WETTING CALIFORNIA'S APPETITE:
THE WATER CHALLENGE FOR SUSTAINABLE AGRICULTURE

A STATUS REPORT AND CALL TO ACTION

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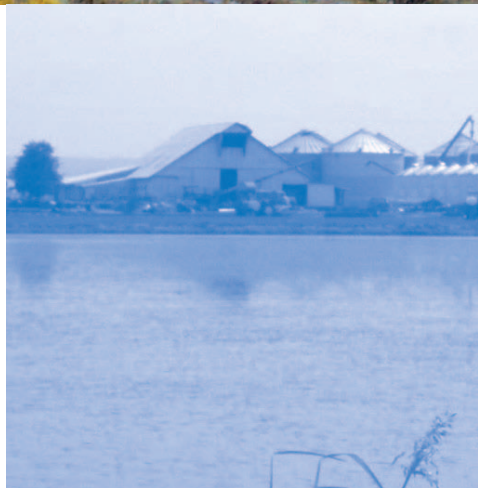

BACKGROUND NOTES

This preliminary study has been undertaken by the Polaris Institute, which carries out research, education, and action on water policy issues. Polaris has produced and/or worked on a number of reports and books on water policy issues including 'The Last Frontier,' [2000] 'Blue Gold' [2002] and 'Inside the Bottle' [2005]. The Institute specializes in producing research and reports on water issues along with follow-up strategies for education and action by citizens and communities. Recently, Polaris has been focusing its work on the growing water demands of agriculture and industry as well as bulk water transfers.

The report that follows has been researched and prepared by Katy Mamen, sustainable food systems consultant who has carried out extensive research on agriculture policy issues in California. Katy played a key role in researching and preparing 'The New Mainstream: A Sustainable Food Agenda for California,' [2005] supporting research papers and the ISEC publication entitled 'Ripe for Change: Rethinking California's Food Economy.'

This project has been carried out under the guidance of the director of the Polaris Institute, Tony Clarke, who has produced several books, reports, and articles on water policy issues as well as being a leading activist in the global water justice movement.

Special thanks to Brock Dolman and Joseph McIntyre for reviewing this report and to the many researchers and advocates (listed in the Appendix) who shared their time and expertise during interviews.

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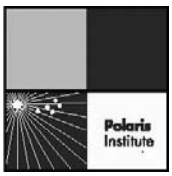

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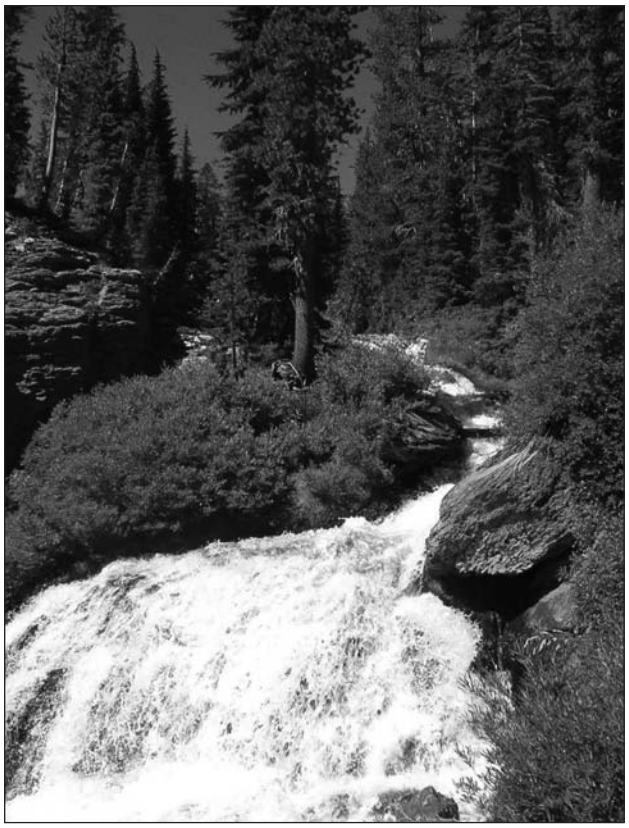
1. INTRODUCTION



The intersection of water and agriculture in California calls to mind a tangle of ecological, economic, and social issues that has spanned the past century. Yet as we move into the coming decades, the threat of insufficient water availability to meet this industry's needs, which currently make up roughly 80 percent of the state's developed surface water and likely an even greater proportion of its groundwater, looms larger than ever. Currently, there are coordinated efforts underway to transition California toward a more sustainable and viable food system. Alongside this work must be a concerted effort to develop and implement sustainable water strategies for food production in the state. Without proactive and forward thinking measures, the landscape of California agriculture – and the state as a whole – will most certainly be shaped, and likely debilitated, by water supply limitations.

So far, it appears that the sustainable agriculture movement has not sufficiently integrated into its agenda the question of how water needs will be sustainably met into the future. How can California realize the goal of achieving a productive and environmentally sound agricultural economy while significantly reducing water inputs? At a more basic level, there appears to be a lack of awareness about the potential for sustainable agriculture to address water supply issues in California. This report represents an attempt to lay the groundwork for efforts to make California agriculture a leader in sustainable water use. Water issues in California, particularly as they relate to agriculture, are longstanding and complex. This report does not attempt to review all of the issues related to California's water supply, nor outline the full host of actors involved at the nexus of agriculture and water. Rather, it combines literature review with expert interviews to:

- overview the context and key issues connected to agricultural water conservation,
- survey the significant research programs and addressing agriculture and water conservation,
- document the actors currently forwarding the agricultural water conservation agenda,
- delineate key directions for alleviating agriculture's pressure on limited water resources while ensuring a successful agricultural sector, and
- articulate preliminary steps toward a strategy for agricultural water conservation that showcases sustainable agriculture.

2. CALIFORNIA AGRICULTURE AND THE THIRST FOR WATER

WATER USE IN CALIFORNIA

There is little doubt that a water crisis is looming in California. Each year, much greater quantities of water are used than can be replenished, and declining water quality removes additional water resources from possible use. Reserves of surface water, as well as groundwater, are being depleted and a significant – and growing – net water deficit is being recorded in most years. In a normal year, California will consume roughly 6 maf/year more water than is supplied through precipitation and imports from Colorado, Oregon, Nevada, and Mexico. A little more than half of all water inputs is either taken up where it falls (e.g. through native vegetation, agriculture, and evaporation) or flows out of the state. The remainder is allocated among environmental, urban, and agricultural uses. The availability of water for environmental use refers to water that is intentionally left in stream for habitat conservation and restoration, species protection, and healthy fisheries, concerns that have grown in recent years.

Water allocated for human use, called developed water, is divided between agricultural and urban uses. In 2000, considered a "normal" water year, the total supply of water to California was roughly 195 maf, 43.1 maf of which is captured for human use as "developed water." Of this developed water, 8.9 maf (20.6 percent) went to urban (including residential, commercial and industrial) users while 34.2 maf (79.4 percent) was used for irrigated agriculture.[i] Total water use, outflow, and evaporation totaled approximately 200 maf, leaving a gap between water supply and demand that translated to a net statewide storage deficit of 5.7 maf/year[1]. This deficit was largely made up by excess removal (overdraft) of groundwater (see Box 1[ii]).

Irrigated agriculture (9.6 million acres of cropland) is by far the leading consumer of developed water in California. According to the USGS, Fresno, California's leading agricultural county, uses more water than any other county in the U.S.[iii] In the hydrologic regions of San Joaquín, Tulare, Lake, and the Central Coast, agriculture accounts for more than 90 percent of groundwater withdrawals.[iv]

BOX 1:
GROUNDWATER WITHDRAWALS

Groundwater overdraft has been a significant problem in California's agricultural areas, particularly in the San Joaquín Valley. Overdraft leads to a dropping water table, which can bring impacts such as land subsidence, dry wells, and saltwater intrusion. According to the U.S. Geological Survey, in 1995, the most recent year of data available, California extracted 14.5 maf of fresh groundwater. This represented 19 percent of all fresh groundwater extracted in the country. 76 percent of this water was used for agriculture.

