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Direct potable reuse in California: the last frontier in water reuse

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Direct potable reuse (DPR) in California: the last frontier in water reuse

California's latest DPR regulations are transforming the landscape of how water and wastewater agencies will provide services to the citizens of California and will lead the way globally. TAG Expert Wade Miller analyses the latest developments in this last frontier for water reuse.

Key takeaways

- California's new DPR regulations will provoke a paradigm shift, transforming the landscape of how water and wastewater agencies will provide services to the citizens of California.

- In terms of opportunities, all the major consulting engineering firms as well as prominent medium and smaller firms are currently extremely busy, working on many of the projects discussed in this article, from San Diego to Sacramento and San Francisco. Billions of dollars will be expended on engineering services over the next decade.

- Equipment suppliers also have much to look forward to. Most knowledgeable observers believe that approximately **35% of total project expenditures will be spent on process equipment, appurtenances, and conveyances.** In 2019, Dr. Shane Trussell, CEO of Trussell Technologies, stated from the podium at the WateReuse Symposium, that "the water reuse market in California alone could be as large as "$30 billion over the next 20 years." That

may turn out to be a modest number. A more realistic "guesstimate," based on the huge projects underway, may be **$20 billion over the next 10 years.**

- The process equipment component, in addition to the equipment employed in indirect potable reuse (IP) such as microfiltration (MF), reverse osmosis (RO), ultraviolet with advanced oxidation processes (UV-AOP), now includes ozone and granular activated carbon. The bottom line and overarching conclusion: the California reuse market is going to be a strong, robust, and attractive one for the next decade at a minimum.

- The new regulations re-affirm California's position as a global leader in advanced reuse and will be closely watched by governments and utilities worldwide. As has happened in previous waves of regulation, the State's framework is highly likely to be emulated to varying degrees and lead to market-creating legislation in other countries during the next 5 years, as local authorities reach for solutions to water supply management challenges that are becoming increasingly intractable. BlueTech will be tracking these developments closely as part of our Market-Creating Regulations and Policy Tracker.

Introduction

California's new direct potable reuse (DPR) regulations went into effect on October 1. This event represents a culmination of more than a dozen years of effort by interested water/wastewater utilities, non-profit organizations such as WateReuse California and the WateReuse Research Foundation (now part of the Water Research Foundation), legislative initiatives resulting in enabling legislation, two expert panels which studied the complex public health issues involved, state regulators at the State Water Resources Control Board (Water Board), and many others.

The development and promulgation of these landmark regulations should be viewed in the context of the history of water reuse in California, which date back to 1962 and the Montebello Forebay Groundwater Recharge Project in Los Angeles. At the recently convened WateReuse California annual conference, Brian Bernados, a retired Water Board regulator, provided that context, as follows:

- Since the 1960s, the Division of Drinking Water (DDW) has reviewed proposals on a case-by-case basis.
- In 2010 the CA Water Code was revised via SB 918 and DDW is given deadlines.
- In 2013 uniform water recycling criteria for groundwater recharge were issued.
- In 2016 the Expert Panel report on the feasibility of DPR was issued.
- In 2017 uniform criteria for surface water augmentation became law.
- In 2018 DDW prepared and issued a Framework for DPR.
- Substantial Research was subsequently conducted on pathogen and chemical control issues.
- In 2020 a second Expert Panel was formed to review DPR.
- In 2021 an enhanced source control report was issued by a separate Expert Panel.

- In 2022 a draft was made public and DDW worked with WateReuse California on the final version.
- In 2023 the second Expert Panel finds DPR regs are protective of public health; and
- In 2023 the Water Board voted to adopt uniform DPR criteria.

This list of actions and initiatives serves to illustrate the breadth, depth, and complexity of how the DPR regulations came to be.

Figure 1 provides even a broader context, showing California's three-phased approach to water recycling, progressing from non-potable reuse in the 1960s to indirect potable reuse (IPR) beginning in circa 1995 at the West Basin Municipal Water District, and now direct potable reuse (DPR) in 2024.

