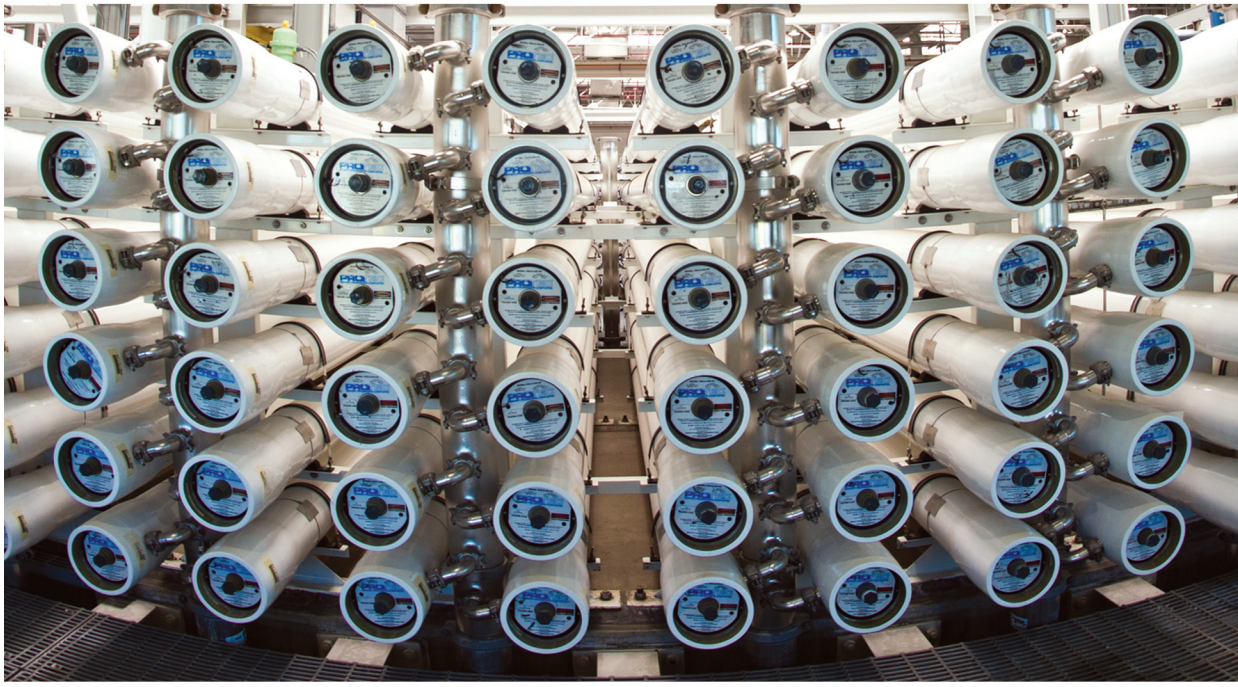
FINAL REPORT



Recommendations of the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse

California State Water Resources Control Board

CALIFORNIA Water Boards

Recommendations of the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse

Convened by the State Water Resources Control Board

Final Report

Prepared by:

Advisory Group on the Feasibility of Developing
Uniform Water Recycling Criteria for Direct Potable Reuse

Under Agreement No. 13-21041
with the California State Water Resources Control Board
Division of Drinking Water

Prepared for:

State Water Resources Control Board
Division of Drinking Water
Sacramento, California, USA

Submitted by:

National Water Research Institute
Fountain Valley, California USA
www.nwri-usa.org/ca-panel.htm

June 2016

DISCLAIMER

This report was prepared by the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse, which is administered by the National Water Research Institute (NWRI) and sponsored by the California State Water Resources Control Board (State Water Board). Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Advisory Group. NWRI and the State Water Board assume no responsibility for the content of this publication or for the opinions or statements of facts expressed herein. The mention of trade names of commercial products does not represent or imply the approval or endorsement of NWRI or the State Water Board. This report was published solely for informational purposes.

ABOUT THE ADVISORY GROUP

The California State Water Resources Control Board's (State Water Board) Division of Drinking Water (DDW) convened the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse in accordance with California Water Code Sections 13560-13569. The purpose of the Advisory Group was to advise the State Water Board and the Expert Panel on the feasibility of developing criteria for direct potable reuse (DPR) in the State of California. The Advisory Group was made up of representatives from various stakeholder interest groups, including water and wastewater agencies, environmental nonprofits, public health officials, business community, taxpayer advocate organizations, government agencies, and other organizations in California.

ABOUT NWRI

Meetings of the Advisory Group were organized and facilitated by the National Water Research Institute (NWRI), a 501c3 nonprofit organization founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI also provided editorial support to prepare and finalize this report.

For more information, please contact:

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Jeffrey J. Mosher, Executive Director
Gina Melin Vartanian, Editor
Suzanne Faubl, Project Manager

June 30, 2016

Mark Bartson, P.E.
Supervising Sanitary Engineer
California State Water Resources Control Board
Division of Drinking Water
1001 I Street
Sacramento, CA 95814

Dear Mr. Bartson:

On behalf of the Advisory Group on the Feasibility of Developing Criteria for Direct Potable Reuse (DPR), we are pleased to submit to the State Water Resources Control Board (State Water Board) the report entitled **Recommendations of the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse**. This report addresses the requirement that the Advisory Group provide advice regarding the development of direct potable reuse [California Water Code 13565(b)(1)] and input for the development of the draft DPR feasibility report by the State Water Board for the California State Legislature [California Water Code 13563(a)(1)]. In performing its investigation of the feasibility of developing uniform water recycling criteria for DPR, the State Water Board must consider recommendations from both the DPR Expert Panel and DPR Advisory Group [California Water Code 13566(b)].

The Advisory Group believes that DPR, when implemented appropriately, has the potential to provide a reliable source of water supply that is protective of public health for communities in California. Uniform water recycling criteria for DPR that is protective of public health and the environment should be a priority of the State Water Board.

This report presents a consensus of the Advisory Group members, which represent a diversity of viewpoints from various stakeholder interest groups, including water and wastewater agencies, environmental nonprofits, public health officials, business community, taxpayer advocate organizations, government agencies, and other organizations in California.

The main purpose of this report is to provide recommendations to the State Water Board specifically on the feasibility of developing regulatory criteria for DPR; however, the Advisory Group also included input on topics identified by stakeholders as important to the discussion of DPR, but not related directly to the feasibility of developing regulations. These recommendations cover a range of topics related to DPR, and many can be implemented by the State or local agencies. They were developed based on the experience and interests of the Advisory Group members.

The information in this report represents a culmination of 11 meetings of the Advisory Group that occurred over a 28-month timeframe. As required by the California Water Code and to ensure public transparency, the Advisory Group was subject to the Bagley-Keene Open Meeting Act (Article 9, commencing with Section 11120 of Chapter 1 of Part 1 of Division 3 of Title 2 of the Government Code). As a result, the process included public input during each of the Advisory Group meetings. This period of engagement was essential for the Advisory Group to fully explore the issues at hand and reach consensus on the recommendations provided in this report.

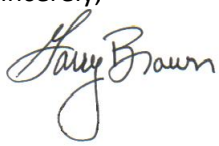
The Advisory Group hopes that the State Water Board will consider the information in this report when preparing its DPR feasibility report for the California State Legislature.

The Advisory Group members also thank the State Water Board for the opportunity to represent their stakeholder groups and for the State Water Board's support of the process. We also appreciate the State Water Board's investment of time, information, and resources towards this effort, which allowed Advisory Group members to participate at meetings and develop this report. The support provided by the State Water Board was critical to the success of the Advisory Group.

In addition, the Advisory Group appreciated the involvement of the DPR Expert Panel in the Advisory Group meetings, and found that interacting with the Panel Co-Chairs at the meetings was helpful in our deliberations on technical and policy issues related to DPR projects.

On behalf of the Advisory Group, I once again express our support and continued interest in implementing DPR projects in California that are protective of public health and the environment and cost-effective for ratepayers. We appreciate the opportunity to transmit our recommendations via this report to the State Water Board.

Sincerely,



Garry Brown
Chair, Advisory Group on the Feasibility of Developing Criteria for Direct Potable Reuse
President and CEO, Orange County Coastkeeper

On behalf of the Advisory Group:

Randy Barnard, P.E., California State Water Resources Control Board
Amy Dorman, P.E., City of San Diego
Conner Everts, Environmental Justice Coalition for Water
Jim Fiedler, P.E., Santa Clara Valley Water District
Julie L. Labonte, P.E., San Diego Regional Chamber of Commerce
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Bruce Macler, Ph.D., U.S. Environmental Protection Agency
Traci Minamide, P.E., BCEE, City of Los Angeles, LA Sanitation
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Frances Spivy-Weber, California State Water Resources Control Board
Ray Tremblay, P.E., BCEE, County Sanitation Districts of Los Angeles County
Andria Ventura, Clean Water Action
Michael Wehner, Orange County Water District

cc: Jeff Mosher, National Water Research Institute
Adam Olivieri, Dr.P.H., P.E., Co-Chair, State Water Board Expert Panel on DPR
James Crook, Ph.D., P.E., Co-Chair, State Water Board Expert Panel on DPR

ACKNOWLEDGMENTS

This report is the product of an advisory group administered by the National Water Research Institute, a 501c3 nonprofit organization based in Southern California. The Advisory Group on the Feasibility of Developing Criteria for Direct Potable Reuse is a requirement of the California Water Code (Sections 13560-13569).

The following members of the Advisory Group attended meetings held from 2014 to 2016 and contributed to the final recommendations provided in this report:

- Chair: Garry Brown, Orange County Coastkeeper
- Randy Barnard, P.E., California State Water Resources Control Board
- Amy Dorman, P.E., City of San Diego *(joined May 2015)*
- Conner Everts, Environmental Justice Coalition for Water
- Jim Fiedler, P.E., Santa Clara Valley Water District
- Julie L. Labonte, P.E., San Diego Regional Chamber of Commerce
- Albert C. Lau, P.E., Padre Dam Municipal Water District
- Bruce Macler, Ph.D., U.S. Environmental Protection Agency
- Traci Minamide, P.E., BCEE, City of Los Angeles, LA Sanitation
- Edward Moreno, M.D., MPH, California Conference of Local Health Officers *(joined Jan. 2016)*
- Keith Solar, Esq., San Diego County Taxpayers Association
- Frances Spivy-Weber, California State Water Resources Control Board
- Ray Tremblay, P.E., BCEE, County Sanitation Districts of Los Angeles County
- Andria Ventura, Clean Water Action
- Mike Wehner, Orange County Water District

The following individuals also served on the Advisory Group when it was initially formed, but left due to changes in their employment:

- Alisa Reinhardt, San Diego Regional Chamber of Commerce (replaced by Julie Labonte)
- Marsi Steirer, City of San Diego (replaced by Amy Dorman)

The Advisory Group is pleased to acknowledge the organizations and individuals whose support, assistance, and resources made this report possible.

State Water Resources Control Board

The Advisory Group was formed at the request of the Drinking Water Program of the California

Department of Public Health (CDPH) in 2013. The Drinking Water Program was officially transferred from CDPH to the State Water Resources Control Board (State Water Board) and renamed as the Division of Drinking Water (DDW) on July 1, 2014. Financial support for the Advisory Group was provided by the State Water Board through Agreement No. 13-21041.

The Advisory Group would like to thank the following State staff for their participation, insight, and assistance:

- Randy Barnard, P.E., State Water Resources Control Board, Division of Drinking Water
- Mark Bartson, P.E., State Water Resources Control Board, Division of Drinking Water
- Brian Bernados, P.E., State Water Resources Control Board, Division of Drinking Water
- Annette Caraway, State Water Resources Control Board, Division of Financial Assistance
- Jing-Tying Chao, P.E., State Water Resources Control Board, Division of Drinking Water
- Cindy Forbes, P.E., State Water Resources Control Board, Division of Drinking Water
- Robert Hultquist, P.E., State Water Resources Control Board, Division of Drinking Water
- Karen Larsen, State Water Resources Control Board, Division of Water Quality
- Michael McKibben, P.E., State Water Resources Control Board, Division of Drinking Water
- Richard Mills, California Department of Water Resources
- Sherly Rosilela, P.E., State Water Resources Control Board, Division of Drinking Water
- Kurt Souza, P.E., State Water Resources Control Board, Division of Drinking Water
- David Spath, Ph.D., P.E., State Water Resources Control Board, Division of Drinking Water
- Christopher Stevens, State Water Resources Control Board, Division of Financial Assistance
- Erica Wolski, P.E., State Water Resources Control Board, Division of Drinking Water

The Advisory Group also thanks the following organizations for providing meeting space and support during this process:

- City of San Diego Public Utilities Department
- Municipal Water District of Orange County
- Orange County Water District
- Padre Dam Municipal Water District
- San Francisco Estuary Institute
- Santa Clara Valley Water District
- State Water Resources Control Board

Advisory Group Administrators

The Advisory Group also appreciates the outstanding services of staff at NWRI, who administered the Advisory Group process, organized and attended 11 Advisory Group meetings, and helped facilitate, organize, and edit this Advisory Group report. The Panel thanks:

- Jeff Mosher (Advisory Group facilitation)
- Brandi Caskey (Administrative support)
- Suzanne Faubl (Advisory Group support and report preparation)
- Jaime Lumia (Administrative support)
- Gina Vartanian (Report editing)

In particular, the Advisory Group recognizes the leadership of Jeff Mosher for overseeing this process and facilitating the meetings.

