 December 13, 2007 Lower Colorado River Basin Intentionally Created Surplus Forbearance Agreement among the Arizona Department of Water Resources, Palo Verde Irrigation District, Imperial Irrigation District, City of Needles, Coachella Valley Water District, Metropolitan Water District of Southern California, Southern Nevada Water Authority, and the Colorado River Commission of Nevada.

specific projects and types of projects that will be treated as ICS. This mechanism allows the Secretary to deliver ICS program water outside of the regular system for the allocation of surplus water and unused apportionment provided for in the Arizona v. California decree.[7] In the absence of the Forbearance Agreement, users on the Lower Colorado River would be subject to “use-it-or-lose-it” incentives similar to those that prevail in other Western reservoirs.

Finally, it is important to note that Extraordinary Conservation ICS credits generated from one Contractor’s water may be used by another contractor located in the same state that either (a) funded or implemented the ICS project, or (b) has a written agreement for the transfer of the ICS credits with the entity that actually funded the project.[8] This latter mechanism allows for some limited “trading” of water using the ICS mechanism, since one party can fund another party to generate ICS credits and receive the resulting credits in exchange for that funding. However, the arrangement for such transfers effectively has to be defined in advance, which prevents the development of a market in ICS credits.

WATER BANKS

As discussed in Section V(D)(1), another formal mechanism that has been used in western states for pooling surplus surface and underground water rights for rental to other users is a water bank. Water banks are designed to facilitate transfer agreements that allow users who can cheaply reduce their consumption to sell their water rights to users who cannot afford to reduce consumption. In addition to encouraging transfers, water banks seek to create water supply reliability during dry years and across seasons, increase efficiency of use, and free up water for new uses. The ability to transfer unused water creates an incentive to conserve and deposit water rights into a water bank. In order to encourage participation, states usually have provisions that exempt water rights participating in a water bank from statutory forfeiture rules. Fundamentally, the purpose of a water bank is to bring buyers and sellers together to complete transactions, and to reduce the time and costs associated with traditional water rights changes.

Table V(D)(2)-1. Examples of Water Banks Operating in the Colorado River Basin

Arizona	Arizona Water Bank
California	Drought Water Bank • Dry Year Purchasing Program
Colorado	Arkansas River Basin Bank • West Slope Bank (not operational)
Nevada	Truckee Meadows • Groundwater Bank • Interstate Water Bank
New Mexico	Pecos River Basin Water Bank • Pecos River Acquisition Program
Utah	No established water bank
Wyoming	No established water bank

Water banks can vary greatly in their geographic scope. Some banks may operate locally for a specific urban area, while others may cover broad, multi-state, regions. Water banks operate in four principal ways: (1) providing for trading in reservoir surface storage; (2) trading in underground aquifer storage; (3) facilitating transactions among entitlement holders; (4) and providing institutional banking services, such as a water trust. Depending on the context and applicable rules, water banks have been operated and administered by public agencies, private nonprofit organizations, private for-profit organizations, and public-private partnerships.

7 Arizona v. California, 376 U.S. 340 (1964).

8 Interim Guidelines, p. 41.

While a number of western states have expressed interest in establishing water banks, they have not always been effective. For example, the Arkansas River Basin Pilot Water Bank was approved by the Colorado legislature in 2001 in order to establish a program for one-year agricultural-to-urban transfers of stored water rights without requiring permanent transfers of water rights out of agriculture. The purpose of the bank was to simplify water transfers, reduce associated costs, and increase available information. Although rules were adopted in 2002 and the bank became operational by 2003, there was limited participation due to the lengthy review period (two to three months for a 1 year lease) and bidders' complaints that asking prices by farmers were too high ($500 - $1,000/af).

As noted in Section V(D)(1), several Upper Basin interests are exploring the potential to create an Upper Basin Water Bank that would operate on the Colorado River and help to reduce the risks of a Compact Call against Upper Basin users.

ISSUES WITH CURRENT APPROACHES TO WATER STORAGE TRADING

Although the cases above provide some limited examples of reservoir storage trading, storage trading is a relatively new concept in the West and has only been implemented in a small number of places. It is important to note, however, that it will not be possible to implement storage trading-based solutions everywhere. The ability to engage in reservoir trading will be inherently limited by the rules and regulations controlling the operation of individual reservoirs, particularly where reservoirs are federally-managed. However, to the extent that rules could be altered to allow it, many Basin reservoirs are large enough to at least theoretically support trading among multiple users.

It is also important to recognize that these storage trading solutions are unlikely to develop without a deliberate effort (or a catalyzing local event that forces change). Reservoir operators have traditionally focused on hydropower production and the management of reservoirs (under the existing use-it-or-lose-it rules) to meet the storage and water delivery obligations associated with water rights and downstream delivery obligations; those operators do not necessarily have the capacity or interest to independently undertake the investigation, implementation and operation of a storage trading program on their reservoirs. However, this concept creates interesting potential opportunities for private capital to finance the development, creation, and operation of these trading systems at the outset in a manner that could generate meaningful investment returns in the future.

GROUNDWATER STORAGE TRADING

As noted in the background report, a few states do comprehensively regulate groundwater use. There are also efforts to expand regulation in other states out of the growing recognition of 1) the substantial threat that unrestricted groundwater development represents to private property rights in overlying land and connected surface water, and 2) the substantial physical, environmental, and economic risks associated with uncontrolled groundwater overdraft and the depletion of shared aquifer resources.

Where groundwater use is regulated, groundwater rights have frequently quantified and allocated groundwater use within defined hydrologic basins in a manner designed to protect surface water users from the impact of groundwater pumping (e.g. Colorado's integrated appropriative system). Groundwater rights have also allocated groundwater among water users based on "sustainable yield" budgets that ensure groundwater withdrawals do not undermine the contribution of groundwater-to-surface water systems or degrade the environment.

To control the drilling of new wells, some states require that new pumpers offset or mitigate aquifer impacts by acquiring and retiring an existing pumper's rights. Utah's demand offset system provides one example of how this can work. This system does not ban new development, but rather insists that new users offset the demand they will place on the public supply by purchasing and retiring an existing user's water rights. There are also examples of local governments who are either expressly authorized to (or have otherwise undertaken to) link land use decisions with available water supply. Where this is allowed, these requirements can facilitate the development of local water markets that drive improvements in efficiency and reallocation of water rights. Since 2005, Santa Fe has been requiring developers to ensure that their water rights are established before submitting building applications. This had led to a trend in developers purchasing water rights from farmers, increasing the value of those rights.

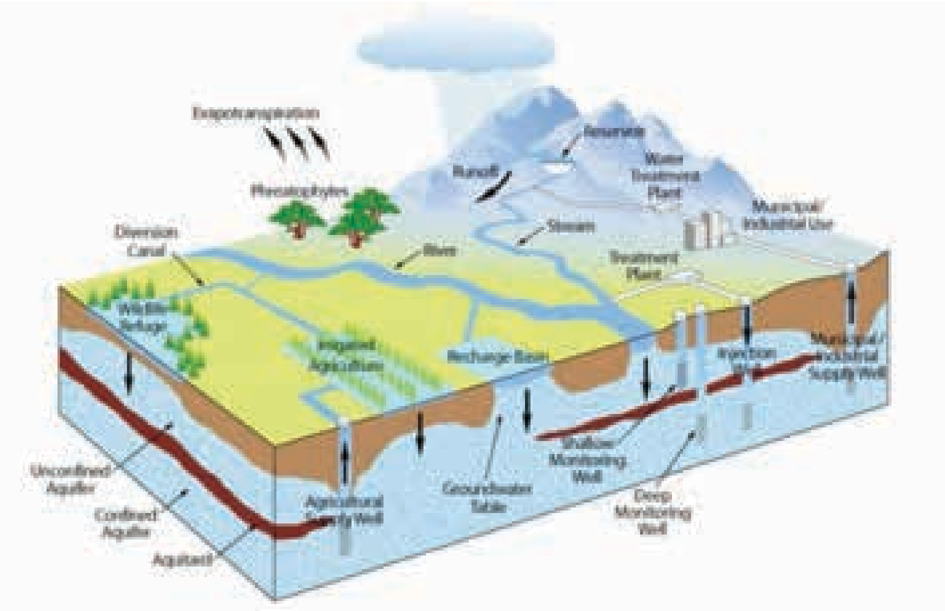


Figure V(D)(2)-10. Example of a more sophisticated approach to aquifer management that reflects the active maintenance of multiple values associated with an aquifer through controls on groundwater use, monitoring activities, and active recharge through injection wells, recharge basins, and use of "natural recharge infrastructure" via wetlands and stream flow. Image courtesy of California Department of Water Resources.

Once groundwater rights systems are established, it becomes possible to develop complementary activities and infrastructure to manage actively manage aquifer storage through recharge activities, controls on new or existing groundwater extractions, and similar measures. These can result in relatively sophisticated approaches to aquifer management that reflect and protect the multiple values – municipal, agricultural, industrial, and environmental – associated with the use and character of groundwater aquifers. See Figure V(D)(2)-10. These regulatory frameworks can then also allow for the creation of incentives to conserve and increase groundwater storage through trading of groundwater. The sections below provide two examples, the storage trading program allowed under Arizona's Groundwater Management Act, and a privately-run storage trading system in Nebraska, of how this can operate in practice.

ARIZONA GROUNDWATER TRADING PROGRAM

Arizona operates a groundwater trading program that is by far the most sophisticated in the Colorado River Basin states. The Arizona Groundwater Management Act of 1980 (GMA) was passed in response to widespread concerns related to groundwater overdraft in the Phoenix and Tucson metropolitan areas and several key agricultural regions that needed to be resolved (as a result of federal conditions on funding) in order to secure the development of the Central Arizona Project (CAP).[9] The GMA limits groundwater use in Active Management Areas (AMAs) and Irrigation Non-Expansion Areas (INAs) and establishes specific management goals for regional aquifers.[10]

Figure V(D)(2)-11. Arizona's Active Management Areas and Irrigation Non-Expansion Areas, courtesy Arizona Department of Water Resources.

The GMA also creates requirements and incentives for greater use of more sustainable non-AMA groundwater, effluent, surface water, and CAP water in Arizona's metropolitan areas. These include restrictions on new development in AMAs that require developers to demonstrate that they have access to a 100-year "Assured Water Supply" whose use will be consistent with the management goals for the AMA prior to the issuance of subdivision permits. Successive 10-year Management Plans for each AMA address the types of water use, conservation requirements, and overall use limitations associated with a series of commercial, industrial, agricultural, and residential water uses within each AMA. These include the amount of water available to individual permitted water users (such as golf courses) as well as the amount of water available under individual groundwater rights.[11]

Within the AMAs, the use of groundwater by individual users is limited by a system of groundwater rights and groundwater use permits. These rights consist generally of three types: Irrigation Grandfathered Rights (IGRs), Type 1 Non-Irrigation Grandfathered Rights, and Type 2 Non-Irrigation Grandfathered Rights.[12] Each type of right has different restrictions associated with it and is subject to different rules regarding transfer or conversion for alternative uses.[13] For example, IGRs (which are derived from historic agricultural uses) are limited to irrigation

9 See Ariz. Rev. Stat. §§ 45-401 et seq.
10 See id. §§ 45-411 to -440.
11 See generally Pinal AMA Management Plan, supra n.18, Chapter 6.
12 Id. §§ 45-463 to -465.
13 See id. §§ 45-470 to -474

use on specific lands and can only be converted to other uses under certain conditions.[14] The quantity of water used under an IGR is revised in each successive management plan (which generally require increased efficiency over time).[15] By contrast, Type 2 rights (which arise from historic non-irrigation uses)[16] may be freely transferable anywhere within an AMA, although rights associated with certain types of uses (such as mining operations) can only be transferred for the same type of use.[17]

Fourteen years after the passage of the GMA, Arizona adopted additional legislation to provide for groundwater recharge programs that authorize permitted users to store, save, replenish, or recover water in Arizona's aquifers within the general framework of the GMA.[18] Storage of water can occur at either an underground storage facility (USF) or a groundwater savings facility (GSF). At a USF, the aquifer is physically recharged with CAP water, effluent, or water from other sources.[19] By contrast, GSFs provide a mechanism by which "in lieu water"[20] from a renewable water supply can be used as a substitute for groundwater use that would otherwise have occurred within an AMA or INA on a gallon-for-gallon basis.[21] However, it is important to note that groundwater storage activities are generally subject to a "cut to the aquifer" that taxes groundwater storage by only granting credits to less than 100% of the water that was stored, producing net gains to aquifer storage even after water is recovered.

Once water is stored in a permitted facility, an equivalent volume of water can be recovered from a different well in the same year (known as "annual storage and recovery"), or else the stored water can be accrued as Long-Term Storage Credits (LTSCs) by the entities undertaking the storage. LTSCs are usable in a variety of ways, including to demonstrate Assured Water Supply requirements, to be held in place for the benefit of the aquifer, or to authorize future extraction of groundwater at the same location or elsewhere within the same aquifer.[22] These credits can also be freely transferred within the same AMA to other users who can use those credits for any of the purposes noted above. This transferability has created a relatively active market in LTSCs among groundwater users.

One of the most substantial recharge programs is managed through the Central Arizona Groundwater Replenishment District (CAGRD), which was established in an effort to ease the requirements for compliance with the assured water supply program – demonstrating consistency with AMA management goals.[23] Landowners and water providers can demonstrate consistency with the AMA management goal by becoming members of the CAGRD and paying a fee to the CAGRD for the privilege of withdrawing groundwater.[24] In exchange, CAGRD replaces the groundwater withdrawn by its members by purchasing and replenishing this water with water derived from renewable supplies or supplies derived from

14 See id. § 45-472.
15 See id. § 45-465.
16 See id. § 45-464.
17 See id. § 45-474.
18 Id. § 45-801.01, et. seq.
19 Id. § 45-811.01.
20 Id. § 45-802.01(9).
21 Id. § 45-812.01.
22 See generally id. at §§ 45-801.01, et seq.
23 See id. §§ 48-3771 to -3784. CAGRD operates as a division of CAWCD, the entity responsible for operation of the CAP canal.
24 See id. §48-3771(B).

outside of the AMA,[25] including LTSCs generated by other users and water from the CAP.[26]

Another significant player in Arizona's storage system is the Arizona Water Banking Authority (AWBA), which was established in 1996 to simultaneously increase utilization of the state's Colorado River entitlement while helping guarantee the future availability of water to CAP customers by storing excess Colorado River water in Central Arizona aquifers.[27] The AWBA effectively operates as an insurance policy for the CAP by banking unused Colorado River water derived from the CAP to be used in times of shortage and securing those water supplies for Arizona, Nevada and California. The latter two states participate in the Water Bank under federal interstate water banking regulations.[28] Each year, AWBA pays the delivery and storage costs to bring Colorado River water into central and southern Arizona through the CAP, and then stores this water underground to generate LTSCs. When backup supplies are needed due to a shortage on the CAP or a withdrawal by Nevada or California, these stored credits can then be extracted from the groundwater aquifers in which they are held to meet the needs of CAP users.

MAMMOTH TRADING

Trading water rights is generally time consuming and can be costly to execute. In the absence of centralized exchanges, potential participants have difficulty locating each other and determining a fair price, while regulations surrounding transactions are generally numerous and complicated. As a result, few active markets in either surface or groundwater rights have developed even where these rights are in fact tradeable. One marketplace for groundwater trading that has recently developed, however, is gaining recognition on a national level.

Researchers at the University of Nebraska and University of Illinois at Urbana-Champaign created a platform that could facilitate transactions of resource rights, where an algorithm matches potential buyers and sellers while ensuring that transactions are compliant with all relevant regulations. Mammoth Trading is a private firm that grew out of that research and so far has a single client: the Twin Platte Natural Resources District (TPNRD) in Nebraska. Mammoth and TPNRD designed a platform to facilitate the exchange of certified irrigated acres, taking what is normally an extremely laborious process, and creating a marketplace that is not significantly more difficult to navigate than eBay.

Under the Mammoth Trading system, market participants are given two months – the length of time the market is open – to identify propert(ies) where they would like to transfer irrigated acres. Sellers state the minimum price they will accept while buyers state the maximum price they are willing to pay. Mammoth then works with the participants to ensure that any changes to their respective lands are acceptable to the TPNRD for exchange, and the transactions are kept anonymous and confidential.

After the market closes, the algorithm matches buyers and sellers, taking into account the various water regulations concerning flow line boundaries, stream depletion factors, slope, etc. Differences in buyers' and sellers' prices are split evenly so that successful participants receive a better price than what they posted. Mammoth then provides participants all necessary paperwork and instructions for completing the transaction with the TPNRD, and performs a title search on all properties, including checking on any liens. If a single large buyer is

25 Id.
26 Id. § 48-3371(C). *27 See Ariz. Rev. Stat. §§ 45-2401 et seq.*
28 See id. § 45-2571.

matched with many sellers (or a single seller has several buyers), Mammoth consolidates all transactions into a single payment and then charges an equal transaction fee to both the buyers and sellers. The entire process under this system takes roughly six weeks to complete a transaction.

Thanks to local regulations that create a “buffer zone” around the Platte River and that give greater tradable credit when the point of extraction for groundwater rights is moved away from the River, this trading platform is also gradually helping to reduce groundwater pumping in the vicinity of the River, reducing the long-term ecological risks to the resource.

ISSUES WITH CURRENT APPROACHES TO GROUNDWATER STORAGE TRADING

Where groundwater storage trading is expressly authorized, existing programs suffer from poor information related to storage credits. Even the sophisticated Arizona market is conducted mostly by email and through informal networks of attorneys and water managers. There is no centralized exchange, and as a result, there are few participants. Players are typically large water users like the CAGRD who maintain staffing and legal resources necessary to identify willing sellers and investigate and close LTSC transactions.