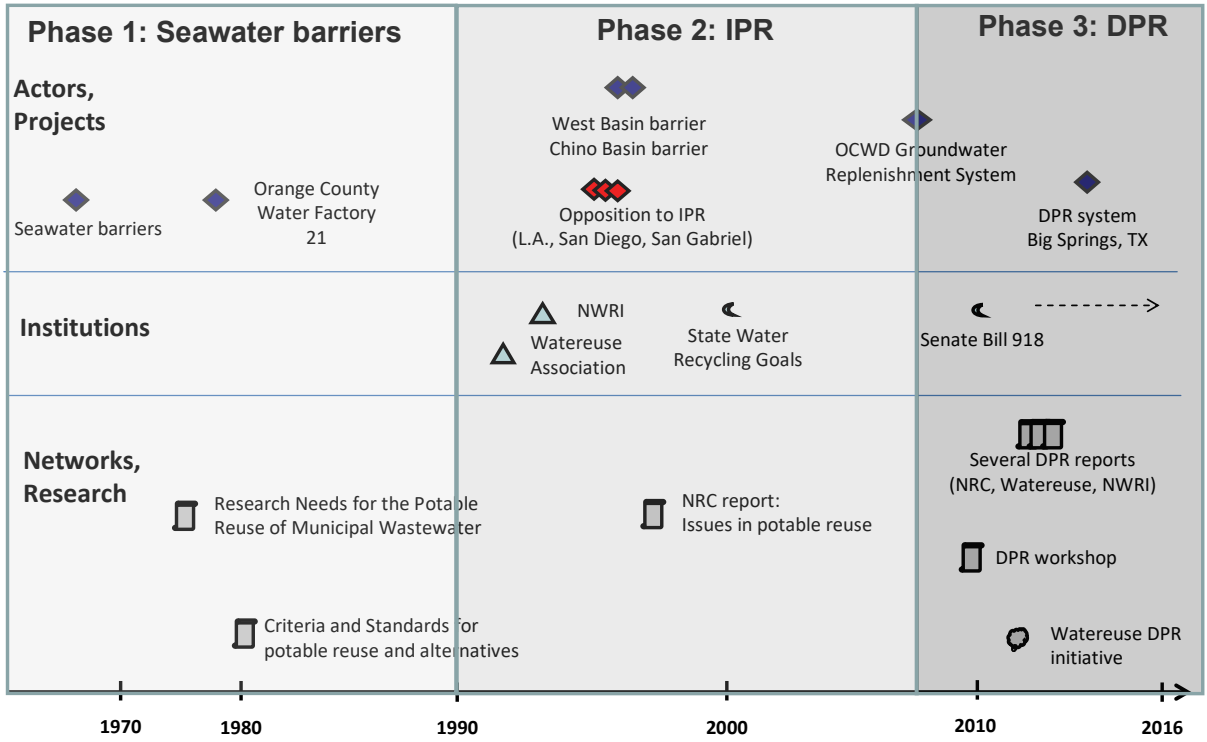


Figure 1: History of potable water reuse in California. *Source: Christian Bain*

Key elements of the new DPR regulations

The DPR regulations include several new and rigorous requirements to ensure public health protection. First are more stringent log removal values (LRVs). Under the IPR regulations, LRVs were 12-10-10 (virus-Giardia-Cryptosporidium). With IPR, there is an environmental buffer. With DPR, there may or may not be an environmental buffer, depending on the detention time to whatever body of water or storage facility the treated water is transmitted. Ideally, this would be a surface water reservoir as is the plan for Pure Water San Diego or a groundwater aquifer, which is currently the case

for the Orange County Water District and the Water Replenishment District in Los Angeles County.

The LRVs for DPR have been established at substantially more stringent levels of 20 (virus)-14 (*Giardia lamblia*)- and 15 (*Cryptosporidium* oocysts). To achieve these LRV targets, the Water Board has included new requirements for treatment technologies, as described in the regulations:

Municipal wastewater used in a DPR project shall receive continuous treatment pursuant to this section prior to entering a water distribution system of a public water system.

