SGMA's First Groundwater Market

AN EARLY CASE STUDY FROM FOX CANYON

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CENTER FOR ECONOMIC RESEARCH & FORECASTING

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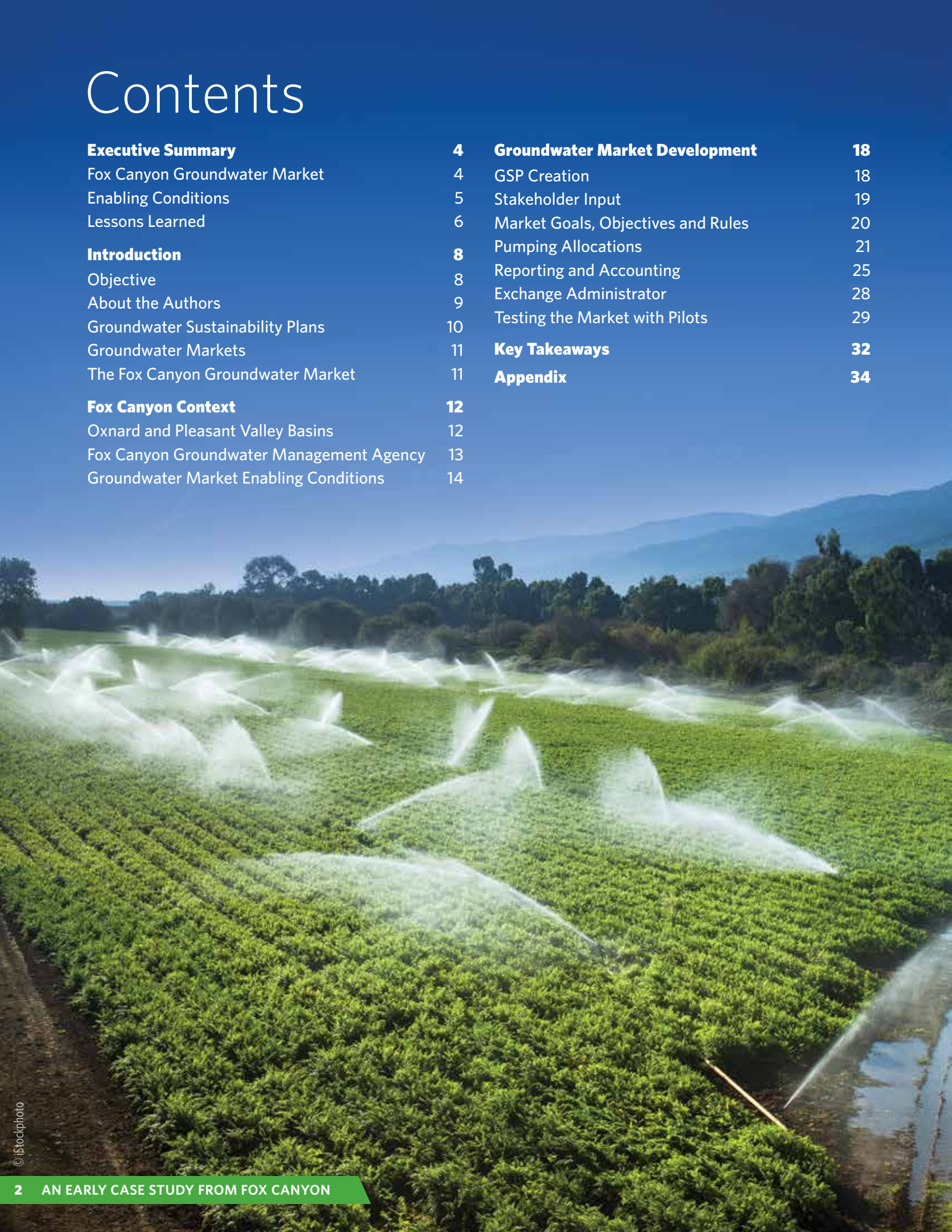

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SUGGESTED CITATION

Heard, S., E.J. Remson, M. Fienup and S. King. 2019. SGMA's First Groundwater Market: An Early Case Study from Fox Canyon. The Nature Conservancy, San Francisco, CA.

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ACKNOWLEDGMENTS

The authors give special acknowledgment to the Fox Canyon Groundwater Management Agency (FCGMA) for their leadership and commitment to developing and launching the Fox Canyon groundwater market. The authors specifically thank Glenn Shepard, Jeff Pratt, Arne Anselm, Kim Loeb, the FCGMA Board of Directors and Agency staff.

In addition, the authors thank John Krist at the Farm Bureau of Ventura County and Edgar Terry at Terry Farms Inc. for their leadership in Ventura County as well as their contributions to this report; Sandi Matsumoto, Brian Stranko, Jeanette Howard, Melissa Rohde and Sally Liu at The Nature Conservancy for their careful and thoughtful review; Kari Cohen and Adam Chambers for their generous support through the Conservation Innovation Grant program.

This material is based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under number 69-3A75-17-289.

Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture.

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Published May 2019

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Acronyms

AF	Acre Feet
AMI	Advanced Metering Infrastructure
CERF	Center for Economic Research and Forecasting
CIG	Conservation Innovation Grant
CLU	California Lutheran University
FCGMA	Fox Canyon Groundwater Management Agency
DAC	Disadvantaged Community
GDE	Groundwater Dependent Ecosystem
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
M&I	Municipal & Industrial
NRCS	Natural Resources Conservation Service
OPV	Oxnard Pleasant Valley Pumpers Group
SGMA	Sustainable Groundwater Management Act
SMA	Special Management Area
TAG	Technical Advisory Group
TNC	The Nature Conservancy

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Executive Summary

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In 2014, amid California's most recent drought, the state passed the Sustainable Groundwater Management Act (SGMA). This new law regulates groundwater at scale for the first time, requiring the state's largest source of stored water to be managed for long-term resilience. SGMA delegates the responsibility of achieving sustainable groundwater management by 2040 to local Groundwater Sustainability Agencies (GSAs). GSAs must achieve sustainability for their groundwater basins by developing and implementing Groundwater Sustainability Plans (GSPs). Balancing groundwater basins to achieve sustainability will require increasing water supply to the basin and/or decreasing water demand. The Fox Canyon Groundwater Management Agency (FCGMA), in western Ventura County, is the first GSA to pursue a groundwater market as a tool to decrease water demand when implementing its GSP.

This white paper outlines FCGMA's experience—the steps taken and lessons learned—in developing the first groundwater market to emerge under SGMA. It is a combined effort of The Nature Conservancy (TNC), California Lutheran University's (CLU's) Center for Economic Research and Forecasting (CERF) and FCGMA, with the support of local growers and the Farm Bureau of Ventura County (Farm Bureau). This document is meant to serve as a resource for GSAs and other public agencies, organizations, practitioners and stakeholders involved in water resource management and contemplating the creation of groundwater markets to meet SGMA's sustainability mandate. This report focuses on the design and testing of the Fox Canyon groundwater market; a companion report will likely follow to evaluate the performance and share additional lessons learned once the market has launched.

Fox Canyon Groundwater Market

Ventura County is one of the most productive counties in the nation, with $2.1B in agricultural revenue in 2017[1]. Its agricultural industry is also largely dependent on

[1] County of Ventura. 2018. Ventura County's 2017 Crop & Livestock Report. Office of the Ventura County Agricultural Commissioner, Camarillo, CA. Available at: https://cdn.ventura.org/wp-content/uploads/2018/07/Ag-Comm-2017-Annual-Crop-Report-final-lr-07-30-18.pdf.https://www.ventura.org/agricultural-commissioner/crop-reports/.

groundwater, and decades of overpumping have resulted in the classification of the Oxnard and Pleasant Valley basins by the State of California as in a state of "critical overdraft," a label that applies to 21 of the 130 basins regulated by SGMA. This means a fast-track for the requisite GSP, which is due in January 2020, two years before the 109 basins that are classified as "high" or "medium" priority.

Cuts of up to 35 percent in groundwater use are expected for the two critical basins to achieve their respective sustainable yields, which is SGMA's requirement for a locally-determined cap on total water use that balances the needs of communities, agriculture and nature. The magnitude of this reduction motivated growers in the Oxnard basin to call for a groundwater market as a tool to provide flexibility, allowing those with unused water allocations to sell to those with unmet demand. Since 2016, FCGMA has worked with growers, environmental groups and other stakeholders to design and test a groundwater market in the Oxnard basin.

Enabling Conditions

Groundwater markets can be a useful tool for achieving basin sustainability, but they are not a fit for every basin or GSA. A number of enabling conditions are necessary to ensure that a groundwater market functions effectively—namely that it is utilized by groundwater users and achieves its intended outcomes. The Fox Canyon groundwater market benefitted from the following enabling conditions:

Stakeholders at a workshop on the Fox Canyon groundwater market © E.J. Remson/TNC

Water Scarcity: Under SGMA, the sustainable yield for a basin serves as a cap on total extractions. In the critically overdrafted Oxnard basin, this cap translates into pumping reductions of as much as 35 percent. This water scarcity creates the conditions for a market by allowing the price of water to reflect its true value to users, motivating both buyers and sellers. Even as water users await FCGMA's forthcoming GSP, the adoption of an emergency drought ordinance (Emergency Ordinance E) has already created a degree of scarcity in Fox Canyon by placing limits on agricultural water use.

Fixed Allocations: A functioning market requires clearly defined and transferrable allocations. SGMA, on the other hand, allows GSAs to determine each basin's path to sustainability, which may include allocating a specific amount of water to each pumper. FCGMA has opted to create a fixed allocation scheme for agricultural pumpers in the Oxnard basin. Any water pumped beyond that which has been allocated to a given user must be purchased on the market or recorded as a violation. Without this strict adherence to fixed allocations, a cap-and-trade style water market will not function in the face of alternative means to secure additional water.

Agricultural Stakeholder Support: The idea for the Fox Canyon groundwater market began with local growers, the majority user (with approximately 60 percent) of groundwater in the area. Area growers are well-organized, and with the support of the Farm Bureau and economics and business academics at CLU, they brought a proposal for a market to FCGMA. Without the buy-in and leadership of the agricultural community, the Fox Canyon groundwater market would likely not have gained traction.

Market Design Expertise: A well-functioning water market requires careful design. This is an iterative process that requires ongoing attention, evaluation and adaptation. CERF and TNC both have expertise in the design of environmental markets. Throughout the development of the Fox Canyon groundwater market, CERF and TNC have contributed by helping facilitate and educate stakeholders, create market rules, launch two market pilot phases, and monitor their performance.

Capacity and Funding: The creation of a water market is a considerable undertaking that requires significant, dedicated capacity from GSA staff, partners and participants. TNC, with support from FCGMA, CERF and the Farm Bureau, secured a Conservation Innovation Grant from the Natural Resources Conservation Service that provided over $1M to bolster the development of the Fox Canyon groundwater market. Without this infusion of funds, the market may not have endured the resource-intensive development phase.

Lessons Learned

Two years of designing and testing the Fox Canyon groundwater market have yielded many lessons learned. Chief among these are:

GSAs wishing to create water markets should create their GSPs with the market in mind. FCGMA created its GSP and water market in parallel. While both require significant agency capacity and resources, this allowed for iteration between the two so that critical elements of the GSP, such as the pumping allocation system, could support a functioning water market. Critical elements of a GSP can support market formation. Without proper attention, some elements may unintentionally exclude the possibility of a market.