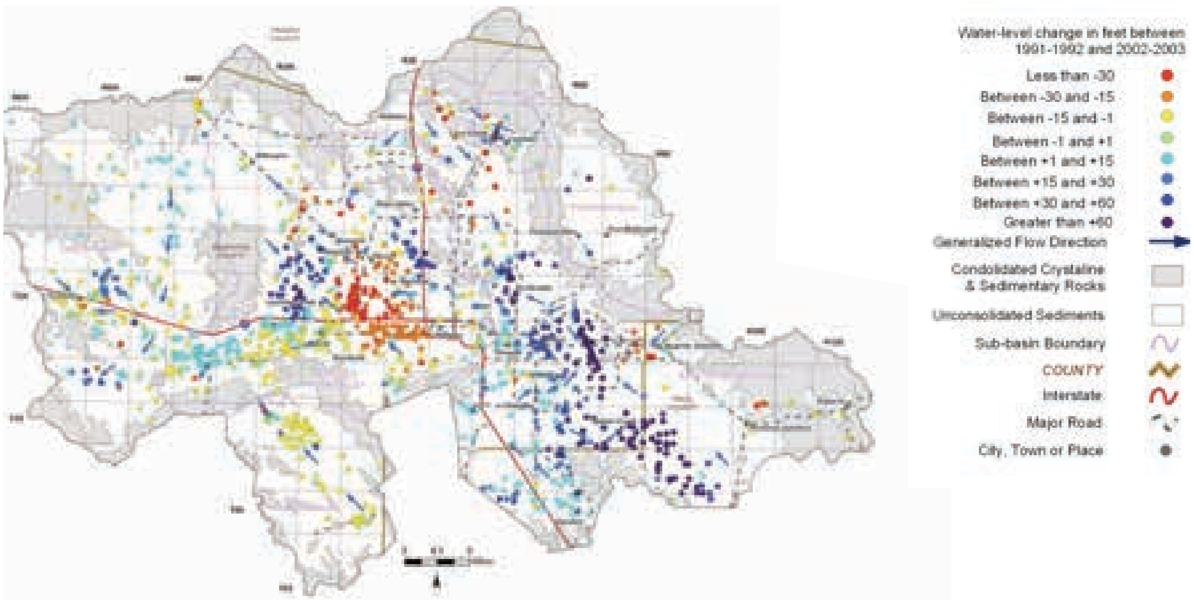


Figure V(D)(2)-12. Expected groundwater deficits (in orange and red) and surpluses (in green) in the Phoenix AMA, correlating to the location of groundwater pumping effort and the location of recharge sites; image courtesy of the Arizona Department of Water Resources.

Storage trading systems may also inadequately address local “area of impact” issues. For example, Arizona’s storage trading system does not distinguish between geographic locations in an aquifer for creation versus withdrawal, such that recharge credits may be being generated in a location that is hydrologically remote from the point of withdrawal. This has resulted in uneven aquifer conditions within the Phoenix AMA where groundwater conditions are favorable near recharge sites but poor in withdrawal areas that are not benefiting from recharge facilities.

The most significant issue for the implementation of groundwater storage trading, however, is a lack of effective groundwater regulation. As noted above, groundwater is largely unregulated in a number of states, which makes recognition or transfer of storage credits difficult. Where groundwater is unregulated or poorly regulated, addressing these deficiencies will be essential to allow for the use of storage trading solutions in the Basin.

However, even in the absence of state-level regulation of groundwater resources, local jurisdictions and land use authorities can offer a variety of options for local regulation and management of water resources. For example, Cochise County, home to the threatened San Pedro River, has adopted local land use regulations that effectively create a protective "buffer zone" around the River, offering incentives in the form of "density credits" to locate development (and with it, new groundwater extraction) outside of the "buffer zone." In combination with other efforts, such as the purchase and retirement of local irrigated farmland by The Nature Conservancy, these kinds of controls have helped to reduce and limit future pumping near the River and restore some surface flow that had been depleted by near-stream pumping.[29] These efforts may only scratch the surface of what could be undertaken through locally-coordinated efforts; as discussed in Section V(D)(1), the potential scope of local control over water through land use planning and zoning, conservation requirements, utility operation, infrastructure construction, financing, incentives, and other means is actually quite broad, and can potentially be coordinated across local jurisdictions through intergovernmental agreements, which are broadly authorized in the Basin.

As another example, Environmental Defense Fund, with support from the Walton Family Foundation, has been actively exploring the potential to create a voluntary groundwater mitigation bank for protection of the Verde River in Arizona, essentially modeled after successful groundwater banks in the Pacific Northwest (such as the Deschutes Water Bank, discussed in Section V(D)(1)). Instead of relying on regulatory mandates associated with groundwater use (which are available in the Pacific Northwest, but are effectively unavailable in rural Arizona), the program would create a market in voluntary mitigation "credits" that would demonstrate the commitment of businesses, agricultural enterprises, and other interests to protect the River, building on local campaigns to boost awareness of the importance of the resource and increase tourism and tourism-related revenues associated with the River.

3. Proposed Solution

To provide for the broader deployment of storage trading solutions in western reservoirs and groundwater basins, private capital could be used to develop, implement, and operate storage trading facilities in both surface water reservoirs and aquifers. These facilities could be created in environments where state and federal regulations and policies, or coordination by local jurisdictions, have created the essential enabling conditions to engage in the trading of reservoir storage or groundwater storage.

29 Forest Legacy Project proposal. (2010).

In order to establish an effective storage exchange tool, key characteristics of a storage trading exchange should include:

- A "plug-and-play" market-based water exchange that can be established in existing surface water reservoirs and/or groundwater aquifers and that can be used by entities with rights to withdraw water from storage in those reservoirs and aquifers;
- Defeats current "use-it-or-lose-it" incentives and tragedy of the commons problems associated with storage reservoirs and open-access groundwater aquifers and generates pricing information with regard to water in surface or groundwater storage;
- Creates incentives to forego use of surface water to which a user is otherwise entitled and/or engage in deliberate storage of water in aquifers in exchange for a transferable credit usable toward future withdrawals;
- Provides centralized information with regard to the availability of storage credits to potential market participants and facilitates storage and trading activities;
- Utilizes exchange rules to support regulatory objectives and generate environmentally-beneficial outcomes for surface flows and groundwater utilization;
- Charges fees and "taxes" exchange transactions in order to produce revenues necessary for exchange operation, payment of investment returns, and water needed for select environmental purposes.

The proposed storage exchange tool would be structured to generate ongoing returns from the establishment and operation of a water storage trading facility utilizing existing physical reservoir storage or underground storage in water-limited systems. By allowing the development and trade in storage credits among water users, such storage facilities would provide a variety of physical and price hedging options and tools to water users to manage physical risks and control speculation. The mechanism would also allow for insurance-type arrangements to cover water users and/or critical ecological values, while providing a return to the storage facility operator and underlying investor via transaction fees and a "tax" on storage transactions, along with the direct marketing of storage credits and services developed in the facility. By managing risks to water users, this tool can limit the ecological risks and pressures that would otherwise be associated with sudden, catastrophic shortfalls, incentivize changes in water withdrawals in a manner that will protect stream flows, and develop water supplies that can be used to meet ecological needs.

The outline below attempts to uncover the investment opportunities in water storage trading; however, given the array of the services that could be provided, and the variability of revenue and costs in establishing trading markets, no specific financial model was developed for the strategies discussed below.

A. Reservoir Storage Trading

For purposes of trading in reservoir storage, the structure would involve several components, as follows:

(1) An investment by third-party investors into a special purpose vehicle (SPV) entity established for purposes of operating one or more water exchanges.

- The SPV receives funds for investigation, start-up, and initial operation (first 2-3 years) from investors, plus guarantee of wind-down costs in event that the exchange is unsuccessful.
- Investors receive a payment stream from the SPV entity based on fees charged for exchange transactions and marketing of "tax" water generated through the creation and transfer of water.
- Investors receive tax benefits associated with dedication of water to environmental purposes.

(2) An agreement for the operation of the exchange between the current reservoir operator and the SPV entity, establishing the terms on which the exchange will operate. Terms would include:

- Defining rules pursuant to which storage credits can be created, stored, transferred, and ordered for delivery through the reservoir without disrupting reservoir operations (e.g. annual limits on the creation of storage credits, total storage availability within the reservoir, annual limits and/or timing limits on the delivery of stored water, deadlines for storage scheduling and delivery orders).
- Defining rules for the treatment of storage credits within the reservoir (e.g. if stored water will be top-water banked, accounting for losses during spills) and the relationship and communications between the SPV and the reservoir operator (delivery schedules).
- Defining special limitations and rules for system stability, e.g. limitations on withdrawals to protect critical reservoir operations (minimum power pool, dead pool, etc.).

(3) If necessary, an agreement among the SPV and reservoir users to enable the creation, storage, and delivery of credits via the exchange.

- Agreement by users who would otherwise be entitled to the use of water forgone by one user to forbear from the use of that water to enable creation of storage credits, and agreement to allow the delivery to a storing party, irrespective of otherwise applicable priorities.
- Agreement by users as to what sorts of conservation actions, forbearance actions, or other activities will be recognized as "legitimate" sources of created storage credits.

(4) A centralized exchange established by the SPV that allows for the creation, storage, transfer, and delivery of storage credits. The exchange would:

- Provide uniform rules for deferring delivery of water from the surface water reservoir, the recognition and verification of storage credits, accounting for stored credits, the transfer of storage credits from one party to another, and the ordering and delivery of stored water.
- Provide a transparent platform for the storage and transfer of credits, including an open "market" and supply-demand matching service. Necessary paperwork for water rights transfers would be vastly simplified through the exchange on behalf of exchange users.
- Apply water "taxes" (a portion of credits created or transferred) that allows the exchange operator to retain a portion of the storage credits passing through the exchange, and assess those "taxes" in a manner that incentivizes or generates environmentally-beneficial use of storage, e.g.:
    - A higher storage tax assessed for storage during low-flow periods when downstream flows are needed for environmental purposes, a lower tax (or avoided tax) during higher-flow periods.
    - Reduced tax for storage during low-flow periods, when water is needed in-stream.
    - Release of "taxed" water during critical low-flow periods to provide in-stream flow, or retention of "taxed" water in reservoir storage during critical low reservoir conditions to reduce the risks of catastrophic shortages.
    - Sale of "taxed" water to generate funds for environmental restoration needs.
- Assess fees for the creation, storage, transfer, and delivery transactions to generate funds necessary to operate the exchange and generate reasonable returns to the underlying investor.

HYPOTHETICAL CASE STUDY (RESERVOIR STORAGE)

A tributary watershed to the Colorado River contains several independent farm enterprises, two irrigation districts, and two downstream municipalities all served by a common storage reservoir. The reservoir is operated by one of the irrigation districts and generates hydropower revenues that fund reservoir maintenance as well as pay for operating costs of the irrigation district, which keeps water costs lower for farmers.

The existing reservoir rules create use-it-or-lose-it incentives for all participants. In addition, modeling and past experience show that drought conditions can drive the reservoir below the minimum power pool in the event of a multi-year drought, unless significant reductions in use occur.

The river downstream of the reservoir is subject to low-flow risks that jeopardize environmental values in-stream (e.g. fish runs), creating potential future regulatory risks and affecting recreational/fishing values important to local tourism. It also creates risk of future Endangered Species Act-driven enforcement.

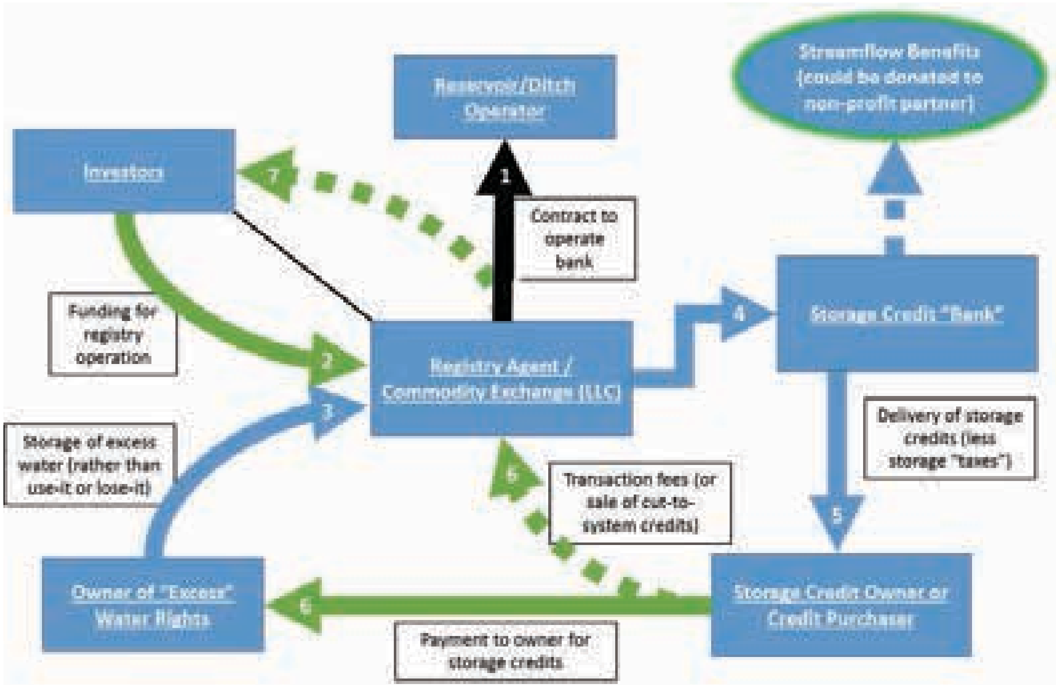


Figure V(D)(2)-13. Structure of Reservoir Storage Trading Mechanism.

HYPOTHETICAL TRANSACTION[30]

1. An investor-supported SPV proposes the operation of an exchange of the existing reservoir and negotiates an exchange operation contract with the reservoir operator that allows for the creation, storage, and delivery of credits. Credits will be top-water-banked within the flood control space of the reservoir so as not to affect existing users and will be subject to an annual evaporation charge when they are carried over to a following year.

2. The SPV also negotiates a forbearance agreement with the primary reservoir users (city, irrigation district, and all but one recalcitrant farming enterprise) in which users agree that conservation activities that result in a net reduction in deliveries out of the reservoir (as compared to recent average use) will qualify as storage-credit generating activities, and users will not attempt to order water when stored or delivered.

30 For tax purposes, the registry agent would have ordinary income from the fees paid to it, while the users who store and transfer water rights for consideration will have ordinary income equal to the payments they receive. The investors in the registry agent would recognize income based upon whether they are positioned as lenders or as equity owners in the registry agent.

3. The SPV establishes an exchange allowing for the creation, storage, transfer, and delivery of reservoir credits among reservoir users. In addition to annual evaporation charges, a "tax" is assessed against water when it is first stored. To incentivize storage during critical periods when reservoir levels are falling, storage taxes are reduced during low-flow conditions. For deliveries, water taken during high-flow or normal conditions is not taxed. The SPV collects net "tax" water and releases it to maintain instream flows during critical low-flow periods in reaches below the reservoir. Once the SPV has developed a reasonable "bank" of stored water that can be used to protect instream flows below the dam, and excess storage credits could then be marketed to generate revenues that could be donated to restoration efforts.

4. The SPV also assesses monetary fees for transactions through the exchange, which are used to pay operating costs of the exchange and pay returns to investors.

5. The irrigation district undertakes savings programs that result in credits generated over many years. Some credits are retained to ensure availability of minimum water amounts to permanent crops in the district for up to a maximum number of consecutive water years. Remaining credits are marketed to other users, including the municipalities.

6. Municipality A contracts with individual farmers to install conservation infrastructure and resulting saved water is used to generate credits each year in the reservoir for the municipality to help support new growth in the service area. This municipality also purchases excess credits from the irrigation district and Municipality B as necessary to establish a strategic reserve.

7. Municipality B invests in a conservation program that generates excess credits each year that are held in a strategic reserve and also purchases storage credits from the irrigation district and the SPV as necessary to insure a portion of its water supply against shortfalls. Once target reserves are achieved, Municipality B markets excess credits to Municipality A.

8. Results: Independent farmers conserve water and receive infrastructure upgrades free of charge. The irrigation district protects high-value permanent crops and develops a new revenue source that pays for investments in infrastructure. Municipality A obtains water supply necessary to support a new growth area and establishes a strategic reserve. Municipality B insures at least a portion of its water supply against drought. System risks as a whole are reduced as the reservoir is now less likely to reach minimum power pool level due to the amount of water stored and incentives to reduce deliveries during low-flow conditions, reducing shortage risks and risks to essential hydropower revenue. In-stream flows are enhanced during low-flow conditions below the reservoir through a combination of behavioral changes around water orders and the dedication of water to in-stream flow by the SPV operator.

B. Groundwater Trading

For purposes of trading in groundwater credits, the structure would involve several components, as follows:

(1) An investment by third-party investors in an SPV entity established for purposes of operating one or more water exchanges.

- The SPV receives funds for investigation, start-up, and initial operation (first 2-3 years) from investors, plus a guarantee of wind-down costs in the event that the exchange is unsuccessful.
- Investors receive a payment stream from the SPV entity based on fees charged for exchange transactions and the marketing of "tax" water generated through the creation and transfer of water.
- Investors receive tax benefits associated with dedications of water toward public/environmental purposes.

(2) An agreement for the operation of an exchange between the local groundwater regulator (this could be a state agency, a local jurisdiction, or a Joint Exercise of Powers Agreement (JEPA) organization composed of multiple local jurisdictions) and the SPV entity, establishing the terms on which the exchange will operate. Terms would include:

- Defining rules pursuant to which storage credits can be created, stored, transferred, and extracted from the aquifer, limits on total storage in each recharge location, and relevant limits on groundwater withdrawals.
- Defining rules for the treatment of storage credits within the aquifer (e.g. if stored water will be protected from withdrawal, rules for those protections) and the relationship and communications between the SPV and the regulator.
- Defining special limitations and rules for system stability (e.g. limitations on withdrawals in critical groundwater areas where large cones of depression have formed and/or where subsidence issues are significant, buffer zones for withdrawals around perennial stream systems, incentives for recharge in problem areas or in areas that protect surface water resources).

(3) Creation or operation of recharge facilities by the SPV where recharge credits will be generated. Options include:

- A contract to engage in source substitution for an existing water user (i.e. a groundwater savings facility).

- An underground storage facility where water is deliberately infiltrated.
- An exchange using existing underground storage (USF) / groundwater savings (GSF) facilities, with the exchange operation facilitating the use of the existing permit system.