WATER SHORTAGES ON THE HORIZON

With significant water deficits even in normal years, California clearly faces challenges in meeting its water demands. It is anticipated that these challenges will only intensify. By 2030, the state's population is projected to increase by 40 percent (over 2000 levels) to 48 million.[v] If per capita consumption remained equivalent, urban water demand would rise by 40 percent, or 3.6 maf, in the same time period. Fortunately, this increase is expected to be offset to some

degree by water-wise urban development and technology, yet the forecasted population increase will almost certainly exacerbate competition for already-tight supplies.

California's burgeoning population is expected to settle largely in the Central Valley. The population in this region is projected to grow from 6.5 million in 2005 to 12 million in 2040.[vi] Competition for the flat, fertile Central Valley land is growing and the state's prime farmland is being developed at an alarming rate. 183,000 acres of farmland was converted to urban uses in California in 2001 and 2002.[vii] Urbanization and the associated paving over of land reduce water availability by disrupting the water cycle. Vegetation and topsoil are replaced by impervious surfaces that hinder the infiltration of water into the soil and aquifers, increasing flooding and diverting more water away as storm water. Urbanization also negatively impacts downstream water quality by washing urban contaminants into waterways. In the category of urban water use, it is important to note that California statistics include reported industrial and commercial water use as well as residential use. As such, in California, it is difficult to project the specific impacts of changing industrial water use on overall water supplies.

Climate change rivals population increase as a leading factor that threatens to greatly exacerbate water shortages in California's future. While its exact effects on water availability, as well as agriculture more generally, are impossible to predict, climate change is expected to alter water supplies in terms of timing of delivery, spatial distribution and increased variability over time. It is now commonly regarded that climate change will intensify California's water problems. There is agreement among climate researchers that in the future more precipitation is expected to fall as rain, rather than snow. The snow pack in the Sierras is California's largest water reservoir, providing three quarters of the state's water supply. Climate modeling in California projects an alarming decrease in the Sierras snow pack of 30-90 percent by the end of this century, depending on the degree to which emissions can be curbed.[viii] Similarly, modeling by Miller et al. predicts reductions in late winter snow accumulation of 50 percent toward the end of the century.[ix] This deterioration of California's main water 'storage' system will have significant impacts on water runoff and delivery downstream throughout the seasons. The associated predicted earlier spring melt would increase flood flows and threaten low-lying areas, as well as the Sacramento-San Joaquin Delta levees.[x] The slight predicted decrease in winter precipitation would exacerbate shortages in water supply. Collectively, these problems could, as researchers indicate, "fundamentally disrupt California's water rights system."[xi]

Climate change indirectly impacts water availability for agriculture in other ways. Kiparsky and Gleick point out that increased summer temperatures and decreased rainfall will reduce soil moisture by 30 percent, resulting in increased demand for crop water applications. In addition, as sea levels rise, coastal agricultural lands will be subject to increased saltwater intrusion and decreased water quality, both on the surface and in groundwater, reducing overall water availability for use. Rising temperatures are expected to increase water demand for irrigation in order to meet rising evaporative demand.

Finally, anticipated declines in water availability and increased competition will likely affect the agriculture sector more than other users. In addition to the indirect impacts of climate change listed

[1] maf/year: million acre feet of water per year. This is enough water to submerge a million acres in water a foot deep. 1 acre foot = 325,851 gallons.

above, Kiparsky and Gleick point out that industrial and urban users tend to be able to pay more for water, creating a market incentive that disadvantages agricultural users. On another level, if enforced reductions in water allocations by sector were proportional, agriculture would face much more significant net declines in water supply. Furthermore, agriculture is the sector must susceptible to water shortages, in particular because of the impacts of insufficient water on crop production, soil loss during dust storms and increases in water costs during times of drought. Rising temperatures are expected to adversely impact the productivity of many agricultural products; in one projected climate-modeling scenario, dairy productivity declined by up to 7-10 percent. However, productivity among some crops is expected to increase. Changing weather patterns and more extreme hot weather events in the summer may significantly alter agro-ecological zones, creating turmoil in the agriculture sector. Perennial crops such as nuts and fruit stand to be particularly impacted. California's agriculture sector in particular must play a role in addressing future water supply issues.

SATISFYING COMPETING DEMANDS FOR WATER

It is challenging to look at agricultural water use in isolation. Agricultural water deliveries are part of a complex system of demand and use among agricultural, urban, industrial, and environmental sectors. Ellen Hanak of the Public Policy Institute for California maintains that "…for years it has been widely known that 80 percent of the water in California is used for agriculture–and often in highly inefficient ways. Some have even argued that we do not have a water shortage problem but a water allocation problem."[xv] Since savings in agriculture are often taken up by urban demands, agricultural water use must not be considered in isolation of the broader context of competing demands.

California water management is becoming increasingly complex alongside intensifying competition for limited resources (Appendix 3 provides an overview of public agencies and their role in state water management). Water quality requirements have become more stringent, new water management options such as conjunctive use (management based on optimal combined usage of surface and groundwater in conjunction in a given area), water markets, and wastewater reuse introduce management complexities. Water management responsibilities are shifting from national and state levels to local and regional levels.[xvi] Current water policy involves dozens of federal, state, and local agencies, and coordination is an ongoing issue that, while beyond the scope of this report, warrants increased attention.

With the rise and formalization of the water market, it is likely that water rights will be increasingly transferred from agricultural to urban uses. The water market has become a well-established component of California's water allocation regime. The statewide market (roughly 1.2 maf/year) currently only accounts for less than 5 percent of total developed water use, although it is expected to increase. Half of purchases are made by state water projects and one third are made by state and federal governments for drought relief and environmental use.[xvii] One key area of water market growth has been water purchased by San Joaquín Valley agriculture to make up for losses resulting from increased water capture for environmental use. While generally water costs to users do not reflect a direct purchase of water (water costs reflect a portion of the overall cost of water transport infrastructure and maintenance), concerns about the commodification of water have been raised. Several water banking and trading projects have been criticized for shifting control of public water resources into private hands, threatening one of our most basic human needs. An additional concern is the current lack of legal water rights regulations governing groundwater.

Agricultural water use is anticipated to decline slightly in coming years, in particular as a result of a shift toward less water intensive, higher value crops and farmland conversion to residential use. It is estimated that approximately 2.1 million acres of farmland will be converted to urban use between 2000 and 2030, including approximately 690,000 acres of irrigated cropland.[xx]

In spite of these reductions, there remain grave concerns that agricultural water demand will exceed supply, particularly in light of competing demands. Already, even in water secure years, some growers experience an insecure water supply that affects their operations.[xxi] Agriculture has been withdrawing more than its allocation of water from several regions, including the Colorado River. Water shortages are one of the greatest threats faced by producers to their future economic viability. Where will the water come from? It is clear that significant additional supplies are limited. Additional water imports from out of state are not practical. California must look to conservation in order to meet its water needs.

Given projected demographic changes, urban use is expected to account for most of the increased demand for water in California in the coming decades. Many analysts look to urban water use as the most promising sector for water savings. Yet, to make up an additional 2 maf of water in a year would require a 25 percent reduction in urban water use, compared with just a 5 percent reduction in agricultural water use. Clearly, there is great potential for agriculture to play a central role in alleviating pressure on California's water resources.

While the future is inevitably unpredictable, there is more than sufficient evidence of impending shortages to warrant a lucid and well thought out strategy for alleviating demand and ensuring a water-secure future for California. The agriculture sector must face the anticipated constraints of a limited supply of available and affordable clean water and take proactive measures to ensure the continuation of a healthy agricultural economy and landscape. Water supply must be addressed front and center in any strategy for agriculture's future in California. Fundamentally, *there can be no sustainable agriculture without a sustainable water strategy.*

3. SUSTAINABLE WATER USE IN AGRICULTURE: RESEARCH AND ADVOCACY

There are many fronts in the broad effort to foster more water-wise agriculture in California. A survey of the research and advocacy work in this field provides a glimpse of the architecture of human resources currently in play for building a water-wise agricultural future. It also points to where gaps in this important endeavor might lie. Here, key programs that play a role in moving the state toward this goal are summarized and evaluated.

RESEARCH

Not surprisingly, agriculture's use of water is a substantial research focus in California. Appendix 1 outlines many of the key institutions carrying out agricultural water research in more detail.

