Maximizing the Benefit of Desalination in California

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I. INTRODUCTION

The current drought is the worst California has seen in 1200 years.[1] As it has dragged on, fields have been fallowed, wildfires have raged, and communities have run out of water. Scientists agree that the cause of the drought is a "ridiculously resilient ridge" of high atmospheric pressure over the northeastern Pacific.[2] Recent research demonstrates that the extreme size and persistence of this blocking ridge are at least three times as likely to occur in the present climate as they are in a climate with preindustrial levels of greenhouse gases.[3]

[1] Paul Rogers, *California Drought the Worst in 1,200 years, New Study Says*, SAN JOSE MERCURY NEWS (Dec. 5, 2014), http://www.mercurynews.com/drought/ci_27070897/california-drought-worst-1-200-years-new-study (citing Daniel Griffin & Keven J. Anchkaitius, *How Unusual is the 2012-14 California Drought*, GEOPHYSICAL RES. LETTERS, 41, 9017-9023 (2014), www.DX.DOI.org/10.1002/2014GL062433).

[2] Press Release 14-129, *Cause of California Drought Linked to Climate Change*, NAT'L SCI. FOUND. (Sept. 29, 2014), http://www.nsf.gov/news/news_summ.jsp?cntn_id=132709.

[3] NAT'L SCI. FOUND, *supra* note 2; *contra* RICHARD SEAGER ET AL., ASSESSMENT REPORT: CAUSES AND PREDICTABILITY OF THE 2011–14 CALIFORNIA DROUGHT 4-5 (2014), http://cpo.noaa.gov/sites/cpo/MAPP/Task%20Forces/DTF/californiadrought/california_drought_report.pdf (stating that one study concluded that global warming would increase the

The data strongly suggests that climate change will cause, or contribute to, more frequent droughts in California as well as much of the Pacific Northwest. California's water supply system is unsustainable under these conditions, and the state is seeking a solution.

Proponents of seawater desalination think they have found that solution. They look to the Pacific Ocean and see a seemingly endless, drought-proof reservoir that dwarfs the Sierra Nevada snow pack. Opponents see a high price tag and the potential for environmental harm. But the truth about seawater desalination is not so black and white. Desalination could be an important part of the state's water supply portfolio, but it comes with serious economic and environmental risks. Put simply, seawater desalination should not be the first option for solving the state's water crisis. This article will examine the current state of desalination in California and suggest water management policies the state should adopt to maximize the benefits of desalination and minimize the risks.

II. WHERE WE ARE: THE CURRENT STATE OF DESALINATION IN CALIFORNIA

A. Seawater Reverse Osmosis Is the Method of Desalination Most Likely to Be Used in California

There are two common types of desalination processes: thermal systems and membrane systems.[4] Developers prefer membrane systems over thermal systems because of their lower capital costs and energy requirements.[5] Reverse osmosis is the most prevalent membrane technology, and most existing and proposed facilities in California use it.[6] Seawater reverse osmosis ("SWRO") draws seawater into the facility for processing through a near-shore intake.[7] Intakes can be broadly categorized as either surface or subsurface.[8] A surface water intake collects water from above the seabed through a large pipe in the water column.[9]

likelihood of high pressure ridges over the North Pacific, but the implications for drought remain uncertain).

4 HARI J. KRISHNA, INTRODUCTION TO DESALINATION TECHNOLOGIES 1, http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/r363/c1.pdf.

5 Angela Haren Kelley, *Seawater Desalination: Climate Change Adaptation Strategy or Contributor?*, 38 ECOLOGY L. CURRENTS 40, 42 (2011).

6 STATE WATER RES. CONTROL BD., CAL. ENVTL. PROT. AGENCY, DRAFT STAFF REPORT ADDRESSING DESALINATION FACILITY INTAKES, BRINE DISCHARGES, AND THE INCORPORATION OF OTHER NONSUBSTANTIVE CHANGES 12, 16 (July 3, 2014), http://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/docs/draft_desal_sed_070314.pdf; CONGRESSIONAL RESEARCH SERVICE, DESALINATION AND MEMBRANE TECHNOLOGIES: FEDERAL RESEARCH AND ADOPTION ISSUES 1 (Jan. 2, 2015), https://www.fas.org/sgp/crs/misc/R40477.pdf.

7 TOM PANKRATZ, AN OVERVIEW OF SEAWATER INTAKE FACILITIES FOR SEAWATER DESALINATION, THE FUTURE OF DESALINATION IN TEXAS 4 (2004), http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R363/C3.pdf.

8 *Id.* at 2.

9 PANKRATZ, *supra* note 7, at 4; NAT. RES. DEF. COUNCIL, PROCEED WITH CAUTION:

A subsurface intake collects water from beneath the seabed via beach wells, infiltration galleries, or seabed filtration systems.[10]

Seawater is pretreated upon entering the facility to remove inorganic solids, sand, oil, bacteria, and other compounds that might foul the reverse osmosis membrane.[11] Hydraulic pressure is then applied to the seawater to push it through the membrane.[12] Salt-depleted water transfers from one side of the membrane to the other, leaving behind highly concentrated brine.[13] The desalinated water is prepared for distribution through the addition of minerals and pH adjusting materials to meet potable water specifications and minimize pipe corrosion.[14] The brine is usually returned to the ocean using diffuser array in a mixing zone or by comingling the brine with wastewater before discharge.[15]

B. SWRO Is an Expensive Water Supply Option

While advancements in SWRO technology have decreased operation costs and energy requirements in recent years, SWRO is still a very expensive option for improving California's water supply reliability.[16] The estimated cost for an acre-foot of desalinated seawater ranges from $1,900 to more than $3,000, an average of four to eight times more expensive than water from other sources.[17] This makes SWRO cost prohibitive for most of California.[18]

1. The initial time and cost to develop an SWRO facility are significant

The price per acre-foot reflects the cost of constructing and operating the facility.[19] Construction costs for desalination plants are high.[20] Exact costs for

CALIFORNIA'S DROUGHT AND SEAWATER DESALINATION 3 (2014), http://www.nrdc.org/oceans/files/ca-drought-seawater-desalination-IB.pdf [hereinafter NRDC].

10 PANKRATZ, *supra* note 7, at 9.

11 STATE WATER RES. CONTROL BD., *supra* note 6, at 45.

12 *Id.* at 12.

13 *Id.*

14 Juan Liang et al., *Impact of Seawater Reverse Osmosis (SWRO) Product Remineralization on the Corrosion Rate of Water Distribution Pipeline Materials*, 311 DESALINATION 54, 54 (2013).

15 STATE WATER RES. CONTROL BD., *supra* note 6, at 82.

16 NRDC, *supra* note 9, at 3.

17 Leila Monroe, *Proceed with Caution: California's Drought & Seawater Desalination*, SWITCHBOARD: NATURAL RES. DEF. COUNCIL STAFF BLOG (May 21, 2014), http://switchboard.nrdc.org/blogs/lmonroe/proceed_with_caution_californi.html.

18 Paul Rogers, *Nation's Largest Ocean Desalination Plant Goes Up Near San Diego; Future of the California Coast?*, SAN JOSE MERCURY NEWS (May 29, 2014), http://www.mercurynews.com/science/ci_25859513/nations-largest-ocean-desalination-plant-goes-up-near; COOLEY ET AL., DESALINATION WITH A GRAIN OF SALT, PAC. INST. 39 (2006), http://pacinst.org/wp-content/uploads/sites/21/2015/01/desalination-grain-of-salt.pdf.

19 COOLEY ET AL., KEY ISSUES FOR DESALINATION IN CALIFORNIA: COST AND FINANCING 9 (Nov. 2012), http://pacinst.org/wp-content/uploads/2013/02/financing_final_report3.pdf.

20 *Id.* at 41.

SWRO facilities vary depending on site-specific requirements, but all SWRO facilities require expensive metals and high-pressure components to be able to withstand the hydraulic pressure used in the desalination process.[21] If the Claude Lewis Carlsbad Desalination Plant in San Diego is any indication, it is likely that there will be significant legal and permitting costs associated with the construction and operation of SWRO plants. The project has undergone six years of permitting, obtained approvals from five different agencies, and faced fourteen lawsuits.[22] The facility will cost about $1 billion, and by the time it delivers the first drop of water, the project will have been in development for eighteen years.[23] The combination of construction, operation, and legal costs may make SWRO desalination economically infeasible in many areas.

2. Proper siting may decrease ongoing pretreatment costs

Water pretreatment is one significant, ongoing cost of desalination that can be decreased, depending on the location of the plant. Pretreatment cannot completely remove fouling compounds from the seawater, and the hydraulic pressure placed on the remaining compounds results in membrane scaling that must be removed through chemical cleaning.[24] These costs can increase the end price per acre foot of desalinated water. Depending on the plant's location, the need for pretreatment can be significantly lessened by use of a subsurface intake.[25]

Subsurface intakes act as a pretreatment system for the plant.[26] This arrangement eliminates the cost of chemicals and maintenance for the pretreatment system, but it cannot completely eliminate scaling, so chemical cleaning may still be necessary.[27] Subsurface intakes are more expensive to construct than surface water intakes, and may not be possible depending on

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21 *Oasys' New Desalination Technology*, THE WATER NETWORK (Nov. 20, 2014), https://water.tallyfox.com/mosaic/text/oasys-new-desalination-technology; ARROYO ET AL., COST OF BRACKISH GROUNDWATER DESALINATION IN TEXAS 1 (Sept. 2012), http://www.twdb.texas.gov/innovativewater/desal/doc/Cost_of_Desalination_in_Texas.pdf; Klaus-Viktor Peinemann & Suzana Pereira Nunes, *Membrane Technology, Volume 4: Membranes for Water Treatment* 164 (Nov. 29, 2010).