(a) A treatment train shall consist of no less than three separate treatment processes, using no less than three diverse treatment mechanisms, for chemical reduction. The treatment train shall include the following treatment processes:

(1) An ozonation process immediately followed by biologically activated carbon (ozone/BAC), unless exempted pursuant to subsection (c), that meets the criteria set forth in this section.

(2) A reverse osmosis membrane process that meets the criteria set forth in this section; and

(3) An advanced oxidation process that meets the criteria set forth in this section.

The DPR regulations build on the already robust IPR treatment train by including two new additional barriers: ozone and biologically activated carbon (O3/BAC). These pre-treatment processes must occur before the reserve osmosis step of the purification process unless it can be demonstrated to the Water Board and an Independent Advisory Expert Panel that an alternative purification step is as protective of public health as O3/BAC.

The new regulations also allow for use of alternative treatment trains, provided their efficacy can be demonstrated. According to the regulations, *"an alternative mechanism to a treatment mechanism identified in subsection (3) may be approved as long as the three treatment train mechanisms include physical separation and inactivation. Use of the alternative shall assure an equivalent or better level of protection of public health with respect to treatment technique diversity and treatment train robustness.*"

Some water agencies are reportedly considering membrane bioreactors (MBRs) as a substitute technology for microfiltration (MF) ahead of the RO membranes.

In addition to these two key provisions, the DPR regulations contain several other critical provisions, all designed to ensure public health protection.

Technical, managerial, and financial capacity

The DPR regulations require the identification of a Direct Potable Reuse Responsible Agency (DiPRRA) which is ultimately responsible for compliance with the regulations.

The DiPRRA must be a public water system, but a DPR project may include other Partner Agencies, including a wastewater utility which would be supplying the "raw material" to be treated for recycling. A DiPRRA must be able to demonstrate that it and all partner agencies possess technical, managerial, and financial capacity sufficient to comply with a joint plan.

The demonstration shall include the following: 1) Identification of those project elements in an engineering report that have associated ongoing costs. Ongoing costs shall include operation and maintenance costs, capital replacement costs, energy costs, personnel costs, and all 20-year life cycle costs of equipment; 2) Identification of reliable and continuing funding sources to cover costs; 3) A description of the available financial, physical, and personnel resources to be made available when and where needed; and 4) A description of tools and processes used for management and accounting, including a strategic asset management plan and a computerized maintenance management system.

Operator certification

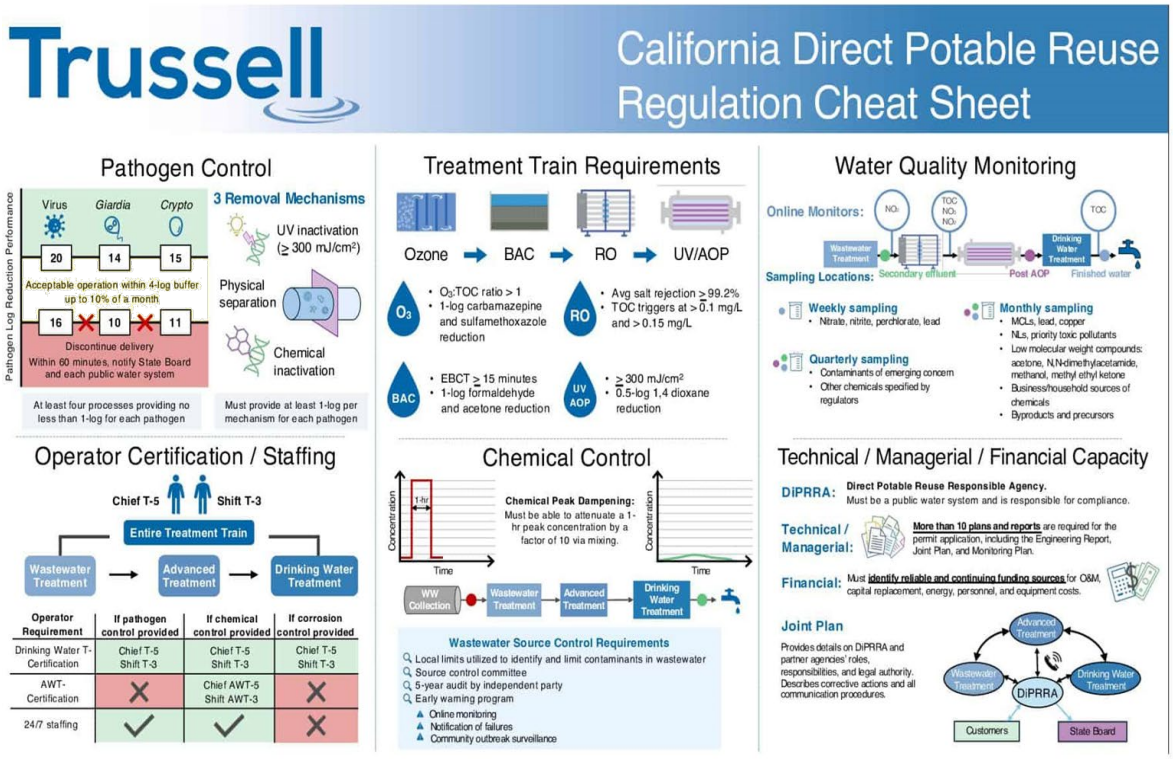
Per the regulations, a DiPRRA shall designate at least one chief operator who holds a valid grade T5 water treatment operator certification to oversee the operations of the entire treatment train used to comply with the requirements of the regulations. The DiPRRA shall designate at least one shift operator who holds at least a valid grade T3 water treatment operator certification to oversee the operations for each operating shift. A DiPRRA shall require that the chief operator(s) for each water treatment plant that provides treatment each holds a valid Advanced Water Treatment Operator grade AWT5TM certificate. A designated chief operator or shift operator shall be on-site at all times when a water treatment plant that provides DPR treatment is operating.