(4) A centralized exchange established by the SPV that allows for the creation, storage, transfer, and extraction of groundwater storage credits in recharge facilities and from new or existing wells. The exchange would:

- Provide uniform rules for the creation, recognition and verification of storage credits, accounting for stored credits, the transfer of storage credits from one party to another, and the extraction and reporting of stored water.
- Provide a transparent platform for the storage and transfer of credits, including an open "market" providing listings of offer and bid prices and volumes, as well as supply-demand matching services to help parties, particularly small users, locate one another and aggregate available credits if necessary to meet specific demands. Paperwork for the creation, transfer, and withdrawal would be simplified by the exchange on behalf of its users.
- Apply water "taxes" (a portion of credits created or transferred) that allow the exchange operator to retain a portion of the storage credits passing through the exchange, and assess those "taxes" in a manner that incentivizes or generates environmentally-beneficial use of storage, e.g.:
    - Higher storage tax assessed for storage in areas remote from groundwater demands, lower tax for storage near demand centers, avoided tax or tax credit for recharge near surface streams where storage will sustain or enhance base flows.
    - Increased tax for withdrawals in high demand areas or within buffer zones near perennial streams; no tax for withdrawals in low demand areas or outside of riparian buffer zones.
    - Prohibition of withdrawal of credits from new wells within riparian buffer zones, unless credits are generated in the immediate area of impact of those withdrawals.
    - "Taxed" water is retained in storage for long-term system benefit.
- Assess fees for creation, storage, transfer, and extraction transactions to generate funds necessary to operate the exchange and generate reasonable returns to underlying investors.

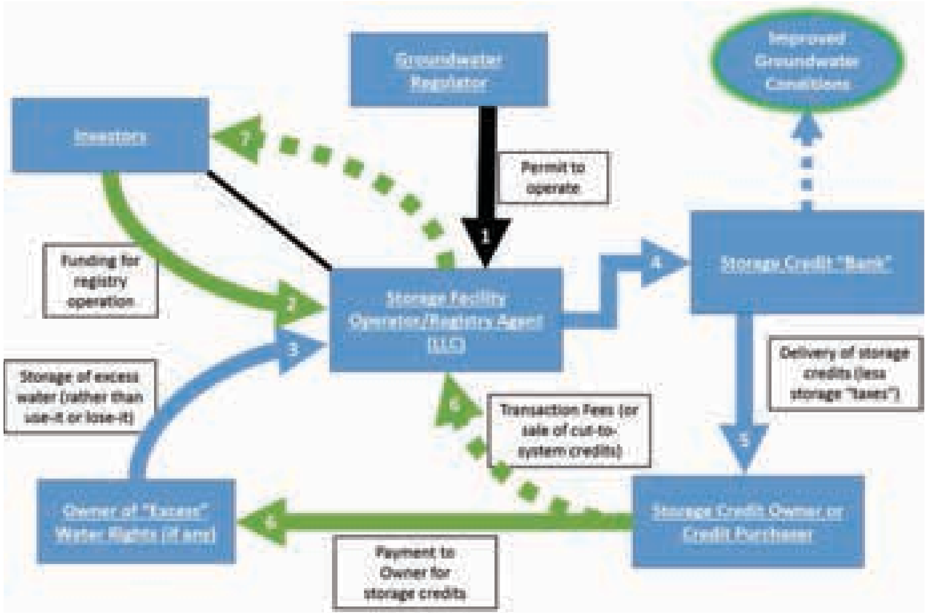


Figure V(D)(2)-14. Structure of Underground Storage Trading Mechanism

HYPOTHETICAL CASE STUDY (UNDERGROUND OR IN-LINE STORAGE TRADING)

An alluvial basin-fill aquifer supports numerous small groundwater users (both agricultural and rural residential), two municipalities, a private water company, and industrial users. The aquifer is bisected by a perennial river that receives base flow from the aquifer. There is new development occurring in the area.

Historically, the aquifer was subject to reasonable use doctrine, which created localized overdraft problems, accumulated groundwater deficits, and two significant cones of depression (one under the agricultural area, and the other amidst the municipalities) that have increased pumping costs, created water quality issues, and now threaten the perennial river. Pursuant to new regulations, the aquifer is now managed by a state regulator that has created and recognizes groundwater rights, and which permits the generation and transfer of storage credits via recharge. However, only one facility presently exists (operated by a municipality) and funding to create and operate other storage facilities is limited.

HYPOTHETICAL TRANSACTION[31]

1. An investor-supported SPV proposes the operation of a groundwater exchange within the aquifer built around the existing regulatory program and negotiates exchange operation permit/approval with the groundwater regulator. This establishes a streamlined system for the creation, storage, and extraction of storage credits and associated permitting and reporting. Permitting for this streamlined system includes a buffer zone around the perennial river as well as a series of rules that incentivize appropriate recharge and withdrawal activities as described further below.

31 For tax purposes, the registry agent would have ordinary income from the fees paid to it, while the users who store and transfer water rights for consideration will have ordinary income equal to the payments they receive. The investors in the registry agent would recognize income based upon whether they are positioned as lenders or as equity owners in the registry agent.

2. The SPV establishes two new recharge facilities – one next to the perennial stream and the other near a demand center – and a source substitution facility in an agricultural district that will provide for the creation of storage credits. The SPV also contracts with a municipality to allow water to be stored at an existing municipal recharge facility to be moved through the exchange.
3. The SPV establishes a formal exchange using the recharge and source substitution facilities for credit generation and existing or new user-owned/provided wells for extraction. The SPV assesses a nominal tax against water when it is first stored, and this water is retained in storage at the recharge site. Taxes are not assessed against water stored in the facility near the stream but are assessed at a higher percentage if water is subsequently withdrawn within the buffer zone. Assessed "taxes" are credited back to the storage credit if water is withdrawn in a low-demand area outside of the existing cone of depression.
4. The exchange provides a transparent platform for trading and listing facilities for credits, together with supply-demand matching services. In addition, the exchange allows for the leasing or sale of groundwater rights through the same listing services. All paperwork is simplified and handled through the exchange so that users of the exchange have only a minimal burden as compared to someone undertaking an independent transaction.
5. The SPV assesses transaction fees for exchange services against the users, which are used to pay operating costs of the exchange and pay returns to investors.
6. Municipalities recharge effluent in recharge facilities, as well as other water that is available to them.
7. The irrigation district establishes a source substitution program that results in reduced withdrawals and the accumulation of credits.
8. Industrial users and the private water company purchase credits to demonstrate availability of water to support new development.
9. The majority of parties seeking to engage in recharge and recovery utilize the exchange due to vastly reduced paperwork burdens, and many small users also participate.
10. Results: The stream buffer and recharge incentives result in the recovery of groundwater levels in the vicinity of the local river. Disincentives for new withdrawals in the buffer area improve stream flow conditions and reduce long-term risk to base flows. Cones of depression partially recover due to the taxation of storage.

VI.
Conclusions and Key Recommendations

VI. Conclusions and Key Recommendations

The blueprints above describe a range of potential investment approaches across the spectrum of environmental and water scarcity issues facing human and environmental users in the Basin. While not all of these blueprints could be immediately deployed in the Basin, many of them have clear, near-term application in a variety of settings from the Basin's rural headwaters to the major cities and agricultural districts in its downstream reaches. However, particularly in light of the absence of robust water market frameworks in the Basin, for these investments to be practically deployed and to provide the environmental benefits that could be derived from them, our research suggests the need for several key investments in deal development capacity, objective setting, and modeling and similar information development. At least some limited investments will likely also be needed related to policy reform. Each of these recommendations is discussed below.

A. Deal Finding/Arranger Team and Revolving Fund for Predevelopment

As noted above, environmental and system risks are continuing to develop in the Basin at ever-increasing scales. The magnitude and rate at which these issues are developing challenge both the capacity of traditional sources of public funding and the modest resources of philanthropic sources to effectively address them. Strategic investment of private capital will be essential to assist in filling critical gaps in meeting future water supply needs for both environmental and human values in the Basin.

Strategic investment of private capital will be essential to assist in filling critical gaps in meeting future water supply needs for both environmental and human values in the Basin.

A basic objective of Walton Family Foundations (WFF) exploration of potential water investment tools was to evaluate the means by which WFF and other foundations could use philanthropic resources to leverage large-scale private investments to accomplish a wider range of outcomes in the Basin than could be achieved through foundation support alone. These investments would provide a mechanism for intervention in Basin environmental problems at far larger scales than could be accomplished through the funding available from charitable sources.

Some of the investment tools described in this report may be deployable without the assistance of outside philanthropic or public sources of funding to identify and design investment opportunities. For example, the municipal water system loss pay-for-performance strategy and dry-year option strategy for agricultural water users may be deployed without up-front investment in due diligence and deal design. The identification of opportunities for such activities through these blueprints may in fact be adequate to encourage the entry of parties capable of investigating and arranging investments. For example, in the case of system loss projects, a number of municipalities in the Basin may be willing to offer an opportunity to implement this strategy via a "request for proposal" or a guarantee of funding in the event that an investor-technology supplier partnership approached them.

In addition, the nature of these types of tools makes them particularly attractive to water users, since the environmental benefit that would be derived from them primarily consists of the reduction in environmental pressure that would be associated with their deployment, rather than a firm requirement of any affirmative environmental commitment. This flexibility could incentivize the achievement of many environmental objectives, without dictating direct participation from either the municipal or agricultural sectors in increased streamflow benefit or restoration activities (which would require establishing clearer definition and more metrics).

In most cases, however, because of the lack of transparent data and information about potential opportunities, the absence of existing market-enabling conditions that would allow for relatively simple transactions with low transaction costs, and the absence of regulatory requirements that would lead to appropriate environmental outcomes in the absence of outside guidance, it is unrealistic to expect that investment opportunities and transactions will be developed organically by investors themselves. In many cases, even the mere identification of specific investment opportunities will require substantial upfront investigation. Sourcing investments will also involve engagement of local capacity and knowledge on the ground, such as local NGOs or other parties that are capable of identifying local opportunities that could fit within the identified blueprints.

This implies a need for continued, significant efforts by NGOs and other partners to engage in local trust-building and education efforts with communities and water users alike in various parts of the Basin. In addition, it will also require some level of "training" and coordination between entities seeking to identify deals and local NGOs or partners with local presence, to ensure that their staff will recognize opportunities when and where they arise. In the absence of such local capacity, it may prove difficult to identify more than a few potential deals.

Once potential opportunities are identified, many transactions will also require substantial due diligence in terms of legal and regulatory requirements, appraisals, engineering feasibility studies, and similar activities. They will also require investment in outreach and discussions with potential parties to a transaction in order to set up a transaction to the point where a pro forma term sheet or offering memorandum could be presented to potential investors. Again, in many cases, particularly where transactions involve the participation of agricultural interests, local businesses, or smaller municipalities, this will likely require cooperation with or engagement of local "boots on the ground" –i.e., entities that have established relationships and trust with local interests. Based on previous experience, only large municipalities and large-scale business interests are typically comfortable engaging in arms-length relationships with investors located in distant financial centers. In addition, as described further below, many transactions will need to be built around specific environmental criteria or objectives that may require up-front modeling, monitoring, data development, or even installation of new monitoring infrastructure as an initial requirement.

As noted in the blueprints outlined in this report, a number of proposed investment structures will also require – or could substantially benefit from – formation of "watershed conservation funds" or similar public funding mechanisms to help to incentivize or fund particular types of transactions. Investment in helping to pull these funds together, to explore downstream-user interests and willingness to participate, and to deal with other factors critical to their success is clearly essential to ensure that these types of public funding streams materialize. This will also aid in ensuring that these funds would be targeted at encouraging the "right" kinds of investment.

Once investment opportunities are identified, it will also be necessary to identify potentially interested investors in the market and then connect them to specific opportunities. This process may be simplified over time by developing an organized fund or similar structure designed to exploit particular opportunities. However, it will likely be necessary to undertake one or more "pilot" transactions as a proof of concept and to have established a deal "pipeline" supported by enough on-the-ground capacity to identify, investigate, and make transactions available on a predictable, regular basis before the assembly of a substantial fund is feasible.

Given the attendant costs, uncertainties, and potentially significant timelines required to identify potential opportunities, undertake required due diligence, establish environmental criteria, and develop the pro forma deal terms for particular investments before the time that they can be brought to investors, it is unrealistic to expect that most of these tools could be developed into real-world investments, absent upfront support from either public or charitable sources. It will also be potentially important to ensure that deals are arranged in a manner consistent with interests of underlying charitable foundations, philanthropic organizations, and donors. This would ensure that investment tools are developed and positioned to fuel the entry of capital into projects that are aligned with (and potentially ensure that the capital also is aligned with) foundation and charitable goals.

Funding for deal-finding and deal-arranger teams to undertake deal identification and deal-development activities will, in our view, be essential to facilitating large-scale private impact investment in the Basin.

As such, funding for a deal-finding and deal-arranger team or teams that could operate in the Basin and undertake deal identification and deal-development activities will, in our view, be essential to facilitating large-scale private impact investment in the Basin. Such a team, or teams, would likely need to have several essential capacities and skill sets to bring to bear. These would include an individual(s) or a firm(s) able to interface with local NGOs, funders, and partner organizations and to coordinate communications and deal-finding efforts. Also, a technical consultant that could deploy required modeling, mapping, engineering, monitoring, and similar expertise would be needed. The team will require legal support to undertake required due diligence and structure transactions. Lastly, a finance team is required that is capable of performing diligence on potential investments, building financial models, and bringing opportunities to the market and/or assembling and operating funds.

One potentially efficient means to accomplish this would be to identify a designated deal-finding and arranger team and provide it with access to a program-related investment style "revolving fund" that could be used to pay the costs of deal-finding and deal-development over time. The costs of this team (and potentially a bonus reflecting the opportunity costs incurred by the fund) could then be repaid into the fund on completion of the deal as part of the "arranger fees" or "management fees" charged into the transaction. While not all proposed deals or transactions would be successful, such a fund could potentially be set up to be large enough to undertake multiple independent investigations at any given time, and might expect to cycle several times before being exhausted.

To assist with the establishment of a "deal pipeline," it may also make sense to invest in some level of centralized opportunity exchange. An innovative example, the West Coast Infrastructure Exchange (WCX), has been pioneered by the West Coast states of California, Oregon, and Washington and the province of British Columbia in response to the crisis in funding for maintenance and expansion of the region's critical infrastructure. Established as a nonprofit 501(c)(3) organization, with a governing board comprised of senior representatives from state governing bodies (governors, treasurers, and so forth), the WCX serves as a platform for exploring cutting-edge new financing mechanisms to underwrite the costs of infrastructure, and provides a platform for connecting government actors with private sector partners in considering partnerships to meet infrastructure needs. The exchange works collaboratively as a broker across the public and private sectors to identify a pipeline of critical infrastructure needs and ready them for private sector investment, and to match public sector agencies with appropriate private sector partners. The WCX could be a potential model for structuring a similar exchange in which a centralized clearinghouse is developed to identify capital needs for water-related investments, match public and private sector partners, and negotiate deals to benefit both.

B. System Modeling and Investigation to Define Environmental Goals and Opportunities

The investment tools described in this report are designed to provide corollary environmental benefits in terms of improved watershed health, enhanced or maintained streamflows, reduced system risks, and other measures. In most cases, this report provides at least basic guidance as to the circumstances and enabling conditions that will need to be present for these benefits to be achieved. However, the research done for this report did not identify the existence of defined criteria against which these relative benefits might be measured in comparison to other externalities that may be generated by a transaction.

Particularly where impact investments will be facilitated by investments made using philanthropic resources, it will be important to define the goals for investment in a particular region as clearly as possible.

Most water transactions will inevitably generate distributional issues and impacts that should be identified and acknowledged as those transactions are structured. For example, transactions may lead to changes in the amount and timing of streamflows above and below the point of transactions due to increases in watershed yields, or to decreases in diversions and/or return flows. This may affect water users in a manner that will need to be understood and acknowledged. Investors should be aware of transactions being linked to changes in downstream reservoir storage and/or the availability of water to downstream claimants, with associated implications for geographic equity in water distribution. Changes in water quality may occur as well.

These water transactions may also create changes in the amount of water available to local agricultural users and communities, with associated economic and/or environmental justice implications for farmworkers, businesses, and residents. It is hard to estimate the cost of local environmental impacts and tradeoffs, which may lack ready interchangeability. For example, the loss of a wetland due to decreased diversions or return flows may generate different impacts than a gain in water available to a trout stream.

In this context, particularly where impact investments will be facilitated by investments made using philanthropic resources, it will be important to define the objectives for investment in a particular region as clearly as possible to provide clear objectives for the investment design. In a similar vein, it is important to develop relatively clear criteria for the design of monitoring efforts and/or environmental, social, economic, or other targets that may be built into a particular investment. Given that the majority of impact investors will be looking for deals with known and quantifiable benefits and rates of return to close – rather than undertaking their own detailed investigations – defining these types of criteria and targets will be integral to proper investment design by an arranger team or other institution seeking to facilitate the entry of impact investors.

Of course, it is also important not to squander unnecessary resources defining such targets, since modeling and investigation at a high level of resolution can often consume vast amount of resources with little tangible benefit. In this context, the "perfect" is clearly the enemy of the "good," and the good may well be the enemy of the adequate. However, substantial targets need to be defined to provide at least a basic framework for investment design, a basic prioritization of tradeoffs between costs and benefits, and the creation of internal investment targets in order to guide the investments in the deal arrangement and due diligence that will need to be performed. In addition, in most cases, at least rudimentary models for evaluating the impact of particular investments on the behavior of complex hydrologic and infrastructure systems will be required. Again, it is unrealistic to believe that these targets and models can be developed by investors themselves in the context of proposed transactions, since in most cases these issues will lie at the core of defining the existence and essential parameters of a potential investment opportunity before an appropriate investor can be identified.

For example, a number of the investment tools described in this report are designed to improve streamflows in critical areas of the Basin, in headwaters areas, in tributaries, and in other vital regions that support ecosystem function. However, in the absence of reasonably clear stream-flow enhancement goals that these water transactions should be designed to accomplish, it will be difficult to evaluate whether particular transactions, either individually or in the aggregate, will provide sufficient environmental benefits such that they will justify the efforts expended to generate them. Although a significant amount of work is currently being undertaken with regard to environmental flows in the Basin, this work is not always proceeding around clearly defined environmental flow targets. Where regulatory targets do exist in the Basin, they tend to be built around endangered species issues.