Several entities within the University of California and California State University systems are working to identify approaches to more efficient water use in agriculture. In the University of California, the Division of Agriculture and Natural Resources acts as the umbrella for agriculture-related faculties and their programs on all campuses. The Department of Land, Air, and Water Resources at UC Davis, the UC Davis Agricultural Issues Center, the UC Berkeley and UC Davis Departments of Agricultural and Resource Economics and Agricultural Extension, as well as established projects such as the Sustainable Agriculture Farming Systems Project and the Long Term Research on Agricultural Systems (LTRAS), each focus to some degree on improving water use efficiency in agriculture.

Given the cross-disciplinary nature of agricultural water conservation, the UC Center for Water Resources was created to stimulate and support (financially and otherwise) water research across the UC system. Much of this work centers on improving agricultural water efficiency through irrigation management, including investigating techniques such as the use of lower quality water for irrigation and improving irrigation efficiency through more precision applications of water. In an attempt to close the research-practice gap, the Center for Water Resources is also actively developing their outreach program to connect cutting-edge research with public policy and praxis, and to act as a clearinghouse and public liaison.[xxii]

In the California State system, perhaps the greatest research focus is on irrigation technology. This work is being carried out under the auspices of several centers in the CSU system. At Cal State Fresno, there are three main centers addressing agricultural water: the Center for Irrigation Technology, which focuses on cutting edge technological improvements; the International Center for Water Technology, which tackles various aspects of water issues; and the California Water Institute, which addresses water quality and policy issues. Fresno also houses the CSU Agricultural Research Initiative, which joins the four colleges of agriculture in the CSU system. Finally, the Irrigation Training and Research Center at Cal Poly is working on a wide range of issues related to irrigation, including modernizing technologies and assessing the role of factors such as salinity, drainage, evapotranspiration, and water balances.

Overall, key agricultural water conservation efforts (and related funding) in California tend to place a significant focus on: (a) better understanding the water cycle as it relates to agriculture, (b) improving irrigation efficiency through technological approaches, and (c) irrigation management practices that reduce water applications. Significantly less research is oriented toward investigating strategies that address the root level, such as management options for decreasing reliance on transported water, or lower-tech solutions such as the contribution that alternative, sustainable, farm-scale systems such as agroecology or dry farming can make toward water-wise agriculture.

In a broader context, the development of irrigation technologies that still form the main thrust of the agricultural water research agenda can be seen as one of the key factors that has facilitated the industrialization of food production in California. The large monocultures of the arid Central Valley would not be possible without the significant investments in the aqueducts that cross California like arteries. Increasing irrigation efficiency is undoubtedly an important part of the solution. However, the research community is still grappling with a conceptual transition from the large-scale water infrastructure projects of the past to a more comprehensive approach that minimizes impacts on wild waterways, wetlands, soil health, and drinking water.

The UC Center for Agroecology and Sustainable Food Systems is one research body taking a more holistic, farm-scale approach to sustainable production that includes improving water quality and alleviating water use. The UC Sustainable Agriculture Research and Education Program (SAREP), currently being incorporated into the newly forming UC Agricultural Sustainability Institute, is another program that addresses the multiple dimensions of agricultural sustainability, including water supply. The UC Center for Agroecology and Sustainable Food Systems and UC SAREP are both critical institutions for connecting the ecological realities faced in California with sound agricultural practices. However, alleviating agriculture's pull on the state's water supplies does not feature strongly in their program areas at this time.

While UC and CSU research are the main focal points of agricultural water use research in the state, it is noteworthy that relevant research is also being undertaken in other colleges and institutions in California. A range of small-scale applied agricultural water conservation research projects are also being carried out by civil society groups. Groups such as the Occidental Arts and Ecology Center WATER Institute, local permaculture groups, the rainwater harvesting movement, and others are carrying out important related research, some of which is described in greater detail below.

ADVOCACY

The landscape of civil society organizations active in addressing water issues in California is vast, yet the stratum of those addressing the intersection of water supply and agriculture in a concerted way is surprisingly thin. A scan of these groups shows that currently there are no organizations whose work focuses strictly on agricultural water conservation and no agriculture advocacy groups with a strong voice for water conservation. However, several NGOs are filling important niches in

promoting agricultural water conservation (Appendix 2 provides an overview of civil society organizations working in this area).

Some organizations focus their efforts on working within the current economic system to improve agricultural water management in California. For example, the Natural Heritage Institute promotes agricultural water conservation through incentive approaches such as water transfers and markets. NHI is currently focusing on conjunctive use opportunities in the Central Valley as an important management adaptation to climate change. Sustainable Conservation is another group working with market levers, primarily addressing water quality through their work with producers in their Partners in Restoration and Sustainable Agriculture programs. The Agricultural Water Management Council helps manage conveyance facilities by working with water managers to improve their delivery of water to users. Each of these groups has made strides toward more sound agricultural water management in California by addressing economic aspects of the puzzle.

Another set of organizations is active in lobbying and litigating for changes that will drive reductions in agricultural water use. Litigation has been an important lever of change in affecting water use in California. Recently, a coalition including the Natural Resources Defense Council (NRDC) and others successfully won a landmark case to restore water flows to the San Joaquin River below the Friant Dam (originally constructed in the 1940s to provide more secure water to agricultural areas) after it was found to violate fishery protection laws. This and other similar lawsuits have impacted water availability for use by agriculture and other sectors across the state. Groups such as Friends of the River, the Planning and Conservation League, and Water for California all work to move legislation toward better water conservation, though each has a limited focus on agriculture. These organizations play an important role in shaping the water context within which the agriculture sector operates.

One very important area of work relating to agriculture and water conservation is the independent research, analysis, and information provision that has been a valuable complement to public sector and academic work. Perhaps most notably, the Water and Sustainability Program of the Pacific Institute for Studies in Development, Environment, and Security has been an important voice analyzing California water and offering viable strategies for extending the realm of what is possible in California. Their strategy *California Water 2030: An Efficient Future* is described below. The Public Policy Institute of California, through their Environment, Growth, and Infrastructure program, is another important voice evaluating California's water future through the lens of ensuring adequate infrastructure to address California's future. While independent think tanks like these are critical, they stop short of taking an active advocacy role in policy change.

Finally, there is a host of advocacy work being carried out to address California's water issues at the local level. Restore the Delta is an exciting new multi-stakeholder campaign working to restore water quality in the California Delta, in part through partnership with the agricultural community. Groups like the Bay Institute and several local groups promote watershed-based approaches to water conservation. The Occidental Arts and Ecology Center's WATER Institute has taken a holistic approach to water conservation by pioneering the field of conservation hydrology. The Institute combines research with demonstration, training, and advocacy to tackle water conservation at the watershed scale. Their mantra "slow it, sink it, spread it" guides smart land-based approaches to water management at the local level. Several organizations, as well as

researchers and individuals, are actively developing low-tech farm-scale techniques for reducing reliance on delivered water, such as storm water capture, dry farming, landscape patterning and others. The California Section of the WateReuse Association has also brought researchers and practitioners together to promote water re-use in agriculture and other sectors. Groups such as the California Association of Resource Conservation Districts, undertake efforts to ensure holistic water management through information provision and program review. Localized, farm-based efforts and the groups that connect them are critical to a statewide conservation strategy.

Several advocacy organizations representing the interests of Central Valley agriculture also address water supply, however generally not with conservation goals in mind. Groups like the California Farm Water Coalition focus on defending agriculture's historical rights to the state's developed water. It appears that there is little effort on from the side of agricultural advocates such as these to develop constructive ways to help the agriculture sector maintain its profitability while reducing its dependence on water.

A preliminary overview of advocacy efforts to alleviate agriculture's pressure on state water resources reveals a diversity of approaches and a range of important work, but also suggests an absence of programs that address this topic in the depth that is called for given the current threats to future water supply. Many of the efforts underway focus on single issues and strategies, with little coordination or collaboration among institutions. In the face of projected water shortages in California, there is an urgent need to crystallize an agricultural water conservation agenda. Both research institutions and advocacy groups promoting sustainable agriculture have generally placed insufficient emphasis on issues of water supply challenges. Conversely, those addressing water quantity issues in California, including the important role of water quality in assuring usable water supplies, generally overlook the potential of sustainable agriculture to play a meaningful role. Improved coordination among these groups has great potential. In order to develop and implement a sustainable water plan for California agriculture, there is a need for greater collaboration, a higher profile of this important issue, and more holistic approaches to moving forward toward a water-secure future.