Enhanced source control

The DPR regulations include the development of a robust source control program that expands beyond the requirements for IPR. The new requirements include the establishment of a monitoring program to provide early warning of potential issues, establishment of a source control committee, establishment of a community outbreak surveillance program, and an expansion of the local limits program to identify and limit contaminants in wastewater. (Source: WateReuse California).

The regulations contain many other provisions, including requirements for a rigorous monitoring program with analyses provided by certified laboratories, preparation and submittal of plans for complying with validation protocols, public notification, and others.

Trussell Technologies has endeavoured to capture the entire DPR process in one flow diagram. This illustrative and valuable flow diagram is shown as Figure 2. Trussell Tech calls the flow diagram *California Direct Potable Reuse Regulation Cheat Sheet.*



. **Figure 2: California DPR regulations cheat sheet.** *Source: Trussel Technologies*

Agencies that are considering DPR

At least 17 different utilities are engaged in a) actual design and construction (City of San Diego), b) nine water/wastewater agencies are engaged in either pilot or demonstration projects, and c) eight agencies have full scale advanced water purification facilities (AWPFs) which could presumably be converted to DPR facilities. Following is a brief summary of some of the largest projects that are underway.

Pure Water Southern California (PWSC)

Metropolitan Water District is partnering with the Los Angeles County Sanitation Districts on Pure Water Southern California, a regional water recycling program that would purify and reuse cleaned wastewater that currently flows into the ocean. At full scale, Pure Water Southern California would produce 150 million gallons of purified water each day. (Source: MWD website)

Los Angeles Department of Water and Power (LADWP)

Pure Water Los Angeles is a new water supply initiative being developed by LADWP in partnership with LA Sanitation and Environment that aims to increase the overall water supply resiliency and reliability for Los Angeles. Through the program, LASAN will upgrade the existing secondary treatment process at the Hyperion Water Reclamation Plant to include membrane bioreactor technology. Secondary effluent from Hyperion will then undergo more treatment at a future Advanced Water Purification Facility as part of the Pure Water Los Angeles program. (Source: LADWP website)

Santa Clara Valley Water District (Valley Water)

Valley Water must meet future water demand and identify a sustainable water supply to combat the effects of future droughts and climate change. A Potable Reuse Project will help reach those water supply goals, which include meeting at least 10% percent of water demand in Santa Clara County through recycled and purified water. This project is envisioned to be a Direct Potable Reuse project located in San José and will allow Valley Water to develop the use of purified water to supplement existing drinking water sources in a manner that minimizes environmental impacts and protects public health. (Source: Valley Water website)