A water market should be developed via a public and transparent process. FCGMA chartered a public stakeholder group, called the Water Market Group, charged with designing the structure and operational mechanisms of the Fox Canyon groundwater market.

An agricultural groundwater well in Fox Canyon. © Matthew Fienup

Like any public process, this group benefited from the diverse input of growers, cities and environmental organizations, among others. Over a period of seven months, the group educated itself on how markets function, established goals, created market rules and made recommendations to FCGMA that became the basis for the ordinances required to create the groundwater market.

Developing allocations is controversial, and measures to alleviate the impacts to pumpers should be compatible with a water market. In Fox Canyon, the prospect of reducing groundwater use by as much as 35 percent generated significant controversy and several proposals to ease this transition. In response, FCGMA opted to gradually ramp down allocations each year and allow unused allocations to be "carried over" to future years. The carryover allowance may initially limit trading, but it incentivizes conservation and is, therefore, an additional tool to achieve basin sustainability. In contrast, a proposal to allow pumpers to borrow from their future allocations would undermine market integrity, by providing an alternative source of supply at no cost. It would also delay the pumping reductions needed to meet the sustainable yield, and was therefore, not adopted by FCGMA.

Cut flowers are one of Ventura County's top crops. © Farm Bureau of Ventura County

Accurate water use data is essential to ensure compliance with both the GSP and water market. FCGMA moved from a system of semiannual self-reporting to tamper-proof telemetric monitoring by requiring Advanced Metering Infrastructure (AMI) on all active agricultural wells to enable accurate reporting of pumping. In Fox Canyon, AMI includes telemetry hardware that reads groundwater meter data and transmits that data to a cloud-based data portal. FCGMA designed specifications for AMI hardware that include tamper detection and other validation measures, which seek to improve the integrity of groundwater extraction data. AMI is required by an ordinance, and TNC and CERF designed a rebate program for FCGMA to offset growers' costs of AMI adoption and water market participation.

Water market goals and rules should be tailored to participants' specific interests and needs. In designing the Fox Canyon groundwater market, growers placed a high value on developing a market via a transparent process to ensure fairness and preserve participant anonymity during trading. These goals were satisfied, in part, via a requirement that trading be administered by a third-party that uses an algorithm to match buyers and sellers while not allowing them to interact with one another directly. As interests and needs differ across basins, so too water markets will differ across a number of dimensions.

Testing the market before moving to full-scale implementation helps to "get the bugs out." The Fox Canyon groundwater market ran two pilot phases. Both have illuminated the degree of administrative and infrastructure complexity involved, and the need for significant time and capacity from FCGMA and partners. The testing phase offers an opportunity to learn about the market's strengths and weaknesses and improve its design before implementing it on a larger scale.

By allowing the price of water to reflect its true value to users, water markets incentivize conservation and investments in efficiency and supplemental supplies, all of which build basin resilience. Groundwater markets are one tool that can aid basins facing a new sustainability mandate under SGMA. The Fox Canyon groundwater market is the first to test this approach, and this report shares the story of its development in the hope that others will benefit from it.

Introduction

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In 2014, California ushered in a new era of water management, with the passage of the Sustainable Groundwater Management Act (SGMA). The move came amid the state's historic multi-year drought and a growing recognition that climate change and population growth will further exacerbate water supply and demand imbalances. Groundwater comprises almost 40 percent of California's water supply, on average, and considerably more in dry years.[2] It is our largest source of stored water,[3] serving as an important buffer in dry years, and it is therefore, critical that we ensure its resilience over the long-term.

SGMA requires groundwater sustainability at the basin level, but it does not specify how to meet this requirement. This responsibility falls to over 250 local agencies, most of them new, and they need tools to achieve basin sustainability. Market-based approaches, specifically groundwater cap-and-trade (referred to hereafter as "groundwater markets"), represent a promising tool for managing groundwater demand while providing users with flexibility in meeting their allocations. The Fox Canyon Groundwater Management Agency (FCGMA) in Ventura County has been an early mover in the space, working with agricultural, environmental and other stakeholders since 2016 to design and implement a groundwater market for basins that face reductions of up to 35 percent in groundwater use to achieve sustainability.

Objective

This white paper outlines the steps taken and lessons learned in starting the Fox Canyon groundwater market, the first formal groundwater market to be created under SGMA. It is a firsthand account by The Nature Conservancy (TNC) and California Lutheran University's (CLU's) Center for Economic Research and Forecasting (CERF), which worked closely with FCGMA, agricultural interests, cities, and others to launch the Fox Canyon groundwater market. The goal of this document

[2] Chappelle, C., E. Hanak and T. Harter. 2017. Just the Facts: Groundwater in California. Public Policy Institute of California, San Francisco, CA. Available: https://www.ppic.org/wp-content/uploads/JTF_GroundwaterJTF.pdf.

[3] Public Policy Institute of California. 2016. Storing Water. San Francisco, CA. Available: https://www.ppic.org/content/pubs/report/R_1016JLR.pdf.

is to demystify groundwater markets and to inform their development elsewhere via a case study that complements existing "how-to-guides"[4] by providing insights from an on-the-ground effort to design and implement the first groundwater market under SGMA. This report is intended to serve as a practical resource for agencies, organizations and other potential stakeholders involved in water resource management. The focus is on the initial phase of designing and testing the Fox Canyon groundwater market, and we anticipate a companion report to evaluate the performance and share additional lessons learned once the market has launched.

About the Authors

The Nature Conservancy

TNC is a global conservation organization dedicated to conserving the lands and waters on which all life depends. Guided by science, we create innovative, on-the-ground solutions to our world's toughest challenges so that nature and people can thrive together. We are tackling climate change, conserving lands, waters and oceans at unprecedented scale, providing food and water sustainably and helping make cities more sustainable. Working in 72 countries, we use a collaborative approach that engages local communities, governments, the private sector and other partners.

TNC has had a presence in Ventura County for 18 years. We own multiple properties, many of them agricultural, with the dual objectives of avoiding their conversion to development and restoring natural floodplains along the Santa Clara River, Southern California's last free-flowing river. As an agricultural landowner, and a consumptive water user, TNC has been formally involved in the process of creating the Oxnard and Pleasant Valley Groundwater Sustainability Plan (GSP). TNC desires that all GSPs address groundwater dependent ecosystems (GDEs), as required by SGMA, and that the plans employ robust methods to accomplish that goal and others. GSAs may consider groundwater markets as one such method. Through our work on the Fox Canyon groundwater market, we have attempted to create a market structure that supports implementation of the GSP, including protection of GDEs. We hope this paper will provide guidance to others wishing to achieve these goals.

Center for Economic Research and Forecasting

CERF is a nationally recognized forecasting center, which provides county, state and national economic forecasts and custom economic analysis for government, business and nonprofit organizations. CERF is a member of the Wall Street Journal's *Economic Forecasting Survey* and the National Association of Business Economics' *Economic Outlook Survey* and also serves as the on-call regional economic experts for the

Harvesting avocados, one of Ventura County's top crops. © Farm Bureau of Ventura County

[4] See, for example: Nylen, G.N.,M. Kiparsky, K. Archer, K. Schnier and H. Doremus. 2017. Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act. Center for Law, Energy & the Environment, University of California Berkeley School of Law, Berkeley, CA and Babbit, C., M. Hall, A. Hayden, A.L.G. Briones, R. Young and N. Brozović. 2017. Groundwater Trading as A Tool for Implementing California's Sustainable Groundwater Management Act. Environmental Defense Fund, New York, NY.

Citrus trees and row crops in the Oxnard basin. © Melinda Kelley/TNC

Southern California Association of Governments. In addition to our economic forecasting work, CERF has a strong policy orientation with expertise in land use, urban containment policy, and environmental markets.

Housed at CLU, in Thousand Oaks, California, CERF has deep roots in Ventura County. Our goal is to be part of innovative policy initiatives that provide greater resilience for the unique communities and delicate ecosystems that comprise Ventura County. Initiatives that serve the long-term viability of the county's rich agricultural tradition are of particular interest to us. The Fox Canyon groundwater market represents a unique collaboration between agricultural, urban, and environmental water users. Our belief is that this effort will contribute to both a stronger regional economy and a healthier natural environment. We feel privileged to play a key role in facilitating stakeholder involvement and implementing this unique response to a pressing regional economic issue. Our hope is that Fox Canyon will serve as an example for other regions confronting similar challenges.

Groundwater Sustainability Plans

Under SGMA, 21 critically overdrafted basins must develop GSPs by 2020; another 109 basins considered high- and medium-priority must have GSPs in place by 2022. Each GSP must identify a basin's sustainable yield—the maximum amount of groundwater that can be withdrawn annually without causing undesirable results[5]—and a path for achieving sustainability over 20 years. A GSP must also include measurable objectives, minimum thresholds, a monitoring plan and projects, and management actions for achieving the sustainable yield.

It is within this context that groundwater markets operate—as an optional tool to be implemented as part of a GSP. Properly managed transfers of groundwater pumping allocations can help improve groundwater levels and water quality in service of GSPs, but the opposite is just as true, highlighting the importance of carefully-designed markets. A strong GSP that balances

[5] Undesirable results include significant and unreasonable chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence and depletion of interconnected surface waters.

economic, environmental and social benefits is critical to long-term basin management, and no groundwater market can make up for shortcomings in any of these areas. Specifically, water within the sustainable yield should provide for human consumption and GDEs—communities and nature should not be required to rely on groundwater markets to meet their water needs. FCGMA used TNC's *GDEs Under SGMA* guidance[6] in its GSP creation, and as a tool to implement the GSP, the Fox Canyon groundwater market helps meet objectives to protect GDEs.

Groundwater Markets

SGMA is expected to result in significant cuts to groundwater use, particularly in critically overdrafted basins. It is this water scarcity that creates the primary driver for a groundwater market. By allowing the price of water to reflect its true value to users, markets incentivize water conservation and efficiency. This, in turn, frees up water that can increase the resilience of the basin, on a whole, in the face of supply constraints.

By allowing groundwater users to trade, markets provide greater flexibility than pure command-and-control schemes. In doing so, markets give individual pumpers control over their respective paths toward a basin's sustainable yield. For agricultural users, markets create the potential for supplemental or replacement revenue in the event of fallowed fields, while freeing up water supplies for permanent crops in need. Municipal and industrial (M&I) users with supply deficits can turn to water markets to meet their demands. Water markets may also incentivize investments in additional supplies, such as recharged wastewater, advanced purification of wastewater and new infrastructure, like groundwater storage, by providing revenue streams that cover or reduce capital costs.

Strawberries are the Oxnard basin's most valuable crop. © Kiliii Yuyan/TNC

With a few noteworthy exceptions, the vast majority of existing groundwater markets have not been created with nature in mind; however, markets can provide environmental benefits through careful design. For example, markets can protect GDEs through the use of special management areas (see *Market Goals, Objectives and Rules*), or they can allow environmental landowners to purchase water for delivery to habitat restoration areas.

The Fox Canyon Groundwater Market

In Fox Canyon, local growers gravitated towards the idea of establishing a groundwater market that allows the trading of pumping allocations early on. Groundwater users recognized that a properly designed water market was attractive in its ability to provide financial incentives to reduce pumping while adding economic flexibility for growers. Reductions in agricultural water use might come from planting low water use crops or utilizing advanced irrigation technology or other agricultural best practices. If the price of water were sufficiently high, a grower might fallow land and lease their allocation to others. Local growers realized that without a water market, even temporary fallowing would result in serious financial impacts to growers in the region.