For example, the Bureau of Reclamation has identified specific minimum flow targets for operations of the Aspinall Unit (comprising the Blue Mesa, Morrow Point, and Crystal dams and reservoirs), in order to support the physical and biological needs of native, endangered fish populations in the Gunnison and Colorado Rivers. Flow targets for both base flows and spring peak flows were established based on recommendations that sought to avoid jeopardizing the continued survival of the Colorado pikeminnow. In a similar fashion, the base flow targets identified for water management on the Yampa River were established through research on riffle habitat availability for endangered fish species present in the

Yampa—Colorado pikeminnow, razorback sucker, humpback chub, and bonytail. However, the base flow recommendations have little to do with any other ecological feature along the river.

Very few specific goals around environmental flows have otherwise been defined in the Basin. It is difficult to find clearly articulated base flow targets, groundwater level objectives, and other measures intended to track achievement of environmental goals in the Basin. In addition, the Colorado River Simulation System (CRSS) model, a long-range planning and policy model developed by the Bureau of Reclamation in the 1970s, is not well-designed to evaluate or address environmental flow issues. The model was developed to forecast possible future river and reservoir system conditions, under a range of hydrologic conditions, using a monthly time-step approach. Data inputs used in the model include physical process parameters, inflow hydrology, and future diversion and depletion schedules in the both the U.S. and Mexico. While the data used are the best available, there is a great deal of uncertainty about them, especially when the model is run out over multiple decades, and a number of assumptions were made regarding model inputs for reservoir operations and water release and delivery.

While criteria to define success are essential, it is also important to recognize that tradeoffs between different values in the Basin are inevitable.

Through its Colorado River Program, The Nature Conservancy (TNC) has undertaken a relatively comprehensive, independent effort to define a broader range of targets (environmental and otherwise) throughout the Colorado River Basin. Starting from the results of a larger ecoregional assessment process and a set of "filters" built around biodiversity and habitat priorities in the Basin, TNC developed and refined a series of simplified basinwide targets and systems, together with the identification of a series of initial, specific "target priority areas" that should be the focus of conservation investment plus a series of detailed measures frameworks. This framework and its accompanying analysis may represent a good starting point for the development of relevant guidance for the design of investment tools.

TNC is also working on the development of a "Flow Road Map" for the Colorado River Basin that collates the existing science around flow needs and priorities, identifies gaps, and defines rough criteria for evaluation of flow health and objectives for improving the same (on both a regulatory and transactional basis). This latter effort may similarly represent a reasonable starting point for establishing specific objectives for water-based investments. Taken together, these measures probably represent the best-developed framework to date for evaluation of environmental needs and desired outcomes at a basinwide scale. In addition, individual NGOs conducting restoration work, in-stream flow enhancement, and other efforts have defined various sorts of targets at scale. Collating these existing targets and engaging NGOs with this existing knowledge base during the design phase will be critical to ensure that particular investments are designed and implemented in a way that will in fact produce the desired benefits.

While criteria to define success are essential, it is also important to recognize that tradeoffs between different values in the Basin are inevitable. In most cases, it will not be possible to design transactions that are truly "win-win," from the perspective of all potentially interested parties, even if they provide direct benefits for the parties concerned. For example, in the case of agricultural investments, this report has focused on alternatives to more traditional "buy-and-dry" strategies in order to avoid approaches that would tend to cause substantial changes in the amount of farmland under production in a particular area over time. Rather, the blueprints in this report favor strategies that can improve farm and ranch economic outcomes while at the same time increasing the amount of water available to other users. However, although they have been designed to minimize the potential for political backlash, even these types of strategies will generate inevitable tradeoffs.

For example, deployment of regenerative agriculture strategies may lower local demand for fertilizer and pesticides or particular sorts of farm equipment. Similarly, changes in crop types that result in lowered water use may alter the nature and quantity of local farm labor requirements. Dry-year-option arrangements may maintain incomes to farmland owners and reduce risks to municipal users or permanent crop growers, but may also impact the availability of land for farm lessees. Recognition and acceptance of these inevitable tradeoffs in establishing investment design criteria will be essential to setting realistic opportunities.

C. Key Policy Reforms

A basic objective of a larger impact investment program in the Basin can, and should be to demonstrate the value of certain types of transactions in a manner that will contribute to longer-term policy reforms in water management. As discussed above, the demonstration of these types of transactions represents a potentially powerful tool for shaping the eventual development of water "markets" in the Basin that will both honor and facilitate the achievement of broader environmental and social goals. In addition, given that substantial reforms of water management are likely to take decades to accomplish, pilot demonstration transactions may provide the best way to "lead the way" toward those larger reforms, rather than the pursuit of large-scale, difficult reforms in isolation through traditional policy advocacy approaches.

However, a recent report to the Brookings Institution (coauthored by one of the authors of this report) identifies a series of reforms that would potentially be particularly valuable in promoting water transactions in the near term. In particular, that report argues that the reform of legal rules to enable short-term water transactions would be an important first step in opening water markets to more efficient, and ecologically beneficial, allocation of water resources. Since a number of existing laws surrounding water rights create barriers to transfer, workarounds for these rules would open markets to more participants without engaging in controversial legal reforms that are difficult to attain. For example, states may allow water users to lease water savings achieved through conservation in order to incentivize and pay for the increased efficiency. Fostering a framework for negotiating and participating in such short-term leases could encourage the establishment of infrastructures and institutions that can enable more-expansive policy change and transfer transactions.

The demonstration of these types of transactions represents a potentially powerful tool for shaping the eventual development of water "markets" in the Basin that will both honor and facilitate the achievement of broader environmental and social goals.

As noted above with the Western Infrastructure Exchange, the establishment of robust market-exchange platforms could also facilitate water trading.

Water banks, in some regions, already accomplish this through increasing system flexibility by pooling water saved by conservation efforts, maintaining environmental values through in-stream flow management, and brokering transactions between willing buyers and sellers. Water trusts, exchanges, and other institutions can also accomplish these goals by matching buyers and sellers, and by increasing the transparency of the water rights that are available to be traded in a market framework.

As the report identifies, an additional and fundamental challenge to the robust function of water markets—as well as many potential water transactions—is the open-access problem presented by unmanaged and unregulated groundwater pumping in the West. To have a strong market, there must be a "good" that is easily identifiable, transferable, and tangible. A property interest in water cannot meet this definition if the resource can be pumped out from under one owner by another user. Some states have made progress in regulating groundwater pumping in a manner that would protect the property interest in water as a resource. To fully realize the potential, such strategies should quantify existing groundwater users' rights, require registration of those users with the state, and install water meters that measure the amounts pumped. Rules should also be established that stop or reverse groundwater declines such that surface water uses are protected. These reforms, although difficult, are a critical priority for improving water management in unregulated groundwater basins.

Finally, the Brookings report urges the continuation and expansion of federal leadership in water management, and notes that federal agencies will have a significant role to play in making changes to their approach for administering water rights and contracts in a manner that provides a more stable platform to encourage and facilitate trading and other water transactions. Our research and outreach in connection with this report suggests strong interest among current federal leadership and agency staff in various positions within the U.S. Department of Interior in promoting strategies that will help bring private capital to bear on water management issues in the West. Sharing information with these agencies regarding these proposed investment blueprints, policy reform and/or funding needs, and specific impact investment opportunities that are identified on the ground could provide the means to jump-start demonstration-scale impact investments in connection with federal projects in various parts of the Basin.

Some additional near-term priorities for policy reform could include defining regulatory or incentive-based flow objectives for reaches that go beyond required Endangered Species Act (ESA) minimums for the support of specific species. There is also great potential for improving monitoring and information collection in environments where data is lacking or inadequate, such as with regard to flow levels in headwaters streams, runoff gauging, groundwater data collection, well monitoring, increased deployment of remote sensing, and other critical information that would inform needs and opportunities for reallocation transactions. Finally, non-profit foundations could also play an important role in promoting "mini-settlement" agreements in key watershed areas that establish and maintain flow targets compatible with the interests of downstream users and local water needs. WFF's existing efforts to promote this kind of thinking in the Verde River and the San Pedro River both represent excellent examples of these opportunities.

D. Conclusion

The tools described in this report provide an initial starting point for structuring investments in the Basin around several key issues—forest health and riparian health, grasslands improvement and water savings in agriculture, proposed solutions for mediating the relationship between agricultural and urban users to manage system risk, controls on municipal demand through management of system loss, methods to finance urban infrastructure, and tools to provide for the development of market-based transactions through a reformed water trust structure and expanded trading via above- and below-ground storage trading. Taken together, successful impact investments in these approaches could produce meaningful changes in the environmental and water scarcity challenges facing the Basin, and could help to pave the way to long-term policy reforms.

We thus believe that there is strong potential for impact investment in the Basin - but for these impact investments to be practically deployed, and to ensure the achievement of environmental benefits that could be derived from them, there will clearly need to be significant upfront commitment of concessionary or other low-return capital to facilitate the development of those investments. However, undertaking those investments would provide a powerful means for the Walton Family Foundation and other charitable actors to amplify relatively small investments of charitable money into large-scale impacts funded by outside private capital. Properly supported, such impact investment is positioned to generate desired environmental outcomes at significant scales that are presently beyond the reach of traditional, philanthropy-supported approaches and advocacy, could create momentum for regulatory reforms, and could powerfully shape the development of water markets as they begin to emerge in the Basin.

VII.
Appendix: Additional Considerations

VII. Appendix: Additional Considerations

A. Summary of Major Federal Environmental Laws Affecting Water Management

A number of major federal environmental laws will have significant relevance for water-based investments as a result of their potential impact on transaction costs and the time required to undertake transactions, as well as their potential to generate demand for regulatory "credits" or other needs that could be used to generate revenues as part of these transactions. The sections that follow provide a brief summary of each and their potential impact on water transactions associated with particular investments.

1. The National Environmental Policy Act

The National Environmental Policy Act (NEPA), enacted in January 1970, is a procedural statute that requires federal agencies to evaluate the potential environmental impact of proposed "major federal actions." Actions that involve federal lands or federally owned or operated water infrastructure will typically trigger a NEPA review. NEPA can also be triggered by another "federal nexus" such as infrastructure crossing federal lands, federal permitting, or interconnection with federal infrastructure, such as that provided by the U.S. Bureau of Reclamation.

A NEPA analysis will typically include impacts to habitat, wildlife, archeological and historical resources, air quality, economic and social impacts, and availability of natural resources. Simple NEPA reviews can typically be satisfied in a year or less through the completion of a relatively quick and simple Environmental Assessment ("EA") that produces a "Finding of No Significant Impact ("FONSI"). More complex reviews can require preparation of a far more costly and slow Environmental Impact Statement ("EIS"), which can take anywhere from a year to several years (Table VI-1).

NEPA can significantly complicate a proposed water transaction, and can introduce significant costs, delays, and uncertainties. It can also require coordination between multiple state and federal agencies (and potentially interested Indian tribes), as well as various consultants, to ensure that the analyses are completed in a timely manner. Applicants can also expect NEPA analysis to generate substantial amounts of public information about a proposed project, which will increase opportunities for public comment and the intervention of advocacy organizations.

In the Colorado River Basin, the checkerboard nature of land ownership and substantial prevalence of federal and tribal land, the prominent role of federal agencies such as the Bureau of Reclamation and the U.S. Army Corps of Engineers in water management, and the joint ownership of much of the Basin's water infrastructure by federal agencies will bring many transactions within the scope of NEPA. It should also be noted that most projects in California will additionally trigger the requirements of the California Environmental Quality Act ("CEQA"), a state-level equivalent of NEPA that applies to decisions made by California's state and local agencies.

Table VII-1. NEPA Process and Timeline

Milestone	Description	Schedule
Notice of Intent to Prepare an EIS	Publication of the Notice of Intent in the Federal Register starts the initial public involvement phase. Notices are also published in local newspapers.	Time to initiate varies based on complexity of project and time required to coordinate cooperating agencies
Scoping Period	The scoping process involves the public and other agencies in identifying the environmental issues to be addressed in the Draft EIS and other potential alternatives to accomplish the purpose and need. Opportunity for Public Review and Comment	Scoping Period: 45-60 days Scoping Meetings: Advance notice required
Draft EIS	The Draft EIS presents the analysis of potential environmental impacts for the proposed action and alternatives. Public comments that were received during the scoping period are considered in the development of the Draft EIS. A notice announcing availability of the Draft EIS is published in the Federal Register and local newspapers. The Draft EIS is filed with the U.S. EPA and made available to interested parties.	Time to prepare Draft EIS varies with scope and complexity of project (months to years)
Public Meetings and Comment Period	NEPA regulations require a minimum of 45 days for the public to comment on the analysis presented in the Draft EIS. Notice of availability and advertisement for public meetings must be published at least 15 days in advance of the first meeting. Opportunity for Public Review and Comment	Comment Period: 45-60 days Open House Public Meetings: 15 days advance notice
Final EIS	The Final EIS is an update to the Draft EIS and incorporates all relevant comments received during the public meetings and comment period. A notice announcing availability of the Final EIS is published in the Federal Register and local newspapers. The Final EIS is filed with the U.S. EPA and made available to interested parties.	Time to prepare Final EIS varies with scope and complexity of project, and time required to respond to comments (months)
30-Day Wait Period	Regulations provide for a 30-day wait period after the Final EIS is published before the agency may take final action.	30 days
Record of Decision	After the 30-day wait period, Lead Agency selects an alternative and issues a Record of Decision. A notice of the Record of Decision is published in the Federal Register and local newspapers and made available to interested parties. Cooperating agencies will use the Record of Decision to help inform their decision-making process.	End of NEPA process absent appeals

2. The Endangered Species Act

The Endangered Species Act ("ESA") will also potentially apply to many water transactions. Section 7 of the ESA requires that federal agencies consult with the U.S. Fish and Wildlife Service ("FWS") to ensure that any agency action neither threatens the continued existence of an endangered or threatened species nor adversely impacts designated critical habitat.[1] Section 9 of the ESA prohibits unauthorized "taking" or killing of listed species of fish, plants, or wildlife.[2] The latter prohibition against unauthorized takings applies to both government and private parties alike, although impacts to habitat alone do not normally qualify as a taking. As such, a project that does not involve a federal agency—such as those involving only state or private lands and facilities—will not need to evaluate impacts to designated critical habitat, but may need to obtain an incidental "take" permit pursuant to Section 10 if endangered species may be harmed.

Section 7 of the ESA applies only to federal agency actions (e.g. granting a permit) and will generally include any project that requires NEPA analysis. Where Section 7 applies, the relevant federal agency initiates consultation with FWS to determine whether listed species are in the area.[3] If there are no listed species or critical habitat in the project area, the Section 7 consultation is concluded. But if a listed species or critical habitat is present, then the relevant federal agency, in what is known as an "informal consultation," will conduct a biological assessment or a biological evaluation (depending on the scope of the project) to determine whether the proposed project "may affect" the species or habitat.[4]

If either the federal agency or FWS believes that an adverse impact could occur, then formal consultation is required.[5] Such consultation will result in a biological opinion from the FWS as to whether a threat is likely posed to the continued existence of listed species, or of critical habitat destruction or adverse modification, and can include required mitigation.[6] It should be noted that California has an independent state law covering endangered species, called the California Endangered Species Act ("CESA"), which applies to state agencies and private parties in a similar manner to the federal ESA.

Conservation banks are authorized under Sections 7 and 10 of the ESA as means of offsetting adverse effects of federal and nonfederal activities permitted under those sections,[7] and can be created via a legal agreement between the bank owner (which can be a private party) and a participating regulatory agency such as the FWS.[8] Specifically, Section 7 requires each federal agency to consult with FWS to minimize impacts on critical habitat through conservation measures for listed species.[9] Such conservation measures include protection of offsite species habitat through purchase of credits in a conservation bank.[10] Nonfederal entities must receive permits for activities that will result in an incidental take of endan-

1 16 U.S.C. § 1536(a)(2).
2 16 U.S.C. § 1538(a).
3 50 C.F.R. 402.12(c).
4 50 C.F.R. 402.12(k), 402.13.
5 50 C.F.R. 402.12(k), 402.14.
6 50 C.F.R. 402.14(g), (h).
7 U.S. Department of the Interior, Fish and Wildlife Service, Guidance for the Establishment, Use, and Operation of Conservation Banks, at 3.
8 Id. at 15.
9 Id.
10 Id.

gered or threatened species.[11] Section 10 authorizes FWS to issue these permits so long as the effects are adequately minimized and mitigated, among other requirements.[12] By protecting habitat, conservation banks can thus be used to create regulatory "credits" under the ESA that are marketable to other entities.

3. The Clean Water Act

The Federal Water Pollution Control Amendments of 1972, commonly known as the Clean Water Act (CWA), compels every state to periodically assess its surface waters, designate uses for each water body, and set water quality criteria to protect those uses. Those criteria are then used to regulate point-source discharges of any pollutant into waters of the United States, which are prohibited unless conducted pursuant to a National Pollutant Discharge Elimination System (NPDES) permit.[13] These permits require dischargers to implement technology-based controls to limit the amount of pollution at the point of discharge.

In addition to the NPDES permitting framework, the CWA also requires states to adopt an antidegradation policy that protects all existing uses of the state's waters. Federal regulations define an existing use as the highest degree of use "actually attained in the water body on or after November 28, 1975."[14] If water quality in a particular water body is higher than is needed to protect existing uses, states may allow some degradation under limited circumstances.[15] If water quality fails to meet the criteria required for an existing use, the water body is required to be listed as "impaired" under § 303(d) of the CWA, and the state must set a total maximum daily load (TMDL) for each pollutant that caused the impairment.[16] The TMDL represents the maximum quantity of a pollutant that may be added to the water body from all sources, including point-source discharges, non point source discharges (such as stormwater runoff), and natural background levels. Existing discharges and new discharges must stay below the total limit. Because most infrastructure projects with the potential to discharge pollution to surface water (e.g. sewage treatment facilities, water treatment facilities, and so forth) will be regulated under the CWA, these requirements can significantly constrain or shape water transactions involving such facilities.

4. Section 404 & Wetland Mitigation Banking

Section 404 of the Clean Water Act can potentially implicate many water-related infrastructure projects. Section 404 of the CWA is administered by the U.S. Army Corps of Engineers ("Corps"), with U.S. Environmental Protection Agency (U.S. EPA) oversight, and regulates discharges (or disturbances) to "waters of the United States" through a permitting system composed of a combination of "nationwide," or generic, permits as well as more complex individual permits.