DPR Expert Panel

The Advisory Group would also like to recognize the State Water Board's Expert Panel on Evaluating the Feasibility of Direct Potable Reuse for its insight, input, and commitment to undertaking this tremendous effort. The Expert Panel members include:

- *Panel Co-Chair:* Adam Olivieri, Dr.P.H., P.E., EOA, Inc. (Oakland, CA)
- *Panel Co-Chair:* James Crook, Ph.D., P.E., Environmental Engineering Consultant (Boston, MA)
- Michael Anderson, Ph.D., University of California, Riverside (Riverside, CA)
- Richard Bull, Ph.D., MoBull Consulting (Richland, WA)
- Jörg E. Drewes, Ph.D., Technical University of Munich (Munich, Germany)
- Charles Haas, Ph.D., Drexel University (Philadelphia, PA)
- Walter Jakubowski, M.S., WaltJay Consulting (Spokane, WA)
- Perry McCarty, Sc.D., Stanford University (Stanford, CA)
- Kara Nelson, Ph.D., University of California, Berkeley (Berkeley, CA)
- Joan B. Rose, Ph.D., Michigan State University (East Lansing, MI)
- David Sedlak, Ph.D., University of California, Berkeley (Berkeley, CA)
- Tim Wade, Ph.D., United States Environmental Protection Agency (Durham, NC)

WateReuse DPR Research Initiative

Finally, the Advisory Group acknowledges the significant time, effort, and investment provided by the WateReuse Research Foundation (now the Water Environment & Reuse Foundation) and WateReuse California, which together launched the California DPR Initiative in June 2012 to assist DDW in its state-

mandated task to determine the feasibility of developing regulatory criteria for DPR. These organizations invested in a DPR research portfolio that included more than 30 projects to investigate various aspects of the feasibility of DPR implementation, such as the reliability of treatment trains, microbial and chemical water quality, water quality and process monitoring, and facility operations.

CONTENTS

ACRONYMS

ATW	advanced treated water
AWTF	advanced water treatment facility
AWWA	American Water Works Association
CASA	California Association of Sanitation Agencies
CCR	consumer confidence report
CEQA	California Environmental Quality Act
CDPH	California Department of Public Health (now DDW)
CEC	constituent of emerging concern
CFR	Code of Federal Regulations
COC	constituent of concern
COS	cost of service
CUWA	California Urban Water Agencies
CWC	California Water Code
CWEA	California Water Environment Association
DDW	Division of Drinking Water (California State Water Resources Control Board)
DPR	direct potable reuse
DWTF	drinking water treatment facility (surface water treatment plant)
GRRP	groundwater replenishment reuse project
MCL	maximum contaminant level
NRC	National Research Council
NSF	National Science Foundation
NWRI	National Water Research Institute
PR	potable reuse
QA/QC	quality assurance/quality control
RO	reverse osmosis
SDWA	Safe Drinking Water Act
SRT	solids retention time
SWA	surface water augmentation
SWRCB	State Water Resources Control Board (California)
TBL	triple bottom line
TMF	technical/managerial/financial

US EPA	United States Environmental Protection Agency
WE&RF	Water Environment & Reuse Foundation
WRCA	WateReuse California
WRF	Water Research Foundation
WRR	water recycling requirements
WRP	water reclamation plant
WWTP	wastewater treatment plant

CHAPTER 1: INTRODUCTION

1.1 Overview of Direct Potable Reuse

To ensure the public has safe, sustainable water supplies now and in the future, water utilities throughout the United States are considering direct potable reuse (DPR) as one strategy to meet the needs of their communities. DPR involves using advanced treatment technologies (such as membrane filtration and ultraviolet disinfection) to remove or destroy viruses, bacteria, chemicals, and other constituents of concern (COCs) as part of the process of converting wastewater into a clean, safe source of municipal drinking water.

Two forms of planned DPR exist:

- In the first form, advanced treated water (ATW) produced at an advanced water treatment facility (AWTF) is introduced into the raw water supply immediately upstream of a drinking water treatment facility (DWTF). To date, the few permitted and operational DPR projects in the United States use this form of DPR.

- In the second form, finished water is produced at an AWTF that also is permitted as a DWTF. This water is introduced directly into the drinking water supply distribution system. At present, projects using this configuration for DPR are in the development stage and have yet to be permitted and operated in the United States.

The first operational DPR project in the U.S. went online in Texas in 2014; at the same time, water utilities in other states—in particular, the arid southwest—have begun moving forward in planning and implementing similar projects. The challenge at present is that state guidance and regulations do not exist for DPR, and current treatment technologies and monitoring strategies are being evaluated to determine their use for DPR.

1.2 Interest in Direct Potable Reuse in California

A number of water agencies in California have begun evaluating the possibility of implementing DPR projects to develop new water supplies that are local, reliable, and drought-resistant. There are a several drivers for the growing interest in DPR in California, among them:

- **The State's support of recycled water as a means to augment water supplies**. For the last decade, the State of California has been a leader in encouraging the increased use of recycled water from municipal wastewater sources[1] to "move aggressively towards a sustainable water future."[2] In particular, in February 2009, the State unanimously adopted, as Resolution No. 2009-0011, an updated water recycling policy with the goal of increasing the use of recycled water in the state over 2002 levels by at least 1 million acre-feet per year by 2020 and by at least 2 million acre-feet per year by 2030 (CWC, Section 13560).

[1] www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/ (accessed 5/16/2016).
[2] www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/recycledwaterpolicy_approved.pdf (accessed 5/16/2016).

- **Significant challenges impacting the availability of water resources in California**. California is experiencing a record-breaking drought. Since 2011, limited rainfall has left most of the State abnormally dry and, since 2014, a large part of the State has been classified as exceptionally dry. The Governor declared a drought state of emergency in 2014.[3] Drought creates challenges such as water shortages, mandatory conservation practices, groundwater overdraft, and changes to water allocations (which is particularly important to farmers, as California is considered the largest agricultural producer in the nation).

- **Proven advanced technologies to safely recycle wastewater**. Utilities in California have been recycling wastewater for more than 50 years. The last few decades have seen monumental leaps in innovative research and state-of-the art advanced treatment technologies for potable reuse, resulting in more efficient and effective water recycling processes to protect public health. These advanced technologies are proven. For example, the Orange County Water District in Fountain Valley, California, has been operating the largest indirect potable reuse project in the world since 2008.

1.3 State-Mandated Evaluation of the Feasibility of Developing Criteria for Direct Potable Reuse

As noted in Chapter 7.3 (entitled "Direct and Indirect Potable Reuse") of the California Water Code[4], the State Water Board is required to "establish uniform statewide recycling criteria for each varying type of use of recycled water where the use involves the protection of public health." Furthermore, it is stated in Section 13560(c) that "If direct potable reuse can be demonstrated to be safe and feasible, implementing direct potable reuse would further aid in achieving the state board's recycling goals."

In 2010, the California State Legislature signed into law SB 918, which requires the Division of Drinking Water (DDW) of the California State Water Resources Control Board (State Water Board) to report to the State Legislature by December 31, 2016, on the feasibility of developing statewide regulatory criteria for DPR. Per the California Water Code [Section 13561(b)], DPR is defined as "the planned introduction of recycled water either directly into a public water system, as defined in Section 116275 of the Health and Safety Code, or into a raw water supply immediately upstream of a water treatment plant."

As part of this task, the State Water Board is required to convene an Expert Panel, as follows:

> 13565. (a)(1) On or before February 15, 2014, the department shall convene and administer an expert panel for purposes of advising the department on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation and investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse. The expert panel shall assess what, if any, additional areas of research are needed to be able to establish uniform regulatory criteria for direct potable reuse. The expert panel shall then

[3] http://ca.water.usgs.gov/data/drought/ (accessed 5/16/2016).

[4] Appendix A contains a copy of Chapter 7.3 of the California Water Code, effective January 1, 2014. www.leginfo.ca.gov/cgi-bin/displaycode?section=wat&group=13001-14000&file=13560-13569 (last accessed January 11, 2016).

> recommend an approach for accomplishing any additional needed research regarding uniform criteria for direct potable reuse in a timely manner.

In addition to the Expert Panel, the State Water Board is also required to convene an Advisory Group, as follows:

> 13565 (b)(1) On or before January 15, 2014, the department shall convene an advisory group, task force, or other group, comprised of no fewer than nine representatives of water and wastewater agencies, local public health officers, environmental organizations, environmental justice organizations, public health nongovernmental organizations, the department, the state board, the United States Environmental Protection Agency, ratepayer or taxpayer advocate organizations, and the business community, to advise the expert panel regarding the development of uniform water recycling criteria for direct potable reuse and the draft report required by Section 13563.

The Advisory Group is working with the State Water Board and Expert Panel so that the State Water Board can meet the following State-mandated deadlines, as required in Section 13563 of the CWC:

- On or before June 30, 2016, DDW shall prepare a draft report summarizing the recommendations of the Expert Panel.
- By September 1, 2016, DDW shall complete a public review draft of its report.
- On or before December 31, 2016, DDW is to provide a final report to the Legislature on the feasibility of developing uniform water recycling criteria for DPR.

Please refer to Chapter 7.3 of the CWC (provided in Appendix A of this report) for a description of State Water Board, Expert Panel, and Advisory Group activities pertaining to this effort.

1.4 Direct Potable Reuse Advisory Group Members

Members of the Advisory Group represent various stakeholder interests, including environmental nonprofits, public health officials, taxpayer advocate organizations, water and wastewater agencies, government agencies, and other organizations in California.

The current members of the DPR Advisory Group are:

- *Chair*: Garry Brown, Orange County Coastkeeper
- Randy Barnard, P.E., California State Water Resources Control Board
- Amy Dorman, P.E., City of San Diego
- Conner Everts, Environmental Justice Coalition for Water
- Jim Fiedler, P.E., Santa Clara Valley Water District
- Julie L. Labonte, P.E., San Diego Regional Chamber of Commerce
- Albert C. Lau, P.E., Padre Dam Municipal Water District

- Bruce Macler, Ph.D., U.S. Environmental Protection Agency
- Traci Minamide, P.E., BCEE, City of Los Angeles, LA Sanitation
- Edward Moreno, M.D., MPH, California Conference of Local Health Officers
- Keith Solar, Esq., San Diego County Taxpayers Association
- Francis Spivy-Weber, California State Water Resources Control Board
- Ray Tremblay, P.E., BCEE, Los Angeles County Sanitation Districts
- Andria Ventura, Clean Water Action
- Michael Wehner, Orange County Water District

Brief biographies of current DPR Advisory Group members can be found in Appendix C. More information about the project, including minutes and presentations from all meetings, is available online at www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/RW_DPR_advisorygroup.shtml.

1.5 Report on the Recommendations of the Direct Potable Reuse Advisory Group

To fulfill its State-mandated charge to advise the Expert Panel, the Advisory Group met 11 times between 2014 and 2016. The list of meeting dates and locations is provided in Appendix D of this report. These meetings included direct interaction with members of the Expert Panel (usually one or both of the Panel Co-Chairs). The Advisory Group agreed to document its overall recommendations in this report, to be submitted to the State Water Board concurrently with the Expert Panel's final report, which documents the Expert Panel's assumptions, conclusions, and recommendations regarding the feasibility of developing uniform DPR criteria.

1.6 Organization of the Report

This document is organized in the following chapters:

1. Introduction
2. Recommendations on Topics Directly Related to the Feasibility of Developing Regulatory Criteria for Direct Potable Reuse
3. Recommendations on Topics Not Directly Related to the Feasibility of Developing Regulatory Criteria for Direct Potable Reuse

In **Chapter 2**, the Advisory Group provides recommendations on the following topics:

- Wastewater Source Control and Operation Optimization and Planning Requirements for DPR
- Advanced Water Treatment Operator Training and Certification
- Technical, Managerial, and Financial Capacity
- Monitoring and Outreach Related to Public Health and Safety of DPR
- Changes to the Consumer Confidence Report (CCR)

- Regulatory Approach to Environmental Impacts
- Direct Potable Reuse Research Priorities for California
- Research on Low-Dose Exposure to Chemicals
- Use of Bioassays to Evaluate Constituents of Emerging Concern (CECs) and Unknowns in Recycled Water

The Advisory Group also included input on topics identified by stakeholders as important to the discussion of DPR criteria and project implementation, but not directly related to the feasibility of creating regulations. Input is provided on the following topics in **Chapter 3**:

- Potable Reuse Terminology
- Scientific Quality and Public Availability of Support Documentation
- Communications and Public Outreach
- Phasing of the Potable Reuse Regulations
- Comparison of Direct Potable Reuse and Other Alternatives
- Determining the Feasibility of a Project
- Environmental Justice
- Effects of Direct Potable Reuse on Environmental Flows
- Effects of Direct Potable Reuse Projects on Water Rates

The recommendations cover a range of topics related to the safety and implementation of DPR in California. These recommendations reflect the experience and interests of members of the Advisory Group, and are expected to benefit both (1) the State Water Board as it develops a DPR feasibility report for the California State Legislature and (2) utilities as they consider DPR as a water supply alternative.

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CHAPTER 2: RECOMMENDATIONS ON TOPICS RELATED TO THE FEASIBILITY OF DEVELOPING REGULATORY CRITERIA FOR DIRECT POTABLE REUSE

The main purpose of this report is to provide recommendations to the State Water Board on the feasibility of developing regulatory criteria for DPR projects. Recommendations are provided on the following topics:

- Wastewater Source Control and Operation Optimization and Planning Requirements for DPR
- Advanced Water Treatment Operator Training and Certification
- Technical, Managerial, and Financial Capacity
- Monitoring and Outreach Related to Public Health and Safety of DPR
- Changes to the Consumer Confidence Report (CCR)
- Regulatory Approach to Environmental Impacts
- DPR Research Priorities for California
- Research on Low-Dose Exposure to Chemicals
- Use of Bioassays to Evaluate Constituents of Emerging Concern (CECs) and Unknowns in Recycled Water

2.1 Wastewater Source Control and Operation Optimization and Planning Requirements for Direct Potable Reuse

DPR requires an integrated treatment system from sewershed through the wastewater treatment, AWTF, DWTF, and distribution processes. Wastewater source control and treatment facility design and operation must be optimized for the integrated system to be protective of public health.

2.1.1 Wastewater Recommendations

In future DPR regulations, the State Water Board should include provisions for "Wastewater Source Control" (§60320.106) and "Operation Optimization and Plan" (§60320.222) that are similar to those found in the regulations for Groundwater Replenishment Using Recycled Water for managing chemicals at the source.[5]

Source control programs are used to augment federal pretreatment programs and are designed to control, limit, or eliminate discharge into wastewater of constituents that can be difficult to treat or that may impair the final quality of advanced treated water for potable reuse. Source control is a beneficial, efficient, and cost-effective strategy for managing constituents in a wastewater collection system. It also creates public confidence and opportunities to educate the community and partner with

[5] http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/RecycledWater.shtml

commercial and industrial dischargers to decrease or eliminate the presence of certain chemicals in wastewater.