City of San Diego (Pure Water San Diego)

This project is under construction, having been initiated years ago and permitted in 2020. The final treatment train includes ozone and BAC in addition to microfiltration, RO, and UV-AOP. Hence, it can be operated as either an IPR or DPR facility, depending on achievement of the new stringent LRVs, detention time in the reservoir (60 days detention time is the demarcation line between IPR and DPR), and achievement of dilution requirements (i.e., at least 10:1).

Several other agencies which are developing or considering DPR projects include Monterey One Water, the City of Santa Monica, San Francisco Public Utilities Commission, East Bay Municipal Utility District, Central Costa Contra Sanitary District, and Moulton Niguel Water District. (Source: Roadmap for Direct Potable Reuse: Considerations for Implementing DPR through the Pure Water Southern California Program).

Benefits and challenges of implementation

The most obvious benefit to DPR is the significant enhancement of water supplies for Southern California. Long dependent on the State Water Project which transports water from northern California and the Colorado River, with IPR and DPR, the potential for DPR will relieve the dependency, to a certain degree, on these traditional sources. Consider the following anecdotal fact: Several notable experts have stated that as much as one billion gallons per day (1 bgd) are discharged into the Pacific Ocean between Santa Monica on the north and San Diego on the south. Imagine capturing the majority of these discharges for beneficial use via recycling. DPR will greatly facilitate the translation of this dream into reality.

Many obstacles and challenges must be addressed, however, in order to realize the benefits of DPR. The list is long, but includes the following:

1) The new regulations require validation protocols to determine how to achieve the new and rigorous log removal values (LRVs) consistently across agencies in a manner that will be protective of public health. A movement called CalVal, short for California Validation, has been formed to develop a validation template. Bob Hultquist, a long-time regulator at DDW, stated the following in a presentation at the recently convened WRCA conference: "The validation template is a rigorous, rational, science-based approach to validate pathogen treatment technologies for use in implementing risk-

based reuse criteria. It focuses on the treatment efficacy and is independent of the exposure route or risk objective, so it is appropriate for any type of reuse."

2) The new regulations are also going to require substantial additional research, given the additional requirements for treatment coupled with the requirement to achieve new log removal values (LRVs) of 20 (virus)-14(*Giardia lamblia*)-15*(Cryptosporidium* oocysts). A nascent research program is being initiated whose overarching objective is to collectively address challenging issues included in the DPR regulations and various items associated with the practical implementation of DPR. Leveraging pilot/demonstration facilities and operational plants available at participating utilities will assist with testing and the collection of data to address the issues. Knowledge transfer of data collected, and recommendations developed, will be a key objective of this work.

Other challenges, as documented in the Pure Water Southern California white paper, include the following:

3) Extensive treatment process evaluations needed to demonstrate regulatory compliance.

4) Public acceptance requires ongoing proactive and intentional outreach and education.

5) Highly integrated, automated response systems needed for real time monitoring and control, especially for diverting water when acute risks are detected.

6) Higher levels of operator certification (including Advanced Water Treatment certification) required at all treatment facilities.

7) Proactive operational responses needed for influent water quality changes (e.g., illicit chemical discharges and spikes).

8) Level of treatment needed may exceed regulatory requirements to maintain existing treated water distribution system quality.

Other implementation challenges include time requirements from the time of initial conception and planning to the time the facility becomes operational. Water agency officials interviewed estimate that the total time required could be as much as 10 years.

The costs of these major projects (e.g. Pure Water San Diego, Pure Water Southern California, Pure Water Los Angeles, Valley Water, etc.) will be billions of dollars. Hence, the agencies must be able to develop the financial resources necessary for implementation.

Finally, permitting will be a challenge, starting with validation protocols and demonstrating that the Direct Potable Reuse Responsible Agency (DiPRRA) has the technical, management, financial, and operational capacity to effectively implement the complex and difficult to achieve requirements for DPR facilities.

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