Environmental Water Markets: Growth, Trends & Outlook

by

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EXECUTIVE SUMMARY

This Masters Project examined the growth and trends in environmental water market activity in the western United States between 2008-18. This Project demonstrated how state laws do and do not shape markets, along with how markets have continued to expand in both overall volume and market value.

For environmental purposes, markets offered an opportunity for environmental buyers (typically non-governmental organizations, NGOs, or state natural resource agencies) to purchase water rights from sellers and dedicate that right to instream flows. A framework of legal elements was necessary for markets to act and react to hydrologic and economic factors. States varied widely in their approach to legal frameworks for environmental transfers, and this analysis showed that there was a low correlation between the relative strength of a state's legal framework and the level of water market activity.

Environmental water markets matured over the last ten years through the use of innovative financing and conservation tools. This maturation did not rely on state legal regimes. Water conservation and dedication of instream flows was successful in spite of these legal elements. While state-level legal elements can enable market conditions and create more flexibility in approaches (e.g., stacking environmental flows with irrigation needs during the growing season), the elements could also act as a barrier, constraining the ability to adapt to environmental needs.

The top purchasers of environmental water were the federal government, state agencies, and NGOs. The presence of NGOs as a top water purchaser signified the maturation of the market over the last ten years because they had increased purchasing power and methods to conserve water. Another metric of the maturation of environmental water markets was that the number of unique buyers increased from 11 to 27 between 2008-2018, while the number of methods used for water conservation also increased from 4 to 11 types.

The heart of water markets was regulatory programs, as 84% of all volume transferred was part of an identified regulatory or statutory requirement. The annual volume traded under these programs remained fairly consistent, but innovation occurred in the approach to dedicating instream flows.

NGOs often purchased water on behalf of these regulatory programs, despite legal frameworks that limited their flexibility. NGOs operated around these barriers by introducing new methods that also allowed them to generally pay less per unit volume (acre-feet, AF) than governmental buyers. Thus, innovation did not increase the total amount of water traded, but innovation did affect the method of acquisition and conservation outcomes. NGOs paid less per acre-foot of water ($56/AF) than the Federal government ($86)/AF and states ($115/AF) for leasing or short-term transactions.

In aggregate, leasing activity operated at a higher volume than permanent transfers; over 5 million AF were leased or temporarily transferred since 2008. Annual volume of transacted water rights increased by 270% over the last 10 years. Permanent transfers totaled only to 154,000 AF, with a 23% increase in annual volume. The leasing activity growth was driven by new entrants to environmental water markets, most notably Texas and Nebraska.

Surface water transfers accounted for the majority of acquisitions by volume, with nearly 50% of leasing activity for surface water. Groundwater leasing is under 10% of total volume. This gap was even larger for permanent transfers, as surface rights constituted 82% of total volume while groundwater accounted for just 14%. Groundwater prices reflected this scarcity value: lease payments averaged $131/AF vs. $67/AF for surface water, and $2,443/AF vs. $1,905/AF for surface permanent transfers.

In 2008, only direct payments (defined as payments made directly to a rights holder for a lease, sale or options contract) were used to acquire water. By 2015, eight identified mechanisms were available to buyers. These tools were advantageous to both buyers and rights holders because they did not constitute a change in ownership of the right. In some cases, these mechanisms were cheaper than acquisition of the right itself.

In the near future, environmental water markets will likely perform similarly as they do now: driven by regulatory requirements and programs, increasing use of an array of methods to conserve and acquire water rights, and responsive to higher volatility in hydrologic conditions. However, there are two divergent paths for the future of water markets: one in which markets reach a ceiling because of institutional barriers that constrain options and keep transaction costs high, or alternatively, market innovations continue to occur that increases participation and reduces barriers, ultimately weaving environmental and non-environmental uses in a single marketplace.

Statutory changes to create more enabling conditions can jumpstart market activity. States with low NGO participation see a correspondingly low mix of conservation tools and payment methods. In order to systematically address the water shortages and environmental degradation occurring throughout western river basins, states must embrace an array of policy options. Otherwise, market activity will remain limited and streamflows (and groundwater levels) will not measurably improve.

Introducing private capital, whether impact investors or institutional investors looking to mitigate water supply risk, can address some of the funding constraints inherent to NGOs. Impact investment can provide capital tied to specific outcomes, such as minimum flow levels or habitat conditions. Impact capital can scale projects across basins, aggregating individual rights transfers to leverage increased flows.

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I. INTRODUCTION

This Masters Project examined the growth and trends in environmental water market activity in the western United States between 2008-18. This study demonstrated how state laws do and do not shape markets, along with how markets have continued to expand in both overall volume and market value. Three factors shape this expansion and maturation: 1) regulatory requirements, as 84% of transfers are based on a federal or state program; 2) innovation and maturation of markets with the inclusion of new types of payments and tools to conserve water; and 3) NGO purchasing power being stronger than that of federal or state agencies. Finally, the report concluded with an examination of future growth opportunities. This included reducing transaction costs, creating open exchanges and encouraging private investment to leverage improving environmental conditions.

Data Collection

This project began as a summer internship with WestWater Research (WWR) in Phoenix, AZ. WWR is a consulting firm for water pricing, valuation and transaction advisory services. All data in this report was collected from WWR's Waterlitix database or otherwise cited. Waterlitix is a comprehensive database of water rights prices and volumes. Transactions of all types, not just environmental, were listed in the database. Working with WWR staff, all available environmental transactions from 2008-2018 were downloaded. The transaction data were a compendium of information from federal and state agencies, irrigation districts, non-governmental organizations, local agencies, or other private clients.

While environmental water markets existed before 2008, this analysis focused on the recent decade in order to examine recent trends in growth and further opportunities for maturation.

Environmental Water Markets

Socioeconomic development in the western United States has been inextricably linked to the ability to pump, move, and store water across river basins. However, one cost of this water-based growth was the decline (or in some cases, total removal) of water instream for aquatic species and adjacent riparian ecosystems. Development of water resources infrastructure enabled the rise of irrigated agriculture in deserts, electrification of rural areas and urban growth[1]. However, demand for water outpaced supply, with over allocation resulting in more rights to water than actual water available.

Markets created an opportunity to trade on this supply and demand imbalance. As environmental degradation continued through the 1960-70s, leaving water instream became a scientific approach to ecosystem restoration and reversing declining fish stocks. States adopted their legal frameworks to allow transferability of water rights between users, specifically

[1] "Environmental Water Markets: Restoring Streams Through Trade," PERC. Accessed April 15, 2020

allowing environmental flows to be a beneficial use (see next section)[2]. This established the ability to more efficiently allocate water between users on the demand-side, as water supplies are increasingly constrained. For instance, declining water levels in the Colorado River basin prompted municipal water agencies in Southern California to lease water on a multi-year basis from farmers in the Imperial Valley, who hold senior rights to the water. The San Diego County Water Authority offered $260 per acre-foot (AF) in 2003, a substantial increase over the $10-15/AF that farmers paid originally[3].

Markets introduced price transparency between buyers and sellers (though this transparency often does not extend to the public or third parties). Water pricing created an incentive to reduce waste and allocate the resource to those willing to pay for it. This added long-term availability as individual demand dropped due to increased irrigation efficiency or switching to less water-intensive crops[4]. For environmental purposes, markets offered an opportunity for environmental buyers (typically non-governmental organizations or state natural resource agencies) to purchase water rights from sellers and dedicate that right to instream flows[5].

Environmental water markets have the flexibility to accommodate short-term needs in response to droughts impacting surface water supplies or groundwater overpumping. They can also adapt to long-term changes in water uses or hydrologic conditions, such as reduced streamflow that imperils aquatic species. Dedicating more water for instream flows can be part of a multi-pronged approach to ecosystem restoration[6].

[2] "Expanding Water Markets in the Western United States: Barriers and Lessons from Other Natural Resource Markets," Review of Environmental Economics & Policy. Accessed April 15, 2020.
[3] *Supra,* note 1.
[4] "Water Share," The Nature Conservancy. Accessed April 15, 2020.
[5] *Ibid.*
[6] "California's Water Market," Public Policy Institute of California. Accessed April 15, 2020.

II. LEGAL FRAMEWORK ENABLING MARKETS

Defining Frameworks

Environmental water markets are a function of the legal ability to transfer water as a defined property right. This transferability allows a third-party purchaser to acquire rights on either a permanent or temporary basis for environmental (and traditional) purposes. However, many states lack a robust framework for defining what, how, when, and where environmental transactions can occur beyond the why (for instream flows).

In 2015, Stanford's Water in the West Program published a framework of ten legal elements that enable environmental water markets in 12 Western states (Kansas and Nebraska were not included in their analysis)[7]. For this project, the ten elements were used as a basis to examine the robustness of policy tools to address water use for environmental purposes (*Figure 1)*. Since the publication of this Stanford report, six states have added or clarified elements related to environmental water markets based on additional analysis for this Masters Project.

A framework of legal elements shapes how markets act and react to hydrologic and economic factors. Establishing a framework is a necessary first step to introduce the potential of market transfers for improving hydrologic conditions. However, these legal conditions also inhibit market functioning by imposing transaction costs and introducing lengthy legal review before transfers can be approved. As outlined in Stanford's report, the ten elements are:

1) *State law identifies fisheries habitat, recreation, or other environmental purposes as beneficial uses*
   Much of western water law is based on the beneficial use or application of water toward irrigation, municipal, or industrial uses, this element adds a range of environmental uses as a beneficial use that subsequently treats water as a property right. This legal recognition of instream uses began in the 1960s, after much of the water in states was already over allocated[8].

