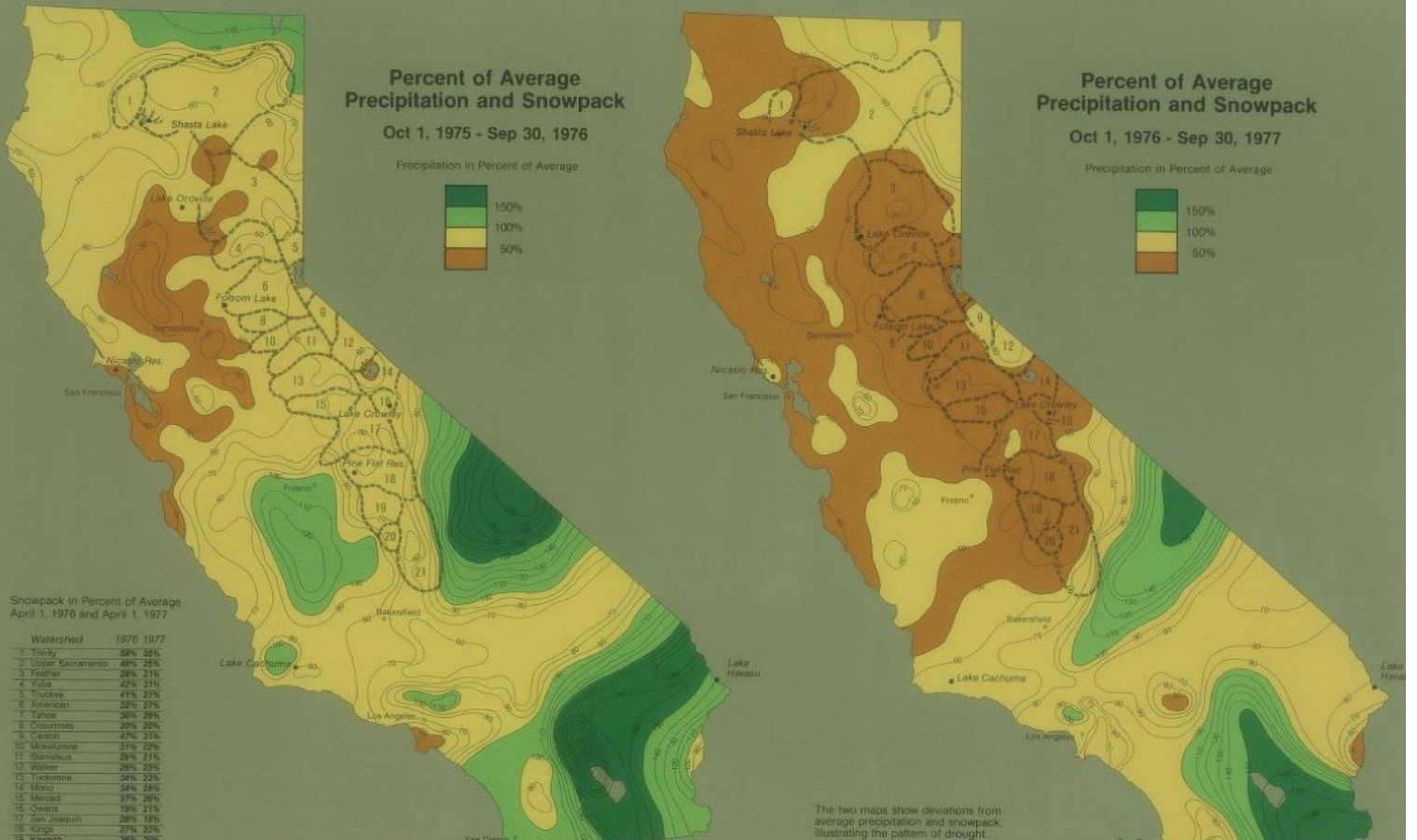


# California Water Efficiency

## LEADING THE WAY INTO THE FUTURE

### Drought Water Years 1976/1977



SCWC Water Energy Task Force 2018

CALIFORNIA  
DATA  
COLLABORATIVE

California water efficiency: leading the way into the future  
SCWC Water-Energy Task Force September 10, 2018

## TABLE OF CONTENTS

<b>Acknowledgements</b>	<b>3</b>
<b>Executive Summary</b>	<b>4</b>
<b>Introduction</b>	<b>6</b>
<b>SCWC and Water Energy Efficiency Task Force Background</b>	<b>7</b>
<b>The opportunity in urban outdoor water usage</b>	<b>8</b>
<b>Overcoming technology barriers through collaboration</b>	<b>12</b>
<b>Unlocking new funding streams for water efficiency programs</b>	<b>15</b>
<b>The Future of Water Management</b>	<b>18</b>
<b>References</b>	<b>19</b>
<b>Appendix 1 -- Inventory of turf multiplier studies</b>	<b>20</b>
<b>Appendix 2 -- Water utility online water efficiency tools</b>	<b>24</b>
<b>Appendix 3 -- Cooperative Procurement Case Studies</b>	<b>27</b>

*“A market transformation (MT) occurs when a new technology or method emerges, is found to be superior, and results in the product and/or service, which pre-dated it, to become obsolete. A prime example of MT in the world marketplace (or a series of market transformation initiatives) are well known to all consumers starting with the shift from vinyl records to the more portable eight track tapes...then eight track tapes to the more compact cassette tapes...cassette tapes to higher sound quality CDs and forward to today’s iPods or similar electronic devices. Clearly the market for audio devices has transformed over time and consumers have no desire to purchase the earlier technologies.”*

-Case Studies of Market Transformation as a Means for Delivering Regional Conservation Results. T. Chesnutt, M. Erbezniak, D. Pikelney. Prepared for The Metropolitan Water District of Southern California

## Acknowledgements

The Southern California Water Coalition would like to extend its deepest gratitude to task force participants and in particular the California Data Collaborative (“CaDC”) coalition of water utilities whose visionary investment in a new nonprofit data platform made this work possible:

- East Bay Municipal Utilities District
- Eastern Municipal Water District
- El Toro Water District
- Inland Empire Utilities Agency
- Irvine Ranch Water District
- Las Virgenes Municipal Water District
- Metropolitan Water District of Southern California
- Monte Vista Water District
- Moulton Niguel Water District
- Sacramento Department of Utilities
- Santa Ana Watershed Project Authority
- Santa Margarita Water District
- Santa Rosa Department of Utilities
- Western Municipal Water District

In addition, SCWC would like to thank Anaheim Public Utilities and Irvine Ranch Water District for graciously hosting meetings for the task force. Lastly, SCWC would like to thank the CaDC research fellows who volunteered their time to contribute to this report.

## Executive Summary

California's water industry has a long tradition of pioneering new technologies and visionary approaches to ensure a bright future for the state. Recently, the state's historic drought made headlines across the globe and Governor Brown has focused on opportunities for increased water efficiency in residential landscapes across the state.

The purpose of this white paper is to use data analysis and research to make recommendations on how to achieve market transformation in outdoor water use efficiency. This market transformation approach is timely and necessary. Assembly Bill 1668 (AB 1668) and Senate Bill (SB 606), passed in the spring of 2018, call for the development of standards and regulations at the state level that set individualized water objectives for urban retail water suppliers.

Included in the legislation is a water budget approach comprised of efficient indoor water use, efficient outdoor water use, efficient outdoor water use for landscape areas irrigated through a dedicated meter, efficient water losses, variances to account for unique local situations and bonus incentives for potable reuse. The water budgets create a custom water efficiency objective that each retail water supplier must meet by before the end of 2025. The legislation provides deference and flexibility to the water suppliers on how meet the efficiency objective but there remains some uncertainty on how this new legislation will impact the average customer.