22 Rogers, *supra* note 18; Christopher Garrett, *The Carlsbad Desalination Project— A Case Study of Permitting and Approvals*, WATER L. & POL'Y MONITOR, 2 (Oct. 1, 2014).

23 Rogers, *supra* note 18; Garrett, *supra* note 22, at 2.

24 Thomas M. Missimer et al., *Subsurface Intakes for Seawater Reverse Osmosis Facilities: Capacity Limitation, Water Quality Improvement, and Economics*, 322 DESALINATION 37, 37 (2013), http://www.kysq.org/docs/2013%20Desalination-Subsurface%20Intakes.pdf; Kevin Westerling, *Forward Osmosis: How It Works, And Why It's Important*, WATER ONLINE (Mar. 24, 2014), http://www.wateronline.com/doc/forward-osmosis-how-it-works-and-why-it-s-important-0001.

25 Missimer et al., *supra* note 24, at 37.

26 *Id.*

27 *Id.* at 37-39, 46.

hydrogeological conditions. As a result, subsurface intakes may not always be a feasible option for cost reduction.[28] Developers should weigh the benefits of siting and reduced operational costs over a larger, upfront construction cost.

3. SWRO is an energy-intensive process

Energy can account for up to fifty percent of the operating costs of an SWRO facility.[29] The high-pressure pumps that force seawater through the membrane account for approximately half of a plant's energy use.[30] The cost of energy therefore significantly influences the price per acre-foot of desalinated water. Reducing energy use and securing low-cost, reliable energy is a primary concern for both developers and end-users.

To reduce energy costs, developers are designing facilities with energy recovery devices.[31] There are several types of these devices, but, generally, they recover pressure from the brine stream and either transfer it or convert it, ultimately saving energy by reducing the amount of pressure the pump must produce.[32] The resulting decrease in energy usage, coupled with the advent of cheaper and more durable membranes, makes desalination an economically viable option in some areas, but it is still not cost-competitive for most of California. [33]

C. The High Energy Requirements of SWRO Raise Environmental Concerns

SWRO facilities are large energy consumers. Depending on the source of the electricity, the plants could exacerbate climate change through increased greenhouse gas emissions. SWRO uses more energy than any other water supply method currently in use in California.[34] Under California's stringent climate change laws, desalination plants will likely be required to have a greenhouse gas

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28 *Id.* at 37-39, 49.

29 NRDC, *supra* note 9, at 3; Kelley, *supra* note 5, at 44; Keven Bullis, *A Cheaper Way to Clean Water*, MIT TECH. REV. (Dec. 16, 2010), http://www.technologyreview.com/news/422045/a-cheaper-way-to-clean-water/.

30 S. Senthilmurugan & Mekapatti Srinivas, *Advanced SWRO Operation*, WATER & WASTES DIG. (2011), http://www.wwdmag.com/membranes-reverse-osmosis/advanced-swro-operation; Bullis, *supra* note 29.

31 Fred Grondhuis, *Examining Isobaric Energy Recovery Systems at SWRO Plants*, INDUSTRIAL WATERWORLD, http://www.waterworld.com/articles/iww/print/volume-12/issue-1/feature-editorial/examining-isobaric-energy-recovery-systems-at-swro-plants.html/ (last visited Mar. 28, 2016).

32 John P. MacHarg, *The Evolution of SWRO Energy-Recovery Systems* 49, 49-50, http://ocean-pacific-tec.com/imagenes/news/18%20D&WR%2011-01%20final%20article.pdf (last visited Mar. 28, 2016).

33 Felicity Barringer, *In California, What Price Water?*, N.Y. TIMES (Feb. 28, 2013), http://www.nytimes.com/2013/03/01/business/energy-environment/a-costly-california-desalination-plant-bets-on-future-affordability.html?pagewanted=all.

34 NRDC, *supra* note 9, at 3.

mitigation plan.[35] For example, the Carlsbad Desalination Plant's mitigation plan uses a combination of on-site reduction measures, off-site mitigation projects, and purchase of offsets or renewable energy credits to achieve net-zero emissions.[36] While some may feel that net-zero emissions should be required for such energy intensive projects, SWRO plants are not the root of the problem, and they cannot be expected to solve it on their own.[37] Until the energy grid migrates to one hundred percent renewables, SWRO facilities, and California's other water supply methods, will continue to impact greenhouse gas emissions.[38]

D. Lack of Desalination-Specific Regulations Causes Uncertainty in the Permitting Process

Under the Clean Water Act and the Porter-Cologne Water Quality Control Act, the State Water Resources Control Board ("SWRCB") is responsible for protecting the water quality of the state's rivers, estuaries, bays, and ocean waters, among other things.[39] As part of these duties, the SWRCB adopts statewide water quality control plans, such as the Ocean Plan, and issues National Pollutant Discharge Elimination System ("NPDES") permits, which contain requirements for both intakes from and discharges to surface water.[40] SWRO facilities that discharge brine into the ocean must have an NPDES permit.[41]

The SWRCB regulates brine discharges through issuance of NPDES permits that have conditions protective of marine life, but until recently, the Ocean Plan did not address harm to marine life from SWRO intakes, had no objective standard for elevated salinity levels, and did not describe how brine discharges should be regulated.[42] This lack of specificity in the regulations created

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35 *See* CEQA Guidelines §§ 15064.4, 15126.4(c), 15126.2(a), 15183.5(b), Appendix F (requiring lead agencies to, among other things, analyze greenhouse gas emissions of proposed projects and consider mitigation measures when those emissions are significant. Note that under Executive Order B-29-15 CEQA would only apply to desalination projects beginning after May 31, 2016.).

36 POSEIDON WATER, CARLSBAD SEAWATER DESALINATION PROJECT, ENERGY MINIMIZATION AND GREEN HOUSE GAS REDUCTION PLAN 24 (May 2008), http://carlsbaddesal.com/Websites/carlsbaddesal/images/Energy-Minimization-and-GHG-Reduction-Plan-052308.pdf.

37 COOLEY ET AL., KEY ISSUES FOR DESALINATION IN CALIFORNIA: ENERGY AND GREENHOUSE GAS EMISSIONS 30-31 (May 2013), http://pacinst.org/wp-content/uploads/2013/05/desal-energy-ghg-full-report.pdf.

38 *Id.* at 3.; NRDC, *supra* note 9, at 3.

39 COOLEY ET AL., PAC. INST., KEY ISSUES IN SEAWATER DESALINATION IN CALIFORNIA: MARINE IMPACTS 18 (Dec. 2013), http://pacinst.org/wp-content/uploads/sites/21/2013/12/desal-marine-imapcts-full-report.pdf.

40 *Id.*

41 *See generally id.*

42 *Ocean Standards*, STATE WATER RES. CONTROL BD., http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/ (last updated Mar. 23, 2015).

uncertainty in the permitting process.[43] The SWRCB adopted a Desalination Amendment to the Water Quality Control Plan for Ocean Waters of California ("Desalination Amendment") that addresses these problems. The Desalination Amendment clarifies the SWRCB's authority to regulate desalination facility discharges; provides guidance to Regional Water Quality Control Boards regarding site, design, technology, and mitigation measures for minimizing marine life mortality; implements a statewide narrative receiving water limitation for salinity; and institutes monitoring and reporting requirements.[44]

E. Surface Water Intakes Can Significantly Damage Marine Life

Impingement and entrainment are two of the most common environmental concerns regarding desalination and occur with surface water intakes.[45] Impingement occurs when a larger marine organism becomes trapped against the screen of a surface water intake by the flow of seawater into the facility,[46] resulting in severe injury or death for the organism.[47] Entrainment occurs when small marine organisms, such as eggs or fish larvae, are pulled through the screen and become entrained in the desalination system.[48] The mortality rate for entrainment is one hundred percent.[49] The Desalination Amendment requires intake screens of one millimeter or smaller on surface water intakes to reduce marine mortality.[50]

Impingement and entrainment can be prevented by the use of subsurface intakes.[51] Subsurface intakes use the seafloor as a filter, preventing organisms from coming into contact with the intake system.[52] Under the Desalination Amendment, regional water boards must require the use of subsurface intakes for seawater desalination facilities.[53] Unfortunately, hydrogeological conditions make subsurface intakes impossible in some locations.[54] The Desalination Amendment allows the use of screened surface water intakes if the regional

43 *See id.*

44 *Id.*

45 Pankratz, *supra* note 7, at 3-4.

46 *Id.* at 3.

47 *Id.*

48 *Id.* at 4.

49 *Id.*

50 STATE WATER RES. CONTROL BD., DRAFT AMENDMENT TO THE WATER QUALITY CONTROL PLAN FOR OCEAN WATERS OF CALIFORNIA ADDRESSING DESALINATION FACILITY INTAKES, BRINE DISCHARGES, AND TO INCORPORATE OTHER NONSUBSTANTIVE CHANGES, L.2.d.1.c (July 3, 2014), http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/draft_desal_amend070314.pdf.

