

## Executive Summary

# Achieving a Sustainable California Water Future Through Innovations in Science and Technology

California Council on Science and Technology  
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## 1. Executive Summary

### Water Innovation Opportunities

California has a long history of success in leveraging innovations in science, technology, management and implementation strategies to improve its resource management, including its continued leadership in energy efficiency. The State's best strategy for dealing with its water challenges, both current and future, lies in taking a system management approach to water similar to the approach used for energy. Also, as with energy, innovative water technologies represent a sound business opportunity for California.

This report highlights innovations in science, technology, management, and implementation across a broad range of water supply, demand and management areas, and suggests strategies and recommendations for continued investment and support of innovation in California. It is our assessment, as detailed in this report, that continued innovation both through the development of new solutions and the broader application of proven successes can help California improve its water management and support a long-term healthy and sustainable water system. In order to be successful, however, we will need to align our efforts on an integrated set of strategies (roadmap) that will require leadership, action and investment by both the public and private sectors.

### Background

This report builds upon the California Council on Science and Technology (CCST) 2011 assessment of California's innovation ecosystem, entitled "Innovate to Innovation" (i2i). The 2011 report identified the management of the California water resources as a serious challenge to California's long-term economic prosperity. This report provides a roadmap of innovations in science and technology that could, if effectively implemented, significantly improve the management of California's water system over multi-year cycles ranging from very low precipitation that can result in drought conditions to significantly above average precipitation that can result in severe flooding. The current study is also designed to complement the 2013 Update of the California Water Plan facilitated by the California Department of Water Resources (DWR) and the Governor's California Water Action Plan prepared by the California Natural Resources Agency, the California Department of Food and Agriculture, and the California Environmental Protection Agency.

### Current Water Challenges

Water is a fundamental resource challenge facing California, and its planning and management is a critical underpinning of California's economy and environment. The impacts of climate change and weather variability, including potentially higher uncertainty in the magnitude of the Sierra Nevada snowpack, rising sea levels, and the prospect of increasingly severe and variable wet-dry conditions throughout the state, threaten the future availability and quality of California's water supply. Additionally, many of the state's aquifers continue to be significantly over-drafted. Historically, California has relied on large-scale engineering solutions to address its water needs and manage floods, building massive water systems based on dams, canals, and pipelines. The aging of this infrastructure, combined with climate change impacts and a growing population, increases the difficulty for the state to ensure adequate water supply for its residents, agriculture, businesses and environment.