Since launching in January of 2016, the California Data Collaborative (CaDC) coalition of water agencies have developed tools by and for water agencies to assist in understanding and navigating complex statewide requirements. As the new regulation evolves and objectives are developed, water managers will need to find ways to work with their customers to meet these new efficiency goals. Further, many of the underlying necessary shifts in natural resource demand management have already been successfully implemented in the energy sector and by leading water utilities around the state.

The Southern California Water Coalition (SCWC) Water Energy Efficiency Task Force was formed to bring together leaders across not only water and energy utilities but also a uniquely broad spectrum of local government, business, labor, and other civic organizations. The SCWC Water Energy Efficiency Task Force has built upon the CaDC's unique repository of data and experience with leading technology practices to provide the following recommendations for supporting water managers as they work to meet their new water efficiency goals:

- **Customer education and incentives are critical to achieve the opportunity in urban outdoor usage.** This whitepaper supports the market transformation framework

developed by the Alliance for Water Efficiency and the “big data” approach to targeted messaging that will continue the current momentum on a cost effective basis.<sup>1</sup>

- **Cooperative purchasing for aerial imagery and other technology to leverage shared resources.** It is recommended that stakeholders support regionally driven cooperative procurement to improve the implementation, measurement of, and education about water efficiency programs. One important opportunity to improve cost-effectiveness and efficiency is using cooperative efforts to acquire aerial imagery.
- **Quantifying carbon and energy embedded in outdoor water use to unlock new conservation funding.** It is recommended that California continue to promote utilizing Investor-Owned Energy Utility (IOU) energy-related conservation investments to fund water conservation (including cold water) which also saves energy. Agencies may want to participate in the Climate Registry’s upcoming process to align the many methodologies currently in use to quantify the energy and carbon embedded in water conservation.
- **Best in class tools and new technology to support water managers in achieving their goals.** Agencies can work together collaboratively through partnerships like the CaDC to develop online tools that will help water agencies quantify their target water usage and help customers quantify the potential savings of switching to water efficient landscaping along with other water management benefits.

Of course, water management involves much more than just urban water use efficiency, and the task force worked to maintain a balanced perspective between water demand management and supply development. Future work will involve building out the roadmap developed at the 2017 Stanford Water Data Summit.

## Introduction

Water agencies face numerous uncertainties and challenges providing supply reliability, such as population and economic growth, increasingly stringent water quality and environmental regulations, aging infrastructure, and the effects of climate change, including droughts and floods. Water agencies are working to overcome these challenges with water management planning and investments, yet future solutions necessitate the increased involvement of land use agencies, business associations, water technology companies and the local community.

---

<sup>1</sup> By “big data” this whitepaper means the integration of a large variety of datasets both within and beyond utilities to achieve a holistic understanding of customer behavior and achieve water efficiency on a cost effective basis. Example documentation detailing this type of water usage “big data” can be seen at [bit.ly/scuba\\_metadata](http://bit.ly/scuba_metadata). In addition, where available there is also an opportunity for greater velocity and volumes of information with high frequency Advanced Metering Infrastructure.

One key area to ensuring urban water reliability in the Golden State is investing in greater water use efficiency, or as Governor Brown stated “making water conservation a California way of life.” The legislation enacting the Governor’s framework, (AB 1668 / SB 606), requires retail urban water agencies to develop water use efficiency objectives customized to the unique conditions of their communities.

Responding to the need for a planning tool, the CaDC coalition of water utilities provided input and quality assurance into a new open source planning tool the Efficiency Explorer version 1.2. This tool won the “Best Urban Tool” award at the 2016 California Water Data Challenge held by state water agencies in partnership with the White House Council on Environmental Quality.

The Efficiency Explorer provides an integrated data visualization and scenario planning tool for future residential water efficiency goals for more than 400 California water retailers (Figure 1). Version 1.2 of the tool is available at the following link (<https://futureofwatermanagement.org/>) and is detailed in publicly available methodology.<sup>2</sup>

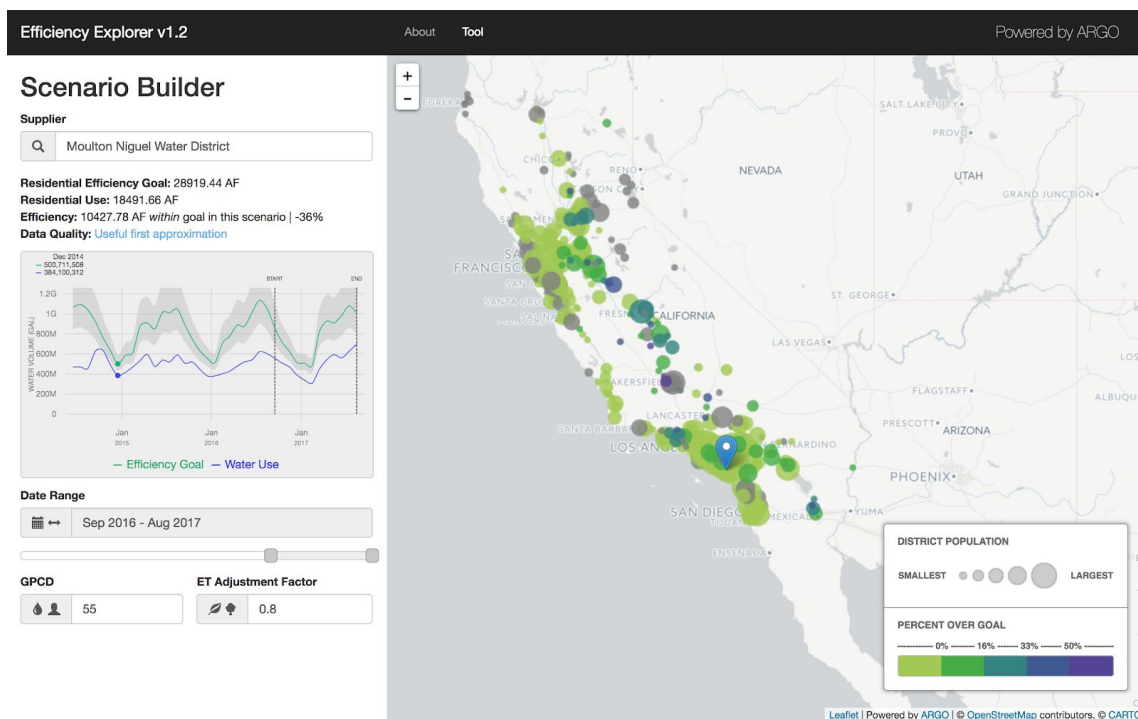


Figure 1. CaDC Integrated Reliability Toolkit v1.2 Residential Efficiency Explorer

<sup>2</sup> California Data Collaborative Efficiency Explorer Methodology: <http://californiadatacollaborative.org/blog/2017/4/28/cadc-statewide-efficiency-explorer-methodology>

## SCWC and Water Energy Efficiency Task Force Background

The Southern California Water Coalition (SCWC) spans Los Angeles, Orange, San Diego, San Bernardino, Riverside, Ventura, Kern, and Imperial counties, and is comprised of approximately 200 member organizations including leaders from business, regional and local government, agricultural groups, labor unions, environmental organizations, and water agencies, as well as the general public. Key technical support is provided by flood control district staff, city engineers, urban planners and redevelopment staff, water resource planners, real estate development professionals, hydrogeologists, and experts from consulting firms.