The definition of "waters of the U.S." has been the subject of extensive litigation and recently proposed regulations. In 2006, the U.S. Supreme Court clarified the extent of CWA jurisdiction under a "significant nexus test."[17] Under the significant nexus test, a tributary or wetland is a "water of the U.S." if it significantly affects the physical, chemical, or biological integrity of downstream, traditionally navigable waters. For practical purposes, this means that most readily discernible watercourse and drainage features will at least potentially qualify as "waters

11 Id. at 4.
12 Id.
13 33 U.S.C. §§ 1311, 1342.
14 40 C.F.R. § 131.3(e).
15 . Id. § 131.12; A.A.C. §§ R18-11-107 to -107.01.
16 33 U.S.C. § 1313(d).
17 Rapanos v. U.S., 546 U.S. 715 (2006).

of the U.S." U.S. EPA and the Corps proposed a rule in 2014 that would explicitly define "waters of the U.S." to include most rivers and wetlands upstream of traditionally navigable waters—including ephemeral streams and washes that are dry most of the year.[18]

Section 404 of the Clean Water Act allows for use of credits under an organized mitigation bank in order to meet the requirements for compensatory mitigation for impacts to wetlands, streams, and other aquatic resources under a "no net loss" standard and CWA Section 404(b)(1). Compensatory mitigation can be accomplished through: the establishment or creation of wetland resources, restoration of degraded wetlands and aquatic resources, enhancement of wetland functions, or permanent preservation of ecologically important wetlands or aquatic resources through mechanisms such as conservation easements. In-kind replacement generally is required when the impacted resource is locally important. Out-of-kind compensation for a wetland loss involves replacement of a wetland area by establishing, restoring, enhancing, or protecting and maintaining an aquatic resource of different physical and functional type. Out-of-kind mitigation is appropriate when it is practicable and provides more environmental or watershed benefit than in-kind compensation (i.e. is of greater ecological importance to the region of impact).[19]

Under a mitigation bank approach, a wetland, stream, or other aquatic resource area that has been restored, created, enhanced, or preserved is set aside to compensate for future conversion of aquatic resources for development activities. The value of a bank is determined by quantifying the aquatic resource functions restored or created in terms of "credits." Permittees, upon approval of regulatory agencies, can acquire these credits to meet their requirements for compensatory mitigation.[20]

B. Special Considerations with Public Partners

Many proposed water transactions will potentially involve public or quasi-public entities with special characteristics that need to be considered in the design of any transaction, including municipalities, irrigation districts, and Indian tribes. While a complete treatment of such considerations is beyond the scope of this report, a few examples of the more important limitations are discussed below.

1. Federal and State Agencies

The majority of water management infrastructure that may be critical in facilitating water market transactions lies under the ownership and control of state and federal agencies and/or public or quasi-public water management districts, such as the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, the Arizona Department of Water Resources, the Imperial Irrigation District, or the Southern Nevada Water Authority, to give only a few examples. Similarly, many of the landscapes critical to maintaining watershed health in the Basin are public lands managed by the U.S. Forest Service, the U.S. Bureau of Land Management, or other state or federal agencies. Those agencies will need to be engaged in partnerships or cooperative agreements in order to implement some of the market-based transactions discussed in this report.

Partnerships between private sector parties, state and federal agencies, and even nongovernmental organizations are subject to a range of additional considerations, requirements, and constraints. Transactions involving federal agencies, such as the FWS and the Bureau of Reclamation, must follow federal acquisition regulations (FAR), procurement guidelines, and various regulations and rules adopted by

18 The text of the proposed rule can be found at http://www2.epa.gov/uswaters.
19 USACE Regulatory Guidance Letter No. 02-2, December 24, 2002.
20 Id.

the agency to guide contracts, agreements, and other transactions with nongovernmental parties. FAR lays out a range of requirements for federal agencies in contracting with private parties ranging from request for qualification (RFQ) processes and guidelines, including the publicizing of contract RFQs, to competitive bidding, information on required sources, and contractor qualifications. FAR also defines the range of contracting methods and types, and specifies guidelines for engaging in each, including from sealed bids to negotiated contracts. Federal partners must adhere to the labor laws, safety regulations, sustainability policies, and other factors that must be considered in federal-private partnerships to contribute to the public interest mission of the agency. Similar state-level rules can apply to activities of state agencies and political subdivisions.

2. Limitations on Joint Public-Private Investment: The Gift Clause

Most western states (including Arizona, California, Colorado, Nevada, New Mexico, and Oregon) have some iteration of the "gift clause" concept in their Constitutions. These provisions prohibit the state or any local governmental entity from giving or loaning its credit or making any donation or grant to any individual, association, or corporation, or to become a shareholder in any company or corporation. They also prohibit any gift, grant, donation, subsidy or loan to, or any use of public credit in the aid of any individual, association, or corporation, and prohibit the state or local governments from becoming a shareholder or member in any company or corporation.

The gift clause could come into play if the parties to an investment structure include any individuals or private entities. If a private party is part of the effort and is receiving any financial benefit, the legal framework for the gift clause analysis will have to be considered. For example, in Arizona, the courts have established a two-prong test that requires that if a private party is receiving a financial benefit from the government, the effort must further a public purpose and the financial benefit must not be so inequitable compared to the public benefit that it amounts to an abuse of discretion.

3. Special Considerations for Irrigation Districts

As noted above, irrigated agriculture accounts for approximately 70% of all water use in the Colorado River Basin (and a similar proportion of water use elsewhere in the West). A substantial portion of this water is controlled either directly or indirectly by agricultural districts. These districts take many different forms, including the acequias of northern New Mexico, mutual water companies in Colorado and Utah, and irrigation and water delivery districts in most western states. However, in nearly all cases, the way in which water rights are held and distributed in these districts will be a critical factor in the feasibility, design, and implementation of water transactions.

In mutual water companies, each irrigator typically owns stock in the company, often referred to colloquially as a "ditch" company. Each share entitles the owner to a specified quantity (or a proportionate share) of the company's water rights, obligates the owner to pay a similarly proportionate share of the company's costs, and grants the owner voting rights equivalent to the number of shares owned. Typically, the shares are also freely transferable within the company, making it easy to transfer water between members. However, the company itself (through its manager and shareholders) will dictate whether and how any transactions involving the mutual company's water will be managed.

Irrigation districts are generally political subdivisions of the state and maintain substantial quasi-public powers, including the ability to levy taxes, exercise eminent domain, issue tax-free bonds, and make rules and regulations for the distribution of water within their boundaries. Water rights within irrigation districts are normally owned by the district itself, which typically holds these rights "in trust" for the landowners within the district. Landowners are entitled to delivery of a certain quantity of water and are subject to the payment of district assessments to cover the district's operating costs. As noted above, water rights tend to be transferable within a district irrespective of state sever-and-transfer requirements, although the district's governing board can typically exercise veto power over any transfer of water rights outside the district and in some cases even can veto transactions occurring outside their boundaries.

As a result, district governance has significant implications for water transactions. Districts are normally governed by a board of directors whose members are elected by the residents or landowners in the district, depending on the requirements of state law. Some districts allow any registered voter in an irrigation district to vote for members of the board (e.g. the Imperial Irrigation District in Southern California), whereas in other districts only property owners may vote for the board, frequently on a one-vote-per-acre basis. In the latter case, the voting rights of large landowners may be limited to a maximum number of acres to prevent undue influence on district elections. These differences can be an important driver of an irrigation district's willingness to undertake transactions with outside parties. They can also create potential conflicts of interest between landowners with water rights who may desire to enter into transactions and elected boards interested in serving broader constituencies or preserving the district's integrity at the expense of individual landowner interests.

It should be noted that many districts were formed as U.S. Bureau of Reclamation projects. Reclamation projects are subject to a variety of special rules and conditions, including limitations on the amount of land that can be held by a single enterprise, rules and policies governing the transfer of water within or off-project, and the nature of federal contract rights to water delivered in Reclamation projects.

4. Special Considerations with Indian Tribes

As noted above, the most significant federal reserved rights in the West are held by Native American tribes, which hold significant rights to many rivers, streams, and groundwater basins in the Colorado River Basin and elsewhere in the West, including extremely significant water rights in the Lower Basin. Most, but not all, of these rights are quantified in court decrees (such as the Arizona v. California decree) or through Congressionally-authorized water settlements.

To date, the transferability of Indian reserved rights remains legally unresolved. Although there are no express barriers to the lease or sale of water by tribes to off-reservation users, there are also no U.S. Supreme Court decisions or federal laws recognizing a general tribal authority to convey water off-reservation.[21] However, the weight of legal authority indicates that transfers of Indian reserved rights for use off-reservation require express Congressional authorization pursuant to the Indian Non-Intercourse Act[22] to be effective. Some leases of Indian reserved rights have been undertaken under the authority granted by Congress to the Secretary of Interior to approve Indian land leases pursuant to 25 U.S.C. Sections 2, 9, and 415,[23] yet the issue remains judicially untested and

21 David H. Getches et al., Cases and Materials on Federal Indian Law 853 (4th ed., 1998).
22 25 U.S.C.A. § 177.
23 Eric L. Garner and Michelle Ouelette, Future Shock? The Law of the Colorado River in the Twenty-First Century, 27 Ariz. St. L.J. 469, 494-495 (1995).

will require litigation or new legislation to resolve.[24]

In light of this uncertainty, tribal water rights that are quantified in settlements typically have the most legally certain status for purposes of water rights transfers. As a part of many settlements, provisions have been included that either expressly forbid or expressly authorize sale or lease of tribal water rights by the tribe for off-reservation use.[25] Nearly all settlements have included provisions for at least limited marketing of water, although the parties to whom water can be marketed are often specified by settlement. Nevertheless, these provisions are often burdened with political controversy. One practical difficulty is that the water to which tribes are entitled by settlement may, in the absence of tribal use, already be used off-reservation by non-tribal users, such that transfers would be opposed by the current users.[26]

Transactions involving tribes are also complicated by the unique legal status of Native American tribes—and their lands—in the American legal system. Indian reservations are considered to be federal lands, which implicates a series of federal laws and regulations that will not necessarily apply, or will apply differently, on private lands. Use of tribal lands can also involve significant archeological and cultural resource issues, employment rules, and other considerations that may be unfamiliar to a developer that has not previously undertaken a project on tribal lands. Indian tribes also enjoy inherent sovereign immunity from suit by all but the federal government. Absent a waiver of sovereign immunity, a tribe (and, in many cases, tribal-owned enterprises) will be immune from private-party suit and from the enforcement of any private-party award against it[27]—even where this leaves an adverse party without a remedy in a contractual setting.[28]

There are also significant issues with regard to the exercise of jurisdiction over a tribe—or the subject matter of a contract with a tribe—which may limit (or even eliminate) the forums available to an injured party in the event of a dispute. Further, as sovereign governments, Indian tribes have the ability to adopt resolutions or ordinances that can alter or invalidate contractual agreements. The only way to limit this risk is to include provisions that allow for termination or rent offsets in the event that the tribe changes the terms of the agreement. Finally, tribal leases are generally subject to approval by the U.S. Bureau of Indian Affairs ("BIA"), and procedural flaws in the approval process can negate it.[29] Leases and right-of-way approvals by BIA are also subject to NEPA.

24 Id. at 41.

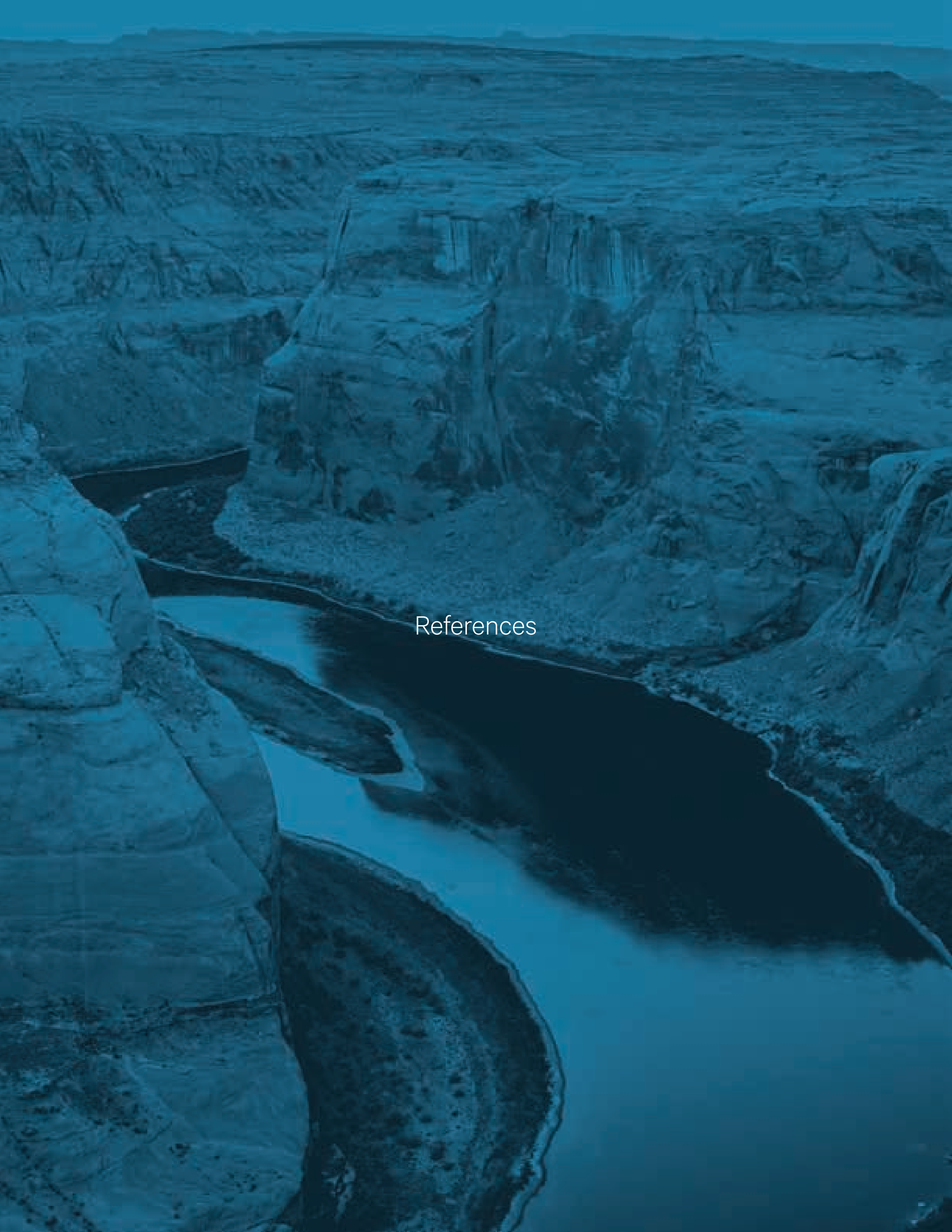
25 Deborah Moore and Zach Willey, Water in the American West: Institutional Evolution and Environmental Restoration in the 21st Century, 62 U. Colo. L. Rev. 775, 791 (1991).

26 Weatherford at 36.

27 See United States v. U.S. Fidelity and Guaranty Co., 309 U.S. 506 (1940).

28 See Pan American Co. v. Sycuan Band of Mission Indians, 884 F.2d 416 (9th Circuit 1989).

29 OMG Apex, Inc. v. Acting Western Regional Director, 43 IBIA 265 (2006) (voiding a lease agreement between the Shivwits Band and OMG for land and water rights on the Shivwits Band reservation).



References

References

"About World Bank Green Bonds," World Bank Green Bonds, World Bank Treasury, n.d. Web, December 10, 2014.

W.S. Abruzzi, The Social and Ecological Consequences of Early Cattle Ranching in the Little Colorado River Basin, Human Ecology 23:75-98 (1995).

"A Cohesive Strategy Is Needed to Address Catastrophic Wildfire Threats," RCED-99-65, published April 2, 1999, publicly released April 16, 1999, www.gao.gov/products/GAO/RCED-99-65.

Robert W. Adler, Restoring Colorado River Ecosystems: A Troubled Sense of Immensity, Island Press (2007).

A. A. Ager et al. (2007), Modeling wildfire risk to northern spotted owl habitat in Central Oregon, USA, Forest Ecology and Management 246 (1): 45–56. See also M. A. Finney et al. (2007), Simulation of Long-Term Landscape-Level Fuel Treatment Effects on Large Wildfires, International Journal of Wildland Fire 16: 712–27.

"Agricultural Water Use in the Colorado River Basin: Conservation and Efficiency Tools for a Water Friendly Future," The Colorado College State of the Rockies Report Card, n.p. Web, January 11, 2015. PDF.

Craig Alexander, et al., Green Bonds: Victory Bonds for the Environment, TD Economics Special Report (November 1, 2013).

American Society of Civil Engineers and Economic Development Research Group, Failure to Act: the Economic Impact of Current Investment Trends in Water and Wastewater Management (2011).

American Water Works Association, Buried No Longer: Confronting America's Water Infrastructure Challenge. Web. http://www.awwa.org/Portals/0/files/legreg/documents/BuriedNoLonger.pdf. January 2015.

American Water Works Association, Water Environment Federation, and Association of Metropolitan Water Agencies, n.d. A Cost Effective Approach to Increasing Investment in Water Infrastructure.

Australian Government Productivity Commission, Market Mechanisms for Recovering Water in the Murray-Darling Basin, Productivity Commission Research Report (March 2010).

Australian Government Productivity Commission, Rural Water Use and the Environment: The Role of Market Mechanisms, Productivity Commission Research Report (August 11, 2006).

K Averyt, et al., Sectoral Contributions to Surface Water Stress in the Coterminous United States, Environmental Research Letters 8, no. 3 (Sept. 1, 2013).

Bruce Aylward, Environmental Water Transactions: A Practitioner's Handbook, Ecosystem Economics (September 2013).

R. D. Baker and B. Rouppet, "Conservation Farming in New Mexico," New Mexico State University and USDA (1996).

Felicity Barringer, "Water Source for Almonds in California May Run Dry," New York Times, December 27, 2014, http://www.nytimes.com/2014/12/28/us/water-source-for-almonds-in-california-may-run-dry.html?smprod=nytcore-iphone&smid=nytcore-iphone-share.

Caylin Barter and Peter Culp, Inventory of Water Trusts in the Western United States, Squire Patton Boggs Research Memorandum (September 3, 2014).

Brooke Barton, "Water Scarcity Means Business for Companies & Investors," Mother Nature Network (content provided by MillerCoors), www.mnn.com/food/beverages/sponsorstory/water-scarcity-means-business-for-companies-investors.