[6] Rohde, M.M., S. Matsumoto, J. Howard, S. Liu, L. Riege and E.J. Remson. 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans. The Nature Conservancy, San Francisco, CA. Available at: https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/.

Fox Canyon Context

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Oxnard and Pleasant Valley Basins

Although it sits on the edge of the Los Angeles metropolitan area, Ventura County is the 11th most productive agricultural county in the nation, with total output valued at $2.1B in 2017[7]. The county has nearly 96,000 irrigated acres of farmland, half of which are within the western portion, in the Oxnard and Pleasant Valley basins (Figure 1). Ventura County is home to some of the highest valued agricultural land in the nation, with sales of row crop farms of more than $70,000 per acre[8]. Total annual groundwater use in the two basins averaged approximately 97,000 acre feet (AF) between 1985 and 2015 and 91,000 AF between 2000 and 2015[9]. A network of about 500 active agricultural wells typically consumes roughly 60 percent of the two basins' annual groundwater; M&I consumes the remaining 40 percent.

Decades of over pumping has significantly lowered groundwater levels in both the inland and coastal parts of the Oxnard and Pleasant Valley basins, exacerbating the seawater intrusion problem along the coast. As a result, both basins are designated as "critically overdrafted" by the state and therefore, must have GSPs in place by January 2020. Initial estimates indicate that extractions may need to be reduced by as much as 35 percent to bring the two basins to sustainable yield and to meet other requirements under SGMA.

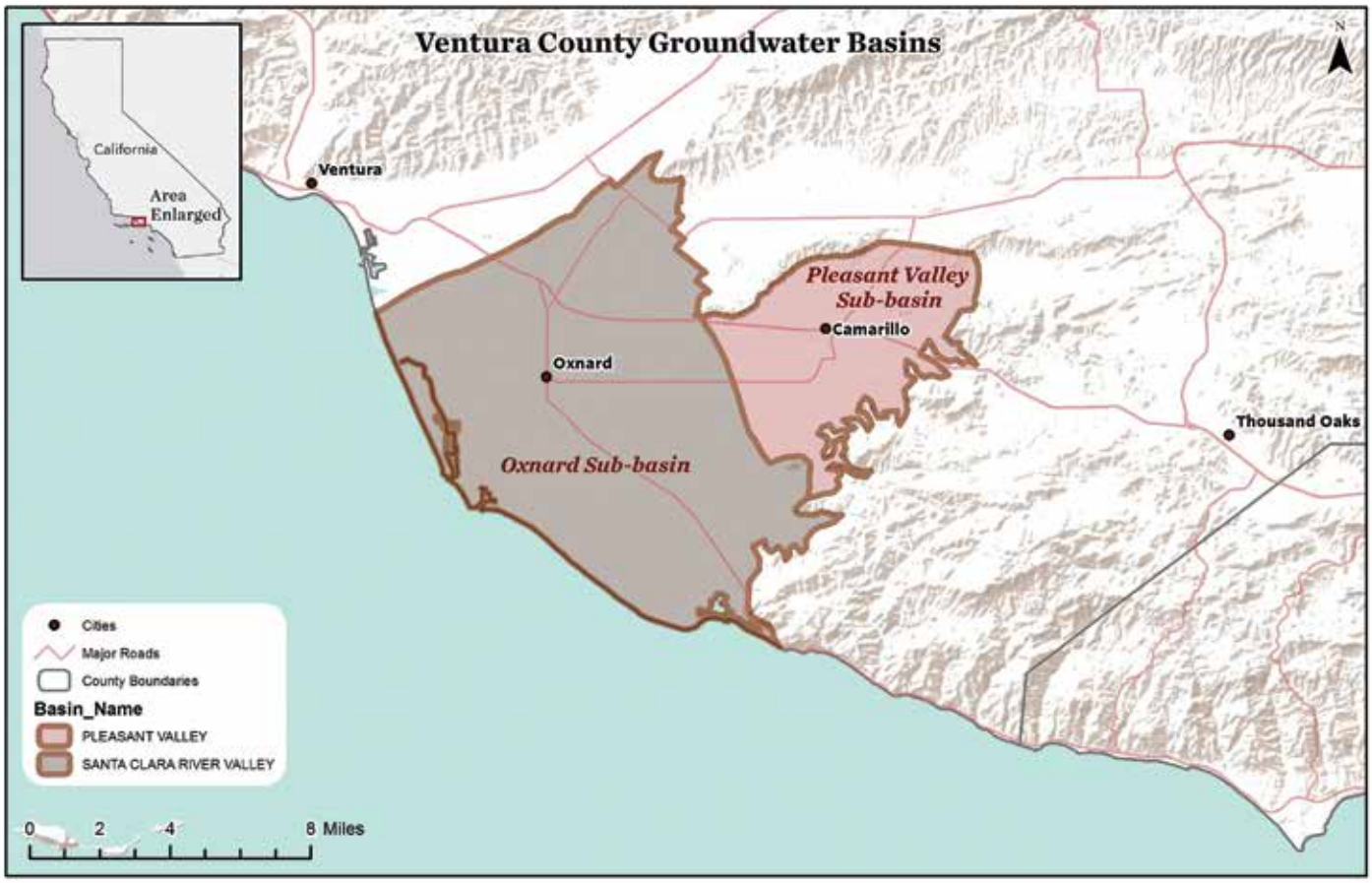
Historically, groundwater recharge from surface water diversions, which are captured through a diversion facility along the Santa Clara River and recharged via percolation ponds feeding the aquifer, equaled about half of total extractions from the Oxnard basin. The river is important ecologically, as it supports several rare protected species including the endangered Southern Steelhead. Concern over

[7] County of Ventura. 2018. Ventura County's 2017 Crop & Livestock Report. Office of the Ventura County Agricultural Commissioner, Camarillo, CA. Available at: https://cdn.ventura.org/wp-content/uploads/2018/07/Ag-Comm-2017-Annual-Crop-Report-final-lr-07-30-18.pdf..

[8] According to Ventura County records.

[9] See Preliminary Draft Groundwater Sustainability Plans for the Oxnard Subbasin and Pleasant Valley Basin (November 2017). Available at: http://fcgma.org/component/content/article/8-main/115-groundwater-sustainability-plans.

Figure 1. Oxnard and Pleasant Valley Basins



the environmental impacts of the diversion, which disrupts steelhead migration, has led to extensive litigation which, among other things, has resulted in limitations on the amount and timing of the diversions, and therefore, the amount of recharge. These changes may reduce future diversions, further constraining the region's water supplies.

Fox Canyon Groundwater Management Agency

In 1982, the California legislature created FCGMA, primarily to address seawater intrusion caused by the overdrafting of Ventura County's coastal aquifers. FCGMA is one of 15 Special Act Districts created by the legislature to manage groundwater in specific basins in California prior to SGMA. Since its creation, FCGMA has managed groundwater in four basins. Management actions have included requirements for well-metering (beginning in 1987), semi-annual extraction reporting, a determination of basin *Safe Yield* (in 1990) and establishment of quantified pumping allocations for water users. Prior to the passage of SGMA in 2014, and in response to a continuing severe drought, FCGMA passed Emergency Ordinance E, targeting a 20-percent reduction in groundwater extractions. Ultimately, the pumping restrictions were largely ineffective at eliminating the overdraft conditions in the Oxnard and Pleasant Valley basins. This history of overpumping, combined with more than two decades of documented seawater intrusion, resulted in the basins' classification as critically overdrafted under SGMA.

The existence of FCGMA was a key driver of the development of the Fox Canyon groundwater market. As a Special Act District, FCGMA did not have to undergo the GSA formation process that most SGMA basins faced. This enabled FCGMA to move directly

Sprinklers irrigate a newly planted field. © Farm Bureau of Ventura County

into the development of the GSP and any tools needed to achieve sustainability, such as a water market. This effectively gave FCGMA a head-start over other basins that must undergo the potentially protracted process of forming a GSA, including addressing often-difficult governance issues related to launching a new agency. Furthermore, FCGMA's 35 years of basin management experience, knowledgeable staff and significant historical pumping data positioned FCGMA as an early mover in the creation of a water market.

Groundwater Market Enabling Conditions

Several enabling conditions make the Oxnard basin particularly fertile ground for the development of a groundwater market and may help parties interested in developing markets in other regions evaluate the suitability of doing so.

Water Scarcity

A primary driver of the Fox Canyon groundwater market is the degree of scarcity that agricultural users will experience as they implement a SGMA-mandated reduction in pumping of as much as 35 percent. SGMA's requirement for a sustainable yield fixes the maximum amount of groundwater available for the diverse needs of all pumpers in a given basin, essentially serving as a cap on total extractions. If the demand for groundwater exceeds the sustainable yield of the basin, reductions in individual pumping may be required. Where an individual water user is unable to reduce extractions, a market creates the opportunity for that individual to buy additional water, essentially paying someone else not to pump or rewarding that water user for reductions in water usage via conservation. Without significant scarcity, a market will not function and is probably not needed.

Fixed Allocations

While SGMA requires each overdrafted basin to achieve a sustainable yield, the method for doing so lies with the individual GSA. FCGMA has chosen to pursue its sustainable yield by moving from an existing system of groundwater allocations that varies by crop type, known as "efficiency-indexed" allocations, to a system of "fixed" allocations that will assign a fixed, historically-based pumping allocation per well. Clearly defined and transferrable allocations are a necessary component of a functioning cap-and-trade market. FCGMA's decision to create fixed allocations—the sum of which equals the total extraction allowed for the basin in a given year—is compatible with its development of a market. In limiting individual water use, the creation of fixed allocations typically generates opposition, controversy and sometimes, litigation. However, a market can help offset some of the pain of fixed allocations by providing opportunities for farmers to benefit from both buying and selling water. Two pilot groundwater markets have taken place in Fox Canyon, and because FCGMA is still in the process of creating its new allocation system to be implemented through the GSP, these two pilots created fixed allocation systems that participants opted in to, forgoing their previous, crop-based allocations.

Agricultural Stakeholder Support

The idea for the Fox Canyon groundwater market initially emerged in early 2014, amid California's most recent drought. Facing the prospect of reduced surface and groundwater supplies, a small group of growers began discussing the potential for a cap-and-trade system as an alternative to FCGMA's indexed allocation system. Area farmers grow a diverse mix of annual and permanent crops, ranging from berries, flowers and vegetables to citrus and avocado orchards. This heterogeneity in both the season and water demand of the region's crops creates opportunities for a water market[10], and was one motivation for growers in the Oxnard basin. After developing concrete ideas about how to implement a groundwater market, these growers, with the help of the Farm Bureau of Ventura County (Farm Bureau), brought their ideas to FCGMA staff and Board of Directors. Agricultural stakeholders in FCGMA's jurisdiction are well-organized, and the leadership provided by this group was critical.

The passage of SGMA in September 2014 provided additional momentum and motivation for stakeholders in western Ventura County to identify potential solutions to support continued agricultural production while also meeting urban water needs. In January 2016, FCGMA formally kicked off the process of creating a water market for inclusion in its GSP.

AMI installed on an agricultural well in the Oxnard basin. © Sarah Heard/TNC

[10] Farger, W. 2011. Responding to Scarcity: Lessons from Australian Water Markets in Supporting Agricultural Productivity During Drought. National Water Commission – Water Markets and Efficiency Group.

