# Roadmap for Direct Potable Reuse: Considerations for Implementing DPR through the Pure Water Southern California Program

September 2024

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

PURE WATER SOUTHERN CALIFORNIA

LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste Into Resources

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## Acronyms and Abbreviations

| | |
|---|---|
| AMP | Allen-McColloch Pipeline |
| AWPF | Advanced Water Purification Facility |
| AWT | Advanced water treatment |
| AWTF | Advanced Water Treatment Facility |
| AWTO | Advanced Water Treatment Operator |
| BAC | Biological activated carbon |
| CECs | Constituents of Emerging Concern |
| CEQA | California Environmental Quality Act |
| CIP | Capital Investment Plan |
| CWEA | California Water Environment Association |
| DDW | Division of Drinking Water |
| Diemer | Robert B. Diemer Water Treatment Plant |
| DPR | Direct potable reuse |
| IPR | Indirect potable reuse |
| ISAP | Independent Science Advisory Panel |
| Jensen | Joseph Jensen Water Treatment Plant |
| MBR | Membrane bioreactor |
| Metropolitan | Metropolitan Water District of Southern California |
| Napolitano Center | Grace F. Napolitano PWSC Innovation Center |
| NPR | Non-potable reuse |
| ODP | Oxidation Demonstration Project |
| PCS | Pressure Control Structure |
| PWSC | Pure Water Southern California |
| RO | Reverse osmosis |
| RWA | Raw water augmentation |
| Sanitation Districts | Los Angeles County Sanitation Districts |
| SCADA | Supervisory Control and Data Acquisition |
| SWA | Surface water augmentation |
| SWP | State Water Project |
| SWRCB | State Water Resources Control Board |
| THM | Trihalomethanes |
| TOC | Total organic carbon |
| TWA | Treated water augmentation |
| Warren Facility | A.K. Warren Water Resource Facility |
| Weymouth | F.E. Weymouth Water Treatment Plant |
| WQDP | Water Quality Demonstration Plant (formerly ODP) |
| WTP | Water Treatment Plant |

# 1 Executive Summary

The Metropolitan Water District of Southern California (Metropolitan), in partnership with the Los Angeles County Sanitation Districts (Sanitation Districts), is developing the Pure Water Southern California (PWSC) program to produce purified water to augment Southern California's drinking water supplies. A central element of this program would be an advanced water purification facility (AWPF) that would purify treated wastewater for indirect potable reuse (IPR) through groundwater recharge and direct potable reuse (DPR) through raw water augmentation (RWA) and/or treated water augmentation (TWA). A simplified illustration of these two forms of DPR are shown in Figure 1. RWA would introduce purified water from the AWPF into the raw water supply upstream of Metropolitan's existing drinking water treatment plants (WTPs), specifically, the F.E. Weymouth and Robert B. Diemer Water Treatment Plants, while TWA would introduce purified water directly into Metropolitan's treated water distribution system.

This white paper outlines how DPR is being considered within the PWSC program, the implications of recently adopted DPR regulatory requirements, the considerations and research needs for implementing DPR, the benefits and challenges associated with different forms of DPR, and the recommended next steps for Metropolitan.

