2016

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Citation Information

Mark Squillace and Anthony McLeod, *Marketing Conserved Water*, 46 Envt'l. L. 1 (2016), *available at* http://scholar.law.colorado.edu/articles/23.

ARTICLES

MARKETING CONSERVED WATER

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Water law scholars have long supported water markets for addressing critical water needs, especially in arid regions like the western United States, and that support seems to be growing among policymakers as well. But translating academic theories about water markets to the field has proved challenging. To be sure, water can be transferred from one use to another use in all western states, but water markets in those states are not presently capable of providing prospective buyers with a reliable source of water when and where they need it. The reasons are myriad, but are primarily related to the high transaction costs and significant lead times needed to consummate transfers. Under the current system, no municipal water supplier in the western United States can guarantee its customers the water they demand if they are forced to rely on the availability of water on the open market.

Remarkably, Australia has managed to adapt its water rights system in such a way that water markets have flourished. The water rights regime in the western United States is different in some significant ways from the Australian system, and thus it is unrealistic to think that the western states can duplicate Australia's experience and success. But there are important lessons to learn from an Australian

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transfer system that has cut approval times for temporary transfers to less than five days and for permanent transfers less than twenty days.

One way for western states to make progress towards developing functioning water markets is to cabin the scope of a marketing program so that it has a better chance of garnering the support of affected parties, and in particular the farmers who will be selling their water to cities for domestic and industrial uses. By focusing on "conserved water"—defined here as water that was previously but is no longer consumed by the water user—states will find it easier to adopt reforms that can provide farmers with incentives to make some portion of their water available for other uses. Farmers can keep farming even as they find ways to use less water to grow profitable crops.

Agricultural scientists have made great progress towards identifying and refining techniques for maintaining stable crop production even while using less water. These techniques, which include deficit irrigation, crop switching, and rotational fallowing, have the potential to free up enough water to serve western communities for many years to come, even in the face of severe, sustained drought. But the law has yet to catch up with the science, and in most western states, transferring conserved water is not legally possible. Even where it is allowed, the process remains too cumbersome. This Article begins a discussion about overcoming the legal obstacles to marketing conserved water and suggests modest and practical reforms to current law that could finally open the western United States to robust water markets.

I. INTRODUCTION

Irrigated agriculture dominates world water use, accounting for approximately 70% of water withdrawals and as much as 93% of water consumption worldwide.[1] Water consumption for agricultural use is especially high in the more arid regions of the world where it has the greatest potential to create tension with other water needs, especially for domestic use.[2] And as the demand for water grows and as water resources become scarcer, the importance of developing strategies that can move agricultural water to other uses has become increasingly urgent. Yet wholesale reform of current legal limits on water transfers seems unlikely, in

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[1] KERRY TURNER ET AL., ECONOMIC VALUATION OF WATER RESOURCES IN AGRICULTURE 3 (2004); UNITED NATIONS WORLD WATER ASSESSMENT PROGRAMME, UNITED NATIONS' WORLD WATER DEVELOPMENT REPORT: BACKGROUND BRIEF (2012), *available at* http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/WWDR4%20Background%20Briefing%20Note_ENG.pdf; *see also* IGOR A. SHIKLOMANOV, WORLD WATER RESOURCES: A NEW APPRAISAL AND ASSESSMENT FOR THE 21ST CENTURY 24 (1998) (noting that in 1998 agriculture accounted for 67% of total water withdrawal and 86% of consumption).

[2] UNESCO, Facts and Figures from the United Nations World Water Report 4: Managing Water Under Uncertainty and Risk 1, 3, 5, 7, 10 (2012), *available at* http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/WWAP_WWDR4%20Facts%20and%20Figures.pdf (discussing regions suffering from absolute water scarcity and noting that in Iraq, Oman, Syria, and Yemen, agriculture accounts for 90% of water use).

large part because of opposition from the agricultural sector to such reform.[3] For this reason, reform advocates should embrace a narrower effort that focuses on transferring "conserved" water, defined here to encompass only that portion of water that was previously consumed but that is no longer consumed in the agricultural enterprise. If so limited, conserved water transfers can be consummated without undermining the economy of local farming communities and for that reason should face far less opposition. They might even garner agricultural community support.

Several promising methods for conserving significant amounts of agricultural water have emerged from the work of agricultural research scientists, including, for example, deficit irrigation, crop switching, and rotational fallowing of land.[4] Providing farmers with economic incentives to adopt these strategies, however, has proved challenging in some parts of the world due in large part to the property rights regimes for water.[5] Specifically, where water rights are defined in terms of "beneficial use" for a particular purpose, and where transferring conserved water to other uses is constrained by law, as it is, for example, in the western United States, the market is not able to function in a way that promotes agricultural to urban water transfers, even where the transferred water is made available through water conservation by agricultural users.[6]

Australia has moved aggressively, and by most accounts successfully,[7] to promote water marketing in the Murray–Darling Basin as a way to address severe water deficits in the most populous region of that vast country. Australia's reforms have been far-reaching, going well beyond "conserved" water,[8] and they may not be practical in other parts of the world, including the western United States. Nonetheless, Australia's experience may offer lessons to the western United States and other regions of the world as they consider whether and how to use water markets to stretch what otherwise might appear to be inadequate water supplies.

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[3] *See, e.g.*, TERESA A. RICE & LAWRENCE J. MACDONNELL, AGRICULTURAL TO URBAN WATER TRANSFERS IN COLORADO: AN ASSESSMENT OF THE ISSUES AND OPTIONS 2–5 (1993), *available at* http://scholar.law.colorado.edu/cgi/viewcontent.cgi?article=1063&context=books_reports_studies.

[4] Bruce Aylward, *Environmental Water Transactions: Reducing Consumptive Use*, *in* ENVIRONMENTAL WATER TRANSACTIONS: A PRACTITIONER'S HANDBOOK 106–07 (Bruce Aylward ed., 2013), *available at* http://www.ecosystemeconomics.com/Training_files/Ch_7_EWTs-Reducing%20Consumptive%20Use.pdf.

[5] *See id.* at 108 (explaining the difficulty of implementing incentive programs).

[6] *See, e.g.*, RICE & MACDONNELL, *supra* note 3, at 6–7 (explaining the limitations on water transfers under Colorado law). These economic disincentives are often reinforced by a political system that tends to favor and protect historic agricultural users.

[7] *See, e.g.*, M.W. Rosegrant et al., *Water Markets as an Adaptive Response to Climate Change*, *in* WATER MARKETS FOR THE 21ST CENTURY: WHAT HAVE WE LEARNED? 46 (K. William Easter & Q. Huang eds., 2014); MICHAEL D. YOUNG, ENVIRONMENTAL EFFECTIVENESS AND ECONOMIC EFFICIENCY OF WATER USE IN AGRICULTURE: THE EXPERIENCE OF AND LESSONS FROM THE AUSTRALIAN WATER REFORM PROGRAMME 8 (2010), *available at* http://www.myoung.net.au/water/publications/OECD_Lessons_paper.pdf.

[8] *See, e.g.*, YOUNG, *supra* note 7, at 6, 18.

This Article begins by examining the opportunities for conserving water in the agricultural sector. It asks not only what the opportunities are but also what the technical and legal obstacles might be. It then pivots to a discussion of the Australian experience with water marketing. In particular, it asks whether that experience can help inform an effort to implement narrower reforms that would promote agricultural water conservation by farmers in the western United States and other parts of the world. This leads to a fulsome discussion of strategies for resolving the technical and legal obstacles to conserved water transfers in the western United States. The Article concludes with a review of specific institutional and legal reforms that might be employed to overcome the current obstacles to a robust water market.

II. WATER SAVINGS FROM AGRICULTURAL WATER CONSERVATION

Not all agricultural water conservation is alike. Water losses that are reduced through more efficient delivery systems and application techniques may shrink water withdrawals and limit run off from irrigated lands but they can also increase water consumption.[9] Depending on where the agricultural lands are situated, such efficiencies can also deprive downstream users of water that they would otherwise receive in the form of agricultural return flows.[10] Likewise, efficiencies can sometimes have adverse ecological consequences, such as where natural streamside vegetation is removed to reduce evapotranspiration.[11] On the other hand, some promising water

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[9] Several methods can be used to change the amount of water withdrawn during delivery application. Ditch lining is the installation of an impervious material, such as urethane or concrete, in an existing or newly constructed field ditch. TEX. WATER DEV. BD., WATER CONSERVATION BEST MANAGEMENT PRACTICES GUIDE 226–27 (2004), *available at* http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/r362_bmpguide.pdf. Conservatively, concrete linings should be able to salvage 80% of the seepage that would occur in an unlined ditch. *Id.* at 227. Center pivot irrigation describes a number of sprinkler technologies where the sprinkler system can rotate around a fixed pivot. *Id.* at 231–32. Depending on the type of system used and the system replaced, new systems can be up to 50% higher in application efficiency. *Id.* Drip irrigation systems allow water to flow directly onto the soil, or into the root zone of crop plants. *Id.* at 234. For corn, researchers in Kansas have found that subsurface drip irrigation has the potential to reduce water needs by 25%. F. R. Lamm et al., *Water Requirements of Subsurface Drip-Irrigated Corn in Northwest Kansas*, 38 TRANSACTIONS OF THE ASAE 441, 447 (1995), *available at* http://www.ksre.ksu.edu/sdi/reports/1995/WaterReq.pdf.

[10] UNITED NATIONS EDUC., SCIENTIFIC, AND CULTURAL ORG., WORLD WATER ASSESSMENT PROGRAMME, THE UNITED NATIONS WORLD WATER DEVELOPMENT REPORT: WATER AND ENERGY 60 (2014), *available at* http://unesdoc.unesco.org/images/0022/002257/225741e.pdf. *See also* Frank A. Ward & Manual Pulido-Velazquez, *Water Conservation in Irrigation Can Increase Water Use*, 105 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 18215, 18219 (2008).

[11] *See, e.g.*, Se. Colo. Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321, 1327 (Colo. 1974) (holding that water salvaged through the removal of non-native tamarisk was still subject to the call of the river). The court's decision was partially driven by a policy interest; it considered "whether the granting of such an unique water right will encourage denuding river banks everywhere of trees and shrubs which, like the vegetation destroyed in these cases, also consume the river water." *Id.* at 1324. However, there are circumstances in which removal of

conservation strategies have emerged that actually reduce water consumption or evapotranspiration,[12] and thus can free up water for other uses.[13] Importantly, these strategies do not require that agricultural lands be retired.[14] On the contrary, they encourage farmers to continue farming even as water resources are freed for other uses. Three particular water conservation strategies are highlighted in this Article. They include:

1) *Deficit irrigation*, where carefully timing and applying water allows crops to grow with substantially less than their normal irrigation water requirement;[15]

2) *Crop-switching*, where farmers temporarily or permanently transition from high water consumptive crops to low water consumptive crops;[16] and

3) *Rotational fallowing*, where parcels of land (often the least productive parcels) are taken out of production every season on a rotating basis to free up a fixed amount of water annually.[17]

One American company that is focused on the technical aspects of water saving strategies in agriculture such as those described above is Regenesis, which has entered into a cooperative research arrangement with the U.S. Department of Agriculture.[18] Their program is designed to: "(1) use less water and document the reduction of crop water use (consumptive use

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weeds and other nonnative plants, such as those adjacent to ditches, can lead to more efficient water transportation and delivery.

[12] *See* Sam Geerts & Dirk Raes, *Deficit Irrigation as an On-Farm Strategy to Maximize Crop Water Productivity in Dry Areas*, 96 AGRIC. WATER MGMT. 1275, 1277–78 (2009) (discussing deficit irrigation as a water optimization strategy); Elias Fereres & María Auxiliadora Soriano, *Deficit Irrigation for Reducing Agricultural Water Use*, 58 J. EXPERIMENTAL BOTANY, 147–48 (2007) (same); BRIAN MCDONALD, EVALUATION OF ALTERNATIVES FOR THE MIDDLE RIO GRANDE REGIONAL WATER PLAN, ALTERNATIVE 11: LOW-WATER CROPS 4–5 (2004), *available at* http://www.dbstephens.com/uploads/directory/fc754183ef684878970c593c36661971/Low_Water_Crops.pdf (discussing the water-saving alternative of switching from higher to lower water-use crops).

[13] Fereres & Soriano, *supra* note 12, at 148; MCDONALD, *supra* note 12, at 4–6.

[14] *See* Geerts & Raes, *supra* note 12, at 1278 (discussing how deficit irrigation permits farmers in water limited areas to obtain yields that allow economic sustainability, hence continued use of the land); Fereres & Soriano, *supra* note 12, at 148 (discussing how deficit irrigation allows for irrigation water to be reduced to a level that will still support agricultural lands); MCDONALD, *supra* note 12, at 1 (discussing switching to less water-intensive corps, which keeps agricultural lands in use).

[15] Geerts & Raes, *supra* note 12, at 1277; Fereres & Soriano, *supra* note 12, at 148.

[16] MCDONALD, *supra* note 12, at 1, 4.

[17] Tyler G. McMahon & Mark Griffin Smith, *The Arkansas Valley "Super Ditch"—An Analysis of Potential Economic Impacts*, 49 J. AM. WATER RESOURCES ASS'N 151, 152 (2013). This is not meant as an exclusive list and variations and combinations of these strategies may prove more efficient in practice. For example, dryland cropping might be an appropriate approach for some farm with sufficient natural precipitation. Other examples involve limiting irrigation to some period early in the season or limiting the number of cuttings for crops that allow multiple cuttings. Some sense of these variations will be provided in the discussion that follows.

[18] Tom Cech, *Regenesis: A New Approach for Irrigated Agriculture*, 2 IRRIGATION LEADER, Sept. 2011, at 22–23.

or evapotranspiration), and (2) maintain historic return flows," increasing returns to irrigators by allowing them to sell surplus water to cities.[19] Regenesis has developed a management tool called Sustainable Water and Innovation Irrigation Management (SWIIM).[20] This program allows farmers to quantify potential water savings by inputting data on cropping patterns, field size, water delivery quantities, crop type, deficit irrigation practices, crop rotations, and other factors.[21] While supporters of the SWIIM program have suggested that using this technology should provide sufficient support for transferring water in the state of Colorado,[22] the legal obstacles to concluding such transfers are significant. These legal issues are the subject of further analysis later in this Article.[23]

Nonetheless, current research would seem to support claims by Regenesis and others that certain water conservation strategies can achieve substantial water savings.[24] Whether these savings can be adequately quantified and then translated in such a way as to make water available for the needs of other users, however, remains a more open and complex question. Before turning to that question, a brief review of current research about the three featured water conservation strategies and the water savings they might achieve is set forth below.

A. Deficit Irrigation

Deficit irrigation (DI) is generally defined as a strategy for maximizing efficiencies in the application of irrigation water.[25] While it can take different forms, it generally promotes water application "during drought-sensitive growth stages of a crop,"[26] while limiting water applications during other periods. While DI can cause stress in crops and lead to decreased production, its goal is to maximize water productivity (WP) or crop water

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[19] *Id.* at 22.

[20] *Id.* at 23.

[21] *Id.* Regenesis claims that SWIIM is an "easy-to-use interface that allows for water and crop management while providing for implementation of optimizing technologies and real-time monitoring of conserved water." *Regenesis Management Group Enters into Water Optimization and Technology Development Agreement with the USDA*, Bus. Wire, Feb. 23, 2010, http://www.businesswire.com/news/home/20100223005007/en/Regenesis-Management-Group-Enters-Water-Optimization-Technology (last visited Feb. 13, 2016). SWIIM includes software, remote sensing, and instrumentation (including field sensors measuring soil moisture), which is directed at allowing water users to fully utilize their water rights. Cech, *supra* note 18, at 23. SWIIM alternatives for management include deficit irrigation (DI), crop rotations, continued full irrigation of selected crops, permanent fallowing, rotational fallowing, introduction of dry land crops or perennial crops, or combinations of these. *Id.*

[22] *See* Cech, *supra* note 18 (stating that SWIIM provides answers to key questions posed by Colorado's Water Court regarding efficient water use and monitoring).

[23] *See infra* Part V.

[24] *See, e.g.*, Geerts & Raes, *supra* note 12, at 1279 (providing a summary of literature suggesting that deficit irrigation can increase water productivity).

[25] *Id.* at 1277 (describing DI as an "optimization strategy" with the goal and effect of maximizing water productivity, despite reducing overall production of fruits and plants).