51 Pankratz, *supra* note 7, at 9.

52 *Id.*

53 STATE WATER RES. CONTROL BD., *supra* note 50, at L.2.d.1.a.

54 Missimer, *supra* note 24, at 38-39.

water board determines that subsurface intakes are infeasible based upon an analysis of criteria specified in the amendment.[55]

SWRO facilities are highly site-specific and the regional water boards will evaluate them on a case-by-case basis. The SWRCB Desalination Amendment requires consideration of past, present, and future anthropogenic effects on marine life, but it does not necessarily require consideration of the cumulative impact of large-scale desalination plants all along the California coast.[56]

F. Brine Can Harm Marine Life if it Is Not Discharged Properly

The SWRO process produces both freshwater and a brine concentrate. The brine is twice as saline as seawater and contains heavy metals released by corrosion of desalination equipment and chemicals accumulated during the pre-treatment process, including coagulants like ferrous chloride, antiscalants, biocides, and detergents.[57] Disposal of this brine can be challenging because it may damage the marine environment if done improperly. The brine's high salinity level makes it denser than seawater, causing it to sink to the ocean bottom where it creates areas with high salt concentrations and low dissolved oxygen levels.[58] These areas of degraded water quality can have harmful sublethal effects or kill marine life.[59]

The Desalination Amendment addresses this harm in part by designating certain brine disposal methods as preferred technology. The most preferred technology is comingling of brine with wastewater to dilute it.[60] Dilution prevents disposed brine from sinking to the bottom and causing marine mortality from hyper-saline conditions. However, dilution does not solve all associated pollution, for the chemicals and heavy metals that are expelled in the brine are not necessarily made less toxic by adding more water.[61] Additionally, combining wastewater with brine may result in chemical reactions that are not yet well understood.[62]

The next best technology is the use of a multiport diffuser; this is the best method of discharge for undiluted or "pure" brine.[63] This method places multiport diffusers on the discharge pipe to encourage brine to mix with the

55 STATE WATER RES. CONTROL BD., *supra* note 50, at L.2.d.1.a.i.

56 *Id.* at L.2.b.

57 COOLEY ET AL., *supra* note 39, at 12.

58 *Id.* at 13.

59 JENKINS ET AL., SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT, MANAGEMENT OF BRINE DISCHARGES TO COASTAL WATERS: RECOMMENDATIONS OF A SCIENCE ADVISORY PANEL ii, 7 (2012), http://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/docs/dpr051812.pdf.

60 STATE WATER RES. CONTROL BD., *supra* note 50, at L.2.d.2.a.

61 JENKINS ET AL., *supra* note 59, at 7.

62 COOLEY ET AL., *supra* note 39, at 15; *id.* at 41.

63 JENKINS ET AL., *supra* note 59, at ii.

seawater rather than sinking to the bottom.[64] Unfortunately, multiport diffusers do not solve the problem of chemicals and heavy metals in the brine.[65] Additionally, at least one field study has shown that turbulence can physically damage delicate eggs and larvae in the marine environment.[66] The cause and effect relations demonstrated by this study raise the possibility that the turbulence caused by diffuser jets could cause marine mortality, though as of 2012 there were no known studies on the subject.[67] These are probably the two best, economically feasible options for brine disposal.[68]

Unfortunately, it is difficult to determine whether these methods will actually mitigate the ecological impacts of brine discharge because there is surprisingly little data on the effects of desalination discharges, despite the fact that large-scale SWRO facilities have been in operation for decades.[69] The few studies that do exist indicate that the ecological impacts of brine discharge vary depending on the characteristics of the brine, the discharge method, the rate of dilution and dispersal, and the sensitivity of local organisms.[70] Many of the toxicity studies lack baseline data[71] and only focus on a few species over a short period of time.[72] The available data show that, generally, benthic invertebrates (such as sea urchins and abalone), are the organisms most sensitive to high salinity, especially during the larval stage.[73] Only a few studies have evaluated the sublethal effects of desalination discharges, such as effects on fish that live close to the shore and have behaviors, such as reproduction or migration, which are triggered by salinity variations.[74]

The Desalination Amendment requires owners or operators of desalination

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64 STATE WATER RES. CONTROL BD., *supra* note 50, at L.2.d.2.b.

65 *See* JENKINS ET AL., *supra* note 59, at 7.

66 *Id.* at 26-27.

67 *Id.*

68 A desalination plant could be equipped with a zero liquid discharge system which would evaporate all of the water in the brine, leaving behind only the salts and completely eliminating the need for brine discharge into the ocean, however, this method has not yet been shown to be economically feasible. COOLEY ET AL., *supra* note 39, at 15.

69 JENKINS ET AL., *supra* note 59, at ii; COOLEY ET AL., *supra* note 39, at 14; J.M. Brown, *Debate Grows Over Brine Disposal*, SANTA CRUZ SENTINEL (Sept. 28, 2012), http://www.santacruzsentinel.com/20120928/debate-grows-over-brine-disposal.

70 COOLEY ET AL., *supra* note 39, at 14.

71 Baseline data would be established by studying and monitoring the marine environment at the proposed site of the desalination plant before construction begins, so that the effects of the plants construction and discharge can be shown as before and after effects. JENKINS ET AL., *supra* note 59, at 42-43.

72 *Id.*

73 PHILLIPS ET AL., UNIVERSITY OF CALIFORNIA, DAVIS, DEPARTMENT OF ENVIRONMENTAL TOXICOLOGY, HYPER-SALINITY TOXICITY THRESHOLDS FOR NINE CALIFORNIA OCEAN PLAN TOXICITY TEST PROTOCOLS 4 (2012), http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/saltoxfr08012.pdf.

74 JENKINS ET AL., *supra* note 59, at ii.

facilities to establish baseline biological conditions at the site before construction begins.[75] These baselines will be helpful in understanding the effects of brine discharge on the surrounding environment because they will enable comparisons of the health of the marine environment both before and after the plant begins operations.[76] This data may help SWRCB in developing NPDES permitting requirements. [77] Unfortunately, the first wave of desalination plants will not have this baseline data, and significant ecological harm may occur if California rushes into a flurry of SWRO construction without it.

G. The Effects of Climate Change on SWRO Facilities Could Be Substantial

Greenhouse gas emissions usually take center stage when people discuss climate change and SWRO, but the effect of climate change on SWRO facilities should also be a concern. Climate change, overfishing, and acidification have each had a profound effect on the oceans, and cumulatively these effects present a potentially costly problem for SWRO facilities in the form of jellyfish. The combination of climate change and overfishing is causing a huge increase in jellyfish populations around the world.[78] If these conditions continue, jellyfish numbers will likely skyrocket.[79] Such a large jellyfish population could cause several problems for an SWRO plant.

Jellyfish can easily become impinged and clog surface water intakes.[80] Jellyfish blooms have blocked the water intake for power plants, and even caused a manual shutdown of a nuclear plant in Sweden by clogging its cooling-water intake.[81] Along with increasing algal blooms and seaweed,[82] jellyfish have caused fouling of pretreatment systems and temporary shutdowns of SWRO plants.[83] These shutdown problems increase operating costs, and the jellyfish bloom events that cause them will become more frequent as the effects of climate change intensify.

Jellyfish are also excellent predators. In Northern Ireland, a jellyfish bloom covering around 10 square miles destroyed an entire salmon farm by killing all 100,000 fish.[84] This example shows the damage jellyfish can cause in large numbers. Also, jellyfish eat eggs and larvae, and can devastate marine

75 STATE WATER RES. CONTROL BD., *supra* note 50, at M.4.a.2.

76 *See* JENKINS ET AL., *supra* note 59, at 42.

77 *See id.*

78 Karla Cripps, *Jellyfish Taking Over Oceans, Experts Warn*, CNN (Nov. 6, 2013), http://www.cnn.com/2013/11/04/travel/jellyfish-taking-over-oceans.

79 *Id.*

80 STATE WATER RES. CONTROL BD., *supra* note 6, at 44.

81 Cripps, *supra* note 78.

82 Missimer, *supra* note 24, at 37.

83 *Id.*

84 Kevin Smith, *Jellyfish Attack Wipes Out N.Ireland Salmon Farm*, REUTERS (Nov. 22, 2007), http://www.reuters.com/article/2007/11/22/us-irish-jellyfish-idUSL2241858320071122.

populations.[85] If jellyfish begin to significantly impact population numbers of local California species, the present allowable mortality rate for impinged or entrained marine organisms may no longer be acceptable, leading to permit changes and additional mitigation requirements, and their associated costs, for SWRO plants.

A change in the allowable mortality rate is made more likely by ocean acidification. Some species, like sea urchins, are especially sensitive to ocean acidification and are most vulnerable to its effects when they are larvae.[86] Unfortunately, the larval stage is also a time when species are likely to be eaten by jellyfish or entrained in an SWRO facility.[87] For facilities using surface water intakes, this mortality risk would be a serious problem. The triple mortality risk increases the likelihood of these species becoming threatened or endangered, resulting in increased operational costs for the facility in the form of permitting, mitigation programs, and facility modifications.

III. WHERE WE OUGHT TO GO

California may be on its way to a desalination hangover. SWRO has substantial economic and environmental risks, and the state may seriously regret over-investment in desalination. Australia is currently facing this overinvestment problem, and California would be smart to learn from its mistakes.

From the mid-1990s to 2012, Australia experienced a severe drought. In response, the country implemented water policy reforms and improved efficiency measures through its National Water Initiative. It began building six large-scale SWRO plants to provide an alternative water supply, all at a cost of $10 billion.[88] Then the drought ended, and by the time the new SWRO plants came online, the country's reservoirs were completely refilled.[89] The demand for desalinated water plummeted, based on oversupply of traditional water delivery methods and the effectiveness of reforms under the National Water Initiative,

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85 *Jellyfish Gone Wild*, NAT'L SCI. FOUND. (last visited Apr. 18, 2016), http://www.nsf.gov/news/special_reports/jellyfish/textonly/ecology.jsp.

86 Meike Stumpp et al., *Digestion in Sea Urchin Larvae Impaired Under Ocean Acidification*, OCEAN ACIDIFICATION INT'L COORDINATION CTR. (Oct. 23, 2013), http://news-oceanacidification-icc.org/2013/10/23/digestion-in-sea-urchin-larvae-impaired-under-ocean-acidification.

