Research Brief

WATER IN THE WEST

STANFORD WOODS INSTITUTE FOR THE ENVIRONMENT

THE BILL LANE CENTER FOR THE AMERICAN WEST

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Storing Water in California: What Can $2.7 Billion Buy Us?

Background

California's water system is complex in its infrastructural, fiscal, and governance landscape. Since 2000, state spending on water through general obligation bonds has provided about $27 billion to fund California's water supply, treatment, and infrastructure.[1,a] Authorized bond funds have supported ecosystem enhancements (27%), flood protection (25%), parks and public access (22%), integrated management (8%), drinking water quality (7%), water supply (6%), and stormwater and runoff (5%).[2] Although state funding is a small percentage (3%)[3,b] of total water expenditures in California, it is an important source of funding for many water agencies.

Proposition 1 — also known as the Water Quality, Supply, and Infrastructure Improvement Act of 2014 — is a bond on the November 4th ballot. If approved, Proposition 1 would provide $7.5 billion for water related infrastructure projects. Of the $7.5 billion available, $2.7 billion — almost 40% — is targeted towards water storage (*Figure 1*). California has two options for water storage — surface water and groundwater storage — and both are eligible under Proposition 1.

There is no single solution to increase the resilience of California's water system to manage climatic change and increased growth. Nevertheless, finding ways to store water during wet years, so that it is available during dry periods, is important for California if it is to increase its drought resiliency. The inclusion of water storage funds in Proposition 1 raises the important question: how should California spend its funds to store water? Although there has been a considerable amount of research on the costs and benefits of surface water storage, there has not been much analysis exploring the benefits and economic costs of groundwater recharge and storage (GRS).

a Costs are converted into 2014 USD value using the Construction Cost Index published by the Engineering-News Record.

b This percentage is from 2008-2011 data on annual water-related spending in California.

About Water in the West and the Authors

A joint program of the Stanford Woods Institute for the Environment and the Bill Lane Center for the American West, **Water in the West** focuses the resources of one of the world's preeminent research institutions to address one of the most urgent questions about the West's future — how the region can continue to thrive despite growing water scarcity.

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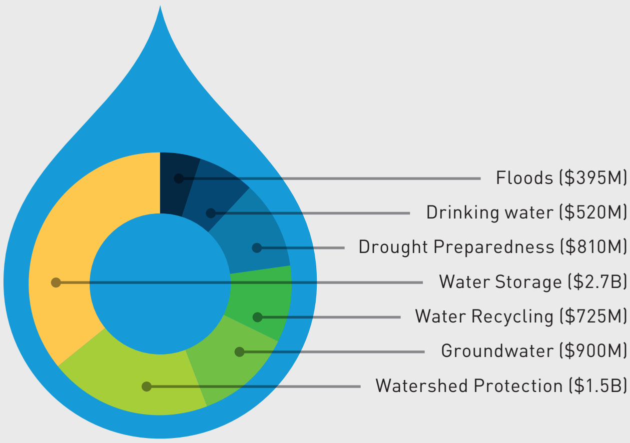
FIGURE 1
Proposition 1 Funding Breakdown



To understand the benefits and economic costs of GRS, we mined post-2000 bond funding applications from four propositions (*Figure 2*). We examined how California has used past bonds to implement GRS projects and answered some key questions: *What are the proposed costs of GRS projects? Is GRS an integrative and versatile water management technique? Which GRS applications are successful in receiving bond funds?* This effort is the most comprehensive analysis of GRS costs in California to date.

Key Findings

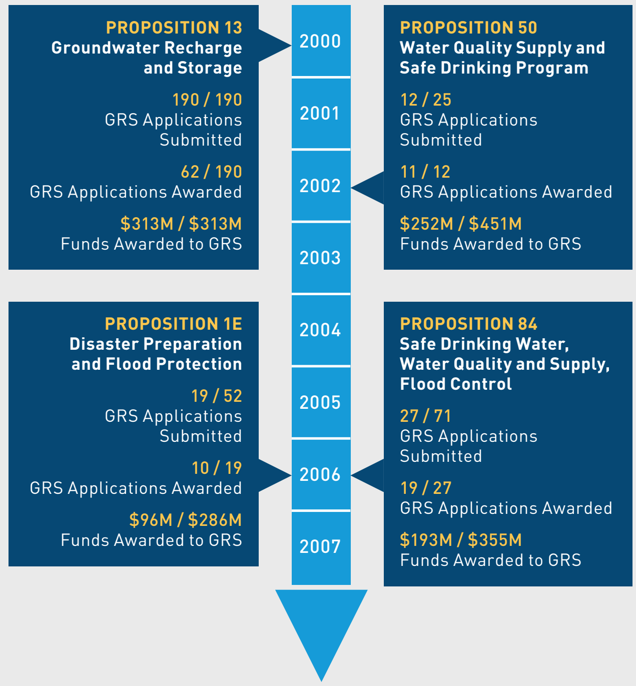
The costs[c] of groundwater recharge and storage projects vary considerably, ranging[d] between $100 and $1,200 per acre-foot, with a median of $400 per acre-foot. These numbers (*Figure 3a*) are based on proposed project costs[e] for both accepted and declined applications. The costs to produce (through wastewater treatment or decentralized stormwater capture) or purchase (from the state water project or other sources) water are not included. Nevertheless, there are multiple factors that influence the range in GRS project costs (*Figure 3a-d*). For example, the type of water used — surface water, stormwater, wastewater, or a blend — can influence GRS costs (*Figure 3d*).