Market Design Expertise

There are few examples of groundwater markets in California to serve as models for the Fox Canyon groundwater market. While groundwater markets do exist in some California basins, they have largely been informal in nature, resulting from the adjudication process. To date, no groundwater basin in California has implemented a formal, centralized exchange of the type being used in Fox Canyon (see *Exchange Administrator*).[11] CERF, within Ventura County-based CLU, has staff knowledgeable in environmental markets who played a leadership role in Fox Canyon's market formation. Before launching the market, CERF facilitated a group of stakeholders interested in learning more about water markets to determine their feasibility in Ventura County. This grew into a formal stakeholder process, chartered by FCGMA, to design the market's goals, objectives and rules (see *Stakeholder Input*). TNC contributed its expertise on environmental market design, working alongside CERF to steer both the design and rollout of the Fox Canyon groundwater market to ensure its functionality and integrity. CLU also has an adjunct professor of economics and business who is a fourth-generation local farmer. This individual originated the idea of the market and was a champion of the market throughout its development (see A Farmer's Perspective).

Capacity and Funding

During the development of the Fox Canyon groundwater market, TNC secured a Conservation Innovation Grant (CIG) from the federal Natural Resource Conservation Service, with the support of FCGMA, CERF, the Farm Bureau and local growers. TNC's primary motivation for pursuing the CIG was to help implement and prove out a sound GSP that provides for the needs of both nature and agriculture, and that will hopefully serve as a model for others to follow. The grant provided over $1M to design and test the market, bringing significant additional resources to the project, specifically for the installation of Advanced Metering Infrastructure (AMI) to collect pumping data and the provision of staff time from both TNC and FCGMA to develop and launch the second phase of a pilot market. The creation of a water market is a considerable undertaking that requires significant, dedicated capacity from GSA staff, participants and partners. In addition to directly funding FCGMA and TNC staff time, the CIG provided momentum for the continued participation of partners, notably CERF, in the development of the Fox Canyon groundwater market. Without the infusion of funds from the CIG, the Fox Canyon groundwater market may not have endured the resource-intensive development and testing phases in the face of competing priorities.

The Santa Clara river flows through the Oxnard basin. © Vertical Perspectives.

[11] Ayers, A. 2016. Trading Institutions in California's Adjudicated Groundwater Basins: Rules, Regulations, and Trading Activity. Unpublished. Fox Canyon Water Market Group; Ayers, A. 2015. Background Information on Adjudicated Groundwater Basins in California. Unpublished. Bren School of Environmental Science & Management, UC Santa Barbara; Enion, M.R. 2013. Allocating Under Water: Reforming California's Groundwater Adjudications. Pritzker Environmental Law and Policy Briefs. UCLA School of Law, Emmett Center on Climate Change and the Environment. Available at: https://law.ucla.edu/centers/environmental-law/emmett-institute-on-climate-change-and-the-environment/publications/allocating-under-water/.

Terry Berries, a farmstand specializing in strawberries in the Oxnard basin. © Matthew Fienup

A Farmer's Perspective: Edgar Terry, Terry Farms Inc.

The ability to buy and sell water in a water market would be an economic benefit to the local agricultural community in Ventura County. The reasons for developing such a system are grounded in both solid economic and business practices.

The ability to trade water will allow market participants that do not use their allocations to sell to other market participants that need additional allocation for their crop(s). This buying and selling of allocation allows farmers to "finish-off" the crop(s) they are growing by getting them to the point where the crop can be harvested and marketed. Without the flexibility of moving unused allocation(s) to their best use, crops can go unharvested. Not having the ability to harvest a crop results in a total loss to the farmer. If a farmer, instead, decides to use more than the allowed water on the crop, then that results in monetary penalties levied by FCGMA and additional over-drafting of the aquifer.

Instituting creative solutions and incentives allows economic players, which a farmer is, to adapt and still prosper over the long term. If incentives are not created or allowed, then productivity is forever destroyed, and all those reliant on the agricultural community are harmed. The result from that destruction will be agricultural entities moving their operations to locations that are more conducive to long-term success.

Water markets are made up of voluntary transactions that benefit both parties and do not harm other pumpers. The farmer that sells the water is economically better off (water is an asset) than if they didn't have that flexibility, and the farmer that purchases the allocation is economically better off because they can harvest and sell their crop without incurring punitive penalties from the GSA.

Increasing the flexibility within systems that are inherently inflexible allows for better outcomes. Water markets are the perfect example of such flexibility.

Groundwater Market Development

© iStockphoto

For nearly two years, a range of stakeholders worked collaboratively to develop the Fox Canyon groundwater market. At a minimum, a functioning water market requires a cap on total extractions, pumping allocations that are clearly defined and transferrable, a means of measuring and enforcing water use and rules that govern the transfer of allocations. Specific aspects of the Fox Canyon groundwater market, such as the approach to measuring water use and managing trading, were designed to fit the needs of local stakeholders and may look different than well-designed markets in other jurisdictions.

GSP Creation

While developing a GSP is a requirement for all basins subject to SGMA, a water market is an optional tool that may be used to implement and achieve the goals of a GSP. FCGMA proceeded with developing its GSP in parallel with the groundwater market, with the general understanding that significant pumping reductions would be required, although the specific sustainable yield had not yet been determined. Any GSA considering a water market should have a similar understanding of the magnitude of pumping reductions to determine whether sufficient scarcity exists to render the market feasible.

The parallel creation of the Fox Canyon GSP and water market allowed for the identification of elements of the GSP that would either support or impede an effective and efficient water market. Certain systems of allocating groundwater pumping, particularly those that do not provide a clearly defined unit of trade, may not be compatible with a market. Methods to achieve pumping reductions that are overly complex or are not clearly quantifiable on a well-by-well basis may not be compatible with a market. For example, allocations that change with the crop type, adjust for precipitation or allow pumpers to borrow from future-year allocations create significant accounting challenges and undermine the integrity and proper functioning of the market. Generally, the prerequisites for an effective market also happen to support efficient basin management. As such, it may be the case that designing

Explanation of Terms

BASE PERIOD: The past period of time over which a pumper's water consumption is used to calculate the basis for their allocation. For example, the average annual amount of water pumped from 2005-2015.

PUMPING ALLOCATION: The amount of groundwater that a pumper may extract annually.

CARRYOVER: The ability to save an unused portion of one's allocation for use in a future year.

M&I SPLIT: The portion of total annual basin groundwater extraction allocated to Municipal and Industrial users, as distinct from agricultural users.

RAMP DOWN: A gradual reduction in pumping during the GSP implementation period (20 years) that will achieve the sustainable yield determined by the GSP.

a water market in parallel with a GSP may produce a more sound and achievable sustainability plan.

Preparation of a GSP is a major undertaking, as is the development of a water market, and pursuing the two simultaneously required significant capacity and resources from FCGMA and partners, including TNC and CERF. Where the ability to trade groundwater allocations is desired, it is important to ensure that a GSP enables a water market. It is equally important to devote sufficient resources to the development of both, particularly since a water market is not under the same deadline pressure as a GSP. It should not be assumed that a basin can simply design a GSP now and defer the design of a market until later. If resources are not available to pursue a GSP and water market in parallel, any GSA intending to create a water market should include input from an expert in market design in its GSP creation process to ensure that it will, in fact, enable a functioning market.

Stakeholder Input

To gain stakeholder input on the creation of its GSP and water market, FCGMA intended to establish three "chartered" stakeholder groups to provide expert guidance and input on FCGMA board decisions. They are the Technical Advisory Group (TAG), Pumping Allocations Group and the Water Market Group. The TAG is a group of professional hydrologists representing various stakeholders appointed by FCGMA to provide technical input to the consultant hired to prepare the GSP. The Pumping Allocations Group's focus was to provide stakeholder recommendations on the design of the allocation formula. The Water Market Group provided stakeholder input on the design of the water market. FCGMA intended for robust stakeholder participation in each group. Two of the three groups achieved that goal—the TAG and Water Market Group—with meetings that were open to the public and that allowed for public input. The TAG also intentionally included an environmental stakeholder seat, held by TNC.

The Pumping Allocations Group, which was initially created with a formal charter from FCGMA, rejected its charter and instead organized itself as a dues-paying group only open to basin landowners. The group adopted the name of Oxnard Pleasant Valley Landowners Group (OPV). The OPV provided extensive input to FCGMA on pumping allocations, historical base period, carryover provisions, M&I split and other topics (see *Explanation of Terms*). About 45 growers participated in the OPV. Because the meetings were private, it was difficult for other stakeholders to evaluate or provide input into the group's recommendations.

CERF facilitated the Water Market Group, which typically had 40-50 participants, including growers, water utilities, municipalities, mutual water companies and environmental representatives. The group held biweekly meetings, with a focus on learning how water markets function, setting goals for the Fox Canyon groundwater market and establishing trading rules. To help build local knowledge on how water markets work,

CERF invited guest speakers with market experience from around the world to address the group. The group also gathered data, case studies and other publications on water markets, which it posted on a group website. A key theme that emerged from the talks and literature was the importance of creating a water market that is transparent, fair, easy to understand and low-cost.

After meeting for seven months, the group unanimously agreed on the outline for the structure and operational mechanisms of a permanent water market as well as a set of interim goals and rules to be used in a series of pilot water markets (see *Market Goals, Objectives and Rules*). The group presented these rules to FCGMA staff and Board of Directors, and they became the basis for the agency's ordinances that authorized two pilot phases to test the water market (see *Testing the Market with Pilots*). The group will reengage, as needed, to address any issues identified in the pilots and to recommend rules for full implementation of the market.

Market Goals, Objectives and Rules

The FCGMA-chartered Water Market Group developed goals, objectives and trading rules for a pilot water market that could ultimately transition to a permanent market for both the Oxnard and Pleasant Valley basins. The Group decided to start simply to understand the mechanics and behavior of a pilot market, with the understanding that the market could be amended as necessary. For example, the market is initially limited to agricultural water users but could be expanded to include other users in the future.

Trading Rules

The Water Market Group created a set of rules for the Fox Canyon groundwater market that outline eligible participants and procedures for enrollment, trading, reporting, monitoring and enforcement (see Appendix). Non-allocation holders, such as agricultural lessees, environmental users and other third parties may trade in the market, with the idea that the additional demand for water would benefit growers. Trades are limited to annual leases of up to 100 percent of an allocation. Permanent transfers are not permitted because of concerns about conversion of agricultural land to development, which would require a long-term water supply and may conflict with County land use plans.

The Fox Canyon groundwater market rules were designed to apply to a fully operational market across the entire Oxnard and Pleasant Valley basins. Before launching the full-scale market, FCGMA opted to run two pilot phases in a portion of the Oxnard basin (see *Testing the Market with Pilots*). Some of the market rules were adapted for this smaller market to maximize its functionality and allow for an evaluation of the market mechanics. The allowance of third-party participation

Fox Canyon Groundwater Market Goals & Objectives

WATER MARKET GOALS

- Provide water users with the flexibility to respond to changing water availability
- Provide mechanisms for groundwater users to comply with GSP requirements
- Incentivize water conservation
- Incentivize the creation of new supplies through private and public investment

OBJECTIVES

- Positively impact the distribution of water quality
- Create transparent and fair market activity
- Create a financially sustainable market
- Make water trading neutral with respect to land use patterns

and trading of new water supplies (e.g., highly treated wastewater effluent) were allowed under the full market but not the pilot phases.