87 *Id.*; SMITHSONIAN MUSEUM OF NAT. HIST., OCEAN PORTAL TEAM, *Jellyfish and Comb Jellies* (last visited Apr. 18, 2016), http://ocean.si.edu/jellyfish-and-comb-jellies; SABINE LATTEMAN, DEVELOPMENT OF AN ENVIRONMENTAL IMPACT ASSESSMENT AND DECISION SUPPORT SYSTEM FOR SEAWATER DESALINATION PLANTS 58 (2010).

88 NRDC, *supra* note 9, at 4.

89 John Ferguson, *Billions in Desalination Costs for Not a Drop of Water*, THE AUSTRALIAN (Oct. 18, 2014, 12:00 AM), http://www.theaustralian.com.au/national-affairs/state-politics/billions-in-desalination-costs-for-not-a-drop-of-water/story-e6frgczx-1227094416376.

which created cheaper alternatives to desalination.[90] Today, four of the six plants are idle, but taxpayers must continue to pay for them.[91] The political blowback to the initial investment in desalination technology has been severe because the conditions that originally motivated the investment changed, and taxpayers are not happy that they must continue to pay for plants that they do not need.[92]

A. California Should Maximize its Existing Water Supply Options

On April 1, 2015, standing on a patch of brown grass that would normally be covered in several feet of snow, Governor Jerry Brown announced Executive Order B-29-15 in response to the current drought and Californians' failure to reduce urban water use.[93] In addition to requiring a temporary twenty-five percent reduction in water use, the Order encourages many practices and technologies that will be useful in maximizing California's water supply.[94] The Order also encourages the California Energy Commission to accelerate the use of renewable energy-powered desalination.[95]

While the renewable energy aspect of the Order partially alleviates concerns about increased greenhouse gas emissions, it does nothing to lessen the potential financial consequences of investing in desalination before maximizing the state's current water supply. The Order suspends the application of the California Environmental Quality Act ("CEQA") to actions taken to implement renewable energy-powered desalination.[96] Projects that begin before May 31, 2016 will not be subject to CEQA for the time required to complete them.[97] This exception provides an incentive to develop desalination plants as quickly as possible, rather than encouraging fiscally responsible desalination development.

If SWRO plants are built before existing water supply options are maximized, the plants can become cost-inefficient when cheaper sources of water become available, as happened in Australia. In response to the current drought, many California cities are improving and implementing conservation, efficiency, and water recycling programs.[98] Some cities are also considering proposals for new

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90 NRDC, *supra* note 9, at 4.

91 *Id.*

92 *See* Ferguson, *supra* note 89.

93 Chris Megerian et al., *Brown orders California's first mandatory water restrictions: 'It's a different world'*, LOS ANGELES TIMES (Apr. 1, 2015), http://www.latimes.com/local/lanow/la-me-ln-snowpack-20150331-story.html#page=1; Executive Order B-29-15 (Apr. 1, 2015), http://gov.ca.gov/docs/4.1.15_Executive_Order.pdf.

94 Executive Order B-29-15 (Apr. 1, 2015), http://gov.ca.gov/docs/4.1.15_Executive_Order.pdf.

95 *Id.*

96 *Id.*

97 *Id.*

98 *See* Matt Stevens, *California seeks to build on of world's largest recycled water programs*, LOS ANGELES TIMES (Sept. 22, 2015), http://www.latimes.com/local/lanow/la-me-ln-mwd-recycled-

SWRO facilities.[99] Instead of pursuing both options simultaneously, California should implement all available conservation, efficiency, and recycling methods before burdening taxpayers with costly, and potentially unnecessary, SWRO facilities.

1. Conservation, efficiency, stormwater capture, and wastewater recycling should be fully implemented

Generally, conservation, efficiency, stormwater capture, and wastewater recycling programs have a smaller environmental impact than SWRO, can be implemented much more quickly, and produce water that is less expensive per acre-foot than SWRO water.[100] These alternatives should first be fully implemented to maximize the existing water supply before the state considers SWRO.

There are many conservation methods that can be implemented, but one is fairly obvious: rip out the lawns. A green lawn in a state experiencing extreme drought makes little sense. It is time for Californians to consider replacing their lawns with drought tolerant landscaping. Outdoor water use accounts for more than fifty percent of residential water use.[101] A small, 1000 square-foot lawn uses about 35,000 gallons of water per year if properly irrigated.[102] A lawn of the same size can use up to 75,000 gallons per year if it is over-irrigated,[103] and residential users over-irrigate lawns and ornamental landscaping by about sixty percent.[104] Replacing lawns and ornamental landscaping with drought tolerant

water-20150922-story.html; Paul Rogers, *California drought: San Jose's new high-tech water purification plant to expand recycled water use*, SAN JOSE MERCURY NEWS (July 17, 2014), http://www.mercurynews.com/science/ci_26160300/california-drought-san-joses-new-high-tech-water; Hudson Sangree, *California looking to recycled water to ease drought concerns*, THE SACRAMENTO BEE (Apr. 14, 2014), http://www.sacbee.com/news/local/article2595660.html; Sonoma County Water Agency, *Recycled Water* (last visited Apr. 18, 2016), http://www.scwa.ca.gov/recycled-water/; City of Pacifica, *Pacifica's NCCWD Water Recycling Facility* (last visited Apr. 18, 2016), http://www.cityofpacifica.org/depts/wwt/caleracreek/; Morgan Hill California, *Water Conservation Rebate Programs* (last visited Apr. 18, 2016), http://www.morgan-hill.ca.gov/715/Water-Conservation-Rebate-Programs; City of Napa, *Water Conservation* (last visited Apr. 18, 2016), http://www.cityofnapa.org/?option=com_content&view=article&id=228&Itemid=314; City of Woodland California, *Water Conservation* (last visited Apr. 18, 2016), http://www.cityofwoodland.org/gov/depts/pw/areas/enviro/water/default.asp.

99 *See* STATE WATER RES. CONTROL BD., STATEWIDE PROPOSED DESALINATION FACILITIES (2014), http://www.swrcb.ca.gov/water_issues/programs/ocean/desalination/docs/proposed_desal_facilities.pdf.

100 NRDC, *supra* note 9, at 2.

101 ASS'N OF CAL. WATER AGENCIES, CALIFORNIA'S WATER: FACTS ON "WATER EFFICENCY [SIC] GARDENS IN FULL BLOOM" (last visited Apr. 18, 2016), http://www.acwa.com/content/conservation/californias-water-facts-water-efficency-gardens-full-bloom.

102 *Id.*

103 *Id.*

104 *Id.*

landscaping would provide significant water savings.[105]

Replacing a lawn can be expensive, but there are options available to help homeowners recover some of that cost. Several cities and water districts have implemented "Cash for Grass" programs that pay homeowners a certain amount per square foot to tear out their lawns and replace them with drought tolerant landscaping.[106] Programs may also have requirements such as mulching and installation of efficient irrigation systems, like drip irrigation, that help ensure that homeowners make the most of the water they will continue to use in maintaining their new landscaping.[107]

The City of Roseville has implemented a particularly successful program. The program provides rebates of fifty cents per square foot of turf grass replaced with water efficient landscaping up to a total of one thousand dollars per address.[108] A representative of the City of Roseville must conduct a pre-conversion site visit before any turf removal is begun, or the conversion will be ineligible for funding.[109] The participant has ninety days from the date of the pre-conversion visit to finish the project.[110] Applications for the program are accepted on a first come, first served basis.[111] As of 2015, 487 people had participated in the program and reduced their water usage by twenty-one percent as a result.[112] The program was so popular that it ran out of funding.[113] Governor Brown acknowledged the effectiveness of these programs in his recent Executive Order, which calls on the Department of Water Resources to begin a statewide lawn replacement initiative in partnership with local agencies.[114]

Cities should similarly begin replacing unused turf on city properties with drought tolerant landscaping. Some cities maintain areas of grass that serve no functional purpose, like small patches of grass around signs.[115] Replacing these areas would save water and, just as importantly, could help residents become

105 See *id.*

106 Daniel Potter, *California Drought Boosts 'Cash for Grass' Programs*, KQED SCIENCE (Dec. 1, 2014), http://blogs.kqed.org/science/audio/take-out-your-lawn-and-get-paid-for-it; David Bienick, *Sacramento Approves 'Cash for Grass' Plan*, KCRA.COM (updated Mar. 5, 2014, 9:52 AM), http://www.kcra.com/news/city-of-sacramento-considers-paying-cash-for-grass/24806130.

107 City of Roseville, *Cash for Grass Program Frequently Asked Questions* (Feb. 28, 2014), http://www.roseville.ca.us/civicax/filebank/blobdload.aspx?BlobID=19136.

108 City of Roseville, *Cash For Grass Rebate Program* (last visited Apr. 18, 2016), http://www.roseville.ca.us/eu/water_utility/water_efficiency/for_home/cash_for_grass/default.asp.