[26] *Id.*

productivity (CWP), terms that essentially measure agricultural product per unit of water.[27] Thus, while deficit irrigation may not maximize the output of biomass, it promotes efficiency by establishing the means for farmers to grow the most crops for the least amount of water. One form of DI, sometimes called regulated deficit irrigation (RDI), involves a fairly technical water application process that requires careful monitoring and management.[28] But DI can also be carried out more simply for some crops by simply changing seasonal applications or eliminating one or more cuttings from crops like alfalfa that provide multiple cuttings during the growing season.[29]

DI offers many advantages. Most importantly, with some crops, it can significantly reduce water consumption while maintaining or only marginally reducing crop production levels.[30] Furthermore, by reducing humidity, crops may be less prone to fungal outbreaks.[31] In addition to its water savings potential, DI offers important environmental benefits by limiting the leaching of nutrients from soils. This protects farmlands and reduces nutrient pollution in waterways.[32]

On the other hand, DI requires farmers to carefully manage the application of water to crops in terms of both timing and amount. Some amount of excess water may be necessary to remove salts from the soil to preserve its salt balance, but efficient and well-managed irrigation methods can reduce the amount of excess water needed.[33] Moreover, while sustained

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[27] Fereres & Soriano, *supra* note 12, at 148–50; R. Bradley Lindenmayer et al., *Deficit Irrigation of Alfalfa for Water-Savings in the Great Plains and Intermountain West: A Review and Analysis of the Literature* 103 AGRONOMY J. 45, 46–47 (2011) (using the term "water use efficiency" to describe the goal of increasing yield while potentially harming productivity).

[28] William L. Stewart et al., *Regulated Deficit Irrigation Reduces Water Use of Almonds Without Affecting Yield*, 65 CAL. AGRIC. 90, 90–95 (2011) (noting various methods of irrigation and explaining the precise measurements required). The article notes that "[t]he objective of regulated deficit irrigation is typically to irrigate so that trees experience mild-to-moderate levels of water stress, in order to achieve an optimal horticultural balance between vegetative growth, which is very sensitive to stress, and fruit production, which is less sensitive." *Id.* at 91.

[29] Lindenmayer et al., *supra* note 27, at 46–47 (explaining that while variations in harvest schedule impact water use efficiency, management is not sensitive according to the variety of alfalfa).

[30] C. Kirda, *Deficit Irrigation Scheduling Based on Plant Growth Stages Showing Water Stress Tolerance*, *in* WATER REPORTS 22: DEFICIT IRRIGATION PRACTICES 3, 4–5 (Food and Agric. Org. of the United Nations ed., 2002), *available at* ftp://ftp.fao.org/agl/aglw/docs/wr22e.pdf.

[31] *See, e.g.*, David A. Goldhamer, *Tree Water Requirements & Regulated Deficit Irrigation*, *in* PISTACHIO PROD. MANUAL 103, 103–16 (L. Ferguson et al. eds., 4th ed. 2005), *available at* http://ucmanagedrought.ucdavis.edu/PDF/Pist%20Prod%20Man.2005.pp103-116.pdf ("In orchards that have slowly permeable soils and applied water ponds on the soil surface for days after an irrigation, or where sprinkler spray patterns are directed into the tree canopies, fungal disease is more prevalent. Higher humidity levels in such orchards promote disease activity . . . . With poor infiltration rate soils, we have shown that buried drip irrigation can reduce orchard humidity, thus reducing incidence of fungal diseases. The key is installing the system such that the soil surface is not (or is minimally) wetted throughout the season.").

[32] *See, e.g.*, Mustafa Unlu et al., *Trickle and Sprinkler Irrigation of Potato (*Solanum Tuberosum *L.) in the Middle Anatolian Region in Turkey*, 79 AGRIC. WATER MGMT. 43, 66–67 (2006).

[33] Fereres & Soriano, *supra* note 12, at 148.

DI can maintain a high level of production without substantial biomass loss, a decreased harvest index can result if insufficient water is applied to the land.[34] The harvest index measures the percentage of the plant that is harvestable product against the parts of the plant that cannot be used.[35] In its more technical applications, DI requires precise knowledge of crop response to drought stress, as drought tolerance varies considerably by the species or subspecies of the crop and with the various stages of growth.[36] For many crops, a typical strategy would be to irrigate during drought-sensitive stages and to restrict water to crops during more drought-tolerant stages.[37] Often the more drought-tolerant stages fall later in the growth cycle, including vegetative and late ripening stages.[38] Soil type also influences the effectiveness of DI and additional research is needed to catalog the DI potential of agricultural regions by soil type and crop. But a look at several specific crops suggests that DI holds considerable promise for conserving water.

1. Alfalfa

Alfalfa is a low WP, high evapotranspiration crop.[39] Generally, reductions in alfalfa irrigation result in decreases in biomass production.[40] Nonetheless, a report by the Pacific Institute estimates that a realistic application of DI for alfalfa grown in the Colorado basin alone could save almost a million acre-feet of water per year.[41] Although DI under such a scenario could result in yield losses of around 25%, the water savings achieved could more than justify the crop losses in terms of economic efficiencies, and if those efficiencies can be captured through the market, irrigators can be afforded incentives that will encourage them to adopt the most cost-efficient DI methods.[42]

Researchers have studied two different approaches to DI for alfalfa. "Partial season" DI involves stopping irrigation during the late summer

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[34] *Id.* at 151.

[35] *Id.*

[36] For example, for many crops, DI applied during specific growth stages, but not in others, can result in water savings without crop stress. *See Crop Irrigation Strategies*, UNIV. OF CALIF. DROUGHT MGMT., http://ucmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies/ (last visited Feb. 13, 2016) (addressing the different irrigation strategies depending on the type of crop).

[37] *See, e.g.*, *Pistachios: Irrigation Management for Pistachio Trees Under Drought Conditions*, UNIV. OF CALIF. DROUGHT MGMT., http://ucmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies/Pistachios/ (last visited Feb. 13, 2016) (explaining that pistachios have some clear drought-tolerant stages during which irrigation is not needed, whereas irrigation is recommended during more drought-sensitive stages).

[38] Geerts & Raes, *supra* note 12, at 1277.

[39] Lindenmayer et al., *supra* note 27, at 47.

[40] *Id.* at 46.

[41] MICHAEL COHEN ET AL., WATER TO SUPPLY THE LAND: IRRIGATED AGRICULTURE IN THE COLORADO RIVER BASIN 74 (2013), *available* at http://pacinst.org/wp-content/uploads/sites/21/2013/05/pacinst-crb-ag.pdf.

[42] *Id.* at 63 (citing Lindenmayer et al., *supra* note 27).

months when crop growth is low and water supplies are typically scarce.[43] "Full season" DI reduces total irrigation throughout the irrigation season.[44] Both the Pacific Institute study and an earlier study by Lindenmayer and others found that partial season DI offers greater water use efficiency for alfalfa than does full season RDI. Still, water savings and crop production efficiencies are highly dependent on soil type and climate, suggesting that a program to maximize water savings will need to choose carefully the regions where DI is employed.[45]

Water use for growing alfalfa varies considerably across the country and so too does the potential for water savings. For example, the Pacific Institute estimates that partial season irrigation of alfalfa in the Palo Verde Valley of southern California can reduce irrigation by 22.7 inches from a full season average of sixty-eight inches per year, for a water savings of more than 33%.[46] Of course, such water savings are going to be limited to places like the lower Colorado River Basin, with its warmer climate and longer growing season.[47] In the lower basin of the Colorado River alone this could yield savings of 834,000 acre-feet of water.[48] Although yields might decrease by 25%, the losses would be covered by a purchase price for the water of $62 per acre-foot.[49] This looks especially attractive when compared to the cost of seawater desalination proposed for southern California at an estimated cost of $1,849–$2,064 per acre-foot.[50]

In contrast to the Pacific Institute report, which focused on California, Lindenmayer compiled nine different studies in the Great Plains and Intermountain West and examined a variety of DI strategies for alfalfa.[51] Lindenmayer found that, on average for that region, DI reduced consumptive use of water from alfalfa crops by 4.3 inches per year from a full season

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[43] Lindenmayer et al., *supra* note 27, at 46–47.

[44] Robert G. Evans & E. Jon Sadler, *Methods and Technologies to Improve Efficiency of Water Use*, 44 WATER RESOURCES RES., July 2008, at 6, *available at* http://onlinelibrary.wiley.com/doi/10.1029/2007WR006200/epdf (explaining that "under full season drought management a given volume is available for distribution within a fixed land area over the course of the growing season").

[45] COHEN ET AL., *supra* note 41, at 61; *see also*, Steve Orloff et al., *Controlled Deficit Irrigation of Alfalfa: Opportunities and Pitfalls*, PROCEEDINGS, CALIF. ALFALFA SYMP., Dec. 2003, *available at* http://ucanr.edu/sites/adi/files/204411.pdf ("The effects of deficit irrigation varied depending on the location and soil type.").

[46] COHEN ET AL., *supra* note 41 at 62.

[47] *Id.* at 63.

[48] *Id.* Farming in the lower basin of the Colorado River occurs primarily in the large irrigation districts of southern California, including, most notably, the Imperial Irrigation District. *See IID History: Water History*, IMPERIAL IRRIGATION DIST., http://www.iid.com/about-iid/an-overview/iid-history (last visited Feb. 13, 2016).

[49] COHEN ET AL., *supra* note 45, at 63. Production declines are not linear. Orloff et al., *supra* note 45. Orloff et al. found that alfalfa production is highest earlier in the season, accounting for 42% of total production in a three-cut season, and 35% for a four-cut season. Cutting off irrigation water in mid-July would allow two cuttings or 61% of the total production in a four-cutting season and 75% for the first two of a three-cut schedule. *Id.*

[50] COHEN ET AL., *supra* note 41, at 63.

[51] *Id.* at 62.

average of 34.7 inches.[52] This corresponds to an approximate savings of 12%. Thus, while the potential for water savings is considerably lower than in warmer states like California with a longer growing season, every three acres of alfalfa grown using RDI in the Great Plains region would still yield a full acre-foot of water, thereby potentially making DI a very attractive alternative to new water projects or other types of water transfers.

Looking at the big picture, and combining the potential savings from employing DI methods for alfalfa in both the upper and lower basins of the Colorado River could yield a 10% reduction in total irrigation water use over the entire basin.[53] Thus, employing DI methods for just one important crop could go a long way towards addressing the water shortage issues that currently plague the Colorado River basin.

Of course, the potential for water savings using DI methods for alfalfa extend well beyond the Colorado River basin. In 2014, American land in alfalfa production was estimated to be 18.4 million acres (7.45 million hectares),[54] and the eleven western states, including some of the most arid in the country, accounted for approximately 7.4 million acres (3 million hectares) of this total.[55] Using even the simplest DI method of eliminating late season cuttings of alfalfa on these arid lands could yield significant quantities of water for water-starved western states while still accommodating the productive use of these agricultural lands.

2. Maize

RDI employed with maize or corn crops also has the potential to yield significant water savings and can sometimes be accomplished without any reduction in yield. The key to maximizing RDI for maize lies in limiting it to the preflowering and postflowering stages of development of the corn plant.[56] One study that focused on farming in northwest China found that the harvest index of corn increased as a result of careful application of RDI during the seedling (preflowering) stage and root elongation (postflowering)

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[52] *Id.*; Lindenmayer et al., *supra* note 27, at 50.

[53] COHEN ET AL., *supra* note 41, at 63.

[54] U.S. DEP'T OF AGRIC., CROP PRODUCTION: 2014 SUMMARY 90 (2015), *available at* http://www.usda.gov/nass/PUBS/TODAYRPT/cropan15.pdf.

[55] Dan Putnam et al., *The Importance of Western Alfalfa Production*, U. OF CAL. ALFALFA & FORAGE (2000), *available at* http://alfalfa.ucdavis.edu/+symposium/proceedings/2000/00-001.pdf. (Western U.S.: "11 western US states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. These states total 7.4 million acres, or 31.2% of the US acreage, and produce 33 million tons per year, or 40.5% of the US production of alfalfa.").

[56] I. Farre & J.-M. Faci, *Deficit Irrigation in Maize for Reducing Agricultural Water Use in a Mediterranean Environment*, 96 AGRIC. WATER MGMT. 381, 391–92 (2009) (describing how RDI during "stage II," of development significantly reduced grain yield). Farre and Faci divide the growing season for maize into three phases: "(a) from emergence to tassel emergence; (b) from tassel emergence to milk stage of grain; [and] (c) from milk stage to physiological maturity." *Id.* at 385. It is only at the middle stage where full irrigation is advised.

stage.[57] That study concluded that savings of over 20% could be achieved over the whole lifetime of the crop.[58]

Farre and Faci studied deficit irrigation in maize crops in northeastern Spain.[59] In particular, they looked at crops grown in 1995 and 1996 and compared plots that used DI at some or all stages of plant development.[60] They concluded that "it is possible to maintain relatively high yields if water deficit is limited to periods other than around flowering stage."[61] While they found evidence of reduced grain yield with DI employed during the seedling stage in 1995 when there was less rainfall than in 1996, the key to maintaining good production was full irrigation during the flowering stage of the plant.[62] They also acknowledged, however, that climate, soil properties, and irrigation practices are important factors to consider in deciding whether DI should be applied to maize crops.[63]

The extent of water savings from using DI for growing maize seems harder to quantify than for alfalfa, but the potential water savings is nonetheless substantial. The Farre and Faci study, for example, notes that for the year 1996, when rainfall was higher, it was possible to obtain yields comparable to yields with full irrigation "with a total irrigation volume of about half of the crop water requirements."[64] In terms of the western United States, the state with the most potential for water savings from using DI methods for corn is Colorado,[65] which had more than one million acres in corn production in 2014.[66] Water consumption (or evapotranspiration) for corn crops in Colorado has been estimated to be in excess of 16 acre-inches per year.[67] If DI methods were used to grow corn in Colorado, a conservative estimate of water savings based upon a 37.5% savings of 16 acre-inches would yield six acre-inches of water.[68] Applying DI methods to just half of the acreage in corn production would yield more than 250,000 acre-feet of water.[69]

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[57] *See* Shaozhong Kang et al., *An Improved Water Use Efficiency for Maize Grown Under Regulated Deficit Irrigation*, 67 FIELD CROPS RES. 207, 210, 213 (2000).

[58] *See id.* at 208, 212

[59] Farre & Faci, *supra* note 56, at 383.

[60] *Id.* at 386.

[61] *Id.* at 393.

[62] *Id.* at 392. The study in China suggested that using DI at the early stage of plant development was important to the success of DI for maize because it allowed the plants to better adapt to drying at later stages. Kang et al., *supra* note 57, at 213.

[63] Farre & Faci, *supra* note 56, at 392.

[64] *Id.*

[65] *See* U.S. DEP'T OF AGRIC., *supra* note 54, at 8.

[66] *Id.*

[67] ANTONY FRANK & DAVID CARLSON, COLORADO'S NET IRRIGATION REQUIREMENTS FOR AGRICULTURE, 1995 Tbl.1 (1999), http://hermes.cde.state.co.us/drupa/islandora/object/co%3A3072/datastream/OBJ/download/Colorado_s_net_irrigation_requirements_for_agriculture__1995.pdf (last visited Feb. 15, 2016) For grain corn the actual evapotranspiration figure is 16.90 inches. For silage corn it is 16.14 inches. *Id.*

[68] *Id.*

[69] *Id.* (the total water requirements for both types of corn is 1,359,570 acre-feet; 37.5% of half of that total is 254,919 acre-feet).

3. Fruit Trees and Vines

For several reasons, DI strategies may hold the most promise for fruit and nut trees and grape vines, even to the point of increasing farmer's profits.[70] One big reason for this is that the economic returns from fruit crops are generally more closely tied to the quality of the fruit than to the amount of biomass produced.[71] This is different from grains, where more biomass is typically better.[72] A second reason for looking closely at using DI for fruit trees and vines is that they are generally less sensitive to water deprivation at some developmental stages than field crops.[73] A final advantage of employing DI for fruit and nut trees and grape vines is that they are well-suited to micro-irrigation systems.[74] While these systems are more expensive to install and maintain, fruit and nut trees and grape vines tend to generate higher income per unit of water used and thus the additional costs associated with successfully employing DI strategies can be more easily justified.[75]

RDI has been successful with several species of fruits, nuts, and vines.[76] Wine grapes in particular seem to benefit from water stress associated with DI techniques, but benefits have also been shown for peaches,[77] apples,[78] pears,[79] citrus,[80] almonds,[81] and pistachios.[82] For example, RDI regimes for citrus fruit can reduce water use by up to 25%.[83] While the weight of

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[70] Fereres & Soriano, *supra* note 12, at 149. *See also* I. Goodwin & A.M. Boland, *Scheduling Deficit Irrigation of Fruit Trees for Optimizing Water Use Efficiency*, *in* WATER REPORTS 22: DEFICIT IRRIGATION PRACTICES, *supra* note 30, at 67.