Special Management Areas

The Fox Canyon groundwater market includes two special management areas (SMAs). These are delineated geographies established by the GSP because of ongoing water quality and quantity problems: the seawater intrusion area and the pumping trough area. To eliminate the risk that trading may negatively impact groundwater quality or levels, the water market restricts the direction of trades for pumpers located in the SMAs. Pumpers in an SMA may only purchase additional water from another pumper within the SMA but may sell to a pumper who is located outside of either of the SMAs. The goal of these directional restrictions is to ensure that transfers of pumping allocations do not result in a net increase in pumping within an SMA. In markets with blind matching, such as Fox Canyon's (see *Anonymity and Algorithmic Matching*), SMAs allow for the protection of resources of concern through the design and application of additional rules. Directional trading, such as that adopted in Fox Canyon is one such example; trading ratios, where the right to pump one unit within an SMA, can be sold for the right to pump more than one unit outside an SMA, is another.

Third Party Impacts

Beyond SMAs, the Water Market Group sought to prevent trading from inadvertently creating areas of concentrated pumping in the basin. This would occur if a preponderance of buyers were in a specific portion of the basin. This could result in lowering water levels in certain areas, which could, in turn, adversely impact surface water flows, GDEs or other local pumpers. Since the Oxnard and Pleasant Valley basins cover a large area with over 500 active agricultural wells, it is unlikely that buyers would be concentrated in certain areas. However, accurate data collected via AMI will make it possible to detect any concentrated pumping impacts, so they can be addressed, if needed.

Edgar Terry, a grower in the Oxnard basin, checks his meter. © Sarah Heard/TNC

A specific third-party impact that concerned some Water Market Group participants during the design phase was the potential to negatively impact drinking water supplies, especially in low-income communities. Designated Disadvantaged Communities (DACs) exist within FCGMA's jurisdiction in the communities of El Rio, Saticoy and part of the City of Oxnard. These DACs are serviced by local water agencies that are not part of the water market. Their drinking water supplies are secured through separate municipal allocations based on historic groundwater usage. Because adequate drinking water supplies are included in the sustainable yield, it is unlikely DACs or residential users would be negatively impacted by the Fox Canyon water market; however, as with other potential third-party impacts, this will be an area to monitor.

Pumping Allocations

An allocation system establishes the amount of groundwater each landowner will be allowed to extract from the basin. In Fox Canyon, the process of determining allocations has occurred as part of the GSP, and the FCGMA continues to consider different approaches as of this writing. The allocations are designed to protect the groundwater resource, collectively amounting to the cap on total extractions, in this case the SGMA-mandated sustainable yield. With a market in place, the trading of water may result in pumping all allowed allocations within the basin in

Groundwater pumped to irrigate crops. © iStockphoto

a given year. However, as long as the total pumping does not exceed the sustainable yield, the groundwater resource remains protected, and participants in the market can extract value from it.

Although creating the allocation scheme is part of FCGMA's GSP, it has direct bearing on the groundwater market, as the market will not function without clearly defined, transferrable allocations. During the extensive allocation discussions with the FCGMA Board of Directors and staff, three primary allocation methods were considered: historical use, a fixed volume per irrigated acre and a hybrid system combining the first two. Proponents of using the historic pumping method argued that it best reflects the actual water needs of a specific site. In addition, it is the method most often used in basin adjudications and is prescribed by SGMA for determining the baseline usage to inform the sustainable yield. An advantage of allocation systems based on historical use is that they "reward" those who have accurately reported their water usage and "penalize" those who have under-reported. Opponents argued that the historical use method penalizes those who have implemented conservation measures that have reduced water use and reward those who failed to adopt water saving measures or related industry best practices.

Others advocated for a fixed allocation system that provides every user with the same allocation per acre of irrigated land. They asserted that this fixed system would be "fair," providing each user with the same amount of water per acre, while also benefitting those who implemented conservation measures in the past. Opponents of the fixed per-acre allocation system noted that as the basin ramped down pumping to achieve sustainable yield, high historic water users would make proportionally larger cuts to their water use compared to the median user, thus feeling more "pain" from pumping reductions. At the same time, some low historic water users would face little or no cuts to extraction, thus escaping pain under SGMA-mandated cuts.

Yet a third faction advocated for a hybrid of the historical and fixed systems of pumping allocation. Ultimately, the FCGMA decided to adopt historic usage as the basis for setting future allocations.

In Fox Canyon, the allocation decision initially included two components: M&I and agriculture uses that would share the overall sustainable yield. Following extensive negotiations between the OPV and cities within FCGMA's jurisdiction, the parties agreed upon a 60 percent/40 percent split, with agricultural users getting the larger share, which generally reflects their historic usage. Subsequently, FCGMA decided that allocations would be assigned to wells regardless of the use of the water, so a specific sub-allocation that divides water between agricultural and M&I users is not needed.

Among agricultural users, there was much debate about the method to determine individual agricultural pumping allocations. The base period for determining historic use was also extensively debated, as different base periods benefitted some growers more than others. For example, a grower that had a more water intensive crop for most of one potential base period would receive a higher allocation than in years with lower water usage. Also deliberated was the method for including surface water, which presented an additional

complexity in the Oxnard basin. Water diverted from the Santa Clara River enters recharge facilities and percolates into the basin. In some years, diverted water is delivered to users by a pipeline and is used in lieu of pumping. Many growers have access to the piped water and pump groundwater only when surface water is not available. Therefore, some growers have very low historic pumping, which would result in very low future pumping allocations. As of this writing, this issue was not yet settled, and FCGMA was considering both sources in determining historic water use and establishing each allocation.

In many environmental markets, the setting of allocations is controversial, and this has been the experience in Fox Canyon[12]. This controversy was exacerbated by the strong influence of the OPV, which arose in place of the public stakeholder group that FCGMA chartered to develop an allocation scheme. Convening an extensive and open dialog between the GSA and stakeholders would likely have provided a more productive forum to work through the controversy of developing an allocation scheme. Ideally, this would have taken place in publicly-noticed meetings to maximize the opportunity for stakeholder participation. The GSA could have taken the lead as the convener, with the goal of achieving consensus on an allocation plan. A transparent forum would have allowed the various pumpers to join together to advocate for certain considerations and express them in an open setting. An additional lesson learned is that a GSA should not assume that any subgroups that form are open and inclusive and therefore, can substitute for the GSA in the role of creating an allocation system in a public and transparent manner.

Harvesting celery, one of the Oxnard basin's top crops. © Farm Bureau of Ventura County

If a GSA intends to create a water market, the allocation system should be designed with this in mind, particularly if it is created before the market. For the purpose of a functioning market, it is important that an individual's allocation be the same whether that individual chooses to participate in the market or not. Some Fox Canyon stakeholders suggested complicated allocation formulae and/or poorly designed flexibility provisions (discussed below) that would make it difficult to calculate individual pumping allocations. This would have undermined the function of the market by making it difficult to determine the amount of a pumper's allocation that is available with certainty at any given time. This is the reason FCGMA adopted a more straightforward allocation formula than the hybrid system that the OPV proposed.

To date, FCGMA is continuing to work through the controversial allocation process, including considering multiple proposals for incorporating flexibility (see *Interannual Flexibility*). Because transferrable allocations are a prerequisite for a water market, any scaling of the Fox Canyon groundwater market beyond the pilot phase will take place only after an allocation scheme replaces the current indexed system.

Ramp-down

In addition to allocations, FCGMA designed a ramp-down method to gradually transition from current pumping rates to the long-term sustainable yield set forth in the GSP. With 20 years to achieve sustainability under SGMA, FCGMA selected a ramp-down approach that reduces each water user's allocation gradually, and by

[12] While FCGMA's allocation system will apply to all pumpers as part of the GSP, and not just those who participate in the market, the experience of determining the allocations mirrors that of other environmental markets.

the same percentage across all users, over 20 years. Initially, there had been discussion about reducing allocations in five-year steps (i.e., flat allocations for five years, then a large reduction). FCGMA identified two problems with this approach. First, it would be difficult to determine progress towards the five-year interim milestones until the end of a given five-year period. Second, it was determined that pumpers would have difficulty implementing the dramatic cut to extractions required in the fifth year of each period. It was thought that gradually decreasing allocations would ease the transition to sustainable yield.

FCGMA adopted a gradual 20-year "straight line" annual pumping reduction to reach the sustainable yield for the Oxnard basin. Its translation to an individual pumping reduction, is calculated as follows:

$$\frac{B - S}{B} = P \rightarrow A^* \frac{P}{20} = R$$

B = Base period basin pumping volume
S = Sustainable yield for basin
P = % pumping reduction required
A = Initial Individual pumping allocation (AF)
R = Annual individual pumping reduction (AF)

OPV proposed a "hybrid" ramp down method that required high historic water users to cut their water use by a larger amount each year than low historic water users. A hybrid ramp-down method can be used to achieve a fixed per-acre allocation of pumping, but with 20 years of transition in order to achieve this result. The downside of the hybrid ramp-down methodology is the complexity of the accounting exercise required to determine, communicate and then verify a different annual reduction for each pumper. Opponents also expressed concerns about the unfairness inherent in a system that requires dramatic cuts to water use among some users while requiring little or no reductions among others.

Interannual Flexibility

Fox Canyon stakeholders sought to build flexibility into the allocation system to help pumpers adjust to the pumping reductions. Two primary ideas were proposed by various stakeholders to achieve this goal. The first was to allow the carryover of any unused allocation from a prior year for use in the future. This allows a grower to build a "water savings account" to offset future dry years. Since a carryover only results from using less water than one is allocated in a given year, it incentivizes conservation. Furthermore, it would never result in the basin exceeding its total 20-year sustainable pumping volume, ensuring compliance with the SGMA-mandated sustainable yield.

FCGMA was receptive to including a carryover provision in the allocation scheme, provided that an individual's carryover balance not exceed 100 percent of the current year's annual allocation. FCGMA included this limitation to address the concern that a significant number of pumpers might accumulate large carryovers and use them at the same time (e.g., a dry year). This temporary, high-volume extraction might stress the basin and could lead to undesirable results and possible state intervention. A carryover allowance is compatible with a water market, although it may initially dampen trading activity, if growers seek to save unused water rather than sell it on the market. However, in the face of sufficient demand, the price for water on the market may be high enough to motivate the sale of conserved water.

An agricultural well meter in the Oxnard Basin. © Sarah Heard/TNC

A second flexibility proposal sought to allow water users to borrow from future allocations. This would allow a pumper to exceed their annual allocation in the current year and "pay it back" in a future year. Opposing stakeholders, including TNC, were concerned that unlike a carryover provision, borrowing would not encourage conservation. In fact, it would do the opposite by encouraging growers to create a water debt. It would also allow annual pumping limits for the basin to be exceeded, and it would only work if there were replenishment, either from supplemental supplies or under-pumping relative to allocations in future years. Absent supplemental supplies, postponing gradual pumping reductions in the near-term, via borrowing, would require even greater cuts in the future that are likely to be met with strong resistance from water users. Because of the aquifer deficit incurred via borrowing, penalties levied for pumping beyond these larger cuts are likely to be steep enough that they would be unaffordable for pumpers. Finally, if pumpers did not repay their water debts, it could put FCGMA in the uncomfortable position of needing to prohibit debtors from pumping in the future or mandate widespread fallowing.