c Costs are converted into 2014 $USD value using the Construction Cost Index published by the Engineering-News Record.

d Presented as the 25th and 75th percentile range.

e Project costs include: land; planning, design, and engineering; capital; administration; environmental compliance, mitigation, and enhancement; construction administration; and contingency.

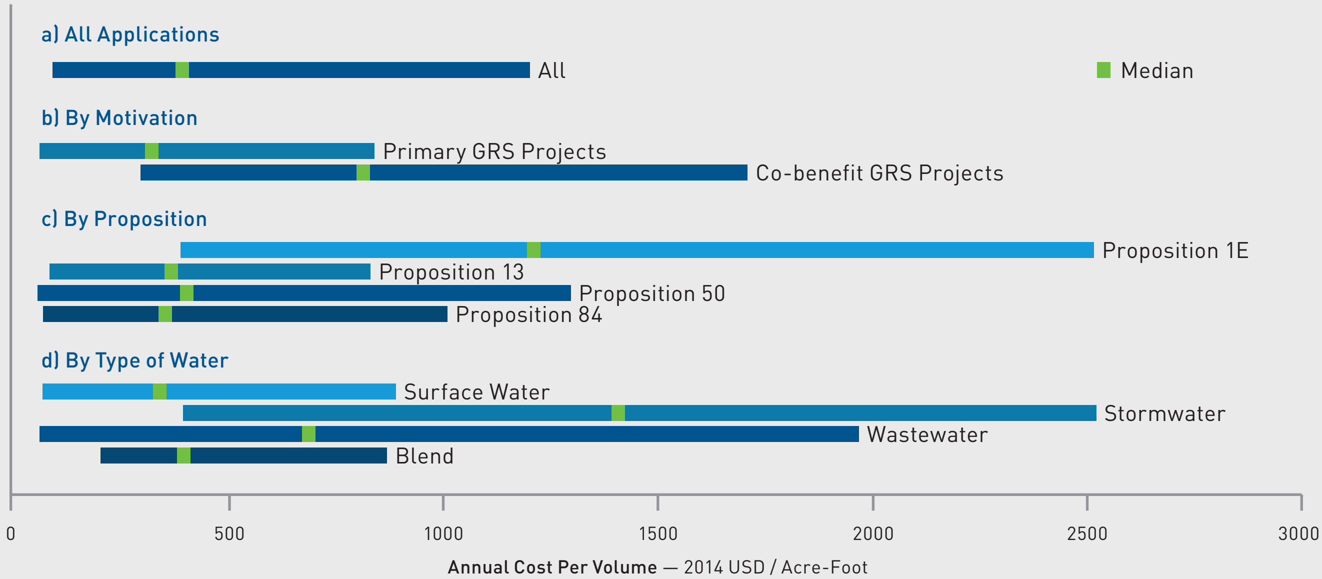
FIGURE 2
Proposition Timeline



Groundwater recharge and storage costs are about three times smaller when the primary purpose is to recharge and store groundwater only. Costs are higher when GRS is used as a co-benefit to other water projects (*Figure 3b*). Co-benefits include, but are not limited to, water quality improvements, flood control, wildlife enhancement, and seawater intrusion prevention.

About 40% of the groundwater recharge and storage applications submitted for bond funds were awarded. High and medium priority groundwater basins represent more than 90% of project applications for bond funding. High and medium priority basins

FIGURE 3
Range[d] of Groundwater Recharge and Storage Costs



represent only 25% of groundwater basins in California, but more than 95% of California's groundwater pumping.[4] The basin prioritization system is the state's strategy for allocating its limited funding to monitor and manage sustainable groundwater use. Although past funding is concentrated in areas with the highest need, there is a demand for GRS that is not being met by state bond funding.