[71] Fereres & Soriano, *supra* note 12, at 153.

[72] *Id.*

[73] *Id.*; R. S. Johnson & D. F. Handley, *Using Water Stress to Control Vegetative Growth and Productivity of Temperate Fruit Trees*, 35 HORTSCIENCE 1048 (2000).

[74] Fereres & Soriano, *supra* note 12, at 153.

[75] *See* Josué Medellín-Azuarra et al., *Jobs Per Drop Irrigating California Crops*, CAL. WATERBLOG, Apr. 28, 2015, http://californiawaterblog.com/2015/04/28/jobs-per-drop-irrigating-california-crops/ (last visited Feb. 13, 2016) (showing revenue per net unit of water for various California crops).

[76] Fereres & Soriano, *supra* note 12, at 154.

[77] D. A. Goldhamer et al., *Effects of Regulated Deficit Irrigation and Partial Root Zone Drying on Peach Tree Performance*, 592 ACTA HORTICULTURAE, Nov. 2002, at 343.

[78] Brian G. Leib et al., *Partial Root Zone Drying and Deficit Irrigation of "Fuji" Apples in a Semi-Arid Climate*, 24 IRRIGATION SCI. 85, 85 (2006).

[79] Peter D. Mitchell et al., *Responses of "Bartlett" Pear to Withholding Irrigation, Regulated Deficit Irrigation, and Tree Spacing*, 114 J. AM. SOC'Y HORTICULTURAL SCI. 15, 17 (1989).

[80] David Goldhamer, *Regulated Deficit Irrigation in Trees and Vines*, *in* AGRICULTURAL WATER MANAGEMENT: PROCEEDINGS OF A WORKSHOP IN TUNISIA 70, 72 (Laura Holliday ed., 2007).

[81] David A. Goldhamer et al., *Regulated Deficit Irrigation in Almonds: Effects of Variations in Applied Water and Stress Timing on Yield and Yield Components*, 24 IRRIGATION SCI. 101, 113 (2006); *see also* Stewart et al., *supra* note 28, at 93–94 (finding that DI could reduce water consumption by 11% for almonds, decreasing kernel size slightly but maintaining the same approximate yield).

[82] F. Iniesta et al., *Quantifying Reductions in Consumptive Water Use Under Regulated Deficit Irrigation in Pistachio*, 95 AGRIC. WATER MGMT. 877, 878, 884–85 (2008).

[83] David A. Goldhamer et al., *Evaluation of Regulated Deficit Irrigation on Mature Orange Trees Grown under High Evaporative Demand*, *in* CITRUS RESEARCH BOARD 2000 ANNUAL REPORT

individual fruits may be slightly reduced, tests show that a larger quantity of the fruit produced with DI methods can be classified as "fancy," rather than for juice, which gives it higher value.[84] Thus, even with the smaller fruit size, growers can achieve higher revenue in many cases.[85]

Pistachios offer yet another illustration of the potential value of DI. One study, for example, looked at three stages of development for the pistachio tree: 1) leaf-out to full shell expansion; 2) full shell expansion to the onset of rapid kernel growth; and 3) rapid kernel growth to harvest.[86] The study found that irrigating at 50% of normal during stage 2 and reducing irrigation of trees by 70% after harvest would reduce overall water consumption by 23.2% without adversely impacting the harvest.[87]

A current study in New Mexico is also looking at potential benefits to pecan farmers.[88] Mature pecan trees have been estimated to use from thirty-nine to fifty-one inches of water annually and thus the potential for water savings from DI would seem to be substantial.[89]

4. Rapeseed

Rapeseed is a crop of increasing importance that is grown for its high oil content.[90] In 1975, for example, worldwide rapeseed oil production stood at 8.8 million metric tons.[91] By 2006, that figure had increased more than five-fold to 47 million metric tons.[92] A hybrid of rapeseed is canola, which is commonly used for cooking. Industrial uses for rapeseed oil include lubricants and plastics manufacturing.[93] Employing DI strategies for rapeseed production could save a significant amount of water, especially in arid and semi-arid regions. In one study that applied different amounts of irrigation water and nitrogen to test fields, researchers found that grain yield could be retained in a DI scenario when normal or high amounts of nitrogen

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16, 18 (2000), *available at* http://citrusresearch.org/wp-content/uploads/2000-GOLDHAMER1.pdf.

[84] *Id.* at 17.

[85] *Id.* at 18 (noting that "the highest gross revenues of all 14 irrigation treatments were the two early season stress [DI] regimes," leading the authors to conclude that with "early season RDI . . . applied water can be reduced by 25% relative to fully irrigated trees without reducing gross revenue").

[86] David A. Goldhamer & Robert H. Beede, *Regulated Deficit Irrigation Effects on Yield, Nut Quality and Water-Use Efficiency of Mature Pistachio Trees*, 79 J. HORTICULTURAL SCI. & BIOTECH. 538, 539 (2004).

[87] *Id.* at 544.

[88] Richard Heerema et. al., *Seasonal Timing of Regulated Deficit Irrigation in Pecans*, N.M STATE UNIV., http://aces.nmsu.edu/rgbi/richard-heerema.html (last visited Feb. 13, 2016).

[89] Charles Rohla, *Shaping up Pecans with Irrigation*, AG NEWS & VIEWS, Feb. 2012, *available at* http://www.noble.org/Global/ag/news-views/2012/02/shaping-up-pecans.pdf.

[90] Soyatech, *Rapeseed Facts*, http://www.soyatech.com/rapeseed_facts.htm (last visited Feb. 13, 2016).

[91] *Id.*

[92] *Id.*

[93] Michael Boland, *Rapeseed*, AGRIC. MKTG. RES. CTR., Mar. 2012, http://www.agmrc.org/commodities-products/grains-oilseeds/rapeseed/ (last visited Feb. 13, 2016).

were applied.[94] For this study, all fields were flood irrigated in the same manner and amount through the stem elongation phase, and DI fields were irrigated only half as frequently after that.[95] With a 40% reduction in water irrigation, rapeseed crops experienced only an 8% reduction in grain yield.[96]

Table 1 summarizes some of the available data on water savings that might be expected from RDI. While the potential for savings is substantial, the application and ultimate expansion of DI programs will likely be limited by the practical obstacles to transferring water saved by such methods. Water savings, while real, are highly dependent on crop type, soil conditions, and climate.[97] In particular, and as described in the concluding section of this Article, establishing pilot water transfer projects for farmers who employ DI techniques should probably focus on particular basins with particular crops, climate, and soil profiles. As more is learned about the water saving advantages of DI, these projects might be expanded to other crops and other regions.

Table 1: Potential Water Savings from DI

Crop	Potential Water Savings	Potential Yield Reductions
Alfalfa[98]	up to 33% (varies by region)	~25% (varies by region)
Maize[99]	over 20%	no significant reduction
Rapeseed[100]	40%	8%
Almonds[101]	11%	little decline, but slightly smaller kernel size
Pistachio[102]	23.2%	no reduction
Citrus[103]	25%	no decrease in profits (reduced yield, but higher quality)

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[94] Javad Hamzei & Jalal Soltani, *Deficit Irrigation of Rapeseed for Water-Saving: Effects on Biomass Accumulation, Light Interception and Radiation Use Efficiency Under Different N Rates*, 155 AGRIC., ECOSYSTEMS & ENV'T 153, 160 (2012).

[95] *Id.* at 154.

[96] *Id.* at 155 tbl.1.

[97] COHEN ET AL., *supra* note 41, at 62.

[98] *Id.* at 62–63 (citing Lindenmayer et al., *supra* note 27). The 33% estimate reflects the highest value for potential water savings, typically in wetter places with longer growing seasons, such as the Lower Colorado River Basin. *Id.* at 62. In the lower basin with a warmer, longer growing season, total consumptive use of water is much higher, but there is a potential to save a greater percentage. *Id.* at 63. For the entire Colorado River Basin, average water savings would probably be closer to 10%. *Id.*

[99] Kang et al., *supra* note 57, at 212. The number reflects a scenario in which DI is performed during stem elongation, with only mild reductions of 20% in later phases. *Id.* If applied during a sustained period, increased DI will lead to reduced biomass for maize. *Id.* at 209.

[100] Hamzei & Soltani, *supra* note 94, at 155 tbl.1.

[101] Stewart et al., *supra* note 28, at 93–95.

[102] Goldhamer & Beede, *supra* note 86, at 544.

[103] Goldhamer et al., *supra* note 77, at 17.

B. Crop Switching

Different crops consume vastly different amounts of water, and even among individual crops, different strains are available that can significantly reduce water consumption. While water consumption rates can vary depending on soil conditions, climate, slopes, and other factors, crop switching clearly has the potential to achieve significant water savings. For example, in the Middle Rio Grande (MRG) Basin in New Mexico, researchers have studied crop switching from alfalfa to sorghum—crops that are both grown in the MRG Basin.[104] Alfalfa is far more water-intensive, consuming 28.2 inches of water per acre annually in the Belen, New Mexico area.[105] By comparison, sorghum grown in the same region consumes only 17.94 inches of water per acre.[106] Switching 5,000 acres from alfalfa to sorghum would reduce consumptive water use by an estimated 4,275 acre-feet per year of water.[107] While the water savings per acre would be more modest, switching all current alfalfa acreage in the MRG Basin to an available alfalfa variety that uses 15% less water would reduce annual consumptive water use by 7,473 acre-feet[108] in a planning region that encompasses over 5,000 square miles.[109]

In the Walker Basin in northwest Nevada, researchers studied the feasibility and potential water savings that would result from replacing alfalfa with alternative crops.[110] A field study demonstrated that water consumption could be reduced by at least half.[111] Replacement crops included lettuce, grapes, barley, wild rye, teff, switchgrass, and onions.[112] When farmers had access to water at current levels, alfalfa remained the least economically risky option, but several other crops both saved water and had the potential to yield significant profits for the farmers. Onions were the optimal choice for water savings and financial stability.[113]

One recent study illustrates the potential water savings that might be achieved from crop switching.[114] It looked at three different scenarios in the Lower Basin of the Colorado River.[115] In the first scenario, shifting 80,000 acres from cotton to wheat would yield a potential savings of 101,000 acre-

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[104] MCDONALD, *supra* note 12, at 1.

[105] H.F. BLANEY & E.G. HANSON, CONSUMPTIVE USE AND WATER REQUIREMENTS IN NEW MEXICO 64 (1965), *available at* http://www.ose.state.nm.us/Pub/TechnicalReports/TechReport-032.pdf.

[106] *Id.*

[107] *See* MCDONALD, *supra* note 12, at 1.

[108] *Id.*

[109] MIDDLE RIO GRANDE WATER ASSEMBLY, MIDDLE RIO GRANDE REGIONAL WATER PLAN ES-1 (2004), *available at* http://www.waterassembly.org/archives/MRG-Plan/C-Summaries/Rio%20Grande%20Executive%20Summary.pdf.

[110] Carol D. Bishop et al., *Conserving Water in Arid Regions: Exploring the Economic Feasibility of Alternative Crops*, 103 AGRIC. SYS. 535, 535 (2010).

[111] *Id.* at 536.

[112] *Id.* at 537.

[113] *Id.* at 540–41.

[114] COHEN ET AL., *supra* note 41, at 64–65.

[115] *Id.*

feet of water.[116] In the second scenario, shifting 74,000 acres from alfalfa to sorghum would save more than 140,000 acre-feet of water.[117] Finally, in scenario three, shifting 74,000 acres of alfalfa to equal amounts of cotton and wheat would yield a whopping 250,000 acre-feet of water.[118]

Research on the potential for water savings from crop switching is summarized in Table 2. The Table describes rough water consumption levels for different crops as compared with water consumption by alfalfa. While actual consumption will vary depending on crop varieties, soil type, and climatic conditions, the Table offers a rough sense for the enormous potential for water savings from crop switching.

Table 2: Average Crop Water Consumption[119]

Crop	**Crop water need (mm/season)**	**Mean crop water need (mm/season)**	**Mean crop water need feet/season**	**Potential water savings from alfalfa baseline (%)**
Alfalfa	800–1600 (508–1200)[120]	1025	3.3625	0
Barley	450–650	550	1.804	46%
Bean	300–500	400	1.313	61%
Beets	254–381[121]	317.5	1.042	69%
Potato	500–700	600	1.968	41%
Sorghum	450–650	550	1.804	46%
Soybeans	450–700[122]	575	1.887	44%
Sugar beet	550–750	650	2.133	37%
Sunflower	600–1000	800	2.625	22%

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[116] *Id.* at 64. The study first suggests shifting 70,000 acres of cotton to wheat but then talks about saving 101,000 acres from shifting 80,000. It appears that it was this latter number that was intended. L. J. Erie et al., *Consumptive Use of Water by Major Crops in the Southwestern United States*, USDA-ARS CONSERVATION RES. REP., NO. 29 (1982), *available at* https://cals.arizona.edu/crops/irrigation/consumuse/conusefinal.pdf. (claiming that 15.4 inches of water would be saved for each acre shifted from cotton to wheat). Multiplying this number by 80,000 and dividing by 12 to convert inches to feet yields 102,667, which is a bit more water saved than claimed in the study.

[117] COHEN ET AL., *supra* note 41, at 64–65.

[118] *Id.* at 65.

[119] Unless cited individually, all column two numbers come from: C. BROUWER & M. HEIBLOEM, U.N. FOOD & AGRIC. ORG., IRRIGATION WATER MANAGEMENT: IRRIGATION WATER NEEDS, PART I, Tbl.4, *available at* http://www.fao.org/3/a-s2022e/index.html (in the Table of Contents, under "Part I- Principles of Irrigation Water Needs," click on "2.4– Determination of Crop Water Needs"). All calculations in columns three, four, and five are based on numbers from column two.

[120] Alternative estimate from Glenn E. Shewmaker et al., *Alfalfa Irrigation and Drought* 1, (2013), *available at* http://www.extension.uidaho.edu/forage/Fact%20Sheets/Alfalfa%20Irrigation%20Facts%202013%20Final[1].pdf (converted from inches per season to approximate millimeters per season).

[121] FRANK DANIELLO, ESTIMATED WATER REQUIREMENTS OF VEGETABLE CROPS (2003), *available at* http://extension.missouri.edu/sare/documents/estimatedwaterrequirementsvegetable2012.pdf (converted from inches per season to millimeters per season).

[122] FAO Land & Water Div., *Crop Water Information: Soybean*, U.N. FOOD & AGRIC. ORG., http://www.fao.org/nr/water/cropinfo_soybean.html (last visited Feb. 13, 2016).

Table 2: Average Crop Water Consumption Continued

Crop	Crop water need (mm/season)	Mean crop water need (mm/season)	Mean crop water need feet/season	Potential water savings from alfalfa baseline (%)
Sweet potato	254–508[123]	381	1.25	63%
Wheat	450–650	550	1.804	46%

Table 2 illustrates that significant water savings can be achieved by switching from high-use crops to those that require less water. For example, assuming mean consumption rates, 10,000 acres of farmland dedicated to alfalfa would consume 33,625 acre-feet of water, whereas a switch to soybeans would consume 18,870 acre-feet, thereby saving 14,755 acre-feet over that area. Likewise, a switch of 10,000 acres from alfalfa to beets would yield 23,205 acre-feet of water, and a switch from alfalfa to sweet potatoes would yield 21,125 acre-feet.

C. Rotational Fallowing

A third strategy for reducing water consumption while protecting rural agricultural economies is rotational fallowing. The goal of rotational fallowing is to leave a small percentage of lands uncultivated every year on a rotating basis to achieve a consistent, measurable quantity of water savings that can then be marketed to other users.[124] While rotational fallowing could leave fewer acres in agricultural production each year, it appears to offer significant benefits to farmers and agricultural communities that eluded them during the "buy and dry" land purchases of the past.[125] By rotating less productive lands and allowing nutrient-depleted lands to be replenished, the lands that remain in production can potentially realize higher agricultural yields.[126]

The most famous example of rotational fallowing in the U.S. involves an agreement between the Palo Verde Irrigation District (PVID) and the Metropolitan Water District of Southern California (MWD). PVID encompasses more than 131,000 acres in Southern California.[127] In the early 2000s, PVID entered into a long-term agreement with MWD to implement land fallowing, crop rotation, and water supply programs, where land is allowed to lie fallow on one- to five-year rotational periods.[128] The program

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[123] DANIELLO, *supra* note 121.

