California State Assembly Select Committee on
Water Consumption and Alternative Sources

New Sources for California's Water Supply

Select Committee Report of March 2016

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TABLE OF CONTENTS

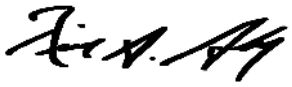
ACKNOWLEDGEMENTS

I want to thank Speaker Emeritus Toni Atkins who authorized the formation of the Assembly's Select Committee on Water Consumption and Alternative Sources. Her understanding of the need to secure adequate water supplies for California demonstrates her leadership and her commitment to the people of this State.

I also want to thank my Assembly colleagues who joined me in a series of Select Committee hearings. They demonstrated their interest in and commitment to securing California's water future.

Thank you's should also be given to the many experts and professionals who provided essential testimony at our hearings. I want to thank the private citizens who attended or watched our hearings and provided their input to our deliberations

Finally, I want to offer a special thank you to Nuriel Moghavem. Mr. Moghavem serves as a Legislative Assistant in my Capitol Office and he took on the assignment of staffing this Select Committee. He organized all of our hearings, managed logistics, and compiled this report. Thank you, Nuriel, for doing an outstanding job.



Richard S. Gordon
Assemblymember, 24th Assembly District
Chair, Select Committee on Water Consumption and Alternative Sources

March 2016

INTRODUCTION

California could have enough water. In the midst of an historic drought, with reservoirs and groundwater basins reaching their lowest recorded levels, it may seem that California simply doesn't have the water it needs to meet its thirsty urban, agricultural and environmental needs. However, the successful response to Governor Edmund G. Brown's April 2015 Executive Order B-29-15, ordering 25% water conservation statewide, and the potential to expand stormwater capture, water recycling and perhaps desalination all show that **California could have all the water it needs – we just need proper planning and investments to use our water more efficiently and wisely.**

The Assembly Select Committee on Water Consumption and Alternative Sources was established in February 2015 to examine the strategies California could take to improve water conservation and expand the portfolio of water sources. Given that California rose to the challenge of conservation, the committee turned its attention to alternative water source strategies such as stormwater capture, ocean desalination and water recycling, holding specific hearings to discuss the latter two in greater detail.

All this was considered through the lens of a changing climate in California, one that is set to be warmer overall with faster fluctuations between El Niño and La Niña periods of wet and dry. Periodic droughts and floods may be our new normal, and the state might have to decrease its reliance on snowpack filling our reservoirs. We will therefore need to better utilize alternative water sources to keep our cities and farms hydrated.

This report is the culmination of several hearings held across the state on issues of water use and opportunities for expanding water sources. It includes summaries of expert testimony at those hearings, including illustrative slides from their presentations, as well as a list of key findings and recommendations compiled by committee staff and approved by the Chair. These findings and recommendations were not voted on by members of the Select Committee and may not reflect the view of each Select Committee member. This report is meant to provide knowledge regarding California's drought, climate change future, and viability of water sourcing strategies including stormwater capture, water recycling and desalination. This knowledge will be essential in adapting California's water infrastructure to climate changes and devising the most effective and environmentally friendly approach to endure the next California drought.

The committee webpage can be found at the URL below and includes background documents for each hearing, speaker biographies, and the slides presented by the experts during their presentation:
http://asmdc.org/members/a24/other-resources/select-committee-on-water-consumption-and-alternative-sources

KEY FINDINGS

The following are key findings that highlight the important takeaways from the Select Committee's three hearings.

- **Hot droughts are our future.** California has long experienced intermittent periods of wet and dry but about half of past droughts coincided with colder weather. Climate change trends suggest that all droughts in the future will be hot ones, increasing their severity and the need for water sources not reliant on snowpack.

- **California's response to Governor Brown's conservation mandate was critical and impressive, but it won't be enough.** Conservation represents the best method to improve California's water security: it is rapid, effective and free. But for California's environmental, agricultural and urban needs to be met, new water sources will need to be developed.

- **Not all alternative water source options are equal.** While the California Water Plan recommends an "all of the above" strategy for improving the diversity of California's water portfolio, the scientific consensus is that some options are more reliable, cheaper and less energy-intensive than others. Regions looking to invest in new water sources should do so with diligence, considering energy costs and local impacts in their analyses.

- **Centralization and decentralization of water recycling are both strong water source options, but there is a tension between them.** On-site reuse is a decentralized water conservation strategy that could yield substantial water savings to the state in conjunction with centralized water projects. However, increased decentralization will present challenges to centralized water systems that depend on revenues to pay for fixed infrastructure costs and sewer systems that depend on high levels of water flow to move sewage.

- **Greater potable reuse of recycled water will be critical to California's water future.** Indirect potable reuse is occurring in California now and is set to expand. The feasibility of regulating direct potable reuse is currently being studied by the State Water Resources Control Board and, if allowed, could be a strategy to use water more effectively.

- **Stormwater capture is an important way to generate new water, but currently faces substantial financing challenges.** Proposition 218 currently limits local agencies' abilities to generate funding necessary to build and operate stormwater capture systems, making it difficult to take advantage of this valuable water source.

- **Innovations in the water sector are scarce.** While high costs of energy and State support for research spurred innovation in the energy sector, the fact that water remains underpriced and the state has not invested in water research has led to a stifled environment for water technology innovations.

POLICY RECOMMENDATIONS

- **California should pursue a diverse water portfolio.** The California Water Action Plan's strategy of promoting a multitude of water sources for our state is the right approach, and underscores that the diversity of our state necessitates a diversity of solutions.

- **Improve elements of California's water management, particularly with data collection and dissemination.** The Sustainable Groundwater Management Act will vastly improve our understanding of California's water, but the lack of a common water accounting framework between state agencies could be limiting our ability to study it and develop new innovative solutions based on our deeper scientific understanding.

- **Proposition 1 funding should be directed at projects suited for California's changing climate**. In the next several years, billions in bond sales authorized by 2014's Proposition 1 will be allocated to water projects. Those that reduce greenhouse gases, improve storage capacity in a warm climate, and are not at risk due to sea level rise should be favored.

- **Desalination should be used as an option of last resort.** Nearly the totality of the testimony between our several hearings agreed that desalination should only be considered after a region has been successful with conservation and has embarked on substantial water reclamation projects as well. Approved projects should be well-sited, well-sized, and minimize environmental impacts to the extent possible.

- **Educate the public about potable reuse of water, especially direct potable reuse.** Expert testimony at our hearings relayed that the scientific and public health communities are approving of the current approach to direct potable reuse. Public perception remains a major barrier to implementation, though data shows improved acceptance with education.

- **Adopt regulations for potable reuse.** The State Water Board will issue its regulatory recommendations for indirect potable reuse and its feasibility study for regulation of direct potable reuse by the end of the year. To speed the implementation of potable reuse in urban California, the legislature should adopt recommendations of those reports.

- **Develop new financing methods and incentives for stormwater capture.** Creating incentives for local agencies that capture stormwater may open up new avenues for financing reclamation projects to secure this valuable water source.

- **The state should provide support for water innovation research and deployment.** The solar power industry expanded in California because of our support for research and commitment to the deployment of solar power technology. This has been a major boon for the state in both the reduction of greenhouse gases and in the creation of thousands of green jobs. California could become a leader in water technology using similar methods.

SUMMARY OF SELECT COMMITTEE HEARINGS

Hearing 1

Overview of Water Consumption and Alternative Sources in California
Tuesday, November 17, 2015, 1:00pm – 5:00 p.m.
California State Capitol, Sacramento

The first Select Committee hearing brought international experts and top scientists in the fields of engineering, climatology, economics, law and the environment – as well as the state's top regulators of water – to discuss the many options California has to use its water more effectively and create new avenues for improved water supply. It established a basic understanding of California's water realities and the menu of options before the State for improvement, setting the tone for subsequent hearings.

International Perspective on Managing Periodic Severe Drought

Eilon Adar, Ph.D., Director, Zuckerberg Institute for Water Research, Ben Gurion University of the Negev, Israel

Dr. Adar joined the committee via Skype from his office in Israel. He highlighted several differences between Israel's and California's hydrology. In Israel, and indeed in the entire Middle East, water is treated like oil and gas: as a national commodity. The government there is authorized to handle water matters "from A to Z," including development, treatment and distribution. While much of this process is privatized, it is ultimately controlled by the national water authority. He believed that a similarly centralized approach to water in California, including common/shared infrastructure, could be an important approach to water management. As an example, he pointed to our ability as a state to treat wastewater, but not to pipe it to agricultural regions as Israel does. Israel has a system of purple pipeline across the nation that sends treated effluent to the agricultural sector, freeing up potable fresh water for urban use. They treat and reuse 85% of their wastewater. He also pointed to the practice in Israel of "forced" central coordination of independent water utilities (equivalent to investor-owned water utility companies in California). This helps water in Israel remain "kept beyond conflict" and unbounded by municipal borders.

Dr. Adar noted that 40% of the total supply of freshwater in Israel is from ocean or brackish desalination. However, it is not used directly; instead, it is blended into the nation's raw freshwater system to provide a water "mélange." He stated that Israel rigorously investigated seawater desalination before building plants, and their findings showed that appropriate brine discharge (release at far distance from the shore, with "suction holes" in discharge pipes to allow dilution before discharge) would have no negative impact on the marine environment. Continuous monitoring has also showed that desalination has had no

measureable impact on seawater quality, especially next to effects of wastewater released from Gaza directly into the Mediterranean.

With regard to water recycling, Dr. Adar stated that Israel does not yet have direct potable reuse of treated water, but rather uses the recycled water for agricultural purposes through a nationwide purple-pipe system. This water was initially subsidized to encourage its use, and is now sold at market price; the inclusion of some nutrients in the water saves farmers the cost of additional fertilizer. Moreover, the agricultural sector in Israel uses all-drip irrigation and in some instances subsurface drip irrigation for crops, increasing efficiency and decreasing direct exposure of the crop surface to the recycled water.

Israel has had success with regard to water conservation, mostly because farmers and urban users pay a high price for water. Urban users pay not only for the water use (by meter) but also for its treatment in the sewage system. Agricultural users pay a subsidized flat price for recycled water nationally, but it is far more expensive than what farmers pay in California for potable water. Some greenhouse farmers in Israel, according to Dr. Adar, have reached 90-92% water use efficiency.

Israel is preparing for impacts of climate changes, and has concluded that lack of water would be problematic for the nation's economy. Less than 5% of the country's GDP comes from agriculture, but the provision of high quality and adequate volume of water to all national economic sectors is seen as essential for continued economic growth. This is why the nation buys their desalinated water 365 days a year, even in wet years, as this gives them the ability to draw less on natural sources of water and recharge their groundwater basins in preparation for dry years.

In Dr. Adar's opinion, California "still uses water in irresponsible ways." Water is wasted in municipalities, partly because flat pricing of water does not encourage conservation. He also believes that the state should impose coordination of regional water authorities both for utilization and also treatment of water, as these, to him, go together naturally. He believes that Israel has "made a fortune" on treating its wastewater and that California could do the same. Lastly, he believes that California needs to invest in statewide water infrastructure to move treated water effluent from urban recyclers to agricultural users.

He left with the following words of wisdom: "Don't be impressed by the current year. Some years are good, many are bad. People tend to forget the troubles if they get a rainy years…pray for one or two more dry years so people will appreciate water and will be willing to give up senior and junior water rights to create a more sustainable water system for California."

Water, Infrastructure and California

Jay Lund, Ph.D., Director, UC Davis Center for Watershed Sciences

Dr. Lund gave an overview of what he called an "enormous topic:" California's water system. He highlighted some important facts about California's water reality. California is

What's in the box?

exceptionally dry as compared to the rest of the United States, has increased variability year-to-year than the rest of America, and also has water users far from where the water ultimately falls. California then has to import water or overdraft groundwater basins, and Dr. Lund testified that we do quite a bit of both in both wet and dry years.

Built infrastructure helps us import this water and manage floods when they occur. Our infrastructure also allows us to generate 15% of our energy from hydropower, but it belongs to many different authorities, limiting the state's ability to coordinate water as a resource. The decentralization has allowed for quite a bit of innovation in California with regard to water, but it also prevents statewide strategic decision-making and opens the state up to many conflicts over water.

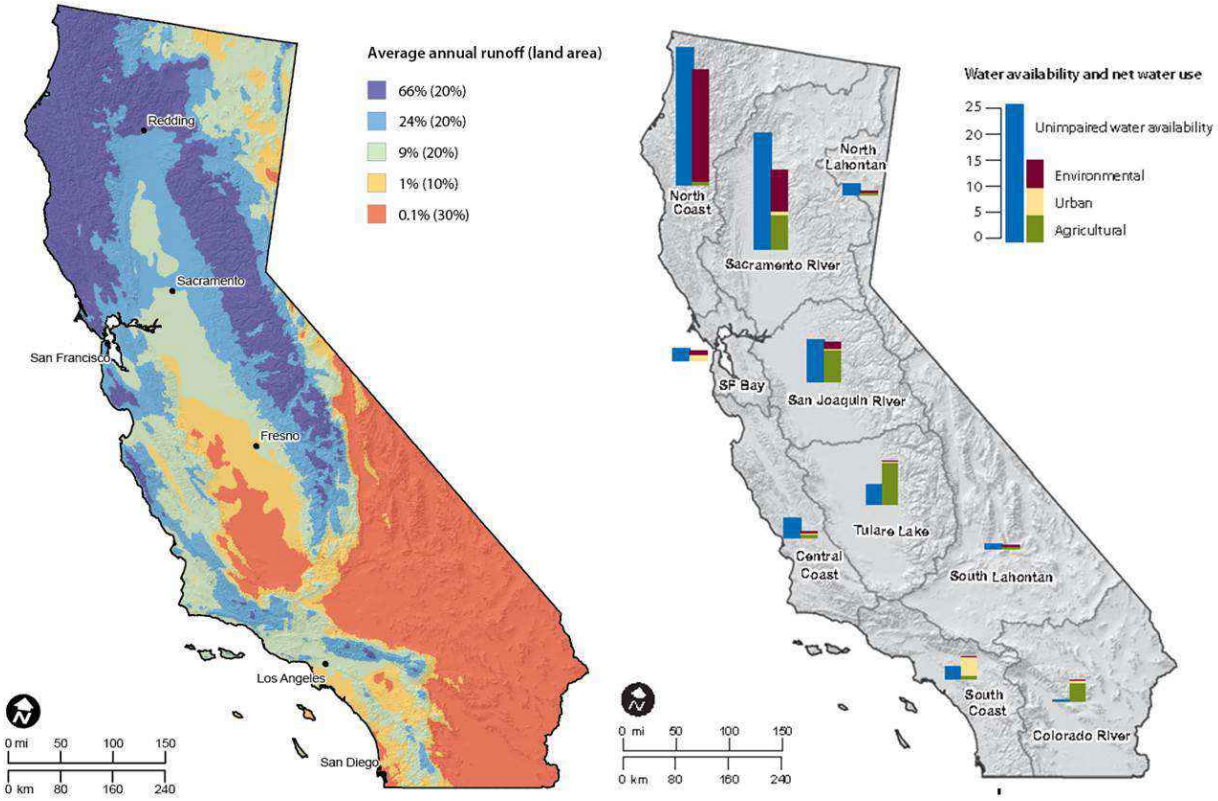
There have been successes, though many have come at environmental cost. Much salmon habitat has been lost through increased dam building and 95% of California's wetlands have disappeared, impacting waterfowl that traditionally migrate across California. In addition, over the past 20 years, the condition of some of California's most sensitive fish populations have worsened. While none have officially gone extinct, more have moved down from "special concern" to "listed" status and even more down from "OK" to "special concern."

Change in the water system comes commonly, according to Dr. Lund, because there are frequent crises that necessitate such change and many potential drivers of reform including global warming, contaminant accumulation, groundwater overdraft, earthquake risk, protecting the Delta, and economic changes including globalization.

Regardless, California has managed drought exceptionally well both historically and in the present. Part of this is due to groundwater overdraft, but in this most recent drought, Dr. Lund identified the move to more profitable crops such as almonds and walnuts as responsible for the agriculture industry's ability to maintain economic growth (only about 4% loss in revenue in 2015 and loss of 10,000 jobs, which is remarkable given the extent of the drought). Half of the farmed acreage in California currently provides about 85% of the revenue and jobs; the remaining half, mostly field crops, grain and feed, are low-revenue and available to be fallowed in times of drought (though this is assuming normal water markets, which California does not quite have).

There is a positive side to drought: it brings attention to water issues, especially the need for continued change. This drought, for instance, has brought the Sustainable Groundwater Management Act (SGMA), lower urban use targets for water consumption, and

Water and People in California



This image shows that most runoff in California happens in the North of the state, in relatively unpopulated areas. In the South of the state, where water use is highest, local supply is more limited.

slightly higher agricultural water prices. Still needed are improved water accounting, improved water management, and improved coordination between state water agencies.

Dr. Lund cautioned against the building of additional dams: overall, the storage capacity gained through new surface water projects is vastly dwarfed by the capacity of groundwater storage in California. This is mostly because many of the most effective surface storage sites in California have already been built, and currently considered projects will be "more expensive to build, and might not give us as much [storage capacity] as we'd like to think."

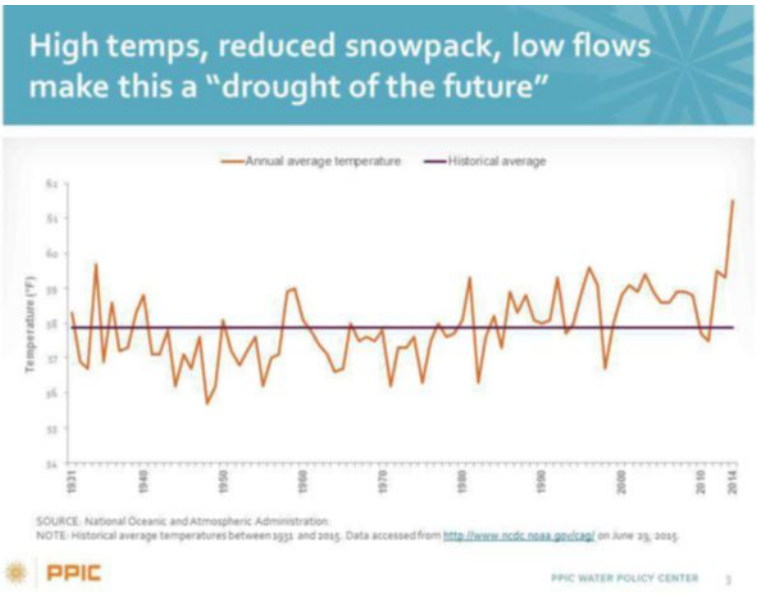
Ultimately, California has a portfolio management approach to its water, and needs to do a better job of "herding its cats." To help manage these "cats," Dr. Lund offered some items that he views as "inevitable" about California's water future: some Delta islands will flood, less water will be diverted from the Delta, urban water use will drop, native species in the wild will die off, solutions will be local, the State's leverage will remain regulatory, nitrate contamination will continue, groundwater will be managed better, the Salton Sea will be restored, and droughts will never be eliminated, but can be managed better.

He hopes that California can leverage new technologies to account for water better, including monitoring of streamflows, estimation of crop water use/return flows, measurement of groundwater levels, and improvement of horizons for flood warning.

Is This Drought "The New Normal?"