SCWC uniquely brings a broad coalition of water utilities, cities, counties, water technology companies, and environmental groups that are all critical to making water conservation a way of life. The Water Energy Efficiency Task Force (Task Force) is focused on the key opportunity to reduce urban outdoor water use as part of an integrated approach to the future of water management. Leveraging its diverse array of perspectives, the task force has investigated and developed recommendations on how to help make conservation a California way of life and assist in improving outdoor water efficiency. These recommendations are outlined in this report.

By better quantifying where we are in transforming the market for outdoor water use, this report first aims to illuminate the path ahead for achieving that important area of urban water efficiency. Second, by supporting cooperative procurement to break through barriers to using useful technologies like aerial imagery, this report aims to support strategies most likely to achieve increased outdoor water efficiency. Lastly, by reviewing methods to measure the amount of carbon saved by water conservation, this report aims to open new potential funding streams for achieving water efficiency goals.

### The opportunity in urban outdoor water usage

**Customer education and incentives:** *This whitepaper supports the market transformation developed by the Alliance for Water Efficiency and the “big data” approach to targeted messaging that will continue the current momentum on a cost effective basis. Agencies can work together collaboratively through partnerships like the CaDC to develop online tools that will help water agencies quantify their target water usage and help customers quantify the potential savings of switching to water efficient landscaping along with other water management benefits.*

Indoor water usage is well understood and has seen tremendous efficiency accomplishments. From 1990 to 2010, Southern California has added several million people without increasing the region's overall water demand through successful water efficiency measures, primarily indoors.<sup>3</sup>

By contrast, outdoor water usage is much less understood. It is frequently cited that between half to two-thirds of residential water usage occurs outdoors, based upon whether the area is in the cooler coastal region or in the hotter inland areas and also based on the typical plant palettes for each region. A long-time effort of water suppliers, especially in response to drought conditions, is the transformation of high water use turf to more water efficient landscape options. To encourage this effort suppliers have provided financial incentives, educational opportunities and outreach campaigns.

This whitepaper conducted an assessment of the research literature to ascertain 1) where the water industry lies on the market transformation curve in outdoor water irrigation and 2) offer recommendations on how to continue transforming the market for outdoor water irrigation on a cost effective basis. The graphic below provides a conceptual illustration of the market transformation curve.

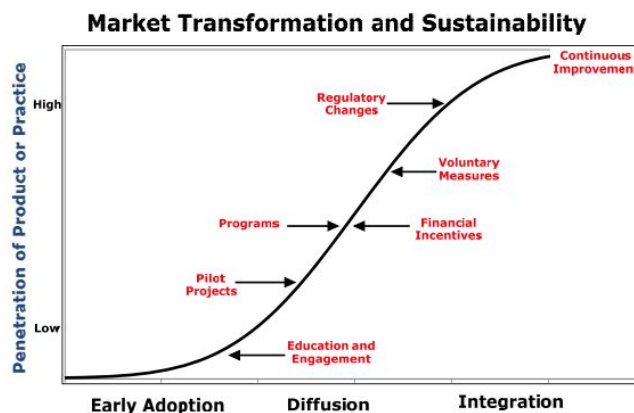


Figure 2. Conceptual diagram illustrating market transformation.

This market transformation approach has been applied in residential solar. The table below summarizes recent progress and provides a reference point for residential outdoor water efficiency. The similarities and differences in what causes California households to adopt solar panels and transform their landscape remains an area for future study.

<sup>3</sup> See the following Economist article (<https://www.economist.com/united-states/2015/04/11/the-price-is-wrong>) as well as the MWD IRP ([http://www.mwdh2o.com/PDF\\_About\\_Your\\_Water/2015%20IRP%20Update%20Exec%20Summ%20\(we b\).pdf](http://www.mwdh2o.com/PDF_About_Your_Water/2015%20IRP%20Update%20Exec%20Summ%20(we b).pdf))



### Net Energy Metering (NEM) Solar Residential Adoption Rates

	2013	2014	2015	2016	2017	2018
Total NEM Residential Solar Count	63673	96086	150322	201904	244531	269304
Residential Customer Count	4,344,429	4,368,897	4,393,150	4,417,340	4,447,706	NA
Adoption Rate	1.47%	2.20%	3.42%	4.57%	5.50%	
5 Year Average	3.43%					

Source: NEM data taken from Department of Energy (DOE) 826 July 2018 file

The task force believes that we are still in the early days of the long work to achieve market transformation in outdoor water efficiency. The newly legislated efficiency goals provide an invaluable benchmarking tool for water managers. Furthermore, even with the hundreds of millions of dollars invested in turf rebates and other outdoor water efficiency programs, the percentage of turf that has been converted to drought-tolerant landscaping statewide remains relatively small (in the single digit percentages rather than a majority of the market like high efficiency toilets). Water suppliers and other stakeholders in water efficiency have much work to do to make water efficient landscape the social norm.

One indicator of the cost effectiveness of turf removal, as a strategy, is whether it results in neighbors removing turf without receiving a rebate (multiplier effect). A summary of the existing research literature on the multiplier effect in Southern California is provided below.

Study	Estimated Multiplier Effect	Year	Utility	General Method (More detail in Appendix 1)
Multiplier Effect Study for Turf Removal	1.36	2015	IRWD	Field Survey / GIS
Multiplier Effect Study for Turf Removal -- 2016 Update	2.63	2016	IRWD	Field Survey / GIS
Evaluating the Effects of Turf-Replacement Programs in Los Angeles County	0.36	2017	LADWP (UCLA / UU)	Utilized google streetview and rebate data

WMWD's Turf Replacement Program Evaluation	2.5	2017	WMWD	GIS inspection via Google Earth
Methods Report on Detecting Turf Removers	0.069	2010-2016	MWD / USC (Andrew Marx)	GIS/NAIP image analysis