[124] Ed Smith, *Palo Verde and MWD's Land Management, Crop Rotation and Water Supply Program*, *in* WATER SHARING: INNOVATIVE STRATEGIES FOR THE COLORADO RIVER BASIN AND THE WEST 24 (2011), *available at* http://www.cwi.colostate.edu/publications/sr/22.pdf.

[125] McMahon & Smith, *supra* note 17, at 160–61.

[126] METRO. WATER DIST. OF S. CALIF., PALO VERDE LAND MANAGEMENT, CROP ROTATION AND WATER SUPPLY PROGRAM [hereinafter PALO VERDE PROGRAM] *available at* http://www.mwdh2o.com/PDF_NewsRoom/6.4.2_Water_Reliability_Palo_Verde.pdf.

[127] Palo Verde Irrigation Dist., *History of PVID and the Palo Verde Valley*, http://www.pvid.org/ (last visited Feb. 13, 2016).

[128] PALO VERDE PROGRAM, *supra* note 126.

pays farmers to temporarily cease irrigating some lands.[129] Each year, the program provides MWD with an estimated 25,000 to 118,000 acre-feet of water for municipal use.[130] In addition to making substantial water resources available to the MWD, one of the program's goals is to ensure that those fallowed lands become more productive.[131] In the PVID, short-term fallowing has led to increased soil organic matter and nitrates, increased nutrient cycling, and improved soil quality, crop growth, and production.[132]

Several mutual ditch companies in Colorado have banded together in an attempt to replicate the success of the PVID fallowing program.[133] The Arkansas Valley Super Ditch, as it is commonly known, is a far more complex project because it involves multiple irrigation districts and it expects to engage multiple buyers for its water.[134] Like the PVID program, however, it would allow the farmers to retain their water rights, without permanent transfer, and it would make water available through a rotational fallowing system.[135] One study of the economic effects of the proposed project found that it would benefit local agriculture by infusing a steady flow of annual income through lease payments and increasing the amount of dryland farming.[136] The Super Ditch has been touted as a means for continuing agricultural productivity, maintaining economic activity in agricultural communities, and keeping a substantial amount of water for irrigation use while at the same time providing urban areas with much needed new water supplies.[137]

III. IDENTIFYING THE TECHNICAL AND LEGAL PROBLEMS

As the previous Section suggests, it is possible to describe with specificity the theoretical water savings that can be achieved through DI, crop switching, and rotational fallowing. Nonetheless, significant technical and legal questions remain to be answered before a robust water market in conserved water can be realized. For example, if a farmer agrees to switch to a less water intensive crop, how are the savings calculated, who determines how much water is conserved, and how is that water savings verified over time? Can transfers based upon water conservation strategies be permanent, or at least long-term, or should they be limited to seasonal or

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[129] *Id.*

[130] *Id.*

[131] *Id.*

[132] Jeremy Cusimano & Vonny Barlow, *The Effects of Short-Term Fallowing on Soil Quality and Crop Growth*, POSTINGS FROM THE PALO VERDE, (June 2013), *available at* http://ceriverside.ucanr.edu/newsletters/Postings_from_the_Palo_Verde_Valley47703.pdf.

[133] Peter Nichols, *Irrigators Negotiate Municipal Water Leases, Keep Water Ownership*, *in* WATER SHARING: INNOVATIVE STRATEGIES FOR THE COLORADO RIVER BASIN AND THE WEST 25.

[134] PETER NICHOLS, *SLIDES: LOWER ARKANSAS VALLEY SUPER DITCH COMPANY, INC.: WATER LEASING PROGRAM*, 6–8 (Dec. 11, 2008), *available at* http://scholar.law.colorado.edu/evolving-regional-frameworks-for-ag-to-urban-water-transfers/2.

[135] McMahon & Smith, *supra* note 17, at 152.

[136] *Id.* at 160.

[137] Nichols, *supra* note 133, at 32.

annual transfers? Furthermore, over what geographic region or basin can conserved water be marketed and what institutional framework is needed to operate temporary (seasonal) and permanent water markets? Finally, what legal obstacles exist to establishing such markets, and can a marketing program be designed that can overcome the political and practical obstacles to a well-functioning water market? Some lessons and answers can be drawn from the Australian experience and these are addressed more fully in a later Section of the Article.[138] But the legal and policy dimensions of establishing and operating a water market in any particular jurisdiction are likely to be *sui generis* and thus the lessons to be drawn from experiences in other states, while offering significant value, must be approached with caution.

A. The Technical Issues

In addition to legal and institutional issues, technological advances may also aid in overcoming obstacles to effective water resource management. The efforts by Regenesis, which were described briefly above, suggest one approach for using technology for enhanced water distribution systems.[139] Additionally, remote sensing systems for monitoring crops could be a boon to resource managers. Remote sensing tools have been used to monitor evapotranspiration, measure agricultural performance, follow patterns of water use, monitor operations through field wetness indicators, and evaluate the impact of irrigation policies.[140] Furthermore, the expanded use of drones in the agricultural sector could offer an efficient and effective means for monitoring agricultural practices. One newspaper account, for example, describes using drones for applications such as "identifying insect problems, watering issues, assessing crop yields or tracking down cattle."[141] Identifying crop types and total acreage in production would seem to be rather elementary extensions of existing drone uses.

In addition, software suites are available that can integrate yield maps, light detection and ranging (LIDAR), elevation maps, and soil surveys for water management.[142] LIDAR itself—with its usefulness for assessing flow rates and drainage, along with soil loss and other variables[143]—could be useful when applied in agricultural contexts. Such technical tools have the

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[138] *See infra* Part IV.D.

[139] *See supra* notes 18–24 and accompanying text.

[140] Wim G.M. Bastiaanssen et al., *Remote Sensing for Irrigated Agriculture: Examples from Research and Possible Applications*, 46 AGRIC. WATER MGMT. 137, 139–43 (2000).

[141] Christopher Doering, *Growing Use of Drones Poised to Transform Agriculture*, USA TODAY, Mar. 23, 2014, http://www.usatoday.com/story/money/business/2014/03/23/drones-agriculture-growth/6665561/ (last visited Feb. 13, 2016).

[142] *See, e.g.*, Ag. Leader, *Water Management Module*, http://www.agleader.com/products/sms-software/advanced/water-management-module/ (last visited Feb. 13, 2016) (advertising a suite with these features).

[143] Stephanie Johnson & Zach Hermann, Presentation to Watershed Professionals Network: Prioritizing Agricultural Nonpoint Source Management Areas Through the Use of LiDAR and GIS (Apr. 25, 2013), *available at* http://www.pca.state.mn.us/index.php/view-document.html?gid=19418.

potential to make water management more responsive to changing conditions and more effective.

B. The Legal Issues

Technical research on innovative water conservation strategies is ongoing, and while more work is plainly needed, it is long past the time for addressing some of the legal and institutional impediments to transferring conserved water. In Colorado and most other western American states, for example, water conserved by the methods described here cannot legally be transferred or sold to urban, industrial, environmental, or any other potential users.[144] It cannot even be transferred to other agricultural land.[145] This is because most western states define property rights in water only in terms of the type and place of use and the amount authorized for diversion.[146] Thus, while a Colorado farmer can use agricultural water rights to grow any crops during the growing season on the particular lands for which that water was appropriated, that farmer cannot sell water that might be conserved by switching crops or fallowing land, even if the farmer commits to a permanent change in her past practice. This is because the scope of a water right has traditionally been legally limited to the reasonable, beneficial quantity of water needed to grow *any* crop the farmer chooses to grow on the particular land for which the water was appropriated.[147] Moreover, since future transfers of agricultural water rights are typically based upon historical consumptive use,[148] farmers in most western prior appropriation states have a perverse incentive to consume as much water as possible over

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[144] *See* Salt River Valley Water Users' Ass'n v. Kovacovich, 411 P.2d 201, 202–03 (Ariz. Ct. App. 1966) ("This Court is of the opinion that the Doctrine of Beneficial Use precludes the application of waters gained by water conservation practices to lands other than those to which the water was originally appurtenant."); *see also* Colo. Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321, 1325 (Colo. 1974) ("Salvaged waters are subject to call by prior appropriators."). California appears to be the only prior appropriation state that recognizes a right to transfer conserved water. *See* CAL. ENVTL. PROT. AGENCY, A GUIDE TO WATER TRANSFERS (1999), *available at* http://www.waterrights.ca.gov/watertransferguide.pdf (explaining California's water transfer system).

[145] This follows from the principle that water rights are appurtenant to the land for which they are appropriated and cannot be used on other lands unless the water rights are transferred pursuant to the relevant state process. *See, e.g.*, McCray v. Rosenkrance, 20 P.3d 693, 702 (Idaho 2001) ("It is clearly the law in Idaho that a water right cannot be resumed when the facts clearly establish that water was not applied to the land of which it was appurtenant.").

[146] *See* Santa Fe Trail Ranches Prop. Owners Ass'n v. Simpson, 990 P.2d 46, 54 (Colo. 1999) (stating that "the right to change a water right is limited to that amount of water actually used beneficially pursuant to the decree at the appropriator's place of use").

[147] *See* WILLIAM GOLDFARB, WATER LAW 35 (2d ed. 1988) (indicating that irrigation is a beneficial use, without reference to what crop is being grown on the irrigated land).

[148] *See* Farmers Reservoir & Irrigation Co. v. Consol. Mut. Water Co., 33 P.3d 799, 807 (Colo. 2001) (stating that "[c]hanges of water rights are limited in quantity and time by historic use").

the long-term to maximize the future value of the right should it eventually be sold.[149]

An additional problem concerns the high transaction costs associated with transferring water under the current system of laws in most western American states. Under these systems, water cannot generally be transferred unless the transferor can demonstrate that the transfer will not cause any injury to other users in the system.[150] Injury can be shown, for example, if the timing of return flows to the stream changes, and the law generally affords no exception for *de minimis* injuries.[151]

California has done more than any other state in removing obsolete legal standards and seeking to overcome the obstacles to transferring conserved water. For example, the California Water Code now provides that where water use "has ceased or been reduced as a result of water conservation efforts . . . [it] may be sold, leased, exchanged, or otherwise transferred pursuant to any provision of law relating to the transfer of water or water rights."[152] In addition, California expressly authorizes temporary transfers of water

> if the transfer would only involve the amount of water that would have been consumptively used or stored by the permittee . . . in the absence of the proposed temporary change, would not injure any legal user of the water, and would not unreasonably affect fish, wildlife, or other instream beneficial uses.[153]

To help facilitate these and other innovative approaches to water transfers, the California Water Resources Control Board published a draft guide to water transfers in 1999,[154] and provides additional information and assistance

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[149] *See* GOLDFARB, *supra* note 147, at 35–36 (explaining that irrigation uses of water can lead to significant waste in prior appropriation states, as farmers have an incentive to pad their water use to prevent forfeiture of unused water).

[150] *See, e.g.*, CAL. WATER CODE § 1701.2(d) (West 2015) (providing that a petition for a permit change must "include sufficient information to demonstrate a reasonable likelihood that the proposed change will not injure any other legal user of water").

[151] *See, e.g.*, Britt Banks & Peter Nichols, *A Roundtable Discussion on the No-Injury Rule of Colorado Water Law*, 44 COLO. LAW., July 2015, at 87 (describing how Colorado water law experts "felt that as Colorado law is currently applied, any impact appears to constitute injury and there is no *de minimis* or other practical materiality standard to define injury"); BARTON H. THOMPSON, JR. ET AL., LEGAL CONTROL OF WATER RESOURCES: CASES AND MATERIALS 307–12 (5th ed. 2013) (demonstrating application of the no injury rule).

[152] CAL. WATER CODE § 1011(b) (West 2015). "Water conservation" is defined by the statute to encompass "the use of less water to accomplish the same purpose . . . allowed under the existing appropriative right." *Id.* § 1011(a). Land fallowing and crop rotation are also expressly included within the scope of the definition.

[153] *Id.* § 1725.

[154] CAL. STATE WATER RES. CONTROL BD., A GUIDE TO WATER TRANSFERS (draft) (1999), *available at*: http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/watertransferguide.pdf [hereinafter *Draft Water Transfer Guide*].

on transfers at its website, including basic information about specific transfers going back to 2009.[155]

Notwithstanding these important reforms, California does not seem to have had much success in promoting transfers of conserved water. Perhaps that is because the process for transferring water in California—even for a single year—remains cumbersome. In particular, while temporary changes of less than one year are exempt from the environmental impact reporting requirements of the California Environmental Quality Act,[156] ad hoc determinations about potential injury to other users and to fish and wildlife must still be made.[157]

Any serious hope that water conservation strategies can be used to help satisfy water demands for other uses will apparently require some further changes to the current legal standards for transferring water. And such changes seem unlikely to be enacted unless the farming community can be persuaded that the changes are in their long-term best interests. Before suggesting a path forward, a look at the evolution of water transfer policies in Australia is instructive.

IV. THE AUSTRALIAN EXPERIENCE WITH WATER MARKETS

In an effort to inform possible pathways for opening water markets in the western United States and in other countries, a comparison with water marketing in Australia, particularly in the Murray–Darling Basin of southeast Australia, is instructive.[158] Australia is the driest inhabited continent on earth and the inter-annual variability it experiences in rainfall and runoff is among the highest in the world.[159] The approaches to water sharing that have been developed in the Basin are highly adapted to this variability.[160]

While Australia's wider legal history is derived mainly from the United Kingdom, a key departure from this tradition occurred through a process of nationalization of water rights in the late nineteenth century and the creation of a system of statutory water rights. This departure occurred first in Victoria in 1886 and the other (then) colonies in the decade or so

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[155] Calif. State Water Res. Control Bd., *Water Transfers Program*, http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/ (last visited Feb. 13, 2016).

[156] CAL. PUB. RES. CODE §§ 21000–21178.1 (West 2007); *see Draft Water Transfer Guide*, *supra* note 154, at 6-1.

[157] *See id.* at 6-3 tbl.1.

[158] The Murray–Darling Basin encompasses a one million km^2 catchment across parts of 4 states and all of one territory. Murray–Darling Basin Authority, *Basin Geography*, http://www.mdba.gov.au/discover-basin/landscape/geography (last visited Feb. 13, 2016); *see also* Murray–Darling Basin Authority, *Basin Boundary*, http://www.mdba.gov.au/sites/default/files/cartographicmapping/8_Murray-Darling_Basin_Boundary.pdf (last visited Feb. 13, 2016).

[159] *See* I. Neave et al., *Managing Water in the Murray–Darling Basin Under a Variable and Changing Climate*, 42 WATER: J. AUSTL. WATER ASS'N, Apr. 2015, at 102 (explaining that "Australia has one of the most variable climates on Earth"); Peter Hillis & Jason Fonti, *Opportunity or Bust? Infrastructure Financing in the Water Industry*, 42 WATER: J. AUSTL. WATER ASS'N, Apr. 2015, at 74 (describing Australia as "the driest inhabited continent").

[160] *See id.* at 102, 104.

thereafter.[161] The system of water rights in Australia, as compared to the United States, is an area ripe for fertile investigation, with Peter Davis providing the standard comparative study.[162] John Tisdell has written a useful complement to this work, setting out the evolution of water legislation in Australia.[163]

By way of overview, each of the state and territory governments that comprise the Murray–Darling Basin have established their own water rights systems. These systems generally include a state based licensing program for forms of water use other than stock and domestic uses.[164] Depending on the state, water rights are assigned to various classes[165]—and these classes are used to ration water based on availability.[166] Higher security rights enjoy a preference and thus a more reliable supply as provided under the water resource planning instrument appropriate to a given system.[167] Water rights within each class enjoy no temporal priority and notions of "prior appropriation" do not apply. The issuance of these rights took various forms and were at times specified as an area of land or tied to particular uses.[168] From the 1980s in particular, a process of volumetric conversion of major classes of water rights improved the transparency and the basis for rationing water within and across classes.[169]

The evolution and history of water markets in Australia have been documented by the National Water Commission.[170] Sarah Wheeler and her colleagues have further provided an overview of the development and impact of water marketing arrangements in Australia since the 1980s.[171] Quentin Grafton and others have made a detailed comparative assessment of water markets in Australia and the United States, with particular insights from the Murray–Darling Basin and the western United States, including the

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[161] P.N. Davis, *"Nationalization" of Water Use Rights by the Australian States*, 9 U. QUEENSLAND L.J. 1, 1, 3 (1975); WARREN MARTIN, WATER POLICY HISTORY ON THE MURRAY RIVER: A HAND BOOK FOR MURRAY IRRIGATORS 306–08 (2005).