2) *Transfers of existing diversionary rights to instream or environmental uses are allowed (either by legislative statue, court opinion, or agency opinion)*
   This recognizes that existing, traditional applications of water can be transferred for instream flows. Otherwise, environmental uses could only be established with new allocations, which is difficult in over-allocated basins.

3) *Transfers of water rights are codified by state law*
   Building on the second element, this distinguishes between states that explicitly allow instream transfers by legislative statute. In some cases, states rely on a court opinion that establishes precedent for transactions or an agency opinion that oversees water

[7] "Environmental Water Rights Transfers," Stanford University. Accessed April 15, 2020.
[8] *Ibid.*

resources and are subject to change.

4) *Private parties can hold rights for instream use*
   Whether non-governmental organizations or individuals can hold instream rights. States that don't allow private parties are limited to state or federal agencies to hold rights.

5) *Permanent transfers of rights to environmental uses are allowed*
   Distinguishes between permanent or temporary transfers, such as leases or other mechanisms.

6) *State law allows short-term leases (less than one year) and has expedited review of transfer applications*
   Short-term leases create flexibility to respond to immediate hydrologic conditions that may not require permanent transfers. Expedited review of applications is crucial to making leases appropriately responsive. Permanent transfers or long-term leases often have multi-year review periods.

7) *Environmental use transfers are subjected to other limitations on use (that do not apply to other water uses) such as geographic limitations, restrictions on purpose or injury to adjacent users*
   Some states categorize environmental uses differently than other beneficial uses, such as restricting transfers out of basin. Injury to adjacent users places the burden of proof on the applicant to show non-injury instead of the adjacent user, which can lengthen application periods.

8) *State law allows water saved from improved irrigation efficiency to be left instream*
   When improved irrigation efficiency conserves water, that "extra" water is considered available for instream use, instead of being allocated to junior rights holders. Some states implicitly restrict the transferability of saved water by diminishing the right if not fully used.

9) *Rights holders can "stack" environmental flows with other diversionary uses and allocate water between the two without additional regulatory review*
   An irrigator, for instance, could allocate a portion of her water to her crops and the remainder to be left instream. Some states require the entirety of diverted water to be applied to the original beneficial use when the right was granted. This option also increases flexibility because it does not require state approval for short-term transfers if a portion of the right is already allocated or stacked.

10) *Rights users can enter short-term, informal agreements without risk of forfeiture or abandonment of their allocation, for partial season transfers or forbearance agreements*
    Because water availability is limited in many western river basins, "use it or lose it" laws were intended to allocate any water not used to junior or new rights holders. That created a perverse incentive for water users to use all of their water, even when not

necessary. This allows users to transfer a portion of their allocation without risk of loss for transfers of typically less than five years.

As noted above, legal frameworks also negatively impact market activity by introducing bureaucratic hurdles that increase regulatory review approval time and transaction costs[9]. Reviews of applications can take years with high legal costs. For example, the average review time of applications for long-term transfers in Colorado is 6.5 years[10]. Short-term transfers often take up to six months to be approved. Higher legal costs reduce the ability of private parties or NGOs to spend more on the right itself, lowering the actual volume of water left instream.

The ten legal elements are unique to environmental markets, as many transfers between non-environmental uses (such as agriculture-to-agriculture transfers) do not have similar restrictions. Buyers and sellers can work together directly on permanent or short-term leases to use water with increased economic efficiency. Separating environmental uses from traditional uses, even though it is a beneficial application of water, prevents enhanced used of market mechanisms to respond to hydrologic conditions.

Since Stanford first published the report in 2015, six states added or clarified elements. Notably, Arizona[11] and Oregon[12] modified provisions protecting temporary instream diversions of water from forfeiture. This can be an important tool for short-term transfers and granting irrigators greater certainty in leasing a portion of their right without losing it on a permanent basis.

These changes demonstrate that environmental water markets are still growing and adapting to changing local conditions. State legislatures and agencies will likely continue to clarify or add provisions enabling market-based transfers in reaction to annual hydrologic variability and support among irrigators and other traditional users.

Market Impacts

Ultimately, states varied widely in their approach to legal frameworks for environmental transfers. There was a low correlation between the strength of a state's legal framework and the level of market activity. For instance, California had nine out of the ten elements, yet its market was largely limited to large transfers of water for wildlife refuges in the Central Valley, of which 94% of activity occurred between 2008-13[13]. Texas had eight elements, but its market was limited to a single aquifer, with no surface water conservation requirements. Arizona and New Mexico only had five elements, including disallowing private parties to hold instream

[9] *Supra,* note 6.
[10] *Supra,* note 7. Other states have lower review times for long-term transfer, but still average between 1-2 years.
[11] Arizona Revised Statutes Title 45. Accessed June 7th, 2019.
[12] Oregon Revised Statues 537.500. Accessed July 31, 2019.
[13] While there is NGO activity in some basins in Northern California, data were unavailable and thus not included in the analysis for this Project.

rights. Yet, they dedicated environmental flows through the use of short-term transfers and groundwater leasing to protect endangered species.

Instream Transfer Legal Elements	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Oregon	Texas	Utah	Washington	Wyoming	Stanford 2015	WWR 2019
Environmental purpose as beneficial use													12	12
Transfers for instream purposes													12	12
Statutory recognition of transfers													10	11
Private parties can hold instream rights													5	6
Permanent transfer to instream													11	11
Short-term leases & expedited review													8	9
Limitation on environmental rights vs. other uses													6	6
Conserved water to be dedicated for instream flows													5	6
Stacking of environmental use with consumptive use on same right													2	3
Protection from forfeiture for temporary diversion or transfer													5	7
State Totals 2015	4	9	7	5	8	5	5	7	8	6	8	4		
State Totals 2019	5	9	7	5	8	6	6	9	8	7	9	4		

Figure 1. Ten legal elements, as originally published by Stanford University in 2015. WestWater Research updated the chart in 2019, identifying some changes in state laws.

In Arizona, NGOs used a variety of tools with irrigators and municipalities to reduce diversions from the Verde River near Sedona. The Nature Conservancy incentivized irrigators to improve water delivery infrastructure (canals) to reduce withdrawals to enhance summer base flows and rewater stretches of the river for improved habitat conditions and recreational use[14]. These projects did not need to adversely affect the underlying property right and was an important tool for NGOs to introduce environmental market activity by paying not for the water, but for how or when it is used.

Yet, some states' frameworks did substantially limit market activity: Wyoming disallowed private parties from holding rights and imposes other limitations on how water can be acquired for instream uses and thus has seen limited activity.

Environmental water markets matured over the last ten years through the use of innovative financing and conservation tools. This maturation did not rely on state legal regimes. Water conservation and dedication of instream flows was successful in spite of these legal elements. While state-level legal elements can enable market conditions and create more flexibility in approaches (e.g., stacking environmental flows with irrigation needs during the growing season), the elements could also act as a barrier, constraining the ability to adapt to environmental needs.

[14] "Places We Protect: Verde River, AZ." The Nature Conservancy. Accessed April 15, 2020.

III. MARKET ACTIVITY

Market Trends

Overall, there were two main aspects for environmental transfers: leases and permanent transfers. Much of the analysis conducted here was based on classifying these two types of transfers due to the differences in prices and overall market size. The other main classification was surface water vs. groundwater, as they are managed differently and highlight different approaches taken by states.

This section will explore other major trends in conservation, including the top purchasers of environmental water These buyers were the federal government, state agencies, and NGOs. The presence of NGOs as a top water purchaser signified the maturation of the market over the last ten years because they had increased purchasing power and methods to conserve water. Another metric of the maturation of environmental water markets was that the number of unique buyers increased from 11 to 27 between 2008-2018, while the number of methods used for water conservation also increased from 4 to 11 types.

However, the heart of markets remained regulatory programs, as 84% of all volume transferred was part of an identified regulatory or statutory requirement. The annual volume traded under these programs remained fairly consistent, but innovation occurred in the approach to dedicating instream flows. NGOs often purchased water on behalf of these regulatory programs, despite legal frameworks that limited their flexibility. NGOs operated around these barriers by introducing new methods that also allowed them to generally pay less per AF than governmental buyers. Thus, innovation did not increase the total amount of water traded, but innovation did affect the method of acquisition and conservation outcome.

This section explores these trends in greater detail, offering examples and case studies of conservation and acquisition of environmental water.

Leases vs. Permanent Transfers

In aggregate, leasing activity operated at a higher volume than permanent transfers; over 5 million AF were leased or temporarily transferred since 2008. Annual volume of transacted water rights also increased by 270% over the last 10 years (*Figure 2*). Permanent transfers totaled only to 154,000 AF, with a 23% increase in annual volume (*Figure 3*). This difference could be explained by the different legal frameworks in states that restrict permanent transfers of rights, acquisition costs, and the need to acquire an annual volume to satisfy regulatory requirements.

Figure 2. Total volumes transferred by leases or short-term agreements. All volumes have been rounded for clarity.

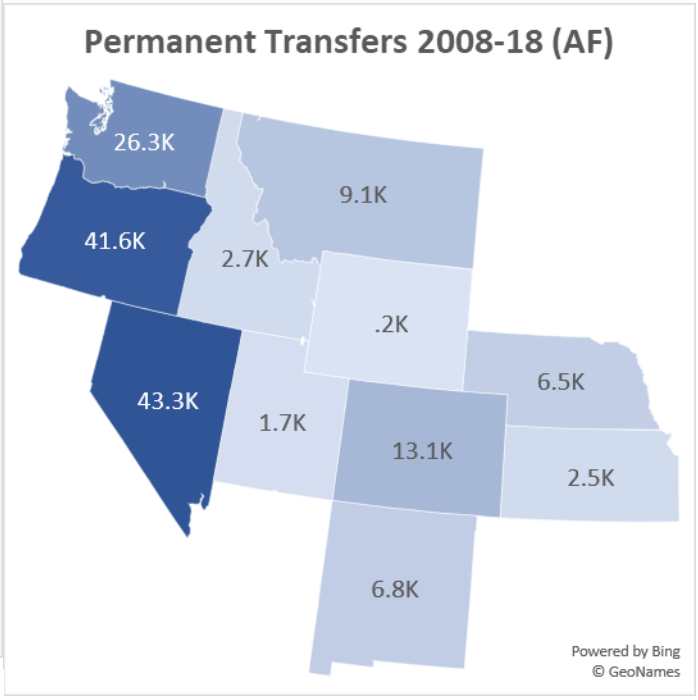

Figure 3. Total volume transferred by permanent acquisition of rights.