Ellen Hanak, Ph.D., Director, Public Policy Institute of California Water Policy Center

Dr. Hanak began her testimony noting that this drought is not the worst that California has experienced but that it is unique in that it has been an unusually hot drought overall in both winters and summers. She believes that this upward trend in overall temperatures is likely to persist, and that the coupling of heat with occasionally low moisture in the future is something that climate models are predicting.



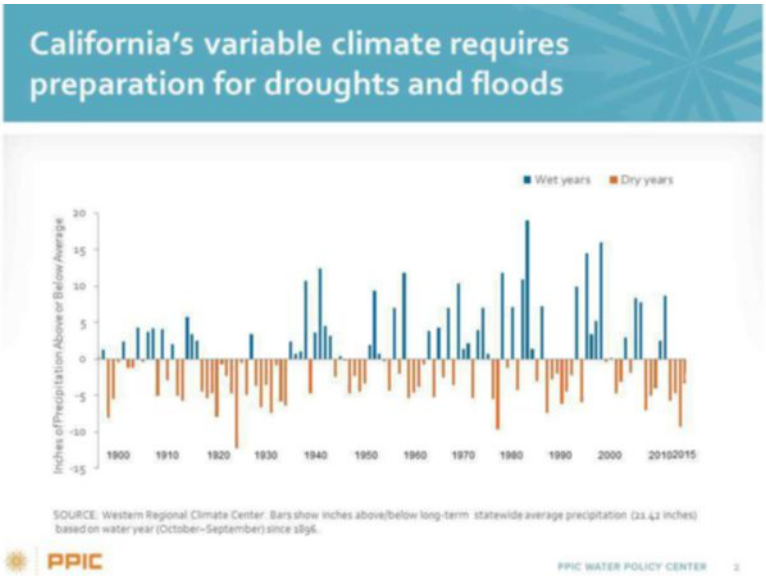
High heats in the past several years have been far outside the norm for year-to-year temperature fluctuations and may reflect a warmer future for California as climate models predict.

Increased heat leads to reduced runoff of water (25-40% of average) and storage (50% of average), leading to curtailments, surface water cuts, increased groundwater pumping, and reduced hydropower leading to increased energy prices. There are also effects in the Delta, with both increased salinity (because of less freshwater coming from the Sierras) and increased water temperature overall.

Dr. Hanak highlighted four main areas of concern. The first is in cities and suburbs: here, the system is very decentralized, but the state has made some positive changes through incentives for both individual users and municipalities. The consequence has been increased regional cooperation and local innovation to reduce water use.

The second area of concern is in agriculture, especially with regard to groundwater basins and the difficulties in water trading in California currently. The challenges that agriculture will face will increase gradually over time, giving the state an opportunity to tackle big issues like land subsidence and dry wells.

The third issue of concern is vulnerable rural communities, especially those whose wells are going dry as the groundwater level drops. These communities don't have the resources to dig deeper wells, and are increasingly in crisis. SB88, the 2015-2016 drought bill, allows consolidation of systems and gives the Water Board authority to provide for hard-hit areas, thus reducing the burden of water quality monitoring from locals. New technologies may allow for remote treatment of this water as well.



While the current drought has been longer than usual, the fluctuation between wet and dry years is expected in California. Annual likelihood of a dry or wet year is not projected to change.

The last area of concern is our ecosystems, in particular the welfare of fish, waterfowl and forests. Flows and habitats are at all-time lows and wildfire risk extremely high. Dr. Hanak noted that interagency cooperation has been solid in responding to these challenges and there have also been innovations in wetlands management (including pop-up wetlands), which have lessened overall effects. But with continued hot and dry drought, there is a risk of many fish extinctions (18 species at risk), necessitating emergency conservation hatcheries, and also risk of high waterfowl mortality. Severe wildfire risk is also likely to persist through this type of drought, with the possible permanent loss of some conifer forests. More funding can mitigate may of these environmental risks.

Ultimately, Dr. Hanak believes that "what is working" includes water conservation, SGMA, regional coordination and coordinated emergency response between states and the federal government. Solutions can include improved water pricing, connecting rural communities to larger water systems to improve their drought resiliency, and some flexibility with water conservation mandates (including credits for recycling water).

In Dr. Hanak's opinion, the big unsolved issues with room for improvement include California's water curtailment system, water information systems, forest management, restoring stressed environments and providing resilience plans for future droughts.

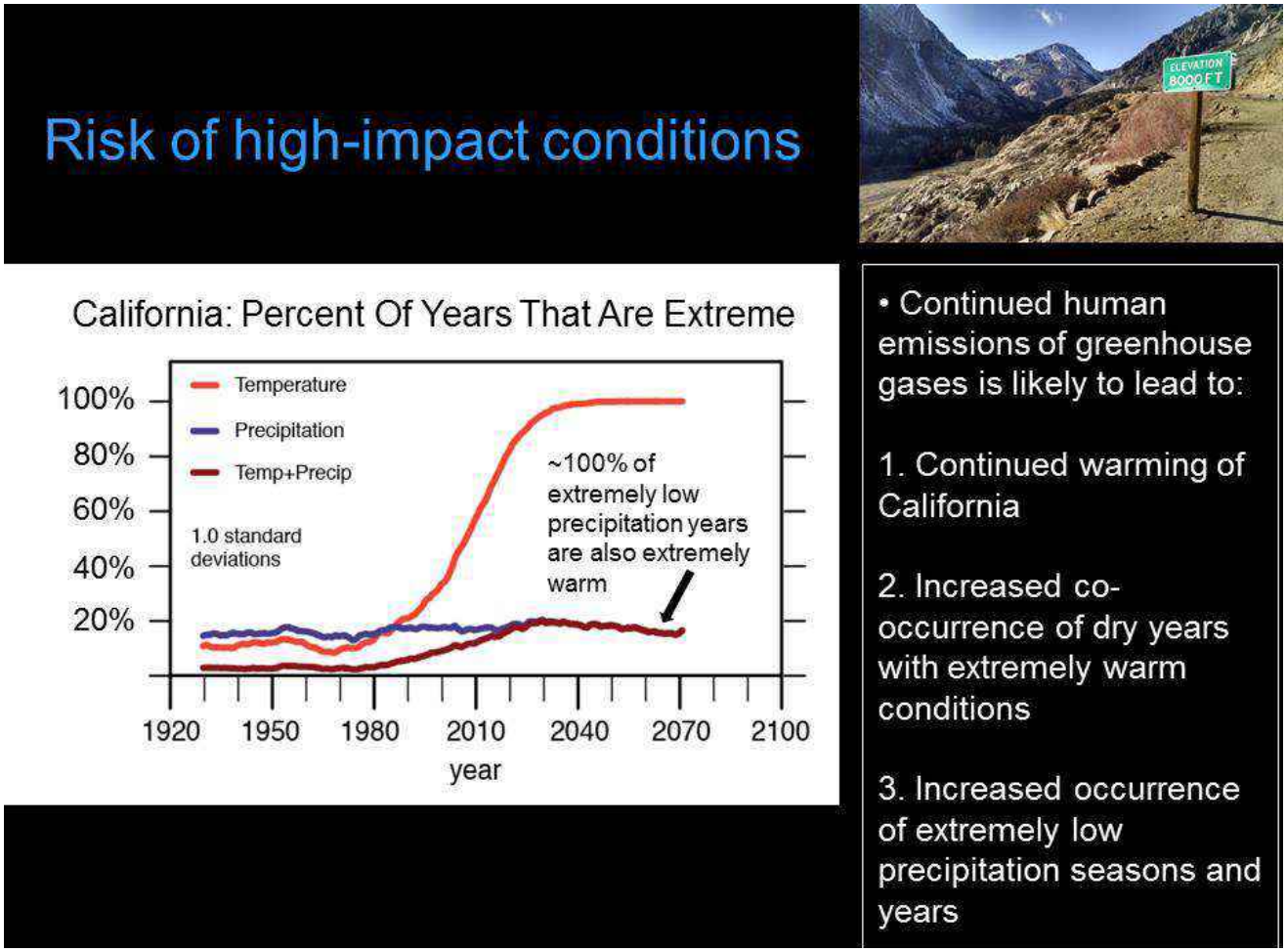
Noah Diffenbaugh, Ph.D., Senior Fellow, Stanford Woods Institute

Dr. Diffenbaugh shared research that shows anthropogenic global warming has intensified the current drought in California and has provided for many of the underlying conditions that lead to drought in the first place. This type of drought, which is both hot and dry,

may be the “new normal” for California, meaning that while drought will not be our constant future, the likelihood that our periodic droughts will also be warm ones is significantly higher now.

He shared the global temperature time series, which shows that we are now 1°C higher in overall temperature compared to pre-industrial levels. That contributes to increased future probability of co-occurrence of low precipitation with high temperature.

By many metrics, this is the most severe drought that California has had in its history. While the low precipitation is not record-breaking, the high temperature effects such as drying out soil and reducing snowpack have made this drought notably severe. He pointed to the “Ridiculously Resilient Ridge,” a persistent high-pressure system that has sat over California’s Pacific coast, blocking storms from dropping rainfall on California over the course of several winters. It is the belief of Dr. Diffenbaugh and Daniel Swain, a graduate student in his lab, that the Ridge has significant human contribution; this would constitute a human-driven climate



Future droughts will invariably be hot droughts in the future, which increases their impact. Furthermore, future drought years are also likely to be drier than drought years of the past.

change impact that has reduced rainfall in California. Overall, however, long-term precipitation averages do not show significant reductions in California in the recent past.

With regard to temperature, long-term averages confirm short-term observations of a significant warming in California. Again, this makes for low-precipitation periods that are warm rather than cold more likely, which significantly increases drought risk. For the first century of observation, Dr. Diffenbaugh notes that wet vs. dry and warm vs. cold have both been effectively like an annual coin flip, so roughly only 25% of years were both hot and dry. But for the last 20 years, California has been "like Lake Wobegon, where all the kids are above average." All years are now warmer than average (though precipitation level has remained essentially at 50/50). Climate models have shown these changes are extremely likely to be related to human activity and release of greenhouse gases to the atmosphere.

California is now likely to be in a regime where *all* years are warmer than average. In other words, future low-precipitation years will likely always coexist with hot years in the future, exacerbating the severity of all our future droughts. There will be earlier melting of snowpack and snowpack that does not persist through winter. This will also increase flood risk overall, as winter precipitation is more likely to be liquid rather than snow.

Dr. Diffenbaugh concluded with the note that these changes have been known for quite some time and have followed in a fairly predictable way. He cited literature from 1988 from Dr. Peter Gleick, which, despite being over 25 years old, correctly predicts the changes to California's hydrology as a result of global warming. He was optimistic about efforts to adapt to climate change in the present and provide for the future by leading in global efforts to curb greenhouse gas emissions.

Current Initiatives to Manage New Water Sources in California

John Laird, Secretary, Natural Resources Agency

Secretary Laird stated that Dr. Diffenbaugh's work was critical in that it showed California moving "from one climate to another" and that the State's infrastructure is designed for what is now a prior climate. This presents us with the challenge of stabilizing the current infrastructure, which is as important as "divining" new sources of water.

With respect to the "divining" process, Secretary Laird pointed to the California Water Action Plan's "all of the above" approach to water management. The Water Action Plan represents the consolidated obligations and short-term plans of all executive branch agencies and departments with water management responsibilities for the next 5 years.

Secretary Laird highlighted challenges of looking at water from a global perspective, and the reliance of the Water Action Plan on regional approaches. As an example, he

discussed water recycling, which only makes sense as a "new" water source if there is underlying water to be recycled (and this recycled water, for instance, may compete with the wastewater needed in desalination to dilute brine discharge). Another example is his belief that discussions of stormwater capture and aquifer recharge, in certain areas of the state, may be premature if the aquifers are currently in need of remediation.

He had some praise for Southern California's water planning as a model, citing their population growth despite using less water and their investments in more reliable water supplies in past decades.

Secretary Laird also sees public acceptance of increased water prices as a challenge, especially in the context of improved water conservation. Because the fixed costs of water infrastructure remain, even with reduced consumption, users may end up paying more for less water; Secretary Laird believes that educating the rate-paying public on this issue serves as a significant roadblock currently. He cited the water rights system and the water allocation system as California's "pre-existing conditions" that prevent the proper pricing of water, but also cited his experiences in local government in Santa Cruz where education of the public opened the doors for more sensible water pricing. The introduction of metering to California over the next 10 years will help with regard to conservation, preparing us for the next drought, and may give the public an understanding of how much water they truly consume.

Another challenge is that there are currently 430 municipal water systems in California, and they drive most of the water infrastructure-building. He cited the paucity of state-built surface water storage facilities and the building of "two Lake Shastas worth" of surface storage by local and private entities as evidence of this. The recently-passed water bond gives incentives for locals to invest more substantially, but Secretary Laird highlighted the need for those investments to make hydrologic sense given a changing climate.

Mark Cowin, Director, Department of Water Resources

Director Cowin highlighted the importance of the California Water Action Plan as a "playbook" for the Department of Water Resources and an invaluable resource for understanding the multiple levels involved in California's water planning.

He believes "one of the best kept secrets in California water" to be the success in the promotion and implementation of Integrated Regional Water Management (IRWM). Bond money has been allocated to these regional entities and this regional approach takes advantage of the decentralization in California to allow for a watershed-specific approach to water challenges across the State. Since Prop 50 (2002), the Director Cowin states that DWR has awarded over $800 million in IRWM grant funds, leveraging $3 billion in local funding for 580 local projects totaling a net increase of 3 million acre-feet (MAF) of water annually. He anticipates the remainder of Prop 84 (2006) dollars to be allocated by the end of this year

($250 million) and there will be significant funding from Prop 1 to allocate in coming years as well.

Director Cowin prioritizes moving “slow and steady” in getting water bond money out the door of his Department, as it gives local agencies the time to raise investment money that they can use in conjunction with the state money for their projects. He did, however, recognize the balance necessary to ensure that money is also delivered when it is needed.

Director Cowin called SGMA the “biggest game-changer in California water in our generation.” Sustaining groundwater as an important resource will now be a priority, and it will lead to much more realistic conversations about what must be done to provide for water systems reliability in the future. There is concern about near-term effects of overdraft, especially subsidence, but DWR is discussing with local governments how they may best help address these issues. Funding is available through Prop 1 to help local counties and cities deal with stressed groundwater basins and DWR is working to build those relationships and provide the funding where it is necessary. Director Cowin also discussed some concern that subsidence may worsen flood conditions this year in the San Joaquin Valley, depending on El Niño.

Another large initiative of the DWR through Prop 1 is implementation and funding of the storage provisions. The Water Commission will set rules for how the state will invest in water storage, but the proposals will be local and seek the state as a partner. DWR sees these projects as important for improving the state’s drought resiliency in the long-term.

Lastly, Delta issues including the WaterFix (a proposal to build two large tunnels directly from the Sacramento River to the State Water Project’s pumping stations in the South Delta) figure large for the DWR and are an effort to modernize the water infrastructure and make them more sustainable for the future. According to Cowin, the tunnels will improve water conveyance and protect the environment. He underscored Secretary Laird’s point about public education serving as a barrier to smart water policy with regard to the WaterFix but believed that teaching around climate change may serve as a vehicle to help Californians understand that our water reality has changed and that water may be more expensive in the future.

Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board

Mr. Bishop cited water conservation as the “easiest, most effective and most efficient method to quickly reduce water demands and extend supplies into the next year.” He described the Governor’s executive order mandating water conservation in 2015 and the Water Board’s specific conservation requirement for each urban system ranging from 4-36% based on residential per-gallon use. He noted that, at the time of his testimony, 72% of water suppliers are meeting their targets with a cumulative savings of 28.1% – about 254.3 billion gallons saved overall. The Water Board has also been enforcing these mandates; while they

have the ability to leverage fines (and have), they prefer to work with local agencies and have instead issued a variety of warnings and letters to promote improved conservation.

Water conservation puts some burden on the supplier to manage fixed costs and the Water Board has held a series of workshops to discuss conservation pricing. According to Mr. Bishop, both he and Governor Brown believe that Proposition 218 is a barrier to cities wanting to implement conservation pricing.

With regard to recycled water, the State Board set policy and targets in 2009 on recycled water. California is currently on track to meet those targets, especially as this recent drought has increased the resolve for local agencies and the public to look to new water sources. Examples include Los Angeles using highly treated wastewater for their seawater barriers rather than potable water, recharging the groundwater basin at the same time. Two main funding sources for such projects are the Clean Water State Revolving Fund, which has a 1% financing rate for recycled water projects up to December 2, 2015. Of the $800 million set aside for water recycling projects, $525 million has been already granted by the Water Board at the time of testimony. The other is the water bond: under Proposition 1, an additional $625 million was allocated to recycled water grants, and $260 million has already been allocated in 2015 by the legislature.

Several policies are currently in development to promote water recycling in California. There is a current statutory obligation for the Water Board to consider surface water augmentation regulations by December 31, 2016. There is also an obligation to investigate the feasibility of direct potable reuse (DPR) of reclaimed water by December 31, 2016. The State Board will release its draft report on DPR by June 30, 2016. The Water Board is also looking into the possibility of using disinfected tertiary treated water for feeding animals, and will issue this third report in conjunction with an expert panel by December 31, 2016.

With regard to stormwater, the Water Board has $200 million in Proposition 1 funding for stormwater capture and reuse projects. Draft guidance for proposals have been released and the Water Board will consider adoptions of those guidelines in December 2015. Funding will be released in Spring 2016. Technical assistance will also be given to disadvantaged communities to ensure they have equal access to all of these funds.

The Water Board, as part of the “all of the above” strategy in the Water Action Plan, has also looked at desalination and in May 2015 amended the Ocean Plan to address desalination facilities. The Ocean Plan Amendment sought to create a uniform process for permitting of ocean desalination facilities while protecting marine life from both intake processes and brine discharge.

Lastly, groundwater cleanup is a priority for the Water Board, and $900 million in Proposition 1 money is allocated to groundwater remediation. There is a strong effort to help in

cleanup of underground water tanks, especially where no responsible authorities come forward to address tanks (dry cleaners, abandoned facilities, etc.).

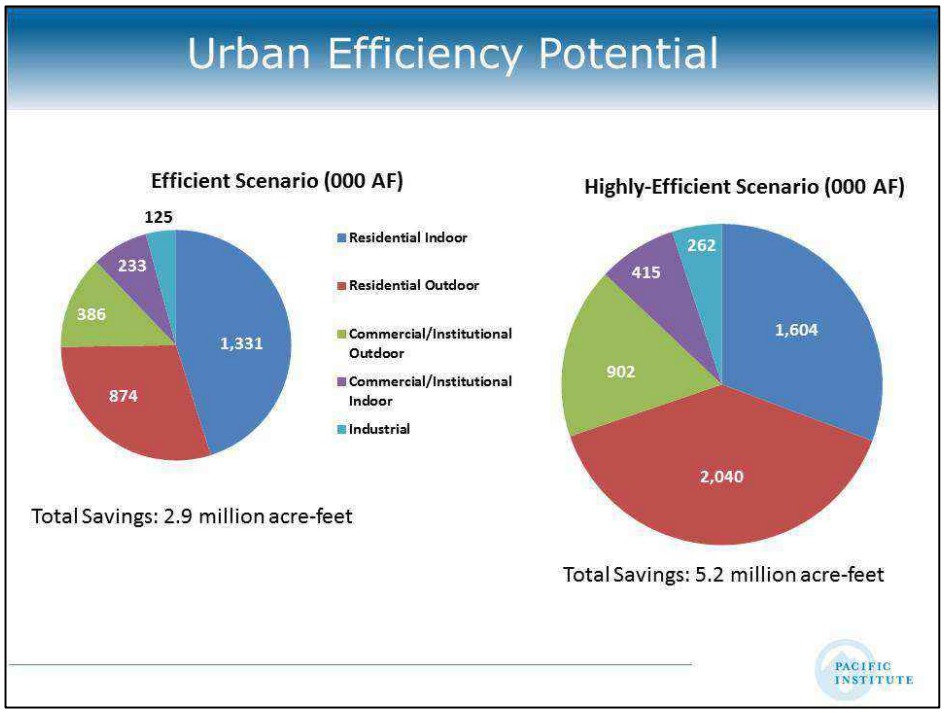
What are California's Strongest Options to Improve Long-Term Water Security?