[162] Peter N. Davis, *Australian and American Water Allocation Systems Compared*, 9 B.C. INDUS. & COM. L. REV. 647 (1968).

[163] John Tisdell, *The Evolution of Water Legislation in Australia*, *in* WATER MARKETS FOR THE 21ST CENTURY: WHAT WE HAVE LEARNED (K. William Easter and Qiuqiong Huang, eds., 2014).

[164] *Id.* at 165.

[165] *See, e.g.*, NAT'L WATER COMM'N, WATER MARKETS IN AUSTRALIA: A SHORT HISTORY 58 (2011), [hereinafter WATER MARKETS IN AUSTRALIA] *available at* http://archive.nwc.gov.au/__data/assets/pdf_file/0004/18958/Water-markets-in-Australia-a-short-history.pdf (describing how New South Wales differentiates between High Security and General Security rights).

[166] *See id.* at 57–58 (describing the rationing systems of Victoria, New South Wales, and South Australia).

[167] *Id.* at 57.

[168] *See, e.g.*, Murray–Darling Basin Auth., *History of Water Licenses in Australia*, http://www.mdba.gov.au/what-we-do/managing-rivers/water-trade/history-of-water-licenses (last visited Feb. 13, 2016) (noting allocations based on crop types and water demands).

[169] *Id. See also* Davis, Australian and American Water Allocation Systems Compared *supra* note 162 (providing a comprehensive historical context to these rights system); MARTIN, *supra* note 161 (explaining the evolution of these issues in New South Wales).

[170] WATER MARKETS IN AUSTRALIA, *supra* note 165.

[171] Sarah Wheeler et al., *Water Trading in Australia: Tracing Its' Development and Impact over the Past Three Decades*, *in* WATER MARKETS FOR THE 21ST CENTURY, *supra* note 7, at 179.

Colorado River Basin and other systems.[172] Finally, Amy Sennett and her colleagues have described some of the challenges and responses in the Murray–Darling Basin from an American perspective.[173]

A. Significant Water Reforms in the Murray–Darling Basin Since 1990

Water management in the Murray–Darling Basin has seen several significant reforms in the last two decades, with three reforms of particular importance to the success of Australia's water markets.

First, in 1994, the Council of Australian Governments (COAG) (the Federal Government along with State and Territory Governments) adopted water resources policy measures that promoted water trade and agreed to separate land and water.[174] The result was an abandonment of the appurtenance doctrine, whereby water rights are tied to a particular tract of land and can be moved to another tract of land, if at all, only with great difficulty and expense. COAG further advanced this agenda with the adoption of a National Water Initiative in 2004.[175]

Second, in 1995, a "cap" on diversions of surface water was introduced in the Murray–Darling Basin.[176] This was an essential step in developing a "cap and trade" scheme. With the adoption of the cap, a range of more specific decisions were made in each state to deal with issues such as underutilized entitlements.[177] Generally speaking, all issued entitlements within a given class were respected equally regardless of their history of use.[178] The cap serves as a limit on the average amount of water *used*, not the water allocated (which is generally an amount 20%–30% higher). Underuse occurs for a range of reasons, including presence of "sleeper" (unused) and "dozer" (partially used) licenses, various risk profiles adopted by water users, and unseasonable rainfall suppressing demand.[179] To address the risk of underutilized allocation causing an increase in use, a range of provisions have been introduced, as well as planned frameworks with provisions

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[172] R. Quentin Grafton et. al., *Comparative Assessment of Water Markets: Insights from the Murray–Darling Basin of Australia and the Western USA*, 14 WATER POL'Y 175 (2012); *see also* R. Quentin Grafton et. al., *Global Insights into Water Resources, Climate Change and Governance*, 3 NATURE CLIMATE CHANGE 315 (2012), (examining extractions in both the Colorado and the Murray–Darling river basins).

[173] Amy Sennett et al., *Challenges and Responses in the Murray–Darling Basin*, 16 WATER POL'Y 117 (2014).

[174] ENV'T AUSTL., MARINE & WATER DIV., THE COUNCIL OF AUSTRALIAN GOVERNMENTS' WATER REFORM FRAMEWORK 4 (1994), *available at* https://www.environment.gov.au/system/files/resources/6caa5879-8ebc-46ab-8f97-4219b8ffdd98/files/policyframework.pdf.

[175] INTERGOVERNMENTAL AGREEMENT ON A NATIONAL WATER INITIATIVE 9–11 (2004), *available at* http://www.nwc.gov.au/__data/assets/pdf_file/0008/24749/Intergovernmental-Agreement-on-a-national-water-initiative.pdf.

[176] *See* MURRAY–DARLING BASIN COMM'N, THE CAP: PROVIDING SECURITY FOR WATER USERS AND SUSTAINABLE RIVERS (2004) *available at* http://www.mdba.gov.au/sites/default/files/archived/cap/cap_brochure_0.pdf.

[177] MARTIN, *supra* note 161, at 123–24.

[178] *Id.* at 124.

[179] *Id.* at 88.

designed to operate should the risk materialize, without restricting access until such increase occurs.[180]

None of this, of course, would be possible in the western United States without essentially abandoning the priority system of water rights. Whatever its merits, the priority system is unlikely to change.[181] In the implementation of the cap, the notion of "beneficial use"—so prominent in the prior appropriation laws of the western United States[182] and a key feature of early Australian water law[183]—was considered irrelevant and entirely abandoned.

Third, the Australian Government enacted the Water Act 2007.[184] This law requires the development of a Basin Plan specifying sustainable diversion limits throughout the Basin for both surface water and groundwater and also other features.[185] The Basin Plan was completed in 2012 and has set limits on water use that will come into effect in 2019.[186] These limits on surface use are approximately 20% lower than 2009 levels and are designed to ensure a sustainable future for the Basin.[187]

These sustainable diversion limits were possible only because of the successful introduction of the cap, and they complement other activities designed to recover water for the environment, such as The Living Murray Initiative.[188] The Basin Plan also provides for uniform water marketing rules across the Basin[189] and, from 2014, prohibits certain restrictions on water marketing such as those that discriminate based on the purpose for which

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[180] *See id.* at 197 (listing several flexible strategies used to avoid inefficiencies).

[181] Aside from political opposition to such a change, it would be difficult and perhaps impossible to overcome legal challenges based upon the "takings" clause of the Fifth Amendment of the U.S. Constitution. *See, e.g.*, Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1027 (1992) (reasoning that regulation that deprives the owner of all value is a *per se* taking unless the regulation is designed to prevent a nuisance); Penn. Cent. Transp. Co. v. New York City, 438 U.S. 104, 124 (1978) (holding that a court should examine the "character" and "economic impact" of the regulation, and most importantly whether it interferes with "distinct, investment-backed expectations"); Casitas Muni. Water Dist. v. United States, 708 F.3d 1340, 1358 (Fed. Cir. 2013) (finding the water lost by the district was not a loss of any property rights in the water, since the district's property right was limited to beneficial use of the water, and the regulation did not reduce deliveries to customers, and thus did not show a loss of beneficial use).

[182] Davis, *supra* note 162, at 688.

[183] *Id.* at 662 (describing the adoption by New South Wales of "'beneficial use' classifications for various irrigation diversion licenses" in 1946).

[184] *Water Act 2007* (Austl.), *available at* https://www.comlaw.gov.au/Details/C2015C00272/Download (select "download" tab and then select one of the Act Compilation file options—PDF, docx, or zip).

[185] *Id.* at 42.

[186] *Water Act Basin Plan 2012* (Austl.), at 28, *available at* https://www.comlaw.gov.au/Details/F2012L02240.

[187] Murray–Darling Basin Auth., *Sustainable Diversion Limits*, http://www.mdba.gov.au/sites/default/files/pubs/CSIRO-summary-of-the-scoring-method.pdf (last visited Feb. 13, 2016) (explaining that the diversion limits in the Murray–Darling Basin will be reduced from the 2009 level of 13,623 gallons per year to 10,873 gallons per year).

[188] *See* MURRAY–DARLING BASIN AUTH., THE LIVING MURRAY STORY: ONE OF AUSTRALIA'S LARGEST RIVER RESTORATION PROJECTS (2011), *available at* http://www.mdba.gov.au/sites/default/files/pubs/The-Living-Murray-story.pdf (discussing the Living Murray Initiative).

[189] *Water Act Basin Plan 2012*, *supra* note 186, at 122.

the water may be used or the owner of the water.[190] Some restrictions are also permissible based on considerations such as environmental impacts, negative impacts on other users (other than an impact arising solely because of an increase in use of the traded water access right), or hydraulic connectivity.[191]

B. Water Marketing in the Murray–Darling Basin

In the Murray–Darling Basin, water marketing is an important feature of water management with temporary and permanent water traded extensively throughout the Basin. For example, in 2011–2012, the amount traded in the southern Murray–Darling Basin was 3698 GL (3.0 million acre-feet) on the temporary market (10,908 trades) and 719 GL (0.6 million acre-feet) on the permanent market (4,709 trades).[192] Trade across state borders, which commenced in the 1990s, is permitted where systems are connected and is included in these figures.[193]

Water marketing has provided manifold economic and environmental benefits. Economically, it provides for water to move to its highest value use and is particularly valuable during periods of drought. In particular, the ability to move water quickly between temporary and permanent crops has resulted in reduced production losses.[194] This has been possible only because water rights are largely fungible, and because transaction costs[195] and processing times for transfers have been minimized.[196] In terms of processing time, for example, standards introduced in 2009 provide for 90% of temporary trades to be approved within five days for intrastate trade and ten days for interstate trade throughout most of the Murray–Darling Basin.[197] For permanent trades the comparable standard is twenty days.[198] Recent performance suggests these standards are generally met or exceeded.[199]

Providing comprehensive information to the market is also a key element of the Murray–Darling Basin program. The Basin Plan requires that

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[190] *Id.* at 125.

[191] *Id.*

[192] R. Quentin Grafton & James Horne, *Water Markets in the Murray–Darling Basin*, 145 AGRIC. WATER MGMT. 61, 64 (2014).

[193] *Id.* at 61–64.

[194] Wheeler et al., *supra* note 171, at 179, 196.

[195] *See* Ronald H. Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1, 15–16 (1960) (discussing transaction costs).

[196] Austl. Gov't Nat'l Water Mkt., *Trade Processing Times—Standards and Performance*, http://www.nationalwatermarket.gov.au/water-market-reports/trade-processing.html (last visited Feb. 13, 2016) (noting that 90% of temporary trades get processed within 10 days throughout most of the basin); AUSTL. NATIONAL WATER COMMISSION, AUSTRALIAN WATER MARKETS REPORT 2010–11 240–54 (2011), *available at* http://archive.nwc.gov.au/library/topic/markets/australian-water-markets-report-2010-11 (select "Section 5" at bottom of page).

[197] *Id.*

[198] *Id.*

[199] AUSTRALIAN WATER MARKETS REPORT 2010–11, *supra* note 196, at 10.

water marketing information be collated and published in a single location.[200] Extensive information about water trading rules and the characteristics of a large number of actively traded water access rights is now available throughout the Basin on the internet.[201] Displaying this information in a single location allows for easier comparisons between different types of water access rights.[202] The price of the sale of water is also now required to be made publicly available.[203]

C. Water Marketing and Water Efficiency

In terms of water use efficiency, the advent of water marketing created positive incentives for potential sellers by placing a marginal cost on losses such as seepage or those arising through inefficient irrigation. This, in turn, motivated sellers to ameliorate these losses where cost-effective. The ability to sell water has also provided opportunities for water users to raise funds to invest in efficient practices on their farms.[204]

Recent reforms in the Basin have aimed to reduce the amount of water being used for consumptive purposes in order to restore water to the environment.[205] The implementation of these reforms has utilized water markets to achieve their purposes.

As part of the reforms associated with the Water Act 2007, over AUD $13 billion is being invested by the federal government, including AUD $3.2 billion to recover water through direct market purchase from willing sellers.[206] A major program in this initiative is the Sustainable Rural Water Use and Infrastructure Program (SRWUIP), which is:

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[200] Murray–Darling Basin Auth., *Basin Plan Water Trading Rules*, http://www.mdba.gov.au/managing-water/water-markets-trade/basin-plan-water-trading-rules (last visited Feb. 13, 2016).

[201] *Id.*

[202] *Id.*

[203] Murray–Darling Basin Auth., *Fact Sheet: New Basin Plan Water Trading Rules Start 1st July 2014*, http://www.mdba.gov.au/media-pubs/publications/new-bp-water-trading-rules-start-1st-july-2014 (last visited Feb. 13, 2016).

[204] MARSDEN JACOB ASSOCS., SURVEY OF WATER ENTITLEMENT SELLERS UNDER THE RESTORING THE BALANCE IN THE MURRAY–DARLING BASIN PROGRAM 20–28 (2012), *available at* https://www.environment.gov.au/system/files/resources/63d24e7b-40bf-41ab-9777-eefc6113c967/files/sellers-survey-report.pdf. *Cf.* DENNIS WICHELNS, AGRICULTURAL WATER PRICING: UNITED STATES 9 (2010) (explaining that farmers can earn money by selling their water rights to others); Ilan Brat, *California Drought Spurs Technology on the Farm*, WALL ST. J., July 16, 2015, http://www.wsj.com/articles/drought-is-the-mother-of-invention-on-the-farm-1437041211 (last visited Feb. 13, 2016) (indicating that farmers are increasingly investing in water efficiency updates).

[205] Austl. Dep't of the Env't, *Restoring the Balance in the Murray-Darling Basin*, [hereinafter *Restoring the Balance*] http://www.environment.gov.au/water/rural-water/restoring-balance-murray-darling-basin (last visited Feb. 13, 2016).

[206] Austl. Dep't of the Env't, *Independent Review of the Water Act 2007*, https://www.environment.gov.au/water/legislation/water-act-review (last visited Feb. 13, 2016) (describing implementation of the AUD $13 billion reforms); *Restoring the Balance*, *supra* note 205 (explaining that "the Australian Government has committed $3.2 billion to purchase water for the environment").

> [I]nvesting in rural water use, management, and efficiency, including improved water knowledge and market reform, and water purchase for the environment. It is the key mechanism to "bridge the gap" to the sustainable diversion limits under the Murray–Darling Basin Plan and consists of three main components: irrigation infrastructure projects, water purchase and supply measures.
>
> The majority of SRWUIP infrastructure funds are committed to projects in the Murray–Darling Basin for improving the operation of off-farm delivery systems and helping irrigators improve on-farm water use efficiency. The water savings generated from these projects are shared between the Australian Government for environmental use, and irrigators for consumptive use.[207]

Through part of SRWUIP known as "Restoring the Balance in the Murray–Darling Basin program, the Australian Government has committed [AUD] $3.2 billion to purchase water for the environment."[208] Water buybacks obtain water for the environment from irrigators who wish to offer their water entitlement for sale.[209] Any water saved through efficiency savings such as those realized under this program, or through any other process, is fully tradable.[210]

D. Lessons Learned

Among the key lessons from the Australian experience is the importance of separating land and water titles and defining water entitlements in terms that facilitate trading so they are fungible within a particular basin or geographic region.[211] Defining all entitlements on a volumetric basis is an essential first step in such a process. With the exception of stored water systems, this condition does not apply in the western United States,[212] which makes it harder to treat water as a fungible commodity. Ongoing efforts to minimize transaction costs, which discourage trading, also characterize the Australian water trading experience.[213]

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[207] Austl. Dep't of the Env't, *Rural Water*, (last visited Feb. 13, 2016) http://www.environment.gov.au/topics/water/rural-water.

[208] *Restoring the Balance*, *supra* note 205.

[209] *See* Austl. Dep't of the Env't, *Progress of Water Recovery Under the Restoring the Balance in the Murray-Darling Basin Program*, http://www.environment.gov.au/water/rural-water/restoring-balance-murray-darling-basin/progress-water-recovery (last visited Feb. 13, 2016) (discussing the environmental benefits of the "Restoring the Balance in the Murray–Darling Basin Program" and cataloging the water purchases secured as of November 2015).

[210] *Water Act Basin Plan 2012*, *supra* note 186. Specifically, the right to trade entitlements is free of restrictions based on class of person (clause 12.07) and purpose for which water is used (clause 12.08), and these apply to entitlements held and used for environmental purposes. *Id.* Some environmental holders are subject to conditions on the tradability of entitlements held as part of their establishing provisions but the market itself does not restrict such trades.