109 *Id.*

110 *Id.*

111 *Id.*

112 Bienick, *supra* note 106.

113 *Id.*

114 Executive Order B-29-15, *supra* note 93.

115 Richard Chang, *Roseville to Replace Turf With Water-Saving Plants in Response to Drought*, THE SACRAMENTO BEE (Jan. 21, 2015, 11:09 AM), http://www.sacbee.com/news/local/article7868712.html.

more comfortable with the look of drought tolerant landscaping and give them ideas for ways they might save water on their own property. Roseville has approved a plan to remove about two acres of grass on city property and replace it with drought tolerant landscaping.[116] The city says the conversion will conserve about 6.9 million gallons of water annually.[117]

2. California must replace its aging water supply infrastructure

Much of the state's water supply infrastructure is aging and inadequately maintained. Los Angeles' water main system is in particularly bad shape.[118] The system has experienced thousands of leaks since the drought began, averaging about four leaks a day.[119] In July of 2014, a ninety-three-year-old water main broke under Sunset Boulevard, flooding the area with about 20 million gallons of water.[120] The break flooded the UCLA campus, causing thirteen million dollars' worth of damage.[121] As of July 2015, the Los Angeles Department of Water and Power paid about $2.5 million to the owners of hundreds of vehicles damages or destroyed in the flooding.[122]

Major blowouts like this one are a problem, but having many small, chronic leaks can be just as bad.[123] For example, one pipe leaked more than half a million gallons over the year that it took the Los Angeles Department of Water and Power ("LADWP" or "the Department") to find it and fix it.[124] Workers had to drill dozens of holes and dig out sections of the road to find the leak.[125] Officials estimate that the city loses about 8 billion gallons of water each year to

116 *Id.*

117 *Id.*

118 CBS LOS ANGELES, *LA County Gets 'C' Grade for Drinking water, 'C-' For Roadways* (Oct. 24, 2012), http://losangeles.cbslocal.com/2012/10/24/la-county-gets-c-grade-for-drinking-water-c-for-roadways/; *see* AMERICAN SOCIETY OF CIVIL ENGINEERS, *California Infrastructure Report Card 2012* 70-75 (2012), http://www.ascecareportcard.org/citizen_guides/Citizen's%20guide%202012_Revised.pdf.

119 Bianca Barragan, *Mapping All the Water Main Leaks Across Los Angeles*, CURBED LOS ANGELES (Feb. 17, 2015), http://la.curbed.com/archives/2015/02/mapping_all_the_water_main_leaks_across_los_angeles.php; Ben Poston & Matt Stevens, *L.A.'s Aging Water Pipes; A $1-Billion Dilemma*, LOS ANGELES TIMES (Feb. 16, 2015), http://graphics.latimes.com/la-aging-water-infrastructure.

120 CBS LOS ANGELES, *Owners of Flood-Damaged Vehicles at UCLA Get First Look* (Aug. 5, 2014), http://losangeles.cbslocal.com/2014/08/05/owners-of-flood-damaged-vehicles-at-ucla-will-get-first-look/.

121 Larry Gordon, *UCLA claims $13 million in flood damage from water line break*, LOS ANGELES TIMES (July 9, 2015), http://www.latimes.com/local/education/la-me-ln-ucla-flood-20150709-story.html.

122 *Id.*

123 Poston & Stevens, *supra* note 119.

124 *Id.*

125 *Id.*

leaky pipes and other unaccounted water losses.[126]

The current pipe problems will cost Los Angeles over one billion dollars to fix.[127] It is unclear where the money will come from, and LADWP concedes that even if they receive the money they are unlikely to be able to fix the problem completely because more pipes will deteriorate in the near future.[128] Currently, the Department needs to replace about 435 miles of water mains, almost half of which were installed in 1930 or earlier. Other pipes, like the 2,500 miles of water mains installed during the mid-century baby boom following World War II, will need to be replaced in about thirty years.[129] It would be almost impossible for the Department to keep up with the rate of pipe deterioration given its limited resources and concerns about quality of life for residents during repairs.[130]

San Francisco and other major cities face similar problems with aging water delivery infrastructure and inadequate funding.[131] California should invest in solving the infrastructure problems it already has before funding new desalination plants. If the state builds new plants before fixing the existing infrastructure, it is not solving a water supply problem. Rather, delivering desalinated water through decayed water infrastructure simply makes leakage and water loss more expensive. As a part of the upgrade to water infrastructure, California should invest in efficiency technology that will monitor the water grid and warn suppliers of leaks to help water suppliers minimize loss. This technology has already proven effective in other countries; Israel has lowered leakage to less than 10 percent by using such water grid monitoring technology.[132] Repairing water infrastructure and installing monitoring technology can significantly reduce water loss and the need for unpredictable, costly investment in desalination technology.

3. California is not using all of its potential water sources

California should invest in developing other, less expensive water sources, such as stormwater and wastewater, before investing in desalination. One-inch of rain in Los Angeles can generate over 30,000 acre-feet of stormwater runoff that is merely discharged into the ocean.[133] If the stormwater runoff from

126 *Id.*

127 *Id.*

128 *Id.*

129 *Id.*

130 *Id.*

131 *Id.*

132 Allison Hewitt, *California Water Agencies Don't Know How Much Their Pipes Leak, UCLA Report Finds*, UCLA NEWSROOM (July 24, 2015), http://newsroom.ucla.edu/releases/california-water-agencies-dont-know-how-much-their-pipes-leak-ucla-report-finds.

133 NRDC, *supra* note 9, at 6.

impervious surfaces were captured instead, it could be redirected to open spaces to allow it to infiltrate into the ground and recharge groundwater supplies.[134] The California Air Resources Board estimates that up to 333,000 acre-feet of stormwater could be captured annually in Southern California.[135] Utilizing stormwater capture would have additional benefits such as reducing carbon dioxide emissions associated with water imports,[136] and preventing surface water pollution that normally results from stormwater runoff.[137]

Additionally, California should start recycling its wastewater. San Diego recently approved a sewage purification system that is expected to supply about one third of the city's daily needs by 2035.[138] However, there is an "'ick' factor" associated with recycling wastewater for domestic and agricultural use.[139] Even so, the severity of California's water crisis makes reusing wastewater necessary, especially given the environmental and cost problems of other options like desalination.[140] Furthermore, watering crops with recycled water has been shown to be a safe method of use. Recycled wastewater could provide a much needed, and more affordable, new water source, particularly towards thirsty California agriculture.[141]

B. California Must Continue to Improve Agricultural Water-Use Efficiency

Continuing to improve water conservation and efficiency in agriculture will free up more water for domestic, industrial, and commercial purposes, potentially lessening the need for desalinated water. The agriculture industry

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134 PAC. INST., ISSUE BRIEF: STORMWATER CAPTURE POTENTIAL IN URBAN AND SUBURBAN CALIFORNIA 2 (June 2014), http://pacinst.org/wp-content/uploads/sites/21/2014/06/ca-water-stormwater.pdf.

135 Linda Sheehan, *Summary of Costs and Benefits of Water Supply Alternatives*, CAL. COASTKEEPER ALLIANCE 1, 3 (2009), http://www.cacoastkeeper.org/document/ccka-water-supply-strategies---costs-and-benefits.pdf.

136 *Id.* at 3; Kelley, *supra* note 5, at 43-44 (noting that the reduction in greenhouse gases would only occur if desalination plants mitigate their indirect emissions).

137 NRDC, *supra* note 9, at 7.

138 David Garrick, *SD Oks Landmark Water Recycling*, THE SAN DIEGO TRIBUNE (Nov. 18, 2014), http://www.sandiegouniontribune.com/news/2014/nov/18/water-recycling-sewer-tap-council-approves/; Gene Cubbison, *San Diego Approves $3.5B Recycled Water Project*, NBC 7 SAN DIEGO (Nov. 8, 2014, 6:13 PM), http://www.nbcsandiego.com/news/politics/San-Diego-Eyes-Recycled-Water-Project-in-Drought-Conditions-283058261.html.

139 Kate Galbraith, *Taking the Ick Factor Out of Recycled Water*, THE NEW YORK TIMES (July 25, 2012), http://www.nytimes.com/2012/07/26/business/global/26iht-green26.html?_r=0.

140 THE GUARDIAN, *Get use to toilet-to-tap water, Californians told* (Aug. 2014), http://www.theguardian.com/environment/2014/aug/07/california-drought-orange-county-toilet-to-tap-water.

141 Israel recycles more than 75 percent of its wastewater, and this provides more than 50 percent of the water used in its agriculture. Alisa Odenheimer & James Nash, *Israel Desalination Shows California Not to Fear Drought*, BLOOMBERG (Feb. 12, 2014), http://www.bloomberg.com/news/articles/2014-02-13/israel-desalination-shows-california-not-to-fear-drought.

uses about eighty percent of California's developed water supply.[142] Several studies have shown that agricultural water use could be reduced by about seventeen to twenty-two percent per year while maintaining productivity and total acreage irrigated, with at least thirteen percent being a reduction in consumptive use.[143] While desalination is unlikely to be a viable source of irrigation water in any case due to cost and distance from the coast,[144] a reduction in consumptive agricultural water use would leave more water available for other uses, decreasing the total amount of water needed from desalination facilities. There are several options available to increase agricultural water use efficiency, but they all require significant investment in irrigation infrastructure to maximize their benefits.

1. Replacing flood irrigation with drip and sprinkler irrigation can reduce the amount of water used and maximize crop-yield per unit of water[145]

While many California farmers already employ water-efficient irrigation techniques, flood irrigation is still used for about forty percent of crops.[146] Flood irrigation is inefficient because of the water lost to evaporation, runoff, and seepage.[147] Sprinkler and drip irrigation are more complex and more expensive than traditional flood irrigation, but the systems can reduce water use, reduce runoff, and increase crop yield and quantity.[148]

However, most irrigation water is not delivered pressurized, so farmers have to purchase pumps to pressurize it prior to use in the irrigation system.[149] The additional expense of pumps, and the energy to run them, may make these irrigation methods economically infeasible for some farmers.[150] Financial

142 NRDC, *Agricultural Water Conservation and Efficiency Potential in California* 1, 1 (June 2014), http://www.nrdc.org/water/files/ca-water-supply-solutions-ag-efficiency-IB.pdf.