Regarding the optimization of wastewater treatment, the Advisory Group recommends the following:

> Operations optimization and planning includes additional measures such as biological nitrogen removal, flow equalization, management of return flows from solids processing, and improved source control and pretreatment, which go beyond the usual wastewater treatment. These measures can be applied as needed on a case-by-case basis. It will not be necessary, however, to implement all potential process modifications at every existing WWTP for a DPR project. Each integrated treatment system needs to be reviewed holistically to determine the most feasible approach to ensuring water quality and efficient operations, with the ultimate goal of ensuring public health protection.

2.1.2 Rationale for Wastewater Recommendations

A crucial consideration for DPR projects is the quality of the feed water to the AWTF. The original focus of operating WWTPs or water reclamation plants (WRPs) was to meet requirements for discharge or non-potable reuse. A higher-quality feed water can improve the quality of the final DPR product water and the operations of the AWTF. The WWTP can also provide additional barriers to improve performance and resiliency; therefore, it is important to reconsider the function of the WWTP or WRP when they function as part of an integrated treatment system to produce drinking water. A number of process modifications can be implemented at existing WWTPs or WRPs to improve the quality of the final effluent, including: (1) influent wastewater flow equalization; (2) improved primary treatment; (3) improved secondary treatment performance via increased solids retention times (SRTs); (4) the addition of microbial selectors to achieve nitrification, denitrification, and/or biological phosphorus removal; and (5) alternative management of return flows from solids processing facilities, including flow equalization, treatment, diversion, and/or elimination.

Pretreatment and source control are therefore important tools available to ensure the protection of public health and optimization of an integrated system. The regulations for Groundwater Replenishment Using Recycled Water[6] contain provisions requiring WWTP optimization (§60320.222. Operation Optimization and Plan) and source control (§60320.206. Wastewater Source Control) that provide a framework (and flexibility) to go beyond the federal Clean Water Act and pretreatment program.

2.2 Advanced Water Treatment Facility Operator Certification

A training and certification program is needed for operators employed at advanced water treatment facilities (AWTF) to ensure that potable reuse projects are operated properly to protect public health and to gain public acceptance of DPR. No AWTF operator certification program currently exists. The proposed certification program would apply only to operators of potable reuse projects that include an AWTF.

[6] Title 22, California Code of Regulations, Division 4, Chapter 3 Water Recycling Criteria

2.2.1 Operator Certification Recommendations

The Advisory Group recommends that the program include or accomplish the following for AWTFs for potable reuse:

a) The operator certification program should be applicable to indirect and direct potable reuse projects that use AWTFs. Operators working at recycled water facilities not involved in operation of AWTF or that use tertiary treated water for groundwater spreading would not need to obtain this certification.

b) Certification should be offered as an add-on license available to both water and wastewater operators who are already certified at a specified level (i.e., a minimum of Level III is suggested for drinking water operators and Grade III for wastewater operators).

c) Operators should be required to (1) have work experience in the operation of a drinking water or wastewater facility and (2) complete course work and training on AWT processes before taking the certification exam.

d) The certification program needs to address the "grandfathering" of operators who are currently working at existing AWT facilities. For instance, operators at existing AWT facilities could be required to complete fewer course prerequisites to qualify to take the certification exam.

e) In addition to topics related to the operations of wastewater treatment and advanced water treatment technologies, the certification program should include public health components, emergency response procedures, drinking water regulations, and other water supply issues.

f) Consideration should be given toward requiring continuing education credits as part of maintaining certification for both grandfathered and non-grandfathered operators.

g) Because certification for potable reuse operators is not included currently in the California Water Code, requirements for such certification should be included in the permit issued for each facility.

h) Ideally, the certification program would be administered by the State Water Board; however, because developing the certification program and associated training is a long-term process, it may be beneficial for the State Water Board to partner with trade associations in developing and implementing an interim certification program. It is important for the State Water Board to be involved in the development and implementation of the certification process to establish the public's trust that trained and qualified operators are running the AWTFs; however, the specific role of the State Water Board would need to be defined, including the degree of involvement (i.e., options include providing oversight, formal acceptance/approval, and/or audit authority).

i) Funding and staff resources must be made available to support the role of the State Water Board.

2.2.2 Rationale for Operator Certification Recommendations

The Advisory Group recognizes that the protection of public health is paramount for the successful implementation of DPR projects; therefore, it is imperative that an AWTF be operated by experienced and well-trained staff to ensure that treatment processes function properly, regulatory requirements are met consistently, and the water produced is safe for public consumption. Also, public acceptance and trust are necessary to receive the support needed to use this resource as a drinking water supply. A statewide AWTF operator certification program would help to build and maintain confidence in the quality of water produced at an AWTF.

Regarding the development of an interim certification program: The California Water Environment Association (CWEA) and the American Water Works Association (AWWA) California-Nevada section, which both have experience with operator certification, have formed ad hoc committees to focus on identifying the components of an AWTF operator certification program. In addition, the Water Environment and Reuse Foundation is managing several projects related to operator training for DPR systems.

This position is also reflected in the white paper entitled "Potable Reuse Operator Training and Certification Framework" prepared by the California Urban Water Agencies (CUWA) in conjunction with its partners: WateReuse California (WRCA), CA-NV Section AWWA, California Water Environment Association (CWEA), California Association of Sanitation Agencies (CASA), and the State Water Resources Control Board's Division of Drinking Water (DDW).

2.3 Technical, Managerial, and Financial Capacity

DPR will involve the funding, design, construction, and operation of complex AWTFs, often at agencies that have limited experience operating these types of facilities. Project proponents must have the technical, managerial, and financial (TMF) capacity to ensure successful implementation of projects.

2.3.1 Capacity Recommendations

An assessment of TMF capacity will be needed for utilities to implement a DPR project. DPR regulations should include language similar to §60320.100(f) and §60320.200(f) in Title 22, California Code of Regulations, Division 4, Chapter 3, whereby a project sponsor must demonstrate to DDW that it possesses adequate capacity using an approach similar to the managerial and technical capability requirements in Health and Safety Code §116540. These standards would apply to all DPR projects irrespective of size of the project proponent's agency.

For DPR projects that are pipe-to-pipe (e.g., when ATW is directly introduced into a drinking water distribution system without treatment through a DWTF), the regulations should include all the requirements in Health and Safety Code §116540 (i.e., including financial capability).

2.3.2 Rationale for Capacity Recommendations

The 1996 Safe Drinking Water Act required states to incorporate TMF capacity into public water systems to ensure that they are sustainable and able to comply with all applicable drinking water laws and

regulations (i.e., federal TMF requirements). In response to the federal TMF requirements, California enacted §116540 of the Health and Safety Code.

For the regulation on *Groundwater Replenishment Using Recycled Water*, the State Water Board applied this requirement in part by only requiring a demonstration of technical and managerial capability. This approach would be appropriate for DPR projects that include a DWTF (e.g., recycled water is blended with raw water prior to treatment at a DWTF). For pipe-to-pipe DPR projects, it may be appropriate to require that all the requirements in Health and Safety Code §116540 be met.

Larger systems generally are able to meet their TMF requirements for successful operations. Most attention has been on small systems that may lack adequate TMF. The US EPA and State Water Board provide funding and support for technical assistance to these systems to improve and develop TMF capacity. With respect to potable reuse, additional TMF capacity may be necessary to ensure adequate operations to protect public health. It is not adequate to be merely capable of meeting normal, established drinking water regulations. The additional public health responsibilities associated with the operation of a potable reuse facility may require a higher TMF capacity.

The State Water Board has developed a TMF Assessment Form for public water systems, which is available at:
www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/TMF.shtml#TMF_Assessment.

The State Water Board has already established TMF requirements for groundwater replenishment reuse projects (GRRP). The relevant regulations are found in §60320.100 (surface application) and §60320.200 (subsurface application) of General Requirements: "(f) Prior to operating a GRRP, a project sponsor shall demonstrate to the Department and Regional Board that a project sponsor possesses adequate managerial and technical capability to assure compliance with this Article."

For GRRPs, the State Water Board has indicated that project sponsors can use portions of the TMF Assessment Form to demonstrate compliance with the managerial and technical capability requirements in the groundwater replenishment regulations.

2.4 Monitoring and Outreach Related to Public Health and Safety of Direct Potable Reuse

The public must have confidence that DPR is safe. Public confidence can be validated by robust, comprehensive, and continuous monitoring regimes of the components that constitute DPR.

2.4.1 Monitoring and Outreach Recommendations

Public confidence that DPR is safe and protective of public health is essential to the success of DPR projects. A robust, comprehensive, and continuous monitoring regimen should be required and include source water quality, wastewater quality, and treatment performance. The monitoring regimen should include a methodical and robust search for CECs and other potentially harmful constituents.

In addition, monitoring requirements and water quality results should be made available to the public. Data and results should be routinely posted to the utility's website and included in CCRs. This recommendation supplements the public notification and CCR requirements in the Safe Drinking Water

Act. Water quality data and relevant public health information should also be made available on a continuous basis. This information will help build public confidence.

2.4.2 Rationale for Monitoring and Outreach Recommendations

"What gets measured gets done" is a common viewpoint in the regulatory community. More specifically, what is measured and reported gets done. As noted in Section 2.5, the following are needed for public acceptance: (1) transparency regarding operations and water quality results, and (2) communication with the public. The public will require assurance that monitoring is robust and constant. The context of the monitoring and reporting requirements of the Safe Drinking Water Act for drinking water systems, both to the regulatory agencies and to the public, is well-known. The public benefits from the required notification for regulatory violations and from the treatment and water quality information in annual CCRs. Wastewater treatment systems do not have these specific requirements.

2.5 Changes to the Consumer Confidence Report (CCR)

Public confidence is also enhanced by transparency and accountability. The Safe Drinking Water Act requires drinking water agencies to annually provide information on water sources, treatment, water quality, and regulatory compliance to their customers through a Consumer Confidence Report (CCR). It is appropriate to include information relating to the additional elements for potable reuse in the CCR.

2.5.1 Consumer Confidence Report Recommendations

The Advisory Group recommends that the CCR requirements be extended to systems that undertake DPR, and that the following information related to the DPR project be included in the utility's annual CCR: Water sources, descriptions of treatment technologies, water quality and monitoring results, and compliance status.

2.5.2 Rationale for Consumer Confidence Report Recommendations

Public transparency and consumer confidence regarding potable reuse facility operations and water quality are necessary to gain and maintain community approval of DPR projects. The CCR provides information to the customers of water utilities and to the public in general on the sources, treatment, storage, and distribution of their drinking water supply. The CCR also provides information on water quality monitoring requirements and results, regulatory compliance status, and drinking water constituent information. The requirement that utilities must transparently provide this information is essential to build and maintain public confidence in their water supply. Inclusion of information on the additional treatment, monitoring, operational, and compliance elements associated with potable reuse is appropriate in this context.

2.6 Regulatory Approach to Environmental Impacts

DPR projects may affect the environment. Stakeholders and permitting agencies can work together to ensure DPR projects meet all regulatory requirements, with the goal of minimizing impacts to the environment.

2.6.1 Environmental Impacts Recommendations

The various local, state, and federal agencies and partners involved in regulating the disposal of waste streams (such as concentrate from reverse osmosis treatment systems) from AWTFs should provide and facilitate a coordinated approach to permitting.

2.6.2 Rationale for Environmental Impacts Recommendations

There is support among regulators, the regulated community, and concerned citizens to reduce, eliminate, or mitigate environmental impacts from water supply projects. In the case of DPR, the environmental impacts from the disposal of reverse osmosis (RO) treatment system brines will need to be considered. Concentrate management from AWTFs is a critical issue to be considered in the permitting of those facilities. While the concentrate may pose a low risk of environmental harm (or even have beneficial uses), the myriad of regulations and regulatory agencies that may be involved can be challenging. A coordinated approach that includes and aligns local, state, and federal agencies working together with project proponents could be a productive approach to assessing and permitting RO concentrate disposal and handling of other concentrates, and, ultimately, to approving DPR projects.

2.7 Direct Potable Reuse Research Priorities for California

More research may be needed to support the development of regulations for DPR. To assure that the most critical research priorities are met, the State Water Board will need to evaluate potential research needs. Several efforts are underway to help advance that process.

2.7.1 Research Priority Recommendations

The State Water Board should evaluate research topics that may be needed to support the development of DPR in California that is protective of human health and the environment. The DPR Expert Panel will provide a list of prioritized research recommendations as part of its report to the State Water Board. Also, the State Water Board has held workshops on recycled water research with other state agencies, utilities, and stakeholders. The outcomes of these efforts can inform research needs for state funding, including funding under Proposition 1, which authorized money from general obligation bonds for water projects (including surface and groundwater storage, ecosystem and watershed protection and restoration, and drinking water protection).

In addition, the State Water Board can play an important leadership role in sponsoring and guiding research on potable reuse. Coordinating research efforts with research foundations such as the Water Environment & Reuse Foundation (WE&RF) and the Water Research Foundation (WRF) should be encouraged. In addition, research generated by NSF-funded research centers (e.g., the Engineering Research Center for Re-Inventing the Nation's Urban Water Infrastructure at Stanford University) also should help inform research priorities in California. Through these efforts, the State Water Board can help drive innovation in water treatment and monitoring to advance the potential to implement potable reuse projects in water-scarce areas of California and the southwestern United States.

2.7.2 Rationale for Research Priority Recommendations

Although the Advisory Group believes enough information may exist to implement DPR projects safely, continued research will benefit the implementation of DPR in California. Because DPR is a relatively new concept, research can help to validate new and existing treatment technologies, test new analytical methods like online sensors, improve the understanding and prediction of the reliability of treatment and monitoring systems, improve operational efficiencies and energy usage, and promote continuous improvements in existing and new technologies. The State Water Board has held several Recycled Water Research Needs Workshops that have produced a list of priority topics and projects; the workshop participants have provided feedback on the relative importance of different research topics. The results of these efforts underscore the need for an ongoing research program.