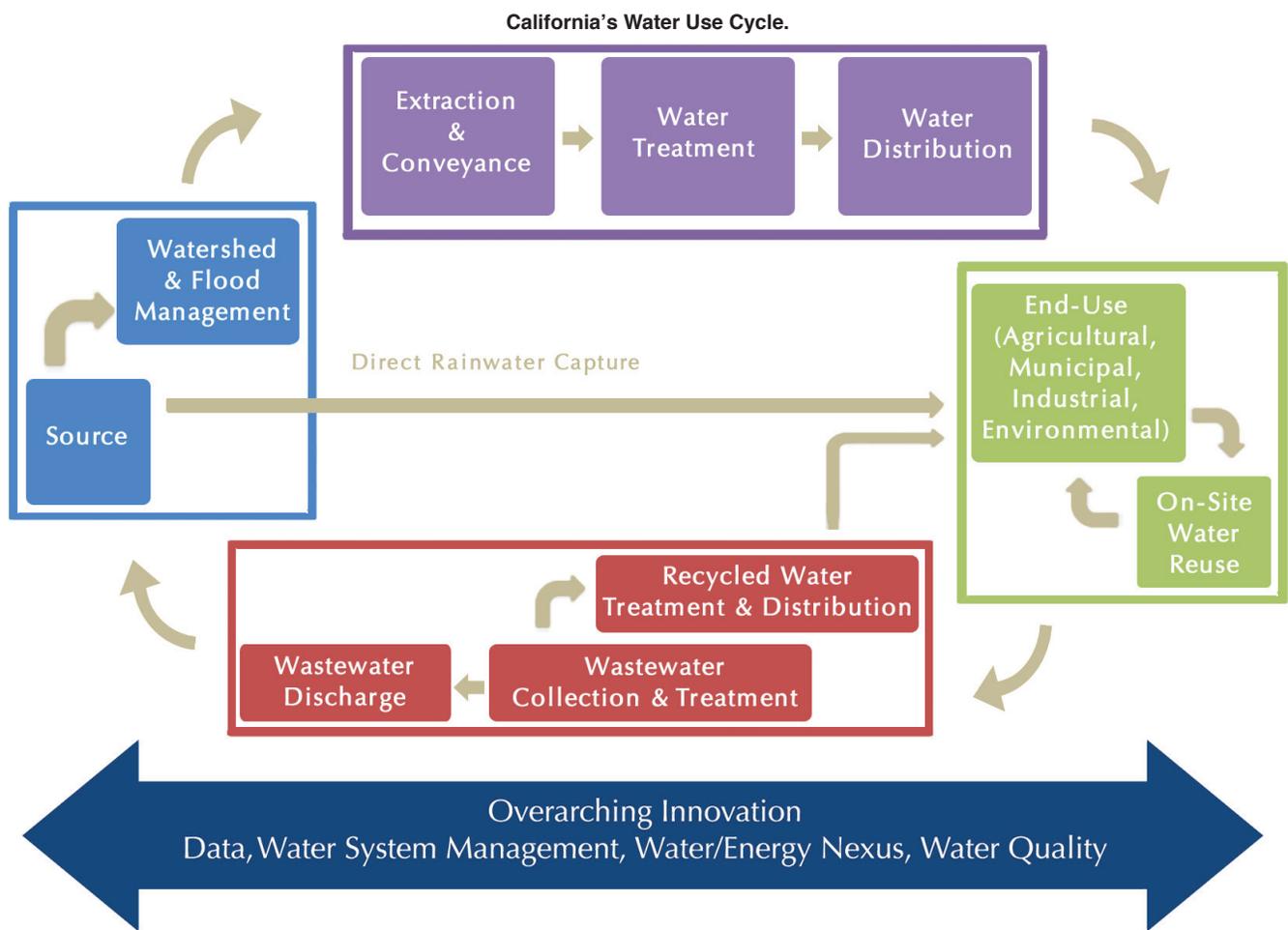
### Conclusions and Recommendations

This report draws on a wide spectrum of water technology experts throughout the state, from academia, state and local agencies, non-governmental organizations, and the private sector, to identify and describe innovative water technologies and/or systems approaches with significant potential to help California achieve water sustainability. Our intent is to include technologies that can be introduced or more widely applied to California's water system(s) within the next five to ten years, and which are suitable for implementation at levels ranging from local to statewide. It is our belief that many of these recommendations lend themselves easily to the development of policy actions needed to support implementation. It is beyond the scope of this study to evaluate the economic viability or potential of individual technologies and other innovations.

**High-Level Conclusions**

The following high-level conclusions characterize the report and form the foundation for the detailed specific recommendations that follow.

- 1. Innovation and policy action have delivered significant benefits and are essential for a sustainable water supply:** Advancements in science and technology such as low-flush toilets and drip irrigation, deployed through appropriate policy actions and economic incentives, have contributed to significant water savings and/or improved water use efficiency as demonstrated by high-level economic metrics (e.g. water use per capita, water use per dollar of GDP).
- 2. The water use cycle frames the issues and opportunities:** The water use cycle provides a useful lens for the analysis of our water challenges. This systems approach clarifies many opportunities for science and technology innovation implementation – both using new technology and through expanded application of proven technology. Innovation opportunities exist at both the individual cycle block level and across the cycle as a whole. (See figure below.)



- 3. An integrated systems management approach is a key to achieving multiple benefits:** The use of a systems management approach for the deployment of current and future innovations proposed in this report can achieve multiple benefits throughout the water use cycle including reduced water consumption at various steps, reduced energy needs, improved economic resiliency and enhanced environmental sustainability.
- 4. The need for a comprehensive integrated information system is pivotal to implementing a systems management approach:** The collection of real time or near real time data on all elements of the hydrologic cycle is a key to good decision making and the analysis of trends and the development of fact-based

forecasts and recommendations. Currently, sufficient information does not exist in a form that allows sustainable management of California water resources.

5. **Opportunities abound for near and long term policy action and implementation:** Individually and collectively, many of these innovations lend themselves easily to policy action to encourage implementation and a broader level of public awareness, understanding and support.