Borrowing from the future would also undermine a water market by reducing incentives for conservation and allowing pumpers to dip into future supplies rather than purchase additional supplies on the market. This would likely induce greater volatility in the price of water and render the market's price signal ineffective. In the early years of a multi-year drought, water users could use their borrowing allowances, thus delaying significant cuts to groundwater extraction and avoiding having to buy available allocation from other water users. During this period, the market price of water would be expected to be extremely low because of the lack of demand, signaling a relative abundance of water available for trade. In the later part of a multi-year drought, water users would all begin to hit their borrowing limits at the same time and likely turn to the market with the expectation of inexpensive water available for purchase. This surge in demand relative to low available supply would quickly cause the market price to switch from extremely low to extremely high. Growers would then be required to forego pumping in order to avoid costly surcharges. Many growers would likely fallow, but others might simply pay surcharges and continue to pump beyond their allocations. This would threaten a GSA's ability to reach its sustainability goals under SGMA.

Celebrating the first installation of AMI in the Oxnard basin. © E.J. Remson/TNC

The topic of borrowing generated considerable controversy in Fox Canyon, and FCGMA considered several different proposals. Proposals varied by the amount one could borrow, the term of the water "loan" and the circumstances under which borrowing would be permitted. Such circumstances included when borrowing might be allowed, such as in dry years or as needed to finish a crop cycle. Ultimately, FCGMA Board of Directors voted against including a borrowing component in the GSP because of the accounting complexity and risk of non-compliance with the sustainable yield.

Reporting and Accounting

Accurate water usage data is critical to achieving GSP goals, because mandated reductions in pumping will be the primary tool to meet those goals. A water market also needs accurate water usage data to ensure that participants trade only unused water allocations and that no exceedances of pumping allocations result from trading.

Citrus groves along the Santa Clara River. © Melinda Kelley/TNC

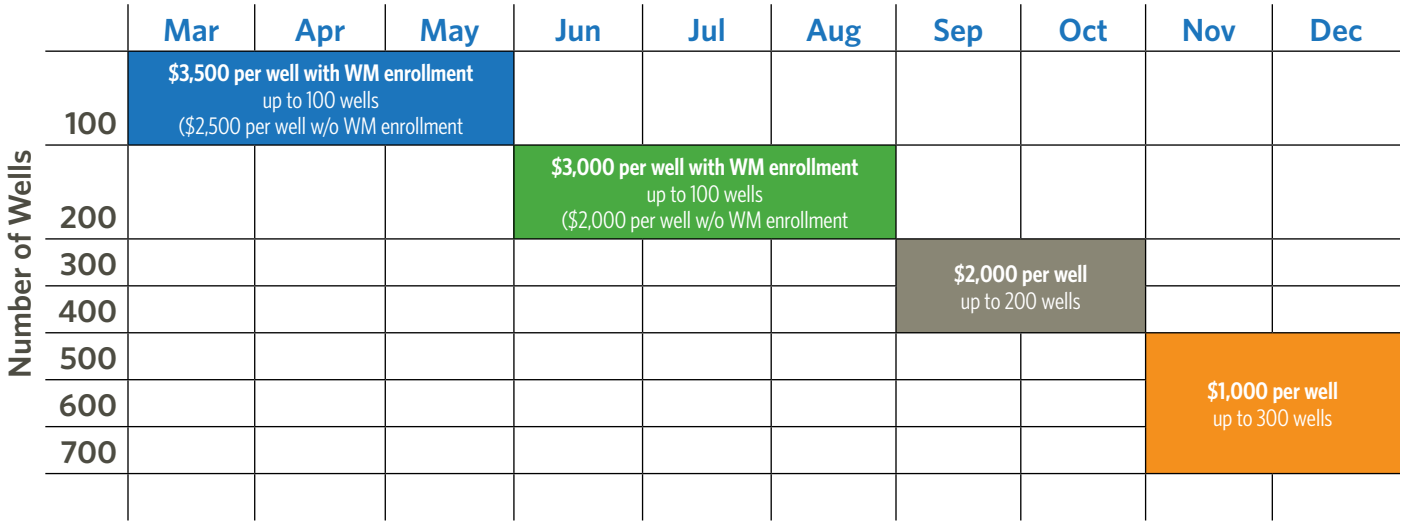
Metering has been required for all agricultural wells in the Oxnard and Pleasant Valley basins since 1987. FCGMA has historically employed a system of semiannual self-reporting of water use. There is evidence that some pumpers may not have reported their water use accurately, in many cases under-reporting actual usage. In 2016, FCGMA foresaw the need for accurate water data to support the preparation and implementation of its upcoming GSPs. FCGMA required pumpers to move to automated monthly reporting with the passage of an ordinance in February 2018 that required the installation of AMI telemetry on all active agricultural wells by December 2018. AMI consists of sensors on meters that automatically read and wirelessly report water usage to a third-party vendor. The AMI vendor then reports monthly water usage to FCGMA.

The use of AMI in Fox Canyon is an illustration of the power of market incentives and the ability of a well-designed market to facilitate better monitoring and reporting. In the early 2000s, FCGMA staff and the Board of Directors began discussing a requirement that all agricultural wells employ electronic monitoring and automated reporting, using early AMI hardware. Protest from the agricultural community was so strong that the plan was abandoned. In 2015, as growers seriously considered the implementation of a water market as part of basin-specific GSPs, growers proposed to FCGMA that they require electronic monitoring and automated reporting. The water market made universal AMI not just politically feasible but imperative. Growers realized that under a system of market transfers, any under-reporting of water use, or other form of "cheating," would devalue allocations available for trade on the market and undermine progress toward the sustainable yield, potentially resulting in further cuts. AMI's benefits extend beyond the Fox Canyon groundwater market, improving FCGMA's monitoring of the sustainable yield by providing the agency with accurate water use data.

Data Ownership

In Fox Canyon, it was critical for FCGMA to agree that the water user owns the data produced by AMI hardware, in order to secure growers' buy-in for AMI adoption. Farmers believed that water usage data collected by AMI, amounted to proprietary information about their business practices. They did not want data at this resolution to be held by FCGMA because, as a public agency, it might be made available to the public. This was addressed by having the AMI vendor

Figure 2. Incentives for AMI Installation and Groundwater Market Participation



report only a monthly pumping total to FCGMA and total pumping year-to-date to the water market administrator, a level that is granular enough to detect cheating while still providing growers with data security.

Incentives

With over 500 active agricultural wells required to install AMI hardware in over just 10 months, FCGMA implemented an incentive program to encourage early installation. The incentives sought to smooth out the demand for AMI so as not to overwhelm the vendor just before the installation deadline and to offset the costs of new equipment for growers. Installation of AMI for Fox Canyon growers starts at a cost of about $2,500 per well, with the option of additional components, such as weather and soil moisture monitoring at a higher cost.

FCGMA used $800K from the CIG secured by TNC to help subsidize installation of AMI and incentivize participation in the groundwater market through grower rebates. To promote early installation of AMI, CERF and TNC designed a tiered approach that would reduce the available rebate from $2,500 to $1,000 over 10 months. The rebate covers the entire cost of the base AMI model for pumpers who contracted for installation within the first three months, for up to 100 wells. Three subsequent tiers stepped the rebate down from $3,500 increments to $1,000, so that the final tier offered rebates of $1,000 for 100 wells for the last three months of the installation window (see Figure 2). The incentive plan included an additional rebate of $1,000 to promote enrollment in the Phase II water market pilot. This $1,000 water market enrollment rebate was available for 200 wells for the first six months of the AMI installation timeline and could be used to cover the cost of more expensive AMI hardware, as well as water market enrollment fees equal to $700 for the first well and $300 for each additional well registered by a single water market participant.

The incentive program was successful in getting about 60 percent of the wells under contract for AMI installation by December 2018. Many completed installations much earlier. About 100 pumpers received the highest rebates due to their early enrollment. A small number of these pumpers were found to be ineligible because their wells are outside the pilot geography. In addition, a small percentage of growers who applied for rebates early did not follow through with the installation process or water market

enrollment. Although FCGMA held two well-attended workshops to explain the process for securing rebates, failure to follow through may have been due to a lack of understanding of the requirements (e.g., executing the installation contract, signing a water market participation agreement, clearing outstanding compliance and eligibility issues with FCGMA). Because rebate amounts were based on application dates, several pumpers who signed up later received lower rebates, even though they completed AMI installation and water market enrollment before those who applied in the earlier rebate windows. Had this been anticipated, rebates would have been based on installation and market enrollment dates instead of the application date.

Exchange Administrator

An entity is needed to administer a water market and operate the trading desk for it to run efficiently. The exchange administrator has important responsibilities, especially related to making and receiving payments and keeping accurate records of trades. It should also have the ability to conduct trades via a secure online website.

The exchange administrator could be the basin GSA or a third party. FCGMA decided to use a third party as the exchange administrator for several reasons. FCGMA does not have experience with running a water market and with the added workload of preparing and administering the GSP process, did not have the resources to do so. Some growers also felt strongly that the exchange administrator should be separate from the regulatory body, in this case FCGMA, and also that it be a party that does not have a direct stake in the water use itself. CERF, which guided the design of the Fox Canyon groundwater market and has a long history in the area, was willing to serve as the administrator. In addition to the enrollment fee, a fee of two percent of each trade is paid by both buyer and seller (four percent total) to the exchange administrator to cover administrative costs.

The Santa Clara River recharges the Oxnard basin and provides habitat for protected species © Melinda Kelley/TNC

Anonymity and Algorithmic Matching

The Water Market Group opted for the exchange administrator to use an anonymized market, in which participants do not know the identity of the person on the other side of a trade. In addition, the Group recommended the use of algorithmic matching rather than a traditional electronic auction. For many years, algorithmic matching has been proposed as a way to reduce transaction costs, eliminate market power and maximize gains from trade. Prominent examples include *smart computer-assisted markets* proposed by Vernon Smith in the early 1990s[13] and smart markets for water allocation proposed by John Raffensperger in the early 2000s[14].

During the design phase of the Fox Canyon groundwater market, concerns arose that a water market might allow an influential party or group to control the price of water, allowing them to extract all of the economic gains from trade, or to exclude other growers from market activity all together. Growers feared that not all market participants would have equal access to water or an equal opportunity to gain from market activity.

The goal of a fair market, free of manipulation, was addressed by the anonymous bid/offer system and

[13] McCabe, K., S. Rassenti and V. Smith. 1991. Smart Computer-Assisted Markets. Science. 2549301:534-8.
[14] Raffensperger, J. and M. Milke, 2017. Smart Markets for Water Resources. Global Issues in Water Policy. Springer International.

the algorithm used to match bids and offers adopted as part of the market rules. Under blind algorithmic matching, all bids and offers are submitted to the exchange administrator anonymously with respect to other market participants. Offers must include the location of the allocation, the volume of water available for transfer and a reservation price, the minimum price that the seller would be willing to accept. Bids must include the location where the water will be applied, volume desired and the maximum price the bidder is willing to pay. In Fox Canyon, matches occur on a weekly basis, and both bids and offers expire in 10 days if not matched.

As implemented in the Fox Canyon groundwater market pilot, it is not possible for an individual to exert pressure on an allocation holder to lease water for a certain price or to a specific landowner, because there would be no ability to control who bid on which offer. Likewise, it is not possible for a market participant to refuse to sell water to a specific landowner, because the seller does not know the identities of bidders on the other side of the transaction.