In addition, the DPR Expert Panel will provide research recommendations based on its effort to determine the feasibility of uniform statewide criteria for DPR. Research by the water community, such as the efforts by the Water Environment & Reuse Foundation and the Water Research Foundation, will continue to address research needs identified by member agencies and prioritized by advisory committees within these organizations. Lastly, federally funded research focused on water treatment, quality, and monitoring, such as that performed by the US EPA and NSF, may help inform future research needs.

2.8 Research on Low-Dose Exposure to Chemicals

A growing area of concern is the impacts of commonly used chemicals and constituents of emerging concern at extremely low doses and/or mixtures of these chemicals at low doses. Because the source water for potable reuse projects will contain higher concentrations of trace organic chemicals, there is a need to better understand the potential impacts they may have on public health and the ability to comply with future drinking water standards.

2.8.1 Low-Dose Exposure Recommendations

Identify the levels of chemicals, including constituents of concern (COCs) and constituents of emerging concern (CECs) that are present in advanced treated water and compare them to levels in other drinking water sources. Investigate potential health effects from low dose exposures from these chemicals and COCs/CECs, especially if they are detected to occur more often in advanced treated water. Specifically:

- Investigate the relative risk and potential for greater public exposure, including to low doses, and the possible need for treatment that would reduce cumulative exposure relative to other water sources.
- Consistent with the Recycled Water Policy, the State Water Board should continue to track the occurrence and potential health effects of unregulated substances.

In addition, evaluate the quality of the source water and consider potential health implications, as well as related factors such as the cost of advanced water treatment. In examining this issue, consider the work on bioanalytical techniques evaluated by the State Water Board, guidance provided by the CEC Advisory Panel as part of the State Water Board's Recycled Water Policy, and the report from the DPR Expert Panel.

2.8.2 Rationale for Low-Dose Exposure Recommendations

More information is needed on the occurrence and effects of COCs and CECs. In addition, although significant data may be available on the human health and environmental impacts of some contaminants (such as endocrine disruptors, carcinogens, and those known to cause reproductive harm), the impacts of low dose/trace amounts and mixtures of multiple chemicals in water and the effects on vulnerable populations are less understood. Finally, while many COCs/CECs are not regulated in drinking water, some are likely to be regulated in the future.

If COCs/CECs such as pharmaceuticals, phthalates, and perfluorinated chemicals are found to be more concentrated or at higher levels in the advanced treated water produced by potable reuse facilities than they are in other drinking water sources, this could impact the treatment and monitoring criteria the State Water Board sets for potable reuse. The regulations may in turn affect the costs and technologies required to meet future maximum contaminant levels (MCLs). An understanding of COCs/CECs can also drive greater source control and green chemistry policies to reduce the levels of these constituents entering the wastewater system.

2.9 Use of Bioassays to Evaluate Constituents of Emerging Concern and Unknown Chemicals in Recycled Water

For the purposes of this recommendation, bioassays (shorthand for biological assay or assessment) involve the use of live human tissue or cells (in vitro) that target specific toxicity mechanisms to determine the biological activity (i.e., a proxy for toxicity) of a chemical or mixture of chemicals. Bioassays could provide an additional tool to evaluate the safety of recycled water for potable water in conjunction with conventional chemical testing and on-line monitoring systems. Additional research and development efforts are needed to determine whether bioassays could be applied to examine risks for unregulated chemicals and unknown mixtures of chemicals.

2.9.1 Bioassay Recommendations

The State Water Board should further study the use of bioassays for monitoring CECs and unknown chemicals in DPR projects. Based on the DPR Expert Panel's presentation relating their findings on bioassays, the Advisory Group agrees that current chemistry-based water quality and indicator-based treatment performance monitoring techniques are able to assess CECs in potable reuse projects. Currently, there are a number of challenges that must be addressed before bioassays can be implemented beyond research efforts. These limitations include: extraction procedures; quality assurance and quality control; standardized methods; treatment of false positives and false negatives; and the ability to interpret the results relative to human health. As the science of bioassays continues to develop, this technique may have the potential to supplement our current monitoring capabilities in the future. The State Water Board should continue to support research on the use of bioassays to move the science forward for possible future use in evaluating CECs/COCs.

2.9.2 Rationale for Bioassay Recommendations

Most CECs are not regulated, and many cannot be measured using traditional chemical analysis at low levels in wastewater or recycled water. Bioassays may offer the potential to provide a method (or methods) to assess the risks of unknown chemicals in recycled water, including the effects of a mixture

of chemicals. It will be important to track the development of bioassays by research scientists and the efforts of the US EPA's Office of Research and Development. The limitations on bioassays are daunting, including analytical methods and interpretation procedures, and need to be adequately addressed through research efforts. The State Water Board may want to consider research on a limited scale to evaluate the usefulness of current bioassay techniques in assessing the performance of advanced water treatment technologies; however, the burden of addressing all bioassay research needs is beyond the reach of the State Water Board and will require federal and international efforts.

CHAPTER 3: RECOMMENDATIONS ON TOPICS NOT DIRECTLY RELATED TO THE FEASIBILITY OF DEVELOPING REGULATORY CRITERIA FOR DIRECT POTABLE REUSE

The main purpose of this report was to provide feedback related to the feasibility of developing regulatory criteria for DPR; however, the Advisory Group also included input on topics identified by stakeholders as important to the discussion of DPR, but not related directly to the feasibility of creating regulations. These recommendations cover a range of topics related to DPR, and many can be implemented by the State or local agencies.

Recommendations are provided on the following topics:

- Potable Reuse Terminology
- Scientific Quality and Public Availability of Support Documentation
- Communications and Public Outreach
- Phasing of the Potable Reuse Regulations
- Comparison of Direct Potable Reuse and Other Alternatives
- Determining the Feasibility of a Project
- Environmental Justice
- Effects of Direct Potable Reuse on Environmental Flows
- Effects of Direct Potable Reuse Projects on Water Rates
- Convening an Expert Panel and Stakeholder Group to Advise the State Water Board in Developing Criteria

3.1 Potable Reuse Terminology

The many technical terms related to potable reuse are often applied inconsistently by various stakeholder groups. The lack of uniform and accepted terminology leads to confusion and a lack of precision when discussing concepts related to DPR projects.

3.1.1 Terminology Recommendations

Use the terms presented in the "Terminology for Potable Reuse" document (Appendix B) to the extent practical when developing new potable reuse regulations and when preparing reports and other documentation pertaining to potable reuse.

3.1.2 Rationale for Terminology Recommendations

The terminology document is intended to reflect the multitude of terms associated with potable reuse. Definitions and alternative terms are provided to demonstrate the breadth of meaning associated with each term. Members of the public have been exposed to some of this terminology through the outreach efforts of individual agencies.

3.2 Scientific Quality and Public Availability of Support Documentation

It is important that the information used to make decisions on DPR projects be scientifically credible. Furthermore, to maintain a process that is transparent, the information should be made available to the public.

3.2.1 Documentation Recommendation

To the extent feasible, the studies, reports, data, interpretations, and other supportive information used to develop DPR criteria, regulations, and permits should have gone through a scientific review process. In addition, the materials used by the State Water Board in developing the criteria, regulations, and permits for DPR projects should be made fully available to the public.

3.2.2 Rationale for Documentation Recommendations

The scientific information used to support potable reuse public health goals and treatment approaches has to be of suitable quality to answer questions and address uncertainties before DPR regulations and operating permits are developed. The data and their interpretation must be reliable. Peer review and publication generally are accepted within the scientific community as a means to ensure the reliability and quality of information; however, many studies and reports do not lend themselves to publication in peer-reviewed scientific journals. Consequently, the Advisory Group does not recommend that the State require all information used to develop criteria and operational components be published in peer-reviewed journals or undergo a formal peer review. Rather, we recommend that, to the extent feasible, the data and interpretation in the reports and studies used to develop criteria, regulations, and permit requirements be scientifically based. To further support transparency and public trust, this information should be made fully available to the public.

3.3 Communications and Public Outreach

Public understanding and acceptance is critical for communities considering a DPR project. Communicating effectively with the public is essential to a project's success.

3.3.1 Communications Recommendations

Utilities should develop a proactive and comprehensive educational outreach program early in the development of a DPR project. The WateReuse Research Foundation (now the Water Environment & Reuse Foundation) has published a "Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse," which includes communication plans for both state-level and community-level outreach. The Advisory Group supports the use of this type of information. In

addition, with the development of regulations, the State Water Board should consider creating a senior level position to provide public education efforts.

3.3.2 Rationale for Communications Recommendations

Although the Advisory Group does not believe that the State Water Board should write a requirement for public outreach into the DPR permit criteria, public acceptance is one of the primary challenges for communities considering the implementation of a DPR project.

DPR is unlikely to proceed in a community unless there is public acceptance that the treatment processes are safe and reliable. In addition, if it is shown that DPR is the best option for that community, then the project proponent would need the support of the customers, including support for rate increases accompanying the financing of an AWTF. A well-planned and well-executed public educational effort by project proponents is essential to obtain public acceptance.

3.4 Phasing of the Potable Reuse Regulations

Given the broad spectrum of potable reuse applications, a phased regulatory approach could be beneficial. This incremental approach could allow for the permitting of more projects throughout the state, and at the same time give the industry and regulators the opportunity to build on the lessons learned from ongoing projects.

3.4.1 Phasing Regulations Recommendations

Ensure that a viable regulatory pathway exists to permit potable reuse projects with environmental buffers that do not meet current regulatory requirements. Options to consider include alternative provisions for groundwater basins (e.g., travel time) and for surface reservoirs (e.g., dilution or retention time) or issuing a case-by-case (or "one-off") permit. These options could be based on information provided in the Expert Panel's Feasibility Report.

When assessing the feasibility of DPR, the State Water Board should consider the following:

- Identify strategies and establish guidelines that the State Water Board can employ for future potable reuse regulations to address the lack of an environmental buffer (i.e., a groundwater basin or surface water reservoir). Such strategies and guidelines might include:
    - Additional treatment barriers.
    - Online and high-frequency monitoring capabilities for chemicals and pathogens or possible surrogates and indicators.
    - Corrective and operational actions to address instrumentation or treatment lapses and off-specification water.
    - Pretreatment practices that are coupled with potable reuse goals.
    - Programs that engage the public in sewershed protection.

- Consider developing separate criteria for the continuum of potable reuse alternatives:

- Projects with surface water reservoirs that do not meet the reservoir criteria in the SWA regulations.
- Projects with no environmental buffer, but that include a DWTF prior to distribution.
- Projects with no environmental buffer and no DWTF prior to distribution.

- If the expert panel determines that development of regulations is feasible, then DDW should within six months create and share with the public a work plan and time line for next steps for developing regulations for DPR, including further research and pilot projects that may be needed.

As DDW develops DPR regulations, DDW should be able to consider DPR projects on a case-by-case basis. In addition, any future legislation should not delay the consideration by regulators of new potable reuse projects.

Finally, the definitions of SWA and DPR in the California Water Code may need to be revised based on the findings of the DPR Expert Panel. Specific terminology should be considered that distinguishes among the various types of potable reuse projects.

3.4.2 Rationale for Phasing Regulations Recommendations

Potable reuse projects can be categorized along a continuum depending on the type and size of the environmental buffer and whether a DWTF is part of the treatment system. As illustrated in **Figure 3-1**, this continuum begins with "de facto" potable reuse, involving large environmental buffers, and proceeds to the middle of the spectrum to planned IPR applications that include environmental buffers of varying sizes. As the environmental buffers are reduced further, the far end of the spectrum illustrates DPR applications that lack an environmental buffer and, ultimately, projects in which finished drinking water is produced by the AWTF.

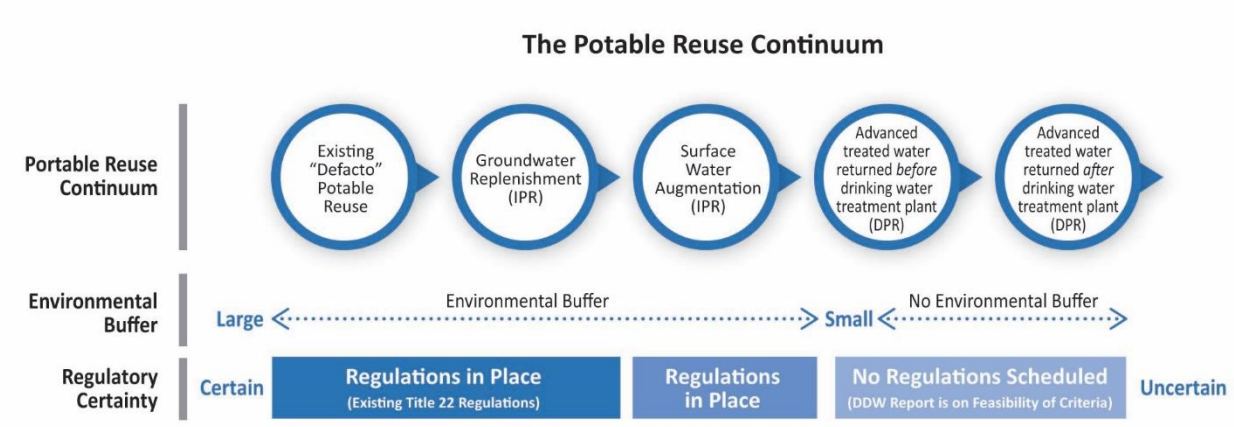

Figure 3-1: The Potable Reuse Continuum

In California, potable reuse regulations are advancing along this continuum, starting with the regulations on Groundwater Replenishment Using Recycled Water, which became effective in 2014.[7] SWA regulations are expected to be adopted in late 2016. The definition of an environmental buffer in SWA projects could provide an important distinction between IPR and DPR projects. Such a distinction will determine which regulations projects are subject to. Because utilities are interested in DPR projects (which do not include environmental buffers), the Advisory Group recommends developing new potable reuse regulations for projects that fall somewhere between SWA and DPR. New regulations should build upon: (1) the experience accumulated from existing groundwater replenishment projects; and (2) the demonstration of work completed to support SWA regulations. The result would be the development of regulations that are scientifically based, protective of public health, and safely expand the scope of potable reuse in California.