An evaluation of the research and advocacy resources for agricultural water conservation in California exposes several gaps. There are many institutions and individuals carrying out important work on pieces of this topic, but the overall picture is one of isolated projects that do not appear to synergize to foment a strong statewide movement for agricultural water conservation. There is a need for more coordination and focus among civil society and researchers to build a strong sustainable water plan. There must be a shift in the current landscape of agricultural water conservation work if California agriculture is to meet its future water needs without a significant impact on its health as an industry.

4. FUTURE SCENARIOS FOR MEETING CALIFORNIA'S AGRICULTURAL WATER DEMAND

Future projections of water availability and use, coupled with possible conservation measures, are important for establishing realistic goals for agriculture. Several efforts to set targets for meeting agriculture's water demands into the future have been undertaken. These scenarios represent the current thinking on potential savings for a water-secure future. They are listed here to provide preliminary baselines for consideration as strategies for water-wise agriculture are formalized.

1. California Water Plan Update 2005. *The California Water Plan* is published by the Department of Water Resources (DWR) and is updated every 5 years, most recently in 2005. The Plan is intended to "provide a framework for water managers, legislators and the public to consider options and make decisions regarding California's water future."[xxiii] It includes a strategic plan, resource management strategies, regional reports, and thorough reference material. In the strategic plan, three future water scenarios are presented: current trends, less resource intensive and more resource intensive. In all three scenarios, agricultural water demand is projected to be reduced by 2030, ranging from 1.9 to 3.5 maf lower than in 2000, a 5-10 percent decline. This reduction is accounted for primarily by farmland conversion to urban uses; water savings from reduction in irrigated land use is assumed to be largely offset by multi-cropping. In the current trends (business-as-usual) scenario, it is presumed that farmers will continue to shift toward drip irrigation, that rising land prices shrink the agricultural footprint, and that multi-cropped areas increase slightly. The Plan estimates very conservatively that between 0.2 and 0.9 maf of additional water could be provided through increased agricultural use efficiency – just 0.6 to 2.6 percent of agriculture's total developed water use.

The California Water Plan promotes 24 specific strategies for meeting future water demand, two of which address agriculture directly: agricultural lands stewardship and agricultural water use efficiency (see Volume 2, Chapters 2 and 3). The specific recommendations (e.g. more research and monitoring, support for technological improvements) made for the state government under each strategy are each important preliminary steps toward increased efficiency, but the Plan forwards only a limited set of strategies to curb agricultural water use. In addition, it does not address water use in agriculture as a whole nor propose a clear plan for transitioning agriculture toward reduced dependence on developed water.

2. Investment Strategy for California Water. *The Investment Strategy for California Water,* published by Water for California and the Planning and Conservation League,[xxiv] reviews a broad range of water conservation and management options for California and forwards a proposal for the state to meet its water needs by increasing water conservation by a total of 4.4 maf/year. The Strategy identifies agricultural water conservation as a first priority and one of the most cost-effective, environmentally beneficial, and socially acceptable water management strategies for meeting California's water supply needs. However, this component of the strategy proposes modest targets of just 0.3 to 0.6 maf of water conserved annually in agriculture, which represents a total increase

in efficiency of less than two percent over 25 years, a more conservative estimate than even the California Water Plan. The Strategy notes that this is a "*very* conservative" estimate. The Strategy proposes that reduction can be achieved through easily instated improved irrigation technology. A greater focus in the plan is instead placed on urban conservation. Generally, the Strategy provides an important call for public funding to be directed away from large water transfer projects toward locally planned and implemented initiatives that increase regional self-reliance.

3. California Water: 2030. The Pacific Institute's proposal for California's water future is outlined in *California Water: 2030,* an update from their study *California Water 2020: A Sustainable Vision*. *California Water: 2030* evaluates the California Water Plan Update 2005 scenarios and proposes an additional "high efficiency" scenario that sketches out how substantial reductions in human water use might be achieved. The Institute argues that the DWR scenarios represent business-as-usual and that even their "less resource intensive" scenario is based on only minor efficiency improvements. The Pacific Institute high efficiency scenario is an extension of the DWR "less resource intensive" scenario that includes additional efficiencies based on current technology proven to be achievable and cost effective and different estimates of water pricing and trends. In this scenario, agricultural water use is projected to decline by a significant 23 percent (8 MAF), with insubstantial changes to crop production. This is accounted for through the DWR projected decline in irrigated crop area as well as changes in cropping patterns. The scenario is conservative in that it argues that these savings can be achieved with broad adoption of *already-existing* technologies rather than new options for increased efficiency.

AGRICULTURAL WATER USE SCENARIOS: BENCHMARKS FOR THE FUTURE?

While the above scenarios lowball the potential for agriculture to contribute to water conservation, all three present valuable elements for future water planning. The California Water Plan is a formidable effort to pull together information and strategies for coordinating water management at the state level. The *Investment Strategy for California Water* offers an important call for locally based management with the goal of increased self-reliance. The Pacific Institute's high efficiency scenario of reducing agricultural water use by 8 maf/year by 2030 is a useful benchmark and is one the agricultural community could consider pursuing as a baseline target. Given that this scenario relies exclusively on existing technology and water prices, there is clearly room for additional savings through other means. The Pacific Institute also calls for a shift from publicly funded large-scale water transfers to support for regional self-reliance. A truly holistic water conservation strategy would be well served by an inclusion of ecological, as well as technological, approaches. There is great potential to move beyond looking at sustainability-related issues in isolation to consider strategies that address more than one problem at the same time, for example, agricultural production that not only conserves water, but builds healthy soil and provides wildlife habitat at the same time.

All three plans for future water conservation stop short of presenting concrete strategies for achieving these reductions. At the same time, advocates of sustainable agriculture have not explicitly incorporated any of these projected savings into their work. Exceptions include Friends of the River, which has taken up the Pacific Institute's high efficiency scenario targets in their Seven Point Plan for River Conservation. The Vivid Picture Project's sustainable food agenda for California, *The New Mainstream,* proposes that advocates of sustainable food systems aim to achieve the modest *Investment Strategy for California Water* targets through rural-urban partnerships; it also calls for a water conservation plan to be completed.

There is significant room for refinement and improvement of future scenarios and targets for reductions in agricultural water use. In light of future water availability scenarios, advocates of sustainable agriculture should be shooting for a much higher bar.

5. FUTURE STRATEGIES FOR SUSTAINABLE WATER USE IN AGRICULTURE

AGRICULTURAL WATER USE IN THE BIG PICTURE

A sustainable water future for California will necessarily involve a broad, multi-level approach. There appears to be growing recognition that expanding storage through additional large-scale infrastructural approaches such as a series of new dams and reservoirs poses unnecessarily burdensome environmental and financial obstacles. While California Governor Arnold Schwarzenegger proposed rolling out two new major multibillion-dollar dam projects in his state plan for 2007, such projects are increasingly controversial. Assemblyman Jared Huffman responded to the proposal by pointing out that "there are a lot of better things we can do with several billion dollars to improve water supply and quality."[xxv] Alternative approaches such as groundwater banking, recycling, and water transfers are generally expected to play a more important role, as well as urban water conservation.[xxvi] In addition, the Public Policy Institute of California has proposed that by 2030, California could obtain up to 2 maf through storage in groundwater basins, up to 1.4 maf by recycling municipal water, and up to 0.5 maf through desalination.[xxvii] Meeting any of these targets will clearly require significant political will, coordination, education, and technological improvement.

A sensible water strategy for California must include conservation and wise water use in *all* sectors, as well as more coordinated management of the state's water supplies. Among the various strategies described above, it is clear that there is great potential for agriculture to significantly reduce overall water use in California, and that this can be done in a way that benefits producers financially and insulates them from future water shortages. The role of agricultural conservation has been overlooked to a significant degree in water conservation plans at the state level.

APPLIED STRATEGIES FOR SUSTAINABLE AGRICULTURAL WATER USE

Agricultural water use is affected by countless factors, including technological advances, soil health, climate, the cost of water, water rights, and cultural factors. The path forward for agriculture clearly calls for a wide range and combination of complimentary strategies. The following is a summary and evaluation of key approaches to agricultural water conservation. The approaches presented here are in no way comprehensive, but are rather intended to outline strategies that could serve in helping formulate a sustainable water use platform for sustainable agriculture in California.