The role of the exchange administrator for the Fox Canyon groundwater market is to seek to make all potential matches. For example, a single offer may be matched with multiple bids, and a single bid may be matched with multiple offers. An algorithm matches the bid with the highest maximum price and the offer with the lowest reservation price first. In the event of two bids (or offers) with the same price, priority is given to the bid (or offer) submitted first. The sale price is the midpoint between the buyer's maximum price and the seller's reservation price. In this way, the economic gain from trade is divided evenly between the buyer and the seller. All other bids and offers are then matched in a similar manner. This form of matching incentivizes market participants to reveal their true price and reduces the opportunity for strategic bidding, such as submitting low bids that do not reflect a participant's true willingness to pay and would therefore, be unlikely to be matched with an offer.

Harvesting peppers, one of the Oxnard basin's top crops. © Farm Bureau of Ventura County

Data Reporting

The exchange administrator for the Fox Canyon groundwater market will report trading activity using aggregated data to ensure grower anonymity. On a weekly basis, the exchange administrator will report the average, low and high prices of water, as well as the total volume of pumping allocation transferred and the number of trades.

Testing the Market with Pilots

During the design phase, the Water Market Group recommended testing the market to ensure that it functions as intended. The Group recommended creating a pilot market with a definitive starting and ending point. The idea was to create a discrete test of the rules and any intended market outcomes, while also allowing FCGMA and market participants to discover and address any unintended consequences of trading. As with the market rules, the Group advocated for starting simply and then creating an adaptive approach that allowed for greater complexity over time. In response, FCGMA, CERF and TNC decided to test the water market via two phases.

Phase I Pilot

The Phase I Pilot was limited to a portion of the Oxnard Basin and tested the basic functions of the water market, such as enrolling participants, verifying well ownership, checking for unresolved violations, ensuring

Specialty crops for sale at a Ventura County farmstand. © Melinda Kelley/TNC

up-to-date meter calibration and installing AMI. Phase I also served as an AMI demonstration project, testing the capabilities of AMI hardware and identifying and troubleshooting site-specific installation challenges. The pilot ran from April through July 2017. Growers representing 47 wells expressed interest in the pilot, but the majority were deemed ineligible because of unresolved violations or uncalibrated meters. Only seven wells successfully enrolled in the pilot, and only five wells completed AMI installation. No trading occurred.

The Phase I Pilot was successful in identifying issues to be addressed in the enrollment process (e.g., incomplete records and obsolete meter calibration). It also implemented and tested the Fox Canyon AMI Data Portal, which was developed as part of the pilot to aggregate pumping data among all wells, and which growers will use to submit bids and offers to the exchange administrator. The portal created three resolutions of data: growers have access to the highest resolution of available real-time data, while the exchange administrator and FCGMA have access to monthly aggregated and year-to-date water use data.

Phase II Pilot

The goal of the upcoming Phase II Pilot is to enroll a larger number of growers (about 100) and test trading over a longer time frame and in a larger geography. This will allow for a robust test of the exchange administrator's system prior to opening the market to all pumpers in the Oxnard and Pleasant Valley basins. The Phase II Pilot was originally scheduled to run for the 2018 water year (October through September). However, it was postponed until early 2019, due to delays in selecting and contracting with the AMI vendor and passing the necessary ordinances, especially the establishment of pumping allocations.

Both pilots have shown that establishing a water market carries a high level of complexity regarding administration and the installation of infrastructure. The testing phase has also highlighted the need for a significant amount of time and capacity, from both FCGMA and partners.

Implementing the Full Market

Upon completion of the Phase II Pilot, it is FCGMA's goal to expand the water market to all agricultural pumpers in the Oxnard and Pleasant Valley basins. Since the GSP will ramp down pumping allocations over 20 years, and unused allocations can be carried over to future years, trading may be light in the first few years. Trading may also vary greatly depending on precipitation: dry years should see more trading, with less in wet years. As the market matures, potential trading impacts should be included in FCGMA's monitoring, required by SGMA, to identify and correct any third-party impacts or other unintended consequences of trading. Areas to watch include concentrated pumping that lowers local water levels, pricing issues impacting specific user types, such as DACs and environmental users, and interference with achieving the GSP's goals.

Future Integration of Additional Components

Once the GSP is adopted and the water market is operational, FCGMA may wish to broaden participation beyond growers to include municipalities, water companies and other entities, including those without groundwater allocations. Allowing trading among different water user types could increase water use efficiency. For example, cities that have adequate water except in times of extended drought may elect to forgo the expense of building expensive peak demand infrastructure and instead rely on acquiring water via the market. The heterogeneity of different user types could also increase market liquidity by generating multiple sources of demand. Any expansion of the market must be monitored for unintended consequences, such as land use change.

The Fox Canyon groundwater market may create other opportunities to meet GSP objectives. FCGMA could use the market to attenuate the need for a fallowing program. Rather than paying a farmer to completely fallow a certain number of acres, FCGMA could participate in the market and bid to purchase an amount of water equal to the water savings that are expected from fallowing. In effect, FCGMA could accumulate small amounts of water savings from several farmers rather than paying one farmer to forego a large amount of water. In theory, a market should provide the same amount of water as a fallowing program at a significantly lower cost. Not only would the market provide FCGMA with water at the lowest cost, due to competitive bidding, it would be more efficient than identifying willing fallowers and entering into separate contracts with each outside of the market.

The water market may attract capital to develop and deliver new supplies, such as treated wastewater, to the Oxnard and Pleasant Valley basins. The water market may also encourage water banking. These could be positive outcomes, if designed to achieve the GSP's goals. Speculators may also wish to participate in the market, a possibility that is currently discouraged by limiting trading to annual allocations, and that requires further evaluation and monitoring for adverse impacts.

Celery growing in the Oxnard basin. © Sarah Heard/TNC

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Key Takeaways

Groundwater markets offer a promising tool for GSAs to use to implement their GSPs and achieve basin sustainability. The experience of developing the Fox Canyon groundwater market has required a learning-by-doing approach to better understand how groundwater markets function, what they need to succeed and the role they can play in complying with SGMA's mandate. It is our hope that the lessons learned described above and the key takeaways outlined below from designing and testing SGMA's first groundwater markets will provide a strong foundation on which others can build to scale the use of this tool throughout California.

Water markets are not well understood by most s takeholders. The Fox Canyon groundwater market is the first to be established under SGMA and as such, all stakeholders involved in its development have been on a steep learning curve. Anecdotal observations revealed that some pumpers believed that the market would be a solution to the difficulties of complying with SGMA. Others feared that it would favor certain groups and harm others unfairly. Very few understood how to set up and operate a market, which is why the chartered Water Market Group led with educating participants about water markets. It is also why the Group and FCGMA opted to test the market via two pilot phases.

Technical expertise is essential to design a well-functioning water market. It is unlikely that a GSA would have the ability to establish a formal water market on its own, given the technical expertise required. Formal water markets typically have lower transaction costs and greater transparency, participation and liquidity than informal markets that have not been intentionally designed[15]. The necessary technical expertise includes designing the rules, preventing cheating and navigating complex issues like avoiding land use change and borrowing from the future. Testing and implementing the market brings an additional set of complexities around confirming the eligibility of participants and validating baseline pumping data, among other topics. Therefore, outside expertise will be needed, at a minimum,

[15] Crase, L., L. O'Reilly and B. Dollery. 2000. Water Markets as a Vehicle for Water Reform: The Case of New South Wales. The Australian Journal of Agricultural and Resource Economics. 44(2):299-321; Donoso, G. 2006. Water Markets: Case Study of Chile's 1981 Water Code. Ciencia e Investigacion Agraria. 33(2):157-71.

AMI installed on an agricultural well in the Oxnard basin. © Sarah Heard/TNC

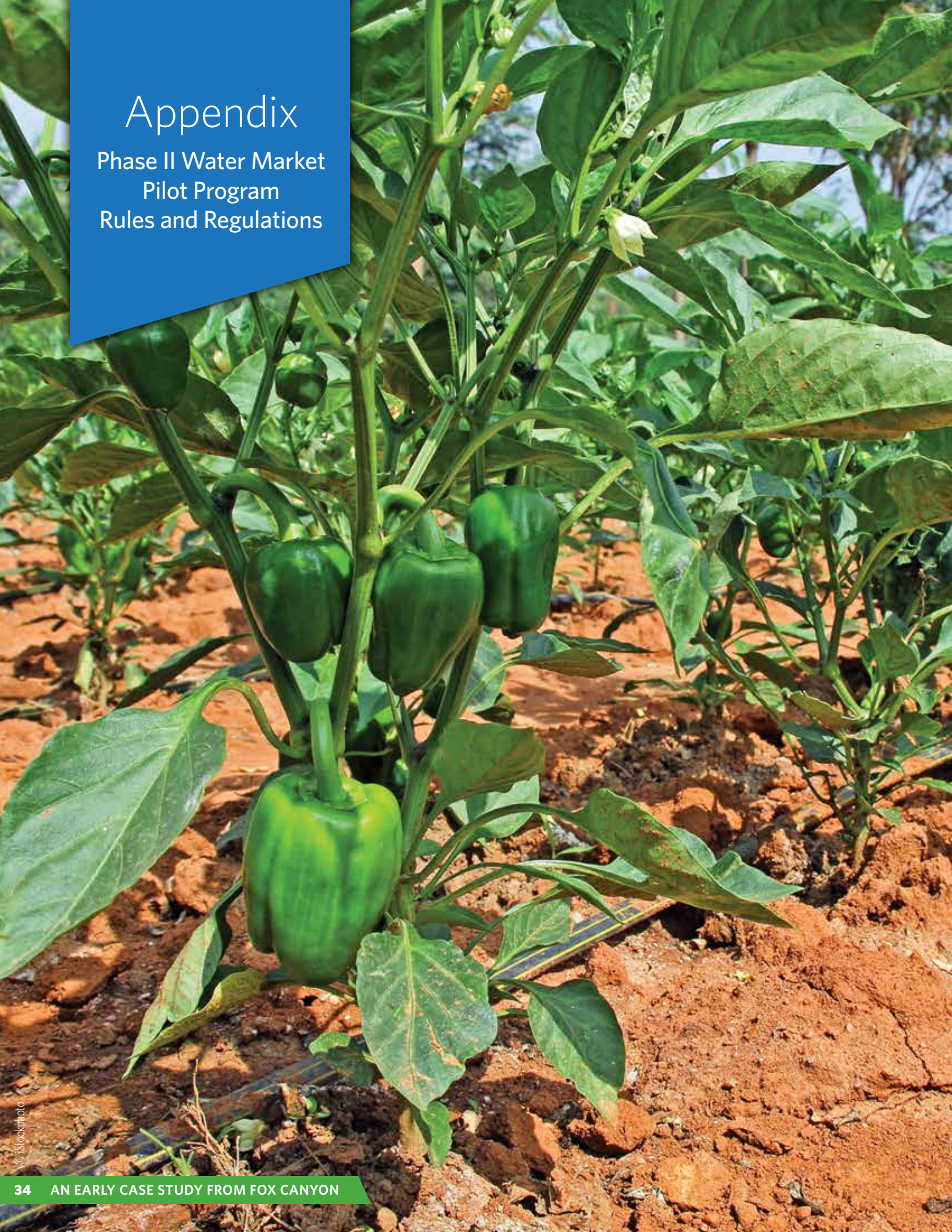
to help develop a water market, and potentially, administer it, with the GSA's oversight. For the Fox Canyon groundwater market, this expertise came from an academic partner, CERF, as well TNC, which both contributed expertise in the design of environmental markets. Technical expertise on the local hydrologic conditions and functioning of the groundwater system is also important so that market rules do not conflict with planned management actions, such as restricting pumping in areas of depressions or poor water quality.