Peter Gleick, Ph.D., President, Pacific Institute

Dr. Gleick began by endorsing the views of previous speakers: "we have a lot of problems, and we have a lot of options." What he disagreed with, however, was the concept of the "all of the above" approach to water sourcing. Dr. Gleick stated that he felt strongly that a portfolio approach is best, but that doesn't mean that everything must be done at the same time. "Not everything is equally economically appropriate," he stated, "And not everything is equally regionally appropriate."

He outlined four key priorities that make most sense economically, regionally, and at the current time. He cited the "Untapped Potential" report from the Pacific Institute in the context of enormous drought and groundwater overdrafting.

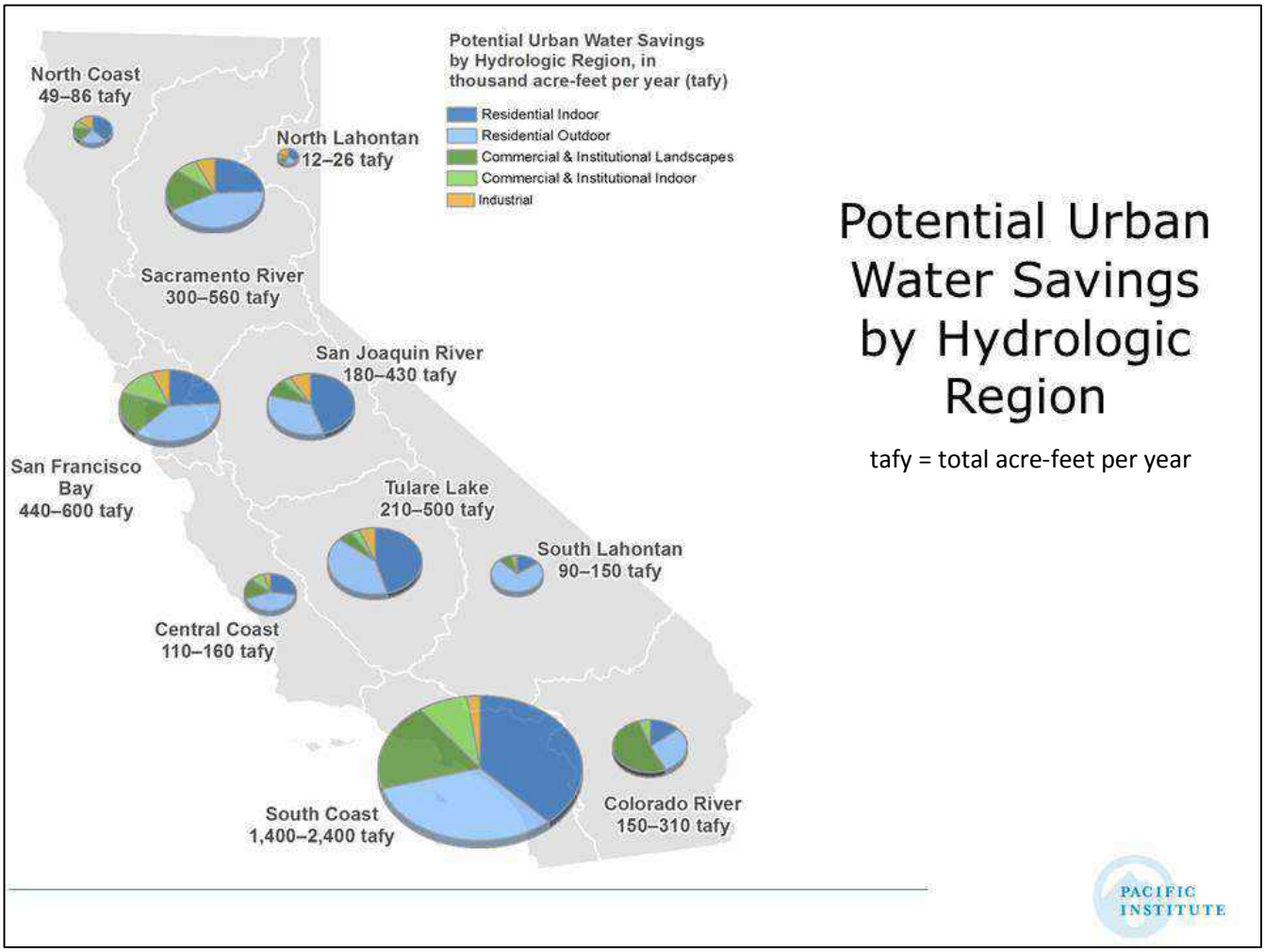
First, Dr. Gleick outlined the importance of increasing efficiency of water use and decreasing overall consumption. Reducing consumption from urban and agricultural uses is a cheap and effective way to increase the overall water supply. Specifically on the urban side, there is both an outdoor and an indoor element to consider. Indoors, water conservation can be accomplished by more conscientious showering, but also through improved appliance efficiency. He included the example of California's toilet efficiency standards put in place in 1986; 0.5 million acre-feet (MAF) has been saved annually due to these simple efficiency standards, even with an expanding population. Showers, faucets, clotheswashers and leak repair represent further untapped indoor conservation potential. The outdoor use of urban water is almost entirely linked to landscaping. An efficient scenario of urban water conservation would save 2.9 MAF of water



and a *really* efficient scenario could save up to 5.2 MAF according to Dr. Gleick. Remote sensing, advanced meters, and social-norms-based messaging are new methods that can help urban users improve their water efficiency. He praised current urban conservation efforts, which have saved 0.8 MAF of water just this year; this alone is more water than any proposed reservoirs could provide for the state.

Second, on the agricultural side, efficiency gains can be made by changing irrigation practices and improving soil monitoring; while these may produce a smaller percentage improvement in water use efficiency, the sheer magnitude of water used by agriculture in California means that small changes can produce large savings.

Third, Dr. Gleick discussed water recycling. California currently uses 0.6 MAF of recycled water, representing 13% of our wastewater. This is not used for agriculture, like Israel, but rather for landscaping, power plant cooling, and ecosystem restoration. That will likely be doubled to 1.2 MAF (an "easy target," according to Dr. Gleick) under current Water Board targets; Dr. Gleick believes that a higher target of 1.8 MAF would be cost-effective and could be achieved before 2030.



Lastly, Dr. Gleick focused on stormwater capture. He highlighted the importance of catching stormwater in the few wet years that California has, and lamented the lack of infrastructure to do that. He believes that 0.5 MAF of stormwater could easily be captured in the Bay Area and the Los Angeles area in particular. Stormwater capture in the Central Valley was not studied, but could be performed in a different way (over spreading grounds, allowing groundwater recharge, rather than urban stream capture).

In conclusion, Dr. Gleick believes that there are many strong options for California to improve its water supply issues and tremendous untapped potential in relatively low-cost solutions. He cautioned against seawater desalination at this time, as it is enormously expensive compared to other sources. He noted that while Israel has implemented seawater desalination as a significant water source, they did so after restructuring agriculture, moving "aggressively" toward wastewater reuse, and cutting urban per capita use to extremely low levels. He underscored the importance of moving to a more diverse water portfolio "in the right order."

Barton "Buzz" Thompson, J.D./M.B.A, Director, Stanford Woods Institute

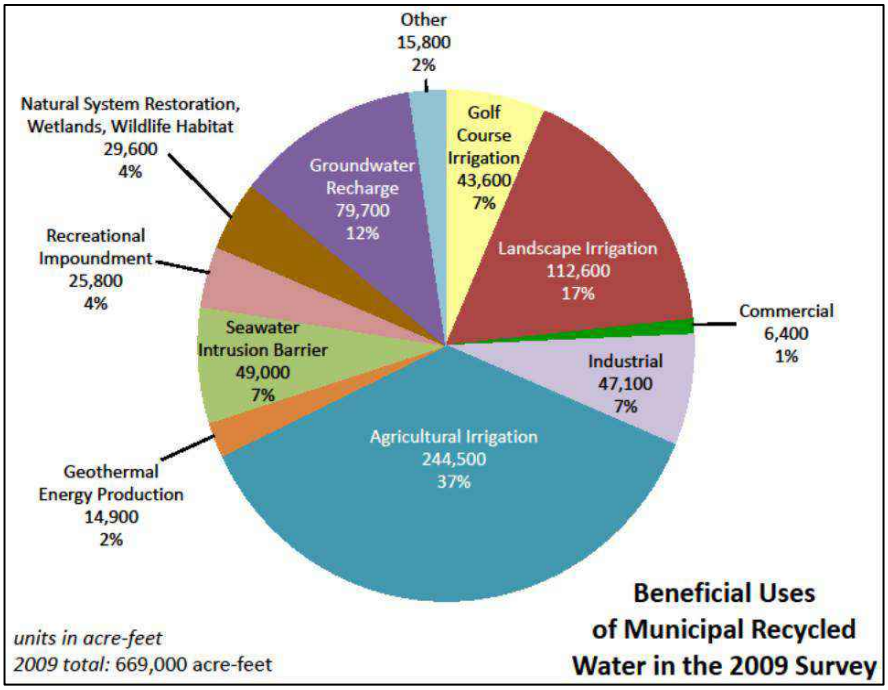
Mr. Thompson agreed that there is great consensus among those who research California water regarding the best long-term solutions, and the best way to prioritize those solutions.

He had two key messages. One was that many opportunities exist currently, and that most of those opportunities are not being addressed quickly enough and with enough state support at this time. Conservation is the "low-hanging fruit" of opportunities; the California Water Plan Update of 2013 identifies 2 million acre-feet (MAF) of potential conservation savings, but Mr. Thompson believes that the Pacific Institute's numbers of 2.9 to even 5.2 MAF are probably more accurate. He showed some new technologies that may improve conservation ability: TaKaDu is an Israeli company that uses sophisticated analytical tools to help water agencies identify leaks, vulnerable pipes, and redundancies that can help save water. The State of Queensland, Australia saved 1 billion gallons a year with this technology and the city of Jerusalem, Israel was able to reduce wasted water to below 10%.

He also underscored the importance of storing water when it is available and diversifying the stream of water sources that we have including reuse and other sources that are predominantly precipitation-independent. He cautioned against investing in new surface storage, showing that the superior availability, security, and cost-effectiveness of groundwater storage in extent aquifers. Citing the research of Rosemary Knight at Stanford, he explained that new technologies will help us understand those aquifers better and be able to measure their true storage levels without drilling.

With regard to diversification of water sources, Mr. Thompson discussed the wisdom of allowing stormwater to trickle into groundwater to be naturally purified: the ReNUWIt project, a collaboration between Berkeley, Stanford, the Colorado School of Mines, New Mexico State, and the Orange County Water District to create infiltration materials in order to purify stormwater that is sent into aquifers.

Graywater systems also hold great promise: if all urban users recycle their laundry and shower water, they would have enough to use for landscaping; if all graywater is included, 40% of toilet flushing would be covered as well. Municipal recycled water holds equal promise, and Mr. Thompson reiterated that we only recycle 13% at the present time – there are a tremendous number of uses for recycled water, so the demand is there, but it does require quite a bit of energy. Researchers at Stanford are devising systems that maximize energy that can be taken *out* of water recycling processes, a game-changer that would make wastewater treatment a net positive energy contributor for the city. No utility was willing to experiment with this kind of process, so Stanford is currently setting up an on-campus test site. As for groundwater remediation for contaminated basins, Mr. Thompson noted that for 49 contaminated basins studied in 2012, only 6 were reusing treated groundwater. 1.3 billion gallons of water could be realized if all of this water was treated and used.

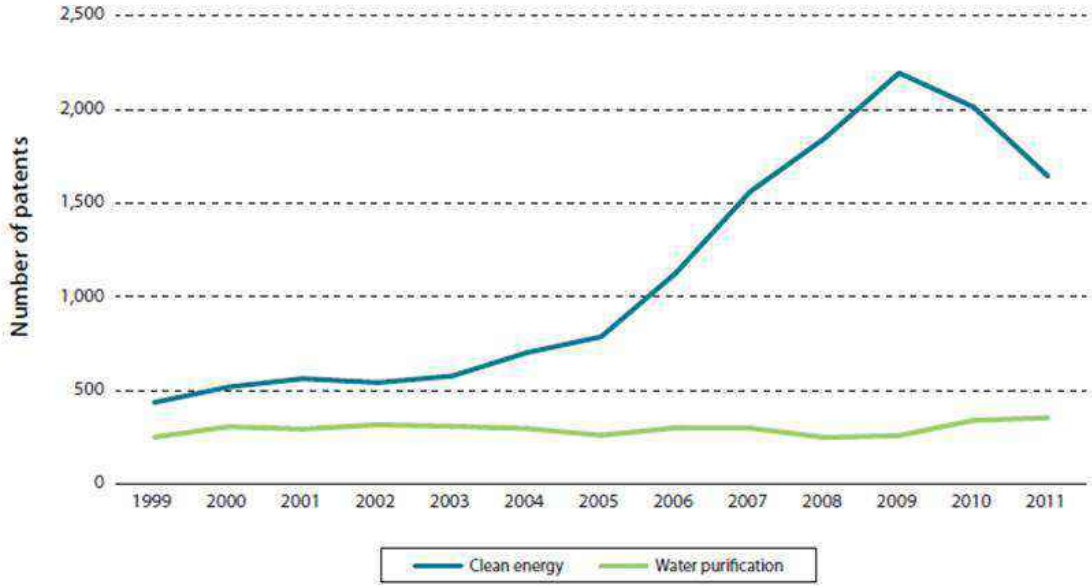


Using desalination, according to Mr. Thomson, presents the most expensive and energy-intensive process for production of potable water. Using United States Bureau of Reclamation data, he underscored the high energy usage of desalination. However, new technologies (including new membranes like graphene) have the potential to decrease the energy consumption of desalination.

Mr. Thompson concluded by saying that no matter how many opportunities seem to exist now, new technologies over the next 5-20 years will expand the possibilities for improving water efficiency and sourcing in California and will dramatically reduce the cost (and increase the security) of the options before us today. He lamented the current lack of support and

FIGURE 2.

Comparison of U.S. Patents Filed under the Patent Cooperation Treaty for Clean Energy and Water Purification, 1999–2011



Source: Organisation for Economic Co-operation and Development (OECD) 2014.

Note: Clean energy = biomass generation + energy efficiency + energy storage + geothermal + hydro & marine power + solar + wind; and water purification is the primary contributor to patent filings in the water sector.

encouragement from the state for such technologies. He compared the current state of innovation in clean energy and water technology by looking at the number of new patents; clean energy patents have increased substantially over time, while water innovation is at a "flatline." He suggested several policies that could promote innovation in this space including public funding of research and development, public venture funds, improved standards, and creation of demand for reform through improved water pricing.

Closing Panel: What are California's Strongest Options to Improve Long-Term Water Security?

Peter Gleick, Ph.D., President, Pacific Institute
Barton "Buzz" Thompson, J.D./M.B.A, Director, Stanford Woods Institute
Jay Lund, Ph.D., Director, UC Davis Center for Watershed Sciences
Ellen Hanak, Ph.D., Director, Public Policy Institute of California Water Policy Center

Q: As we think about decentralizing water treatment and usage, how do we deal with the problems associated with decentralization of systems and subsequent difficulty in maintaining central infrastructure?

BT: Decentralized systems are more efficient inherently because the water isn't being transported over long distances and communities can treat the water to the exact level needed in that community.

JL: Decentralization for agriculture in California works less well than for urban use. Centralization would allow wiser recharging of groundwater and management of shared resources. Ultimately, agriculture is very price-sensitive and can't incur large costs like cities can in terms of new water technologies.

Q: If you could have complete control over the delivery of water in California, what changes would you make to the system?

PG: In addition to things we've discussed with regard to water conservation/efficiency, recycling and stormwater, there are two additional "really hard" things. One would be Prop 218 reform; Prop 218 is currently "a barrier to smart water use and proper funding to water infrastructure." The second would be acceleration of the Sustainable Groundwater Management Act target dates; the current implementation date of 2040 is too far in the future and may not help in the next drought. He cited the experience of the delayed water metering mandates, and his belief that an accelerated timeline there would have eased current drought difficulties.

BT: I would consider how to create a system that encourages greater conception and adoption of new water technologies. The way to do that would be more realistic water pricing, which also comes down to Prop 218 challenges, and a more systematic approach to water research and development in water suppliers. In the energy sector, there are large research and development operation. Some large water suppliers do this, but not most, and not to the extent that they should. I would require water suppliers to do R&D or encourage collaboration in this effort.

EH: The water rights system "seems like a heavy lift" but might not be so challenging if approached the right way. She pointed to an upcoming Public Policy Institute of California report on how to manage the current water rights system in California. The use of technologies to measure water consumption by all rights users and improved markets to allow trading of water rights would serve dual goals of strengthening water rights and improving water efficiency. Lastly, she proposed California taking over the Central Valley Project and merging it with the State Water Project, making it a public utility. This would alleviate coordination challenges and would come at low cost to the state.

JL: Problems exist in three fields. One is ecosystems, another is the Delta, and the third is groundwater. When looking at those three problems, a better water accounting system would go a long way to improving all three. Understanding where water goes, who is using it and how much is returned will help understand how to allocate water and determine its worth. Currently, state agencies use different accounting systems which makes coordination on this issue difficult.

Q: We clearly have a problem in water innovation. To what extent is this related to a lack of perceived return on investment, and to what extent is that all tied to water pricing?

BT: Lack of innovation in water is very much driven by low water pricing. The relative wealth of innovation in energy is because energy is expensive, so new technologies are valuable. So long as we do not charge the full cost of water, we are never going to either get people to adopt conservation technologies nor will we have the water suppliers have sufficient funds for research and development. When I look at innovation barriers in water, it is due to fragmentation of the industry and water pricing.

PG: I would add that smart regulations can also drive innovation. The efficiency standards for toilets, refrigerators and other appliances, for instance, have driven innovation in other sectors.

Q: What specific regulations should be eliminated or added?

EH: Currently, environmental regulations with regard to water allocated to the environment aren't very clear, which makes it difficult for business and agriculture to make intelligent decisions with regard to water. If the state sets standards for environmental flows in a given watershed, others can better predict how they may use water in that area in a more concrete way and work creatively to manage water. This was done on the Yuba River in the early 2000s and more recently on the Eel River.

BT: A survey was done earlier this year of wastewater suppliers and they were asked about barriers. They cited revenue as the number one barrier followed by regulations. There was no specific regulation, but instead a suite of them. A state agency could look systematically at this issue and see what groups of regulations could be shifted to spur innovation and change in water recycling specifically. Moreover, as Peter Gleick states, regulations that set standards statewide can be helpful.

Q: Closing statements?