(A) IMPROVED IRRIGATION EFFICIENCY AND MANAGEMENT

Fine-tuning irrigation systems in California for improved efficiency has long been the mainstay of agricultural water conservation in the state. Significant strides in this field have been made in the past few decades. For instance, between 1980 and 2000, California reduced applied water by 38 percent among 32 selected crops[xxviii] and there is potential for significant additional improvements.

The thrust of this strategy has been technological in nature. Today, producers are increasingly employing precision management tools such as global positioning systems (GPS), remote sensing technology, extensive land-based sensor networks, and sophisticated geographic information systems (GIS) software to ensure just the right amount of water, fertilizers and other chemical applications at the right time in the right place. CIMIS, the California Irrigation Management Information System,[xxix] includes a network of 125 high tech weather stations across the state and functions to provide irrigation scheduling information to over 6,000 users. Precision management, intended as a tool for managing both water quality and use, is based on the philosophy that if you apply just the correct amount of water and chemicals, contamination and runoff will be reduced. This is a promising suite of technologies, but there are significant economic implications of such approaches for producers and water managers alike. A broader cost-benefit analysis has yet to be conducted.

Several important, less technical, approaches are also being developed. UC researchers are advancing irrigation techniques that reduce water applications through an understanding of plant science. Deficit irrigation, a technique for reducing evapotranspiration while maintaining optimum productivity, is being applied on some crops. Root drying irrigation, currently being field tested in fruit trees, alternately irrigates opposite sides of a tree, triggering a biochemical response in the tree whereby loss of water due to transpiration is reduced. A range of other applied irrigation management techniques such as eliminating or reducing furrow runs, irrigating salt-tolerant crops with poorer quality saline water, and root drying irrigation, all contribute to the constellation of irrigation management options that will continue to make California agriculture less water intensive. These techniques promise to be more economically feasible than several of the technological approaches described above. Continuing to improve irrigation efficiency is going to be an important part of a sustainable water use strategy for California agriculture. Less resource-intensive technologies, or appropriate technology, must be considered at the core of irrigation efficiency approaches to water conservation.

(B) AGRICULTURAL LAND STEWARDSHIP

Good stewardship of agricultural lands is essential to water conservation. Practices such as conservation tillage, management of cover cropping, and planting riparian buffers help maintain soil water retention and improve water quality. On another level, addressing the question of what gets planted where, while taking into account the geography, soil properties, and climatic conditions of a place – and doing this on farm after farm – will add up to not only sound water use patterns, but a more sustainable

CONSUMPTIVE VS. APPLIED WATER

Applied ag water can be separated into two components: that which is taken up by plants and that which infiltrates and/or runs off the land. The latter component includes water that recharges groundwater aquifers and surface water such as streams and rivers. General reductions in applied water are important, but even more important to overall water use are reductions in consumptive water (i.e. the amount of water 'consumed' by a crop through evapotranspiration or by animals. This water is the component of use that is not returned to the watershed). Consumptive use can be reduced by, for example, fallowing land. Also, certain crop management practices, such as deficit irrigation, can decrease evapotranspiration and thus consumptive use. Overall reductions in applied water are important too, since not all applied water is returned directly to the stream and is available for re-use; water quality is a factor in consumptive water use. Water that is put through an agricultural system and returned to the watershed can be degraded to a point where it is not usable by those downstream and can thus be considered to be consumed. Agricultural practices that maintain water quality must compliment water conservation strategies.

and less resource dependent agriculture. For example, the industry may reconsider whether water-intensive crops such as alfalfa, cotton, irrigated pasture, and rice (which together consume 54 percent of the state's agricultural water) should be grown in areas where agriculture is overdrawing water, such as along the Colorado River. Some analysts have recommended shifting cropping patterns in California away from water-intensive crops to higher-value, less water intensive crops, which could reduce water demand by 3.5 maf while increasing farm income by upwards of $1.5 billion. Some producers are investigating planting native perennial bunchgrasses to reduce water demands for pastureland. California could also work to couple agricultural land retirement (and even urban development) with areas where agricultural lands are seriously degraded and drainage impaired. Applying agroecological or permacultural philosophies at the farm scale, philosophies that rely on producers having a relationship with the land rather than eliminating local variability for blueprint farming, are vital to increasing water sustainability in the state. Developing water budgets at the local watershed scale and other approaches to achieve local water self-sufficiency are promising.

(C) STORM WATER MANAGEMENT

Approaches that capture and retain excess storm water generated by upstream development and impervious surfaces offer great hope for future water management in California. Several large-scale groundwater banking projects are underway and have been held up as an alternative to large dams. The Kern Water Bank, the largest of its kind, can store up to 1 maf of water in underground reservoirs. However, this project, 48 percent owned by a private company and subject to unaccountable oversight, has been heavily criticized as an attempt to privatize control of California's water.[xxxi]

A range of smaller-scale, farm-based approaches could, if implemented widely, go a long way toward alleviating water applications in agriculture. Industrial agriculture acts much like a storm water drain, diverting water from the soil and back to local waterways. Good management involves capturing and retaining as much precipitation as possible. Retaining storm water through land management approaches such as creating levies, berms, and swales and harvesting rainwater[xxxii] are effective in capturing water for local recharge and essentially serve to level out peaks in the hydrograph.[xxxiii] Approaches such as these sequester sediment that would otherwise impact water quality downstream, recharge groundwater, and facilitate wetlands recharge. Promoting techniques such as site-specific rainwater harvesting, landscape patterning, and conservation hydrology at a broad scale promise to move California agriculture toward water sustainability.

(D) IMPROVING WATER QUALITY

Water quality is clearly a central issue in the water conservation debate. Water that passes from an agricultural system back to the stream cannot be re-used if it is overly degraded. As such, this water, since it is not readily available for re-use downstream or as groundwater, has been essentially "consumed" by agriculture even though it is returned to the stream. Agriculture is the nation's leading contributor of nonpoint source pollution. The State Water Board has estimated that agriculture contributes more than half of the state's water pollution, including particulate matter from soil erosion, increased runoff, pesticides, manure, and salinization.[xxxiv] California's industrial-scale dairies are a lead source of poor water quality, being a major source of salts and other

pollutants. Managing the agricultural system in ways that maintain, or even increase, water quality downstream is key to maintaining usable water supplies and should be a goal of all agriculture. Sustainable production systems are particularly important to maintaining California's water supply because of management approaches that result in fewer chemical residues and healthy soil structure that better retains water.

(E) DRY FARMING

Dry farming is a concept that is only just starting to gain traction in California. Dry farming refers to the production of crops without irrigation water inputs. It typically involves selection of drought-resistant varieties, land management to maximize the use and retention of natural precipitation, and a range of related practices. Several producers are successfully practicing dry farming techniques, and are anecdotally finding that this produces superior quality products but lower yields. There are currently no significant research programs exploring the application of dry farming methods in California. Dry farming techniques and principles comprise a very promising sustainable production approach for reducing agricultural water use.

SUSTAINABLE AGRICULTURE AND CALIFORNIA'S WATER FUTURE

Many of the above strategies can be implemented in ways that have more or less of an "ecological footprint." As described, there are many promising approaches that can significantly reduce agriculture's reliance on distributed water and local groundwater. Evidence points toward solutions that take into account local conditions, implemented at the farm- or local-scale with the watershed as the focal point for management. There is great potential for more fully integrating these water-saving practices with mainstream agriculture. These approaches, while they naturally lend themselves to the coastal regions, can be adapted for Central Valley agriculture to a large degree. And, while largely overlooked in the current dialogue around water conservation in California, these strategies do collectively have real potential to impact overall water use at the state level.

A sustainable water strategy for California should be founded on approaches that do not trade off one ecological problem for another. On all these fronts – improving water quality, applying farm-based appropriate technology, and sound water management and land stewardship techniques – there is clearly a call for sustainable agriculture to lead the way.

6. TOWARDS A SUSTAINABLE WATER PLATFORM FOR CALIFORNIA AGRICULTURE

As a society, we have long been operating under the supposition that the agriculture industry can continue to grow and flourish because we can always manipulate water supplies to provide greater quantities. Today, we are faced with the reality that we are reaching the hard limits of our supplies, that these supplies will become scarcer in the future, and that competition is increasing. The time for readjusting our assumptions and charting a new course is long overdue.