Sarah Bates, Land Trusts and Water: Strategies and Resources for Addressing Water in Western Land Conservation , Center for National Resources and Environmental Policy, University of Montana (2014).

Susannah Birkwood, Peterborough prison social impact bond pilot fails to hit target to trigger repayments, Third Sector, August 7, 2014, www.thirdsector.co.uk/peterborough-prison-social-impact-bond-pilot-fails-hit-target-trigger-repayments/finance/article/1307031.

Veronica Blette et al., "Water Loss Control: Tools, Policies and Successful Programs," October 15, 2014.

Bridget Boulle, Sean Kidney, and Padraig Oliver, Bonds and Climate Change: The State of the Market in 2014, Report of Climate Bonds Initiative, July 2014. Web, 10.

Jesse A. Boyd, Hip Deep: A Survey of State Instream Flow Law from the Rocky Mountains to the Pacific Ocean, Natural Resources Journal Vol. 43 1151 (Fall 2003).

Mark K. Briggs & Steve Cornelius, Opportunities for Ecological Improvement Along the Lower Colorado River and Delta, 18 Wetlands 513 (1998).

Tim Carlson, Patrick Hickey, and Clark Tate, Sustainable Funding Options for a Comprehensive Riparian Restoration Initiative in the Colorado River Basin, Tamarisk Coalition, February 25, 2011.

Casey Brown and Miguel Carriquiry, Managing hydroclimatological risk to water supply with option contracts and reservoir index insurance, Water Resources Research Vol 43, W11423 (November 2007).

Daniel Bunk, U.S. Bureau of Reclamation, Management of Colorado River Reservoirs and Current State of the System, Presentation to Colorado River Shortage Preparedness Workshop (April 22, 2014).

Garance Burke, In Dry California, Water Fetching Record Prices, The Associate Press, July 2, 2014, www.bigstory.ap.org/article/dry-california-water-fetching-record-prices.

Ben Caldecott, Green Infrastructure Bonds: Accesssing the scale of low cost capital required to tackle climate change, Climate Change Capital (undated).

California State Water Project Overview, California Department of Water Resources, www.water.ca.gov/swp/index.cfm, 2015.

Carpe Diem West, Mapping the River Ahead: Priorities for Action Beyond the Colorado River Basin Study, Center for Natural Resources and Environmental Policy, University of Montana (March 2014).

Erin Carson and Eric Davis, State-Backed Green Bonds Emerge Following International Model, Issue brief, Enerknol, October 14, 2014. Web, 2.

Pamela Case and Gregory Alward, Patterns of Demographic, Economic and Value Change in the Western United States: Implications for Water Use and Management, U.S. Department of Agriculture, Forest Service, Report to the Western Water Policy Review Advisory Commission (August 1997).

"A Case Study in Efficiency - Agriculture and Water Us in the Yuma, Arizona Area". Yuma County Agriculture Water Coalition. February 2015.

Stephanie L. Castle, et al., Groundwater Depletion During Drought Threatens Future Water Security of the Colorado

River Basin, Geophysical Research Letters, 10.1002/2014GL061055 (August 2014).

"Celebrating Arizona Rivers: August 2012: The Gila River." River of the Month Series by EDF, Sierra Club, Grand Canyon Trust, Sonoran Institute, and Western Resource Advocates.

CH2MHill, West Coast Infrastructure Exchange: Final Report (November 2012).

"Chicago Water Agency Plans $225 Million Green Bond, with More Expected," Environmental Finance,

n.p., December 10, 2014. Web, December 18, 2014.

"China's Hard Line on Biotech Burns U.S. Hay." The Wall Street Journal. Jesse Newman. Web, December 15, 2014.

Peggy Clifford, et al., Analysis of Water Banks in the Western States, Washington Department of Ecology and West-Water Research, Publication No. 04-11-011 (July 2004).

Michael J. Cohen, Municipal Deliveries of Colorado River Basin Water, Executive Summary, Pacific Institute iii (2011).

Michael Cohen, Juliet Christian-Smith, and John Berggren, Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin, Pacific Institute (May 2013).

B. Colby and G. B. Frisvold, 2011. Adaptation and Resilience: The Economics of Climate, Water, and Energy Challenges in the American Southwest, Washington, D.C.: Earthscan Press.

Colorado Agricultural Water Alliance. Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures. 2008.

Colorado Division of Water Resources, General Administration Guidelines for Reservoirs (2011).

"Colorado Freshwater Forum: Exploring Colorado's Solutions to a National Challenge", the Johnson Foundation, October 18, 2011. Web, June 9, 2015.

The Colorado River Basin: An Overview, The Colorado College, August 2011. Web, January 13, 2015, 1.

The Colorado River Delta Water Trust, Sonoran Institute (2010), available at http://www.sonoraninstitute.org/where-we-work/northwest-mexico/delta-water-trust.html.

Colorado River Governance Initiative, Cross-Boundary Water Transfers in the Colorado River Basin: A Review of Efforts and Issues Associated with Marketing Water Across State Lines or Reservation Boundaries (June 2013).

Colorado River Modeling Work Group Charter, March 2010.

Colorado River Water Users Association, River Uses: Agriculture, http://www.crwua.org/colorado-river/uses/agriculture.

Colorado Water Conservation Board, Colorado's Water Supply Future: Alternative Agricultural Water Transfer Methods Grant Program Summary (2011)

Colorado Water Conservation Board, Decades Down the Road: An Analysis of Instream Flow Programs in Colorado and the Western United States (July 2005).

Colorado Water Institute, Agricultural/Urban/Environmental Water Sharing: Innovative Strategies for the Colorado River Basin and the West (December 2010).

Richard T. Conant, Challenges and opportunities for carbon sequestration in grassland systems: A technical report on grassland management and climate change mitigation, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations (2010).

"Corps of Engineers Water Resources Infrastructure: Deterioration, Investment or Divestment?" 2012. USACE, Committee of US Army Corps of Engineers Water Resources, Science, Engineering, and Planning.

Chuck Cullom, Central Arizona Project, Shortage Impacts to Arizona & Near and Longer-Term Risks, Presentation to Colorado River Shortage Preparedness Workshop (April 22, 2014).

Peter W. Culp, Feasibility of Purchase and Transfer of Water for Instream Flow in the Colorado River Delta, Mexico, Udall Center for Studies in Public Policy (2001).

Peter W. Culp, Jonathan King, and Carlos de la Parra, Getting to the Right Side of the River: Lessons for Binational Cooperation on the Road to Minute 319, 18 U. Denv. Water L. Rev. 36 (2014).

Peter W. Culp and Robert J. Glennon, The Last Green Lagoon: How and Why the Bush Administration Should Save the Colorado River Delta, 28 Ecology L.Q. 903, 931-32 (2002).

Peter Culp and Robert Glennon, "Parched in the West but Shipping Water to China, Bale by Bale," Wall Street Journal. October 5, 2012.

Peter W. Culp, Robert J. Glennon, and Gary Libecap, Shopping for Water: How the Market Can Mitigate Water Shortages in the American West, Hamilton Project (2014).

Peter W. Culp, Francisco Zamora, and Jennifer Pitt, U.S. Participation in the Restoration of the Colorado River Delta: Current Challenges and Opportunities, Sonoran Institute (2004).

Mariella Czetwertynski, The Sale and Leasing of Water Rights in Western States: An Overview for the Period 1990-2001, Water Policy Working Paper #2002-002, Andrew Young School of Policy Studies (March 2002).

Deboodt, T.L., M.P. Fisher, J.C. Buckhouse, and J. Swansen. 2009. Monitoring Hydrological changes due to western juniper removal, a paired watershed approach. The Grazier May 2009: 5-12. Oregon State University, Corvallis Oregon.

J.S. Deems, et al., Combined impacts of current and future dust deposition and regional warming on Colorado River Basin snow dynamics and hydrology, Hydrol. Earth Syst. Sci., 17, 4401-4413 (2013).

Jeff Deems and Jeff Lukas, Dust-on-snow and hydrologic impacts in the Colorado River Basin, Intermountain West Climate Summary, Vol 7: 1 (January 2011).

Kelly DiNatale et al., Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures, Colorado Water Institute, Special Report No. 20 (September 2008).

Drinking Water Infrastructure: An Advocate's Guide, Report of American Rivers, July 2013. Web, December 16, 2014, 4.

"Drip Irrigation for the Home Garden." Sustainable Landscaping. Healthy Landscapes, n.d. Web, January 13, 2015.

J. Driscoll, "Economics: Conservation Tillage Demonstration and Outreach Project," Colorado State University, accessed August 10, 2012, http://conservationtillage.colostate.edu/Economics.html.

Dunne & Leopold (1978) Water in Environmental Planning.

Carolyn Mansfield duPont, Jim Levitt, and Linda Bilmes, "Green Bond and Land Conservation: Navigating a New Funding Landscape", Harvard Kennedy School, manuscript in preparation.

"Ecologists Turn to Planned Grazing to Revive Grassland Soil," NPR, August 5, 2013. Web, January 22, 2015.

Susanna Eden, et al., Agricultural Water to Municipal Use: the Legal and Institutional Context for Voluntary Transactions in Arizona, The Water Report (December 15, 2008).

Edwards Aquifer Authority, Voluntary Irrigation Suspension Program Option, http://www.eahcp.org/index.php/flow_protection/vispo.

"Effects of Climate Variability and Accelerated Forest Thinning on Watershed-Scale Runoff in Southwestern USA Ponderosa Pine Forests," PLOS, October 2014.

"Environmental Impacts of Farming," WWF Global. N.p., n.d. Web, January 13, 2015.

EPA Drinking Water Needs Infrastructure Survey and Assessment, 2013.

"Expanding Bond Market for Green Projects," JPMorgan Chase, n.d. Web, December 10, 2014.

Fact Sheet: Increasing Investment in U.S. Roads, Ports and Drinking Water Systems through Innovative Financing. The White House Office of the Press Secretary, www.whitehouse.gov/the-press-office/2015/01/16/fact-sheet-increasing-investment-us-roads-ports-and-drinking-water-syste. May 2013.

Fact Sheet on the BLM's Management of Livestock Grazing. http://www.blm.gov/wo/st/en/prog/grazing.html. November, 2014.

Ben Falk, "Build Healthy Soil Through Regenerative Grazing," Mother Earth News. N.p., September 2014. Web, January 22, 2015.

Farmland LP. Rep. Vital Farmland REIT, LLC, November 18, 2014. PDF, January 22, 2015, 12.

Joseph M. Feller, The Adjudication That Ate Arizona Water Law, 49 Ariz. L. Rev. 405, 425 (2007).

Peter Fimrite. "Fish vs. Farmers in Conflict over Klamath River." SFGate. N.p., 19 July 2013. Web. 23 Jan. 2015.

"Flagstaff Watershed Protection Project Cost Avoidance Study," Arizona Rural Policy Institute, October 2014.

Steven Folkman, "Water Main Break Rates in the USA and Canada: A Comprehensive Study," Utah State University Buried Structures Laboratory, April 2012.

Philip l. Fradkin, A River No More: The Colorado River and the West (1981).

Daniel Fullmer, Kate Greenberg, and Dan Keppen, Innovations in Agricultural Stewardship: Stories of Conservation and Drought Resilience in the Arid West, National Young Farmers Coalition and Family Farm Alliance, May 17, 2015. Web, June 9, 2015.

FY15 U.S. Senate Emergency Supplemental Appropriations Bill.

Eric L. Garner & Michelle Ouelette, Future Shock? The Law of the Colorado River in the Twenty-First Century, 27 ARIZ. ST. L.J. 469 (1995).

Dustin Garrick, Amy McCoy, and Bruce Aylward, The Cornerstones Report: Market-Based Responses to Arizona's Water Sustainability Challenges, Ecosystem Economics (June 2011).

Dustin Garrick, et al., Environmental Water Transactions: Lessons Learned & Future Prospects, National Fish and Wildlife Foundation (March 2008).

Dustin Garrick and Bruce Aylward, Transaction Costs and Institutional Performance in Market-Based Environmental Water Allocation, Land Economics 88(3) 526-560 (August 2012).

"Get to Know Responsibly Grown" Whole Foods Markets. Web, June 15, 2015.

David H. Getches, Et Al., Cases and Materials on Federal Indian Law (4th ed. 1998).

Peter H. Gleick, The New Economy of Water: The Risks and Benefits of Globalization and Privatization of Fresh Water, Pacific Institute (February 2002).

Robert Glennon, Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters. Washington, DC: Island Press, 2002.

Robert J. Glennon & Thomas Maddock, III, In Search of Subflow: Arizona's Futile Effort to Separate Groundwater from Surface Water, 36 Ariz. L. Rev. 567 (1994).

R. Godin and I. Broner. "Micro-Sprinkler Irrigation for Orchards." Colorado State University Extension. Colorado State University, November 2013. Web, January 13 2015.

Sarah Goodyear, Got Spare Water? You Can Make Millions in California, Next City, July 7, 2014, www.nextcity.org/daily/entry/drought-west-california-water-selling.

R. Quentin Grafton, et. al., An Integrated Assessment of Water Markets: Australia, Chile, China, South Africa and the USA, National Bureau of Economic Research, Working Paper 16203 (2010).

R. Quentin Grafton, et. al., A Comparative Assessment of Water Markets: Insights from the Murray-Darling Basin of Australia and the Western US. Rep. N.p.2011.

Brian E. Gray, A Model Water Transfer Act for California, 4 Hastings W. –Nw. J. Envtl. L. & Pol'y 3 (1996)

Green Bond Principles, 2014. N.p., n.d. Web, January 13, 2014.

Green Bond Sixth Annual Investor Update, Report of The World Bank, September 2014. Web, 3.

"Green Projects from Around the World," World Bank Green Bonds, World Bank Treasury, n.d. Web, December 10, 2014.

David J. Guy, When the Law Dulls the Edge of Chance: Transferring Upper Basin Water to the Lower Colorado River Basin, 1991 Utah L. Rev. 25, 43 (1991).

Craig Hannah, "Performance Contracting Finances Water Loss Reduction Program," Waterworld, October 2011.

"Healthy Forests & Water Security: New Research Links Forest Thinning to Water Runoff Gains," The Nature Conservancy, Arizona Rural Policy Institute, October 2014.

Alden R. Hibbert, Managing Vegetation to Increase Flow in the Colorado River Basin, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-66 (November 1979).

Scott Hodge, For the Sake of Tax Reform, the Muni Bond Exemption (and Tax Deduction) Must Go, Forbes, March 21, 2013, www.forbes.com/sites/realspin/2013/03/21/for-the-sake-of-tax-reform-the-muni-bond-and-state-tax-exemptions-must-be-abolished/.

Christopher J. Huggard and Arthur Gomez, Forests Under Fire: A Century of Ecosystem Mismanagement in the Southwest, University of Arizona Press, 187 (2001)(quoting Professor J.W. Toumey, Our Forest Reservations, Popular Science Monthly (June 1901)).

David R. Huggins and John P. Reganold, “No-Till: the Quiet Revolution”, Scientific American, 2008.

Jeffrey A. Hughes, Sharlene Leurig, Assessing Water System Revenue Risk: Considerations for Market Analysts, UNC Environmental Finance Center & Ceres (August 2013).

Gregory Hobbs, Reviving the Public Ownership, Antispeculation, and Beneficial Use Moorings of Prior Appropriation Water Law, 84 U. Colo. L. Rev. 97 (2012).

Eric Holthaus, The Thirsty West: 10 Percent of California’s Water Goes to Almond Farming, Slate, May 14, 2014, www.slate.com/articles/technology/future_tense/2014/05/_10_percent_of_california_s_water_goes_to_almond_farming.html.

Norris Hundley, Jr., Water and the West: The Colorado River Compact and the Politics of Water in the American West (1975).

“Issuing Bodies,” Climate Bonds Initiative, n.d. Web, December 10, 2014.

Emilia Istrate, “Municipal Bonds Build America: A County Perspective on the Changing Tax-Exempt Status of Municipal Bond Interest,” National Association of Counties Policy Research Paper Series, issue 1, 2013.

B.F. Jacobs, R.G. Gatewood, and C.D. Allen. 2002. Watershed restoration in degraded piñon-juniper woodlands: A paired watershed study 1996-1998. Final report to: USGS-BRD Research/NPS-Natural Resource Preservation Program. Bandelier National Monument, Los Alamos New Mexico.

Tim James et al., The Economic Importance of the Colorado River to the Basin Region. Rep. L William Seidman Research Institute, W. P. Carey School of Business, Arizona State University, December 18, 2014. Web.

Carly Jerla, U.S. Bureau of Reclamation, Water Budget at Lake Mead, Presentation to Colorado River Water Users Association (December 2013).

David C. Johnson, Joe Ellington, and Wes Eaton, Carbon Sequestration: A Practical Approach, New Mexico University Institute for Sustainable Agricultural Research, Web, June 12, 2015.

Mike Jolliffe, “Considerations for Ecological Flow Transactions” (presented at the Water Markets Design Workshop, Bren School of Environmental Science and Management, UCSB, November 8, 2014); Amy Beaty, “Colorado Water Trust” (presented at the Water Markets Design Workshop, Bren School of Environmental Science and Management, UCSB, November 8, 2014).

Darrick Jolliffe and Carol Hedderman, Peterborough Social Impact Bond: Final Report on Cohort 1 Analysis, August, 7, 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/341684/peterborough-social-impact-bond-report.pdf.

Lana Jones and Bonnie Colby, Measuring, Monitoring, and Enforcing Temporary Water Transfers: Consideration, Case Examples, Innovations and Costs (June 2012).

Key Terms of the Quantification Settlement Among the State of California, IID, CVWD and MWD, available at http://www.cvwd.org/wateriss/Key-Terms.htm (Oct. 15, 1999)

Kimura, S. and J. Antón, “Risk Management in Agriculture in Australia”, OECD Food, Agriculture and Fisheries Papers, No. 39, OECD Publishing (2011). – cite for dry-year option paper

Hamida Kinge, What's on Tap: America's Failing Water Infrastructure, Americancity.org, n.d. Web, December 16, 2014, 33.

C. Kirda, Deficit Irrigation Scheduling Based on Plant Growth Stages Showing Water Stress Tolerance. Natural Resources Management and Environment Department, n.d. Web, January 22, 2015.

Lisa M. Krieger, California Drought Puts Farmers in a Bidding War for Water, CAdrought.com, July 21, 2014, www.cadrought.com/california-drought-puts-farmers-bidding-war-water.