Measured by market value, lease transfers totaled $223.6 million, while permanent sales equaled $188.5 million (*Figure 3*). However, permanent transfers saw a 24% decrease in annual value compared to 2008, despite a 10% increase in aggregate price per AF from $2,594 to $2,851. For leases, the market grew by 144%, marked by a 75% increase in the average lease price from $57/AF to $100.

The leasing activity growth was driven by new entrants to environmental water markets, most notably Texas and Nebraska. Both states created state regulatory programs to address groundwater overpumping that depletes streamflow. Texas' market activity aimed to protect municipal water supplies and endangered species within the Edwards Aquifer (San Antonio's main water supply), with recent annual volumes around 80,000 AF[15].

[15] "Flow Protection Measures," Edwards Aquifer Authority. Accessed April 15, 2020.

Nebraska was one of the few states (along with New Mexico and Washington) to manage surface water and groundwater conjunctively. Natural Resources (NRDs) and Irrigation Districts were the primary buyers of lease rights, beginning their purchasing program in 2015. The program created exchanges within each NRD to allow buyers to purchase water rights on a per season basis that can then be left in an aquifer to supplement stream flows[16]. The program grew quickly, with a 69% increase in annual volume traded, for a total of 176,000 AF. While it may take many years for depleted aquifers and streams to recharge to sustainable levels, the high growth in annual trading activity suggest that market-based approaches can act quickly to address hydrologic problems.

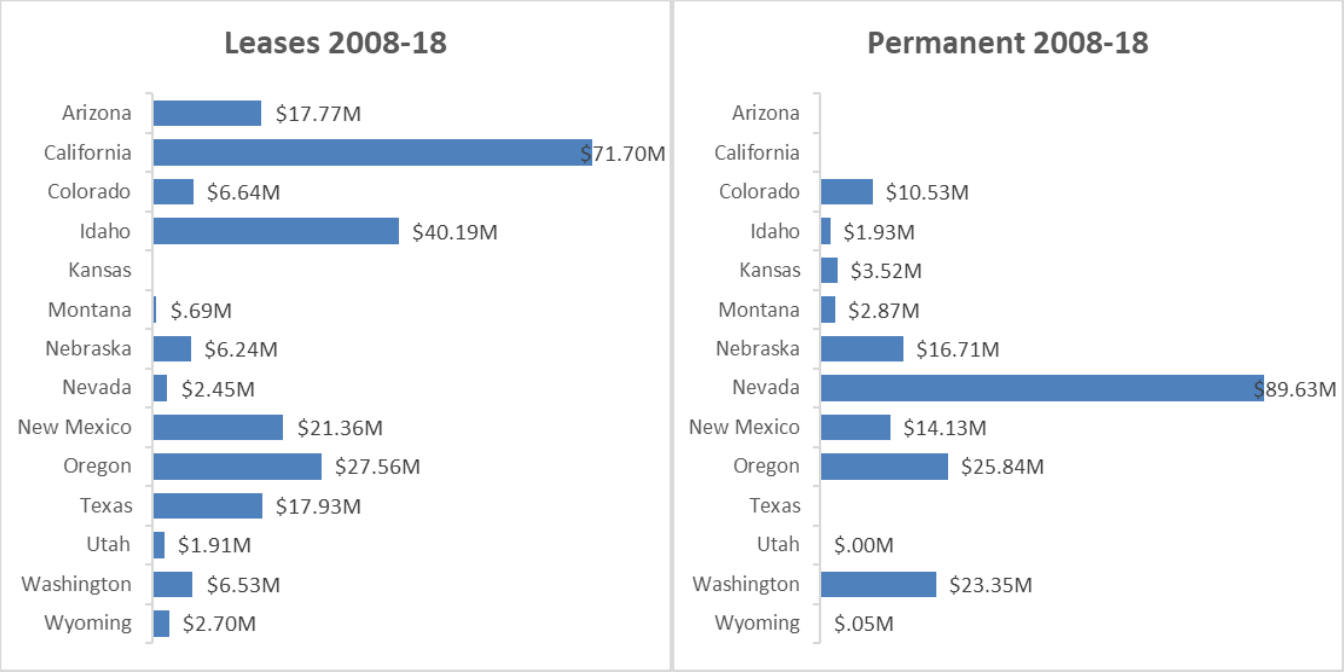

Figure 4. Aggregate market value of leased and permanently transferred water. Blank values indicate no market activity. Figures have been rounded for clarity.

Surface water vs. groundwater

Surface water transfers accounted for the majority of acquisitions by volume, with nearly 50% of leasing activity for surface water. Groundwater leasing was under 10% of total volume[17]. This gap was even larger for permanent transfers, as surface rights constituted 82% of total volume, while groundwater accounted for just 14%.

[16] "Innovative water market to help farmers and wildlife," Lincoln Journal-Star. Accessed April 14, 2020.
[17] The remaining 40% is designated as "storage" water, water left in reservoirs for future access or to maintain minimum operating levels. Storage water was not further analyzed for this project.

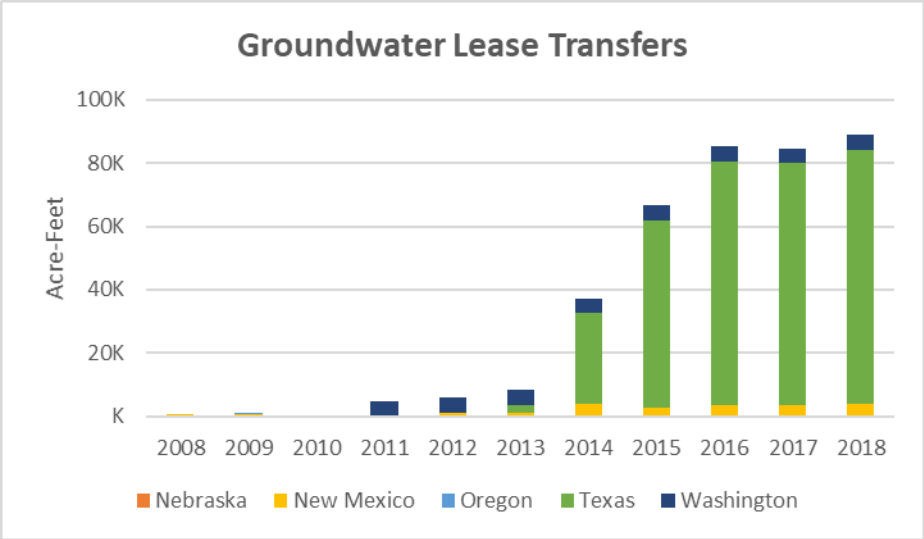

Figure 5. Annual groundwater transferred via lease or short-term agreements.

Groundwater markets were less active due in part to how states managed subsurface water. Only New Mexico, Washington, and Nebraska managed groundwater and surface water conjunctively (and also were active in both lease and permanent groundwater markets). Thus, limiting groundwater pumping to increase streamflow was a limited policy option for most states. However, there was a marked increase in annual volumes traded, mainly due to Texas (*Figure 5*).

Texas' restrictions on pumping sought to protect endangered aquatic species, and relied on new leasing types, including options payments. Options allowed for high annual volumes of water to be protected at lower cost. This secured supplies for the municipal users of the Aquifer and introduced price certainty for rights holders.

Groundwater prices reflected this scarcity value: lLease payments averaged $131/AF vs. $67/AF for surface water, and $2,443/AF vs. $1,905/AF for surface permanent transfers. Concerns about overpumping of groundwater among agricultural-intensive regions in the Great Plains prompted high prices relative to permanent acquisition of surface water. For instance, In Nebraska, the average price was $2,915, a substantial increase from $2,248 paid for surface water rights. As with leasing activity in the state, Nebraska Natural Resource Districts and Irrigation Districts were the primary buyers.

California only recently began regulating groundwater pumping, passing a statewide management act in 2014. Groundwater basins across the state must implement sustainability plans to recharge aquifers over the next 20 years beginning in January 2020. It is likely that market activity will increase as a result of new restrictions on pumping and the accessibility of intrabasin transfers of rights[18].

Leasing surface water was primarily driven by acquisition programs in California and Idaho (*Figure 6*). In California, the federal government leased water to supplement flows in national wildlife refuges in the Central Valley, as well as increased instream flows in the San Joaquin River for endangered salmon species. However, environmentally related transfers decreased

[18] "SGMA's First Groundwater Market: Fox Canyon," The Nature Conservancy. Accessed April 15, 2020.

significantly over the last few years, as 94% of transfers by volume occurred between 2008-13. One factor was the high unit price paid, an average of $78/AF that was inflated due to competing demands for water for non-environmental purposes in agriculturally dominant regions. This effectively priced out NGOs from being active market participants, except in far Northern California (away from most agricultural production).