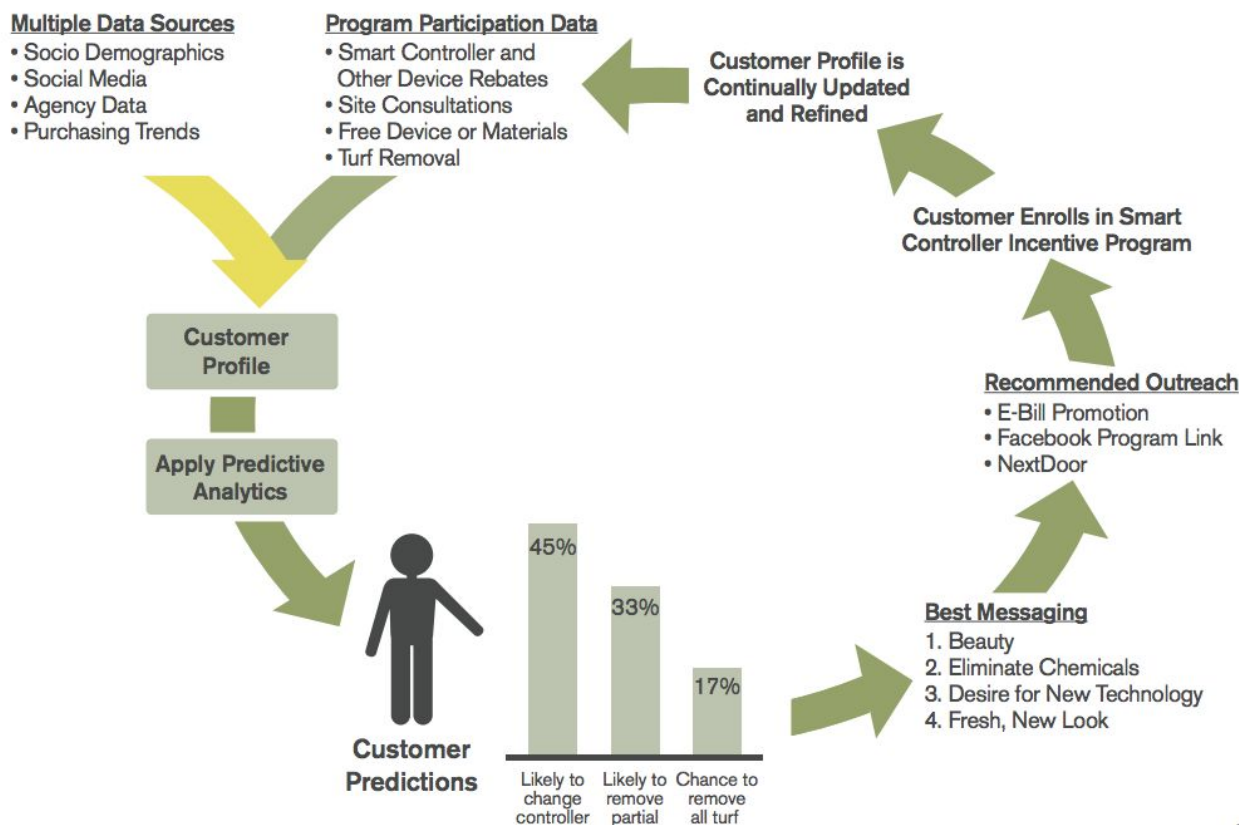
Another indicator of the effectiveness of turf removal is whether the turf is later re-planted. If the turf is re-planted, the turf removal rebate program would be considered not cost effective. If the water efficient landscaping remains, this historic investment could represent the tipping point in making drought tolerant plants mainstream and would be viewed as a visionary and extremely cost effective program.

This reality highlights the importance of overcoming outstanding barriers and continuing the momentum in transforming the market for outdoor water use efficiency. The Alliance for Water Efficiency outdoor water market transformation report identified four barriers to drought tolerant landscaping. This AWE report built on an authoritative literature review and nationwide survey of customers. The four barriers are customer barriers, program barriers, supply chain barriers, and contractor barriers.

The AWE report emphasized the importance of understanding the unique motivations and circumstances that determine whether or not a customer will convert their landscape toward more water efficient practices. The report prioritizes a “big data” approach in continuing market transformation. A “big data” approach utilizes all available information to achieve a holistic understanding of a customer's water usage behavior, motivations, and environmental actions. That information is integrated securely and protects customer privacy so that water efficiency programs can respect the autonomy of California households and ensure cost effective use of taxpayer dollars. The value of this approach is succinctly captured in the following quote from AWE.

*“How do we tease out customer patterns and microtarget? We do what the most successful businesses are doing. We use big data, analytics, customer segmentation, and personalization.”*  
 -Alliance for Water Efficiency 2018 Market Transformation Report

## Sample Customer



**Figure 3.** Diagram from AWE showing how a “big data” approach can support market transformation in outdoor irrigation.

This customer-centric approach can be used to optimize and ensure the highest return on investment of existing programs. The Metropolitan Water District of Southern California (Metropolitan) has committed \$50 million a year in its conservation budget and increased its conservation marketing to \$15 million a year in the current budget cycle. Continuing market transformation in outdoor water use efficiency will require increased coordination and collaboration across the water industry.

For example, databases collected for different purposes can be difficult to consolidate because they lack a common key, or because of unanticipated or uncontrollable variations in the way a common key is recorded. For example, participants in the Metropolitan’s Turf Rebate Program entered their own addresses on the program application form. Frequent misspellings and the use of abbreviations make it very time consuming to match these addresses to those contained in retail agency billing files. Problems like this cause unnecessarily difficult to leverage data from different sources for program planning and evaluation. A cooperative approach, like that discussed in the next section, offers one path to addressing the underlying data management barriers.

The AWE 2018 market transformation report also stresses the importance of providing tools to actual customers who strongly expressed interest in the design and implementation of their lawn conversion project in the AWE survey. The AWE 2018 market transformation report also stresses the importance of providing tools to actual customers who strongly expressed interest in the design and implementation of their lawn conversion project in the AWE survey.

Water suppliers have developed many tools to provide education and assistance with landscape transformation. Appendix 2 has a list of water supplier resources. The challenges are ensuring that customers are aware of the tools water suppliers have, and using them effectively and that water suppliers are aware of any additional tools needed. Water suppliers also require tools to better measure landscape transformation and customers need better tools to understand the benefits of landscape transformation.

The CaDC is committed to proactively supporting water managers in achieving their water efficiency goals and providing its tools as a public service to the California water community. This collaborative approach also provides an opportunity to streamline the procurement of aerial imagery that can help water managers better understand outdoor water usage and set the utility-scale outdoor water budgets called for by the water efficiency legislation.

## Overcoming technology barriers through collaboration

**Cooperative purchasing for aerial imagery and other technology.** *It is recommended that stakeholders support regionally driven cooperative procurement to improve the implementation, measurement of, and education about water efficiency programs. One important opportunity to improve cost-effectiveness and efficiency is using cooperative efforts to acquire aerial imagery.*

The California water industry is uniquely fragmented. Over 80% of Californians are served by the state's three largest electricity utilities. In contrast, California has thousands of local public water systems, 411 of which have over 3,000 meter connections. Approximately 170 local water retailers serve 80% of the state by metered connections.<sup>4</sup> This institutional fragmentation could result in duplication of effort and creates a unique opportunity for collaboration and shared services.

### **The Case for Cooperative Purchasing**

Water utilities have shared needs. By coordinating procurement across jurisdictions, water agencies can work together to save time and money. This process, known as cooperative purchasing, reduces the administrative burden by limiting the need for duplicative Requests for

---

<sup>4</sup> This figure is derived from the 2015 Urban Water Management Plan data. The official state data recorded in Urban Water Management Plans and the Public Water System Statistics offer conflicting values.

Proposals (RFPs). Participating agencies have the opportunity to benefit from a single competitive bidding process. Cooperative purchasing happens when:

- ***Multiple entities identify their needs up front and run a shared competitive bidding process.*** The cooperative purchasing process can be organized and managed by a single jurisdiction; a Council of Government (COG) or Joint Powers Authority (JPA); or a third-party cooperative purchasing organization. This method of purchasing can help participating agencies aggregate demand to negotiate price discounts with vendors. It also can save governments time and money by consolidating the administrative burden of purchasing.
- ***One jurisdiction or organization competitively procures a good or service and other jurisdictions use (or “piggyback”) on the resulting contract.*** This procurement method saves governments time spent researching and procuring a solution; it can sometimes help governments achieve a better price on goods or services (for instance, a volume discount may be negotiated that would not be possible for a smaller agency operating on its own).