A truly sustainable approach must rethink more fundamentally the face of agriculture in California and work to develop cooperative, not competitive, approaches. It must take into account the long-term wellbeing of producers in the state and ultimately reduce water needs while maintaining economic viability. This is not an unrealistic option – alternatives exist. What's missing is a more comprehensive and holistic approach that marries water conservation goals with the sustainable agriculture agenda.

Large-scale water distribution projects have long enabled the industrialization of agriculture in California. The vast water conveyance infrastructure in the state was set up first and foremost to serve the needs of the large-scale blueprint agriculture of the Central Valley. Agriculture in California's future is going to have to rely on a different approach to meeting its water needs that is markedly different than previous approaches. There is a need for a new vision and plan for taking us there.

Sustainable agriculture – production systems that maintain or improve soil health, limit external inputs, minimize toxic outputs, and are of manageable scale – has great potential for assuming a key role in reducing agricultural water use in California. As California agriculture transitions toward sustainability, water conservation *must* be a focal point of sustainability practices. Production systems that do not take seriously the limited water supplies in California cannot be considered to be truly sustainable. Sustainable agriculture and water conservation are natural partners; California would be well served by approaches that meet both water conservation targets *and* the broader sustainable agriculture agenda.

It is difficult to quantify the extent to which the range of sustainable agriculture approaches use less water than conventional agriculture. Simply measuring overall water use on a farm is itself problematic. However, it is clear that sustainable agriculture does contribute to water conservation by reducing chemical outputs and nonpoint source water pollution, providing superior storm water management, improving water retention in topsoil as well as deep soil storage, better integrating animal manures into the farm system, and other sound water practices that better manage water resources. Many argue that sustainable agriculture is such a small slice of California's production that any real strategy for water conservation must focus on improving the irrigation technology that serves large producers in the Central Valley. Yet if we can truly achieve a statewide shift toward sustainable production, and this shift explicitly holds water conservation as a core principle, real and lasting change can be achieved.

A reduction in agriculture's demand for water will serve the sector in the long run by insulating producers from water shortages they may not be prepared for. It will help shield producers from the impacts of drought and low-water years. It can also help leverage a wider group of stakeholders to work for sustainable agriculture and the associated improvements in water quality will build urban political support for sustainable agriculture.

ADDRESSING THE GAPS

The universe of efforts to address agricultural water use outlined above reveals several important gaps that must be proactively addressed as California agriculture shifts toward sustainability. These gaps include:

- PLATFORM DEVELOPMENT: First, there is not currently a clear and well-articulated water conservation platform for sustainable agriculture. Several isolated workshops and projects on farm water management exist but there is no formalized or ongoing work in this field. There is no unified voice in the sustainable agriculture movement for a water-wise agenda. In addition, there remains a wide gap between the sustainable agriculture community and the constellation of organizations addressing water issues more generally in California. There is great potential for the work occurring in both communities to synergize and complement each other.
- SUPPORTING RESEARCH: There is also a dearth of research supporting the role sustainable agriculture can play in statewide water conservation. There is a need for research programs that address this group of issues, including the role of practices such as dry farming, rainwater harvesting, landscape patterning, and, more broadly, conservation hydrology in supporting agricultural water reductions across the state. Research efforts must also focus on applying these principles at different production scales, and on the challenging task of finding ways to measure water savings. In addition to the practical applications, there is a need for the development of policy options and economic levers that support sustainable agriculture and water conservation.
- PUBLIC POLICY OPTIONS: Policy options that support holistic, ecological approaches to water conservation on the farm are lacking. There is great potential to develop policy language and work with local and state authorities to support sustainable agricultural water use and articulate its potential as a real and affordable alternative to large-scale dam projects.
- NEW SYNERGIES AND ALLIANCE BUILDING: Finally, there is room for much more awareness about the potential for sustainable agriculture to meaningfully address shortages in water supply, and for water supply to form part of a sustainable agriculture agenda. The gulf between the movements for sustainable agriculture and water conservation alludes to the lack of connections being made. Education can bridge this gulf and stimulate collaboration and sound strategies for agricultural water conservation.

There is a great deal of work to be done on the road to a more water secure future for California agriculture. The gaps listed above represent the kind of factors that must be addressed as advocates of sustainable food and farming systems bring the water issue into their purview.

MOVING FORWARD

In light of the need, and potential, for sustainable agriculture to more formally adopt water conservation as a core principle, a range of activities should be considered toward the development of a concrete work plan for advocates to adopt and implement. The following overarching goals, addressing key needs, must be taken up:

(1) Formulate a robust and inclusive sustainable water platform for California agriculture, one with sustainable agriculture at its core and one that includes an ecological framework for water conservation.

(2) Bring water conservation front and center in the sustainable agriculture movement and develop strategies for promoting water-wise sustainable agriculture in the mainstream.

- Create a work plan (including a research agenda) and promote adoption of its elements among key change makers.
- Conversely, leverage the issue of our ailing water supplies to further the case for sustainable agriculture in California. Dwindling water supplies are one more argument for widespread adoption of sustainable agriculture in California.

(3) Shift consciousness: increase literacy about the intersection of water conservation and sustainable and key strategies for change.

- Develop educational materials for key target groups to build broad support for water conservation in agriculture
- Promote and support demonstration projects
- Document, articulate, and promote good practices

(4) Build bridges among stakeholders to bring together a broad and unified coalition in support of sustainable agriculture.

- Create linkages between the sustainable agriculture movement and water advocacy, environment, and fish groups, local government commissions, urban water conservation interests, and other stakeholders
- Increase coordination and collaboration among these stakeholders

Together, these elements make up a preliminary agenda for moving California agriculture toward a more water-secure future. Advocates of sustainable agriculture may consider implementing and building on these goals and activities in the move toward a more sustainable future for the next generation.

APPENDIX 1:
SELECTED RESEARCH INSTITUTIONS AND PROGRAMS ADDRESSING AGRICULTURAL WATER USE

THE UNIVERSITY OF CALIFORNIA CENTER FOR WATER RESOURCES

The Center for Water Resources stimulates and supports water-related research both within and among the various academic departments and research organizations of the University. The broad research focus includes the conservation, development, management, distribution, and utilization of water resources with a view to the optimum present and future use. The WRC engages the resources of the University of California with other institutions in the state for the purpose of developing ecologically-sound and economically efficient water management policies and programs in California.

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THE UC SUSTAINABLE AGRICULTURE RESEARCH AND EDUCATION PROGRAM (SAREP)

SAREP is a statewide program within UC Agriculture and Natural Resources. It was created through the grass roots efforts of organizations and individuals concerned about the environmental impacts of agriculture, the health of rural communities, and the profitability of family farming operations in California. The University of California established SAREP with three mandates: administer competitive grants for research on sustainable agricultural practices and systems, develop and distribute information through publications and on-farm demonstrations, and support long-term research and sustainable farming systems on UC farmlands.

CONTACT:
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Food Systems Coordinator
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UC DAVIS DEPARTMENT OF LAND, AIR, AND WATER RESOURCES

Land, Air, and Water Resources is a multidisciplinary department with faculty who specialize in atmospheric, plant, resource, soil and water science, hydrology, and water engineering. Teaching and research focus on both agricultural and environmental science. The faculty contribute to numerous other undergraduate and graduate programs in the Colleges of Letters and Science, Engineering, and Agricultural and Environmental Sciences.__ Graduate programs include Atmospheric Science, Soil Science, and Hydrology, as well as Undergraduate programs in Atmospheric Science, Soil and Water Science, Hydrology, and Environmental and Resource Sciences are available at the Davis Campus of the University of California.

CONTACT:
Wesley W. Wallender, Professor and hydrology specialist at SAFS
University of California, Davis
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continued

David A. Goldhamer,Water Management Specialist
Kearney Agricultural Center
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Email: dagoldhamer@ucdavis.edu
Fax: 559-646-6593

Jeffrey P. Mitchell, Extension Specialist
Department: Vegetable Crops, UC Davis_Location:
Kearney Agricultural Center
Telephone: (209) 891-2660
Fax: (209) 891-2513_E-mail: mitchell@uckac.edu
General Research Interest Statement:

My work addresses water management, resource use efficiency and postharvest product quality aspects of integrated vegetable production systems.