PG: We hope it'll be a wet winter, but not too wet – because of flood risk – but even if it is wet, these problems aren't going away and are important for the state's sustainability. We need continued attention to water issues.

BT: There are solutions! We are not facing a dire future with no ways to solve our water challenges. The policies and technologies are available, it's just a matter of setting up our institutions in a way that allows us to adopt them.

EH: We have great opportunities now ahead of us, and California has shown time and time again that it can rally to solve big issues, but that requires leadership from above.

JL: We need to always be between complacency and panic. Either extreme isn't right and either extreme doesn't help us to address real problems, but being in the middle allows us to attack problems rationally and determine the best solutions.

PUBLIC COMMENT

Susan Jordan, Director of California Coastal Protection Network

Ms. Jordan stated that on the topic of desalinated water, she does not believe that desalinated water would allow water to remain in Northern California or decrease dependence on the Colorado River. She believes that claims that it would be are untrue. She stated that desalination is an investor-driven, for-profit venture. Profit motive drives choices that reduce infrastructure costs by not using the newest technologies, such as open-ocean intakes previously used by power plants. Use of these old technologies is a cost to the state with regard to protection of marine resources. She agreed with the panel's thoughts about desalination and look forward to the next hearing about desalination.

Hearing 2

Possibilities and Pitfalls for Desalination in California
Friday, December 11, 2015, 10:00 a.m. – 12:30 p.m.
Metropolitan Water District Board Room, Los Angeles

The second Select Committee hearing convened experts to discuss seawater desalination in California as an option in a diversified regional water portfolio. Discussion focused on current seawater desalination projects, important conservation and energy implications of desalination, the current regulatory framework for ocean desalination, and the state of the art in desalination technology.

Overview of desalination and water/energy nexus

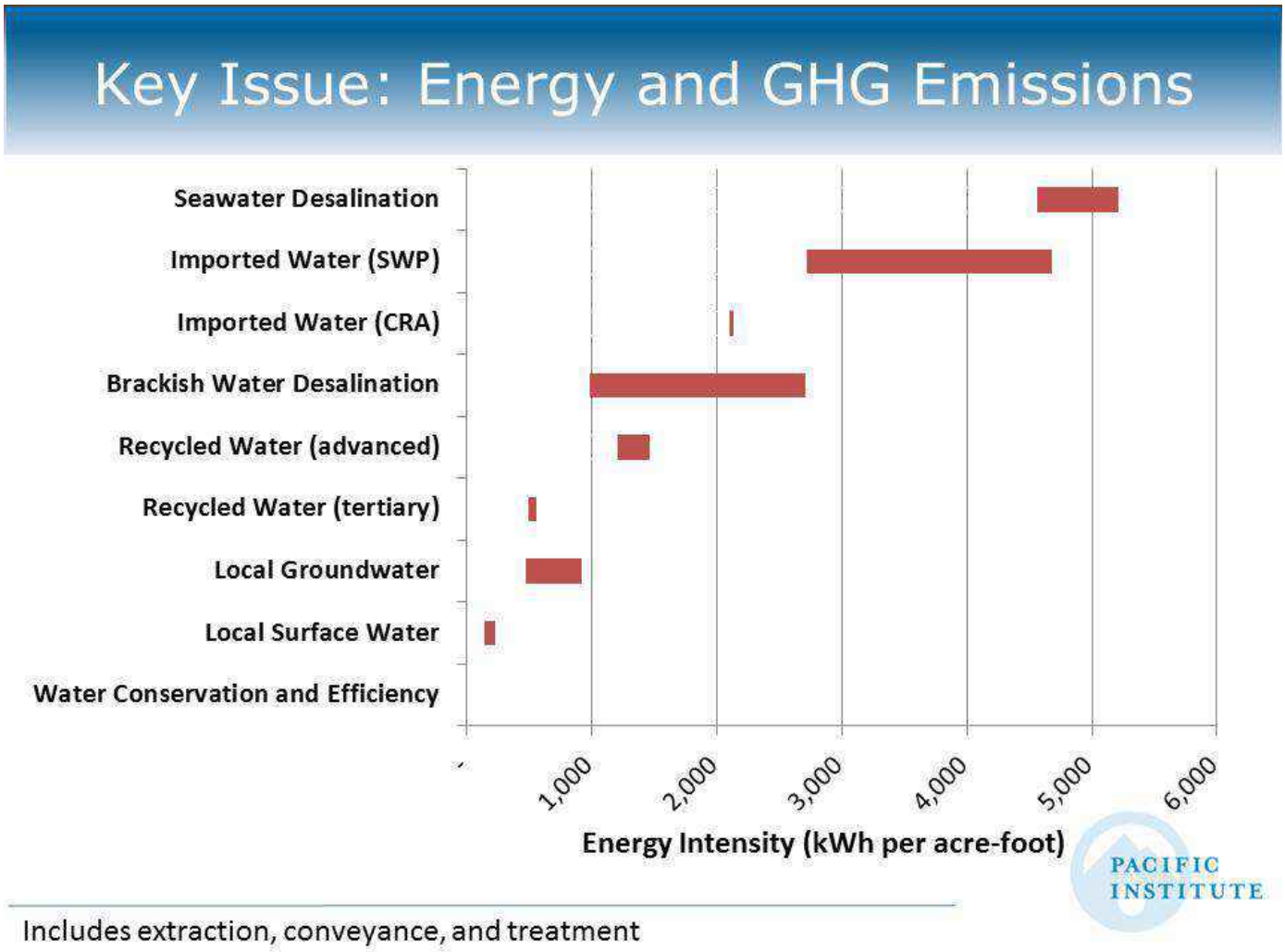
Heather Cooley, Water Program Director, Pacific Institute

Ms. Cooley began her testimony by providing a general overview of desalination, with emphasis on the water/energy nexus and environmental impacts of desalination both direct and indirect.

For context, Ms. Cooley pointed out that the majority of desalination done in the US is of brackish water and only 8% is of seawater. Three ocean desalination plants exist presently in California: in Sand City (0.3 million gallons/day), Catalina Island (0.3MGD) and Carlsbad (50MGD) She provided an overview of desalination methods including thermal and reverse osmosis processes. There are up to 11 proposed plants in California for seawater desalination and two in Mexico near the US border. Many of these are clustered in southern California and the Monterey area. Two are proposed on the Central Coast. Many of the 11 are competing projects (particularly in Monterey) and not all 11 will ultimately be completed.

Ms. Cooley described the reasons why desalination is attractive: it provides an abundant source of new water which is independent of weather conditions, it provides water authorities with some diversity in water sourcing, and it also permits a strong local control over this new source. That local control contrasts with the current interconnectedness of water sources in California, which necessitates a centralization of control at the state level. But with those benefits come several challenges and issues that regions must address when embarking on desalination initiatives.

First is energy use and greenhouse gas emissions. When comparing the energy intensity of water sources in California, desalination is at one extreme (5000 KWh/AF) compared to State Water Project water (about 3000 KWh/AF in San Diego). This represents a significant increase for energy burden, which has implications for the volume of greenhouse gases that are emitted to produce fresh water.



The second challenge to desalination is cost and financing of projects, and this is linked in many ways to the energy expenditure. The reverse osmosis process is the most energy intensive and expensive element in desalination and the price of energy spikes during a drought (because of the statewide decrease in hydropower). This means that desalinated water is most costly when it is most needed. Independent of energy, there are other costs that must be considered, including a 37% capital cost to establish a plant and additional costs needed to pump water uphill if the facility is built at sea level. The flipside of the 37% capital cost is that about 63% of the costs in desalination are variable, which makes desalination uniquely volatile as a water source. In other types of water sourcing, the fixed costs predominate and make the pricing of the end product more predictable. Lastly, demand risk – the possibility of new water sources becoming available – can prove challenging to desalination projects, as happened in Santa Barbara in the 1990s and Australia after the conclusion of their Millennium Drought.

The third and final challenge outlined by Ms. Cooley relates to impacts on marine life. These can be broken down into challenges at the point of water intake (impingement and entrainment of sea life) and brine discharge. Intake impacts are not as well understood, but one can minimize risks by building subsurface intakes that use sand as a natural filter or reducing pumping during key periods. Brine tends to sink to the bottom of the sea floor due to its density and this impact can prove quite adverse to sea life in a local area. Putting the discharge point in an area of high mixing or using multi-port diffusers on the brine discharging implement can also mitigate risks.

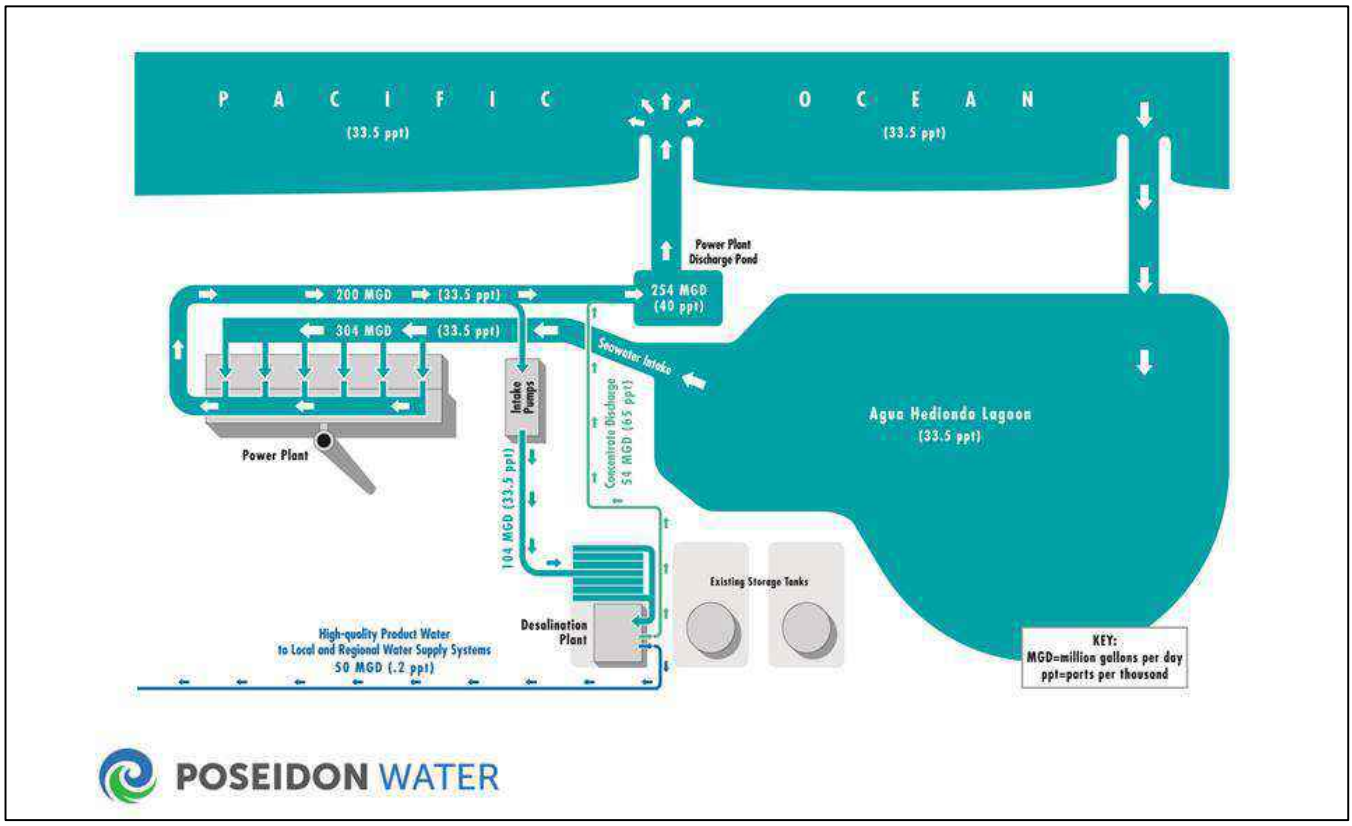
Ultimately, Ms. Cooley concludes that desalination must be deeply analyzed by regions wishing to implement it and that all risks must be properly mitigated. She reflected that there is no statewide process currently for oversight or coordination when regions do consider desalination (such as best siting across California's coast), though there are regulations to comply with should regions choose to go down the route of desalination.

Current desalination projects in California

Scott Maloni, VP of Project Development, Poseidon

Mr. Maloni shared some background regarding Poseidon Water, a privately-held company that builds and operates desalination facilities nationally. In California, they have built the first large-scale desalination plant of its kind in Carlsbad and are in final stages of proposing an identical plant in Huntington Beach.

The Carlsbad plant is collocated with the Encinas Power Station at the Agua Hedionda Lagoon, which is a source of cooling water for the Power Station as well as a site for local recreation and environmental mitigation. The Carlsbad plant cleans up the lagoon's water to produce its drinking water and utilizes the Power Station's intake to bring in the 100 million



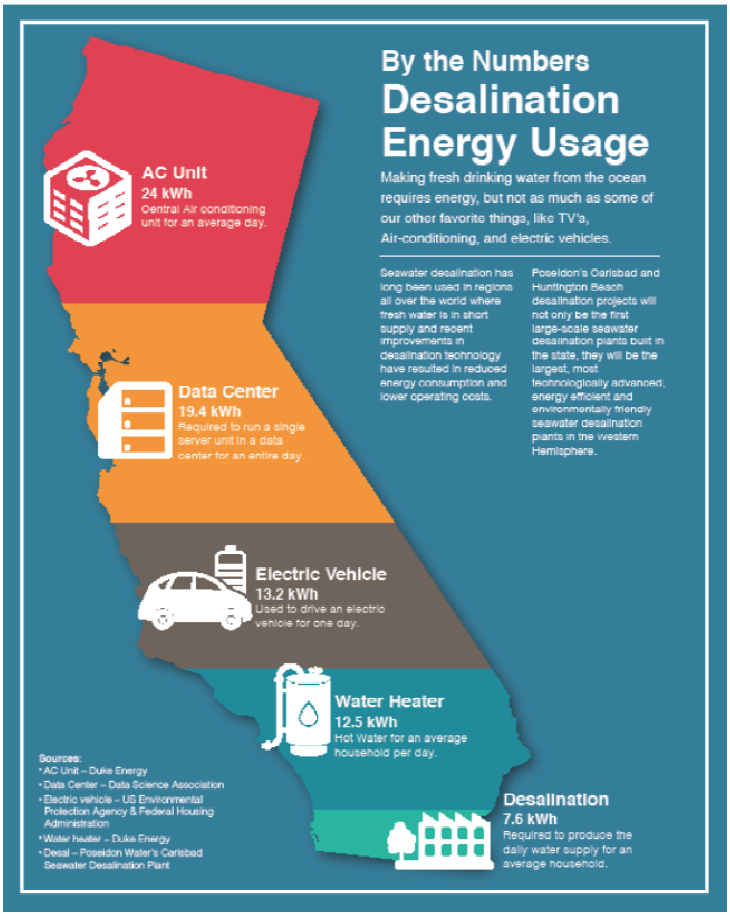
Site layout of the Poseidon desalination facility in Carlsbad, showing co-location with Encinas Power Station and position of Agua Hedionda Lagoon. The desalination facility uses water that has travelled through the power plant and disposes its brine into the discharge system of the power station.

gallons a day required for desalination. Once the Power Station is decommissioned, Poseidon is committed to rebuilding the intake screening infrastructure to comply with the California State Water Resources Control Board's new Ocean Plan Amendment (OPA). Mr. Maloni expressed optimism that the OPA would make planning for these projects in the long-term more streamlined and less uncertain, but also expressed that the current permitting process is "duplicative, onerous, cumbersome, and expensive." A one-stop shop for permitting, like costal power plants enjoy from the California Energy Commission, would streamline a process that currently sits between "a half-dozen" regulatory agencies.

The desalination process used at the Carlsbad plant includes primary and secondary water treatment followed by a reverse osmosis (RO) process using 16,000 total RO membranes. The facility also includes significant energy recovery processes to reduce the overall energy cost by 50%. In addition to the plant, a 10 mile water delivery system was built to get the water from the plant to the customers of the San Diego County Water Authority (SDCWA), Poseidon's partner.

The SDCWA is a public agency which provides San Diego with its currently imported supply of water; their interest in portfolio diversification has been strong in the past several

decades, and they viewed desalination as an important part of that effort. The $922 million build was financed by Poseidon, and all water for the life of the desalination plant (30 years) has been purchased by SDCWA at a fixed price. Ultimately, Poseidon is responsible for the plant siting, financing, permitting, construction and operation and will own the plant for a period of 30 years.



Context of desalination facility energy usage per capita, compared with other major energy uses, according to Poseidon.

Ultimately, Poseidon projects that their water will have a lower cost than imported water over the lifetime of the plant and that the price will remain competitive with wastewater recycling. They are minimizing and mitigating environmental impacts, and believe that their current build is in line with SWRCB regulations with regard to impingement and entrainment. Furthermore, their brine discharge method is in line with contemporary research and has also been approved by the Water Board. With regard to energy consumption, they hope to power their entire facility using renewable energy in the near future, though they discussed some barriers to doing so currently.

Our hearing took place on the Friday before the facility was set to officially open, but a 30-day, billion-gallon test run had already been successfully completed, according to Mr. Maloni. Their proposed second plant at Huntington Beach will have a hearing at the Coastal Commission in March of 2016 for permitting.

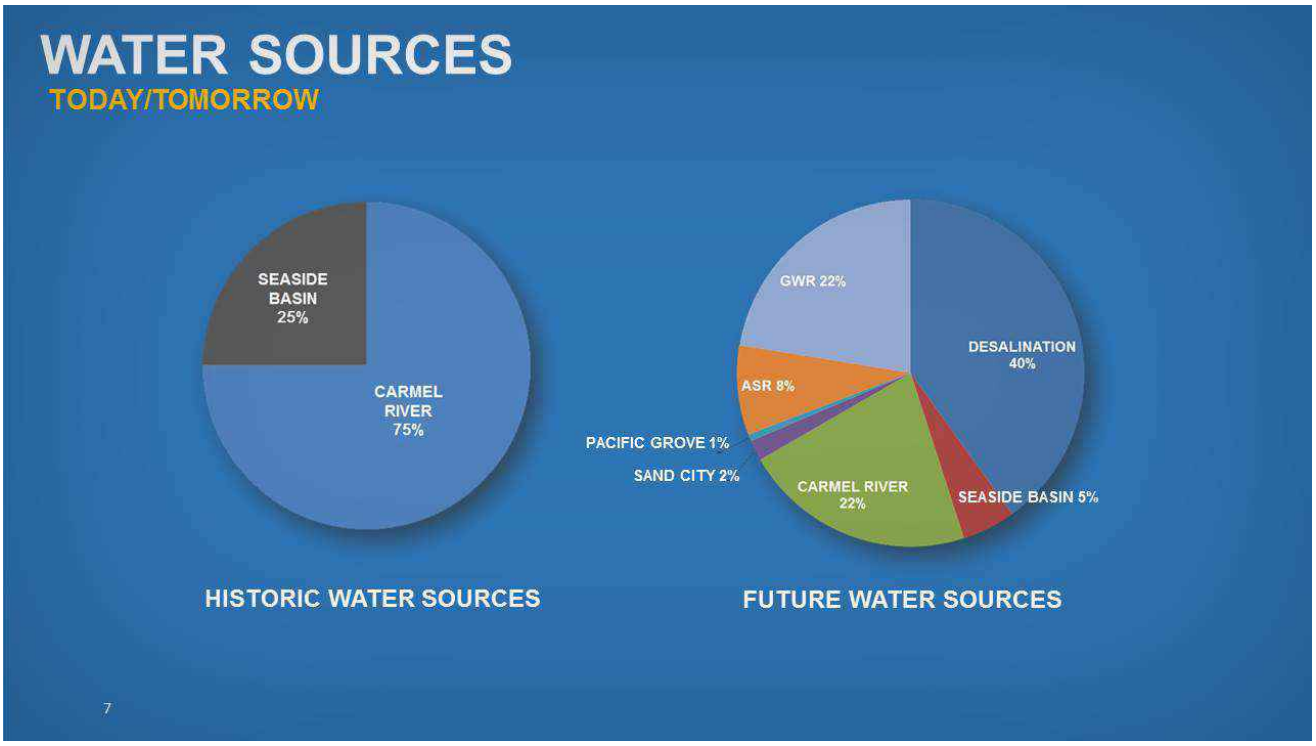
Rich Svindland, VP of Operations for California American Water

Mr. Svindland described the changing demographics and water sourcing in the Monterey Bay area, highlighting the declining population (due to the closing of Fort Ord) and the improved diversification of sources over the last 10 years.