143 *Id.* at 2; CHRISTIAN-SMITH ET AL., POTENTIAL WATER SAVINGS ASSOCIATED WITH AGRICULTURAL WATER EFFICIENCY IMPROVEMENTS: A CASE STUDY OF CALIFORNIA, PAC. INST., 209 (2012).

144 Paul Rogers, *California drought: Santa Barbara looks to ocean desalination for new water; are other cities next?*, SAN JOSE MERCURY NEWS (Apr. 7, 2015), http://www.mercurynews.com/drought/ci_27869861/california-drought-santa-barbara-looks-ocean-desalination-new?source=infinite-up.

145 CHRISTIAN-SMITH ET AL., *supra* note 143, at 200.

146 NRDC, *supra* note 142, at 4; CHRISTIAN-SMITH ET AL., *supra* note 143, at 200; the forty percent of crops that use flood irrigation does not include rice fields because continuous flooding is the most productive method of irrigation for rice since it is an aquatic plant. CALIFORNIA RICE COMMISSION, ENVIRONMENTAL SUSTAINABILITY REPORT (May 2012), http://calrice.org/pdf/Sustainability+Report.pdf.

147 CHRISTIAN-SMITH ET AL., *supra* note 143, at 200.

148 COOLEY ET AL., SUSTAINING CALIFORNIA AGRICULTURE IN AN UNCERTAIN FUTURE, PAC. INST. 1, 39-40 (July 2009), http://pacinst.org/wp-content/uploads/sites/21/2014/04/sustaining-california-agriculture-pacinst-full-report.pdf.

149 CHRISTIAN-SMITH ET AL., *supra* note 143, at 209-10.

150 *Id.*

incentives could be the solution to minimizing farmers' transition expenses, like subsidies, or by investing in water delivery infrastructure.

2. Irrigation scheduling can prevent over-watering and increase crop yield

Water management is an essential feature of efficient agricultural water use. Irrigation systems only deliver water to crops and, without proper management, over or under-watering can still occur, which diminishes the benefits of improved irrigation.[151] Irrigation scheduling allows farmers to make sure they are applying the right amount of water at the right time depending on weather, soil conditions, and the life stage of the crop.[152] Such services can be provided by consultants, computer models, and soil moisture sensors.[153] California already provides information that can assist farmers in irrigation scheduling through the California Irrigation Management Information System ("CIMIS").[154] Approximately twenty percent of California farmers use CIMIS-based services and, on average, the use of CIMIS resulted in an eight percent yield increase and thirteen percent reduction in water use.[155]

Unfortunately, farmers' ability to use irrigation scheduling is dependent on their water supplier's capabilities.[156] Irrigation scheduling only works if a farmer can apply the right amount of water at the right time, and some water suppliers do not have the infrastructure to provide water on demand.[157] To allow for increased water scheduling, the state should invest in irrigation infrastructure so that more water suppliers can provide farmers water on demand.[158]

3. Regulated deficit irrigation needs to be expanded

Regulated deficit irrigation ("RDI") is the practice of reducing irrigation during stress-tolerant stages of a crop's lifecycle to reduce water use while minimizing negative impacts on yield.[159] In fact, some farmers that grow wine grapes already implement this practice because it can increase the quality of the

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151 *Id.*

152 *Id.*

153 CHRISTIAN-SMITH ET AL., *supra* note 143, at 201; *Smart Irrigation*, SARE.ORG, http://www.sare.org/Learning-Center/Bulletins/Smart-Water-Use-on-Your-Farm-or-Ranch/Text-Version/Water-Management/Smart-Irrigation (last visited Mar. 31, 2015); U.S. BUREAU OF RECLAMATION, IRRIGATION SCHEDULING USING REAL TIME SOIL MOISTURE MEASUREMENTS (Dec. 2003), https://www.usbr.gov/uc/progact/waterconsv/pdfs/IMSReport_Master1.pdf.

154 CHRISTIAN-SMITH ET AL., *supra* note 143, at 201; *CIMIS Overview*, CAL. DEP'T OF WATER RES., http://www.cimis.water.ca.gov (last visited Mar. 31, 2015).

155 CHRISTIAN-SMITH ET AL., *supra* note 143, at 202.

156 COOLEY ET AL., *supra* note 148, at 48.

157 *Id.*

158 *Id.*

159 CHRISTIAN-SMITH ET AL., *supra* note 143, at 203.

crop.[160] The 2005 California Water Plan estimated that applying RDI to tree crops and wine grapes could save 1 to 1.5 million acre-feet of water per year.[161]

Implementing RDI on a large scale would require additional labor and infrastructure, like plant-based sensors, to monitor plant stress.[162] It is possible that RDI could reduce water use for crops like walnuts, olives, and oranges, among others, but only a few crops have been proven to respond positively to RDI.[163] More research is necessary to build the understanding of local conditions and crop types necessary to fully implement RDI.[164]

C. Water Service Providers Should Decouple Revenue from Sales and Implement Tiered Rate Structures

Some California water providers have a disincentive to promote conservation: their revenue and sales are linked. The more water providers sell, the more money they make.[165] Decoupling rates from sales would break that link. The California Public Utilities Commission ("CPUC") started a pilot decoupling program in 2008.[166] However, the CPUC only regulates about sixteen percent of residential water use in California, significantly limiting the scope of the pilot program.[167] CPUC should expand the program to all regulated water utilities, and non-CPUC providers should similarly decouple. Decoupling has already proven effective in promoting conservation in the energy sector,[168] and California's water industry should follow suit.

Ideally, utilities would implement inclining tiered rate structures. In a tiered rate structure, the more water a customer uses, the more they pay for each unit of water. Following the electric sector's example, water providers would calculate a baseline level of water use for each region.[169] The baseline should be

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160 *Id.* at 208.

161 *Id.* at 204.

162 COOLEY ET AL., *supra* note 148, at 51.

163 *Id.* at 49.

164 *See id.* at 51.

165 John Erickson & Greg Leventis, *Conserving Regulated water: Revenue Decoupling, Incentives, and Equity*, POL'Y MATTERS J. (2014); Amy Standen, *True Water Restrictions Rare, Even in California's Record-Breaking Drought*, KQED SCIENCE (Apr. 28, 2014), http://blogs.kqed.org/science/audio/true-water-restrictions-rare-even-in-californias-record-breaking-drought-3.

166 CAL. PUB. UTIL. COMM'N, REPORT TO LEGISLATURE: PROGRESS AND ACHIEVEMENTS TOWARDS WATER CONSERVATION GOALS PUBLIC UTILITIES CODE § 2714.5 (2008), http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=1466.

167 CAL. PUB. UTIL. COMM'N, REGULATORY RESPONSIBILITIES OF THE CALIFORNIA PUBLIC UTILITIES COMMISSION (2008), http://www.cpuc.ca.gov/water/.

168 CAL. PUB. UTIL. COMM'N, CALIFORNIA'S DECOUPLING POLICY (2008), http://www.fishnick.com/pge/Decoupling_Explained.pdf.

169 CAL. PUB. UTIL. COMM'N, *What is Baseline* (2009), http://www.cpuc.ca.gov/cfaqs/whatisbaseline.htm.

enough to meet the daily needs of the average household in the region. Customers who use more than this baseline would be charged more per unit of water exceeding the baseline. As an example, the City of Santa Cruz successfully uses this pricing method to enforce mandatory conservation measures.[170] Rate restructuring should also consider seasonal rates. For example, rates might change in November and May, like rates for natural gas.[171] This seasonal rate structure would allow providers to charge more for water during the summer, when it is more important to conserve.

The Governor's Executive Order requires urban water suppliers to develop rate structures and pricing mechanisms to maximize water conservation.[172] Unfortunately, Proposition 218 may prevent water suppliers from easily implementing block or tiered rate structures and may prevent seasonal rates entirely. Proposition 218 limits fees and charges for governmental services to the public to the cost of providing the service to the parcel at issue, among other things.[173]

The 4th District Court of Appeal recently struck down the tiered water rate structure used by the City of San Juan Capistrano, holding that the City violated Proposition 218 because the rates were not tied to the cost of providing water to each parcel.[174] The City of San Juan Capistrano calculated four consumption tiers and structured the rates for the tiers so that the combined revenues would not exceed the city's costs.[175] The city made no effort to tie the rates in each tier to the actual cost of providing service to each tier.[176] Rather, customers in the lower tier were charged less than the cost of service to their parcels, and customers who used more water, and so were in a higher tier, were charged more than the cost of service to their parcels to make up that difference, effectively subsidizing the lowest tier to encourage conservation.[177] Because higher tier customers were charged more than the cost of service to their parcel,

170 Standen, *supra* note 165; Paul Rogers, *California drought: Santa Cruz pushes the limit with the state's toughest water rationing laws*, SAN JOSE MERCURY NEWS (Aug. 3, 2014), http://www.mercurynews.com/drought/ci_26269016/california-drought-santa-cruz-pushes-limit-states-toughest (noting that part of the reason for the city's strict water use rules is that Santa Cruz is isolated and receives most of its water from the nearby San Lorenzo River).

171 CAL. PUB. UTIL. COMM'N, *Baseline*, *supra* note 169.

172 Exec. Order B-29-15, *supra* note 93.

173 CAL. CONST., art. XIII D, section 6(b).

174 Capistrano Taxpayers Ass'n., Inc. v. City of San Juan Capistrano, 235 Cal. App. 4th 1493 (2015); Staff and Wire reports, *California drought: Court rules tiered water rates violate state constitution*, SAN JOSE MERCURY NEWS (Apr. 20, 2015), http://www.mercurynews.com/drought/ci_27954116/california-drought-court-rules-tiered-water-rates-violate.