AGRICULTURAL ISSUES CENTER

Because of today's more intense competition for resources, continuing environmental concerns and broader global linkages, public policy decisions impacting California agriculture are more complex than ever before. The UC Agricultural Issues Center's mission is to provide broadly-based and objective information about public policy issues affecting California agriculture and their significance for California's economy and natural resources. For 15 years, the Center has served as a forum where important and often controversial trends and issues involving California agriculture – ranging from water transfers to international trade – have been identified, studied and debated.

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THE DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

The Department of Agricultural and Resource Economics at UC Davis is recognized nationally and internationally for the quality of its faculty and for the strength of its undergraduate and graduate programs. The Department's professional staff consists of 22 teaching and research faculty and 6 cooperative extension specialists.

CONTACT:
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UC SANTA CRUZ CENTER FOR AGROECOLOGY AND SUSTAINABLE FOOD SYSTEMS

The mission of the Center for Agroecology & Sustainable Food Systems (the Center) is to research, develop, and advance sustainable food and agricultural systems that are environmentally sound, economically viable, socially responsible, nonexploitative, and that serve as a foundation for future generations.

CONTACT:
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SUSTAINABLE AGRICULTURE FARMING SYSTEMS (SAFS) PROJECT

SAFS provides leadership in scientific research and education in alternative, more sustainable approaches to growing food and fiber, including minimizing the impact of farming practices on soil and water resources. SAFS serves the California agricultural community, particularly farmers, farmworkers, ranchers, researchers,

industry professionals, policy makers, educators and students. SAFS will soon be part of the University of California ANR/UC Davis campus joint Agricultural Sustainability Institute (ASI), which includes the UC Sustainable Agriculture Research and Education Program.

CONTACT:
Wesley W. Wollender (see above)
Website: http://safs.ucdavis.edu

LONG TERM RESEARCH ON AGRICULTURAL SYSTEMS (LTRAS PROJECT)

The SAFS site operates alongside UC Davis' Long Term Research on Agricultural Systems (LTRAS). LTRAS is the only research program in California attempting to monitor slowly changing processes and variables. The LTRAS site hosts a 100-year main experiment and various shorter-term experiments, all focussed on improving the sustainability and environmental impact of agriculture.

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Email: srkaffka@ucdavis.edu

CALIFORNIA STATE UNIVERSITY AGRICULTURAL RESEARCH INITIATIVE

The California State University Agricultural Research Initiative (ARI) is a comprehensive applied agricultural and environmental research program joining the CSU's four colleges of agriculture and the state's agriculture and natural resources industries and allied business communities. The ARI fosters the development and evaluation of new and promising technologies that have the potential for improving food safety, environmental stewardship, economic performance, and long-term sustainability of California's agriculture industry. ARI projects and programs build upon a successful record of past applied research accomplishments and augment, enhance, and extend the basic research conducted by the nation's land grant universities.

CONTACT:
Joe Bezerra, Executive Director
CSU Fresno, California Agricultural Technology Institute
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CENTER FOR IRRIGATION TECHNOLOGY

In our unique position as an independent research and testing facility, the Center for Irrigation Technology (CIT) plays a vital role in assisting designers, manufacturers and users of irrigation equipment to make the technological advances required for our growing, changing world.

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INTERNATIONAL CENTER FOR WATER TECHNOLOGY

The International Center for Water Technology was established to provide education and research to assist in developing and adopting innovative solutions and technologies that improve water use efficiency. The program's broad mandate includes water supply and quality; flood protection; and environmental enhancement. Activities focus on extended education, laboratory and field research, and policy development. While the program targets opportunities and issues within the San Joaquin Valley region, solutions and experiences are applicable worldwide.

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CALIFORNIA WATER INSTITUTE

The California Water Institute (CWI) was founded to be a forum for unbiased, open, collaborative discussion, research and education on water-related issues benefiting the entire state. Its specific goals are to carry out concise, comprehensive studies that will provide the direction for better future uses and conservation of the State's waters, to promote practices that will enhance and preserve the State's water resources and their quality, to serve as a center for research, education, planning, policy evaluation, and information transfer, to communicate the results of its research and studies with the residents of California, and to collaborate with agencies and institutions in California to seek a positive resolution to the State's complex water problems.

CONTACT:
Laura Ramos or David Zoldoske, Director
(see above)

THE IRRIGATION TRAINING AND RESEARCH CENTER

The Irrigation Training and Research Center (ITRC) was established in 1989 at California Polytechnic State University, San Luis Obispo, as a center of excellence, building on a history of contributions to the irrigation industry. The first commitment of ITRC is to enhance Cal Poly's strong irrigation teaching program through outside activities in training, research, and technical support. Irrigation faculty members comprise the board of directors; an industry advisory board provides guidance and support. Cal Poly and ITRC are proud of their ability to combine sophisticated theory with a "hands-on" approach to provide a usable product.

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APPENDIX 2:
SELECTED ADVOCACY ORGANIZATIONS ADDRESSING WATER USE IN AGRICULTURE

AGRICULTURAL WATER MANAGEMENT COUNCIL

The Agricultural Water Management Council is a non-profit organization established in 1996 dedicated to bringing together all interested parties in agricultural water management with the expressed goal to achieve greater water management efficiency. All those interested in the management of agricultural water are invited to join the Council and participate in its program.

The Council works in a voluntary and cooperative manner to establish a consistent, unified, and credible process that will advance agricultural water management in California and assist agricultural water suppliers in demonstrating that they are using water efficiently. It is the Council's responsibility to aid the signatory water suppliers through development and implementation of Water Management Plans to increase efficiency.

Their main focus is water management planning, specifically helping water suppliers improve their ability to deliver water and manage the delivery of that water to the growers. In 1999, they developed a widely accepted MOU regarding efficient water management practices by agricultural water suppliers in California. Focus on managing conveyance facilities, for example improving canal lining, automation and coordination.

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Website: www.agwatercouncil.org

ENVIRONMENTAL JUSTICE COALITION FOR WATER

The Environmental Justice Coalition for Water is a network of more than fifty grassroots and intermediary organizations. EJCW works to empower community members to become strong voices for water justice in their communities. We enable community members to take control of their water resources by participating in water policy, planning and decisions. We ensure policy makers are listening to the concerns of community members and hold policy makers accountable for the heavy impacts water policy has on low-income communities and communities of color. The coalition is building a collective, community-based movement for democratic water management and allocation in California.

CONTACT:
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FRIENDS OF THE RIVER

FOR is dedicated to preserving, protecting, and restoring California's rivers, streams, and their watersheds. The organization accomplishes its mission by providing public education, citizen activist training and organizing, and expert advocacy to influence public policy decisions on land, water, and energy management issues. Friends of the River is California's statewide river conservation group, with a well established track record of winning lasting victories for river conservation. FOR works to preserve California's most pristine rivers, restore those rivers that

have been damaged by ill-considered dams, and advocate for common sense policies on river management and smart water use.

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NATIONAL HERITAGE INSTITUTE

Since its inception, NHI has been a leader in the formulation and enforcement of environmental regulations. They also work with harnessing market forces for change. An example of environmental damage due to market failure is California's water management. Legal and institutional barriers to the emergence of water markets freezes the allocations of scarce water resources in the hands of those who first appropriated them, and inhibits reallocation in the direction of higher contemporary social values, including the rehabilitation of nearly extirpated salmon stocks throughout the Central Valley rivers. Moreover, without markets, agricultural areas frequently have little incentive to conserve water, since there are few economic rewards for doing so. The result is a continual increase in diversions and erosion in natural river flows. NHI is developing the Conjunctive Use Project in the Central Valley of California to expand the benefits of the fixed endowment of water and to enhance its storage and delivery infrastructure to meet future water needs.

CONTACT:
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Natural Heritage Institute
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NRDC

NRDC is working in California's Central Valley, targeting the effects of wasteful agricultural practices. We promote more efficient irrigation, press the federal government to remove subsidies that discourage efficiency, and work to restore water to the San Joaquin River, after years when diversion for farming ran it dry.

CONTACT:
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Website: www.nrdc.org

OCCIDENTAL ARTS AND ECOLOGY CENTER WATER INSTITUTE

OAEC's WATER Institute (Watershed Advocacy, Training, Education & Research) promotes an understanding of the importance of healthy watersheds to healthy communities. OAEC's WATER Institute builds upon OAEC's many years of regional watershed research, restoration, advocacy, community organizing, and activism. Activities include the development of watershed-scale water budgets, the pioneering and development of the field of conservation hydrology, the training of watershed group leaders, work on regional water policy and demonstration projects on their 80-acre site.