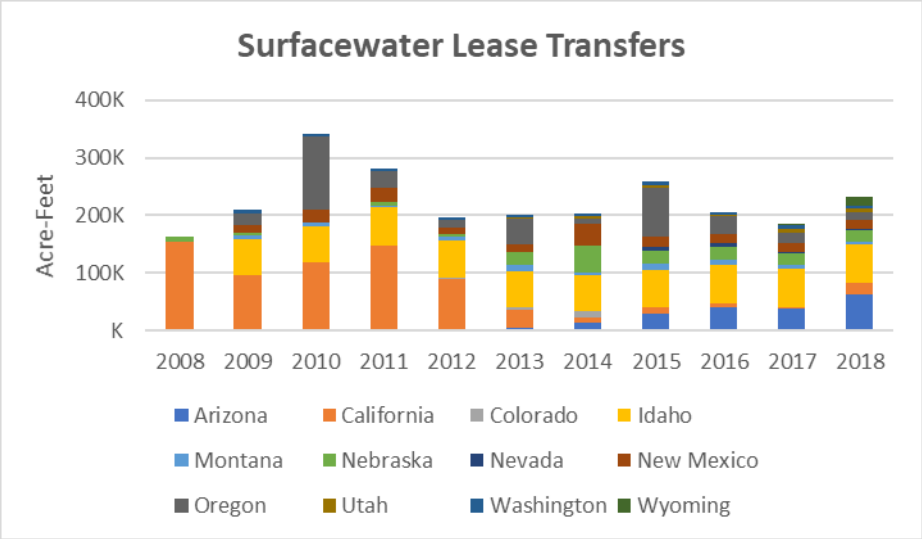

Figure 6. Annual surface water leasing volume. Volumes remained fairly consistent except for a spike in 2010 in Oregon. California's annual leasing activity declined by 2013, other states increased their activity.

Top Buyers & Sellers: Federal, State, NGOs

The top 3 buyers by volume and value were the federal government, state agencies, and NGOs. The number of unique buyers doubled from 10 to 20 between 2008-18. NGOs became more active participants in both regulatory and non-regulatory markets.

The federal government was the largest buyer in the market, leasing nearly 3.7 million AF as part of regulatory requirements (*Figure 7*). However, it only acquired 8,500 AF of permanent rights (mainly in Nevada).

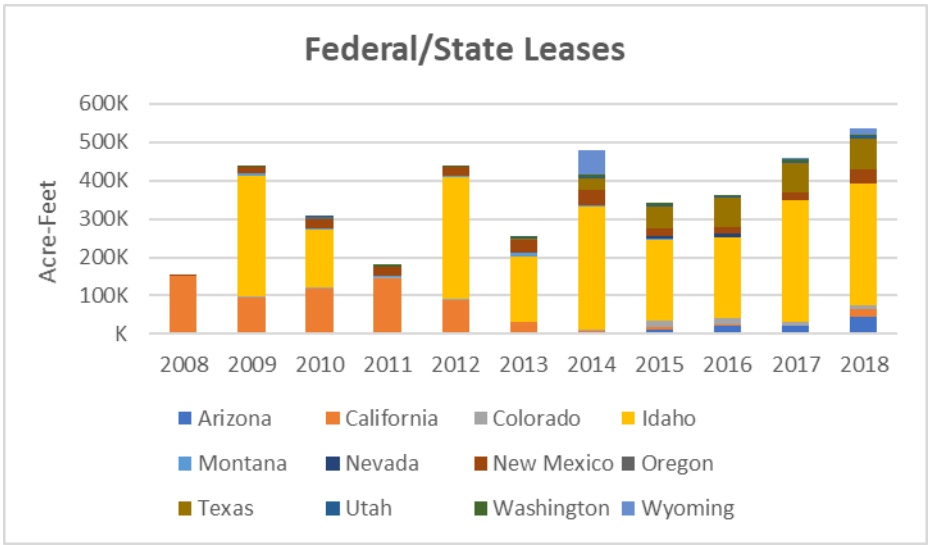

Figure 7. Combined annual volumes acquired by state and federal agencies. In 2008, activity was limited to a couple of states but has grown steadily since.

State agencies or statewide regulatory programs were the 2nd largest purchaser of

leases by volume (571,000 AF), as well as for permanent rights (23,000 AF).

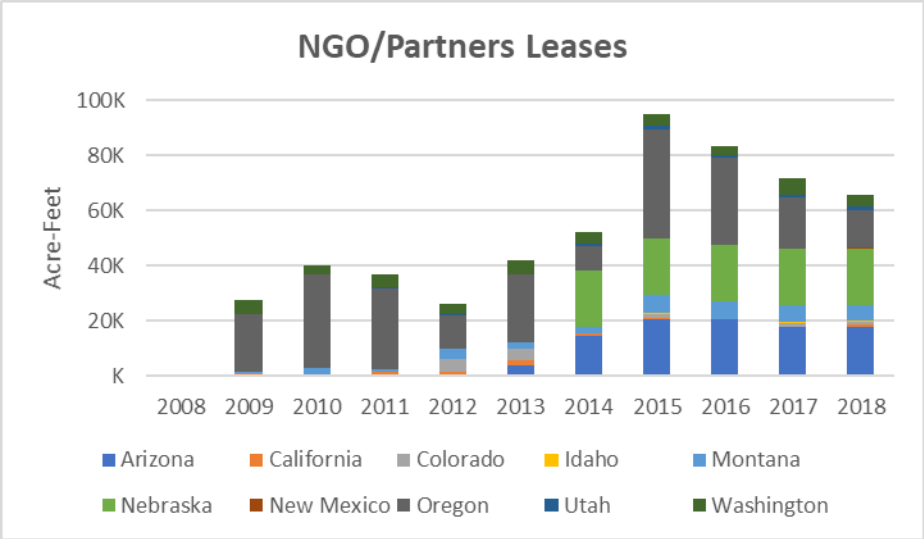

Figure 8. Combined annual volumes acquired by NGOs, either independently or in partnership with other entities.

NGOs were close behind states in leasing activity, with 533,000 AF in total. NGOs became larger participants beginning in 2015. Annual average volume more than doubled from 31 to over 78,000 AF between 2008-14 (*Figure 8*). This market activity also extended to permanent transfers, as NGOs accounted for over 70% of total volume acquired—mainly in Nevada, Oregon and Washington.

NGOs flexed their market muscle by negotiating prices more effectively than governmental entities. In aggregate, NGOs paid less per acre-foot of water ($56/AF) than the federal government ($86/AF) and states ($115/F) for leasing or short-term transactions, even when paying through the same regulatory program, such as the Pilot System Conservation Program along the Colorado River Basin (PSCP)[19].

However, one notable exception was the Columbia Basin Water Transaction Program (CBWTP), as the state agencies within the basin paid an average of $18/AF vs. NGOs of $52/AF[20]. NGOs such as Trout Unlimited or the Freshwater Trust were involved in expensive projects to change points of diversion (the locations of which are specified in a user's right) and upgrade infrastructure such as of conveyance canals and on-farm equipment to reduce consumptive use. State agencies paid for traditional transfers of actual water rights. NGOs, through these other mechanisms to reduce consumptive use, allowed greater market activity despite the higher cost. This enabled bypassing certain regulatory requirements (such as limitations on private parties holding instream flow rights) and high transaction costs.

[19] PSCP is a federal program funding state and local conservation projects along the CO River Basin to augment storage levels in Lake Mead and Lake Powell. It is referred to the PSCP in the Lower Basin, while also known as the System Conservation Pilot Program for projects in the Upper Basin. In this report, PSCP will refer to both the Lower and Upper Basin. "Pilot System Conservation Program," Bureau of Reclamation. Accessed April 15, 2020.

[20] CBWTP is a federally designated program that is run by the National Fish and Wildlife Federation, a quasi-non-governmental organization that is Congressionally chartered. It works with local organizations to fund water transactions to restore endangered species, with rights primarily held by partnering state agencies in OR, WA, ID, and MT. "2021 Request for Proposals," National Fish and Wildlife Foundation. Accessed April 15, 2020.

Regulatory Programs

Regulatory programs were the backbone of state environmental markets. 84% of total volume was transacted with a federal or state mandate[21]. This either was minimum flow conditions to protect endangered species or to augment reservoir storage levels.

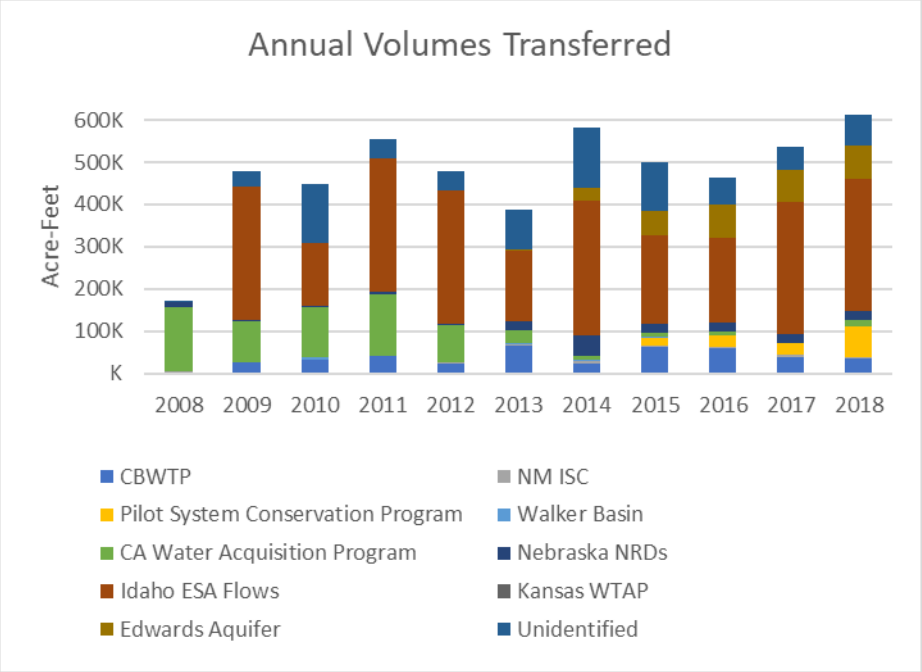

Figure 9. Annual volumes of water as part of regulatory programs.