[211] YOUNG, *supra* note 7, at 12.

[212] Roderick E. Walston, *Western Water Law*, 1 NAT. RES. & ENV'T 6, 6 (1986) (explaining that water rights in the western United States are based on "actual need and use," rather than being defined volumetrically).

[213] *See, e.g.,* RAY CHALLEN, INSTITUTIONS, TRANSACTION COSTS, AND ENVIRONMENTAL POLICY: INSTITUTIONAL REFORM FOR WATER RESOURCES 75–76 (2000) (explaining that the institutional

Transaction costs have frequently been identified as major reasons that United States water markets have failed to result in robust trading.[214]

In their thorough examination of water markets in the Murray–Darling Basin, Grafton and Horne identified several key lessons including:

- Water markets support regional resilience
- Capping extractions promotes effective use and sustainability
- Reliable, accessible, and timely market information promotes effective decision making
- Markets can promote environmental outcomes
- Acquiring water for the environment through buybacks has proved effective
- Prices contain information on scarcity and risk
- Basin-wide and local perspectives have roles to play
- Effective monitoring and control of extractions are critical for sustainability.[215]

The development of water markets in the Murray–Darling Basin is an example of settling on a decision to introduce markets for their attendant benefits and then dedicate effort to addressing the issues that arise in order to bring the market to fruition. These water markets have also proved to be an effective tool for managing competing demands of agricultural and environmental uses. An alternative approach based on working through all policy problems before committing to water markets would have been less likely to have been successful. In other words, the Australian experience suggests that western states might consider the desirability of pressing forward with new water marketing programs without worrying that every conceivable problem has not been solved. The problems will be identified with experience and can then be addressed as needed. Moreover, the risks associated with moving forward can be greatly minimized by focusing on markets that have the greatest potential for success. Using this standard, this Article suggests that a focus, at least initially, on markets for *conserved* water might make sense. Moreover, states can use pilot programs to test the

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structure of the Murray–Darling Basin water market is partially explained by a desire to reduce transaction costs); Lin Crase et al., Towards an Understanding of Static Transaction Costs in the NSW Permanent Water Market: An Application of Choice Modelling (Jan. 2001) (Paper presented at the 45th Annual Conference of the Australian Agricultural and Resource Economics Society), *available at* http://ageconsearch.umn.edu/bitstream/125588/2/Crase.pdf (discussing a conceptual model for pricing water entitlements that accounts for transaction costs).

[214] *See, e.g.*, Barton H. Thompson, *Institutional Perspectives on Water Policy and Markets*, 81 CAL. L. REV. 671, 704–05 (1993) (indicating that "high cost of statutory transfer proceedings, however, almost certainly deters many transfers").

[215] Grafton & Horne, *supra* note 192, at 67–69.

potential for new water marketing schemes, thereby minimizing the consequences for any unsuccessful marketing programs.

V. SOLVING THE TECHNICAL AND LEGAL PROBLEMS WITH WATER MARKETS

Without some sort of national program for promoting water markets, such as Australia adopted for the Murray–Darling Basin, solving the technical and legal problems with water marketing—even in the somewhat narrow category of conserved water—will prove challenging. Since a national solution is almost impossible to imagine in the western United States, where local control over water resources is a nonnegotiable condition of water policy, tackling the more nuanced problems with water markets under the current technical and legal regime is the only realistic path forward.

Perhaps the ever-threatening crisis facing water managers around the West will help push policymakers in a reform direction. California, in particular, which faces what are perhaps the most serious water problems in recent memory,[216] seems prepared to consider any reasonable reform measures. Indeed, California appears to be the only state that currently recognizes the value of establishing a market for conserved water as evidenced by its adoption of laws that expressly allow transfers of conserved water.[217] Yet notwithstanding California's efforts, a robust water market for conserved water has yet to emerge in that state. So, what more can be done?

First, unlike in Australia's Murray–Darling Basin, water rights in the western United States are not defined in terms of a fungible property right.[218] But a fungible right in conserved water is possible if states can develop and implement simple yet accurate methods for measuring and verifying water savings that can gain the confidence of all potentially affected parties. Second, states must restructure their water management institutions to accommodate a robust marketing program as was done in the Murray–Darling Basin. Finally, the current water transfer laws must be transformed so that they no longer pose a serious obstacle to sensible water marketing programs. While wholesale reforms such as those used in the Murray–Darling Basin are politically impractical, more modest reforms focused on conserved water could nonetheless lead to a substantial water marketing program. None of this will be easy. The following offers some

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[216] *See* CAL. DEP'T OF WATER RES., CALIFORNIA'S MOST SIGNIFICANT DROUGHTS: COMPARING HISTORICAL AND RECENT CONDITIONS i (2015), *available at* http://www.water.ca.gov/waterconditions/docs/DWR_DroughtBroch_070815-web.pdf (providing that the period between 2012 and 2014 set several climate records, including being the driest three year period of statewide precipitation on record).

[217] *See supra* notes 154–156 and accompanying text.

[218] William A. Wilcox, Jr. & David Stanton, *Maintaining Federal Water Rights in the Western United States*, ARMY LAW., Oct. 1996, 3 (discussing western state water law's focus on priority in time stemming from mining law principles).

initial ideas for reforming current law and making conserved water markets a reality.

A. Establish Markets for Conserved Water

While the Australian experience shows the value of moving forward with a marketing program, even before every problem is fully addressed, a headlong rush into a water marketing program without first defining the basic parameters and structure of a program would be foolish. Set forth below is a review of the three key steps that will have to be taken to establish a marketing program for conserved water. These include:

1) identifying basins with a high potential for water conservation and a high demand for additional water resources;

2) measuring the amount of water saved by water conservation methods appropriate to those basins; and

3) establishing an appropriate institutional framework for managing a conserved water transfer program.

This last step is especially important and receives extended treatment in this Section.

1. Targeting Basins for Conserved Water Marketing Programs

While a broad-scale program for marketing conserved water could be adopted, states should focus their initial efforts on identifying water basins with a high potential for both water conservation, as narrowly defined in this Article, and water demand. The Front Range of Colorado, with its growing population and strong farming traditions, might be a good candidate. The pecan growing regions of New Mexico in the Rio Grande Basin and the almond and pistachio farms of central California suggest other areas with high potential for conserved water markets.

Any legislation adopted to facilitate the program should articulate a policy of rolling out the program slowly and focusing, at least initially, on high potential areas. The legislation might also incorporate an adaptive management scheme[219] that provides the implementing agency with the flexibility needed to improve the program based upon the experience gained from early implementation.

2. Measuring and Verifying Water Savings

In some ways, this should be the simplest problem to solve. While much new research will likely be needed, especially to expand conserved water programs to include deficit irrigation, sufficient information is already available to implement conserved water programs. For instance, we know enough about evapotranspiration rates for many crops in many soil types to

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[219] For a discussion of adaptive management, *see infra* note 237 and accompanying text.

be able to estimate with good accuracy the amount of consumptive water savings from crop switching.[220] We know, for example that shifting ten acres from alfalfa to sorghum in the lower Colorado River Basin is likely to yield something on the order of nineteen acre-feet of conserved water.[221] Some standard adjustment may have to be made to account for uncertainty. To address the problem of uncertainty and reassure existing water users, states might set a policy of reducing the amount available for conserved water transfers by 10% to account for uncertainty and to protect natural stream flows. But what cannot be allowed is an extensive process for challenging a scientifically-based administrative decision that has documented the extent of water savings to be expected through the application of particular conserved water practices in particular basins.[222] These numbers will need to be settled for a designated trading basin if a market is going to emerge. But, as suggested above, states can target particular basins with high potential for agricultural-to-urban water transfers, which should serve to stimulate any necessary research and help the agency design pilot projects.

Likewise, water savings from rotational fallowing can be fairly readily ascertained. Since fallowing typically involves leaving a specific percentage of land uncultivated,[223] the water user can be required to reduce diversions by that same percentage, allowing for the transfer of the consumptive portion of the water right that was not diverted. Once again, however, perfect certainty cannot be expected and should not be required.

Because deficit irrigation takes many forms, it is somewhat harder to generalize about the accuracy of water savings claims. Some types of DI can surely be measured with great accuracy, such as proposals to forego a second, third, or fourth cutting of alfalfa.[224] More sophisticated, RDI techniques that involve changes to the timing of water applications may prove harder to measure, and special attention will be needed to train regulators as to how they can verify the extent of water savings. Once again, however, research efforts can be targeted to trading basins that hold the prospect of significant water savings and high water resources demand.

Of course, establishing trading basins for conserved water where water can be easily bought and sold is only the first step. Before conserved water marketing can become a reality, changes to both the institutional

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[220] *See, e.g.*, TIMOTHY K. GATES ET AL., IRRIGATION PRACTICES, WATER CONSUMPTION, & RETURN FLOWS IN COLORADO'S LOWER ARKANSAS RIVER VALLEY (2012) (analyzing evapotranspiration for various crops in the Lower Arkansas River Valley).

[221] COHEN ET AL., *supra* note 41, at 64 (noting a rate of 1.9 acre-feet saved per acre converted).

[222] One of the great mysteries of the prior appropriation system is why the system is so rigid with respect to water transfers when it is so tolerant about uncertainties that exist in other parts of the water administration system. *See generally* Mark Squillace, *Accounting for Water Rights in the Western United States*, *in* WATER ACCOUNTING: INTERNATIONAL APPROACHES TO POLICY AND DECISION-MAKING 270 (Jayne M. Godfrey & Keryn Chalmers eds., 2011) (suggesting improvements in the regulatory system for managing water rights).

[223] *See supra* Part II.C.

[224] *See supra* Part II.A.1.

frameworks used to manage water resources and to the laws that govern water use will be needed. These issues are addressed more fully below.

3. Establishing an Institutional Framework for Managing Conserved Water Transfers

Every western state has a developed comprehensive system for managing its water resources. With the exception of Colorado, all of these states rely almost entirely on administrative agencies to manage their water resources.[225] Colorado is unique in setting up a system of water courts, water judges, and water magistrates[226] that are largely responsible for managing surface water rights.[227] All of these western states, however, take a similar approach to processing and approving water transfers—a term generally defined broadly to include a change of use, change of place of use, and change of point of diversion.[228] And the restriction on transfers that is most common among these states is the requirement that the applicant demonstrate "no injury" to existing water users.[229]

The no injury requirement has proved a formidable obstacle to water transfers. Injury can be demonstrated in many ways, but as a general rule

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[225] *See* GREGORY J. HOBBS, JR., CITIZEN'S GUIDE TO COLORADO WATER LAW 12 (2004), *available at* http://www.colorado.edu/geography/class_homepages/geog_4501_s14/readings/CG-Law2004.pdf (explaining that Colorado is the only western state that uses courts instead of an administrative permitting system to determine water rights).

[226] MARILYN C. O'LEARY, UTTON TRANSBOUNDARY RES. CTR., AN ANALYSIS OF THE COLORADO WATER COURT SYSTEM 7–9 (2003), *available at* http://uttoncenter.unm.edu/pdfs/Colorado_Water_Courts.pdf (describing the structure of Colorado's water court system).

[227] The management regime for groundwater in Colorado is complex. Most groundwater is deemed "tributary" to surface water and unless exceptions apply, is managed by the water courts as part of the surface water system. *See* COLO. REV. STAT. ANN. § 37-90-103(10.5) (West 2015) (defining "nontributary groundwater" as water that would not deplete the flows of a surface stream by 0.1% if withdrawn over 100 years); Safranek v. Town of Limon, 228 P.2d 975, 977 (Colo. 1951) ("Under our Colorado law, it is the presumption that all ground water so situated finds its way to the stream in the watershed of which it lies, is tributary thereto, and subject to appropriation as part of the waters of the stream." (citing DeHaas v. Benesch, 181 P.2d 453, 456 (1947))).

[228] *But see* Thayer v. Rawlins, 594 P.2d. 951, 955–56 (Wyo. 1979) (holding that a change in the point of discharge does not generally require state approval). Note, however, that point of discharge changes can have serious negative consequences for existing water users. *See id.* at 952 (approving a new city water system in which effluent discharges previously used by defendants for irrigation would now be discharged downstream and thus unavailable).

[229] *See* THOMPSON, JR. ET. AL., *supra* note 151, at 313 ("Procedurally, a water right holder who wishes to change the point of diversion or the type, place, or time of use has the burden of presenting at least a *prima facie* case that the change will not injure junior appropriators. In most states, the burden of proof then shifts to any protesters to refute the evidence and demonstrate that the proposed change would injure them." (citations omitted)); Danielson v. Kerbs AG., Inc., 646 P.2d 363, 374 (Colo. 1982) ("The burden of proof to establish that a change of use will not injure the rights of other users from the same source rests upon the person seeking the change."); Farmers Reservoir & Irrigation Co. v. Consol. Mut. Water Co., 33 P.3d 799, 811 (Colo. 2001) (stating that after an applicant meets their initial burden, the objectors have the burden of proving injury); CF & I Steel Corp. v. Rooks, 495 P.2d 1134, 1136 (Colo. 1972) (noting that once petitioner made a prima facie case in support of the change, "[i]t was then the responsibility of the protestants to show the injury resulting to them").

most states have determined that transfers should be limited to the amount of water consumed by the transferor's historic use,[230] presumably on the theory that maintaining consumptive use is less likely to injure third parties. But injuries can occur even where the transferee does not propose to increase consumptive use, such as where the transfer changes the timing of return flows to the original stream.[231] And the law generally makes no provision even for relatively minor injuries.[232] An important consequence of this fact is that opponents of a proposed transfer are quite often in a strong position to make credible objections. Overcoming those objections takes time and costs money. Lawyers representing both sides often hire experts and the experts frequently offer conflicting views about the potential consequences of a transfer.[233] With no certainty about when, if ever, a proposed transfer might be approved, about the amount of water that might ultimately be approved for transfer, or about the ultimate financial cost of consummating a transfer, parties seeking municipal water supplies and others seeking access to new water supplies are understandably reluctant to rely on such transfers to secure the water they need.

Streamlining the transfer process will require some legislative changes or clarifications as described below. But it will also require some institutional changes. It seems highly unlikely that western states in the United States will be able to match Australia's success in approving temporary transfers within five days and permanent transfers within twenty days. However, substantial progress is possible. Set forth below are several institutional reforms that would move the states in the right direction toward achieving the critical goal of timely review and approval of water transfers.

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[230] THOMPSON, ET AL., *supra* note 151, at 330 ("[M]ost states provide that water sellers can transfer only the water that they have historically been using."); *See, e.g.*, Santa Fe Trail Ranches Prop. Owners Ass'n v. Simpson, 990 P.2d 46, 56–57 (Colo. 1999) (finding that a change in water right must be limited to the amount historically withdrawn for that right); Weibert v. Rothe Bros., Inc., 618 P.2d 1367, 1371–72 (Colo. 1980) ("The right to change a point of diversion or place of use is also limited in quantity and time by historical use."); Basin Elec. Power Coop. v. State Bd. of Control, 578 P.2d. 557, 566 (Wyo. 1978) (holding that a purchaser could not consume more water than a seller had historically consumed, even in the absence of injury to junior appropriators (citing WYO. STAT. ANN § 41-3-104 (1977) ("[C]hange in use, or change in place of use, may be allowed, provided that the quantity of water transferred by the granting of the petition shall not exceed the amount of water historically diverted under the existing use . . . nor increase the historic amount consumptively used under the existing use, nor decrease the historic amount of return flow, nor in any manner injure other existing lawful appropriators.")).

[231] *See Draft Water Transfer Guide*, *supra* note 154, at 3-8 (pointing out that an agricultural user in California can recapture and reuse water and thereby cause downstream users injury even though that same user cannot transfer the recaptured water even if the injury to the downstream user would be the same).

[232] *See* THOMPSON ET AL., *supra* note 151, at 307 (summarizing the "no injury" rule).

[233] Mark Squillace, *Water Transfers for a Changing Climate*, 53 NAT. RESOURCES J. 55, 60–61 (2013).

a. Establish a Simple, Predictable, and Transparent Administrative Process for Making Conserved Water Determinations

In order for a robust market in conserved water transfers to flourish, all affected parties will have to understand how it works and what will be the likely outcome of any application. Put another way, the system will have to follow a well-understood and predictable formula for determining the amount of water that can be marketed. So, for example, farmers who propose to switch from alfalfa to soybeans in a particular transfer basin will need to know how much conserved water per acre they can expect to make available for sale. Prospective buyers and other potentially affected parties will also benefit from such predictability.