Andy Laurenzi and Peter W Culp, et al., Sustainable Water Management: Guidelines for Meeting the Needs of People and Nature in the Arid West, Sonoran Institute (2007).

Nathan Lee and Alice Plant. Agricultural Water Use in the Colorado River Basin: Conservation and Efficiency Tools for a Water Friendly Future. Rep. N.p., n.d. Web, January 14, 2015.

Gary D. Libecap, Water Rights and Markets in the U.S. Semi-Arid West: Efficiency and Equity Issues (October 21, 2010).

Daniel F. Luecke, et al., A Delta Once More: Restoring Riparian and Wetland Habitat on the Colorado River Delta (1999).

Glen MacDonald and B.L. Turner, "Water, Climate Change and Sustainability in the Southwest," Proceedings of the National Academy of Sciences of the United States of America, 107, no. 50 (Dec. 14, 2010): 21256-62.

Lee MacDonald and John Stednick, Forests and Water: A State-of-the-Art Review for Colorado, Colorado State University, CWRRI Completion Report No. 196 (2003).

Ruth Mathews, Instream Flow Protection and Restoration: Stetting a New Compass Point, 36 Envtl. L. 1311 (2006).

Meeting Water Needs through Investing in Nature, Nature.org, www.nature.org/ourinitiatives/regions/northamerica/unitedstates/texas/tx-es-conference-13.pdf.

Metropolitan Water District, Palo Verde Land Management Crop Rotation and Water Supply Program... at a Glance, available at: http://www.mwdh2o.com/mwdh2o/pages/news/at_a_glance/Palo-Verde-fact-Sheet.pdf.

Lewis Milford, et al., Clean Energy Finance Through the Bond Market: A New Option for Progress, Brookings-Rockefeller Project on State and Metropolitan Innovation (April 2014).

C. Montagne and C. Orchard, Holistic Management Gets Results in the Northern Rockies. A New Environmental Intelligence, The Allan Savory Center for Holistic Management (2001).

Deborah Moore and Zach Willey, Water in the American West: Institutional Evolution and Environmental Restoration in the 21st Century, 62 U. Colo. L. Rev. 775, 791 (1991).

Milton N. Nathanson, Updating the Hoover Dam Documents, U.S. Bureau of Reclamation, U.S. Department of Interior (1978).

National Farmers Federation, Productivity Commission Discussion Draft on Rural Water Use and the Environment: The Role of Market Mechanisms (July 12, 2006).

National Interagency Fire Center, http://www.nifc.gov/fireInfo/nfn.htm.

"Native Crops: Commercial Uses for Prickly Pear and Guayule." Native Crops: Commercial Uses for Prickly Pear and Guayule. The Arizona Experience, December 4, 2012. Web, January 14, 2015.

The Nature Conservancy, Colorado River Program Measures Report.

Gerald R Noonan, The overgrazing of Arizona rangelands. Science Quest Technical Paper 2 (October 20, 2011).

R. A. O'Brien et al., 2003. "Indicators of Rangeland Health and Functionality in the Intermountain West." U.S. Department of Agriculture, Rocky Mountain Research Station, General Technical Report RMRS-GTR-104.

Michael O'Donnell and Bonnie Colby, Dry-Year Water Supply Reliability Contracts: A Tool for Water Managers, Department of Agricultural and Resource Economics, The University of Arizona (October 2009).

Office of the State Engineer, Division of Water Resources, Guide to Construction and Administration of Dams in Colorado (2010).

"Organic Agriculture: What Are the Environmental Benefits of Organic Agriculture?" Food and Agricultural Organization of the United Nations. N.p., n.d. Web, January 21, 2015.

Pacific Northwest Project, The Economic Importance of Western Irrigated Agriculture: Impacts, Water Values, and Strategic Policy Questions, Report to The Family Farm Alliance and Irrigation Association (August 2013)

Painter, T. H., J. Deems, J. Belnap, A. Hamlet, C. C. Landry, and B. Udall (2010), Response of Colorado River runoff to dust radiative forcing in snow, Proceedings of the National Academy of Sciences, in press.

Panum Parikh, et al., Application of market mechanisms and incentives to reduce stormwater runoff: An integrated hydrologic, economic and legal approach, Environmental Science & Policy 8,133-144 (2005).

"Pasture Project," Wallace Center. N.p., n.d. Web, January 23, 2015. www.wallacecenter.org/pastureproject.

O. Pechony and D. T. Shindell, Driving forces of global wildfires over the past millennium and the forthcoming century, Proceedings of the National Academy of Sciences of the United States of America, November 9, 2010, vol. 107, no. 45.

Barbara Pleasant, "Use Cover Crops to Improve Soil," Mother Earth News. N.p., October–November 2009. Web, January 22, 2015.

V. Ponce, Sustainable Yield of Groundwater. San Diego State University, 2007.

Dale Pontius, Colorado River Basin Study, Report to the Western Water Policy Review Advisory Commission (1997).

Sandra Postel, "Wildfires in the Western U.S. Are on the Rise, Posing Threats to Drinking Water," National Geographic, April 29, 2014.

President Signs Bill Creating New WIFIA Loan Program, Squire Patton Boggs LLP (June 2014).

James Pritchett, Quantification Task: A Description of Agriculture Production and Water Transfers in the Colorado River Basin, A Report to the CRB Water Sharing Working Group and the Walton Family Foundation, Colorado Water Institute, Special Report No. 21 (January 2011).

C. Luther Propst, Peter W. Culp, Searching for Cibola: Community-Based Environmental Restoration in the Colorado River Watershed, 42 Ariz. L Rev. 259 (2000).

Q4 2014 Green Bonds Market Outlook, Report of Bloomberg New Energy Finance, October 10, 2014. Web, 19.

Rationale for Water Releases from the Elkhead Reservoir Endangered Fish Pool to Augment August-October Base Flows in the Yampa River, April 3, 2008, www.coloradoriverrecovery.org/documents-publications/technical-reports/isf/YampaMaybellFlowaddendum.pdf.

RBC Capital Markets, Green Bonds: Fifty shades of green (March 26, 2014).

Heike Reichelt, Green bonds: a model to mobilize private capital to fund climate change mitigation and adaptation projects, Euromoney Environmental Finance Handbook (2010).

Marc Reisner, Cadillac Desert (1986).

J. Restaino and D. Peterson (2013), Wildfire and fuel treatment effects on forest carbon dynamics in the western United States, Forest Ecology and Management 303 (2013): 46–60.

Dolores Rey, Javier Calatrava, and Alberto Garrido, Water markets in Australia, Chile and the U.S.A., Working Paper (undated).

John Roach, That's Nuts: Almond Boom Strains California Water Supply, NBC News, June 13, 2014, www.nbcnews.com/business/markets/thats-nuts-almond-boom-strains-california-water-supply-n130586.

Tom Ryan and Chris Harris, Assessing the Potential Impact of Invasive Species Water Use on the Lower Colorado River, October 2014.

Sacramento River Basin Report Card and Technical Report, Sacramento River Watershed Program (April 2010).

Allan Savory, The Savory Grazing Method or Holistic Resource Management, Rangelands 5(4) (August 1983).

Savory Institute, Holistic Management Research Portfolio (2012).

Joseph L. Sax, et al., Legal Control of Water Resources (3rd ed. 2000)

Glen D. Schaible and Marcel P. Aillery, 2012. Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands, EIB-99, U.S. Department of Agriculture, Economic Research Service. www.ers.usda.gov/media/884158/eib99.pdf.

Schulte et al., Bridging Concern With Action: Are U.S. Companies Prepared for Looming Water Challenges, Pacific Institute & Vox Global (April 2014).

Elizabeth Schuster, et al., Understanding the Value of Water in Agriculture: Tools for Negotiating Water Transfers, University of Arizona (January 2012).

Nabil Shafike, Salim Bawazir, and James Cleverly. "Native versus Invasive: Plant Water Use in the Middle Rio Grande Basin." Southwest Hydrology Volume 6 Number 6 (2007): 28-30.

Patrick B. Shafroth, Curtis A. Brown, and David M. Merritt, "Saltcedar and Russian Olive Control Demonstration Act Science Assessment: U.S. Geological Survey Scientific Investigations Report 2009-5247," U.S. Geological Survey, 2010.

Mannava V.K. Sivakumar, et al., Natural Disasters and Extreme Events in Agriculture: Impacts and Mitigation (2005).

Ed Smith, PVID General Manager, PVID/MWD Land Management, Crop Rotation and Water Supply Program, Presentation (undated).

Andy Soos, The Dusty Colorado River, Environmental News Network, September 22, 2010.

Mark Squillance, The Water Marketing Solution, 42 Envtl. L. Reptr. News & Analysis 10800 (2012).

Mark Squillace, Water Transfers for a Changing Climate, Legal Studies Research Paper Series Working Paper, University of Colorado (2012).

The State of the Municipal Securities Market, www.sec.gov/spotlight/municipalsecurities.shtml, Web, December 23, 2014.

L. William Staudenmaier, Between a Rock and a Dry Place: The Rural Water Supply Challenge for Arizona, 49 Ariz. L. Rev. 321, 325-326 (2007)

Stephanie Strom, California's Thirsting Farmland, New York Times, April 20, 2014.

Daniel Sumner, Food Prices and the California Drought, UC Davis Center for Watershed Sciences, April 22, 2015, http://californiawaterblog.com/2015/04/22/food-prices-and-the-california-drought/.

"Sustainable Land Management," The Dixon Water Foundation. June 9, 2015.

Scott Swinton et al. "Ecosystem Services and Agriculture: Cultivating Agricultural Ecosystems for Diverse Benefits," Ecological Economics 64 (2007): 245–52. Science Direct. Web, January 14, 2015, 247.

Tamarisk Coalition, Colorado River Basin Tamarisk and Russian Olive Assessment, December 2009.

Tamarisk Coalition, Desert Rivers Collaborative, 2014, www.tamariskcoalition.org/programs/desert-rivers-collaborative.

Tamarisk Coalition, Independent Peer Review of Tamarisk and Russian Olive Evapotranspiration Colorado River Basin (Tamarisk Coalition: Grand Junction, Colorado, USA, 2009).

A. Dan Tarlock, Law of Water Rights and Resources (2013).

Aaron Thiel, "Climate Change Impacts on Agriculture in the Colorado River Basin," UWM Center for Water Policy, n.d. Web, January 13, 2015.

J. Thornton, R. Sturm, and G. Kunkel, Water Loss Control Manual, 2d ed.,, McGraw Hill, 2008.

Trout, Witwer & Freeman, P.C., Acquiring, Using, and Protecting Water in Colorado (2004)

A. L. Westerling et al. (2006), Warming and earlier spring increase Western U.S. forest wildfire activity, Science, vol. 313, no. 578: 940–43.

Alexander Wood, Watering Down Federal Court Jurisdiction: What Role Do Federal Courts Play in Deciding Water Rights?, 23 J. Envtl. L. & Litig. (2008).

U.S. Bureau of Reclamation, Colorado River Basin Water Supply and Demand Study, U.S. Department of Interior (2012).

U.S. Bureau of Reclamation, Colorado River Water Salinity Control Program, available at: http://www.usbr.gov/projects/Project.jsp?proj_Name=Colorado+River+Basin+Salinity+Control+Project

U.S. Bureau of Reclamation, Colorado River Water Quality Office, Colorado River Salinity: Economic Impacts on Agricultural, Municipal, and Industrial Users (1980).

Bureau of Reclamation, Lower Colorado River Multi-Species Conservation Program, December 30, 2013, www.lcrmscp.gov/general_program.html.

U.S. Bureau of Reclamation, Record of Decision for the Aspinall Unit Operations Final Environmental Impact Statement, April 2012.

U.S. Bureau of Reclamation, Upper Colorado Region, Colorado River Storage Project, Flaming Gorge Operations, http://www.usbr.gov/uc/rm/crsp/fg/fgOps.html

U.S. Bureau of Reclamation, "U.S. Department of the Interior and Western Municipal Water Suppliers Developing Water Conservation Projects as Part of a Landmark Collaborative Agreement," October 8, 2014, http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=48006.

U.S. Department of Agriculture, USDA Agricultural Census, 2012.

U.S. Department of the Interior, Fish and Wildlife Service, Guidance for the Establishment, Use, and Operation of Conservation Banks, at 3.

U. S. Department of the Interior, "Water Quality in the Upper Colorado River Basin". 1996-1998.

U.S. Environmental Protection Agency, Control and Mitigation of Drinking Water Losses in Distribution Systems, EPA Office of Water (November 2010).

U.S. Environmental Protection Agency, Drinking Water Infrastructure Needs Survey and Assessment, Fifth Report to Congress, U.S EPA Office of Water (April 2013).

U.S. Environmental Protection Agency, Water Audits and Water Loss Control for Public Water Systems (undated)

"U.S. Farmers Making Hay with Alfalfa Exports to China." Los Angeles Times. David Pierson. Web, June 8, 2014.

U.S. Geological Survey, Salinization of the Upper Colorado River – Fingerprinting Geologic Salt Sources, Scientific Investigations Report No. 2009-5072 (2009).

USACE Regulatory Guidance Letter No. 02-2, December 24, 2002.

A. De Vliegher and L. Carlier, Eds. "Permanent and Temporary Grassland Plan, Environment and Economy." Grassland Science in Europe Volume 12. (2007) 247-258, Print.

Richard W. Wahl, Markets for Federal Water: Subsidies, Property Rights, and the Bureau of Reclamation (1989).

Water Efficiency for Instream Flow: Making the Link in Practice, Alliance for Water Efficiency, American Rivers, and Environmental Law Institute (October 2011).

Water Leak Detection and Repair Program, Georgia Environmental Protection Division Guidance Document, Watershed Protection Branch (August 2007).

Water Resource Advocates, Filling the Gap: Commonsense Solutions for Colorado's Front Range, May 2012.

Water Transfers in the West: Projects, Trends, and Leading Practices in Voluntary Water Trading, Western Governors' Association and Western States Water Council (December 2012).

"Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin." The Pacific Institute, Michael Cohen, Juliet Christian-Smith, and John Berggren. May 2013.

Keith T. Weber and Bhushan S. Gokhale, Effect of Grazing Treatment on Soil Moisture in Semiarid Rangelands, 161–74. Final Report: "Forecasting Rangeland Condition with GIS in Southeastern Idaho." N.p.: 2010. Print, 162.

Western Forestry Leadership Coalition, The True Cost of Wildfire in the Western U.S. (April 13, 2009).

WestWater Research, Review of Western U.S. Environmental Water Leasing Programs (July 2003).

Ray L. Wilber & Northcutt Ely, The Hoover Dam Documents, U.S. Bureau of Reclamation, U.S. Department of Interior (1948).

Water Development, Extraction, and Diversion, http://cpluhna.nau.edu/Change/waterdevelopment6.htm. November, 2014.

"Water in the West", Bureau of Reclamation Historic Dams, Irrigation Projects, and Powerplants, www.nps.gov/nr/travel/ReclamationDamsIrrigationProjectsAndPowerplants/Water_In_The_West.html.

"Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin." The Pacific Institute, Michael Cohen, Juliet Christian-Smith, and John Berggren. May 2013.

"Water Wastewater Utility Revenue Bonds Get High Ratings from Moody's, S&P," Spokane City,

November 6, 2014. Web, December 18, 2014.

"What Are Cover Crops?" Midwest Cover Crops Council. N.p., n.d. Web, January 11, 2015.

"What Is Agroforestry? Association for Temperate Agroforestry. N.p., n.d. Web, January 14, 2015.

Hugh Wheelan and Daniel Brooksbank, eds., Green Bonds: The Future of Sustainability Financing,

Report of Responsible-Investor/Bank of America Merrill Lynch, October 2014. Web, 37.

Courtney White, The Carbon Ranch: Fighting Climate Change One Acre at a Time, Quivira Coalition, December 2010. Web, June 9, 2015.

Allen Williams and Rod Ofte, "Organic Grass-fed Beef Success", The Pasture Project, 2015.

Alexander Wood, Watering Down Federal Court Jurisdiction: What Role Do Federal Courts Play in Deciding Water Rights?, 23 J. Envtl. L. & Litig. 242 (2008)

Karl Wood, Grazing Management for Healthy Watersheds, New Mexico Watershed Management: Restoration, Utilization, and Protection, New Mexico Water Resources Research Institute (November 2001).

Donald Worster, Rivers of Empire: Water, Aridity, and the Growth of the American West (1985).

S. C. de Vries et al. 2010. "Resource use efficiency and environmental performance of nine major biofuel crops, processed by first-generation conversion techniques." Biomass and Bioenergy 34: 588–601.

Zamora et. al, Conservation Priorities in the Colorado River Delta: Mexico and the United States, Sonoran Institute, Environmental Defense, University of Arizona, Pronatura Noroeste Dirección de Conservación Sonora, Centro de Investigación en Alimentación y Desarrollo, and World Wildlife Fund— Gulf of California Program (2005)

Zeedyk, B. and J. Jansens. 2004. An introduction to erosion control. The Quivira Coalition, Santa Fe, New Mexico USA.
Sponholtz, C. 2005. Agro-ecological Restoration. M.A. Thesis, Prescott College, Prescott, Arizona.

Cited Elements of the Law of the River

Arizona Department of Water Resources, Substantive Policy Statement: Policy and Procedures for Transferring an Entitlement of Colorado River Water (May 24, 2004).

Arizona v. California, 373 U.S. 546 (1963).

Arizona v. California, 376 U.S. 340, 342 (1964).

Arizona v. California, 439 U.S. 419, 429 (1979).

Boulder Canyon Project Act, 45 Stat. 1057, 43 U.S.C. § 617 (1928).

Colorado River Basin Project Act of 1968, 43 U.S.C. §§ 1501-56 (1968).

Colorado River Compact, Pub. L. No. 56, 42 Stat. 171 (1922)

Colorado River Operating Criteria, 35 Fed. Reg. 8951 (Department of Interior, June 4, 1970).

Colorado River Storage Project Act of 1956, Pub. L. No. 84 485, 70 Stat. 105 (1956).

Forbearance and Fallowing Program Agreement Between Palo Verde Irrigation District and the Metropolitan Water District of Southern California, dated August 18, 2004.

Minute No. 319, Interim International Cooperative Measures in the Colorado River Basin Through 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California, International Boundary and Water Commission (November 20, 2012).

Offstream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States, 43 C.F.R. § 414 (1999).