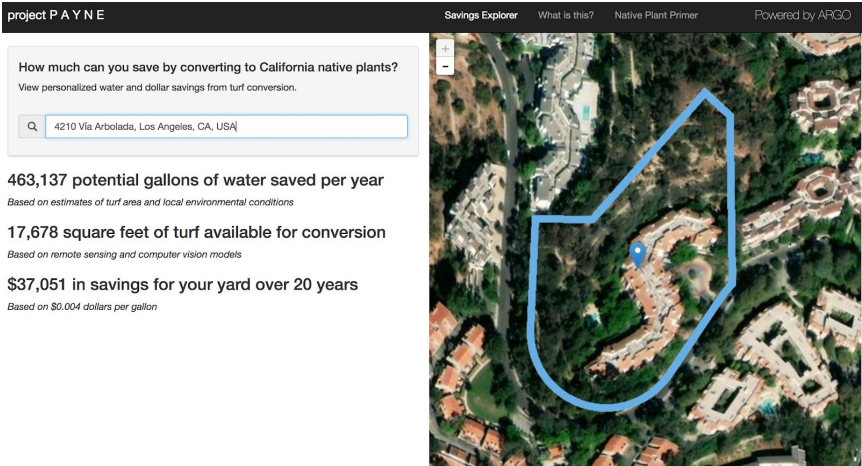
One tool that is variable for measuring progress and understanding the benefit of landscape transformation programs is aerial imagery. Imagery and the analysis associated with it can be useful at key points to measure progress towards additional water use efficiency. It can also be used as an impactful communication tool when showing customers how much water is used for landscape irrigation and the benefits of landscape transformation. Aerial imagery can also be useful to other government agencies for tracking changes in land use, geographical surveys and many other purposes. As much as possible, this aerial imagery should be utilized for multiple benefits like integrated reliability planning, conservation program benchmarking, water rate setting, tax assessment, urban-wildland fire management and other areas of urban planning to maximize the return on invested taxpayer dollars.

Given the shared need for aerial imagery for water suppliers and other government agencies throughout California, there is a clear opportunity to utilize a cooperative framework. There are a number of precedents, in California and other states, for the procurement of aerial imagery and its analysis. The table below offers several examples where cooperative efforts have for aerial imagery purchase have resulted in cost savings in excess of 25% and also additional multiple benefits. Those examples are further detailed in Appendix 3. These examples can be used as a template for additional efforts and applied to other areas resulting in cost savings. For example, local water utilities that invest in Advanced Metering Infrastructure could partner with nearby agencies to maximize the usage of the resulting hourly or higher frequency data. There is also an array of new digital tools available for water managers to utilize to achieve specific water reliability objectives.

Lead Agency	Partners	Area
LA County	LA Regional Imagery Acquisition Consortium (“LARIAC”) composed of cities, universities and others in the county	LA County
Sacramento Area Council of Governments (SACOG)	Regional Water Authority and participating water suppliers and cities	Greater Sacramento area
Santa Ana Watershed Project Authority (SAWPA)	Local water retailers and water management agencies in the SAWPA service area	Santa Ana Watershed

**Multiple benefits**

There is also an opportunity to work cooperatively on tools to communicate with customers. One example is the web calculator developed in partnership with the CaDC coalition of water utilities to show residential customers the benefits of turf transformation. The new web calculator tool showing customers the water and financial savings from switching their landscapes helps fill that gap. That tool is developed by Applied Research in Government Operations (“ARGO”) and funded by the Innovative Conservation Program (ICP) funded by Metropolitan and others. A screenshot of the alpha version of the tool is shown below.



**Figure 4.** Prototype web tool showing the water and financial savings of converting from lawns to CA native landscaping.

Of course, these technologies still cost money to implement. Because of the multiple benefits of water conservation, which include energy savings, there is an unique opportunity for the energy

sector to partner with the water sector to finance and, thereby, accelerate the implementation of water conservation as a the new normal.

## Unlocking new funding streams for water efficiency programs

*(Task Three: inventorying methodologies to quantify the embedded carbon in water)*

**Quantifying carbon and energy embedded in water conservation.** *It is recommended that California continue to promote utilizing Investor-Owned Energy Utility (IOU) energy-related conservation investments to fund water conservation (including cold water) which also saves energy. Agencies can participate in the Climate Registry's upcoming process to align the many methodologies currently in use to quantify the energy and carbon embedded in water conservation.*

Studies by the California Energy Commission<sup>5</sup> in 2005 and Public Utilities Commission (CPUC) in 2010<sup>6</sup> show that most of the energy in the water sector is attributed to customer end uses such as heating water. The studies confirm that it also takes energy to pump water to end users and thus carbon is embedded in most of the water used in California. The challenge is measuring how much energy and carbon is embedded. There are several tools and approaches available to water agencies for assessing the energy and GHG's embedded the water supplies delivered to their customers. These tools vary in their purpose and methodology.

This section inventories the various methodologies as the foundation for aligning an approach that meets the requirements of unlocking IOU energy efficiency investments in water conservation. Methodologies from five different sources were reviewed to understand what each approach has in common as well as how each is unique. The following sources were chosen for being largely representative of the different approaches often used by water agencies.

- Appendix O: Voluntary Reporting of Energy Intensity. *California Department of Water Resources 2015 UWMP Guidebook.*
- A High-Resolution Assessment of Water Utility Energy Intensity. *UC Davis Center for Water-Energy Efficiency.*
- AWE Tracking Tool Version 3.0 Documentation. *Alliance for Water Efficiency.*

---

<sup>5</sup> California Energy Commission:

<https://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF>

<sup>6</sup> Public Utilities Commission:

<ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%201/Study%201%20-%20FINAL.pdf>

- Water-Energy GHG Guidance. *The Climate Registry*.
- Embedded Energy in Water Studies 1 & 2. *California Public Utilities Commission*.

Additionally, the California Air Resources Board - Department of Water Resource Water Energy grant methodology was considered. This methodology focuses on hot water end uses but does not touch on energy embedded in water through utility operations; therefore it was omitted from this comparison. Finally, the CPUC has developed a Water Energy Cost Effectiveness Calculator<sup>7</sup> which the IOUs may use to support energy investments into cold-water conservation programs.

Each of these studies, reports, or tools utilizes the same basic methodology. The amount of energy used is divided by the volume of water processed to obtain an *energy intensity* (EI) associated with processing that water, often expressed in kilowatt hours per acre-foot (kWh/AF) or similar units.

$$\text{energy intensity} = \frac{\text{energy inputs} - \text{energy outputs}}{\text{volume of water}}$$

In most cases the only energy input considered is electricity purchased from (and occasionally provided to) the grid. Energy intensity calculations also include renewable energy sources such as small-scale hydropower and the many solar projects implemented by member agencies across the state. These renewable energy investments decrease the GHG emissions of the energy embedded in the water.

Greenhouse gas (GHG) intensity is then obtained by multiplying the energy intensity (minus the renewable energy) of water by an emission factor characterizing the mass of GHGs released during the generation of each unit of energy. This may be expressed in units of carbon dioxide equivalent (CO<sub>2</sub>e) per unit of energy, e.g. pounds per kilowatt hour (lbs/kWh) or similar.

$$\text{GHG intensity} = \text{energy intensity} \times \text{emission factor}$$

The emission factors used are often acquired from the EPA Emissions and Generation Resource Integrated Database (eGRID)<sup>8</sup> and as such they represent an average of the electricity mix across the entire state of California. Although local electricity mixes may vary substantially, eGRID emission factors are typically used for simplicity of calculation. Similarly, factors such as agency investments in solar electricity generation, or the incorporation of energy from natural gas use tend to be excluded from the studies reviewed here.

Note in The Climate Registry's (TCR) Water Energy GHG guidance, organizations are first asked to measure an entity-wide carbon footprint using the General Reporting Protocol (GRP).

<sup>7</sup> See here for the calculator: <http://cpuc.ca.gov/General.aspx?id=4139>

<sup>8</sup> <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>



The GRP enables agencies to calculate emissions associated with the energy they actually purchase/consume (whether generated with renewables, natural gas, etc), and calculate emissions from sources beyond energy (e.g. wastewater management).