For this to work efficiently, an administrative agency charged with approving conserved water transfers must be identified and empowered to make the critical decisions. The process might then proceed as follows:

First, the agency can identify one or more basins where a high potential for conserved water transfers exist. These will likely be rural areas with substantial acreage planted in high water consumption crops like alfalfa along water systems that are easily accessible by prospective buyers, most likely urban water utilities. Once conserved water transfer basins are designated, the agency can then set about determining the extent of consumptive use for the dominant crops in the basin, based upon crop, climate, and soils. Ideally, peer-reviewed studies will already be available to document such use, but, if not, the agency might commission research universities to carry out such studies.

The delineation of water transfer basins and determinations about the consumptive use of various crops within the basin should be developed through a traditional notice and comment rulemaking process.[234] An administrative appeal and limited judicial review of any decision under this first step might be appropriate, but the standard of review should be highly deferential to the agency—as it usually is with agency rulemaking proceedings[235]—especially if the agency commits to an adaptive management scheme going forward as proposed below.

Second, the agency could invite applications from interested farmers to have their water rights quantified in terms of consumptive use. As suggested above, for this to work efficiently, the determination will have to be largely formulaic. The farmer will have to demonstrate the number of acres historically farmed for particular crops and the agency will then use the

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[234] *See, e.g.*, COLO. REV. STAT. § 24-4-103 (2013); WYO. STAT. ANN. § 16-3-103 (2013); N.M. STAT. ANN. § 12-8-4 (2005).

[235] *See, e.g.*, Chevron, U.S.A., Inc. v. Nat. Res. Def. Council, Inc., 467 U.S. 837, 844 (1984) ("We have long recognized that considerable weight should be accorded to an executive department's construction of a statutory scheme it is entrusted to administer, and the principle of deference to administrative interpretations."). Consumptive use calculations can be made through a rulemaking or legislative-type process, allowing an opportunity for public comment and review. The agency should be accorded wide discretion to make a reasoned choice based upon evidence in the record; once that decision is made, the agency should be allowed to apply it in the field.

consumptive use numbers for those crops in that basin to calculate the farmer's consumptive use right. This calculation will form the baseline against which conserved water transfers might be measured. So long as the agency uses the formula devised during the first step there should be no basis for appeals or further review.

Third, the agency will entertain an application from the farmer to transfer conserved water based upon a plan to switch crops, fallow land, or engage in some form of measurable DI scheme. A modest reduction of perhaps 10% of the calculated conserved water amount might be assessed to account for possible uncertainties associated with the calculations. This would have the ancillary benefit of protecting natural stream flows. As with the initial calculation of consumptive use, the agency will have to determine the new consumptive use based upon research data and field experience, and, like that original determination, additional research might be needed to make the initial judgments about conserved water savings.

To be clear, basin-wide decisions about the consumptive use of particular crops in particular transfer basins should be made through notice and comment rulemaking proceedings, subject to the same limited appeal rights as might be available for the initial consumptive use determinations. Once these decisions are made, however, the agency should be free to use a formula to calculate the conserved water savings.

Farmers who are interested in marketing conserved water will likely gravitate toward conserved water strategies for which accurate measurements are available and clear rules have been established. Over time, however, new research and information from past conserved water transfers will allow for refinement of the data and the employment of other strategies.

Finally, the agency will need to establish a monitoring and verification process to ensure that farmers who transfer conserved water follow through with their plans. While much of this might be accomplished with self-reporting, modern drone technologies or infrared photography might offer an efficient means for agencies to oversee and verify at least some of the activities promised by the transferors.[236]

As part of the approval process, agencies might also commit farmers to cooperating with researchers who can improve the data on consumptive use following the conserved water transfer, and farmers might be asked to commit to an adaptive management scheme[237] whereby conserved water

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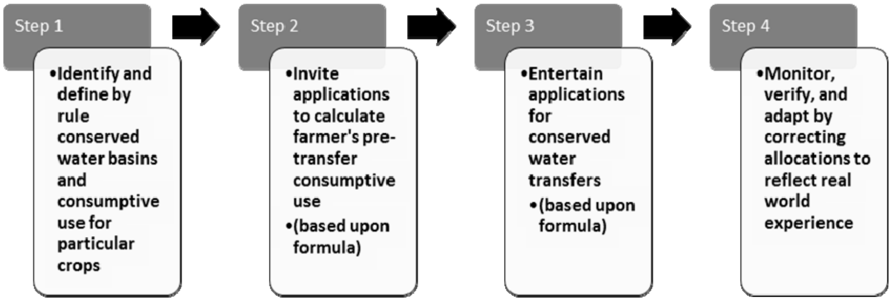
[236] *See, e.g.*, Doering, *supra* note 141 (outlining the future agricultural market for drones); Johnson & Hermann, *supra* note 143 (describing the high accuracy and increasing availability of agricultural drones).

[237] The theory of adaptive management traces to a 1978 book written by C.S. "Buzz" Hollings and several colleagues. C.S. HOLLINGS ET AL., ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (1978). The authors of this book criticize the traditional environmental impact assessment process because it fails to account for the dynamic nature of ecosystems. *Id.* at 7. The adaptive process that they outline responds to this problem by emphasizing a constant cycle of: 1) collecting information; 2) establishing metrics to evaluate resource conditions; 3) monitoring resources to measure management success; and 4) adapting management to reflect the new information that emerges from this process. *Id.* at 55. Since the time of the Hollings

calculations might be adjusted up or down to reflect new information obtained during the monitoring process. Figure 1 roughly illustrates the adaptive management process envisioned here.

Figure 1.



The notice and comment rulemaking proceedings will take a minimum of several months but once the rules are final, transfers themselves should proceed fairly quickly. While it seems highly unlikely that all of the post-rulemaking steps can be completed in less than five days for temporary transfers and twenty days for permanent transfers as they are in Australia, temporary transfers in particular ought not to take much longer. Once the kinks in the system are worked out and the necessary data becomes available, there is no reason why temporary transfers should take more than fifteen to twenty days.

b. Establish a Transparent Administrative Process and a Water Exchange Where Conserved Water Can Be Bought and Sold

Australia has been successful in part because of its commitment to transparency. Price and water security information about individual transactions is available online.[238] If western states hope to find similar success with water markets, they will likely have to commit themselves to a similar level of transparency.

In some ways, the commitment to transparency should not be difficult if the more robust form of water marketing proposed here is limited to conserved water transfers. One could imagine, for example, that a conserved

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book, adaptive management has become a popular initiative, especially for land management agencies. *See, e.g.*, GEORGE H. STANKEY ET AL., U.S. FOREST SERV., ADAPTIVE MANAGEMENT OF NATURAL RESOURCES: THEORY, CONCEPTS, AND MANAGEMENT INSTITUTIONS, 1 (2005), *available at* http://www.fs.fed.us/pnw/pubs/pnw_gtr654.pdf ("The concept of adaptive management has gained attention as a means of linking learning with policy and implementation.").

[238] *Restoring the Balance*, *supra* note 205.

water right in a hypothetical Muddy Creek Conserved Water Transfer Basin for ten acre-feet, with a priority date of 1900, could be listed for sale at a specified price once the state agency had approved a conserved water plan for the applicant.[239] Other potential buyers and sellers will be able to see the listing and decide on an appropriate offer and purchase price as the market develops. Before long the website should function effectively as a public water exchange, which is essentially how the Australia system operates.[240] If prices are sufficiently high, other farmers will respond by submitting conserved water plans and making more water available.

As part of the exchange, states might establish an efficient system for buying and selling rights online, or they might simply offer the exchange as a place to record private transactions. In the interests of transparency, however, states must insist that all transactions be recorded and that the purchase price for the water rights be included in the records. Without this critical information, the market cannot be expected to function efficiently and, since the water itself is universally understood to be the property of the state,[241] demanding price information as a condition on the sale of the state's water should not raise legal objections.

c. Focus on Temporary Transfers

The Australian water market is designed to work with both temporary and permanent water rights, although a substantial majority of the transfers occur on the temporary market.[242] As used in this Article, and as defined under the Australian system, a temporary transfer is one that lasts for one

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[239] Western United States water rights will be identified (and to some extent valued) based upon their priority date. Australia does not use priority dates but lists water rights on its website in terms of its level of security, or the chance it will actually be available for use. *See, e.g.*, Austl. Dep't of the Env't, *Average Prices of Offers Pursued from Recent Tenders*, http://www.environment.gov.au/water/rural-water/restoring-balance-murray-darling-basin/average-prices-offers (last visited Feb. 13, 2016) (noting that a water right with "low reliability" is less secure and therefore commands a much lower price).

[240] *See* WATER MARKETS IN AUSTRALIA, *supra* note 165, at 11 (describing the trading platforms, which rely on publicly available information). Australia has several water exchanges associated with large irrigation network schemes and some private owners, which provide a place for sellers and buyers to meet. *See, e.g.*, Waterfind Australia, *About*, http://www.waterfind.com.au/about/ (last visited Feb. 13, 2016) (providing that the Waterfind online trading platform has been used by over 11,000 customers); Ruralco Water, http://www.ruralcowater.com.au/ (last visited Feb. 13, 2016) (providing information about Ruralco Water, a water brokering firm).

[241] At least since the Institutes of Justinian in 533 A.D., water has been understood as a common resource with public rights in the rivers and seas. J. INST. 2.1.1. (Thomas Collett Sandars trans., 1922). More explicitly, all states in the western United States expressly devote constitutional language to declaring water to be the property of the state. *See, e.g.*, COLO. CONST. art. 16 § 5 ("The water of every natural stream, not heretofore appropriated, within the state of Colorado, is hereby declared to be the property of the public . . . ."); WYO. CONST. art. 8, § 1 ("The water of all natural streams, springs, lakes, or other collections of still water, within the boundaries of the state, are hereby declared to be property of the state.").

[242] *See* Grafton & Horne, *supra* note 192, at 64 tbl.1 (showing that there were 10,908 allocation trades in 2011–2012, while there were only 4,709 entitlement trades during the same period).

year or less.[243] For agricultural water rights, it might be understood even more narrowly as a "seasonal" right, valid only during the irrigation season.

Urban water utilities in the western United States might understandably feel wary about relying on a temporary water market that they fairly perceive as being less secure. But their concerns about the temporary market are more reflective of the historic absence of a healthy market for temporary water rights, rather than legitimate concerns about the availability of water. If a robust temporary water market were to develop, buyers would begin to feel far more secure about their ability to get water in water short years when and where they need it. Presumably the price of water would rise with scarcity, but it is unlikely that prices would rise to the point where expensive infrastructure projects will look more attractive to municipal suppliers. This is because the supply of water potentially available from irrigated agriculture is so substantial, as documented earlier in this Article.[244]

These arguments alone might not provide a sufficient basis for focusing on a temporary transfer program to address critical water needs. But a powerful case for temporary transfers can be made because of their economic and social advantages. Unlike permanent transfers, temporary transfers can be far more easily abandoned. If a temporary transfer does not yield sufficient compensation for the farmer, or if the residual farming activities are not sufficient to overcome the loss that results from the temporary sale, the farmer can choose to forego the transfer in future years. Moreover, given the uncertainty that might attend some judgments about the scope of conserved water rights, and the impacts on third parties when they are transferred, a temporary transfer model allows for adjustments. Indeed, if a monitoring and adaptive management program is demanded by the regulatory agency as a condition for approving the transfer, appropriate refinements will be built into the system. All of this seems far more likely to gain the acceptance, and perhaps even the support, of the agricultural community than a program for the permanent transfer of conserved water.

If a temporary water market can be established successfully and demonstrated to work efficiently, with minimal adverse impacts on the agricultural community, then the program might be more easily extended to include permanent transfers. But it seems unnecessary to engage in what might rightly be perceived as overreaching at the outset of such an important program.

As with other aspects of transfer law, California appears to be the farthest along among western states in encouraging temporary transfers. The California Water Code expressly provides for expedited processing of

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[243] *Id.* at 62 (explaining that allocation trades involve specified volumes "assigned to a water entitlement over a water year"). *See also* Murray–Darling Basin Auth., *Glossary*, http://www.mdba.gov.au/media-pubs/publications/wam-report-2010-11/wam-web-2010-11/glossary (last visited Feb. 13, 2016) (defining "temporary transfer" to mean "water entitlements transferred on an annual basis").

[244] *See supra* Part II.

short-term (less than one year) water transfers.[245] Under section 1725 of the California Water Code, a water rights holder can temporarily transfer their rights "if the transfer would only involve the amount of water that would have been consumptively used . . . in the absence of the proposed temporary change."[246] Such transfers are also exempt from compliance with the environmental review process of the California Environmental Quality Act.[247] The law, however, retains a basic no injury standard that includes possible adverse impacts on fish and wildlife,[248] and this could make temporary transfers difficult to consummate. Section 1435 does allow the State Water Resources Control Board to issue a temporary transfer without complying with the normal transfer procedures where there is an "urgent need" for the water,[249] but even here, the Board must still make no injury findings along with a finding that the transfer is in the public interest.[250]

d. Promote Dry-Year Options for Conserved Water

To address the security concerns of urban suppliers, especially in the short-term as markets are becoming established, states should expand and liberalize programs for dry-year options by making them easier to arrange with conserved water. A dry-year option is essentially an agreement between a farmer and a city water supplier that guarantees to the city the right to use the water during a dry year as that term is defined in the agreement.[251] Historically, dry-year options have given cities the option of using an entire agricultural water right during the dry year.[252] To minimize the risk that a cyclical drought would take land out of production during multiple years over a relatively short period of time, dry-year options have sometimes been

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[245] CAL. WATER CODE §§ 1425, 1725 (West 2009) (providing for temporary transfers); *Id.* § 1728 (defining temporary changes as those involving a transfer for a period of one year or less).

[246] *Id.* § 1725.

[247] *Draft Water Transfer Guide*, *supra* note 154, at 6-1.

[248] *Id.* at 3-7 to 3-8.

[249] *Id.* at 6-11.

[250] *Id.* The State Water Resources Control Board clearly takes its mandate to expedite short-term transfers seriously. As it notes in the guide:

> The SWRCB gives the processing of short-term transfers its highest priority . . . . The key for rapid action by the SWRCB has been the development and disclosure of the likely impacts of the proposed transfer on other legal users of water and to fish and wildlife . . . . In 1997 and 1998 the average time to approve a water transfer was less than two months. [But] in some cases in the past the approval was achieved within hours of receiving the formal request.

Id. at 6-1. Despite these substantial efforts, anything even close to an average processing time of two months is still far too long for a viable temporary transfer program.

[251] ORG. FOR ECON. COOP. AND DEV., WATER AND CLIMATE CHANGE ADAPTATION: POLICIES TO NAVIGATE UNCHARTED WATERS 92 (2013).

[252] Bonnie G. Colby, *Structuring Voluntary Dry Year Transfers*, N.M. WATER RES. RESEARCH INST., Oct. 2005, at 152, *available at* http://www.wrri.nmsu.edu/publish/watcon/proc50/colby.pdf (explaining that dry-year options allow buyer to "pay an up-front fee which secures the option to transfer irrigation water to a new use if specified dry-year conditions are met").

limited so that they cannot be exercised too frequently.[253] But this undermines the security that the purchaser of the option so desperately seeks.

With transfers of conserved water, farmers are still farming even while they are making water available for other uses by consuming less. So, the concerns that have led to problematic limits on dry-year option contracts would appear to be unnecessary if the options are used to transfer conserved water rather than the water right wholesale.

B. Empower an Agency to Promote Conserved Water Transfers

As previously discussed, California has come a long way toward setting out a program for conserved water transfers.[254] But California has yet to realize the potential for such transfers to address its water needs. Legislation that articulates a policy that: 1) supports and promotes conserved water transfers; 2) empowers a specific agency to implement that policy; 3) outlines a simple and transparent program for conserved water transfers; and 4) is designed to avoid significant legal challenges when such transfers are approved, could go a long way towards invigorating a conserved water transfer program. Some suggested details for such a program are outlined in the previous Section of this Article.[255] But the details of the program should largely be left to the agency that is charged with managing it. This is critical to ensuring that the agency has sufficient flexibility to adapt the program as may be warranted based upon the experience gained from the successes and failures that are inevitable during the early stages of an ambitious new water transfer regime such as proposed here.