Because of those factors, the sizing of a possible desalination facility in Monterey is an important decision point; Monterey will not have a tremendous demand for new water in the

way San Diego does, and the population may change in unpredictable ways in the future. The tourism industry in Monterey is awaiting a bounceback after the recession in 2008, for instance, which may or may not occur.

The proposal to have a desalination plant in Monterey began in the 1990s to be collocated with the power plant at Moss Landing; this proposal beat out two others based on its favorable environmental review. That being said, Mr. Svindland did note that the permitting process has been quite onerous, especially compared to the quick build time; Cal Am has spent $40 million on this project already, and they are still awaiting an environmental impact report.



Monterey's historic and future water sources. The region has had to decrease its reliance on Carmel River water and its seaside basins; to do this, it has developed a multitude of new sources to supply its residents.

The California American Water project to improve Monterey's water reliability and source diversity includes aquifer storage (about 1300 acre-feet annually), groundwater replenishment (3,500 AF), and desalination (6,252 AF). Mr. Svindland pointed out that the Cal Am project uses the more environmentally favored subsurface intakes, something they were able to do because of the specific siting and sizing of their proposed plant. There is an existing outfall pipe used locally for brackish water desalination discharge that they will be able to use which utilizes a large number of defusers to output brine at ocean-level concentrations. All of these proposed elements are helping Cal Am's project meet the Water Board's Ocean Plan Amendment.

The overall project will cost $338 million, though only a third of the cost will be attributable to the desalination complex. They have purchased 5MW of renewable energy from a nearby landfill which captures and converts emissions from the waste, and that will cover all of their energy needs.

Ultimately, Monterey's comprehensive water plan has allowed them to restore the Carmel River watershed, replenish the seaside basin, and implement desalination using renewable energy sources and minimizing ocean life impacts. Because of this approach, Cal Am has earned the support of the environmental community for its proposal. Mr. Svindland cited one of the sources of success as their collaborative approach with many regional and statewide interest groups.

Current regulatory framework

Tom Luster, Senior Environmental Scientist, Coastal Commission

Permit review for coastal proposals in California requires many agencies at multiple levels of government for final approval. For desalination proposals, an interagency working group and a pre-application review aims to reduce redundancies.

Mr. Luster highlighted that California currently has an effective and comprehensive state permitting system for seawater desalination proposals in which the Coastal Commission plays a key role. The Coastal Commission has attempted to streamline the complexities of permitting by creating a pre-application review process with an interagency working group; this working group seeks to decrease major changes that end up becoming mandated during the permitting process. That would then decrease the need for re-review by an entity which has already studied a previous version of the proposal. Over 30 proposals have been approved by the coastal commission over the past decade.

In Mr. Luster's opinion, the long process for permitting is largely due to decisions made outside the permitting process (by water agencies or local governments) that include deviations from the recommendations and priorities reflected in the Coastal Act and Water Board Ocean Plan Amendment (OPA) regarding desalination. These deviations often require additional time for analysis before approval. More efficient permitting could be achieved from the Coastal Commission's perspective if proposals are well-designed and well-sited, and in line

with the OPA. Furthermore, effective and frequent coordination between desalination applicants and permitting agencies would also improve the efficiency of permitting.

After a project is permitted and a facility is built, the Coastal Commission does site-specific checks to ensure that requirements are complied with. Where mitigation requirements exist, performance standards have been agreed upon and can be monitored over time.

Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board

Mr. Bishop framed his testimony by explaining the State Water Resources Control Board's recent Ocean Plan Amendment regarding desalination. The need existed for such an amendment because, while desalination is currently a small part of California's portfolio, it is increasing in importance for certain regions. The Water Board wanted to ensure that agencies looking to expand ocean desalination did so in the context of other sources of water that could be cheaper, more environmentally neutral, and less energy-intensive.

Opportunities for desalination were presented with the passage of the Prop 1 (2014) Water Bond: $100 million was set aside for desalination projects. In 2015, Governor Brown recommended $30 million of cap and trade funds to be allocated for water-energy efficiency technology deployment, including desalination powered by renewables, but that proposal was turned down by the legislature. Many desalination projects have been proposed since the mid-2000s, and that increased demand highlighted the need for consistent state regulations to protect ocean waters from degradation while still supporting use of ocean water as an alternative water supply.

An example of a 1mm intake screen. These screens will be necessary for ocean water intake systems if subsurface intakes are infeasible in order to reduce mortality of fish and their eggs.

That need led to the Ocean Plan Amendment (OPA). The Amendment was created by a scientific peer review process with an expert panel, subjected to extensive stakeholder outreach and interagency collaboration, and adopted by the Water Board in April 2015. At the time of Mr. Bishop's testimony, the Office of Administrative Law had not yet approved the Amendment but was working toward it. The Amendment has three components.

The first regards intakes. The OPA requires subsurface intakes unless it is impossible to accomplish "within a reasonable period of time, taking into account economic, social and technological factors." If it is found to be infeasible after study, screened intakes must be used (minimum 1mm screen). Firms can use alternative technologies if they are proven to be superior.

The second factor in the Amendment regards brine discharge. Comingling brine with wastewater before discharge is considered best, but as wastewater is increasingly seen as a resource by local agencies, it may not be available for dilution of brine. Multiport diffusers are the next best option for brine discharge: this is a more straightforward method that is used in Australia. Flow augmentation (a type of in-plant dilution that occurs when a desalination facility withdraws additional source water for the specific purpose of diluting brine prior to discharge) is considered unacceptable, but an exception was made for the Poseidon Carlsbad plant since 80% of the construction was completed at the time of the Ocean Plan Amendment's development. And again, firms can use alternative technologies for brine discharge if they are proven to be superior.

An example of a multiport diffuser, which rapidly mixes, disperses, and dilutes brine. This is seen as an acceptable method of brine discharge by the Water Board.

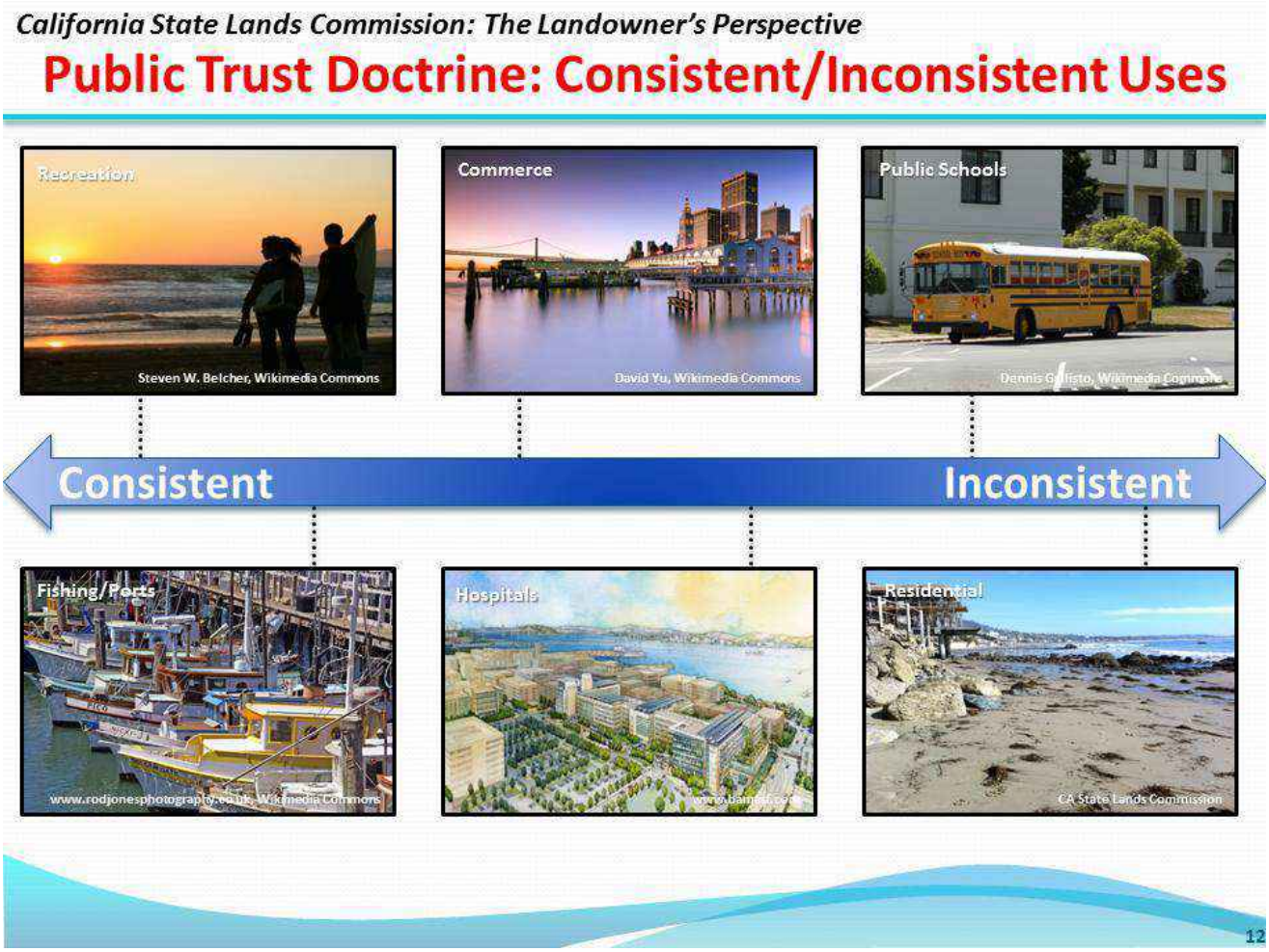
The third element in the Amendment is a salinity limit in the environment local to the brine outfall. This is meant to limit the area of higher salinity where the brine gets diluted and mitigate impacts to a larger ocean environment.

Lastly, due to provisions in the Porter-Cologne Act, firms are required to mitigate impacts for mortality of all marine life associated with the building and maintenance of the proposed facility. Mitigation is required in-kind if possible; out-of-kind mitigation is allowed for soft-bottom impacts and open-ocean impacts.

Mr. Bishop underscored a point made previously by Mr. Luster that for permit applicants concerned with long permitting time, adherence to the approved best practices in the Ocean Plan Amendment would speed things up. If alternative designs are proposed, time must be spent evaluating such an alternative and its impacts.

Cy Oggins, Chief, Environmental Planning and Management Division, State Lands Commission

Mr. Oggins began by underscoring the State Land Commission's (SLC) firm commitment to the Public Trust Doctine, which traces its roots back to ancient times and is reaffirmed in case law and the California Constitution. The SLC has many functions including leasing land for commercial, industrial, recreational, ecological and open space uses.



The commitment to the Public Trust Doctrine guides the SLC's decision-making when considering applications, and Mr. Oggins presented a "spectrum" of uses that ranged from the most consistent with the Public Trust Doctrine to the least consistent. Where desalination falls on that spectrum is determined on a case-by-case basis, as details in specific proposals and in specific locales can vary.

Considered by the State Lands Commission are both environmental and cultural factors that may impede on the public's Trust needs at that location. Lease conditions may be imposed to make up for impacts on Public Trust resources and sovereign lands, including possible rent payments. Mr. Oggins then outlined the State Land Commission's varying roles in eight different active desalination proposals, emphasizing that the differences in proposals and sites dictate the role of SLC.

Mr. Oggins underscored that the State Lands Commission strives to be helpful to applicants and is committed to assisting applicants through the permitting process. Their primary priority is to preserve the Public Trust, but they are open to working with desalination

applicants to find solutions that can allow responsible desalination that preserves public resources.

Environmental Impacts of Desalination

Conner Everts, Executive Director, Southern California Watershed Alliance

Mr. Everts noted that the issue of desalination has now "peaked" here in California. He relayed his experiences from the drought in 1987-1992 and the desalination plant built in Santa Barbara at that time. It came online after the drought ended as a backup water supply, but was never ultimately used due to its high cost.

Regarding the plant soon to come online in Carlsbad, Mr. Everts noted that he had been opposed to the plant for a long time, and recommended that Californians closely follow the results of the plant's opening and data regarding its energy usage to inform their opinions about desalination.

Climate change and the current drought are two factors that Mr. Everts points to as major drivers for developing a conservation ethic and for looking at desalination. He believes that California's response to the conservation mandate shows that we can handle deep cuts in our usage and have an appetite for expanded water reclamation programs. He lamented the amount of water that runs off into the ocean annually: in Mr. Everts' opinion, fully treating and using that water would "end this discussion" about desalination. He quoted David Nahai, former Chair of the Los Angeles Regional Water Quality Control Board and former General Manager at Los Angeles' Department of Water and Power in saying that "agencies that are doing desalination first have failed at water management." Conservation must come first, as has been done in nations overseas.

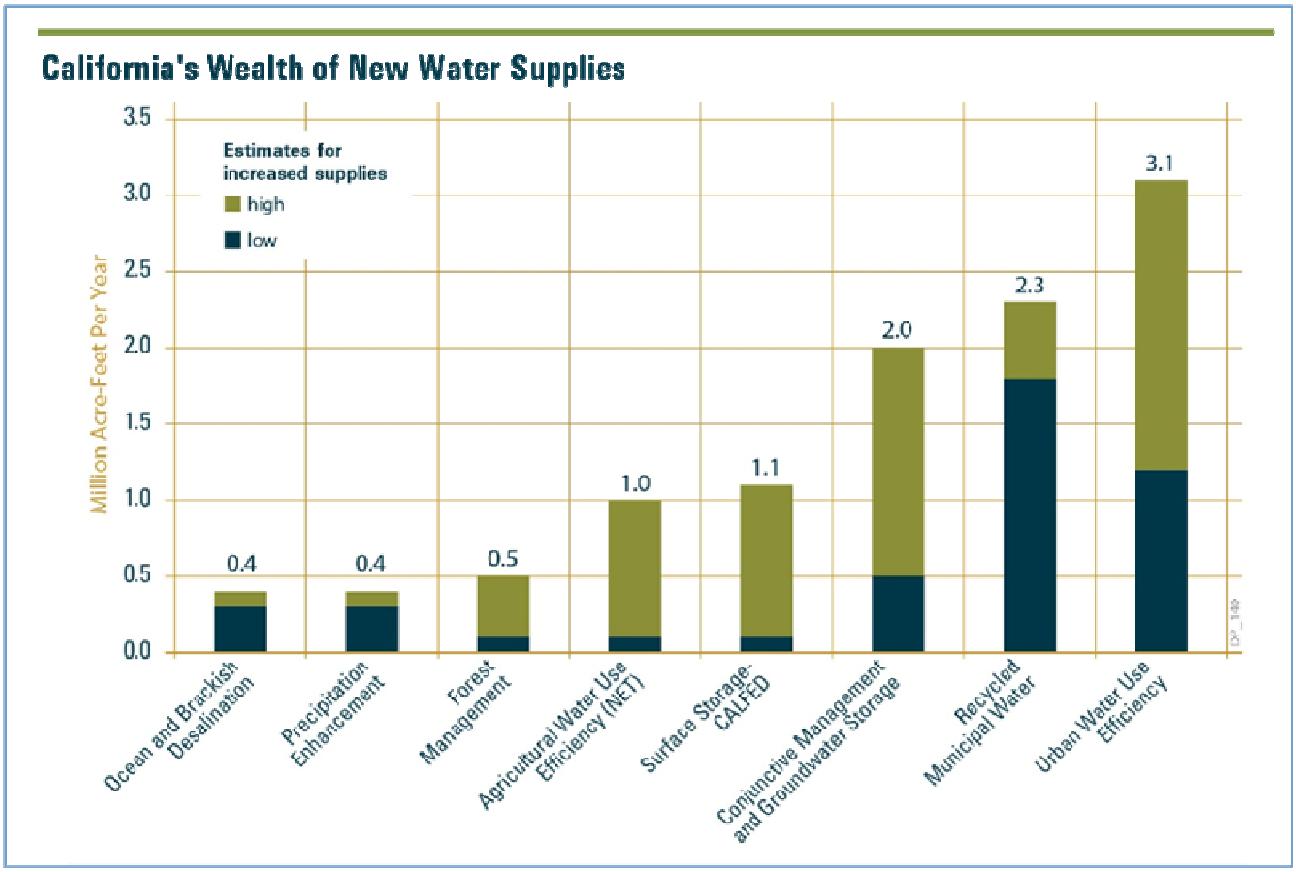
He also criticized 30-year contracts for water between water agencies and desalination companies, believing it would reduce the incentive to develop other water sources over that period. Moreover, the next 30 years could be full of uncertainty, and terms of a deal today could make little sense decades from now.

Mr. Everts then looked at the history of desalination proposals in California, applauding cities like Los Angeles and Long Beach that had chosen against desalination in favor of conservation, water recycling and stormwater capture. Marin and Santa Cruz also both voted down desalination proposals. He framed the decision-making in San Diego that approved the Carlsbad plant as a "battle" between water interests in San Diego and Los Angeles. He responded directly to Poseidon's point about the long permitting and build process, noting that since this is the first large-scale desalination plant in the state, it deserves the review and analysis that it is receiving.

In conclusion, Mr. Everts noted that communities seeking desalination solutions must hold public hearings, look at their untapped water options, and include the energy impacts in their assessments. Only then should siting and sizing considerations be made and a formal proposal developed.

Sean Bothwell, Policy Director, California Coastkeeper Alliance

Mr. Bothwell contextualized the limited supply gained from desalination (as compared to water recycling, improved efficiency, and improved groundwater management) and the substantial gains that improved conservation could instead supply.