### Specific Recommendations

We have developed the following specific recommendations regarding particular technologies, management approaches and implementation strategies, along with actions that can achieve multiple benefits in the near term. These near-term actions are typical of many choices that are available. Investment and policy decisions should be based on the best use of options under consideration for the local, regional or statewide best interest. The order of the recommendations is based on the project team’s general assessment of their importance and potential. We have also identified barriers to implementation and specific parties most logically responsible for facilitating adoption of these recommendations along with a list of possible next steps – all included after the recommendations below.

1. **Develop and implement an integrated water information management system** for water supplies, uses, and quality including precipitation, runoff, and storage; for surface water, groundwater, and water use. *In situ* and remote monitoring devices and networks should be expanded and linked to an integrated data management system, or implemented where not available but needed. A common portal, such as DWR’s Water PIE and UC Davis’ HOBBS, that forms the cyber core of a flexible data and information-management program and capable of supporting data analysis, trending and scenario forecasting, should be developed with a common set of standards to link data collection from all sources with an integrated data management system. **Near-Term Actions:** The Governor and key agencies should immediately take the lead to form a consortium of parties, including the State Water Resources Control Board and the Department of Water Resources as well as a broad coalition of water experts in academia, trade organizations and non-governmental organizations with the specific goals of (1) evaluating what is realistic and practical to do in the short term, (2) designing the data collection and management system to accomplish the near-term task while maintaining capability for future flexibility and then (3) fully implementing this recommendation.
2. **Expand the use of monitoring technology and management practices** including meters and advanced metering infrastructure (AMI) focused on system performance, all water and energy usage, including the monitoring of groundwater withdrawals, and the implementation of management practices for sustainability uses. **Near-Term Actions:** Encourage the metering of all water usage, both agriculture and urban, from all sources, to ensure system use efficiency, quantify demand, and optimize resources inputs for long-term sustainable and reliable water supplies.
3. **Improve water use efficiency in all sectors and at all stages of the water cycle** through applications of proven and developing technology and management practices.
  - In the **agricultural sector**, encourage and incentivize the expanded use of irrigation system designs, installation and management that help improve water use efficiency. Provide real-time information on system performance and field conditions to optimize decision-making. Promote the development of drought/salt tolerant plants, appropriate water treatment, and seek multiple benefits from agricultural practices like vegetative “filter strips” that benefit both water quality and the environment. **Near-Term Actions:** Employ technology that monitors system performance, including water and energy use and soil/water status, to also provide “alerts” regarding system changes that will often require corrective action.
  - In the **urban sector**, encourage and incentivize appropriate landscapes and efficient irrigation methods, the expanded use of high efficiency plumbing devices and appliances, the development of leak detection and management processes including the use of self-repairing materials for distribution systems capable of handling small to moderate leaks, the expanded use of on-site graywater and rain water/stormwater harvesting, and increased use of recycled water. **Near-Term Actions:** Encourage and accelerate the use/retrofit of water efficient landscapes and irrigation systems, and the retrofit of plumbing fixtures and water-using appliances with high-efficiency devices. Depending upon local conditions and priorities, encourage the use of graywater recycling systems in all new construction and major retrofit projects, the expanded use

of water recycling technologies and the construction of rain water/stormwater collection, treatment and retention systems.

- **In all sectors**, utilize proven “system thinking” strategies that facilitate holistic problem solving approaches such as foot-printing, goal setting and integrated system planning and design across the water use cycle.

**Near-Term Actions:** Encourage the use of proven “system thinking” including smart water technology tools at the local, regional and statewide level to achieve multiple benefits for water savings, energy savings, economic resiliency and environmental protection.

4. **Restore and protect watersheds and enhance flood management planning including floodplain restoration** (constructed and natural) to increase recharge and groundwater storage, capture and retain storm-water runoff, reduce anthropogenic contamination and improve water quality, and provide for sustainable water systems.

**Near-Term Actions:** Identify and support high impact actions to restore and protect watersheds including floodplains and encourage actions to improve the operation of these watersheds and the enhanced collection and storage, both surface and subsurface, of stormwater runoff utilizing proven commercial products and design approaches.

5. **Develop new and expand the application of proven chemical, physical, and biological water treatment technologies** for the treatment of surface water and groundwater with an emphasis on (1) salinity management and nitrate control and (2) recycling water with the appropriate quality for the intended use.