An important development for the maturation of environmental water markets, was allowing NGOs or local agencies (e.g., Natural Resource Districts) to be partners in the actual acquisitions. Partnerships introduced greater flexibility and purchasing power. Legacy regulatory programs, such as Idaho's, had simple approaches: the designated state agency purchased water rights from irrigators and left it instream or for reservoir storage[22]. Newer programs, like the Pilot System Conservation Program (established in 2015) gave greater autonomy to NGOs and local agencies that reflected their increased flexibility and market innovations.

Annual volumes traded under these programs fluctuated between 380-612,000 AF, despite volumes under individual programs declining or disappearing (94% of transfers for California's Water Acquisition Program occurred from 2008-13 and Kansas' Water Transfer Assistance Program only operated between 2009-16).

New programs since 2014 include the PSCP or Texas' programs in the Edwards Aquifer. The PSCP leases water from rights holders in the Colorado River Basin to prevent or reduce diversion and maintain storage levels in Lake Powell and Lake Mead. While the program is not explicitly designed for instream or environmental uses, focusing instead on preventing the

[21] The remaining 16% was either unclassifiable or part of local cooperative efforts to supplement streamflows.
[22] Idaho's regulatory requirement is derived from a 2004 settlement between the Federal government and Native American tribes, notably Nez Perce. The Bureau of Reclamation annually purchases and stores water reserved to the tribes to supplement flows for endangered salmon species that the tribe relies on for cultural significance. Other limited activity takes place between state agencies and NGOs for other related endangered species recovery activities. "Agreement Summary," Department of the Interior. Accessed April 15, 2020.

water levels from dropping below the elevation required to pump the water downstream and ensure allocation to all users. While there is not an explicit environmental use, there is an auxiliary benefit of more water being left in basin rivers as a result of reduced diversions.

In the short-term, regulatory programs will likely continue to be the driver of environmental water acquisitions. This is due in part to continuing declines of endangered species populations, necessitating further investments in maintaining minimum environmental flows and habitat restoration. Additionally, new regulatory measures to combat groundwater overpumping in California introduces an opportunity for market mechanisms to address basin-wide usage caps. Mega-basin programs, like the PSCP targeting seven states along the Colorado River, will also likely rise in popularity as a multi-pronged response to increasing hydrological variability and demand. Mega-basin programs can also be easier to implement because there are more potential rights holders willing to sell or transfer their rights. Conversely, smaller basins could offer more immediate conservation and restoration gains due to more headwater streams and low-order rivers, leading to measurable outcomes for buyers[23].

Water Conservation Tools

Market growth over the last 10 years introduced a variety of approaches and mechanisms to conservation of stream flows. This was reflected by the annual increase in the number of tools used: in 2008, only direct payments (defined as payments made directly to a rights holder for a lease, sale or options contract) were used to acquire water. By 2015, eight identified mechanisms were available to buyers (*Figure 10*). This increased mix of tools could be attributed to the larger role of NGOs in leasing and permanent sales. Additionally, these mechanisms demonstrated innovative approaches to mitigating policy barriers in states where rights cannot be permanently transferred for instream purposes.

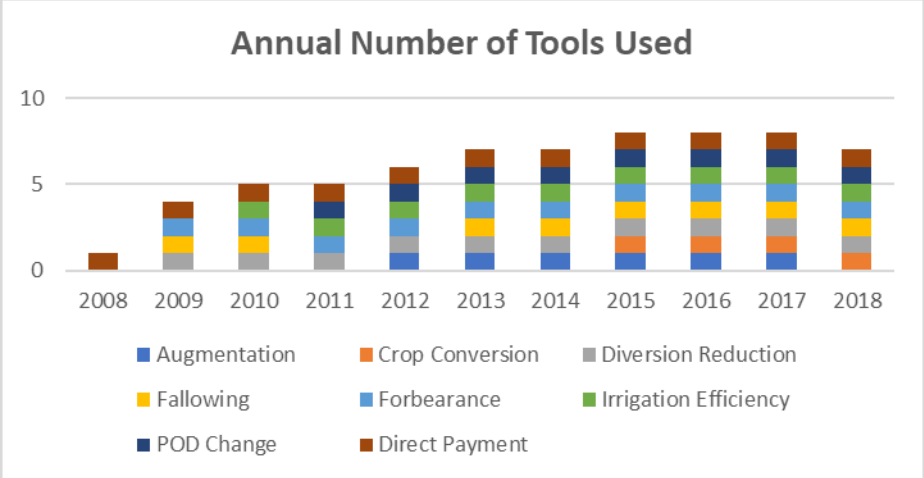

Figure 10. Annual number of environmental tools used, as identified at the same of the transactions. Direct payments denote leases or permanent transactions that could not otherwise be identified or actual acquisition of the right.

[23] For example, acquiring 10 AF of water for instream flows will be more impactful in a small headwater stream than 10 AF left in the Columbia River. Because of the smaller geographic focus, acquisitions in headwater streams can be more expensive than operating at a larger scale.

90% of acquisitions were made by direct payment (by total volume). Of the remaining 10%, land fallowing payments and projects to increase on-farm irrigation efficiency are the most common (*Figure 11*).

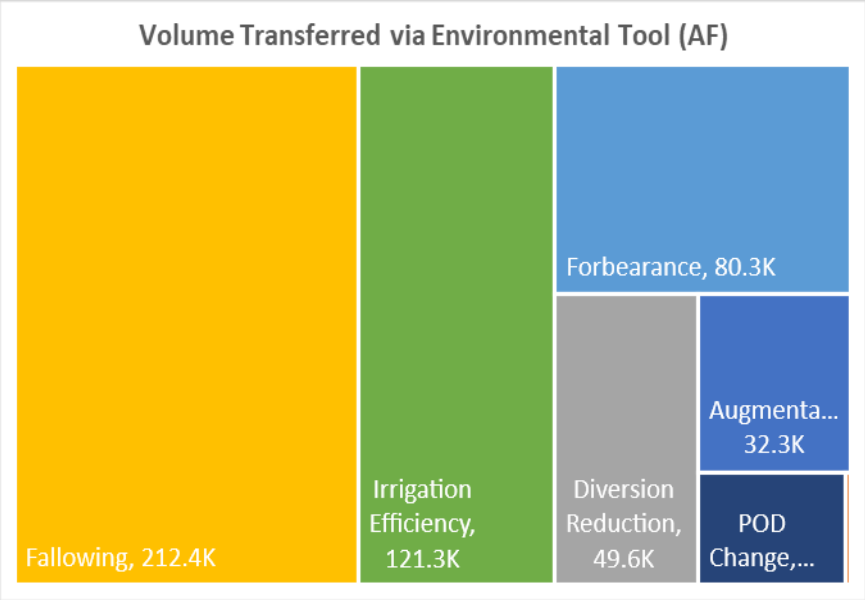

Figure 11. Volumes transferred by environmental tool. Not shown is direct payments, which is 90% of transactions by volume, and crop conversion, which is too low to be displayed (700 AF).

These tools were advantageous to both buyers and rights holders because they did not constitute a change in ownership of the right. In some cases, these mechanisms were cheaper than acquisition of the right itself (*Figure 12*).

Every state used some combination of these tools: Arizona used six; and Montana, Oregon, and Washington used five each. Only Kansas, Nebraska, and Texas stuck with direct payments, as their market activity was limited to mitigating groundwater overdraft.

Rates for these different tools varied for the top three buyers: federal government, state agencies, and NGOs (*Figure 12*). For every tool used to lease rights, NGOs paid the least per AF, while the federal government paid the most. While prices were most often location-dependent, or a function of scarcity, this disparity between prices for similar tools demonstrated the inherent flexibility that NGOs held. They were able to negotiate with rights holders or seek creative solutions around market barriers.

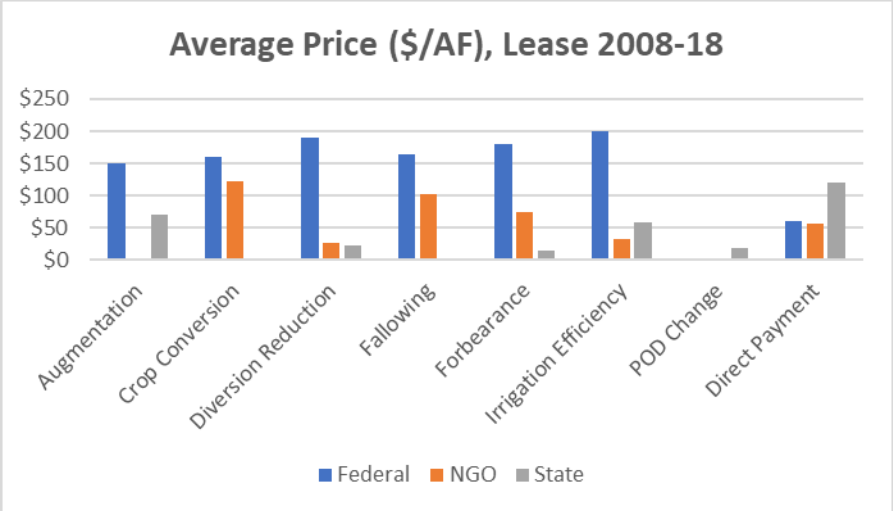

Figure 12. Average price paid for leases by NGOs, states and the Federal government (top 3 buyers) for environmental tools. NGOs pay less across the board.