Quantification Settlement Agreement by and Among Imperial Irrigation District, A California Irrigation District; The Metropolitan Water District of Southern California, A California Irrigation District; and Coachella Valley Water District, A California Irrigation District, dated Oct. 10, 2003.

Pilot Fallowing and Forbearance Program Agreement Between Yuma Mesa Irrigation and Drainage District and Central Arizona Water Conservation District, as presented to the CAWCD board on September 5, 2013.

Record of Decision, Colorado River Interior Surplus Guidelines, 66 Fed. Reg. 7,772 (Dep't Interior, Jan. 25, 2001)

Record of Decision, Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operation of Lake Powell and Lake Mead, U.S. Bureau of Reclamation, U.S. Department of the Interior (Dec. 2007).

Treaty Between the United States of America and Mexico Respecting Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, Feb. 3, 1944, U.S.-Mex., art. 10, 59 Stat. 1219, 1237 (1944)

United States-Mexico Agreement on Colorado River Salinity, Minute No. 242 of the IBWC: Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River, August 30, 1973.

U.S. Bureau of Reclamation, Final Environmental Impact Statement, Colorado River Surplus Criteria, U.S. Department of Interior (2000).

U.S. Bureau of Reclamation, Final Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead, U.S. Department of Interior (November 2007).

Upper Colorado River Basin Compact, reprinted in Ray L. Wilbur & Northcutt Ely, The Hoover Dam Documents A167 (1948).

Cited Cases

98-01 Op. N.M. Att'y Gen. (1998).

Arizona Cooper Co. v. Gillespie, 100 P. 465, 469-70 (Ariz. Terr. 1909), aff'd 230 U.S. 46 (1913).

Arizona Public Service Co. v. Long, 773 P.2d 988 (Ariz. 1989).

Arizona v. California, 376 U.S. 340 (1964).

Cappaert v. United States, 426 U.S. 128,138 (1976).

City and Cnty. of Denver v. Northern Colo. Water Conservancy Dist., 130 Colo. 375, 276 P.2d 992 (1954).

Colorado River Water Conservation Dist. v. U.S., 424 U.S. 800, 809 (1976)

Doney v. Beatty, 220 P.2d 77 (Mont. 1950)

Fourzan v. Curtis, 29 P.2d 722 (Ariz. 1934)

In re Rights to Use Water in the Big Horn River, 753 P.2d 76 at 99 (Wyo. 1988).

In re the General Adjudication of All Rights to Use Water in the Gila River System and Source (Gila II), 857 P.2d 1236, 1241 (Ariz. 1993).

In re The General Adjudication of All Rights to Use Water in the Gila River System and Source (Gila III), 989 P.2d 739, 743, 747 (Ariz. 1999).

In Re the General Adjudication of All Rights to Use Water in the Gila River System and Source (Gila V), 35 P. 2d 68, 76 (Ariz. 2001).

Kirkpatrick v. Butler, 483 P.2d 790 (Ariz. Ct. App. 1971)

Nevada v. Morros, 766 P.2d 263 (Nev. 1988).

OMG Apex, Inc. v. Acting Western Regional Director, 43 IBIA 265 (2006)

Pagosa Area Water and Sanitation Dist. v. Trout Unlimited, 170 P.3d 307 (Colo. 2007).

Pan American Co. v. Sycuan Band of Mission Indians, 884 F.2d 416 (9th Circuit 1989).

Phelps Dodge Corporation v. Arizona Department of Water Resources, CV 05-0321 (Ariz. Ct. App. 2005).

Pinal AMA Management Plan, supra n.18, Chapter 6.

Pyramid Lake Paiute Tribe of Indians v. Hodel, 882 F.2d 364 (9th Cir. 1993).

Rapanos v. U.S., 546 U.S. 715 (2006).

Reese v. Qualtrough, 156 P. 955, 960 (Utah 1916)

Southeastern Colorado Water Conservancy District v. Shelton Farms, Inc. 529 P.2d 1321 (Colo. 1974).

Southern Pacific Co. v. Proebstel, 150 P.2d 81 (Ariz. 1944)

United States v. U.S. Fidelity and Guaranty Co., 309 U.S. 506 (1940).

United States v. New Mexico 438 U.S. 696, 702 (1978).

Winters v. United States, 207 U.S. 564, 576-77 (1908)

Referenced Statutes

1980 Arizona Groundwater Management Act, codified at ARIZ. REV. STAT. ANN. §§ 45-401 to -704.

Ariz. Rev. Stat. § 45-107(A)(1-2)

Ariz. Rev. Stat. § 45-107(D)

Ariz. Rev. Stat. § 45-141(A)

Ariz. Rev. Stat. § 45-151

Ariz. Rev. Stat. § 45-152.01

Ariz. Rev. Stat. § 45-172(A)

Ariz. Rev. Stat. § 45-176

Ariz. Rev. Stat. § 45-401 et seq.

Ariz. Rev. Stat. § 45-411 to -440

Ariz. Rev. Stat. § 45-462(A)

Ariz. Rev. Stat. § 45-463

Ariz. Rev. Stat. § 45-464

Ariz. Rev. Stat. § 45-465

Ariz. Rev. Stat. § 45-469(A-D)

Ariz. Rev. Stat. § 45-470(A)(1)(a-b)

Ariz. Rev. Stat. § 45-470 to -474.

Ariz. Rev. Stat. § 45-801.01, et. seq.

Ariz. Rev. Stat. § 45-802.01(9).

Ariz. Rev. Stat. § 45-811.01.

Ariz. Rev. Stat. § 45-812.01.

Ariz. Rev. Stat. §§ 45-2401 et seq.

Ariz. Rev. Stat. §§ 45-2571

Ariz. Rev. Stat. § 48-3771 to -3784

Ariz. Rev. Stat. §48-3771(B).

Ariz. Rev. Stat. § 48-3371(C).

Colo. Rev. Stat. § 37-60-115(8)

Colo. Rev. Stat. §§ 37-80.5-101-104.5

Colo. Rev. Stat. § 37-83-105(1)

Colo. Rev. Stat. § 37-92-102(3)

Colo. Rev. Stat. § 37-92-103(5)

Colo. Rev. Stat. § 37-92-302

Colo. Rev. Stat. § 37-92-305(3)

Colo. Rev. Stat. § 37-92-308(6)(b)

Colo. Rev. Stat. §37-92-309(3)

Cal. Water Code § 475

Cal. Water Code §§ 481-484

Cal. Water Code § 1011

Cal. Water Code § 1014

Cal. Water Code § 1015

Cal. Water Code § 1020

Cal. Water Code § 1021(a-b)

Cal. Water Code § 1025-1025.5

Cal. Water Code § 1244

Cal. Water Code § 1257.5

Cal. Water Code § 1260

Cal. Water Code §§ 1425-1428

Cal. Water Code § 1430-1432

Cal. Water Code §§ 1435-1442

Cal. Water Code §§ 1700-1707

Cal. Water Code §§ 1725-32

Cal. Water Code §§ 1735-1737

Nev. Rev. Stat. § 111.167

Nev. Rev. Stat. § 533.023

Nev. Rev. Stat. § 533.0243(1)

Nev. Rev. Stat. § 533.025

Nev. Rev. Stat. § 533.030

Nev. Rev. Stat. § 533.045

Nev. Rev. Stat. § 533.060

Nev. Rev. Stat. § 533.075

Nev. Rev. Stat. § 533.345

Nev. Rev. Stat. § 533.363

Nev. Rev. Stat. § 533.370

Nev. Rev. Stat. § 533.436

Nev. Rev. Stat. § 533.437

Nev. Rev. Stat. § 533.438

Nev. Rev. Stat. § 533.4385

Nev. Rev. Stat. § 533.504

Nev. Rev. Stat. § 533.550

Nev. Rev. Stat. § 533.560

N.M. Stat. § 7-5-22

N.M. Stat. § 7-5-23

N.M. Stat. § 7-5-24.1

N.M. Stat. § 7-5-25

N.M. Stat. § 72-12-7(A-B)

N.M. Stat. § 72-14-3.3

N.M. Stat. § 7-5-28

N.M. Stat. § 72-1-2.3(A)

N.M. Stat. § 72-6-3(A)

N.M. Stat. § 72-2-9.1(C)

N.M. Code Ann. 19.25.13.16(E)

N.M. Code Ann. 19.25.13.16(F)

N.M. Code Ann. 19.25.13.31

Reclamation Act of 1902, 32 Stat. 388, 390 (1902) (codified as amended at 43 U.S.C. § 383 (1986))

Utah Code Ann. § 73-3-3(1-2, 5-7)

Utah Code Ann. § 73-3-3.5(2-3, 6)

Utah Code Ann. § 73-3-30(1-3, 6-10)

Utah Code Ann. § 73-3-5.5

Wyo. Stat. Ann. § 41-3-104

Wyo. Stat. Ann. § 41-3-114(a)

Wyo. Stat. Ann. § 41-3-320

Wyo. Stat. Ann. § 41-3-401(a & f)

Wyo. Stat. Ann. § 41-3-402(j)

Wyo. Stat. Ann. § 41-3-1001(a-d, f)

Wyo. Stat. Ann. § 41-3-1002(b)

Wyo. Stat. Ann. § 41-3-1002(c-d)

Wyo. Stat. Ann. § 41-3-1007(a-b)

Wyo. Stat. Ann. §§ 41-3-1009-1011

16 U.S.C. § 1536(a)(2).

16 U.S.C. § 1538(a).

25 U.S.C.A. § 177.

33 U.S.C. §§ 1311, 1342.

33 U.S.C. § 1313(d).

40 C.F.R. § 131.3(e).

50 C.F.R. 402.12(c).

50 C.F.R. 402.12(k), 402.13.

50 C.F.R. 402.12(k), 402.14.

50 C.F.R. 402.14(g), (h).

§ 131.12; A.A.C. §§ R18-11-107 to -107.01.

About the Authors

Peter Culp, Squire Patton Boggs, Partner

Peter Culp is a partner in the Phoenix office of Squire Patton Boggs (US) LLP, an international law firm, where he practices in the areas of water, natural resources, and environmental law. He is best known for his expertise on water resource scarcity and water policy issues, including the complex laws governing the domestic and international management of the Colorado River. He represents a variety of municipal, agricultural, non-profit, and investment clients in matters related to surface water rights, groundwater rights, and state and federal water policy, and also serves on several public boards and commissions related to water resource management and policy.

His published works on water and natural resource issues have appeared in a variety of publications including the Wall Street Journal, the Arizona Republic, the Arizona Law Review, the Nevada Law Journal, Ecology Law Quarterly, and Southwest Hydrology, and he is recognized by Chambers USA, The Best Lawyers in America, and Southwest Super Lawyers. For his work on Colorado River issues, Culp has twice received the annual Partners in Conservation Award from the U.S. Secretary of Interior, together with The Nature Conservancy of Arizona's Outstanding Conservation Achievement Award and the Arizona Capitol Times' Leader of the Year Award in Public Policy (Environment). Culp received his J.D. summa cum laude from the University of Arizona in 2001.

Ricardo Bayon, Encourage Capital, Co-founder and Chief Impact and Innovation Officer

Ricardo Bayon is a Partner and a member of the Board of Directors of Encourage Capital. He was a co-founder of EKO. At Encourage he leads the water team and is in charge of new business and innovation. He also works across several other investment sectors. Ricardo is a member of the Investment Committee of the EKO Green Carbon Fund. Prior to co-founding EKO in 2007, Ricardo helped found and served as the Managing Director of the Ecosystem Marketplace, a web site and information/analysis service covering the emerging environmental markets. In that capacity he co-authored a number of publications on voluntary carbon markets, mitigation banking, and ecosystem services, including The State of Voluntary Carbon Markets 2007: Picking up Steam and Voluntary Carbon Markets: An International Business Guide to What They Are and How They Work, and Conservation and Biodiversity Banking: A Guide to Setting Up and Running Biodiversity Credit Trading System.

For nearly two decades he has specialized on issues related to finance, banking, and the environment. He has done work for a number of organizations, including Insight Investments, the International Finance Corporation (IFC) of the World Bank, IUCN, The Nature Conservancy, Domini Social Investment, among others. His articles have appeared in publications such as The Washington Post, The Atlantic Monthly, and the International Herald Tribune. He has also written numerous publications and chapters on mitigation banking, biodiversity markets, markets for water quality, and other environmental markets. He was born in Bogota, Colombia, and is currently based in San Francisco.

Jason Scott, Encourage Capital, Co-founder and Managing Partner

Jason Scott is a Co-Managing Partner and on the Board of Directors of Encourage Capital. He was a co-founder of EKO. Jason is a member of the Investment Committee of the EKO Green Carbon Fund. Prior to EKO, Jason was a founding Director and investment analyst at Generation Investment Management, co-founded by David Blood and former Vice President Al Gore, Jr. As its first employee, Jason helped build the firm and its first and second products, investing in global listed equities and climate change solutions respectively. From 1999 to 2004, Jason worked with Acumen Fund, Flatiron Future Fund/Foundation and New Philanthropy Capital. From 1996-1999, Jason was President of a NYC-based software company. Previously, Jason helped found and build Public Allies, a youth and community development organization.

In 1998, the Rockefeller Foundation selected Jason as a fellow in its Next Generation Leadership Program. He co-founded Cleantech for Obama and served on several transition advisory boards for the Obama Administration and is currently on the boards of Oil Change International, the Frankfurt Zoological Society, and Public Allies. Jason also co-founded and jointly leads a network of family offices investing in Cleantech, Renewables and other Environmental Opportunities (called the CREO Syndicate). Jason graduated from Duke University cum laude and has a M.B.A. with honors jointly from Columbia and London Business Schools.

Tom Melton, Encourage Capital

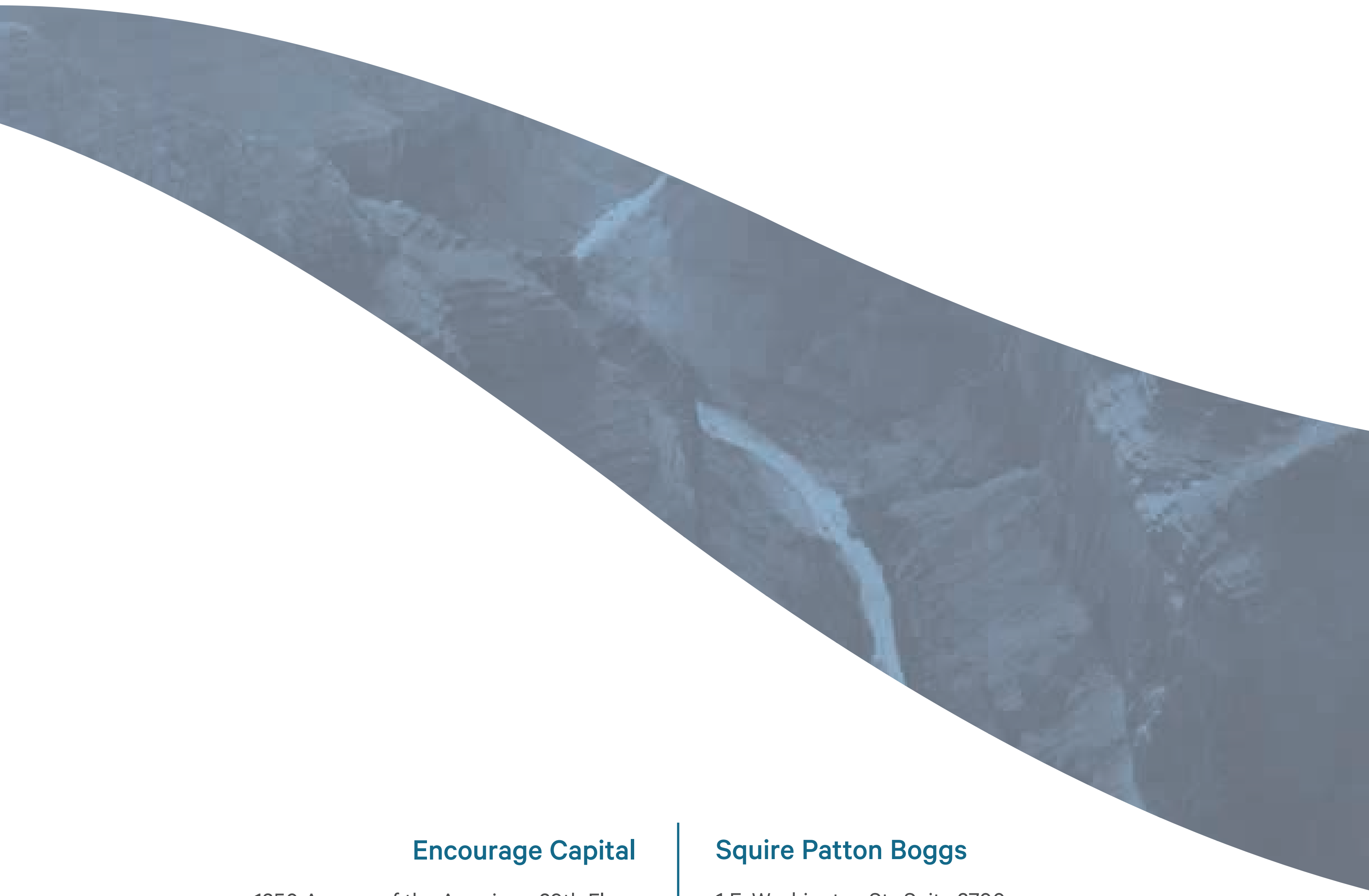
Tom works with Encourage Capital's water team and also reviews direct deals in environmentally-focused investment opportunities. Tom joined Encourage Capital after receiving his M.B.A. from the Yale School of Management with additional coursework at the Yale School of Forestry and the Yale Law School. Prior to business school, Tom worked for American Capital – a private equity firm focused on mid-market leveraged buyouts, and he began his career in M&A Investment Banking at Wachovia Securities and Lazard.

Tom received his B.A. in Economics and Commerce from Hampden-Sydney College, and he completed the General Course program at the London School of Economics. Tom is a founding director of Tumaini, Inc., a non- profit organization focused on secondary education in east Africa.

DISCLAIMER

encourage capital

SQUIRE PATTON BOGGS



Encourage Capital

1350 Avenue of the Americas, 29th Floor
New York, New York 10019

Squire Patton Boggs

1 E. Washington St., Suite 2700
Phoenix, AZ 85004