**Near-Term Actions:** In addition to effective water conservation measures, expand recycling and the use of desalination and nitrate reduction technologies and other advanced water treatment technologies, where appropriate, to both broaden our portfolio of water sources and advance public health goals of increasing the availability of safe drinking water.

6. **Integrate water, energy and land use planning and management** to improve resilience and tap multiple benefits of reduced energy demand for water systems and reduced water demands from energy systems.

**Near-Term Actions:** Encourage and facilitate investments, both public and private, in coordinated and integrated water and energy efficiency options and source-shifting of supplies to tap multiple benefits including greenhouse gas emissions reductions. Evaluate water, energy, and land-use plans and strategies based on multiple benefit criteria and incentivize these integrated solutions.

7. **Continue to support and fund initiatives by various public sector institutions** at the federal, state and local levels whose research will be integral to advancing innovation to address California’s water challenges.

**Near-Term Actions:** The Governor and key agencies, working with their local and federal counterparts, should take the lead for developing funding for the research that is critical for California’s water future. Also encourage increased coordination between water-related entities/agencies at the federal, state, regional and local level. Going forward, California must act with some urgency as it will continually be water challenged.

8. **Expand the use of private sector initiatives** to identify and develop new technologies, techniques and services to include networks to broker information, and expand the use of public/private partnerships to accelerate development, piloting and commercialization of needed technologies.

**Near-Term Actions:** The Governor’s Office of Business and Economic Development, in collaboration with other government agencies and representatives of the public and private sector, should spearhead and assure that this recommendation is effectively implemented.

9. **Identify, evaluate, adapt and implement best practices** from around the U.S. and the world that can help California meet its water use efficiency, water treatment and water management goals.

**Near-Term Actions:** Elected officials and appropriate state, local and federal agencies along with a network of individuals from academia, NGO’s and others should develop and maintain relationships with key parties around the U.S. and the rest of the world, be open to innovations and seek out and implement best practices. A responsible State Official should be assigned the responsibility of assuring that this action is achieved.

### Barriers to Implementation

Each recommendation including possible near-term actions has with it an associated set of barriers that must be addressed in order for the roadmap to be successfully implemented. The most significant barrier to the effective implementation of these recommendations is the lack of agreement on a strategic plan for water in the state and the

lack of leadership to assure that the strategic plan is implemented, driven largely by the heavily fragmented nature of water resource management in California today. Once we address this issue, the next most significant barrier is insufficient funding, which is likely to remain a significant constraint over the coming years despite California's recent exit from years of deficits. The very complex legal infrastructure and arcane water rights laws further complicate any implementation planning. Resistance to the implementation of many of these recommendations will come from a number of invested parties and this could slow the process significantly. In addition, lack of public understanding and support for several of these actions is a challenge that must be dealt with.

### Agents of Change

Each recommendation and proposed near term action has with it a set of parties who are critical to successful implementation. These include (1) federal, state, regional and local political leaders, (2) state, regional and local water agency leaders, (3) water experts in academia, the national labs, industry, non-government organizations (NGO's) and think tanks, and (4) the various stakeholders associated with each recommendation and its implementation plan. Overall, we encourage decision makers to create policy and funding approaches to implement the recommendations included in the report.

### Next Steps

1. Develop implementation plans associated with each of the Near-Term Actions identified above including any policy actions required.
2. For the broader recommendation areas, an organized and disciplined approach is needed to assure that the roadmap proposed can be successfully implemented. This includes:
  - a. The need to refine the tools and methods to quantify and assess the multiple benefits in water management needed to facilitate implementation of identified innovations.
  - b. Where necessary, assess the economic viability of the identified technology innovations and assess the potential impact of these innovations on the overall California water system.
  - c. Identify the policy actions required to encourage, incentivize or mandate the implementation of these recommendations where their economic viability and potential justify such actions.
  - d. Develop detailed implementation plans including processes to assure buy-in from all involved stakeholders.
3. CCST could potentially conduct or facilitate the completion of these analyses, contingent upon securing adequate funding.



## Appendix A: Steering Committee

The CWF Steering Committee, responsible for the planning, oversight of the work, and final product review was comprised of the following:

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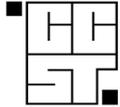
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