Even in policy-constrained states that limited acquisition of rights to governmental entities or permanent transfers of rights to instream flows, NGOs identified innovative methods to restore and augment flows.

Payment Types

Along with the mix of environmental tools, payment methods introduced greater flexibility for buyers and rights holders. For example, dry-year options in Texas were based on annual hydrologic conditions (i.e., groundwater levels above a certain elevation), such that irrigators received $50/AF annually from the state to reserve the right to call that water for a "strike" price of $170/AF when withdrawals needed to be reduced or curtailed. Owners who signed up received an annual payment, incentivizing participation and increasing the ability to swiftly make adjustments when necessary (a strike was called once, in 2015).

Similarly, contingent payments fluctuated annually or within a season based on stream flow timing and rate requirements. Irrigation efficiency upgrades, forbearance and land fallowing was done in some states on a split-season basis. This reserved water in dry summer months for instream use. Dry-year options introduced price certainty to both buyers and sellers, while contingent payments were more responsive to short-term hydrologic conditions. These payment methods, while accounting for a low volume of water transferred over the last ten years, were an increasingly effective method for long-term and short-term planning on behalf of buyers and sellers.

Market Outlook

While states' legal frameworks certainly impacted market potential and activity, it did not completely curtail markets. The increased number of buyers introduced a greater diversity in methods and tools for acquiring and conserving water. The larger pool of buyers helped reduce prices as well, as NGOs consistently paid less per AF than federal or state buyers. In fact, NGOs acquired more water (temporary and permanent combined) than states. This increased purchasing power introduced further innovation in markets.

Going forward, the mix of environmental tools is likely to shift (on a volumetric basis) away from direct payments and towards fallowing, irrigation efficiency projects, or other methods to conserve water. However, NGOs pay a higher price for those type of projects. Funding limitations inherent to NGOs could impact markets, especially in expensive or competitive markets such as California.

V. THE FUTURE OF ENVIRONMENTAL WATER MARKETS

In the near future, environmental water markets will likely perform similarly as they do now: driven by regulatory requirements and programs, increasing use of an array of methods to conserve and acquire water rights, and responsive to higher volatility in hydrologic conditions. However, there are two divergent paths for the future of water markets: one in which markets reach a ceiling because of institutional barriers that constrain options and keep transaction costs high, or alternatively, market innovations continue to occur that increases participation and reduces barriers, ultimately weaving environmental and non-environmental uses in a single marketplace.

Barriers to Growth

As noted throughout this report, states' legal frameworks do not necessarily inhibit market activity. However, some states with a low number of legal elements face constraints that are emblematic of the broader struggles to measurably improve instream flows and habitat conditions. For example, New Mexico[24], Utah[25], and Wyoming[26] had limited activity, as measured by total number of transactions and acre-feet transferred. To introduce more market participation, states need to address legal barriers. Broadly, the historical doctrines of western water law, based on prior appropriation and "use it or lose it" principles entrench high water usage even when not economically efficient.

Statutory changes to create more enabling conditions can jumpstart market activity. States with low NGO participation see a correspondingly low mix of conservation tools and payment methods. In order to systematically address the water shortages and environmental degradation occurring throughout western river basins, states must embrace an array of policy options. Otherwise, market activity will remain limited and streamflows (and groundwater levels) will not measurably improve.

Another crucial element is successful partnerships. Any market success is dependent upon willing buyers and sellers. In some states where government agencies are the main buyer, rights holders are distrustful of partnering with institutions, particularly where reductions in use may lead to forfeiture or abandonment of the right. Allowing private parties to hold rights creates new partnership opportunities, as well as conservation methods that don't require the

[24] New Mexico has surface and groundwater leasing programs aimed to supplement required minimum levels in the Rio Grande, with fish protection also a benefit that are managed by the Interstate Stream Commission. PSCP projects have also focused on the San Juan-Chama basin. NGO activity has been very limited.

[25] While Utah does allow private parties to hold rights, NGOs like Trout Unlimited are restricted to projects that benefit native trout only. *Supra,* note 7.

[26] In Wyoming, 82% of total leasing transaction occurred in 2018, as the Bureau of Reclamation paid irrigators to switch or fallow crops in the headwaters of the Colorado River basin. And there has been only one permanent transaction, by the state Game and Fish Department. This low activity is a reflection of Wyoming's low number of legal elements, including not allowing private parties to hold rights.

transfer of the right itself. Yet, high transaction costs could constrain NGO activity and remain a long-term barrier to market participation.

Growth Opportunities

The alternative path to enhanced transaction activity builds off the market innovations introduced over the last ten years by NGOs. State markets continue to use a wide array of tools such payments for crop switching, partial-season forbearance, or dry-year options payments to secure water supplies. As both buyers and sellers become more familiar with how to structure transactions, the costs and review times decline. When transaction costs drop, each dollar can be leveraged farther for acquiring actual instream flows. Expediting review of short-term leases or other immediate responses to hydrologic needs adds flexibility for buyers and sellers[27].

Introducing private capital, whether impact investors or institutional investors looking to mitigate water supply risk, can address some of the funding constraints inherent to NGOs. Impact investment can provide capital tied to specific outcomes, such as minimum flow levels or habitat conditions. Impact capital can scale projects across basins, aggregating individual rights transfers to leverage increased flows[28]. See *Appendix I* for two potential investments that conserve water and create economic value for investors and rights holders.

States can also facilitate more participation and transparency by creating open exchanges and water banks. Open exchanges would include information on price, historical use, amounts of diversion and consumption, and other characteristics that improves information distribution and market knowledge[29]. Water banks would allow for the virtual transfer of rights between buyers and sellers, with administrative costs borne by a third party (typically a state entity)[30]. Encouraging facilitation by increasing transparency and transaction costs can result in increased market activity.

In the long-term, continued market maturation will strengthen the bargaining power of environmental buyers such that the goal of instream flows is not to maintain minimum levels on a seasonal basis but increase permanent allocation of environmental flows. Basin-wide frameworks that create an annual budget for all types of uses, including environmental needs, ensures flows are allocated more efficiently and are dynamically responsive to changing hydrologic conditions[31].

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[27] "Environmental Water Rights Transfers," Stanford University. Accessed April 15, 2020.
[28] "Liquid Assets: Investing for Impact in the CO River Basin," Encourage Capital. Accessed April 15, 2020.
[29] "A Framework for Developing a Score Card for Enabling Conditions for Environmental Water Transactions in the Colorado River Basin," AMP Insights. Accessed April 15, 2020.
[30] "Water Banking," Washington Water Trust. Accessed April 15, 2020.
[31] *Supra,* note 27.

APPENDIX I: LIQUIDITY FLOWS: IMPACT INVESTING

Potential Market Driver

As noted in the previous section, the rise of nongovernmental organizations fundamentally altered the environmental water market landscape over the last several years. NGOs such as The Nature Conservancy and Trout Unlimited acted as environmentally focused water rights buyers, dedicating flow rights for instream purposes or establishing payment structures to improve flows without altering the right itself. Among private investors, transactions with positive impact or outcome was a source of increased attention to address critical social and environmental issues.

Yet, interest among private investors for projects that specifically rededicate water for environmental purposes has been just that: interest. Analysis for this project showed that there have not been acquisitions among private investors to restore instream flows as the primary benefit. Instead, investors purchase farm and ranchland to enhance environmental services, such as increased soil carbon content or wildlife habitat acreage. Some of these investments also focused on water-related benefits, such as riparian habitat restoration or water quality. However, investments structured for the primary benefit of water conservation could strengthen the market with a fresh infusion of capital and innovative approaches.

This section presents two theoretical transactions, based on real-world inputs and assumptions, to demonstrate relatively "shovel-ready" projects for investors. While water conservation is the main environmental driver, an investor could easily introduce other practices to enhance the sustainability features. For instance, farm practices could switch to organic methods or emphasize soil-carbon regeneration. However, these projects focus on revenue generated from water conservation and current agricultural practices.

Investment Thesis: Guayule Crop Conversion in Pinal County, AZ

Pinal County is located between Phoenix and Tucson. Overreliance on groundwater pumping and junior apportionment claims over Central Arizona Project (CAP) water deliveries from the Colorado River have necessitated changes to irrigation methods and a recalculation of crops suitable for the region. Converting to crops with higher economic value and lower consumptive water use may provide an investment opportunity by selling the excess water to other irrigators or to supplement in-stream flows for environmental purposes in the Colorado River Basin.

Water Management

Agricultural users in Pinal County have junior claims to Colorado River water due to a deal struck in 1992 to reduce groundwater overdrafting. Prior to 1992, agricultural producers relied on groundwater for irrigation, but concerns about long-term effects of withdrawals led to the passage of Arizona's Groundwater Management Code in 1980. This law formed "active management areas" (AMAs) that allocated and managed water use to "extend the life of the agricultural economy for as long as feasible" in Pinal AMA and other rural, agricultural-dependent regions[32]. But in 1992, Pinal growers agreed to a lessor claim on deliveries from the Central Arizona Project (receiving excess supplies available in wet years) for the marginal cost of pumping ($77/AF in 2017). However, this allocation of water will be cut beginning in 2017 from a high of 400,000 AF per year initially to 300,000 AF, decreasing to 225,000 in 2024 and zero AF in 2030.

As a result, irrigators in the Pinal AMA will face increasing supply constraints from declining CAP deliveries, careful management of groundwater, and potential further surface water cuts from drought-induced restrictions on Colorado River water. For instance, when surface levels at Lake Mead drop below 1,090 ft., Arizona must cut back an additional 192,000 AF (June 2019 levels are 1,084 ft.)[33]. These present and future constraints present an opportunity to examine water usage among irrigated crops within the Pinal AMA and explore alternatives that reduce water consumption and create higher value crops.