In terms of the quantification of energy intensity, the primary differences among the studies examined in this report amount to differences in project scope and detail. In other words, what aspects of the water system are included and in how much detail is each aspect examined? Additionally, some of the studies address only embedded energy, while others also consider embedded GHGs. Table 1 provides a high-level summary of each study in terms of its scope and detail. Each of these factors is explained more fully in Appendix 3.

Table 1. A high-level summary of the energy and GHG quantification and reporting methodologies reviewed here.

	CWEE LADWP Study	DWR - Method A	DWR - Method B	DWR - Method C	AWE Trackin g Tool	TCR - Metric A	TCR - Metric B	TCR - Metric C	CPUC Study 1 & 2
Includes Embedded Source Energy							✓	✓	✓
Includes Non-electricity Emissions						✓	✓	✓	
Includes Wastewater	✓				✓				✓
Break out by Supply Source					◦				✓
Break out by Delivered Product				✓	◦			✓	✓
Cumulative Use Through System	✓								✓
Level of Detail:	-	-	-	-	-	-	-	-	-
System Average			✓			✓	✓	✓	
By Process		✓		✓	✓	◦	◦	◦	
By Asset	✓								✓

◦ means optional for the methodology.  
 ✓ means required for the methodology.

This methodological fragmentation frustrates the ability for water conservation to be eligible for energy efficiency funds. The California water industry needs clarity on what methods are

required for water conservation to count for those funding streams. The Climate Registry's workshops beginning in Fall 2018 offer an excellent opportunity to achieve that clarity across the current methodological fragmentation.

Note this fragmentation highlights the importance of the common nonprofit data platform in which the CaDC coalition of water utilities made a visionary investment. The final section highlights the long term value of this platform for water managers.

## The Future of Water Management

**Best in class tools to support water managers in achieving their goals.** *Agencies can work together collaboratively through partnerships like the CaDC to develop online tools that will help water agencies quantify their target water usage and help customers quantify the potential savings of switching to water efficient landscaping along with other water management benefits.*

In September 2017, the CaDC held its annual Water Data Summit at Stanford Graduate School of Business, working with participants to develop a roadmap for the future of the water industry. Senior water managers, analysts, state agency leadership, environmental organizations, academic researchers, technology companies and other participants committed to better use of water data came together to discuss the future of the California water industry. Over two days the group of water data leaders aligned on a roadmap to achieve necessary changes to ensure water reliability into an uncertain future.

There are multiple opportunities for water suppliers to collaborate on rate setting to measuring conservation programs that water suppliers can work together to meet whatever challenges arise. The CaDC Summit and projects and tools developed since then are excellent examples of what can be done when we work together to develop a broad vision and then take specific steps to enact that vision. Moreover, the unique thing about modern open source software and data tools is that the water data practices pioneered by the visionary coalition of CaDC water utilities can be utilized across the California water industry. The basic model of bringing together best in class data science talent with the relevant water expertise through focused technical collaborations could be deployed in stormwater management, Delta fish counts, Sierra snowpack and countless other important areas of water management.

There are also existing legislative mandates to modernize the underlying water data. In the third quarter of 2019, any ecological and water data held by state agencies will be made available on California's statewide water data platform. There is an excellent opportunity to build upon the work of the visionary CaDC coalition of leading local water managers and achieve data sharing and analysis goals. That water data integration will not "solve" California's water problems in any sense of the word, yet it is hard to imagine a future where California meaningfully addresses those issues without proactive modernization and improvement of its water data systems. That vision has been central to the CaDC since its inception:

*“Throughout our state’s history, water utilities have come together to pioneer new physical infrastructure to ensure a safe and reliable supply for the people of California. This project will honor that tradition and California’s world renowned “pioneering spirit” by boldly building the world’s first data utility to manage cutting edge data infrastructure. Climate change, demographics, and thousand year hydrological records suggest water scarcity will be the new normal in the twenty first century. Yet while the future is ultimately uncertain, by working smartly and collaboratively, we can prepare to adapt to whatever the future holds.”*

-Founding memorandum of understanding amongst participating California Data Collaborative utilities signed in January 2016.

## References

Alliance for Water Efficiency. AWE Tracking Tool Version 3.0, User Inputs.

Alliance for Water Efficiency. 2018 Market Analysis and Recommendations.

Alliance for Water Efficiency. Landscape Transformation Study: 2018 Analytics Report.

Aspen Institute (2017). INTERNET OF WATER: Sharing and Integrating Water Data for Sustainability. Accessed at

<https://assets.aspeninstitute.org/content/uploads/2017/05/Internet-of-Water-Report-May-2017.pdf>

Bennett, B., Park, L., & Wilkinson, R. (2010). Embedded Energy in Water Studies: Statewide and Regional Water-Energy Relationship. *Prepared by GEI Consultants/Navigant Consulting for the California Public Utilities Commission Energy Division, Managed by California Institute for Energy and Environment, CALMAC Study ID CPU0035.*

Bennett, B., Park, L., & Wilkinson, R. (2010). Embedded Energy in Water Studies: Water Agency and Function Component Study and Embedded Energy– Water Load Profiles. *Prepared by GEI Consultants/Navigant Consulting for the California Public Utilities Commission Energy Division, Managed by California Institute for Energy and Environment, CALMAC Study ID CPU0050.*

California Data Collaborative (2017). Statewide Efficiency Explorer Methodology, Version 1.1. Accessed at

<http://californiadatacollaborative.org/blog/2017/4/28/cadc-statewide-efficiency-explorer-methodology>

California Department of Water Resources (2015). 2015 UWMP Guidebook for Urban Water Suppliers.

Case Studies of Market Transformation as a Means for Delivering Regional Conservation Results. T. Chestnutt, M. Erbezniak, D. Pekelney. *Prepared for the Metropolitan Water District of Southern California.*

Climate Registry (2015). Water-Energy GHG Guidance, Version 1.0.

Center for Water-Energy Efficiency (2016). A High-Resolution Assessment of Water Utility Energy Intensity. *Prepared for Los Angeles Department of Water and Power and Los Angeles Bureau of Sanitation.*

Mayer, P. W., DeOreo, W. B., Opitz, E. M., Kiefer, J. C., Davis, W. Y., Dziegielewski, B., & Nelson, J. O. (1999). Residential end uses of water.

Mini, C., Hogue, T. S., & Pincetl, S. (2014). Estimation of residential outdoor water use in Los Angeles, California. *Landscape and Urban Planning*, 127, 124-135.

Pittenger, D, Hodel, D. UC Riverside. The California Drought and Landscape Water Use.

Redstone Strategy Group and The Water Foundation (2018). Governance and Funding for Open and Transparent Water Data: Implementing Assembly Bill 1755. Accessed at <https://www.redstonestrategy.com/wp-content/uploads/2018/05/Water-Foundation-2018-05-18-Final-Report.pdf>

Seapy, B. California Urban Water Conservation Council (March 2015). Turf Removal & Replacement: Lessons Learned.