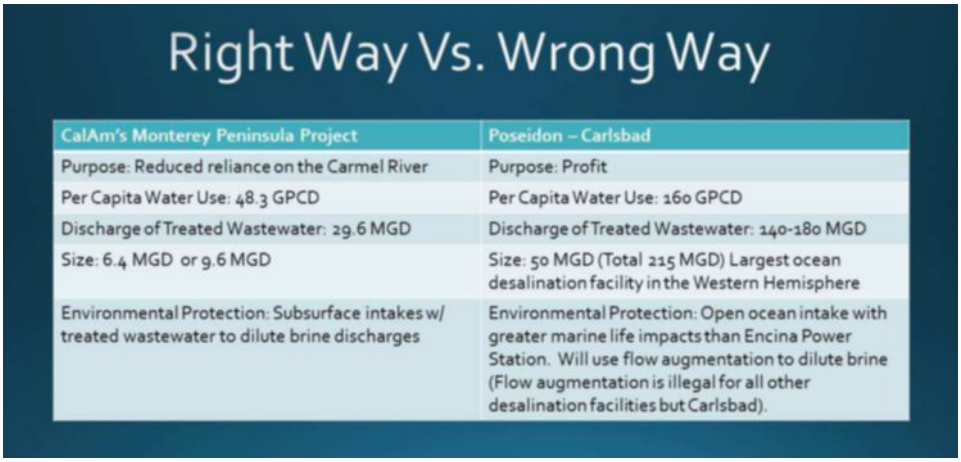
The adoption of desalination by any locality should be in context of other potential water sources. Water recycling, use efficiency, and improved groundwater management can provide far more water for a given region (typically at low comparative cost) and should therefore be pursued first when water is scarce.

With regard to climate change, Mr. Bothwell testified to high greenhouse gas emissions that can be expected due to desalination's high energy requirements. Secondly, many of the proposed desalination facilities are in sea level rise inundation zones and are not adapted to the flooding that they may therefore experience.

On the issue of desalination facility ocean intakes, Mr. Bothwell discussed the danger of using open-ocean intakes and the environmental superiority of subsurface intakes. Screened intakes, which are acceptable per the OPA if subsurface intakes cannot be built, only provide a 1% reduction in entrainment, according to Mr. Bothwell. This is compared to a 100% reduction from subsurface intakes. In particular, he pointed to a study showing that all northern anchovy larvae and all CIQ gobies would be entrained using a 1mm screen.

On brine disposal, Mr. Bothwell testified that high salinity can be toxic to marine life and that proper brine dilution is critical to environmental safety in desalination proposals. Using the best available technology for brine disposal is an important part of the Ocean Plan Amendment.

Ultimately, Mr. Bothwell pointed to Cal Am's approach to desalination as the "right way" for a community to consider the technology as a water supply option. Monterey has exhausted other methods of developing water supply and has put hard work into water conservation. The proposal put forth by Cal Am is well-sized for the local population and uses subsurface intakes and treated wastewater brine dilution outfalls. He contrasted that with Poseidon's approach in San Diego, which he considered the "wrong way" to consider desalination. Mr. Bothwell underscored the importance of enforcing the Ocean Plan Amendment with all future proposals.



Mr. Bothwell's perspective on the "Right Way" and "Wrong Way" to pursue desalination projects with respect to the environment.

As a note of caution, Mr. Bothwell pointed to Australia as an example of a region that looked to desalination as a solution which did not materialize; the facilities there came online after their drought ended, at this time, the majority of facilities are not producing water. Nevertheless, ratepayers there are still paying down capital costs and continuing upkeep costs. Similarly, he pointed to Israel as a nation that installed desalination , but only after deep conservation (44 gallons per capita per day in Israel vs 105 in California) and water recycling efforts (94% of water reused in Israel vs 13% in California).

The California Coastkeeper Alliance's position on desalination is formally that "cost-effective water supply options, such as conservation, stormwater capture, and water recycling should be pursued before ocean desalination is considered as an option of last resort. Ocean

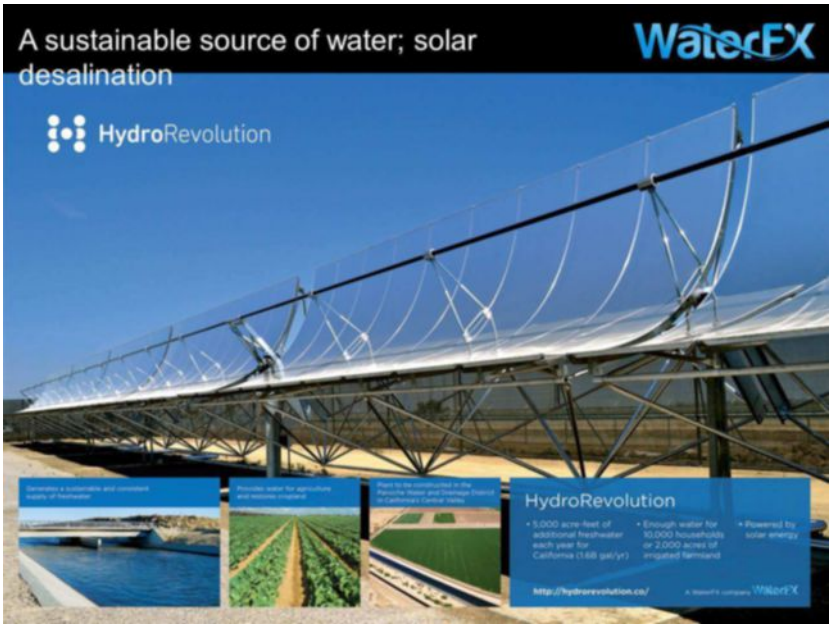
desalination has extremely high energy demands making it expensive to the ratepayer, and should be properly sized and sited to mitigate impacts to marine life." Mr. Bothwell relayed that desalination should be seen as an option of last resort, but is not off-limits to members of his organization.

What is the future of desalination technology?

Aaron Mandell, Co-founder and chairman WaterFX

WaterFX is a company focused on new desalination technologies. Mr. Mandell stated that he looks to clean energy as a model for how water technology will evolve.

He focused on California's groundwater resources, which have been depleted by about 1.5 MAF per year independent of annual precipitation. This he considered the cost of *not* doing desalination, and an important fact carrying its own environmental implications.



WaterFX performs thermal distillation on brackish water using solar power as a form of water recycling. It is not performed on seawater. The WaterFX technology is a zero-discharge technology: the saltwater is distilled with 93% efficiency, so all remaining salt waste products are recovered as solids. The company focuses on purifying impaired water for agricultural uses. They have a pilot project at the Panoche Water District in Firebaugh, aggregating about 45,000 AF of impaired water annually which cannot be discharged into the San Joaquin River. Using WaterFX's desalination product, they are cleaning up 5,000 acre-feet of this water so that it can be reused over about 100 acres of land.

Mr. Mandell believes that California's strongest water resource is our leadership in the clean energy space. Solar-powered processes in a distributed manner can be a strong solution for water recycling in California, especially for non-coastal regions, and fit into the current paradigm of increased solar panel usage and decentralization of utility development.

Dr. Sami Maalouf, California State University, Northridge

Dr. Maalouf presented his research, which focuses on the impacts of brine outfalls for desalination and possible improvements in planning or design. He began by stating that he believes desalination must be a last source of water for localities, but that there is need to develop water sources rapidly due to actively depleting aquifers. He outlined the concept of a "sacrificial zone" created by the high-density brine which falls to the ocean floor in a plume, negatively affecting marine life in that region.

Siting for these facilities, he argues, should not only optimize the siting of the facility itself, but also the intake and outlet zones and tunnels to mitigate their impact. Multiport outfalls are effective ways of disposing of brine, but the outfall needs to have an optimized mixing zone in the water to lower the effects of the sacrificial zone.

Dr. Maalouf studied the Cambria desalination facility and came to the conclusion that planners should utilize a simulation-optimization framework prior to proposing a facility in order to correctly design the best possible facilities. He concluded by pointing out that humanity's future will include hundreds of coastal megacities – including several in California – and so it is in our best interests as a species to keep our oceans healthy.

Dr. Andrea Achilli, Humboldt State University

Dr. Achilli's research focuses on energy embedded in wastewater and brine and ways in which this energy could be recovered to improve the energy efficiency of water purification.

To do this, an entity can use pressure-retarded osmosis: this process generates energy from the mixing of wastewater and concentrated brine during the brine outfall process. This power is therefore zero-emission and environmentally neutral.

A pressure-retarded osmosis system can be used to link wastewater treatment facilities with desalination facilities, synergistically improving the energy efficiency of both. Dr. Achilli estimates that it could save up to 1kWH per cubic meter of water treated, which is "a lot." It could bring desalinated water into the neighborhood of imported water in terms of embedded energy.

PUBLIC COMMENT

Cathy Green, Board President, Orange County Water District

The OCWD manages their local groundwater basin, serving 2.4 million residents. They have focused on developing local sustainable water supplies, including a partnership with the Orange County Sanitation District for the Groundwater Replenishment System. Treated wastewater is purified in an advanced process (100 million gallons a day) and injected into the groundwater. They have also entered into a purchase deal with Poseidon Water for up to 56,000 AF per year from the proposed Huntington Beach desalination project in an effort to diversify their water portfolio. The District's long-term plans view the desalination plant as a priority and the 56,000 AF as the largest single source of new water available to the District. They view the desalination as an option for water over the next 40-70 years and are proud of their efforts in water conservation and reclamation.

Terry Spragg, Terry G. Spragg & Associates

50 million gallons of freshwater are available in Humboldt Bay at $100 per AF. Entities in that region have offered that water for sale but have been unable to find customers because of the difficulty in moving the water. Mr. Spragg suggests his proprietary water bag technology. A test run of two water bags was performed in Washington State over 100 miles and it was successful. The technology is flexible and, according to Mr. Spragg, a low-emission alternative to desalination.

Linda Escalante, Natural Resources Defense Council

The NRDC believes that desalination should only be pursued after other less energy intensive and expensive options have been exhausted. This includes conservation, water recycling, and stormwater capture through the use of green infrastructure. Desalination facilities, if built, should reduce their use of energy and use renewable energy when possible. Siting should optimize the large energy consumption of desalination facilities since connection into the electric grid can directly be tied to increased greenhouse gas emissions. Furthermore, potable water developed through desalination is an expensive source of water, the demand for which may shift as conditions change and other water sources become cheaper and more available. NRDC has concerns about environmental impacts in ocean water intake and in brine discharge and opined that the Water Board's Ocean Plan Amendment is an effective way to address these issues. They recommend that less costly and less environmentally impactful water sourcing options should be considered before desalination and it should be guided by a comprehensive statewide policy when implemented using the best technology and best possible siting to mitigate environmental impacts.

Bruce Reznik, Executive Director, Los Angeles Waterkeeper

Mr. Reznik discussed what he called "the myth of all of the above." As we live in a world of finite resources, the idea that we could utilize every possible alternative water source is a false one. Making choices often hinders other choices and often some are mutually exclusive. Mr. Reznik believes that conservation, stormwater capture and recycling are the best options for California and should be pursued first, possibly to the exclusion of other sources such as desalination. Furthermore, California must remain a leader in greenhouse gas emission reduction, and therefore must we concern ourselves as a State with developing the most energy efficient water source modalities possible.

Scott Houston, Board Member, West Basin Municipal Water District

West Basin Municipal Water District serves 1 million customers in the Los Angeles area and has felt constrained meeting the State's water conservation mandate. Constituents have decreased their water demand to meet the State's goal, but West Basin is beginning to look at alternative water sources to improve their overall supply. Those alternatives include ocean water desalination. In the midst of population growth and economic development, they believe it is an option to consider. Currently, public comment is being taken, meetings are being held with NGOs and other stakeholders, and two sites are being considered in El Segundo and in Redondo Beach for a large facility. West Basin has been working on a desalination test site and a demonstration plant for several years and believe that a larger facility would serve their needs well. Furthermore, polling recently done in the District shows that water concerns are foremost for their clients and West Basin looks forward to meeting the region's needs.

Additional written testimony was supplied by the West Basin Municipal Water District from Board of Directors President Gloria Gray in response to comments made by Messrs. Bothwell and Everts. They underscored that their plans for a desalination facility in Redondo Beach or El Segundo are in total compliance with the California Ocean Plan and that they are interested in studying desalination after already investing substantially in water conservation and recycling. They have had a number of scoping meetings and other discussions with stakeholders in the environmental community and are "committed to having transparent and open dialogue with all stakeholders through the Environmental Impact Report process and during any future phases." The full letter can be accessed on the Select Committee webpage.

Ray Hiemstra, Associate Director, Orange County Coastkeeper

Mr. Hiemstra highlighted the diversity of viewpoints, technologies and proposals at the hearing today and linked it to the strength that California enjoys in its diversity. OC Coastkeeper believes that Poseidon's plan to replicate its Carlsbad facility in Huntington Beach does not reflect the inter-regional diversity between San Diego and Orange Counties. Whereas San Diego imports much of its water (95%), Orange County only imports 50% of its water and has a large aquifer with which it can do water recycling. He advised against "hammering a

square peg into a round hole" and instead employing more specific designs for the more specific needs of local communities. He referenced a project at Doheny Beach which he believed would make more sense given the local conditions there. The design of that plant has been embraced by environmentalists, but is not being built because of its high cost.

Craig Cadwallader, Surfrider Foundation – South Bay Chapter

Mr. Cadwallader voiced concerns with the West Basin desalination proposal. He views the West Basin Municipal Water District as an important ally in the region and appreciates their collaboration on several local projects. The Surfrider Foundation is not opposed to desalination but believe that alternatives such as conservation and recycling should be pursued first. In particular, he lauded West Basin Water District's initiative in water recycling and believed that it should be expanded further. He believed that there was currently a "once in a lifetime" opportunity to reduce effluent released to the Santa Monica Bay from the Hyperion Treatment Facility by recycling that water. This resource would be an excellent opportunity for West Basin to generate a new source of water that is preferable to desalination. If desalination must be done, The Surfrider Foundation would like to see subsurface intakes used in conjunction with proper brine discharge methods.

Stephen Keese, The Environment Friendly Desalination Company

Mr. Keese submitted written testimony. He included information on his organization, the Environment Friendly Desalination Company, which has "an economical and environment friendly desalination technology that produces no brine. It makes possible the production - without environmental damage - of sufficient potable water to reliably supply all the imported water that Southern California and the Central Coast need." He proposes that this technology would make the twin tunnels unnecessary, and would produce crystal salts that could then generate their own revenue. Mr. Keese also submitted to us his report: "Save The California Coast From Concentrated Brine: A Report On The Damage Caused By Dumping Concentrated Brine From Desalination Plants Into The Ocean."

Joseph Rizzi, Inventor

Mr. Rizzi submitted written testimony regarding his proposal for The Benicia Salinity Control Louvers, which could add 2+ trillion gallons of water for California. According to Mr. Rizzi, the "Salinity Control Louvers is the best and least costly way to add trillions of gallons of fresh water for the environment and for export and an ideal way to meet the Co-Equal Goals as required by law." He proposes that these salinity control gates located at Benicia could be installed in months and add 7 to 46 MAF to California's water supply. They would also make the proposed tunneling plan obsolete.

Hearing 3

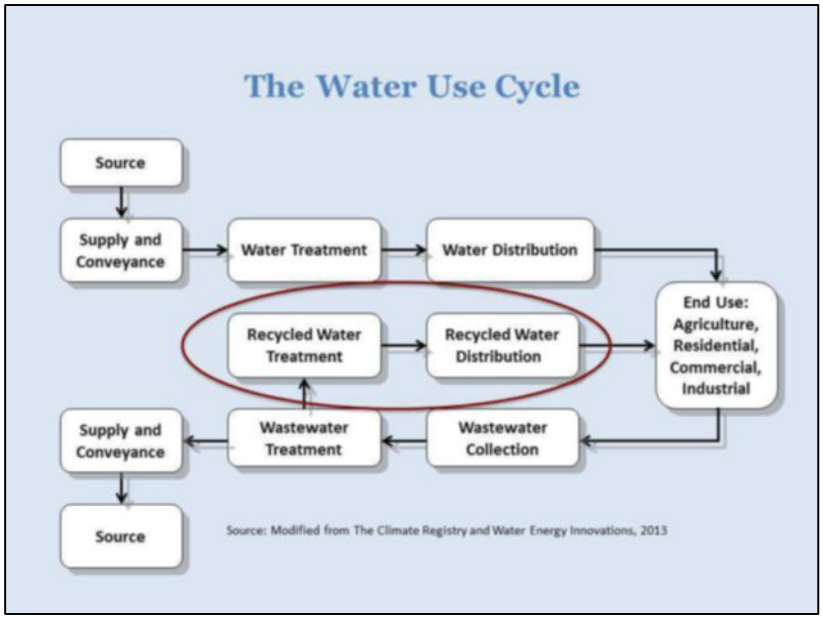
Urban Water Recycling and Reuse in California
Wednesday, January 20, 2016, 2:00 p.m. – 4:30 p.m.
California State Capitol, Sacramento

The third and final Select Committee brought together experts from across the state in academia, government and industry to discuss the many facets of water recycling and reuse in urban California. The hearing took deep dives into on-site water reuse as well as municipal initiatives in stormwater, recycled water and indirect potable reuse. The hearing concluded with a panel on direct potable reuse and a tasting of advanced purified recycled water.

Overview of urban water reuse and recycling

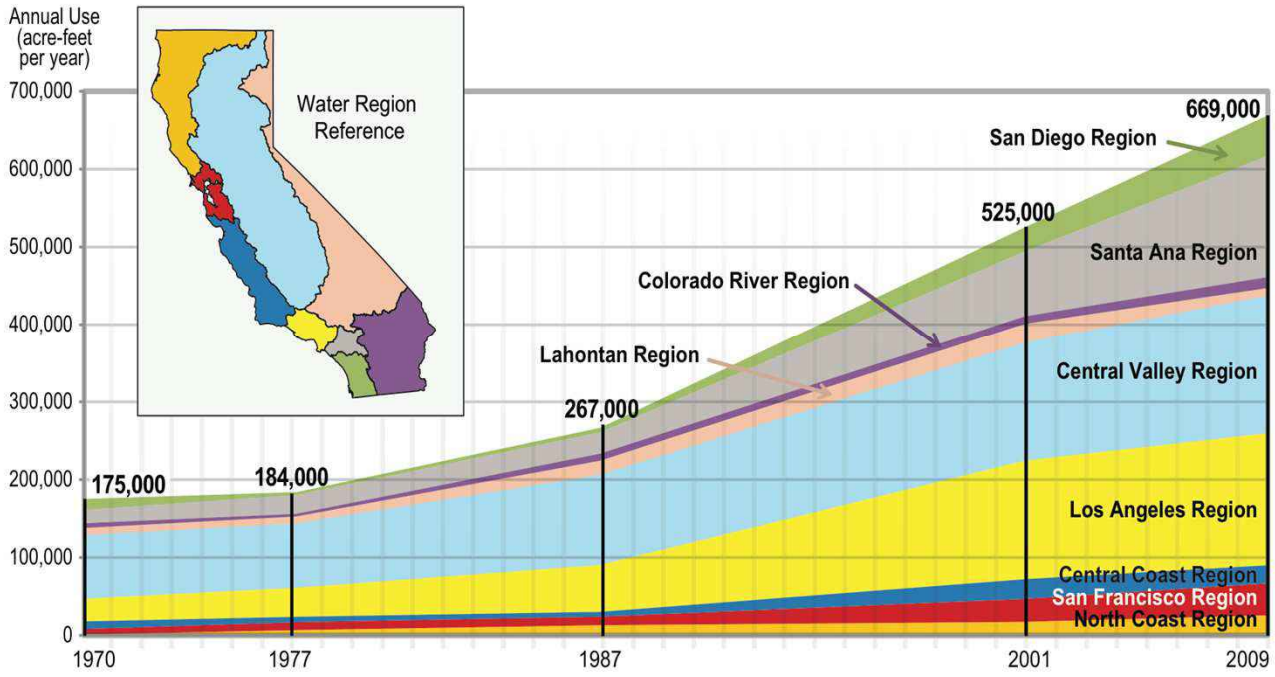
Dr. Newsha Ajami, Director of Urban Water Policy at Stanford University Water in the West and NSF-ReNUWIt initiatives

Dr. Ajami shared that the current drought's challenges present an opportunity to analyze the way California manages its water. Given that California will need to broaden its water portfolio to endure future droughts, water recycling will become extremely important element of California's water future.