C. Reinterpret the No Injury Rule

One of the hallmarks of water transfer law in prior appropriation states is the no injury rule. It essentially holds that transfers may be approved only if they can be accomplished without harming existing appropriators.[256] While the laws themselves tend not to define injury, the cases that have considered the matter appear to take a somewhat absolutist view that existing appropriators are protected against any injury.[257] Given the myriad ways that

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[253] For example, Colorado's "interruptible supply agreements" cannot be exercised more than three years in any ten-year span, and then cannot be approved for another ten-year period after that. COLO. REV. STAT. § 37-92-309(3)(c) (2013).

[254] *See supra* notes 154–157 and accompanying text.

[255] *See supra* Part V.A.

[256] THOMPSON, *supra* note 151, at 180 ("[A] kind of blackletter principle of prior appropriation law is that an appropriator cannot transfer or change a water right in a way that injures another appropriator on the stream.").

[257] *See, e.g.*, Farmers High Line Canal & Reservoir Co. v. City of Golden, 975 P.2d 189, 197 (Colo. 1999) ("When a petition for a change in use or point of diversion is filed, junior appropriators are given the opportunity to object to the change on the grounds that it will encroach upon their vested water rights."); Okanogan Wilderness League, Inc. v. Town of Twisp, 947 P.2d 732, 737 (Wash. 1997) (en banc) ("Washington's statute is consistent with the

existing appropriators might be affected or harmed without consequence by the activities of other water users, including, for example, crop switching to higher consumptive crops,[258] recapturing and reusing water before it leaves one's property,[259] and diverting water in excess of a right due to the limited accuracy of measuring devices,[260] the strict view of injury in the water transfer context is perplexing. But wholesale change of the notion of injury in the water transfer context is unnecessary. All that is needed is the recognition that *de minimis* injuries, including injuries that result from changes in the timing of return flows, should not give rise to a claim or cause of action against the proponent of the transfer. Indeed, changes in the timing of return flows can result from changes in irrigation practices that are plainly not actionable, such as shifting from furrow irrigation to sprinklers.[261] Thus, if states are serious about the importance of using water transfers to meet future water needs, then they must find ways to minimize the transaction costs associated with such transfers. Introducing greater flexibility into the meaning of injury in the transfer context would be an important and welcome beginning.

D. Shift the Burden of Proof to the Party Claiming Injury

In most western states, the burden of proving that no one will be injured as a result of a transfer is on the applicant.[262] The applicant is thus

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principle of Western water law that the diversion point of a water right put to beneficial use may be granted unless that change causes harm to other water rights.").

[258] THOMPSON, *supra* note 151, at 180 ("[S]enior appropriators should be rewarded for their entrepreneurship with unfettered ability to make changes in how they exercise their prior appropriation rights," including "low-value economic uses and relatively inefficient methods of use, such as growing alfalfa."). *See also In re* Water Rights in Silvies River, 237 P. 322, 327 (Or. 1925) (considering a change in land use from pasturing to more consumptive hay, the court found that "[i]t does not appear to have been the intention of the company to relinquish its rights to the use of these waters, but rather to delay or partly suspend the application of the waters to a beneficial use"); McPhee v. Kelsey, 74 P. 401, 404 (Or. 1903) (considering ditch rights that became contested after both plaintiffs and defendants switched to alfalfa, the court found no intent from the outset of the agreement to grow alfalfa).

[259] Cleaver v. Judd, 393 P.2d 193, 195 n.4 (Or. 1964) ("It has been recognized in Oregon that an appropriator is justified in recapturing waste water remaining on his own land."); Bower v. Big Horn Canal Ass'n, 307 P.2d 593, 601 (Wyo. 1957) (finding that an appropriator of seepage from another's land "takes his chances that the supply will be kept up; that he has no right thereto, no matter how long he may have used it").

[260] *See* Squillace, *supra* note 222, at 271 (noting how errors due to inaccurate measurement tend to result in higher diversions due to incentives).

[261] *See* Lawrence J. MacDonnell, Montana v. Wyoming*: Sprinklers, Irrigation Water Use Efficiency and the Doctrine of Recapture*, 5 GOLDEN GATE U. ENVTL. L. J. 265, 288, 293 (2012) (noting how the increased efficiency resulting from replacing furrow irrigation with sprinklers has caused courts to be "very supportive when appropriators have themselves made such improvements").

[262] *See, e.g.*, Farmers Reservoir & Irrigation Co. v. Consol. Mut. Water Co., 33 P.3d 799, 811–12 (Colo. 2001) ("[T]he applicant for a change of water right . . . bears the initial burden of establishing the absence of injurious results from the proposed change . . . . Once the applicant successfully meets this initial burden, however, the objectors have the burden of going forward with evidence of injury to existing water rights. When contrary evidence of injury has been

tasked with proving a negative and the result is often an extended and expensive hearing where experts battle over evidence of any possible injury to existing users.[263] On the one hand, it might be argued that the burden is rightly placed on the party who proposes to alter the stream to the potential detriment of existing users. But on the other hand, as the owner of the water, the state has a responsibility to ensure that private uses of water are serving the broad public interests. Fulfilling that responsibility may be compromised by a system that makes it harder and more expensive to move water to places where it is most needed.

While shifting the burden of proof to the person claiming injury arguably makes sense in all water transfer cases, a less radical change might simply provide that where a party seeks to transfer conserved water and where that party agrees to dedicate 10% of the conserved water amount back to the stream, the burden of proving injury as a result of that transfer should be placed on the party claiming injury.

E. Loosen the Rules on Speculation for Conserved Water Transfers

Elwood Mead, the water resources visionary who served as the first State Engineer in Wyoming and as the Commissioner of the Bureau of Reclamation during the construction of the Hoover Dam,[264] is well-known for decrying the risks of speculation in water.[265] Water transfers were viewed by Mead as the chief vehicle for promoting speculation and it was perhaps for that reason that the original 1890 Wyoming water law, which was largely drafted by Mead, contained an outright prohibition on transfers.[266] Wyoming,

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presented, the ultimate burden of showing absence of injurious effect by a preponderance of the evidence continues to rest on the applicant.")

[263] PETER W. CULP ET AL., STANFORD WOODS INST. FOR THE ENV'T, SHOPPING FOR WATER: HOW THE MARKET CAN MITIGATE WATER SHORTAGES IN THE AMERICAN WEST 15 (2014), *available at* http://waterinthewest.stanford.edu/sites/default/files/market_mitigate_water_shortage_in_west_paper_glennon_final.pdf.

[264] WILLIAM D. ROWLEY, U.S. DEP'T OF INTERIOR, THE BUREAU OF RECLAMATION: ORIGINS AND GROWTH TO 1945 235, 300–01 (2006); Mark Squillace, *Water Marketing in Wyoming*, 31 ARIZ. L. REV. 865, 867 (1989). The lake behind the Hoover Dam is, of course, named for Mead. *Id.* at 866–67 n.9.

[265] *See* Squillace *supra* note 264 at 884 (discussing Mead's conviction that improperly managed water transfers could encourage speculation); Mark Squillace, *One Hundred Years of Wyoming Water Law*, 26 LAND AND WATER L. REV. 93, 98 (1991) (citing Mead's concerns about water speculation as a reason water transfers in Wyoming have always been problematic). Given the comparisons with Australia drawn in this Article, it is interesting to note that Mead spent eight years in Victoria, Australia, as the Chairman of the Rivers and Water Supply Commission of the state of Victoria from 1907 to 1915. Arthur W. MacMahon, *Selection and Tenure of Bureau Chiefs in the National Administration of the United States*, 20 AM. POL. SCI. REV. 548, 564 (1926).

[266] *See* WYO. STAT. ANN. § 41-3-101 (LexisNexis 2013) ("Water rights for the direct use of the natural unstored flow of any stream cannot be detached from the lands, place or purpose for which they are acquired."). In 1973, Wyoming amended its laws to specifically provide for transfers under limited conditions. WYO. STAT. ANN. 41-3-104 (LexisNexis 2013). But the State's skepticism about transfers, which traces back to Mead, remains a powerful influence on Wyoming state policy. *See, e.g.*, Basin Elec. Power Coop. v. State Bd. of Control, 578 P.2d. 557,

however, is not alone in its hostility toward speculation in water and the history of western water law is replete with failed efforts by water entrepreneurs to obtain water rights for speculative purposes.[267] Yet it is far from clear that the current hostility towards speculation serves any constructive purpose. To be sure, states are rightly concerned about speculators developing a monopoly over water resources but states could easily establish rules limiting ownership of water to a minor percentage within any single basin, and strict enforcement of abandonment and forfeiture laws can help ensure incentives to put the water to a productive use.[268]

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563 (Wyo. 1978) (explaining that Wyoming statute would only allow an appropriator to obtain a water right to the extent that the water right can be put to a beneficial use). *See generally* Squillace, Water Marketing in Wyoming, *supra* note 264; Squillace, One Hundred Years of Wyoming Water Law, *supra* note 265; Mark Squillace, *A Critical Look at Wyoming Water Law*, 24 LAND & WATER L. REV. 307 (1989).

[267] *See, e.g.*, Stephanie Landry, *The Galloway Proposal and Colorado Water Law: The Limits of the Doctrine of Prior Appropriation*, 25 NAT'L RES. J. 961, 961 (1985) (detailing the legal and political obstacles to a plan to build the largest reservoirs in Colorado to store water for leasing to San Diego); High Plains A & M v. Se. Colo. Water Conservancy Dist., 120 P.3d 710, 717 n.2 (Colo. 2005) ("[T]he privilege of diversion is granted only for uses truly beneficial, and not for purposes of speculation." (quoting Combs v. Agricultural Ditch Co., 28 P. 966, 968 (Colo. 1892))); *see also In re* Application for Water Rights, 307 P.3d 1056, 1064 (Colo. 2013) (finding that an applicant must show intent not based on speculative sale or transfer, and that the applicant can and will complete appropriation); Upper Yampa Water Conservancy Dist. v. Dequine Family L.L.C., 249 P.3d 794, 798–99 (Colo. 2011) (holding that governmental entities have an exception to anti-speculation by showing 1) a reasonable water supply planning period, 2) substantiated population growth projections, and 3) the amount of available unappropriated water is reasonably necessary, above its current water supply and that no appropriation can be based on sale or transfer, notwithstanding a contract, in the absence of a specific plan and intent for application to beneficial use); Pagosa Area Water & Sanitation Dist. v. Trout Unlimited, 170 P.3d 307, 317, 320 (Colo. 2007) (approving a limited government exception to anti speculation doctrine with a 50-year planning period for government agencies' securing water supplies); Sandra Zellmer, *The Anti-Speculation Doctrine and Its Implications for Collaborative Water Management*, 8 NEVADA L.J. 994, 1000–01 (2008) (detailing resistance from Colorado River Basin states regarding Chevron's plan to lease water to Nevada).

[268] Some states like Colorado might consider tightening their abandonment and forfeiture rules to address the speculation problem. Colorado, for example, only provides for abandonment, which requires an intent to abandon. COLO. REV. STAT. § 37-92-402(11) (requiring a rebuttable presumption of abandonment, with special circumstances possible to negate finding of intent to abandon). Colorado has allowed a company unable to finance the infrastructure to use its water right to sell the water despite a claim of abandonment. East Twin Lakes Ditches & Water Works, Inc. v. Bd. of Cnty. Comm'rs of Lake Cty., 76 P.3d 918, 919–20 (Colo. 2003). Washington and Montana also use rebuttable presumptions. *See* Okanogan Wilderness League v. Town of Twisp, 947 P.2d 732, 739 (Wash. 1997) (describing a rebuttable presumption of abandonment after long periods of nonuse as "the general rule in western water law"); 79 Ranch, Inc. v. Pitsch, 666 P.2d 215, 217 (Mont. 1983) (finding that after 40 years of non-use, a rebuttable presumption is raised and burden is shifted to the nonuser to show there was no intent to abandon). Other states allow defenses to forfeiture that include drought or unavailability of water, active service in the military, legal proceedings, legally imposed production or acreage quotas, and other reasons that warrant nonuse. *See, e.g.*, ARIZ. REV. STAT. ANN 45-189(E) (providing that drought, military service in crisis, operation of legal proceedings, and water use restrictions are sufficient cause for nonuse); N.M. STAT. ANN. 72-5-28 (circumstances beyond the control of the owner not cause for forfeiture); IDAHO CODE 42-

Speculation in water rights was of far greater concern during the early settlement of the American West when valuable new water rights were still being acquired. As Elwood Mead noted:

> If [the right to transfer water] is [sustained], water rights . . . will become personal property. The water of the public streams will become a form of merchandise, and limitations to beneficial use a mere legal fiction. It will render futile and useless the requirement of the State statute that the lands to which the appropriation is attached must be described in certificates, because the right can be separated from this land without any legal formality as soon as the certificate is recorded. If water is to be so bartered and sold, then the public should not give streams away, but should auction them off to the highest bidder.[269]

At the time that Mead was writing, water resource managers were rightly concerned that some water users would claim more water than they needed for their initial water allocations with the hope, and perhaps the expectation, that they would be able to sell any water they did not need.[270] But our western water resources programs have long since transitioned from an era of allocation to an era of reallocation.[271] And in an era of reallocation, concerns about speculation are far more suspect because they may interfere with the efficient operation of water markets. In the conserved water context for example, allowing an entrepreneur to pay a farmer to engage in DI in exchange for providing the investor with some portion of the conserved water rights could move the states much more quickly and efficiently to embrace conserved water transfers. Once again, Australia's experience suggests that speculation in water does not pose significant problems and may help the markets function more efficiently.[272]

Current prior appropriation law largely relies upon the doctrine of beneficial use to deny speculative water right claims. As Colorado Supreme Court Justice Gregory Hobbs noted in *High Plains A & M, L.L.C. v. Southeastern Colorado Water Conservancy District,* "[a]ctual beneficial use is the basis, measure, and limit of an appropriation."[273] Thus, when an

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222(2)–(3), 42-223(6) (preventing forfeiture due to circumstances beyond rights owner's control).

[269] Squillace, *Water Marketing in Wyoming*, *supra* note 264, at 884 (quoting ELWOOD MEAD, IRRIGATION INSTITUTIONS 264 (1903)).

[270] *See id.* (discussing Mead's concerns about water speculation).

[271] *See* Steven J. Shupe et al., *Western Water Rights: The Era of Reallocation*, 29 NAT. RESOURCES J. 413, 413–14 (1989) ("[W]e are entering an era of water 'reallocation' in the West that is just as significant as the allocation era of the previous century, and which presents as many difficult questions.").

[272] In Australia, speculative behavior has occasionally been raised as a concern for water markets but such problems have not been borne out. This may be because of the fact that the Murray–Darling Basin supports a large number of equivalent entitlements in given classes and a deep and well informed market. In practical terms, a water entitlement can only yield value to the owner if the water is either used or sold to a buyer willing to accept the price. At this point every owner has their asset again evaluated by the market.

[273] 120 P.3d 710, 719 (Colo. 2005).

applicant for a water right is unable to demonstrate how and where it will use the water, the courts often reject the application on the grounds that is speculative.[274]

Wholesale rejection of the anti-speculation doctrine is not necessary, however, to allow conserved water transfers to go forward—even where the applicant has not identified a final place or type of end use. Rather, the States might consider allowing such transfers to go forward so long as the conserved water is deposited in a state water exchange for the appropriate water basin. This would promote the sensible state policy of making water more readily available to address short- and long-term needs without abandoning the anti-speculation doctrine in its entirety.

VI. Conclusion

Innovative water conservation strategies supported by arrangements that allow saved water to be transferred to other uses hold great promise for addressing stresses on water supplies caused by climate change and overuse. As Australia's experience shows, such strategies are likely to prove more efficient and more protective of environmental values than water development projects that are often promoted as a necessary response to water supply stresses. In order for these strategies to succeed, however, certain legal and institutional obstacles to transferring the water saved must be overcome.

Recognizing the potential efficiencies that might be achieved with robust water markets, water experts and policymakers have worked hard to overcome these obstacles for many years but they have had little to show for their efforts. To be sure, transfers are occurring in the western United States as they have been for well over 100 years, but the market has not developed in a way that affords sufficient assurances for parties that need to know that water resources will be available when and where they are needed.

One possible way to reinvigorate water markets is to focus on the transfer of conserved water. Conserved water transfers raise far fewer objections than other forms of water transfers because they allow farmers to keep farming and they can be designed to be accomplished quickly and efficiently. That is not to say that implementing programs that promote such transfers will be easy or without political costs. But as our water systems become increasingly stressed, we must look more closely at creative solutions that are capable of addressing our present and future water needs without upending the entire water rights system. They just might work.

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[274] *See* Landry, *supra* note 267, at 1010 n.107 (providing examples of several courts applying the anti speculation doctrine to proposed water rights transfers).