3.5 Comparison of Direct Potable Reuse and Other Alternatives

Any community considering DPR should conduct an analysis to compare other available supply alternatives for generating additional potable water. Due to differing characteristics of each community, the analysis should be done on a case-by-case basis and should become a component of the public information process.

3.5.1 Comparison Recommendations

The differences between DPR, IPR, ocean desalination, groundwater desalination, stormwater capture, graywater, and other alternative water sources should be evaluated by project proponents. Public outreach campaigns by utilities should include dialogue on alternative source water strategies.

3.5.2 Rationale for Comparison Recommendations

As California addresses its water management problems, coastal communities may need to choose from a number of alternatives, such as DPR, IPR, ocean desalination, groundwater desalination, stormwater capture, graywater, and other alternative water sources. These sources of water often require advanced treatment technologies. All potentially provide new local, drought-resilient sources of drinking water. A discussion within the community of the differences between these water sources is needed to better understand these options.

3.6 Determining Feasibility of a Project

Water supply project options, including DPR projects, can benefit from a robust feasibility analysis.

3.6.1 Project Feasibility Recommendations

Agencies should use assessment tools such as a triple bottom line (TBL) analysis for various factors including economic, social, and environmental factors as part of determining the feasibility of implementing a DPR project.

[7] www.cdph.ca.gov/services/DPOPP/regs/Pages/DPH14-003EGroundwaterReplenishmentUsingRecycledWater.aspx

3.6.2 Rationale for Project Feasibility Recommendations

Sustainability is a consideration for any new water supply project. Sustainability, however, should include a commitment to be transparent about a project's impact on costs, the public, and the environment. A feasibility analysis such as TBL is one way to measure these factors.

Traditionally, these tools analyze sustainability by measuring impacts on the "three Ps" (that is, Profit, People, and Planet,) as follows:

- Profit: Typically measures an organization's traditional profit and loss, but in this context, it more accurately refers to project cost.
- People: Measures the social responsibility of the project.
- Planet: Measures the environmental responsibility of the project.

For water projects in general, including potable reuse projects, these analyses should take the following into account:

- Economic/Profit component: Measure the cost of a particular project, compared to other available water supply alternatives.
- People/Social component: Identify a community's available water supply alternatives, with a goal toward providing water for the needs of the community.
- Environmental/Planet component: Identify the environmental benefits of reuse and recycling compared to other alternatives, including water supply alternatives that provide water for ecosystems.

3.7 Environmental Justice

All communities should have access to safe, clean, and affordable water. In addition, it is important to protect communities from experiencing disproportionate impacts from DPR projects that benefit the larger society. These considerations must be part of proper implementation of DPR projects and the state's strategy to ensure equitable access to potable water.

3.7.1 Environmental Justice Recommendations

An independent research organization such as the Water Environment & Reuse Foundation (WE&RF) should focus a study on environmental justice issues that may affect the viability and equitable access to potable reuse as a means of providing sustainable, affordable, and safe drinking water supplies to small systems and disadvantaged communities. This effort entails evaluating the effects of building projects on local neighborhoods and the needs of water-scarce areas that may not have the resources or expertise necessary to implement these technologies.

Specifically consider:

- The potential impacts of any potable reuse infrastructure on local or fence-line communities (i.e., the neighborhood adjacent to the potable reuse facility that would be directly affected by the daily operations of the facility).

- Assess whether communities that depend on small water systems, and/or disadvantaged communities without a strong financial base, can implement potable reuse technologies to ensure sustainable water supplies. It is important to understand the technical, fiscal, and other challenges that such communities would face, and to identify opportunities to address those challenges.

3.7.2 Rationale for Environmental Justice Recommendations

Regarding the potential impacts of potable reuse infrastructure on local or fence-line communities: While such studies may be captured under CEQA requirements for individual projects, research on a broader scale on the potential for disproportionate impacts on these communities would better inform such analyses.

Regarding the potential for disadvantaged communities to implement potable reuse technologies: These communities face the greatest challenges in providing safe and affordable drinking water to residents now, and for ensuring sustainable water supplies in the future. While implementing potable reuse projects in large, well-funded water districts could potentially allow for reallocation of traditional water sources, many rural disadvantaged communities struggle to have access to those supplies. Consequently, in a state that has embraced the concept of "the human right to water," it will be necessary to explore the challenges faced by disadvantaged communities in implementing potable reuse strategies. In addition, the State Water Board should identify the most viable strategies (if any), and how these challenges might ultimately be addressed. Finally, the State Water Board should look for applicable lessons from abroad that might inform California water policy.

3.8 Effects of Direct Potable Reuse on Environmental Flows

DPR projects can affect local hydrologic conditions. It is important to understand how changes in hydrology will affect local environmental conditions.

3.8.1 Environmental Flows Recommendations

Greater understanding is needed of the potential environmental impacts of not replacing wastewater diverted from the environment for potable reuse. This knowledge should be used to inform decision making when permitting recycled water projects. The analysis should include whether current regulatory requirements, such as under Water Code 1211, California Environmental Quality Act, and Triple Bottom Line evaluations, are adequate to address competing water needs, such as the protection of endangered species and ecosystems, groundwater recharge, and drinking water supplies in communities downstream of water reuse projects.

3.8.2 Rationale for Environmental Flows Recommendations

Maintaining surface water flow and groundwater recharge is a tremendous challenge in some areas of the State. Climate change, drought, and competing uses of water will continue to stress current water

supplies. In addition to the competing uses described above, flow problems have wide-ranging repercussions beyond water quantity. For instance, changes in flow and related temperature fluctuations may play significant roles in increasing cyanobacteria and macrophyte production in the Sacramento-San Joaquin River Delta. While the State has implemented restrictions on water reuse to protect both competing human and environmental needs, expanding potable reuse in some parts of the state may add challenges to already stressed water sources. Better understanding is necessary on a regional level to ensure that potable reuse projects are implemented in a matter that does not reduce drinking water accessibility in other communities or create environmental harm.

3.9 Effects of Direct Potable Reuse Projects on Water Rates

Designing, permitting, constructing, and operating DRP projects can be complex, time-consuming, and costly. Consequently, water suppliers that implement DPR projects potentially will need to assess possible impacts on water rates and charges associated with these projects.

3.9.1 Water Rates Recommendations

Utilities should evaluate the cost of a DPR project, including all technical requirements and barriers needed, and the corresponding impacts on water rates and charges, and compare it with the cost of water supply alternatives and their impacts on water rates and charges.

3.9.2 Rationale for Water Rates Recommendations

Current California law requires that water suppliers establish water rates and charges that do not exceed the cost of service (COS) to water service customers. Determining COS is a methodical process in which revenue requirements should lead to a fair and equitable allocation of costs in proportion to the service each customer receives.

New sources of water supply, such as potable reuse, are more costly than traditional water supply options, such as imported water or groundwater pumping. However, in many areas, traditional water supply options are at best fully allocated and at worst over-allocated. Potable reuse often is assumed to be the least costly alternative for new water supplies; however, each project is unique, so this assumption should be empirically proven for each project. It is important to realize that potable reuse projects will range along a spectrum of configurations from “indirect” DPR projects that may include a smaller environmental buffer to “direct” DPR projects in which treated drinking water is introduced directly into a water supply system without treatment through a DWTF. The latter scheme could include many costly technical barriers or controls.

Further, to be credible, an analysis of the costs of a potable reuse project and its impact on water rates and charges must be compared to other water supply alternatives and their impacts on water rates and charges. This analysis must be done on an “apples-to-apples” basis (i.e., subsidized-to-subsidized or unsubsidized-to-unsubsidized); however, it would be appropriate to include the avoided costs of other regulatory mandates. One example is the avoided cost of upgrading to secondary wastewater treatment at the Point Loma Wastewater Treatment Plant when calculating the costs of the City of San Diego’s potable reuse project. Alternative supplies of water would not provide that avoided cost.

Further, while risk and reliability can be difficult to price, it would be appropriate to take these issues into consideration. While potable reuse and desalination are costlier than other water supply sources, they are drought-proof and can be a reliable source that carries less risk than other comparative supplies. Risks may include allocations and supply cutbacks or natural disasters that may reduce or stop supply deliveries.

3.10 Convening an Expert Panel and Stakeholder Group to Advise the State Water Board in Developing Criteria

The State Water Board may wish to solicit feedback from other interested groups if it is determined that it is feasible to develop regulatory criteria for DPR.

3.10.1 Expert Advice Recommendations

If the DPR Expert Panel advises the State Water Board that it is feasible to develop uniform water recycling criteria for DPR, then the State Water Board may benefit from the involvement of another Expert Panel in further assisting the State Water Board in developing criteria and regulations. In addition, it may be useful to form a stakeholder group to provide insights and a different perspective on options for regulatory criteria.

3.10.2 Rationale for Expert Advice Recommendations

The State Water Board has consulted both an Expert Panel and an Advisory Group in evaluating the feasibility of developing criteria for DPR, as required in the California Water Code. Both the DPR Expert Panel and Advisory Group have been effective forums for gathering technical input and addressing stakeholder views on the challenges, issues, and merits of DPR. Beyond December 2016, the State Water Board may wish to convene a new Expert Panel and a Stakeholder Group as forums for further technical review and public engagement as progress is made on DPR criteria and, potentially, the regulations.

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CHAPTER 4: REFERENCES

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APPENDIX A: CALIFORNIA WATER CODE SECTIONS ON POTABLE REUSE

CALIFORNIA WATER CODE
CHAPTER 7.3 DIRECT AND INDIRECT POTABLE REUSE
SECTION 13560-13569

13560. The Legislature finds and declares the following:

(a) In February 2009, the state board unanimously adopted, as Resolution No. 2009-0011, an updated water recycling policy, which includes the goal of increasing the use of recycled water in the state over 2002 levels by at least 1,000,000 acre-feet per year by 2020 and by at least 2,000,000 acre-feet per year by 2030.

(b) Section 13521 requires the department to establish uniform statewide recycling criteria for each varying type of use of recycled water where the use involves the protection of public health.

(c) The use of recycled water for indirect potable reuse is critical to achieving the state board's goals for increased use of recycled water in the state. If direct potable reuse can be demonstrated to be safe and feasible, implementing direct potable reuse would further aid in achieving the state board's recycling goals.

(d) Although there has been much scientific research on public health issues associated with indirect potable reuse through groundwater recharge, there are a number of significant unanswered questions regarding indirect potable reuse through surface water augmentation and direct potable reuse.

(e) Achievement of the state's goals depends on the timely development of uniform statewide recycling criteria for indirect and direct potable water reuse.

(f) This chapter is not intended to delay, invalidate, or reverse any study or project, or development of regulations by the department, the state board, or the regional boards regarding the use of recycled water for indirect potable reuse for groundwater recharge, surface water augmentation, or direct potable reuse.

(g) This chapter shall not be construed to delay, invalidate, or reverse the department's ongoing review of projects consistent with Section 116551 of the Health and Safety Code.

13561. For purposes of this chapter, the following terms have the following meanings:

(a) "Department" means the State Department of Public Health.

(b) "Direct potable reuse" means the planned introduction of recycled water either directly into a public water system, as defined in Section 116275 of the Health and Safety Code, or into a raw water supply immediately upstream of a water treatment plant.

(c) "Indirect potable reuse for groundwater recharge" means the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system, as defined in Section 116275 of the Health and Safety Code.

(d) "Surface water augmentation" means the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply.

(e) "Uniform water recycling criteria" has the same meaning as in Section 13521.

13561.5. The state board shall enter into an agreement with the department to assist in implementing this chapter.

13562. (a) (1) On or before December 31, 2013, the department shall adopt uniform water recycling criteria for indirect potable reuse for groundwater recharge.

(2) (A) Except as provided in subparagraph (C), on or before December 31, 2016, the department shall develop and adopt uniform water recycling criteria for surface water augmentation.

(B) Prior to adopting uniform water recycling criteria for surface water augmentation, the department shall submit the proposed criteria to the expert panel convened pursuant to subdivision (a) of Section 13565. The expert panel shall review the proposed criteria and shall adopt a finding as to whether, in its expert opinion, the proposed criteria would adequately protect public health.

(C) The department shall not adopt uniform water recycling criteria for surface water augmentation pursuant to subparagraph (A), unless and until the expert panel adopts a finding that the proposed criteria would adequately protect public health.

(b) Adoption of uniform water recycling criteria by the department is subject to the requirements of Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

13562.5. Notwithstanding any other law, no later than June 30, 2014, the department shall adopt, by emergency regulations in accordance with Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, requirements for groundwater replenishment using recycled water. The adoption of these regulations is an emergency and shall be considered by the Office of Administrative Law as necessary for the immediate preservation of the public peace, health, safety, and general welfare. Notwithstanding Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, emergency regulations adopted by the department pursuant to this section shall not be subject to review by the Office of Administrative Law and shall remain in effect until revised by the department.

13563. (a) (1) On or before December 31, 2016, the department, in consultation with the state board, shall investigate and report to the Legislature on the feasibility of developing uniform water recycling criteria for direct potable reuse.

(2) The department shall complete a public review draft of its report by September 1, 2016. The department shall provide the public not less than 45 days to review and comment on the public review draft.

(3) The department shall provide a final report to the Legislature by December 31, 2016. The department shall make the final report available to the public.

(b) In conducting the investigation pursuant to subdivision (a), the department shall examine all of the following:

(1) The availability and reliability of recycled water treatment technologies necessary to ensure the protection of public health.

(2) Multiple barriers and sequential treatment processes that may be appropriate at wastewater and water treatment facilities.

(3) Available information on health effects.