Agriculture in the Pinal AMA

The Pinal region currently produces a mix of low-value crops such as alfalfa and corn silage (used as livestock feed), along with specialty crops including melons and peppers. Alfalfa is grown on 37,000 acres, out of a total of 130,000 irrigated acres in the county. Alfalfa enjoys comparatively high yields, with an average of 8-9 tons/acre between 2011-15. Alfalfa prices have historically been the highest among the top planted crops in Pinal but have seen a declining trend from $225/ton to $162 between 2011-15. Alfalfa is also the largest water user, requiring a consumptive use of 5.84 AF/acre (which includes losses from evapotranspiration during irrigation, percolation into groundwater, and runoff back into the water system). The

[32] "Overview of the Arizona Groundwater Management Code." AZ Dept. of Water Resources. Accessed July 2, 2019.
[33] "Lower Basin Drought Contingency Operations." Bureau of Reclamation, May 20, 2019. Accessed July 2, 2019.

applied irrigation method also affects the amount of water diverted, as flooding a field (level basin method) applies just 60% of diverted water toward consumptive use, while drip irrigation tops out at 93%[34].

Agricultural producers are charged for their water consumption, with both a fixed and variable cost structure. There are two main irrigation districts in the AMA, Maricopa-Stanfield Irrigation & Drainage District (MSIDD) and the Central Arizona Irrigation & Drainage District (CAIDD). Each irrigation district, due to differences in climate and soil type, are charged different water prices and allocation amounts from the Central Arizona Project. The fixed assessment rate per acre is $26 for MSIDD and $38 for CAIDD. Producers in MSIDD are allocated 4.4 AF/acre at a cost of $52/AF, while CAIDD users received 5.5 AF/acre at a rate of $58. Consumption above those levels results in an "excess fee" of $70 and $58 for MSIDD and CAIDD, respectively. Thus, there is an incentive for producers to limit their water usage within their initial allocation to reduce costs.

Guayule Crop Conversion

Crop conversion to a lower-usage crop could provide financial benefits along with water market benefits. Specifically, within Pinal County, an emerging opportunity exists to finance the conversion of fields from alfalfa production to guayule. Guayule is a shrub native to the desert Southwest and can be used as a natural source of rubber and latex. Indeed, it was once commercially produced in the early 1900s as an alternative to more expensive rubber from the Amazon[35]. Now, it competes against rubber production in Indonesia and other parts of Southeast Asia.

Guayule, as a native crop, is less water-intensive than traditional commodity crops in the region. Its consumptive water use is between 2-3 AF/acre. While yields (5 tons/acre) are lower than current crops planted in Pinal (on a per tonnage basis), prices are comparatively higher, as much as $200/ton.

Bridgestone Tires is currently exploring guayule cultivation to provide a domestic source of rubber production for tires, with experimental plots in Pinal AMA. While domestic production in the short-term won't be enough to offset global sourcing, it provides an opportunity to plant a crop with a lower water requirement that fetches a higher price. Guayule operates on two-year cycles, such that it can be harvested for rubber two years after planting, and generally every two years after, for a six-year lifecycle. For the purposes of this model, the revenue and cost figures have been amortized over a six-year period to show revenue and costs on an annual basis. Additionally, to encourage production, Bridgestone is subsidizing planting and harvesting costs in pilot plots.

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[34] "National Engineering Handbook Part 652: Selecting an Irrigation Method," Natural Resources Conservation Service. Accessed April 14, 2020.
[35] "Guayule," College of Agriculture & Life Sciences, University of Arizona. Accessed July 2, 2019.

Investment Model

To construct a model transaction in Pinal AMA, historical data on water usage, crop yields and prices were used to estimate gross income for a farmer. Production costs, such as establishment and water costs, were totaled to produce net returns to an investor. The model assumes the farm is in the Maricopa-Stanfield Irrigation & Drainage District, with an allocation of 4.4 AF/year.

The model assumes an investor would purchase a farm, then operate it with a farmer under a lease agreement (either the previous owner or a new, young farmer seeking entry). The deal would have a ten-year exit, with sale of the land occurring in the final year. Cash flows come from two sources: Guayule production revenue, and the lease of saved water to supplement in-stream flows for environmental purposes. Such purposes could include maintaining water in-stream to benefit Colorado River flows, or in-lieu credits for not pumping groundwater. These Long-term Storage Credits are given by the state of Arizona in-lieu of further groundwater pumping and can be sold or traded. Alternatively, in-lieu water can be "banked" and received later during drought or other low-flow periods. Groundwater storage would comply with the state's Groundwater Management Act, while in-stream flows could be part of the System Conservation Pilot Program in the lower Colorado River Basin, which is a federally-run program that seeks to mitigate the impacts of drought and correspondingly low reservoir levels by keeping more water in the River.

The model calculates lease revenue based on a fixed price, $150/AF, but the amount of water consumed varies by crop type and irrigation method. Converting alfalfa to guayule production for instance, reduces consumption by 3,337 AF/year (over a 1,000-acre field). This is based on level basin irrigation, which floods fields and has a 60% efficiency. While further water savings could be realized by investing in center pivot or drip irrigation infrastructure, guayule production benefits from maintaining flooded fields-- it provides a higher percentage of resin from the woody fiber to be used in rubber production.

Guayule production may have additional revenue streams, as it can be used in bioenergy production. The guayule plant has a useful lifespan of six years, after which the plant's stems and branches can be ground-up into bagasse. Bagasse is like sawdust, and generates 8,000-9,000 BTUs/lb., roughly equivalent to charcoal[36]. Economic studies suggest that the guayule plant biomass could be sold to a processing plant to extract bagasse for $167/ton, or just the post-rubber feedstock for $57/ton[37]. However, the location and scale of processing plants in Arizona is unclear, thus this revenue stream was not included in the pro forma.

Potential Risks

[36] Wood, Marcia. "Is This Desert Shrub a Fuel of the Future?" Agricultural Research Service, USDA. February 2009. Accessed July 2019.

[37] Sabaini, Priscila S., et al. 2018. *Techno-economic analysis of guayule pyrolysis biorefining: Production of biofuels from guayule bagasse via tail-gas reactive pyrolysis.* Industrial Crops & Products: 112: 82-89. Accessed July 2019. Figures converted from $/metric ton to $/US ton.

Current laws for environmental transfer of water in Arizona are limited. While existing water rights can be transferred for in-stream purposes, only the state government can hold this new right for it to maintain its priority date. This limits the market potential for transfers between private users, like NGOs, that might hold a right to provide environmental services. Instead, NGOs use informal transactions, such as temporary diversion reduction or forbearance agreements or financing more efficient irrigation infrastructure (such as drip).

Thus, a market for water in Pinal AMA is limited to temporary, informal transaction instead of a permanent sale of the water right. The model reflects this by annually leasing water, with the water right ultimately being retained by the investor.

The market for guayule is currently limited to Bridgestone's investment in experiential fields and is not yet at scale. Bridgestone, to encourage production, is paying for all planting and harvesting costs, substantially lowering costs to the producer/investor. Should guayule be grown on the scale necessary to compete with current rubber sources abroad, it is possible that such agricultural subsidies may not continue. Absorbing these additional costs for production and harvesting will affect cash flows from the crop and affect returns.

Finally, the model anticipates the sale of the farmland in year 10. Observed appreciation of local land value (as measured by compound annual growth, or CAGR) has been anemic over the last 10-15 years[38]. Sale prices dropped during the Great Recession and have been slow to recover at both the low and high ends of the market. The model assumes a 5% annual increase in the land value, but this could be lower depending on economic conditions at the time of the sale.

Impact & Returns

A typical alfalfa farm diverts 7,580 AF annually, consuming 5,837 AF (over a 1,000 acre field) (77% efficiency). For guayule, the same acreage consumes only 2,500 AF. Diversions decline by 4,333 AF. This water can be leased out for an assumed price of $150/AF paid by an NGO. Leasing revenue is over $500,000, accounting for nearly one-third of total annual revenue.

The unlevered rate of return (IRR) is 18.4% (33.4% levered with a 60/40 debt to equity ratio). The multiple of capital invested is nearly 6x. The net present value, which measures the sum of discounted cash flows, is $5.2 million. This is a competitive investment in line with other market returns.

[38] "Pinal County Market*A typical* Trends," American Society of Farm Managers & Rural Appraisers. Accessed July 10, 2019.

Water Analysis	
Diversion for Required Current Irrigation (af)	7,580
Consumptive Use for Current Irrigation (af)	5,837
Consumptive Use for Guayule (2.5 AF/acre)	2,500
Efficiency Rate (Flood irrigation)	77%
Water Diversion Required for Guayule	3,247
Reduction in Water Diversion	4,333
Direct Reduction in Crop Consumption	3,337
AF Price Paid by NGO for Lease	$150
Annual Water Revenue from Lease	$ 500,490

Figure 13. A snapshot of potential water savings and leasing payments from guayule crop conversion.

Investment Returns	
MOIC:	5.95
Unlevered IRR:	18.4%
NPV:	$5,219,598
Levered IRR:	33.2%

Figure 14. Investment returns. The model projects both unlevered and levered scenarios. A 60-40 debt to equity ratio is assumed to project levered returns. The MOIC and NPV shown here is based on this 60% debt leverage.

Investment Thesis: Rotational Fallowing in the Imperial Irrigation District, CA

The Imperial Irrigation District is in California's Imperial Valley, bordering Mexico. It is one of the premier agricultural producers in the state, with over half a million acres of irrigated farmland and $2 billion in annual economic output. The irrigation district relies entirely on imported deliveries from the Colorado River. It is the single largest rights holder to water, with over 3.1 million acre-feet delivered annually.