175 Capistrano Taxpayers Ass'n., Inc. v. City of San Juan Capistrano, 235 Cal. App. 4th 1493, 1498-99 (2015).

176 *Id.* at 1506.

177 *Id.* at 1499.

the rate structure violated Proposition 218.[178]

The court noted that tiered rate structures do not necessarily violate Proposition 218, but to be in compliance a service provider may only charge more per unit of water in a higher tier if it actually costs the service provider more to provide each unit of water in that tier.[179] This ruling makes it very difficult for service providers to implement tiered rate structures because it appears to require very precise accounting and may open service providers who attempt to implement tiered rates to the possibility of a lawsuit.

D. Mandatory Water Restrictions Should Automatically Apply When a Drought Is Declared

Despite the fact that California is in its fifth year of a drought, many water conservation efforts are still voluntary or lack enforcement.[180] This is shortsighted because droughts are difficult to predict,[181] and beginning at least some mandatory conservation efforts in the first year of a drought would be a sensible precaution in case the drought continues for several years. For example, if mandatory restrictions had begun in the first year of the current drought, California would have had more water in 2015. Beginning and enforcing restrictions earlier in a drought is a common sense decision that seems to be unpalatable to most water managers and politicians, primarily because they do not want to make people angry.[182] But people will certainly be angry if their service provider can no longer supply them with water.

Conservation measures should automatically be required when a drought reaches a certain level of severity. However, the need for such precautionary measures does not necessarily require Californians to jump into a state of emergency every time a drought is declared. After all, droughts vary in duration and geographic impact. Conservation measures should be tiered based on the extent of the drought within each region, progressively increasing with the severity of regional drought conditions. The measures that will be required at each level of increasing drought severity should be decided on before a drought occurs so that people have notice of the specific measures they will be expected to take and can prepare for them if necessary.

For example, the State might use the drought intensity measured by the U.S. Drought Monitor to set the categories for conservation.[183] An area considered

178 *Id.* at 1515-16.

179 *Id.* at 1515.

180 Standen, *supra* note 165.

181 NATIONAL DROUGHT MITIGATION CENTER, PREDICTING DROUGHT (last visited Apr. 18, 2016), http://drought.unl.edu/DroughtBasics/PredictingDrought.aspx.

182 *Id.*

183 *See, e.g.*, United States Drought Monitor, California (as of Mar. 24, 2015), http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?CA.

"Abnormally Dry" might only have voluntary conservation measures, such as recommended limitations on watering ornamental landscaping, whereas a "Moderate Drought" area might make those measures mandatory and add additional conservation measures. In turn, an "Exceptional Drought" area might have severe mandatory rationing. If pre-determined conservation measures automatically apply when the drought reaches a certain category of severity, it takes the difficult decision to implement those measures out of the hands of politicians and water managers, so that the possibility of political blowback does not affect the state's ability to cope with drought.

Still, mandatory conservation will not be effective without adequate enforcement. Even areas that currently have mandatory restrictions often do not have "water cops" to look for violations, and officials typically cannot give citations unless they see the violation in progress.[184] Jurisdictions could use water meters to measure usage and enforce reductions. While meters would not directly help enforce specific use restrictions (e.g., limiting lawn watering to Wednesdays), the metadata could be used to develop better conservation programs and help enforce daily household water use limits.

Governor Brown's Executive Order requires a mandatory twenty-five percent reduction in urban water use.[185] The Order requires the consideration of past per capita water use in service areas so that those areas that use more will be required to achieve proportionally greater reductions in comparison to those that use less.[186] To implement the twenty-five percent reduction, the SWRCB adopted an emergency regulation that uses a sliding scale.[187] This way, communities that had already lowered their water use did not have to reduce their water consumption as much as those who had not been conserving.[188] In February 2016, the SWRCB adopted an extended and revised emergency regulation which extends the urban water use restrictions through October 2016.[189] On the whole, Californians have responded well to the need for conservation; urban water suppliers have reported a cumulative savings of 24.8 percent for the preceding eight months since restrictions began, putting the state

184 Standen, *supra* note 165.

185 Cal. Exec. Order B-29-15 (Apr. 1, 2015), http://gov.ca.gov/docs/4.1.15_Executive_Order.pdf.

186 *Id.* A straight 25 percent reduction per household would be more difficult for households that conserve than for households that waste water, creating an incentive to use as much water as possible before mandatory restrictions begin.

187 STATE WATER RES. CONTROL BD., MEDIA RELEASE: URBAN WATER CONSERVATION PLUMMETS IN FEBRUARY 1 (Apr. 7, 2015), http://www.swrcb.ca.gov/press_room/press_releases/2015/pr040715_rgcpd_febconservation.pdf.

188 *Id.*

189 STATE WATER RES. CONTROL BD., MEDIA RELEASE: CALIFORNIANS SAVE 1.1 MILLION ACRE-FEET OF WATER, URGED TO STAY FOCUSED ON CONSERVATION (Feb. 25, 2016), http://www.swrcb.ca.gov/water_issues/programs/conservation_portal/docs/2016feb/pr22516_jan_conservation_pr.pdf.

well on track to meet its conservation goals.[190]

E. Regulatory Agencies Should Err on the Side of Caution when Assessing Potential Environmental Impacts.

If SWRO is still necessary in an area after other water sources and conservation methods have been used, regulatory agencies should err on the side of caution when assessing potential environmental impacts. SWRO can sometimes be beneficial to the environment by, for example, leaving more freshwater in ecosystems. However, SWRO can also be harmful to the environment by causing marine mortality, inducing growth, and contributing to climate change. Based on these effects, it is not possible to categorize SWRO as cumulatively positive or negative for the environment. Rather, California must strike a balance between the need for SWRO and the need for environmental protection. Because the overall impact of building and operating multiple large-scale SWRO facilities in California is unknown, regulatory agencies and localities should err on the side of caution, take all feasible water conservation measures, and be reasonably certain of a facility's necessity before approving it and the attendant environmental harm.

California should require the owner, operator, or developer of a proposed SWRO facility to show that existing water supply options in the service area are maximally utilized before beginning the permitting process. This initial finding would minimize desalination impacts on the marine environment and energy usage; as well as preventing unnecessary facility development. Only SWRO facilities that are absolutely necessary would be permitted, limiting both overall development and size, and reducing the ultimate cost to California taxpayers.

F. The Owner or Operator of a Desalination Facility Should Be Required to Make a Showing of Significant Need

After making an initial showing that existing water supplies have been maximized, SWRO owners or operators should then be required to make a showing of significant need. Currently, an owner or operator of a desalination facility must consider whether the need for desalinated water is consistent with any applicable urban water management plan when determining whether the potential plant site best minimizes harm to marine life.[191] Such a consideration is not a difficult hurdle to clear, and a more significant showing, based on the potential for marine mortality in SWRO facilities where surface intakes are used, should be required.

Under the Desalination Amendment, surface intakes can only be used if the

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190 *Id.*

191 STATE WATER RES. CONTROL BD., *supra* note 50, at L.2.b.1.

regional water board determines that subsurface intakes are not feasible.[192] Surface intakes would be screened, but even if the proposed screen and low velocity requirements are implemented perfectly, the surface water intake method will still cause marine mortality. The smallest size screen proposed by the SWRCB is still large enough to allow twenty percent of small marine organisms to pass through the screen and become entrained in the facility.[193] This level of mortality should be justified by a showing of significant need before an SWRO can be permitted.

To make this showing, the owner or operator should have to first prove that the existing water resources of the served area have been maximally utilized. Second, they should have to prove that the area's water needs still cannot be met or that continued use of the existing water resources is causing, or will cause, environmental harm that exceeds the maximum potential harm of the surface water intake. The inability to accommodate growth beyond existing water resources should not be considered a showing of significant need. Excessive growth would put more pressure on coastal resources in addition to the increased marine mortality caused by the surface water intake.

The City of Monterey provides a useful illustration of both significant need scenarios, though it is unclear whether they have maximized their existing water resources. A state-issued cease-and-desist order requires drastic reductions in pumping from Monterey's main water source, the Carmel River, by 2017.[194] The city will not be able to meet its needs with the remaining water, creating a significant need that the city could show to justify developing desalination.[195] Even if Monterey did not have to find a new water source, the city could still make a showing of significant need because its continued use of this water source is harmful to the threatened steelhead population of the Carmel River.[196] This harm outweighs the potential harm of the desalination surface water intake that the City has proposed because Monterey has proposed to locate the intake in an underwater canyon where it will be less likely to impinge or entrain marine life.[197] Therefore, so long as Monterey maximized usage of its existing water supply, including implementing all appropriate conservation measures, an owner

192 *Id.* at L.2.d.1.c.i.

193 *Compare id.* at L.2.d.1.c.i (stating that 0.5mm is the smallest screen proposed by the SWRCB), *with* PANKRATZ, *supra* note 7, at 8 (stating that 0.5mm screens can reduce entrainment by up to eighty percent).

194 Bruce Delgado & Jason Burnett, *Test Slant Well Critical Step for Desal Plant*, MONTEREY HERALD (Nov. 11, 2014), http://www.montereyherald.com/opinion/20141111/bruce-delgado-jason-burnett-test-slant-well-critical-step-for-desal-plant.

195 *See id.*

196 *Id.*

197 Michael Kassner, *Data Center to Help Desalinate Sea Water for Drought-Stricken California*, TECHREPUBLIC (Sept. 3, 2014), http://www.techrepublic.com/article/data-center-to-help-desalinate-sea-water-for-drought-stricken-california/.

or operator of a proposed SWRO facility would be able to make a showing of significant need and begin appropriate development of the facility.