(4) Mechanisms that should be employed to protect public health if problems are found in recycled water that is being served to the public as a potable water supply, including, but not limited to, the failure of treatment systems at the recycled water treatment facility.

(5) Monitoring needed to ensure protection of public health, including, but not limited to, the identification of appropriate indicator and surrogate constituents.

(6) Any other scientific or technical issues that may be necessary, including, but not limited to, the need for additional research.

(c) (1) Notwithstanding Section 10231.5 of the Government Code, the requirement for submitting a report imposed under paragraph (3) of subdivision (a) is inoperative on December 31, 2020.

(2) A report to be submitted pursuant to paragraph (3) of subdivision (a) shall be submitted in compliance with Section 9795 of the Government Code.

13563.5. (a) The department, in consultation with the state board, shall report to the Legislature as part of the annual budget process, in each year from 2011 to 2016, inclusive, on the progress towards developing and adopting uniform water recycling criteria for surface water augmentation and its investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse.

(b) (1) A written report submitted pursuant to subdivision (a) shall be submitted in compliance with Section 9795 of the Government Code.

(2) Pursuant to Section 10231.5 of the Government Code, this section is repealed on January 1, 2017.

13564. In developing uniform water recycling criteria for surface water augmentation, the department shall consider all of the following:

(a) The final report from the National Water Research Institute Independent Advisory Panel for the City of San Diego Indirect Potable Reuse/Reservoir Augmentation (IPR/RA) Demonstration Project.

(b) Monitoring results of research and studies regarding surface water augmentation.

(c) Results of demonstration studies conducted for purposes of approval of projects using surface water augmentation.

(d) Epidemiological studies and risk assessments associated with projects using surface water augmentation.

(e) Applicability of the advanced treatment technologies required for recycled water projects, including, but not limited to, indirect potable reuse for groundwater recharge projects.

(f) Water quality, limnology, and health risk assessments associated with existing potable water supplies subject to discharges from municipal wastewater, stormwater, and agricultural runoff.

(g) Recommendations of the State of California Constituents of Emerging Concern Recycled Water Policy Science Advisory Panel.

(h) State funded research pursuant to Section 79144 and subdivision (b) of Section 79145.

(i) Research and recommendations from the United States Environmental Protection Agency Guidelines for Water Reuse.

(j) The National Research Council of the National Academies' report titled "Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater."

(k) Other relevant research and studies regarding indirect potable reuse of recycled water.

13565. (a) (1) On or before February 15, 2014, the department shall convene and administer an expert panel for purposes of advising the department on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation and investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse. The expert panel shall assess what, if any, additional areas of research are needed to be able to establish uniform regulatory criteria for direct potable reuse. The expert panel shall then recommend an approach for accomplishing any additional needed research regarding uniform criteria for direct potable reuse in a timely manner.

(2) The expert panel shall be comprised, at a minimum, of a toxicologist, an engineer licensed in the state with at least three years' experience in wastewater treatment, an engineer licensed in the state with at least three years' experience in treatment of drinking water supplies and knowledge of drinking water standards, an epidemiologist, a limnologist, a microbiologist, and a chemist. The department, in consultation with the advisory group and the state board, shall select the expert panel members.

(3) Members of the expert panel may be reimbursed for reasonable and necessary travel expenses.

(b) (1) On or before January 15, 2014, the department shall convene an advisory group, task force, or other group, comprised of no fewer than nine representatives of water and wastewater agencies, local public health officers, environmental organizations, environmental justice organizations, public health nongovernmental organizations, the department, the state board, the United States Environmental Protection Agency, ratepayer or taxpayer advocate organizations, and the business community, to advise the expert panel regarding the development of uniform water recycling criteria for direct potable reuse and the draft report required by Section 13563. The department, in consultation with the state board, shall select the advisory group members.

(2) Environmental, environmental justice, and public health nongovernmental organization representative members of the advisory group, task force, or other group may be reimbursed for reasonable and necessary travel expenses.

(3) In order to ensure public transparency, the advisory group established pursuant to paragraph (1) shall be subject to the Bagley-Keene Open Meeting Act (Article 9 (commencing with Section 11120) of Chapter 1 of Part 1 of Division 3 of Title 2 of the Government Code).

(c) On or before June 30, 2016, the department shall prepare a draft report summarizing the recommendations of the expert panel.

(d) The department may contract with a public university or other research institution with experience in convening expert panels on water quality or potable reuse to meet all or part of the requirements of this section should the department find that the research institution is better able to fulfill the requirements of this section by the required date.

13566. In performing its investigation of the feasibility of developing the uniform water recycling criteria for direct potable reuse, the department shall consider all of the following:

(a) Recommendations from the expert panel appointed pursuant to subdivision (a) of Section 13565.

(b) Recommendations from an advisory group, task force, or other group appointed by the department pursuant to subdivision (b) of Section 13565.

(c) Regulations and guidelines for these activities from jurisdictions in other states, the federal government, or other countries.

(d) Research by the state board regarding unregulated pollutants, as developed pursuant to Section 10 of the recycled water policy adopted by state board Resolution No. 2009-0011.

(e) Results of investigations pursuant to Section 13563.

(f) Water quality and health risk assessments associated with existing potable water supplies subject to discharges from municipal wastewater, stormwater, and agricultural runoff.

13567. An action authorized pursuant to this chapter shall be consistent, to the extent applicable, with the federal Clean Water Act (33 U.S.C. Sec. 1251 et seq.), the federal Safe Drinking Water Act (42 U.S.C. Sec. 300f et seq.), this division, and the California Safe Drinking Water Act (Chapter 4 (commencing with Section 116270) of Part 12 of Division 104 of the Health and Safety Code).

13569. The department may accept funds from nonstate sources and may expend these funds, upon appropriation by the Legislature, for the purposes of this chapter.

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APPENDIX B: TERMINOLOGY FOR DIRECT POTABLE REUSE

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Recommendations of the
Advisory Group on the Feasibility of
Developing Uniform Water Recycling Criteria for
Direct Potable Reuse

Convened by the State Water Resources Control Board

Terms and Definitions for Potable Reuse

Prepared by:

Advisory Group on the Feasibility of
Developing Uniform Water Recycling Criteria for Direct Potable Reuse

Under Agreement No. 13-21041
California State Water Resources Control Board
Division of Drinking Water

Prepared for:

State Water Resources Control Board
Division of Drinking Water
Sacramento, CA

Submitted by:

National Water Research Institute
Fountain Valley, California USA
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June 2016

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This document is the product of the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse, which was established by the State Water Resources Control Board – per Section 13565(b)(1) of the California Water Code – to provide advice and input regarding "the development of uniform water quality criteria for direct potable reuse."

As required, the Advisory Group consists of representatives from water and wastewater agencies, local public health agencies, environmental organizations, environmental justice organizations, public health nongovernmental organizations, the State Water Resources Control Board, the U.S. Environmental Protection Agency, ratepayer or taxpayer advocate organizations, and the business community.

Members of the Advisory Group include the following individuals:

- Randy Barnard, P.E., California State Water Resources Control Board
- Garry Brown (Chair), Orange County Coastkeeper
- Amy Dorman, P.E., City of San Diego
- Conner Everts, Environmental Justice Coalition for Water
- Jim Fiedler, P.E., Santa Clara Valley Water District
- Julie L. Labonte, P.E., San Diego Regional Chamber of Commerce
- Albert C. Lau, P.E., Padre Dam Municipal Water District
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- Frances Spivy-Weber, California State Water Resources Control Board
- Ray Tremblay, P.E., BCEE, County Sanitation Districts of Los Angeles County
- Andria Ventura, Clean Water Action
- Michael Wehner, Orange County Water District

The following individuals also had served on the Advisory Group, but rotated off due to changes in employment:

- Alisa Reinhardt, San Diego Regional Chamber of Commerce (replaced by Julie Labonte)
- Marsi Steirer, City of San Diego (replaced by Amy Dorman)

The Advisory Group is pleased to acknowledge the following organizations and individuals, whose support, assistance, and resources contributed to the development of this document.

Ad Hoc Committee on Potable Reuse Terminology

The Ad Hoc Committee on Potable Reuse Terminology was instrumental in reviewing and refining terms and preparing this document on behalf of the Advisory Group: Amy Dorman (Chair), Garry Brown, Al Lau, Keith Solar, Marsi Steirer, and Michael Wehner.

Partner Organizations

The following organizations provided input during the development of this document:

- Association of California Water Agencies (ACWA)
- American Water Works Association (AWWA), California-Nevada Section
- California Association of Sanitation Agencies (CASA)
- California Urban Water Agencies (CUWA)
- California Water Environment Association (CWEA)
- National Water Research Institute (NWRI)
- WateReuse Association (WRA) and WateReuse California

State Water Resources Control Board

The Advisory Group was formed at the request of the Drinking Water Program of the California Department of Public Health (CDPH) in 2013. The Drinking Water Program was officially transferred from CDPH to the State Water Resources Control Board (State Water Board) and renamed as the Division of Drinking Water (DDW) on July 1, 2014. Financial support for the Advisory Group was provided by the State Water Board through Agreement No. 13-21041.

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- David Spath, Ph.D., P.E.

Advisory Group Administrators

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- Jeff Mosher (Advisory Group Administrator)
- Suzanne Faubl (Advisory Group Staff Support)
- Brandi Caskey
- Jaime Lumia
- Gina Melin Vartanian

Document Preparation

Finally, the Advisory Group appreciates the time and effort of the following individuals who helped prepare this document:

- Reviewed by: Amy Dorman and Bill Pearce, City of San Diego
- Incorporated by: Anthony Van and Peter Martin, City of San Diego
- Edited by: Suzanne Faubl, Gina Melin Vartanian, and Jeff Mosher, National Water Research Institute

1. INTRODUCTION

Potable reuse (more specifically, direct potable reuse) is a new strategy being considered to augment public water supplies. The terminology surrounding potable reuse is new as well, with different terms being used throughout the industry to describe the same processes, products, or technologies. This inconsistency is not just occurring on a state-by-state basis, due to different states having different regulatory language and water supply project needs, but it is also occurring on a project-by-project basis among neighboring communities. Consequently, the most basic of concepts – "recycled water," for instance – can be viewed as unacceptable by some (e.g., "do not drink" signs) or as forward-thinking by others (e.g., the next wave of "green" technology).

California has been a leader and pioneer in implementing innovative potable reuse projects, particularly in the last 10 years, and now is breaking new ground with direct potable reuse. As such, the State should consider taking the lead in developing standard terminology for potable reuse. Having standard terminology (that is, clear, appropriate definitions) would create a common ground for regulators, utility personnel, public health officials, industry groups, consultants, researchers, and vendors/manufacturers to seek, share, and understand information about the needs and challenges associated with potable reuse systems.

Another reason to have standard terminology is to communicate properly with the public about the value and safety of potable reuse. As noted in Tchobanoglous et al. (2015):

> Appropriate terminology—not technical jargon—is needed when discussing potable reuse. For example, the term "recycled water" may be viewed negatively by some members of the public, whereas "purified water" implies that the water has been treated to a high level and is viewed positively by the public (though it may not be the appropriate term for use within the engineering community). Efforts are being undertaken currently to develop consistent terminology for potable reuse within the water industry. The same is needed for the public. Accurate, understandable, and constructive terminology needs to be developed that can be used, industry-wide, when speaking with the public about potable reuse.

Overall, the goal of developing standard terminology is to assist communities in California (and elsewhere) in successfully planning, promoting, designing, financing, permitting, and operating planned potable reuse projects.

2. TABLE OF TERMINOLOGY

The terms and definitions provided in **Table 1** were developed by the Ad Hoc Committee on Potable Reuse Terminology, a subcommittee of the Advisory Group. Various resources were used to help develop these terms, including documents from stakeholder groups like WateReuse Research Foundation, American Water Works Association, City of San Diego, and Federal and State sources (e.g., regulations, statues, and/or laws). In addition, these stakeholder groups were given the opportunity to provide feedback.

To assist the reader, the following information is provided in the table:

- Potable reuse terms, any associated or similar terms, and definitions.
- References and sources.
- Location in the California Water Code, if applicable.

The intent of the terminology is to provide a shared understanding of the potable reuse terms in use today. It can be used as a resource or starting point for the development of standard potable reuse technology in the State of California, if appropriate, and when discussing potable reuse in general.

Table 1: Terms and Definitions for Potable Reuse

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Advanced Treatment	Advanced Water Purification, Advanced Water Treatment (See *Full Advanced Treatment*)	This term is often used to mean additional engineered treatment after secondary or tertiary treatment of wastewater to remove contaminants of concern to achieve public health or specific beneficial reuse parameters. However, the amount and type of advanced treatment applied is subject to the application, site-specific parameters, and federal, state, or local regulatory requirements.	Framework for Direct Potable Reuse (WateReuse, 2015).	Title 22, Section 60320.108(c), 60320.201, and 60320.201(i). WC, Section 13529.2(c) and 13564(e).
Advanced Treated Water (ATW)	Purified Water, Advanced Treated Recycled Water	Water produced from an advanced water treatment facility for direct and indirect potable reuse applications.	Framework for Direct Potable Reuse (WateReuse, 2015).	
Advanced Oxidation Process (AOP)		A set of chemical treatment processes whereby oxidation of organic contaminants occurs on a molecular level through reactions with hydroxyl radicals. The advanced oxidation process typically employs hydrogen peroxide, hypochlorite, ozone and/or ultraviolet light, which break down organic molecules into metabolites.		
Augmentation	Augmentation of Water Supply, Raw Water Augmentation, Reservoir/ Groundwater Augmentation	The process of adding purified water to an existing source water supply (such as a reservoir, lake, river, wetland, or groundwater basin) for use as drinking water after further treatment. Recycled water may also be used for groundwater augmentation if it first receives soil aquifer treatment (SAT).	Adapted from WateReuse Glossary www.watereuse.org/product/07-03	WC, Section 116551, 10608.12(m)(2), and 10752(f).