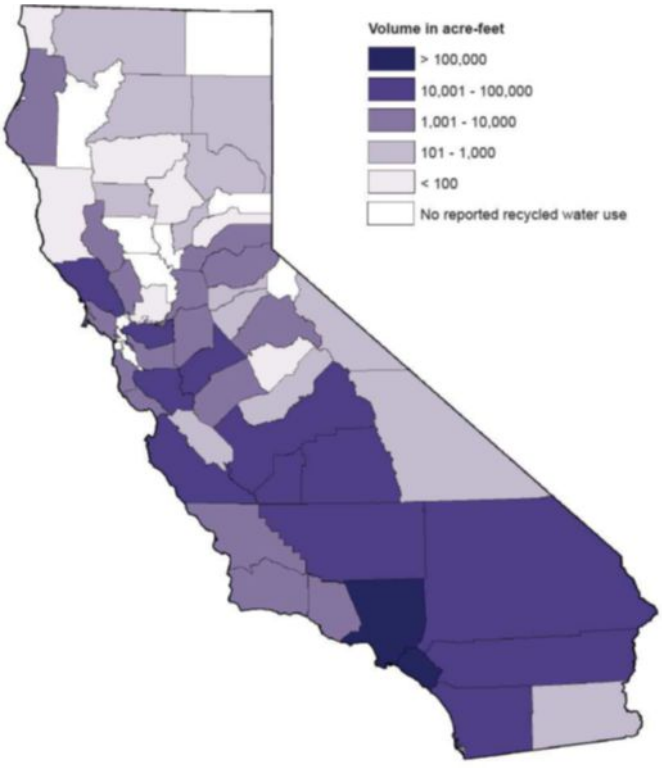


The circled area represents a new path in the water use cycle that investment in water recycling creates.

Municipal treatment of wastewater is one approach to expanding water recycling in California. Currently, water is drawn from its source, conveyed to treatment facilities, distributed to users, collected as wastewater, treated once more, and then returned to its source. Centralized recycling facilities allow for a second use after the second treatment point. The second use could be non-potable (purple piping) or potable depending on the treatment level. With regard to potable reuse, indirect treatment is currently being done in California and will expand in the future; direct potable reuse is not currently practiced, but the state is studying the issue.



This figure shows the amount of recycled water per year that is created in California by hydrologic region. The Los Angeles and Santa Ana watersheds perform the most water recycling in urban environments.

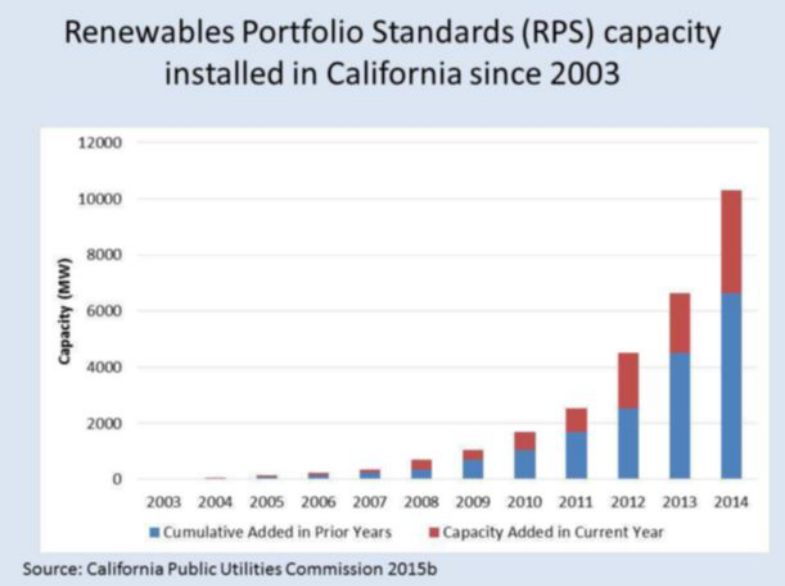


This figure shows the amount of recycled water per year that is created in California by county. Counties in southern California – or in the southern end of the Central Valley – perform the most recycling.

Since the 1970s, the use of recycled water in California has expanded – we currently recycle 13% of our water, and that percentage is considerably higher in places such as Orange County which have invested substantially in water recycling. In Central California, recycled water is used for agricultural purposes, whereas in urban settings the uses are fairly diverse.

Stormwater is an excellent source of water that can be recycled or reused: because it is fairly clean, it is low-cost to purify. However, the covering of our urban settings with impervious surfaces such as asphalt and concrete is a challenge to groundwater infiltration of stormwater, and major initiatives in low-impact development and green infrastructure are underway to mitigate this challenge. Dr. Ajami highlighted a project at TreePeople in Los Angeles, where a large rainwater cistern was placed below a parking lot and now provides the facility with a cheap and reliable source of water.

Another approach to expanding water reuse in California is expanded on-site reuse in graywater systems that utilize impaired water for non-potable uses such as toilet flushing, irrigation, and cooling systems. Two strengths of on-site reuse are the element of education and empowerment it provides to consumers about being water wise and its efficiency in capturing water locally for reuse.



Dr. Ajami highlighted the effectiveness of California's Renewables Portfolio Standards in improving output of energy from renewable sources. She recommended a similar approach to encourage development of water from alternative sources.

There are several challenges and opportunities with regard to water recycling and reuse in California, but most come down to the issue of cost. In Dr. Ajami's opinion, cost-sharing between developers, end-users, and local/state governments can be an enabler in expanding water reuse and recycling initiatives. Moreover, policies such as portfolio standards, demand-side management and more realistic water pricing can also improve the utilization of the most efficient sources of water reuse. Lastly, green banks can help finance larger-scale projects.

Dr. Ajami thought it most helpful to compare the water technology sector to that of energy, and provided several illustrations of how state interventions in energy standards led to booming innovation and utilization of renewables. She pointed most closely at the Renewables Portfolio Standard passed in 2002 and the spike in green energy innovation and capacity in California since that time.

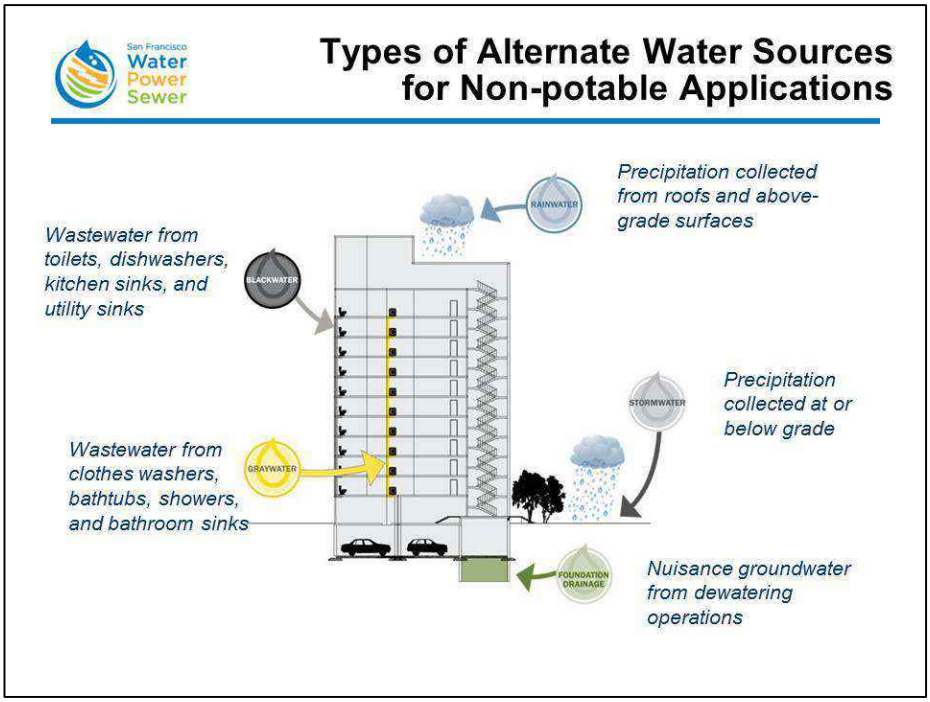
Ultimately, the reason these changes occurred in energy is because energy is expensive to its consumers, who always look to reduce cost where possible; at this time, water prices are still quite low relatively, and Dr. Ajami viewed this as a challenge to further change in the water space. In her opinion, "We need to move to 21st century solutions by providing 21st century opportunities for people."

On-site water reuse

Paula Kehoe, Director of Water Resources, San Francisco PUC

The San Francisco Public Utilities Commission (SF PUC) is a water retailer and wholesaler responsible for water, power and sewer service in the City and County of San Francisco, with clients across the Bay Area. The SF PUC is seeking to diversify its water supply portfolio and has made major efforts in conservation, groundwater management, recycled water, and non-potable water reuse.

It is this last point that Ms. Kehoe discussed at this hearing. Non-potable sources that can be reused include rainwater (precipitation caught above ground), stormwater (precipitation caught at the ground), nuisance groundwater, graywater (wastewater from clothes washers, tubs, showers, and sinks) and blackwater (wastewater from toilets, dishwashers, kitchen sinks and utility sinks). To encourage adoption of onsite reuse, the SF PUC developed regulatory oversight for onsite reuse systems in private buildings including the water quality standards, permitting process, and monitoring/reporting framework; they work in collaboration with the SF Departments of Public Health, Building Inspection, and Public Works to manage this effort. Regulations include mandated water and sewer connection, backflow protection requirements, cross-connection testing prior to operation, and operator training level mandates.



Concurrent with the regulations, San Francisco required on-site reuse for projects over 250,000 square feet beginning in 2015.

The SF PUC has also led a national onsite water reuse systems effort, inviting state and local agencies from across North America to discuss best practices for regulating onsite reuse projects in their constituencies. Subsequently, they published a blueprint for developing local management systems to govern onsite reuse. Currently, they are developing recommendations for on-site reuse at commercial and multi-family developments in conjunction with several expert panels. These panels are examining water quality standards globally with the goal of recommending one or several as best practices for communities looking to regulate on-site reuse. She expressed thanks for the State Water Board's support on their expert panel and believes that this form of state support for local initiatives is "a step in the right direction."

Ralph Petroff, Executive Chairman, Nexus eWater

Mr. Petroff's company, Nexus eWater, produces the "first home water recycler for graywater that meets California's rigorous new certification standards for on-site greywater treatment and recycling." There are two challenges for on-site reuse in California, according to Mr. Petroff: innovation and deployment.

With regard to deployment, Mr. Petroff believes three things will be helpful for adoption. New homes should be made "recycle-ready" in the way that builders were incented to make new homes "solar-ready" over the past decade; this would present a $3,000 investment during the home-building process that could be upgraded anytime. Second, a public benefits charge for water could fund the equivalent of a New Solar Homes Partnership for on-site reuse. Lastly, on-site reuse should be considered an important part of the state's conservation strategy; Mr. Petroff believes that 2 million acre-feet could be saved through expanded on-site reuse.

An onsite reuse system installed in a family home.

The technology for on-site reuse is expanding; currently, reuse devices can treat recycled water to better than NSF standards, and can therefore be used for almost all outdoor uses and toilet flushing indoors. Furthermore, the price of installing a device – $8,000 per home now – will almost certainly decrease as technology evolves. Home builders are in support of expanded on-site reuse, according to Mr. Petroff, primarily because a lack of water is slowing down home building.

Mr. Petroff discussed some secondary benefits of increased onsite reuse. First, energy is spent to move water in California, so reusing water locally would theoretically reduce that energy expenditure. The reduction in embedded energy, combined with an energy recycler that draws power from the increased average temperature of impaired water, would save 2000-4000 kWH per household, according to Mr. Petroff's calculations, equivalent to a "fair-sized solar panel." The energy recycler costs an addition $2,000 on average.

Second, the reduction in this water conveyance, as well as the reduction in usage of gas-powered water heaters, can be expected to reduce greenhouse gas emissions. Third, Mr. Petroff explained that increased onsite reuse would subsequently decrease demand on sewer systems, reducing the overall infrastructure cost for a community's "plants and pipes."

Lastly, the user interfaces of on-site reuse devices (and their associated apps) increase citizens' sense of personal responsibility over water usage by increasing the amount of information available to them and the level of their control.

The big challenge to expanded onsite reuse, according to Mr. Petroff, is a lack of state subsidization and support, which a public benefits charge could alleviate.

Stormwater, recycled water and indirect potable reuse

Mike Wehner, Assistant General Manager, Orange County Water District

Orange County's Groundwater Replenishment System (GWRS) is the largest indirect potable reuse system in the world, creating 100 million gallons of clean water daily that is injected into the Orange County Groundwater Basin. This water would otherwise have flowed to the ocean.

The Orange County groundwater basin supplies 75% of the water for north and central Orange County; the GWRS supplies about 20% of the water entering the basin. Before the GWRS, the Basin was only able to support 62% of the area's needs. It helped Orange County create a new, local water supply that reuses a wasted resource – improving water reliability. It is also cost-effective and uses one-half the energy of imported water and one-third the energy of seawater desalination. OCWD has also been able to improve water quality in the basin with GWRS, as imported Colorado River water, for instance, actually has a higher salinity and thus increases the Total Dissolved Solids (TDS) in the groundwater over time.

The purification system includes microfiltration, reverse osmosis, UV, and advanced oxidation. With regard to reverse osmosis, the most energy intensive step in the process, advances in membrane technology have increased efficiency and thus energy savings over the past several years. The System is permitted by the Division of Drinking Water, which has stringent regulations for a number of different chemicals and hormones in drinking water.

Governor Brown and other state leaders tasting advanced purified demonstration water from the Orange County Water District's Groundwater Replenishment System.

An important element of OCWD's intiative to develop this indirect potable water resource was public outreach; many initiatives in other places, according to Mr. Wehner, have been halted by public and political opposition. The OCWD took a comprehensive approach of reaching out to community leaders and environmental groups, gained broad community support, and now continue that outreach assisted by media interest. OCWD believes that the public can accept indirect potable reuse projects if there is

demonstrated need, community leadership, high water quality, and strong regulatory safeguards.

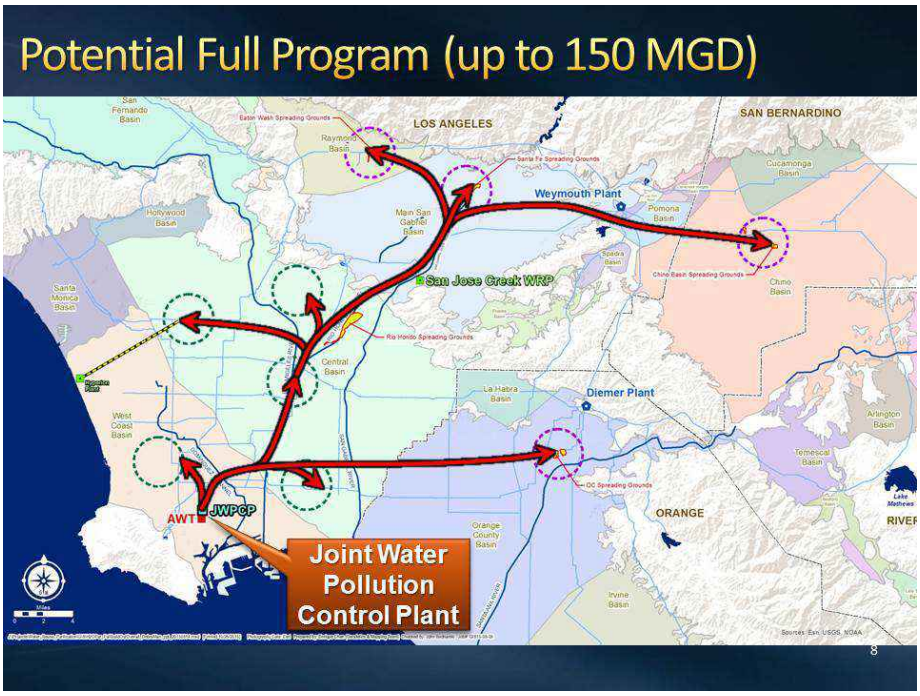
Ultimately OCWD hopes to expand their water recycling initiatives. They are requesting Proposition 1 funds and seeking conservation credits from the Water Board for developing this local, renewable supply. Ultimately, they look forward to direct potable reuse regulations and hope that legislation can be enacted that would allow for more effective public education regarding the potability of advanced purified recycled water.

Debra Man, Assistant General Manager, Metropolitan Water District of Southern California

Ms. Man framed her testimony by stating that Metropolitan Water District views recycled water as a strong component of their "all of the above, gotta do it all" approach to building a diverse water portfolio for Southern California. Metropolitan currently serves 4 million acre-feet per year of water to 5,200 square miles of Southern California using about 45% local resources and about 55% imported water.

Metropolitan developed an integrated resources plan in 2015 that includes goals of maintaining Colorado River and State Water Project supplies, achieving additional conservation savings, and developing new local water supplies. They have reduced their projected groundwater pumping by about 250,000 acre-feet annually and will be focusing on improving the sustainability of their groundwater basins.

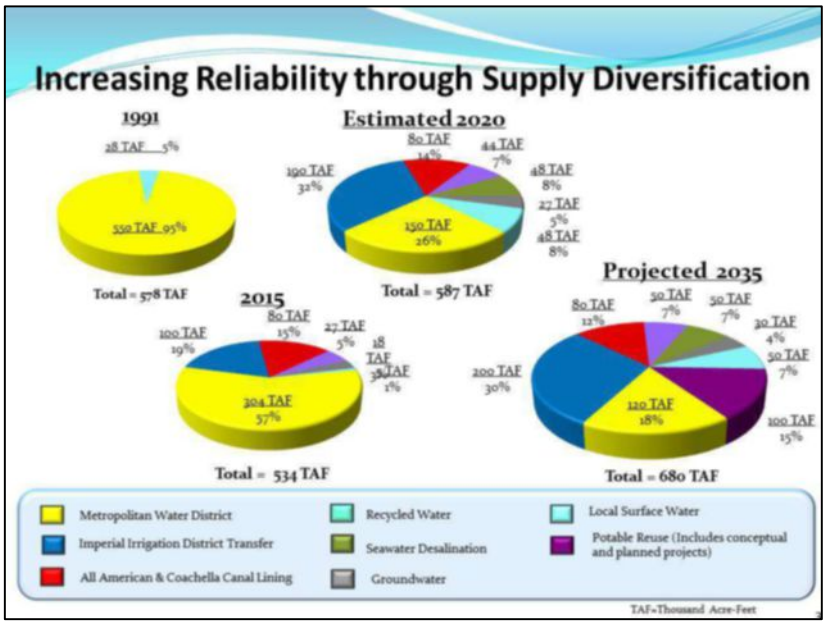
One way is through a water recycling program that recharges groundwater basins. In partnership with the Los Angeles Sanitation District, a collaboration to recycle up to 150 million gallons a day is in the works at the Joint Water Pollution Control Plant in Carson. A 1 million gallon per day demonstration plant is currently ongoing and will help with environmental studies and planning financing. If the project is deemed to be feasible by the end of 2016, construction will begin in early 2017 with a phased approach to a full-scale facility.