## Appendix 1 -- Inventory of turf multiplier studies

Study	Estimated Multiplier Effect	Year	Utility	General Method	Detailed Data Sources / Methodology
Multiplier Effect Study for Turf Removal	1.36	2015	IRWD	Field Survey / GIS	<p>IRWD provided consultant, DCSE, information on single-family, residential customers who participated in the Turf Removal Rebate program. The consultant collected data to identify the rate at which landscape transformation, from turf to drought-tolerant landscapes, occurred among homes that did not receive a rebate. Fourteen representative neighborhoods in IRWD service territory (2,950 households) were selected for the study. Neighborhoods were surveyed in person (drive routes) where photo and videos helped consultant and IRWD correctly identify the landscape (four types), and proximity to customers who had participated in the Turf Removal Rebate program. A survey was administered to customers that had transformed their landscape either with or without a rebate to try to ascertain when the transformation occurred and the reason for doing so. For non-responsive customers, DCSE relied on Google Earth and Google Street View to determine the year of landscape change. U.S. Census demographic data evaluated on the neighborhood level to assess how income and education levels influenced landscape conversions, and what type. A regression analysis was performed on the data to find trends in landscape types, installation dates, and saturation levels of drought-tolerant landscapes.</p>

Multiplier Effect Study for Turf Removal -- 2016 Update	2.63	2016	IRWD	Field Survey / GIS	For the 2016 study update, consultant used the same driving routes as 2015 to identify new landscape transformations, determine the rate of adoption changes from 2015, and the saturation level of drought-tolerant landscapes in 2016.
Evaluating the Effects of Turf-Replacement Programs in Los Angeles County	0.36	2017	LADWP (UCLA / UU)	Utilized google streetview and rebate data	The UCLA-University of Utah study (Pincetl et al.) examined front-yard turf replacement rebate program participation between February 2014 and April 2016 in Los Angeles County. Data included only single-family residential properties (96% of the total) and were aggregated at the census block group level, normalized by total number of households to create a participation rate. Only block groups with at least one completed rebate project were included. This rate served as the dependent variable in three different types of regression analysis (OLS, fixed effects, and geographically-weighted regression) incorporating five independent variables: median income, median household income, median parcel area, rebate rate, and owner occupation rate. The researchers also looked for clustering using a LISA procedure. Finally, they cataloged and evaluated a random sample of 1,000 properties from the dataset using Google Street View. 400 of those included pre- and post-conversion imagery. They also noted whether the next-door or across-the-street neighbors appeared to have replaced a lawn as well (36% had).

<p>WMWD's Turf Replacement Program Evaluation</p>	<p>2.5</p>	<p>2017</p>	<p>WMWD</p>	<p>GIS inspection via Google Earth</p>	<p>The WMWD study (Matlock) analyzed 193 turf replacement rebate recipients, representing 85% of program participation from 2009-2015. 52 of those participants were randomly selected and each was matched with two non-participating neighbor controls. The neighbor controls were selected to match the 52 rebate recipients in lot size, HOA watering requirements, outdoor water requirements (e.g., pools), climate, and evapotranspiration factors; four were excluded due to missing or inaccurate water usage data. Finally, monthly water usage data for July 2007–December 2016 were compiled for the 193 rebate recipients and remaining 100 neighbor controls, along with project completion date, square footage replaced (both raw total and as a percentage of total irrigable area), and rebate amount. A “difference in differences” test was conducted to compare the two groups as follows: first, a paired, one-tailed t-test compared each rebate recipient’s one-year “before” period to their one-year “after” period; next, a paired, two-tailed t-test compared before-and-after water use for the neighbor controls, using the same time periods as their respective matched recipients; and finally, a mean t-test was used to evaluate the difference between the before-and-after water use differences in the two groups. In addition, the relationships between water usage and the other variables were examined with a correlation analysis and an ANOVA test. The researches also attempted to quantify a multiplier effect wherein nearby neighbors convert their turf to drought-tolerant landscapes without applying for a rebate. This portion of the study had two parts. First, they randomly selected 54 of the rebate recipients and conducted a Google Earth visual assessment of 10 surrounding neighbors to quantify nearby turf replacement, and</p>
---	------------	-------------	-------------	--	---



					second, they used Google Earth's time feature to observe how many of those had converted their turf after their rebate-recipient neighbor had converted theirs.
Method s Report on Detectin g Turf Remove rs	0.069	2010 -201 6	MWD / USC (Andrew Marx)	GIS/NAIP image analysis	The USC study (Marx 2018) analyzed 58,009 participants in Metropolitan Water District's turf rebate program. Those addresses were geocoded, joined to parcel data, and analyzed for spatial clustering. Six study areas of approximately 600 parcels each were selected in areas where high clustering of rebate participation had been observed. Within each study area, NAIP satellite imagery was analyzed to identify lawns that had been converted to drought-tolerant landscaping within three time periods (2010-2012, 2012-2014 and 2014-2016). The same imagery analysis was conducted in three additional study areas that were similar to the first six areas, except that they had no rebate participation. Results of analysis of those three areas were used to measure a baseline conversion rate to subtract from the conversion rate observed in the six study areas where rebate clustering was high.

## Appendix 2 -- Water utility online water efficiency tools

### **East Bay Municipal Utilities District**

- Conservation and Rebates: <https://www.ebmud.com/water/conservation-and-rebates/watersmart-tips/>
- Homeowners Association: <https://www.ebmud.com/water/conservation-and-rebates/residential/homeowners-associations-hoas/>
- Leaks and High Bills: <https://www.ebmud.com/customers/billing-questions/leaks-and-high-bills/>
- Water Budgets: <https://www.ebmud.com/water/conservation-and-rebates/residential/save-pro/>
- Watersmart Gardener: <https://www.ebmud.com/water/conservation-and-rebates/watersmart-gardener/>
- Watersmart Tips : <https://www.ebmud.com/water/conservation-and-rebates/residential/watersmart-calculator/>

### **Eastern Municipal Water District**

- Residential Rebates: <https://www.ebmud.com/water/conservation-and-rebates/residential/watersmart-calculator/>
- Inland Empire Landscape Guidebook: <https://www.emwd.org/use-water-wisely/water-wise-landscape-resources>
- Water Wise Landscape Design Concept Plans: <https://www.emwd.org/use-water-wisely/water-wise-landscape-design-concept-plans>
- Water Wise Landscape Resources: <https://www.emwd.org/use-water-wisely/water-wise-landscape-resources>
- Water Wise Tips: <https://www.emwd.org/use-water-wisely/water-wise-landscape-resources/water-wise-tips>

### **El Toro Water District**

- Residential Rebates: <https://etwd.com/conservation/rebates/>
- Water Wise Tips: <https://etwd.com/conservation/waterwisetips/>
- Landscape Workshops: <https://etwd.com/conservation/landscape-workshops/>

### **Inland Empire Utilities Agency**

- Irrigation: <https://www.ieua.org/use-water-wisely/landscaping/irrigation-controllers/>
- Landscape Design Service: <http://cbwcd.org/186/Landscape-Design>
- Rebates: <https://www.ieua.org/use-water-wisely/rebates/>
- Smart Landscape Care and Maintenance Site: <https://www.ieua.org/use-water-wisely/smartscape-landscape-care-and-maintenance-site-visit/>
- Water Saving Garden Planner: <https://www.ieua.org/use-water-wisely/landscaping/plants/>

- Water Saving Plants: <http://www.ie.watersavingplants.com/>
- Workshops: <https://www.ieua.org/use-water-wisely/workshops/>

### **Irvine Ranch Water District**

- Large Landscape & HOA: <https://www.irwd.com/save-water-money/large-landscape-hoa>
- Rebates: <http://rightscapenow.com/rebates/residential-rebates>
- Right Scap: <https://www.irwd.com/save-water-money/single-family-homes>
- Water Schedule: <http://rightscapenow.com/landscape-resources/watering-schedules>