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Beneficial Reuse	Reuse, Water Reuse	The use of recycled water for purposes that contribute to the economy or environment of a community, such as for drinking water, landscape irrigation, industrial and commercial uses processes, or environmental flows (e.g., wetland or river enhancement).	Adapted from 2013 City of San Diego WPDP Final Report Glossary (San Diego, 2013).	Title 22, Section 60301.200. Direct Beneficial use. WC, Section 13553.1(a). Beneficial Use.
Constituent of Emerging Concern (CEC)	Pharmaceuticals and Ingredients in Personal Care Products	Chemicals or compounds not regulated in drinking water or advanced treated water. They may be candidates for future regulation depending on their ecological toxicity, potential human health effects, public perception, and frequency of occurrence.	Framework for Direct Potable Reuse (WateReuse, 2015).	SWRCB Recycled Water Policy (2013).
De Facto Potable Reuse	Unplanned potable reuse	The downstream use of surface water as a source of drinking water that is subject to upstream wastewater discharges (also referred to as "unplanned potable reuse").	Framework for Direct Potable Reuse (WateReuse, 2015).	
Direct Potable Reuse (DPR)		The delivery of purified water to a drinking water plant or a drinking water distribution system without an environmental buffer. Additional treatment, monitoring, and/or an engineered buffer(s) would be used in place of an environmental buffer to provide equivalent protection of public health and response time in the event that the purified water does not meet specifications.	Framework for Direct Potable Reuse (WateReuse, 2015). Water Code Section 13561(b) "Direct potable reuse" is the planned introduction of recycled water either directly into a public water system, as defined in Section 116275 of the Health and Safety Code, or into a raw water supply immediately upstream of a water treatment plant.	WC, Section 13561(b), and numerous other locations.

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Disinfection		The removal, inactivation, or destruction of microorganisms in a water supply that may be harmful to humans. Commonly used disinfectants include chlorine and its derivatives, ultraviolet light, and ozone. Chlorine and its derivatives can also be used to provide residual disinfection that protects the water as it is conveyed through pipelines to homes and businesses.	Adapted from 2013 City of San Diego WPDP Final Report Glossary (San Diego, 2013).	Title 22, numerous places. Title 17, Section 64651.33.
Drinking Water	Finished Water, Potable Water, Treated Water	Water conveyed through pipelines to homes and businesses that is safe for human consumption and meets all federal, state, and local health authority drinking water standards. Water treatment and distribution facilities that produce drinking water require an operational permit issued by the federal, state, or other designated permitting authority.	Adapted from 2013 City of San Diego WPDP Final Report Glossary (San Diego, 2013).	Title 22, numerous places. WC, numerous places.
Drinking Water Plant	Drinking Water Treatment Facility; Water Treatment Facility, Public Water System, Surface Water Treatment Plant	A group or assemblage of structures, equipment, and processes to produce water that is safe for human consumption and domestic water use. Conventional drinking water plants use a four-step process of flocculation, settling, filtration, and disinfection to produce water that is safe to drink (see Drinking Water). However, the amount and type of treatment applied varies based upon the source water quality of a public water system and other federal, state, or local regulatory requirements. These facilities are regulated under the Safe Drinking Water Act and permitted by the SWRCB Division of Drinking Water.	Adapted from 2013 City of San Diego WPDP Final Report Glossary (San Diego, 2013).	Title 22, numerous places. Water Treatment Plant. H&SC, numerous places. Title 17, Section 63750.85. Water Treatment Facility. Title 17, Section 64651.23. Conventional Filtration Treatment.

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Engineered Buffer	Engineered Storage Buffer	Any assemblage of man-made structures, equipment, processes, monitoring, or storage prior to introducing advanced treated water into a drinking water system. A potable reuse project may use an engineered buffer to ensure adequate protection of human health and response time in the event that purified water or recycled water does not meet the required specifications.	Framework for Direct Potable Reuse (WateReuse, 2015).	
Environmental Buffer	Natural Buffer	A water body such as an aquifer, wetland, river, or reservoir which provides a number of benefits. Benefits include contaminant removal, dilution and blending, and time to detect and respond to failures before final treatment and distribution. These benefits, in conjunction with varying levels of upstream treatment, provide the necessary public health assurances required of potable reuse projects.	Adapted from 2013 City of San Diego WPDP Final Report Glossary (San Diego, 2013).	
Filtration		A process that separates small particles from water by using a porous barrier to trap the particles while allowing the filtered water to pass through.	2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, numerous places. Title 17, Section 64651.43. Filtration.
Finished Water		Water produced by an advanced water treatment facility that meets all federal, state, and local regulatory requirements for a drinking water treatment plant. Finished water can be introduced directly into a water supply distribution system.	Framework for Direct Potable Reuse (WateReuse, 2015).	

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Full Advanced Treatment (FAT)	Also see *Advanced Treatment*	The treatment of an oxidized wastewater using a reverse osmosis and an oxidation treatment process.	CCR Title 22, Sec. 60320.201. Full advanced treatment is the treatment of an oxidized wastewater, as defined in section 60301.650, using a reverse osmosis and an oxidation treatment process.	Title 22, Section 60320.201 and 60320.200.
Groundwater		Water beneath the land surface that supplies wells and natural springs. A groundwater basin is any underground area that has the capacity to store water.	2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, Section 60301.370, and numerous other places. WC, numerous places.
Groundwater Replenishment Reuse Project	Groundwater Recharge Project, Indirect Potable Reuse, Aquifer Storage and Recovery	The process of adding recycled water to a groundwater basin for use as a source of water for drinking water supplies. Surface spreading involves augmenting groundwater with tertiary treated recycled water via spreading basins followed by soil aquifer treatment. In addition, full advanced treatment is needed for augmenting groundwater with recycled water by direct injection.	Title 22 Sec 60301.390. Ground- water Replenishment Reuse Project (GRRP). "A “Groundwater Replenishment Reuse Project” (GRRP) involves the planned use of recycled municipal wastewater that is operated for the purpose of replenishing a groundwater basin designated in the Water Quality Control Plan [as defined in Water Code section 13050(j)] for use as a source of municipal and domestic water supply.	Title 22, Section 60301.390, and numerous other places.

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Indirect Potable Reuse		The addition of recycled water to augment groundwater or surface waters. Groundwater and surface waters are considered environmental buffers for providing public health protection benefits, such as contaminant attenuation dilution, and time to detect and respond to failures before final treatment and distribution. Indirect potable reuse can used advanced treated water, but can also be accomplished with tertiary effluent when applied by spreading (i.e., groundwater recharge) to take advantage of soil aquifer treatment (SAT).	2013 City of San Diego WPDP Final Report (San Diego, 2013). Framework for Direct Potable Reuse (WateReuse, 2015). Section 13561(c) "Indirect potable reuse for groundwater recharge" means the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system, as defined in Section 116275 of the Health and Safety Code.	Title 22, numerous places. WC, numerous places.
Membrane Filtration		A term used for a group of mechanical filtration treatment processes used to separate particles and/or molecules from water. Membrane filters are characterized by the size of the openings (pores), which are ranked from the largest to the smallest pore size: microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.	Adapted from the 2013 WPDP Final Report (San Diego, 2013).	Title 22, numerous places. Membrane. Title 17, Section 64651.54. Membrane Filtration.
Microfiltration		A low-pressure membrane filtration process that uses tiny, hollow, straw-like membranes separate small suspended particles, bacteria, and other materials from water.	Adapted from 2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, Section 60301.320(b).

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Multi-Barrier Processes		Purification processes that consist of several independent barriers that provides reduction and or elimination of chemical and pathogen constituents. Example treatment processes include: filtration; disinfection; microfiltration; reverse osmosis; advanced oxidation; soil aquifer treatment.	Water Reuse Terminology (ACWA, 2016).	
Non-Potable Reuse	Recycled Water	Includes all recycled or reclaimed water reuse applications except those related to water supply augmentation and drinking water (i.e., potable reuse).	WateReuse Glossary www.watereuse.org/product/07-03	Title 22, numerous places. WC, numerous places.
Pathogen		A microorganism (e.g., bacteria, virus, Giardia, or Cryptosporidium) capable of causing illness in humans.	Framework for Direct Potable Reuse (WateReuse, 2015).	
Potable Reuse		A general term for the use of recycled water to augment drinking water supplies. Potable reuse, which covers both indirect and direct potable reuse, involves various forms of treatment options. Potable reuse can be the addition of advanced treated recycled water or purified water to augment a drinking water supply. This form of potable reuse utilizes advanced treatment technology in combination with either environmental or engineered buffers to ensure that all necessary public health requirements are met to allow the water to be used as a drinking water supply. Potable reuse can also be accomplished with tertiary effluent when applied by spreading (i.e., groundwater recharge) to take advantage of soil aquifer treatment (SAT).	WateReuse Glossary www.watereuse.org/product/07-03	

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Primary Drinking Water Standards	Primary Maximum Contaminant Levels (MCLs)	Legally enforceable federal and state standards developed under the Safe Drinking Water Act that must be met by public water systems. Primary drinking water standards protect public health by limiting the levels of contaminants in drinking water.	2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, numerous places. H&SC, Section 116275(c), and numerous other places.
Public Water System (PWS)	Drinking Water System	A system used to provide the public with water for human consumption through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves at least 25 individuals.	Section 1401(4)(A) of the Safe Drinking Water Act.	
Purified Water	Advanced Treated Purified Water	Water that has passed through a wastewater treatment plant and a full advanced treatment plant, and has been verified through monitoring to be suitable for augmenting drinking water supplies.	2013 City of San Diego WPDP Final Report.	
Recycled Water	Recycled Water, Reclaimed Water, Recycled Municipal Water, Water Recycling	Water that is used more than one time before it passes back into the water cycle. For example, wastewater that has been treated to a level that allows for its reuse for a beneficial purpose such as irrigation. Recycled water is sometimes called “reclaimed water.” With additional treatment, including advanced treatment, recycled water can be used as a source of water for a drinking water supply (see potable reuse).	Terminology Source: WateReuse Glossary www.watereuse.org/product/07-03	Title 22, numerous places. WC, numerous places (1350-13569).

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Reliability	Treatment Reliability	The ability of a treatment process or treatment train to consistently achieve the desired degree of treatment, based on its inherent redundancy, robustness, and resilience.	Framework for Direct Potable Reuse (WateReuse, 2015).	
Retention Time	Retention Time	The amount of time that purified water or recycled water is retained in a water body, such as a groundwater basin or surface water reservoir, prior to being extracted.	Adapted from 2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, numerous places.
Response Retention Time		The amount of time that purified water or recycled water shall be retained underground for to allow a project sponsor sufficient response time to identify treatment failures and implement actions necessary for the protection of public health.	Title 22 *Chapter 3. Water Recycling Criteria* Section 60320.124. Response Retention Time. (a) The recycled municipal wastewater applied by a GRRP shall be retained underground for a period of time necessary to allow a project sponsor sufficient response time to identify treatment failures and implement actions, including those required pursuant to section 60320.100(b), necessary for the protection of public health.	Title 22, numerous places.

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Reverse Osmosis		A high-pressure membrane filtration process that forces water through semi-permeable membranes to filter out large molecules and contaminants, including salts, viruses, pesticides, and other materials.	Adapted from 2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, Section 30320.201(a), and numerous other places.
Secondary Drinking Water Standards	Secondary Maximum Contaminant Levels (MCLs)	Drinking water quality standards that serve as guidelines to assist public water systems in managing drinking water aesthetic conditions such as taste, color, and odor.	2013 City of San Diego WPDP Final Report (San Diego, 2013).	Title 22, numerous places. H&SC, Section 116275(d), and numerous other places.
Soil Aquifer Treatment (SAT)	Natural Filtration	The process of treating water by percolating through soil and into an underground aquifer. SAT is a groundwater aquifer recharge option in which water is introduced into the groundwater through soil percolation under controlled conditions. SAT is used to artificially augment the groundwater to withdraw freshwater again at a later stage. During percolation, natural soil filtration occurs and the water enters the aquifer, where mixing occurs.	WateReuse Glossary www.watereuse.org/product/07-03 Sustainable Sanitation and Water Management (www.sswm.info).	Title 22, Section 60320.118.
Source Control		The elimination or control of the discharge of constituents into a wastewater collection system that can impact wastewater treatment, are difficult to treat, and can impair the final quality of the secondary effluent entering the advanced water treatment facility.	Framework for Direct Potable Reuse (WateReuse, 2015).	Title 22, Sections 60320.106 and 60320.206.

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Source Water	Raw Water, Water Source	A local or imported water source that through treatment can be safely utilized as a domestic water supply. Some source water does not require any treatment, while some source water requires additional treatment, to be considered safe for human consumption and meet all federal, state, and local health authority drinking water standards.	Title 17 Section 64402.10. Water Source. **"**Water source" is an individual groundwater source or an individual surface water intake. Sources which have not been designated as standby sources shall be deemed to be water sources.	Title 22, numerous places.
Surface Water Augmentation	Surface Water Augmentation Project (SWSAP), Indirect Potable Reuse	The process of adding purified water to an available surface source water supply (such as a reservoir, lake, river, and/or wetland) for eventual use for drinking water after further treatment.	Adapted from WateReuse Glossary www.watereuse.org/product/07-03	WC, Section 13561(d), and numerous other places.
Title 22 Standards		Requirements established by the California State Water Resources Control Board for the production and use of recycled water. Title 22, Chapter 3, Division 4 of the California Code of Regulations, outlines the level of treatment required for allowable sued for recycled water.	Water Reuse Terminology (ACWA, 2016).	

Term	Related Terms	Definition	References and Sources	Referenced in State Water Board Regulations or Statutes*
Wastewater		Treated effluent from a conventional wastewater treatment facility. The level of wastewater treatment can vary. Wastewater can be domestic wastewater from a municipality or community or is can be industrial/commercial wastewater from industrial facilities and businesses.	Water Reuse Terminology (ACWA, 2016).	
Wastewater Treatment	Conventional Wastewater Treatment	A combination of treatment steps that stabilize and remove solids and organic material from wastewater. Although there are many variations and configurations of wastewater treatment plants, a series of the following steps could be included: preliminary treatment, primary treatment, secondary treatment, tertiary treatment, and disinfection.	Adapted 2013 WPDP Final Report Glossary (San Diego, 2013).	Title 22, numerous places. WC, Section 13625(b), and numerous other places.