Historical Fallowing Programs

However, the Colorado River Basin is approaching its twentieth year of drought. Water supplies, and consequently, reliability of deliveries has declined. In order to meet future demand and growth, other major California water districts, notably the Metropolitan Water District of Southern California (MWD) and the San Diego County Water Authority (SDCWA) brokered an agreement with IID to transfer a portion of its water to their districts. In 2003, these groups signed the Quantification Settlement Act, which was the largest agriculture to urban water transfer in the US. Under the QSA, IID will transfer up to 300,000 AF annually to MWD, SDCWA and the Coachella Valley Water District, with SDCA receiving 200,000 AF. In order to make this water available, IID undertook a series of measures to improve efficiency, including lining of the All-American and Coachella Valley canal to reduce conveyance losses, rotational fallowing of agricultural fields in Imperial Valley, and on-farm irrigation infrastructure upgrades.

The rotational fallowing program paid farmers within the district to not plant crops and reduce their water diversion entitlement, on either a whole- or partial-farm basis. The program operated from 2003-2017, fallowing acreage that conserved an average of over 119,000 AF annually[39]. Fallowing payment rates ranged from $60/AF in 2004 to $175/AF in the last years of the program[40].While some of that water was delivered to urban users, the QSA also specified that some water was to be made available for the Salton Sea.

The Salton Sea is the largest lake in California, created in 1905 after the Colorado River breached a levee. An accidental effect of a major flood event, this had the unanticipated consequence of creating a nearly 340 square mile lake. Since then, the lake has become important nesting habitat for migratory birds and is the home of the largest population of migratory waterfowl outside of the Everglades[41]. The Sea relies on runoff and return flows from irrigated fields for its inflows (via the New and Alamo rivers), receiving an average of 1.1 million AF annually since 2015. However, the annual evaporation rate equals nearly 70 inches, totaling 1.3 million AF. Thus, current agricultural runoff volume is not enough to sustain lake levels. This results in: 1) increased salinity levels (concentration has increased from 38g/L to 58 g/L from 1950-2016) that impacts aquatic species and 2) lakebed exposure of particulate matter and

[39] "2016 Fallowing Program Status Report," Imperial Irrigation District. Accessed July 9, 2019.
[40] "Fallowing," Imperial Irrigation District. Accessed July 9, 2019.
[41] "Salton Sea Facts," Salton Sea Authority. Accessed July 9, 2019.

toxins that negatively impact air quality throughout the Imperial and Coachella Valleys[42,43]. The exposed lakebed, or playa, currently totals 32 square miles. Should the Sea continue to decline at current rates, the playa will increase to 130 square miles by 2047.

The rotational fallowing and efficiency improvements were designed to supplement flows over the 15-year period from 2004-2018. Agricultural runoff in the Imperial Valley is the biggest contributing factor to Salton Sea inflows, averaging between 39%-68% of all flows from the Valley into the Sea. However, since the fallowing program has ended, annual inflows are projected to decline to 718,000 AF between 2018 to 2047. This will create an anticipated exposure of 3,500 acres of additional lakebed in 2018, increasing to 48,300 acres in 2028[44].

In response to this environmental and public health problem, the state of California, the Bureau of Reclamation, Imperial irrigation District, along with other groups, have been working on a comprehensive management plan to rebuild habitat to reduce lakebed exposure. However, additional fallowing of farmland is not currently a part of this strategy, as the plan focuses on creating new habitat to reduce lakebed exposure.

The Quantified Settlement Agreement only identified rotational fallowing as an initial 15-year option for deliveries of water to SDCWA and flows for the Sea. After the program ended in 2018, water will instead come from on-farm irrigation infrastructure upgrades and canal lining. However, increased inflows will be necessary to address salinity concerns and increase wetted areas. Thus, fallowing should still be considered a mitigation option to increase inflows into the Sea.

The Drought Contingency Plan, enacted in April 2019 among Colorado River Basin states and the federal government, also mandates cuts to California's allotment of Basin deliveries in certain conditions. Namely, should Lake Mead levels drop between 1,045-1,040 ft., California will need to cut back 200,000 AF, with further cuts if Lake Mead levels decline further[45]. The Plan sets these conditions through 2026 and has not yet been factored into other management plans for Salton Sea restoration and flow needs. Thus, it is likely that rotational fallowing will be a necessary option when deliveries of Colorado Basin water are curtailed, and Salton Sea levels must be mitigated.

Investment Model

The investment model examines an opportunity to purchase a 1,000-acre farm in the Imperial Valley and fallow either all or part of the acreage to lease water for Salton Sea inflows. To construct the model, recent data were used to estimate farm purchase price, land appreciation, property taxes, legal fees, and other costs[46]. The investment is structured with a 10-year life,

[42] "Phase I 10-year Plan." August 2018. CA Natural Resources Agency. Accessed July 9, 2019.
[43] "Salton Sea Hydrology Modeling." October 2018. Imperial Irrigation District. Accessed July 9, 2019.
[44] *Supra* note 4.
[45] "Lower Basin Drought Contingency Operations." March 2019. US Bureau of Reclamation. Accessed July 10,2019.
[46] "Imperial County Market Trends," American Society of Farm Managers & Rural Appraisers. Accessed July 10, 2019.

with fallowing occurring in years 4-10 and sale of the land in the final year. In years 1-3, farming operations continue as a revenue source. The standard diversionary volume for irrigation in the Imperial Valley is 10.4 AF/acre, with about half of that amount being consumptively used (water that is used by crops, percolates underground, evaporates from the field, or runs off into a downstream canal or stream). The remainder is lost to evapotranspiration during conveyance or leaks out from unlined canals. By fallowing the fields, the investor can lease the full diversion volume.

An agreement to lease water would likely be with an environmental NGO interested in Salton Sea restoration, or government agencies (such as IID or the state Natural Resources Agency). The assumed lease rate was based on the final years of IID's rotational fallowing program, set at $175/AF and increased to $200/AF. To convert to a price per acre, $200/AF was multiplied by the historic diversion volume of a farm, 10.41 AF/acre, for $2,081/acre and rounded to $2,100. Water savings are quantified on an annual basis, with up to 2,602 AF available to supplement in-stream flows.

Potential Risks

While the funding source for the water lease is unsecure, it is likely that parties interested in Salton Sea restoration will return to a rotational fallowing program. While the 2018 Farm Bill included $200 million for Salton Sea restoration, it is unclear how much of that funding will be for fallowing. Other funding sources include recently approved California state water bonds. In both cases, the timing of funding is uncertain, and thus any potential investment may not realize gains on fallowed lands immediately. However, the model does assume no fallowing until year 4, demonstrating a pathway to financial returns without immediate fallowing.
Other risks include a lower land value appreciation. Observed appreciation in values (as measured by compound annual growth, or CAGR), demonstrate recovery from the Great Recession at the high-end of the market. However, appreciation in value for sale in year 10 could decline due to macroeconomic forces, affecting sale price and overall investment value.

Investment Returns

The model assumes a 500-acre farm with a typical water allocation of 10.41 AF/acre, for a total diversion of 5,200 AF. Fallowing 50% of the acreage produces 2,600 AF to be leased. Projections for leasing available water leads to revenue of $565,000 beginning in year 4. However, expenses reduce overall revenue to $367,000. In total, this transaction could return a leveraged rate of 13.4% (9.5% unlevered) and a multiple of capital invested of 3.3x. The net present value is $1.8 million. These figures are based on a 60%-40% debt/equity split.

Water Analysis	
Pre-enrollment (annual)	
Total Diversion (AF)	5,204
Consumptive Use (AF)	2,500
Post-fallowing (annual)	
Total Diversion (AF)	2,602
Consumptive Use (AF)	1,250
Available Flows (AF)	2,602

Figure 15. Projected water savings from fallowing to be used to supplement Salton Sea levels.

Returns ($ in 000s)

Year:	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Farming Revenue	$113	$115	$118	-	-	-	-	-	-	-
Fallowing Revenue	-	-	-	565	580	594	609	624	640	656
Total Revenue	**$113**	**$115**	**$118**	**$565**	**$580**	**$594**	**$609**	**$624**	**$640**	**$656**
Overhead Expenses	($184)	($188)	($193)	($198)	($203)	($208)	($213)	($219)	($224)	($230)
EBITDA	**($71)**	**($73)**	**($75)**	**$367**	**$377**	**$386**	**$396**	**$405**	**$416**	**$426**
Acquisition Cost (Full Equity)	(6,836)	-	-	-	-	-	-	-	-	-
Deal Costs	(287)	-	-	-	-	-	-	-	-	-
Sale	-	-	-	-	-	-	-	-	-	12,913
Unlevered Cashflow	**($7,194)**	**($73)**	**($75)**	**$367**	**$377**	**$386**	**$396**	**$405**	**$416**	**$13,339**
Unlevered Yield	*-1%*	*-1%*	*-1%*	*5%*	*5%*	*5%*	*5%*	*6%*	*6%*	*6%*
Debt	$4,274	-	-	-	-	-	-	-	-	-
Interest Expense	-	($262)	($262)	($262)	($262)	($262)	($262)	($262)	($262)	($3,779)
Levered Cashflow	($2,920)	($336)	($337)	$105	$114	$124	$133	$143	$153	$9,560
Discounted Cashflow	($2,717)	($290)	($272)	$79	$80	$80	$80	$80	$80	$4,638
Levered Yield	*-2%*	*-3%*	*-3%*	*13%*	*13%*	*13%*	*14%*	*14%*	*14%*	*15%*

Investment Returns	
NPV:	**$1,838,608**
Unlevered IRR:	**9.5%**
MOIC:	**3.31**
Levered IRR:	**13.4%**

Figure 16. Projected cash flows based on fallowing and water leasing.

APPENDIX II: ACKNOWLEDGEMENTS

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