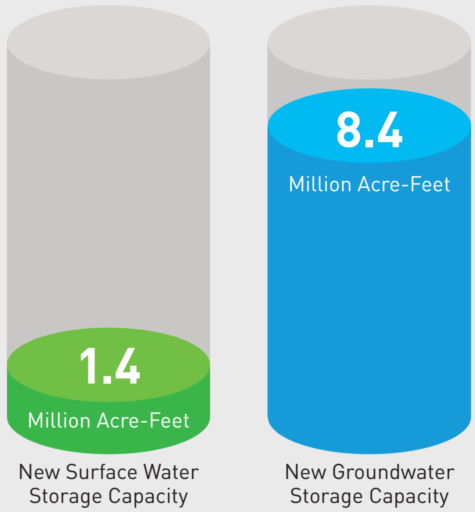
Discussing California's Water Storage Options

California gets money and water in the bank with groundwater storage. The 2014 water bond has earmarked $2.7 billion for water storage projects that improve the state water system, serve public benefits, and are cost-effective. Assuming that surface and groundwater storage projects meet the criteria to serve public benefits, how much surface and groundwater storage can California get with $2.7 billion? Using a median cost of $1,900 per acre-foot[5,f] for surface water storage, that amount could fund approximately 1.4 million acre-feet of new surface storage capacity. Conversely, if the $2.7 billion from Proposition 1 earmarked for water storage were to be spent on GRS[g], California could gain about 8.4 million acre-feet of new groundwater storage capacity (*Figure 4*). **For the same amount of money, groundwater storage could provide about six times more storage capacity than surface water storage.**

f This median cost was calculated based on the capital costs and new storage capacity for eligible reservoir projects: building Temperance and Sites Reservoirs, and expanding Shasta, Los Vaqueros, and San Luis Reservoirs.

g This was calculated using $320 per acre-foot as the median GRS cost for projects with the primary purpose to recharge and store groundwater (*see Figure 3b*).

FIGURE 4
How Much Storage Can You Get With $2.7B?



Groundwater recharge and storage projects can serve as an integrative and versatile water management tool. When GRS is used as a co-benefit to other water projects, costs are higher but benefits are greater too. Past bond applications show that communities are integrating GRS into flood control, stormwater management, and wastewater recycling projects. Doing so can augment California's water supply, buffer risk, and serve local water management objectives.

A diversified water portfolio would provide a more continuous supply of water that is subject less to seasonal and interannual variability. Unlike surface water, which is influenced largely by the Sierra snowpack, wastewater is produced continuously in urban centers. Although wastewater may be a feasible option only for population centers, the impacts of enhancing local self-sufficiency will be felt statewide because California's water system is interconnected.

As California's water resources become subject to climatic change, a diversified water portfolio can give water managers an adaptive edge. California's 161 major surface water reservoirs currently have a storage capacity of 920 million acre-feet, and the historical average use of that capacity is only 70% of the total.[6] With unused surface water reservoir space and increasing groundwater space due to overdraft, it is not the size of the reservoir that is the issue, but the availability of water to fill it.

The decentralized configuration of GRS allows local water managers to take advantage of a diversified water portfolio. Most of the popular surface water storage projects in consideration for the $2.7 billion water storage funds would be managed centrally, reducing supply and demand flexibility.

Higher priority basins are getting bond funds, but the overall demand for bond funds is unmet. GRS projects are proposed primarily in higher priority basins. Although past bond funds are concentrated in the areas with the highest need, a demand in GRS projects remains throughout California and is not being met by past state bond funds.

Conclusion

Our analysis of how California has used past bonds to implement GRS projects reveals that:

- Groundwater recharge and storage is more cost-effective than surface water storage.
- Groundwater recharge and storage can serve as a versatile water management tool and promote a diversified water portfolio.
- Past bond funding is concentrated in areas with higher basin prioritizations, and a demand in groundwater recharge and storage projects remains unmet through state bond funds.

These findings suggest that groundwater recharge and storage can play an important role in managing California's water resources in the future.

References

1. Legislative Analyst's Office. 2009. Financing Water Infrastructure. Sacramento, California. Available at http://www.lao.ca.gov/handouts/resources/2009/Financing_Water_Infrastructure_82609.pdf

2. Chappelle, C., A. Fahlund, E. Freeman, B. Gray, E. Hanak, K. Jessoe, J. Lund, J. Medellín-Azuara, D. Misczynski, D. Mitchell, J. Nachbaur, R. Suddeth. 2014. *Paying for Water in California*, Technical Appendix C (*Table C2*). San Francisco: Public Policy Institute of California.

3. Hanak, E., B. Gray, J. Lund, D. Mitchell, C. Chappelle, A. Fahlund, K. Jessoe, J. Medellín- Azuara, D. Misczynski, J. Nachbaur, R. Suddeth. 2014. *Paying for Water in California* (*Table 1*). San Francisco: Public Policy Institute of California.

4. California Department of Water Resources. 2014. CASGEM Basin Prioritization. Available at http://water.ca.gov/groundwater/casgem/basin_prioritization.cfm

5. Lund, J. 2014. Should California expand reservoir capacity by removing sediment? Available at http://californiawaterblog.com/2014/06/09/should-california-expand-reservoir-capacity-by-removing-sediment

6. California Department of Water Resources. 2014. *Summary of Storage in Major Reservoirs as of September 30, 2014*. Available at http://cdec.water.ca.gov/cgi-progs/reservoirs/STORSUM

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