Developing a water market requires significant agency and stakeholder capacity. Even an experienced and well-resourced agency like FCGMA will be challenged by implementing the GSP process, given the capacity required. In the case of the Fox Canyon groundwater market, seven months of meetings were needed to create basic rules to govern the market. CERF put in hundreds of hours as the facilitator and market designer working with FCGMA, the AMI vendor, software programmers and others. TNC contributed a similar level of capacity through administration of the CIG from NRCS, which funded incentives for AMI installation and pilot participation, along with staff time. A period of two years was required to run the two pilot phases, even though each phase will have run for six months or less, because of the time required to get the necessary ordinances passed, install AMI and enroll market participants.

A successful water market must be transparent, fair and low-cost. This applies to both the market itself, as well as the process of designing it. FCGMA's chartered Water Market Group was open to all, and broad stakeholder participation from growers, municipalities, environmental groups and others enabled diverse perspectives and open dialogue about important issues, such as participant anonymity, data security and how best to prevent permanent land use change. It was an explicit goal of the Group to design a fair market that would allow any interested grower to participate, and this goal led to the adoption of rules that uphold anonymity and allow non-allocation holders to trade. Minimizing the transaction costs of trading is another way to ensure the market is open to all who which to participate. The Group sought to do this by starting simply, creating rules that are easy to understand and abide by and establishing an exchange administrator to handle all trading. Incentives provided by the CIG offset the costs of participating in the Phase II pilot. Whether the market turns out to be transparent, fair and low-cost in practice is something to test via the upcoming Phase II pilot and the further rollout of the market and adapt, as necessary.

Appendix

Phase II Water Market Pilot Program Rules and Regulations



Definitions

Agency	Fox Canyon Groundwater Management Agency (FCGMA)
AMI	Advanced Metering Infrastructure
Applicant	Entity seeking to be admitted to the Water Market Pilot
Bid	An electronic message submitted to the water market trading desk to buy a temporary transfer of extraction allocation
Exchange Administrator	California Lutheran University
Executive Officer	The individual appointed by the Agency's Board of Directors to administer Agency functions and his/her designee
Participant's Market Allocation	An allocation of groundwater pumping based on the Participant's total allowed pumping in the 2017/18 water year, to be used during theProgram Period.
Matched	Refers to the matching of a particular bid and offer by the Exchange Administrator
Maximum Price	The highest price per unit that a Participant is willing to pay in order to receive a transfer of groundwater extraction allocation from another Participant
Offer	An electronic message submitted to the exchange administrator to sell a temporary transfer of extraction allocation
Participant	Registered owner of the groundwater extraction facility, as reflected in the Agency's books and records
the Pilot	Extended Phase 2 Water Market Pilot Program
Program Period	August 1, 2018 – July 31, 2019
Pumping Trough	An area designated by the Agency as a pumping trough for the purpose of the Pilot (see Appendix 1 for a map of this area)
Reservation Price	The lowest price per unit that a Participant would be willing to receive in order to transfer available groundwater extraction allocation to another Participant
Review Committee	The committee established to review and decide on a particular dispute in accordance with these Rules
Revised Allocation	Participant's Market Allocation net of any transfers of Units to/from another Participant(s)
Rules	Operating rules and regulations set forth herein
Seawater Intrusion Area	An area designated by the Agency as subject to seawater intrusion for the purpose of the Pilot (see Appendix 1 for a map of this area)
Unit	Groundwater extraction allocation of one acre-foot
Water Available For Trade	Revised Allocation minus Total Pumping Year to Date, as reported in the Ranch Systems Data Portal

Water Market & Advanced Metering Pilot Rules

BASICS

Program Period: August 1, 2018 – July 31, 2019.
Unit Traded – one acre-foot of extraction allocation to be used during the Program Period

- Water eligible for trade
  - One-year *Market Allocation* – equal to the Participant's total allowed pumping in 2017/18 water year.
- Type of allowable trades
  - Temporary transfer of up to 100% of Water Available for Trade during the Program Period.

BECOMING A PARTICIPANT

To be admitted as a Participant, an Applicant must:

- Submit to the Exchange Administrator an accurately completed and signed Participant Agreement form and pay an enrollment fee equal to $700 for the first well and $300 for each additional well included in the CombCode.
  - Each Participant and Participant's Authorized Representative agrees to observe and to engage in conduct required by the Rules. Each Participant and Participant's Authorized Representative agrees to abide by any procedures, regulations, notices, directions, decisions, requirements and conditions issued by the Exchange Administrator and by FCGMA.
- Satisfy the eligibility requirements specified below.

ELIGIBILITY REQUIREMENTS

- Only agricultural operators in the Oxnard Basin who are authorized by the Agency may participate.
- Only operators who have installed an AMI device that meets the specifications promulgated by the Executive Officer of the Agency on each of its active extraction facilities may participate.
- Only operators who are in compliance with all Agency ordinances and regulations may participate.

COMMENCEMENT OF PARTICIPATION

- The Applicant will be admitted as a Participant and commence participation in the Water Market Pilot when the Exchange Administrator notifies the Applicant of confirmation of admission.
- Following admission as a Participant, the Exchange Administrator will provide each Participant with the assigned Market Allocation, notification of any limitations on trade, and instructions for participating in the Pilot.

PARTICIPANT'S AUTHORIZED REPRESENTATIVE

- A Participant may apply to the Agency to have an employee, lessee or other individual approved as a Participant's Authorized Representative. Written authorization must be on file with the Agency.

Trading

BASICS

- Only a Participant or Participant's Authorized Representative may submit Bids and Offers.
- Offers and bids are submitted to the trading desk anonymously with respect to other market participants.
- A participant may withdraw a Bid or Offer at any time before it is Matched.
- The Exchange Administrator may cancel a Bid or Offer at any time before it is matched in the circumstance that the Bid or Offer does not comply with the Rules or to otherwise ensure a fair, orderly and transparent market.

OFFERS

- Offers must be submitted electronically to the Exchange Administrator.
- Offers must include:
  - Maximum number of Units available for transfer
  - Reservation Price
  - Expiration date of offer (21 days unless otherwise specified)
  - 4-digit pin, as written on the Participant's signed Participation Agreement

- When submitting an Offer, the Participant is authorizing the Exchange Administrator to transfer the number of Units specified in the Offer to the extent that the Offer (or part of an Offer) is Matched with a Bid. When submitting an Offer, the Participant is authorizing the Exchange Administrator to revise the Participant's Market Allocation based on the number of Units transferred.

BIDS

- Bids must be submitted electronically to the Exchange Administrator.
- Bids must include
    - Maximum number of Units desired for transfer
    - Maximum Price
    - Expiration date of bid (21 days unless otherwise specified)
    - 4-digit pin, as written on the Participant's signed Participation Agreement
- When submitting a Bid, the Participant is authorizing the Exchange Administrator to transfer the number of Units specified in the Bid to the extent that the Bid (or part of a Bid) is matched with an Offer. When submitting a Bid, the Participant is authorizing the Exchange Administrator to revise the Participant's Market Allocation based on the number of Units transferred.

MATCHING

- The Exchange Administrator shall seek to make all potential matches. For example, a single offer may be matched with multiple bids and a single bid may be matched with multiple offers.
- The Bid with the highest Maximum Price and Offer with the lowest Reservation Price will be matched first. In the event of two bids (offers) with the same price, priority will be given to the bid (offer) which was submitted first.
- The sale price is the midpoint between the buyer's Maximum Price and the seller's Reservation Price.
- Matching will take place at 4pm on Friday, during each week of the Pilot, as long as there are at least 1 active Offer and 1 active Bid. Bids and Offers which are received after 4pm on Friday during a particular week will be included in the Matching which occurs during the following week.
- Any Units which are part of an active Bid or Offer and which can not be Matched in a given week will be included in the following week's Matching, unless the Bid or Offer has expired or is withdrawn.
- The Exchange Administrator will begin accepting Bids and Offers on April 1, 2019 and will continue accepting Bids and Offers until 4pm on Friday, July 26, 2019.

CLEARING AND SETTLEMENT

- When Bids and Offers are Matched, the Exchange Administrator will send notification to both parties including the number of units transferred and the average price. Following notification, buyer will transfer the specified amount of money (Units purchased times the average price plus the required fees) to the designated financial account.
    - Buyers will make only one payment, even if their Bid is Matched with multiple Offers.
    - Failure to make payment within 14 days will result in suspension of participation in the Pilot.
- Once payment is received from buyer(s), the Exchange Administrator will authorize payment to the seller (net of any fees)
    - If a single offer is matched with multiple bids, the Exchange Administrator will collect payment from all buyers and authorize a single payment to the seller.
- A fee of 2% of each trade is paid by both buyer and seller (4% total) to the Exchange Administrator for administrative costs.

REPORTING

The Exchange Administrator will report the transfer of extraction allocation to FCGMA following matching.

- Upon completion of a match, each Participant's Market Allocation will be revised by the Units transferred and potential FCGMA surcharges will apply based on each party's Revised Allocation.

PRICE INFORMATION

- Weekly average price, 4-week average price, maximum and minimum sale price during the previous 4 weeks will be reported to market participants by the Exchange Administrator.

LIMITATIONS ON TRADE

- No transfer shall be allowed that results in a net increase in the total Market Allocation for Participants located in the Seawater Intrusion Area or in the Pumping Trough.
- A Participant who has a well that is located in the Seawater Intrusion Area may only receive a transfer of Market Allocation from another Participant who also has a well that is located in the Seawater Intrusion Area.
- A Participant who has a well that is located in the Pumping Trough may only receive a transfer of Market Allocation from another Participant who also has a well that is located in the Pumping Trough.

MARKET-RELATED DISPUTES

- Any Participant may notify the Exchange Administrator of any market-related dispute between the Participant and another Participant or between the Participant and the Exchange Administrator arising in relation to any of the Rules.
- Disputes between Participants will be handled by the Exchange Administrator. Any Participant who is party to a decision by the Exchange Administrator relating to a dispute may request to have the decision reviewed by the Review Committee.
- Disputes between a Participant and the Exchange Administrator will be referred to the Review Committee. The Participant agrees to submit such a matter to the Review Committee for a decision before seeking other legal remedy and then to submit such a matter to binding arbitration in accordance with the rules and procedures of the American Arbitration Association.

Monitoring, Investigation & Sanctions

MONITORING & INVESTIGATION

- The Exchange Administrator will monitor compliance by Participants and Participant's Authorized Representatives with the Rules and may at any time investigate the activities of a Participant.
- As part of any investigation, the Exchange Administrator may require a Participant to provide any information, document or record relating to the Participant's activities in the Pilot or the performance of its obligations under the Rules.

SANCTIONS

Possible sanctions for violations of the Rules include:

- Restriction, suspension or termination of participation
- A public statement identifying the Participant
- Surcharges by the Agency
- Disgorgement of any money arising from the contravention of the Rules

CONFIDENTIALITY

The Exchange Administrator will endeavor to take all reasonable measures to protect trading information from unauthorized use or disclosure, except as required by law or as expressly specified herein.

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