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PACIFIC INSTITUTE

The Pacific Institute for Studies in Development, Environment, and Security is an independent, non-profit center created in 1987 to conduct research and policy analysis in the areas of environment, sustainable development, and international security. The Institute strives to improve policy through sound research and consistent dialogue with action-oriented groups from the international to local level. The Institute has three broad

goals: (1) to conduct policy-relevant research on the nexus of international security, environmental change, and economic/social development; (2) to collaborate on complementary research efforts with other organizations and individuals; and (3) to actively work on developing solutions with policymakers, activists, and the general public. The Institute's Water and Sustainability Program works to improve efficiency, ensure basic access to water, and protect the environment.

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PLANNING AND CONSERVATION LEAGUE

PCL is the only organization solely devoted to making California a better place to live by lobbying the California State Legislature on a full range of environmental issues and by sponsoring environmental initiatives. PCL is also California's only statewide environmental coalition. PCL coordinated the *Investment Strategy for California Water*, a project of Water for California. This document identifies the most cost-effective, environmentally beneficial and socially acceptable water management strategies for the state. It directs public investments to local planned and implemented programs to increase regional water self-sufficiency. The *Investment Strategy* analyzed a wide range of management options, all the way from conservation and recycling to transfers, desalination and construction of new dams. The Strategy was developed in a fully open and inclusionary process. All drafts were posted for comment on the PCL website. Input from two public workshops helped guide development of the Strategy. Each of the recommendations is fully documented by multiple, credible sources.

The Planning and Conservation League, publishers of the *Investment Strategy for California Water* (described below), has a small but active water program and they are active in lobbying the state government on water supply issues. They currently focus on issues such as desalination, water rate reform and groundwater use reporting. Working to change the culture and work toward a water-wise California through a combination of water conservation, recycling groundwater cleanup, and storm water capture. The organization Water for California collaborated with PCL on the Investment Strategy and focus their efforts on water conservation with a focus on overdraft issues and water supply politics.

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PUBLIC POLICY INSTITUTE OF CALIFORNIA

The Public Policy Institute of California (PPIC) is a private, nonprofit organization dedicated to improving public policy in California through independent, objective, nonpartisan research. As California's economy grows, so does urbanization in the state, creating both the setting for economic development and challenges for its future. Continuing urban growth places great stresses on the state's ability to manage the consequences of development and to provide the physical infrastructure for key elements, such as roads, schools, and water. PPIC's research targets specific infrastructure issues, such as how it can be provided and paid for, and identifies areas of special need, such as the Central Valley, where the consequences of future growth are likely to be especially powerful.

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RESTORE THE DELTA

Restore the Delta is a grassroots campaign of residents and organizations committed to restoring the California Delta so that its waters are fishable, swimmable, drinkable, and farmable. A coalition of California Delta residents, community groups, farmers, business leaders, fishermen, faith-based communities, unions, and environmentalists, Restore the Delta envisions the California Delta as a place where a vibrant local economy, tourism, recreation, farming, wildlife, and fisheries thrive as a result of resident efforts to protect our water way commons.

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WATEREUSE ASSOCIATION

The mission of the California Section of the WateReuse Association is to promote responsible stewardship of California's water resources by maximizing the safe, practical, and beneficial use of recycled water and by supporting the efforts of the WateReuse Association.

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SUSTAINABLE CONSERVATION

Sustainable Conservation advances the stewardship of natural resources using innovative, pragmatic strategies that actively engage businesses and private landowners in conservation. Founded in 1992, Sustainable Conservation partners with business, agriculture and government leaders to find practical ways that the private sector can protect clean air, clean water and healthy ecosystems. The award-winning nonprofit organization leads powerful collaborations that produce lasting, win-win solutions to critical environmental problems.

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WATER FOR CALIFORNIA

Water for California is a non-profit organization dedicated to promoting the conservation and the equitable and environmentally sensitive uses of California's water. Their focus is on water supply issues and the politics of water supply. They have no programs focused specifically on agriculture, but their project *Investment Strategy for California Water* addresses agricultural water use to some degree.

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APPENDIX 3:
PUBLIC AGENCIES INVOLVED IN CALIFORNIA WATER MANAGEMENT

Many State departments and agencies oversee California's water resources. DWR operates the SWP and is responsible for overall water planning. SWRCB integrates water rights and water quality decision-making authority. SWRCB and the nine Regional Water Quality Control Boards are responsible for protecting California's water resources. Pursuant to the Porter-Cologne Water Quality Control Act, water quality control plans for each of the nine regions become part of the California Water Plan. Other State agencies and their roles in water management follow:

- California Bay-Delta Authority–Oversees the 23 State and federal agencies working cooperatively through the CALFED Bay-Delta Program to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem.
- California Coastal Commission–Plans for and regulates land and water uses in the coastal zone consistent with the policies of the Coastal Act.
- California Department of Conservation–Provides services and information that promote environmental health, economic vitality, informed land-use decisions, and sound management of California's natural resources.
- California Environmental Protection Agency–Restores, protects, and enhances the environment to ensure public health, environmental quality, and economic vitality.
- California Integrated Waste Management Board–Manages the estimated 76 million tons of waste generated each year by reducing waste whenever possible, promoting the management of all materials to their highest and best use, and protecting public health and safety and the environment.
- California Public Utilities Commission–Regulates privately owned water and other utility companies.
- Colorado River Board–Protects California's rights and interests in the resources provided by the Colorado River.
- Delta Protection Commission–Responsible for preparation of a regional plan for the "heart" of the Delta.
- Department of Fish and Game–Regulates and conserves the state's wildlife and is a trusteefor fish and wildlife resources (FDC § 1802).
- Department of Toxic Substances Control–Provides technical oversight for the characterization and remediation of soil and water contamination.
- Reclamation Board–Plans flood controls along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the U.S. Army Corps of Engineers.

FEDERAL GOVERNMENT

USBR operates the CVP, the largest water project in California, and regulates diversions from the Colorado River. Other federal agencies play important roles in the regulation and management of California's water resources:

- Army Corps of Engineers–Plans, designs, builds, and operates water resources projects (navigation, flood control, environmental protection, disaster response, etc.).
- Federal Energy Regulatory Commission (FERC)–Regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to license hydropower projects.
- National Marine Fisheries Service (NOAA Fisheries)–Protects and preserves living marine resources, including anadromous fish.
- National Park Service–Manages national parks, including their watersheds.
- U.S. Bureau of Land Management- Manages federal lands.
- U.S. Bureau of Reclamation–Constructs federal water supply projects and is the nation's largest wholesaler of water and the second largest producer of hydroelectric power.
- U.S. Department of Agriculture (USDA)–Manages forests, watersheds, and other natural resources.
- [USDA] Natural Resource Conservation Service- Provides technical and financial assistance to conserve, maintain, and improve natural resources on private lands.
- U.S. Environmental Protection Agency–Protect human health, safeguarding the natural environment.
- U.S. Fish and Wildlife Service–Conserves, protects, and enhances fish, wildlife, and plants and their habitats.
- U.S. Geological Survey–Provides water measurement and water quality research.
- Western Area Power Administration–Manages power generated by the Central Valley Project.

PUBLIC AGENCIES, DISTRICTS, AND LOCAL GOVERNMENTS

Local city and county governments and special districts have ultimate responsibility for providing safe and reliable water to their customers. In general, California has two methods for forming special districts that develop, control, or distribute water: (1) enactment of a general act under which the districts may be formed as set forth in the act, and (2) enactment of a special act creating the district and prescribing its powers. (See Volume 4 Reference Guide for article "What's So Special about Special Districts? A Citizen's Guide to Special Districts in California.") Cities and counties are the land management and planning entities as well as resource management agencies that most influence the location and amount of population growth within the state. Many counties have adopted ordinances that require permits for certain uses of groundwater within their boundaries.

Excerpted from: Department of Water Resources (2005). *California Water Plan Update 2005*. Volume 1, Ch. 3: 35-38.

APPENDIX 4:
INDIVIDUALS INTERVIEWED FOR THIS STATUS REPORT

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Jonas Minton, Planning and Conservation League
Brock Dolman, OAEC Water Institute
Peter Ferenbach, Friends of the River
John Cain, Natural Heritage Institute
Kathryn Charlton, Agricultural Water Management Council

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