The Metropolitan Water District of Southern California's plan with the Los Angeles County Sanitation District to treat water at the Joint Water Pollution Control Plant in Carson and replenish up to nine groundwater basins in the Los Angeles area.

Toby Roy, Water Resources Manager, San Diego County Water Authority

The San Diego County Water Authority serves 3.2 million people in San Diego with 24 member retail agencies. SDCWA has focused on diversification of their water supply since the early 1990s including water recycling and desalination. Up to eight agencies within SDCWA are interested in indirect potable reuse projects in the San Diego area.



San Diego County has invested substantially in alternative water sources since the 1990s in order to become more self-sufficient and subsequently has an increasingly diverse water portfolio.

Ms. Roy focused on San Diego's unique hydrogeology, noting that very few accessible groundwater basins exist in the San Diego area. Water agencies in San Diego have therefore built a large number of reservoirs over time. This makes indirect potable reuse using groundwater recharge difficult, and agencies such as the City of San Diego are subsequently implementing surface water augmentation as an alternative approach to potable reuse. Surface water augmentation regulations will be released by the Water Board in the coming year. Some member agencies have also focused on non-potable water recycling and have built extensive purple pipe infrastructure.

Brent Eidson, Public Utilities Deputy Director, City of San Diego

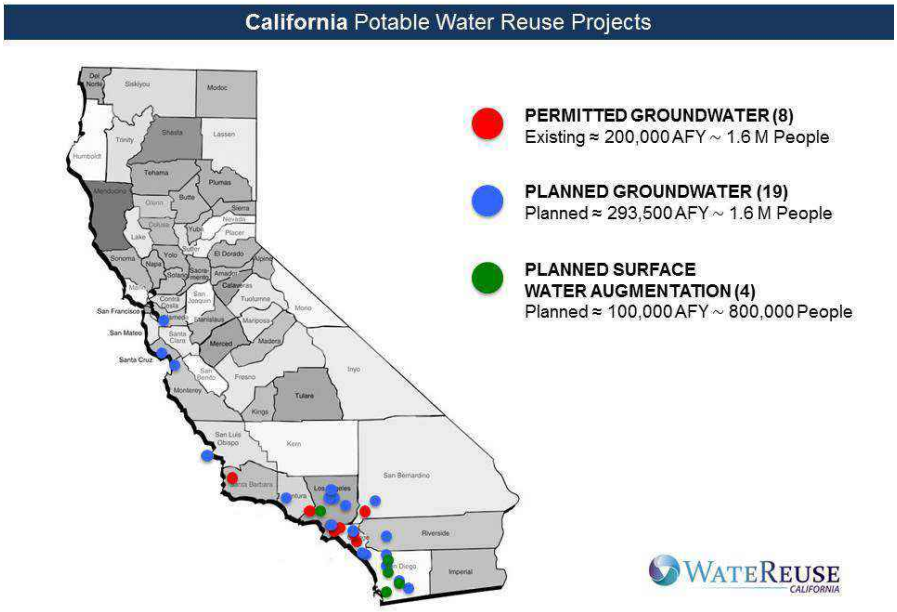
The City of San Diego's Public Utilities Department serves 1.3 million water customers and 2.5 million wastewater customers. Mr. Eidson explained that 85-95% of water in San Diego is imported, and that has prompted an increased focus on local water supplies such as recycled water. That focus has been sharpened by a tripling in the price of imported water since 2000.

In addition to conservation, groundwater development and desalination, San Diego is beginning its Pure Water program: indirect potable reuse through surface water augmentation. Pure Water has a well-developed public approach that focuses on the safety, reliability and cost-effectiveness of potable reuse.

Pure Water hopes to have a 30 million gallon per day facility ready by 2021 with expansion to 83 million gallons by 2032. This would represent one-third of all locally used water. A demonstration plant is active now and San Diego believes it has been quite successful in meeting water quality standards, energy efficiency goals, and helping San Diego with public outreach and education.

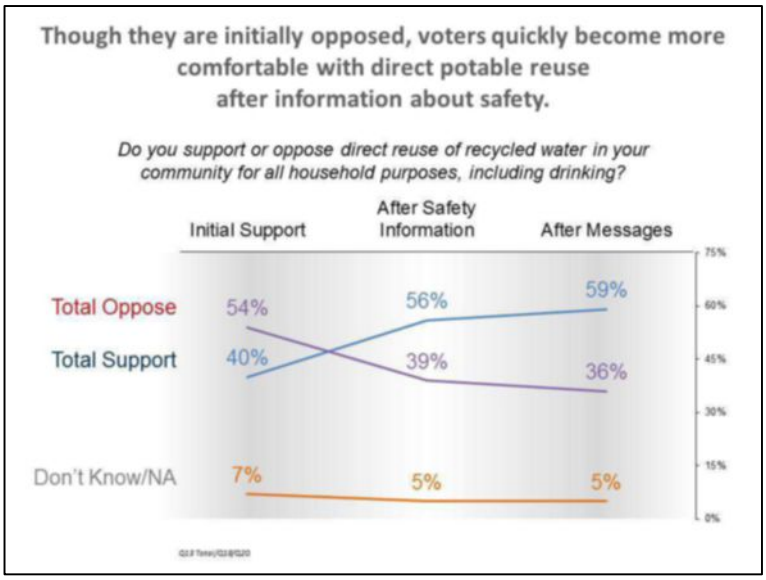
Direct potable reuse

Jennifer West, Managing Director, WateReuse California



WateReuse "promotes responsible stewardship of California's water resources by maximizing the safe, practical and beneficial use of recycled water."

Ms. West began by highlighting SB 918 by Senator Pavley (2010), a statutory mandate for the State Water Resources Control Board to study the feasibility of developing regulations for direct potable reuse (DPR). They are currently doing this with a panel of national water quality experts and an advisory panel made up of California water community and environmental leaders. A draft report will be released in June of this year with a final report due in December 2016.



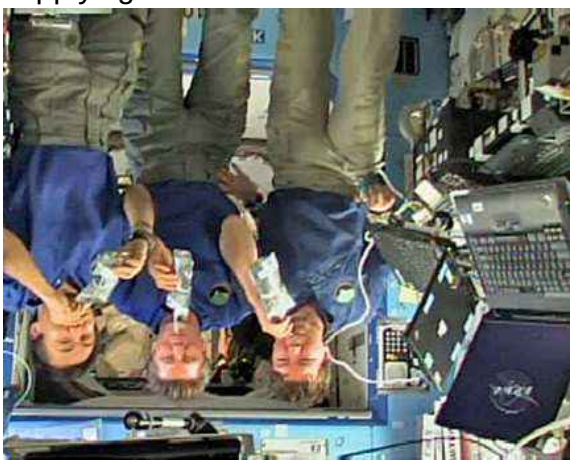
According to Ms. West, a strong implementation of DPR could yield 1.1 million acre-feet per year, about enough for 8 million Californians' potable needs. It is a local, sustainable source of water which reduces discharges to the ocean and requires less dependence on rainfall. It reduces the need for water conveyance, which is costly and leads to greenhouse gas emissions. There are three different types of DPR, most of which include some kind of reservoir or buffer before reaching the customer. A complete flange-to-flange DPR system is likely much farther out in the future, and WateReuse is active in the research space to test the economic, engineering, public health, and public perception implications of DPR.

Notably, the public acceptance of direct potable reuse – which is a significant barrier to implementation – improves with education and presentation of safety messages. According to

Ms. West, education is a key element in making the public more comfortable with DPR and should be a main focus of the state as it rolls out DPR regulations.

Michael Flynn, Water Technology Development Laboratory, NASA Ames Research Center

Mr. Flynn discussed the idea of water sustainability in the context of advanced life support. His objectives when working on a water project in space are to keep the astronauts alive, provide them with a habitable environment, and reduce cost to NASA. It costs a tremendous amount of money to launch anything into space, and so Mr. Flynn's program works to improve water efficiency in space and on the International Space Station (ISS) to bring down the cost of supplying water.



On the ISS, all carbon is sequestered, there will soon be no garbage (including human solid waste), and 100% of water is recycled. The direct potable reuse system on the ISS is the only one of its kind globally and has been functioning since 2009; studies done on the health of the astronauts have been shown to have no adverse effects due to the water. Because failure is not an option on the ISS, the DPR system is built with a series of fail-safes.

NASA is using many of the lessons learned from the Space Station to develop small-scale potable reuse systems for use on Earth. Number one is fail-safe design: routine testing and monitoring is not enough to ensure safety, as one will drink the water and get ill before test results come back. Systems need to operate autonomously, and all maintenance needs to be scheduled. Lastly, on the ISS, all water is treated to potable standards: this reduces plumbing complexities and reduces the number of purification elements which could fail.

Using those lessons, NASA is developing appliances to improve water efficiency, including a recycling clothes washer (80% water recovery), a graywater toilet (75% water recovery), and a cooling tower water recycler that uses forward osmosis. NASA is also developing an environmentally sustainable desalination technology with no entrainment or generation of solid waste. They are building water recycling systems for Army Forward Operating Bases abroad (pictured at right). Lastly, NASA has proposed a three-year study to test DPR in a small population (~300 participants) focusing on washing machine and bathroom potable reuse systems with complete human health studies and economic analyses. Mr. Flynn believes that a consumer-driven approach – such as with these efficient appliances – will be effective and will improve citizen understanding of the importance of water efficiency.

A mobile water recycling unit that NASA could install at a Forward Operating Base or other such remote location.

Jim Fiedler, Acting CEO, Santa Clara Valley Water District

Santa Clara Valley Water District serves many roles in its local area, managing both groundwater and surface water reserves, importing water, and providing flood protection. Two million people are served, including 5,000 well customers. SCVWD relies on 55% imported water and, at this time, only 5% comes from recycled sources, all non-potable.

Mr. Fiedler explained that in Northern California, water recycling is more an issue of wastewater management; in Southern California, it is more of a water supply issue. SCVWD is looking to rapidly expand its recycled water goals to 20,000 acre-feet (AF) of potable supply by 2020 and 45,000 AF by 2025. The advanced purified water would be mixed with non-potable purple-pipe supply in the short term both to improve the quality of that water and to demonstrate feasibility and safety of their system.

In the long term, SCVWD would look to serve advanced purified recycled water to customers both indirectly (with groundwater recharge) and directly (by tapping directly into a raw water line). SCVWD sees many benefits in tapping directly into a raw water line and serving purified water to customers, primarily with lower infrastructure costs and simpler operations as compared to groundwater injection systems. Energy expenditure for conveyance and pumping is also lower for DPR than IPR. Furthermore, as reverse osmosis technology progresses, the energy costs associated with purification will also decrease.

SCVWD has done extensive public outreach on potable reuse including public tours, stakeholder engagement, leadership publicly drinking water, and even allowing a local news team to independently test the water. Polling that SCVWD has done now shows that the majority of the population supports potable reuse and SCVWD continues its commitment to it.

Mr. Fiedler's testimony was followed by a tasting of purified water from Santa Clara Valley Water District's Advanced Recycled Water Treatment Facility.

siliconvalley

ADVANCED WATER PURIFICATION CENTER

PUBLIC COMMENT

Andria Ventura, Toxics Program Manager, Clean Water Action

Ms. Ventura is part of the advisory group to the expert panel at the Water Board investigating the feasibility of regulations to manage direct potable reuse. She praised the collaborative approach of the process, integrating the views of the environmental community, and wanted to bring to the public's attention that all sides were working together on the study with "deep commitment." She underscored her belief that direct potable reuse must be part of California's water portfolio, but that "We have to get it right. If we don't get it right, it won't sustain us in the future." She stated that the involvement of the environmental community in the process will improve public trust in direct potable reuse, and that members of that community are committed to educating the public on DPR. She recommended that the legislature continue to embrace a collaborative approach to difficult issues in water and the environment and also to recommit to strong anti-pollution policies to keep contaminants out of water in the first place.

Paul Cook, General Manager, Irvine Ranch Water District

Mr. Cook provided written testimony. Irvine Ranch Water District (IRWD) has long been a leader in recycled water: in fact, they designed the ubiquitous purple pipes that are used today to distinguish recycled water, and currently reuse 81% of their water. Mr. Cook wrote to share IRWD's experiences with recycled water and to advocate for a "fit-for-purpose" approach to recycling and reuse in the State. This approach matches the level of water treated to its intended use "without expending unnecessary funds, energy, or other resources to treat the water to a level higher than is necessary to protect public health and safety." Recycled water is currently viewed in statute as waste rather than a resource, which is impairing opportunities for reform; subsequently, Titles 17 and 22 of the California Code of Regulations must be updated to reflect this new reality. Lastly, he encourages the State to take a science-based and cost-benefit approach to regulating indirect and direct potable reuse projects in order to allow the technologies to reach their full potentials. His full letter can be accessed on the Select Committee webpage.

CONCLUSION

This report summarizes the findings of the Assembly Select Committee on Water Consumption and Alternative Sources and includes recommendations for next steps to mitigate coming droughts.

Our first hearing included the testimony of top regulators and scientists from California and abroad to understand how they look at our State's changing climate and water future, establishing a framework for our subsequent hearings. Our second hearing focused on seawater desalination as an alternative water source, and scientists, environmentalists and desalination companies all shared their perspectives on its merits and risks. Lastly, our third hearing focused on the current and future states of water recycling, looking broadly at on-site reuse and centralized wastewater treatment solutions, including direct potable reuse. We even had a tasting of advanced purified recycled water because we believe that leadership's visible adoption of this water source is important to solidify the trust of the public.

It is our hope that this report will both inform and inspire our State's policymakers to deeply consider all perspectives when regulating or approving new water sources. Our hearings highlighted some foundational concepts that should inform all future decision-making – such as the water/energy nexus, the differing environmental impacts of various water sources, and regional variability of California's hydrogeology. Furthermore, the strengths and weaknesses of centralized or distributed systems for improving water efficiency and utilization are critical for state and local governments to consider as they support and invest in new water solutions.

There is still much work to be done to better understand the nature of our water security. Our Select Committee did not fully investigate stormwater capture as an alternative water source, partly because questions surrounding its financing are currently a major hurdle. Indeed, substantial gaps exist in our State's support for water innovation, and sustainable financing mechanisms for research and water technology deployment will be needed to secure our water future. Such research – critical to furthering our understanding of water in California – will require better water accounting and investments to improve the volume and quality of data. Lastly, the role of the federal government in California's hydrology cannot be denied and strong collaboration with Washington, particularly with regard to funding and protection of environmental water, will be needed for better drought management going forward.

Water is essential to so much of our society and economy. Though collective action, bold leadership, and careful investments, we are enduring one of the most significant droughts in a generation. But California must always be looking for solutions to the next drought to guarantee that we will face no obstacles to remain one of the world's economic and cultural leaders.

APPENDIX 1: SELECT COMMITTEE HEARING AGENDAS

Members
Katcho Achadjian
Luis Alejo
Autumn Burke
Rocky Chavez
Young Kim
Anthony Rendon
Miguel Santiago

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ASSEMBLY SELECT COMMITTEE ON
WATER CONSUMPTION AND ALTERNATIVE SOURCES
RICHARD S. GORDON, CHAIR
ASSEMBLYMEMBER, TWENTY-FOURTH DISTRICT

Overview of Water Consumption and Alternative Sources in California
Tuesday, November 17, 2015
1:00 p.m. – 5:00 p.m., State Capitol, Room 447

AGENDA

1:00: Welcome and Opening Remarks
- Chairman Rich Gordon
- Members of Select Committee

1:10: International perspectives on managing periodic severe drought
- Eilon Adar, Ben Gurion University of the Negev, Be'er Sheva, Israel

1:40: Water, infrastructure, and California
- Jay Lund, Director, UC Davis Center for Watershed Sciences

2:00: Is this drought "The new normal?"
- Ellen Hanak, Director, PPIC Water Policy Center
- Noah Diffenbaugh, Senior Fellow, Stanford Woods Institute

2:40: Current initiatives to manage new water sources in California
- Secretary John Laird, California Natural Resources Agency
- Director Mark Cowin, California Department of Water Resources
- Chief Deputy Director Jonathan Bishop, State Water Resources Control Board

3:40: What are California's strongest options to improve long-term water security? (followed by panel including Jay Lund and Ellen Hanak)
- "Buzz" Thompson, Director, Stanford Woods Institute
- Peter H. Gleick, President, Pacific Institute

4:35: Public Comment

4:50: Closing Comments
- Chairman Rich Gordon

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ASSEMBLY SELECT COMMITTEE ON
WATER CONSUMPTION AND ALTERNATIVE SOURCES

RICHARD S. GORDON, CHAIR
ASSEMBLYMEMBER, TWENTY-FOURTH DISTRICT

Possibilities and Pitfalls for Desalination in California
Friday, December 11, 2015, 10:00 a.m. – 12:30 p.m.
Metropolitan Water District Board Room, Los Angeles

10:00: Welcome and Opening Remarks
- Chairman Rich Gordon
- Members of Select Committee

10:10: Overview of desalination and water/energy nexus
- Heather Cooley, Water Program Director, Pacific Institute

10:30: Current desalination projects in California
- Scott Maloni, VP of Project Development, Poseidon
- Rich Svindland, VP of Operations for California American Water

11:00: Regulatory perspectives
- Tom Luster, Senior Environmental Scientist, Coastal Commission
- Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board
- Cy Oggins, Chief, Environmental Planning and Management Division, State Lands Commission

11:30: Environmental Impacts of Desalination
- Conner Everts, Exec Director, Southern California Watershed Alliance
- Sean Bothwell, Policy Director, California Coastkeeper Alliance

12:00: What is the future of desalination technology?
- Aaron Mandell, Co-founder and chairman WaterFX
- Dr. Sami Maalouf, California State University, Northridge
- Dr. Andrea Achilli, Humboldt State University

12:20: Public Comment

12:30: Closing Comments
- Chairman Rich Gordon

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California Legislature

ASSEMBLY SELECT COMMITTEE ON
WATER CONSUMPTION AND ALTERNATIVE SOURCES

RICHARD S. GORDON, CHAIR
ASSEMBLYMEMBER, TWENTY-FOURTH DISTRICT

Urban Water Recycling and Reuse in California
Wednesday, January 20, 2016, 2:00 p.m. – 4:30 p.m.
California State Capitol, Sacramento, Room 444

AGENDA

2:00: Welcome and Opening Remarks
- Chairman Rich Gordon
- Members of Select Committee

2:10: Overview of urban water reuse and recycling
- Dr. Newsha Ajami, Director of Urban Water Policy at Stanford University Water in the West and NSF-ReNUWIt initiatives

2:30: On-site water reuse
- Paula Kehoe, Director of Water Resources, San Francisco PUC
- Ralph Petroff, Executive Chairman, Nexus eWater

3:00: Stormwater, recycled water and indirect potable reuse
- Mike Wehner, Assistant General Manager, Orange County Water District
- Debra Man, Assistant General Manager, Metropolitan Water District
- Toby Roy, Water Resources Manager, San Diego County Water Authority
- Brent Eidson, Public Utilities Deputy Director, City of San Diego

3:40: Direct Potable Reuse
- Jennifer West, Managing Director, WateReuse California
- Michael Flynn, Water Technology Development Laboratory, NASA Ames Research Center
- Jim Fiedler, Acting CEO, Santa Clara Valley Water District

4:15: Tasting of purified water from Santa Clara Valley Water District's Advanced Recycled Water Treatment Facility

4:20: Public Comment

4:30: Closing Comments
- Chairman Rich Gordon