G. The Owner or Operator of a SWRO Facility Should Consider the Effects of Climate Change on the Operation of the Facility

In addition to the two threshold findings above, owners and operators of SWRO facilities should consider the impact of climate change on plant operations. Unfortunately, the climate change effects likely to cause problems for SWRO facilities may be unavoidable. Like many climate change related effects, they are almost inevitable now.[198] As such, owners, operators, and permitting agencies need to take climate change-related possibilities into account when considering whether to develop an SWRO facility. There is no way of knowing if or when a particular SWRO facility will have to deal with climate change, but with the high cost of construction and an expected facility lifetime of over 30 years, it would be irresponsible to simply ignore these problems.[199]

H. Technology Is Getting Better; California Should Be Patient

There are promising new desalination technologies that would reduce or eliminate some of the economic and environmental concerns associated with SWRO. While some of them have not yet been applied to seawater, they provide an indication of the direction in which technology is moving. If California takes the time to implement water conservation measures and modernize its water infrastructure first, the technology may vastly improve by the time the state invests in desalination facilities.

1. Solar desalination may become a viable method of desalination for agricultural water

The company WaterFX has invented a solar desalination method that would allow farmers to recover water at a cost of about $450 per acre-foot, much less than SWRO.[200] The company conducted a pilot project in Panoche Water and Drainage District for in 2013 and the Aqua4™ Concentrated Solar Still that was used in the project was still in use there as of 2014.[201] The technology uses

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[198] CARLSBAD SEAWATER DESALINATION PROJECT, PROJECT AGREEMENTS, http://carlsbaddesal.com/project-agreements (last visited Feb. 26, 2016).

[199] *Id.*

[200] Kevin Fagan, *California Drought: Solar Desalination Plant Shows Promise*, SF GATE (Mar. 18, 2014), http://www.sfgate.com/science/article/California-drought-Solar-desalination-plant-5326024.php.

[201] *Id.*; WaterFX, Embracing Renewable Desalination (Jan. 31, 2014), http://waterfx.co/central-valley/embracing-renewable-desalination/.

evaporation to clean brackish drainage water, and it has proven very effective and efficient, allowing a greater than ninety-three percent recovery.[202] In fact, it is so much more efficient than SWRO that the company is planning to add a component to the system that would process the salts that are removed from the water for resale.[203] Such efficiency is not possible with SWRO, which can only desalinate about half of the water it takes in, leaving the other half twice as saline and the salts unrecovered.[204]

Solar desalination has another promising feature that may benefit both agriculture and the environment. Along with agricultural runoff, the WaterFX pilot project collected runoff from the surrounding foothills.[205] The runoff collected salts from the soil on its way to the facility.[206] This means that the project not only removed salts from the irrigation water, it also removed built up salts from the soil that may harm crops and wildlife. This salt collection would be a very beneficial side effect for any area with significant amounts of salts built up in the soil from years of agricultural use.[207]

2. Methods utilizing naturally created osmotic pressure are less energy-intensive and produce less brine

Traditional reverse osmosis methods require a substantial amount of energy to create the hydraulic pressure used to push water through the filtration membrane.[208] One often proposed solution would use solar or wind energy to power desalination plants. But desalination plants normally do not produce their own solar or wind energy, and their ability to use these sources is limited by the amount they can receive from their energy provider.[209] However, there is a largely untapped renewable energy source within every desalination plant that could be used to lower greenhouse gas emissions and decrease energy costs: salinity gradient power.[210] Salinity gradient power is exploited in both Forward Osmosis ("FO") and Pressure Retarded Osmosis ("PRO") systems. FO and PRO use natural osmotic pressure to draw water through the membrane, instead of the hydraulic pressure used in traditional reverse osmosis.[211]

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202 *Id.* Note that SWRO has only a fifty percent recovery rate.

203 *Id.*

204 NRDC, *supra* note 9, at 3.

205 Fagan, *supra* note 200.

206 *Id.*

207 CAL. DEPT. OF FOOD AND AGRIC., SOIL SALINIZATION (last visited Apr. 18, 2016), https://www.cdfa.ca.gov/agvision/docs/soil_salinization.pdf.

208 COOLEY ET AL., *supra* note 37, at 4-5.

209 *Id.* at 23-24.

210 Andrea Achilli et al., *Experimental Results from RO-PRO: A Next Generation System for Low-Energy Desalination*, 48 ENVTL. SCI. & TECH. 6437, 6437 (2014).

211 Ali Altaee et al., *Evaluation of FO-RO and PRO-RO designs for power generation and seawater desalination using impaired water feeds* In Press, Corrected Proof DESALINATION 1-2

The company Oasys has recently made huge strides in the area of forward osmosis.[212] FO can desalinate wastewater that is up to five times as saline as seawater.[213] This system is commercially available, and it is already being used by hydraulic fracturing companies to treat water from exhausted shale gas wells.[214] It is actually less expensive for companies to use this method than to ship the water to be stored.[215]

FO uses natural osmotic pressure to desalinate water in a two-step process.[216] FO uses a concentrated brine solution containing high concentrations of carbon dioxide and ammonia to draw the water through the membrane, thereby eliminating the need for hydraulic pressure.[217] After being drawn through, the water is heated to remove the draw solution.[218] This method is more efficient than traditional thermal desalination because the process does not actually involve boiling the water.[219] Instead, low-temperature heat changes the state of the draw solution from liquid to vapor since the draw solution will evaporate at a lower temperature than water.[220] The draw solution is then recovered and used again.[221] FO has not been implemented on the same scale as an SWRO facility, so the fiscal cost of large scale FO facilities is still unknown, but the process uses considerably less energy, requires no chemical cleaning and has a higher recovery rate.[222] This means it would have fewer indirect emissions and require less feed water, resulting in less environmental harm.

PRO is similar to FO in that it uses osmotic pressure created by a draw solution to desalinate water, but PRO can use the concentrated brine from the SWRO process as its draw solution.[223] This fact makes it ideal for combining with traditional SWRO. Researchers at Humboldt State University and the University of Southern California have received a grant from the California Department of Water Resources to begin developing a portable, prototype desalination system in Samoa, California that combines PRO with traditional RO.[224] This system, called "RO-PRO," can mitigate the harm associated with

(2014).

212 Westerling, *supra* note 24.

213 *Id.*

214 *Id.*

215 *Id.*

216 Bullis, *supra* note 29.

217 *Id.*

218 Westerling, *supra* note 24.

219 *Id.*

220 *Id.*

221 *Id.*

222 Bullis, *supra* note 29; *but see* Alissa Malinson, *Study shows forward osmosis desalination not energy efficient*, PHYS.ORG (July 24, 2014), http://phys.org/news/2014-07-osmosis-desalination-energy-efficient.html#inlRlv.

223 Achilli et al., *supra* note 210, at 6438.

224 HUMBOLDT STATE UNIV., *New Desalination Technology Could Answer State Drought*

brine discharge and reduce energy requirements, especially for plants that are already equipped with an energy reduction device.[225]

RO-PRO uses two sources of feedwater: seawater and an impaired, lower salinity water source, such as wastewater.[226] The seawater is pressurized using a hydraulic pump before entering the RO system for desalination.[227] After leaving the RO system, the freshwater stream continues on to be processed for distribution, but the brine stream remains within the system and moves to the PRO subsystem.[228] The brine must be depressurized by about half for the PRO process, but the energy from depressurization can be recovered through an energy recovery device or a turbine and generator, lowering energy requirements.[229] The brine stream is then used as a draw solution to pull freshwater from the impaired water source, resulting in a brine stream that has the same salinity as seawater.[230] The energy, or pressure, stored in the solution is exchanged with the RO seawater feed to increase the amount of pressure in the feed prior to reaching the hydraulic pump, so the pump uses less energy. Finally, the diluted brine is discharged back into the ocean without the risk of harm to marine life from hyper-saline conditions.[231] Waiting for these technologies to reach large-scale viability before embarking on a mass-building plan of SWRO plants will allow more efficient desalination technologies to predominate in California.

IV. CONCLUSION

Seawater desalination is, and should be, a part of California's water supply portfolio, but it should not be the first option. California should maximize use of its existing water supply before investing in SWRO. The state must modernize its infrastructure, develop a cohesive plan and conservation measures for addressing drought conditions, and continually encourage conservation and responsible development. Instituting these measures before investing in large-scale SWRO development will lessen the serious financial risk posed by building unnecessary facilities and will protect coastal resources by preventing construction and operation of unnecessary facilities.

When undertaking SWRO development, responsible state agencies must

Woes, HUMBOLDT STATE NOW (Feb. 12, 2015), http://now.humboldt.edu/news/new-desalination-technology-could-answer-state-drought-woes.

225 *Id.*; Prante et al., *RO-PRO desalination: An integrated low-energy approach to seawater desalination*, 120 APPL. ENERGY 104, 105 (2014).

226 Prante et al., *supra* note 225, at 105.

227 *Id.*

228 *Id.*

229 *Id.*

230 *Id.*

231 *Id.*

create regulations that minimize the possible growth inducing and cumulative effects of multiple large-scale desalination plants and should consider how the environment may change in the near future as a result of drought and climate change. Before being granted a permit, owners or operators of potential plants must demonstrate that an area has maximized its existing water supply and that a significant need exists for desalinated water. Development should utilize the most current and efficient technology to reduce environmental impacts.

Seawater desalination is not inherently good or bad. Whether California benefits from it or is harmed by it depends on whether the state chooses to proceed cautiously and consider all sides of the issue or, instead, continue down a path that will fail to use its water resources efficiently.