### **Las Virgenes Municipal Water District**

- Efficient Outdoor Water Use:  
<https://www.lvmwd.com/conservation/efficient-outdoor-water-use>
- Tips on Irrigation:  
<https://www.lvmwd.com/conservation/efficient-outdoor-water-use/tips-on-irrigation>
- California-Friendly Plant Guide:  
<https://www.lvmwd.com/conservation/efficient-outdoor-water-use/california-friendly-plant-guide>
- Contact Professional Landscaper:  
<https://www.lvmwd.com/conservation/efficient-outdoor-water-use/california-friendly-plant-guide>
- How to Garden in a Drought:  
<https://www.lvmwd.com/conservation/efficient-outdoor-water-use/how-to-garden-in-a-drought>

### **Metropolitan Water District of Southern California**

- Classes- <http://www.bewaterwise.com/classes.html>
- Gardens- <http://www.bewaterwise.com/garden.html>
- Grants & Incentives- <http://www.bewaterwise.com/grants---incentives.html>
- Rebates- <http://www.bewaterwise.com/rebates.html>
- Toolkit- <http://www.bewaterwise.com/toolkit.html>

### **Monte Vista Water District**

- Classes and Workshops- <https://www.mvwd.org/workshop.cfm>
- Rebates- <https://www.mvwd.org/ps.watchthewater.cfm?ID=118>
- Resources for Teachers- <https://www.mvwd.org/ps.watchthewater.cfm?ID=134>
- Stuff for Kids- <https://www.mvwd.org/ps.watchthewater.cfm?ID=134>
- Water Wise Gardening Classes- <https://www.mvwd.org/ps.watchthewater.cfm?ID=125>
- Water Wise Landscaping- <https://www.mvwd.org/ps.watchthewater.cfm?ID=180>

### **Moulton Niguel Water District**

- Rebates & Programs <https://www.mnwd.com/rebates/>
- Water Saving Tips <https://www.mnwd.com/watersavingtips/>
- Landscape Transformation Center  
<https://www.mnwd.com/landscape-transformation-center/>
- Education Programs <https://www.mnwd.com/education/>
- Workshops <https://www.mnwd.com/workshops/>

- Water Saving Tools <https://www.mnwd.com/watersavingtools/>

### **Sacramento Department of Utilities**

- Irrigation Scheduler: <http://beyondthedrought.com/>
- Residential Rebates: <http://www.cityofsacramento.org/Utilities/Conservation/Residents/Residential-Rebates>
- Residential Water Wise Services: <http://www.cityofsacramento.org/Utilities/Conservation/Residents/Residential-Water-Wise-Services>
- Resources: <http://www.cityofsacramento.org/Utilities/Conservation/Water-Education/Resources>
- Water Wise Tools: <http://www.cityofsacramento.org/Utilities/Conservation/Water-Wise-Tools>

### **San Bernardino Valley Municipal Water District**

- Defend the Drop- <http://defendthedrop.com/>
- San Bernardino Valley Water Conservation Demonstration Garden- <https://garden.csusb.edu/>
- Water Saving Garden Friendly - <http://www.ie.watersavingplants.com/>

### **Santa Ana Watershed Project Authority**

- Resources- <http://www.sawpa.org/resources/>
- Patti Bonawitz Demonstration Garden- <http://www.sawpa.org/patti-bonawitz-demonstration-garden/>

### **Santa Margarita Water District**

- Classes and Events: <http://www.smwd.com/170/Classes-Events>
- HOA Landscape: <http://www.smwd.com/174/HOA-Landscape>
- Leak Detection: <http://www.smwd.com/168/Leak-Detection>
- Plants: <http://www.smwd.com/175/Plants>
- Rebate Programs: <http://www.smwd.com/179/Rebate-Programs>
- SMWD SustainaBlue Landscapes: <http://www.smwd.com/180/SMWD-SustainaBlue-Landscapes>
- Water Data for SMWD: <http://www.smwd.com/173/Weather-Data-for-SMWD>
- Watering Guide with Water Calculator: <http://www.smwd.com/183/Watering-Guide>
- WaterSmart Portal: <http://www.smwd.com/192/WaterSmart-Portal>

### **Santa Rosa Department of Utilities**

- Do-It-Yourself: <https://srcity.org/827/Do-It-Yourself>
- Find and Fix Leaks: <https://srcity.org/2252/Find-Fix-Leaks>
- Free landscape Design Templates: <http://www.savingwaterpartnership.org/concept-plans-and-design-templates/>
- Rebates & Free Services: <https://srcity.org/834/Rebates-Free-Services>
- Watering Recommendations: <https://srcity.org/821/Watering-Recommendations>

**Western Municipal Water District**

- Programs to help you: <https://www.wmwd.com/265/Programs-to-Help-You>
- Rebates: <https://www.wmwd.com/411/Rebates>
- Water-wise Landscaping: <https://www.wmwd.com/283/Water-wise-Landscaping>

## Appendix 3 -- Cooperative Procurement Case Studies

### Case Studies

Water agencies have cooperatively procured aerial imagery in a few different ways. The following cases illustrate four different mechanisms for making the purchase:

***Los Angeles Region Imagery Acquisition Consortium (LARIAC):*** LARIAC is a regional consortium spearheaded by the County of Los Angeles Internal Services Department. It was started in 2006 as a way to aggregate the high-resolution aerial imagery needs of public agencies in the Los Angeles County region, including water agencies, and provide a forum to share knowledge and technical expertise. Approximately every three years, LARIAC solicits signed statements from Los Angeles County cities and other public agencies to determine the exact specifications for the scope of work before putting the contract out for bid. Following the negotiation and execution of the contract, LARIAC/Los Angeles County takes on the upfront financial cost and is then reimbursed by participants for the use of imagery and analysis. Should additional municipalities or public agencies join, any surplus from the additional fees collected by LARIAC can be put toward partial refunds to participating agencies or used to procure additional imagery functionality. Purchasing together produces cost savings for individual agencies. For instance, the City of Los Angeles has reduced their imagery procurement costs from \$1M to \$750,000.

***Sacramento Area Council of Governments (SACOG) and the Regional Water Authority (RWA):*** As an organization, SACOG represents the interests of the 22 cities and 6 counties in the Sacramento region. Over the last 12 years, SACOG has run 4 separate solicitations for aerial imagery services on behalf of its members. Earlier this year, the RWA was able to join the pending contract between SACOG and its aerial imagery vendor. In doing so, RWA was able to secure heavily discounted access to imagery that SACOG members were also purchasing. They were also able to negotiate coverage of additional geographic areas not included in the original contract at a rate lower than what they would have paid on their own.

***Santa Ana Watershed Project Authority (SAWPA):*** Beginning in 2007, SAWPA has procured aerial imagery on behalf of the Santa Ana watershed, allowing local jurisdictions to utilize the imagery and analysis for water-related research and planning. In order to determine the watershed's imagery needs, SAWPA collects information from jurisdictions to understand the imagery requirements with regard to resolution and use before putting together a series of specifications for vendors. SAWPA is able to tell each participating agency the precise costs for a variety of imagery options, allowing them to make an informed decision based on their available budgets. SAWPA is then able to charge a small administrative fee of 2.5% to participating agencies, far lower than the savings enjoyed through the cooperative purchasing process alone.

**State of Minnesota:** The State of Minnesota maintains a master contract with 9 separate aerial imagery providers to streamline the process of imagery procurement for government agencies in Minnesota and beyond. The master contract allows interested governments to avoid the standard RFP process; instead, since vendors have been pre-qualified, governments that wish to procure imagery circulate a Statement of Work to the pre-qualified vendors and evaluate their submissions. This saves local jurisdictions the time and money of running a full competitive bidding process. Buyers can procure imagery from a trusted vendor at a rate likely lower than what they would have paid by putting it out to bid themselves.