* WC = Water Code; H&SC = Health and Safety Code

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APPENDIX C: BIOGRAPHICAL SUMMARIES OF ADVISORY GROUP MEMBERS

Randy Barnard, P.E.
Recycled Water Unit Chief, Division of Drinking Water, California State Water Resources Control Board

Randy Barnard has more than 23 years of experience working with new and advanced water treatment technologies. He has worked with wastewater, recycled water, potable water, and nuclear reactor coolants. Barnard has spent 13 years with California's Division of Drinking Water, and for the last 6 years has been their regulatory authority on recycled water issues. His position manages the review of potable and recycled water projects, including: recycled water treatment and distribution, surface water augmentation, and groundwater recharge projects across California. He provides technical expertise to local, state, and federal governmental agencies, and various private projects worldwide on issues related to the delivery of safe potable and recycled water supplies. Barnard holds a California Professional Engineering License in Chemical Engineering and a B.S. in Chemical Engineering from University of California, San Diego.

Garry Brown
Founder and President CEO, Orange County Coastkeeper

In 1999, Garry Brown founded Orange County Coastkeeper, a grassroots environmental organization that works to protect and preserve the marine habitats and watersheds of the region through education, advocacy, restoration, research, and enforcement. Brown previously served as an assistant city manager, as an advocate and executive director for trade associations in the real estate and building industries, and twice as president of a chamber of commerce. In 2001, he founded the Orange County League of Conservation Voters and in 2006 he commenced publishing "Coastkeeper Magazine." He serves on the Board of Directors for numerous environmental organizations, including Nature Reserve of Orange County, American Green Power, and The Harbor Safety and Oil Spill Response Committee for Port of Los Angeles/Long Beach, and he chairs the OC Transportation Authority Environmental Cleanup Committee. Brown holds a B.A. in Government from University of Redlands.

Amy Dorman, P.E.
Project Delivery Manager, Pure Water San Diego, City of San Diego Public Utilities Department

Amy Dorman has 25 years of experience in the engineering industry, and has worked for the City of San Diego for more than 20 years. She is the Project Delivery Manager for the City's long-term potable reuse program, the Pure Water San Diego Program, and oversees the delivery of Pure Water facility projects from planning through start-up and commissioning. As part of Program planning, Dorman has provided oversight of the Program feasibility studies, drafted the initial 20-year Program schedule, and is overseeing the pre-design of the purified water pipeline. Prior to her work on the Pure Water San Diego Program, she was

involved with several projects that now serve as the basis for the Program, including the Water Purification Demonstration Project and Recycled Water Study. Dorman earned a B.S. from University of California at Berkeley and an M.B.A. from San Diego State University.

Conner Everts
Facilitator, Environmental Water Caucus

Conner Everts is executive director of the Southern California Watershed Alliance and co-chair of the Desal Response Group. He is chair of Public Officials for Water and Environmental Reform (POWER). Everts was elected to the Casitas Municipal Water District and was president of the Ojai Basin Management Ground Water Agency. He was the convener of the California Urban Water Conservation Council and on is on the state task forces on TMDLs, Desalination, and the SWRCB recycled water stakeholder process. He feels his most important work is as elder advisor to the Environmental Justice Coalition for Water and with the Southern California Steelhead Coalition; in this capacity he helps remove dams on streams where he caught fish as a youth.

Jim Fiedler, P.E.
Chief Operating Officer, Santa Clara Valley Water District

Jim Fiedler leads Santa Clara's water supply program, which includes water importation, surface reservoir operations and storage, groundwater management, raw and treated water delivery, drinking water treatment, water recycling and purification, and conservation programs. A member of the water district staff since 1982, Fiedler has more than 35 years of leadership and engineering experience in the area of water supply, flood protection and watershed stewardship. He serves as the Chair of the San Francisco Estuary Institute (SFEI) Board of Directors and on the board of the WateReuse Association, and is Past President of National Association of Flood and Storm Management Agencies (NAFSMA) and a past Board member of the San Francisco Bay Planning Coalition Fiedler holds a B.S. in Civil Engineering from Loyola Marymount University in Los Angeles and an M.S. in Civil Engineering from Stanford University. He is a registered civil engineer in the State of California.

Julie L. Labonte, P.E.
Senior Vice President and Director of Programs-Americas, MWH Global

Julie L. Labonte has more than 26 years of experience in utility engineering in both the private and public sectors. At MWH Global, she helped guide the strategies of the company's program management practice. She is now the MWH Program Consultant Manager for the multi-billion dollar San Diego Pure Water Program, the leading potable reuse infrastructure program in the nation. Before joining MWH, Labonte was Director of the San Francisco Public Utilities Commission's $4.7 billion Water System Improvement Program (WSIP), one of North America's largest water capital improvement programs. Labonte was named the 2013 Government Civil Engineer of the Year in the U.S. by the American Society of Civil Engineers and received the Outstanding Civil Engineer in the Public Sector in the State of California award from the same organization in 2011. She is involved with Water for People and is also on the board of Africa Development Promise. Labonte holds a B.S. in

civil engineering from United States International University in San Diego, and master's degrees in civil engineering and environmental engineering from San Diego State University and University of California at Berkeley, respectively. She is a registered civil engineer in the State of California.

Albert C. Lau, P.E.
Director of Engineering and Planning, Padre Dam Municipal Water District

Albert Lau has more than 20 years of experience in water utilities in both the public and private sectors. He currently plans, organizes, and executes the daily operations of the Engineering Department for Padre Dam, including the capital improvement program, development services, and construction management. Additionally, he is responsible for developing and implementing the potable reuse program, including the Advanced Water Purification Demonstration Project. Lau is a member of the Regional Advisory Committee for the San Diego Integrated Regional Water Management Program, which provides leadership in regional water resources management and planning. He serves as Vice Chair for the Technical Advisory Committee for the Metro Wastewater JPA and is a member of the Cal-Nevada Advanced Operators Certification Committee. Lau holds a B.S. in Civil Engineering from California Polytechnic University, Pomona; an M.S. in Civil Engineering from University of Colorado, Boulder; and an M.B.A. from San Diego State University. He is a registered civil engineer in California.

Bruce Macler, Ph.D.
Toxicologist, US Environmental Protection Agency

Bruce Macler has provided expertise on toxicology and risk assessment for environmental water issues for the US Environmental Protection Agency since 1989. He manages regulatory workgroups and an extensive research program on drinking water treatment, coordinates water-related emergency response, and is involved in public outreach and communications. Prior to joining the EPA, Macler held academic and research positions at NASA, University of California (UC) Berkeley, and State University of New York (SUNY) Stonybrook. He has authored more than 90 articles and research publications on biotechnology, microbial risk assessment and drinking water regulations, and teaches and lectures widely. He holds a B.S. and Ph.D. in Biochemistry from UC Berkeley.

Traci Minamide, P.E., BCEE
Chief Operating Officer, LA Sanitation (City of Los Angeles)

Traci Minamide assists the General Manager of LA Sanitation (LASAN) with an emphasis on waste water treatment and water reclamation. She has served the City for more than 25 years in many capacities including water planning, industrial pretreatment, environmental regulations, wastewater treatment, and water reclamation. Minamide holds a B.S. in Civil Engineering from California State Polytechnic University at Pomona, an M.S. in Environmental Engineering from Loyola Marymount University, and a certificate in Executive Management for State and Local Government from Harvard University. She is a licensed civil engineer in the State of California and a Board Certified Environmental Engineer through the American Academy of Environmental Engineers and Scientists. She currently serves on the Board of Directors for the California Association of Sanitation Agencies.

Edward Moreno, M.D., M.P.H.
Monterey County Health Officer and Director of Public Health

As County Health Officer for Monterey, California, Edward Moreno enforces health and safety code and local ordinances that protect public health. His work focuses on protecting individuals, families, and communities from threats such as food and water borne illnesses, natural and man-made disasters, toxic exposures, and preventable injuries. As the representative of the California Conference of Local Health Officers, he provides a public health perspective on matters related to direct potable reuse. He received a B.S. from University of Notre Dame, an M.D. from University of California, San Francisco, and a M.P.H. from California State University, Fresno.

Keith R. Solar, Esq.
Managing Shareholder, San Diego Office, Buchanan Ingersoll & Rooney, LLP

Keith Solar represents public and private clients in connection with water rights and water-related issues, with particular emphasis in desalination and potable reuse. Since 2002, he served as special counsel to the City of Carlsbad, and since 2012, he has represented IDE Americas, Inc., each with respect to the Claude "Bud" Lewis Carlsbad Desalination Plant, a 54 million gallons per day seawater desalination plant, designed and operated by IDE, which is the largest in the Western Hemisphere. Solar has extensive experience related to negotiating and documenting the purchase, sale, and lease of adjudicated groundwater rights and real property acquired for associated water rights. He has also worked on projects related to the acquisition, disposition, and lease of privately owned or municipal water systems, and on many technical and legal issues related to desalination facilities. In 2014 and 2015, he was named "Water Law – Attorney of the Year in California" by Corporate INTL Magazine. Solar holds an A.B. from Indiana University and a J.D. from McGeorge School of Law at University of the Pacific.

Frances Spivy-Weber
Vice Chair, California State Water Resources Control Board

Frances Spivy-Weber was first appointed to the State Water Resources Control Board in 2007, reappointed and elected Vice-Chair of the Board in 2009, and reappointed by Governor Brown in 2013 to a four-year term. Before being appointed to the Board, she served as the executive director of the Mono Lake Committee since 1997. From 1983 to 1992, Weber served as the director of international programs for the National Audubon Society. She previously was a legislative assistant for the Animal Welfare Institute from 1978 to 1982. Spivy-Weber is currently serving as Chair of the Water Policy Center Advisory Council with the Public Policy Institute of California, and is a member of the Advisory Board of Syzergy. She previously served as a member of the Bay-Delta Public Advisory Committee and co-chair of its Water Use Efficiency Committee. She was also co-chair of the Southern California Water Dialogue and convener of the California Urban Water Conservation Council. She has served on many boards, including the Water Education Foundation, California Council of Land Trusts, and Clean Water Action/Clean Water Fund.

Raymond L. Tremblay, P.E., BCEE
Department Head, Facilities Planning Department, Sanitation Districts of Los Angeles County

Raymond Tremblay has been a member of the Sanitation Districts' engineering staff since 1993 and has served in various capacities in wastewater treatment and solid waste facilities planning, construction, operation, and regulatory compliance. He became Department Head in 2013 and is responsible for planning and environmental review for new facilities, property management, and all information services for the Districts. He previously served as Monitoring Section Head for water quality at all wastewater treatment facilities and as Assistant Department Head of the Technical Services Department. Tremblay serves on the Board of Directors for the Urban Water Institute, the WateReuse Association, and Water Environment & Reuse Foundation. He is a Registered Civil Engineer in the State of California and is a Board Certified Environmental Engineer by the American Academy of Environmental Engineers and Scientists.

Andria Ventura
Program Manager, Clean Water Action/Clean Water Fund

Andria Ventura left a 13-year career in publishing in 1995 to work on environmental issues for the New Jersey Environmental Federation, Clean Water Action's New Jersey chapter. As an organizer she worked on a wide array of issues including drinking water protection, the state's Source Water Protection program, and stopping incineration. She also served on her town's environmental commission. Ventura joined the California staff in May 2003, after a two-year hiatus in Hawaii volunteering with the Waikiki Zoo's elephant program and working at the Oceanic Institute. She manages our toxics program which includes overseeing our water cleanup, drinking water contaminants and standards, and chemical policy programs. Ventura represents Clean Water Action on the Californians for a Healthy and Green Economy (CHANGE) Coalition and the BizNGO Policy Working Group, an organization that focuses on reforming state and national policies to adopt safer chemicals and sustainable materials.

Michael P. Wehner
Assistant General Manager, Orange County Water District (Fountain Valley, CA)

Mike Wehner has almost 40 years of experience in water quality control and water resources management. Initially he spent 20 years with the Orange County Health Care Agency. Since 1991, he has worked for Orange County Water District (OCWD). In his current position he manages the Water Quality and Technology Group, which includes the Laboratory, Hydrogeology, Water Quality, Research and Development, and Health and Regulatory Affairs departments. In this capacity, he is involved with OCWD's Groundwater Replenishment System (the nation's largest IPR project), including by providing technical guidance and managing monitoring programs for the purification facility. He also managed OCWD's 8-year Santa Ana River Water Quality and Health Study, which evaluated using effluent-dominated river waters for groundwater recharge. Wehner serves on independent advisory panels for potable reuse projects for Los Angeles Department of Water and Power, Monterey Regional Water Pollution Control Agency, City of San Diego, and Singapore Public Utilities Board. He received a Master's of Public Administration from California State University, Long Beach, and a B.S. in Biological Sciences from University of California, Irvine.

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APPENDIX D: ADVISORY GROUP MEETING DATES AND LOCATIONS

All meetings of the Advisory Group were open to the public.

Meeting #1
February 21, 2014, at CalEPA Building in Sacramento, California

Meeting #2
July 11, 2014, at Orange County Water District in Fountain Valley, California

Meeting #3
November 10, 2014, at Santa Clara Valley Water District's Silicon Valley Advanced Water Purification Center in San Jose, California

Meeting #4
February 20, 2015, at the City of San Diego North City Water Reclamation Plant in San Diego

Meeting #5
May 1, 2015, at Cal EPA Building in Sacramento, California

Meeting #6
July 29, 2015, at Padre Dam Municipal Water District in Santee, California

Meeting #7
October 22, 2015, at San Francisco Estuary Institute in Richmond, California

Meeting #8
January 19, 2016, at Orange County Water District in Fountain Valley, California

Meeting #9
March 3, 2016, at San Francisco Estuary Institute in Richmond, California

Meeting #10
April 8, 2016, at Orange County Water District in Fountain Valley, California

Meeting #11
June 15, 2016, at CalEPA Building in Sacramento, California