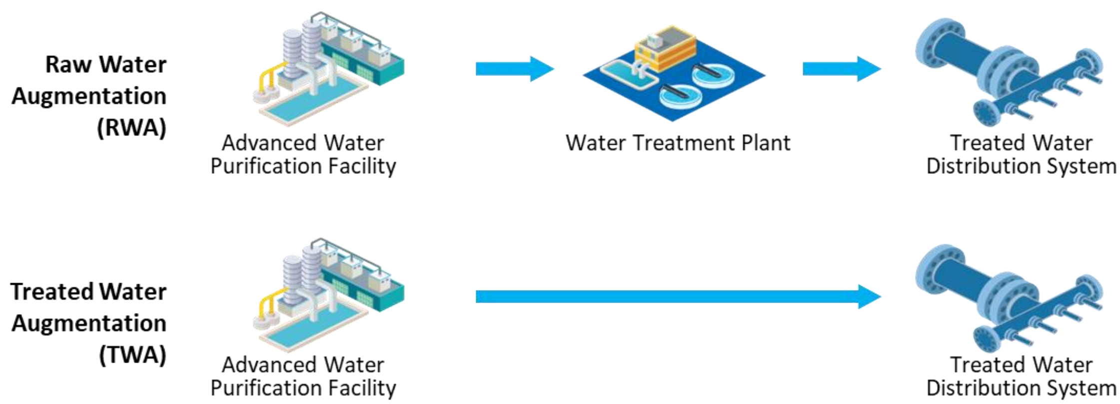


**Figure 1: Illustration of the Two Forms of DPR**

Regulatory requirements for DPR in California were adopted by the State Water Resources Control Board (SWRCB) on December 19, 2023, approved by the California Office of Administrative Law (OAL) on August 6, 2024, and will go into effect on October 1, 2024. These regulations establish comprehensive guidelines to achieve exceptionally high levels of treatment, exceeding those required for surface water, when using municipal wastewater as a source of supply. DPR requires an extraordinary level of performance validation, real-time monitoring, integrated automated control and response, stringent operator certification, and meticulous coordination, protocols, and planning. The regulations were designed to ensure seamless communication, operation, monitoring, and response among all agencies involved in a DPR project for safeguarding the public water supply. The requirement for the DPR responsible agency (known as the "DiPRRA") to possess the necessary technical, managerial, and financial capacity—such as identifying funding sources to cover 20-year life cycle costs and ensuring the availability of financial, physical, and personnel resources when needed—underscores the stringent nature of these regulations. To deliver a robust DPR project across multiple agencies, the regulations mandate a long-term commitment of resources to ensure alignment of funding, staffing, technical expertise, and comprehensive management—all vital for sustaining a complex DPR project and protecting public health.

Through the PWSC program, Metropolitan has been developing its strategy for IPR, as well as RWA, in recent years. The recent adoption of regulatory criteria for DPR offers an opportunity to also explore TWA as part of the PWSC program. Metropolitan is currently assessing phasing options that consider both RWA and TWA. Integrating DPR into Metropolitan's existing water treatment and distribution system presents unique challenges and opportunities. Both forms of DPR require research on treatment process selection, water quality, and the hydraulic and operational impacts on distribution systems, whether involving new or existing infrastructure. The introduction of new water sources into the distribution system can alter flow patterns, detention times, and water chemistry, potentially affecting disinfectant residual stability, corrosion control, biofilm control, and microbial quality. These factors must be thoroughly examined.

Metropolitan's adaptive research approach, which has been successfully applied to past treatment innovations, will be used to address knowledge gaps, validate treatment performance, and build operational expertise for DPR implementation. Metropolitan has identified key next steps in the areas of water quality and technical research, partnerships and outreach, and operational and workforce readiness to inform the decision-making process for the optimal integration of DPR water into the public water system, ensuring continued reliable supplies of high-quality water delivered to its member agencies.

A DPR Research Plan will be developed addressing actions noted below and further detailed in Section 7 of this white paper.

### 1.1 Water Quality and Technical Research

A comprehensive plan will be developed that identifies research needed to address knowledge gaps for both RWA and TWA, identify effective treatment strategies, formulate monitoring and response system concepts, and evaluate potential impacts on raw and treated water distribution systems. Executing a comprehensive DPR Research Plan will require staffing, equipment, and facility resources, as much of the work will expand current duties and responsibilities. Budgeted Capital Investment Plan (CIP) funds will be leveraged for expanding the testing capabilities at the Grace F. Napolitano PWSC Innovation Center (Napolitano Center). Technical studies will also be necessary to develop conceptual facilities and improvements to address the operational and hydraulic complexities of integrating DPR into Metropolitan’s existing treated water system. Studies are also proposed to assess feasibility, environmental impact, and cost associated with the integration of purified water into the treated water system through TWA.

### 1.2 Partnerships and Outreach

Partnering with leading research institutions and industry experts will be crucial for advancing DPR development for Metropolitan. Engaging with industry and associations to spearhead efforts in identifying appropriate real-time monitoring technologies will be critical to the success of research and regulatory permitting for the AWPF. Continuing close collaboration with regulators and Metropolitan's Independent Science Advisory Panel (ISAP) will be essential to ensure appropriate prioritization and scope for all necessary research initiatives.

Public engagement is a key component of these partnerships, crucial for further developing Metropolitan's approach to DPR. Building on existing research regarding public opinion on potable reuse, community outreach will help foster a well-informed and supportive public, essential for the successful implementation of DPR.

### 1.3 Operational and Workforce Readiness

DPR projects require a comprehensive treatment and monitoring regime due to the unique nature of the source water, which, unlike surface water, is not specifically protected or selected to minimize reliance on treatment. The multiple barriers utilized in DPR demands an exceptional attention to detail, ensuring that the final treated water is safe for public consumption. Developing in-house expertise will be integral to the successful implementation of a DPR project, consistent with how Metropolitan has historically adapted innovation into existing practices for treatment and conveyance.

Building operational readiness will begin with a core group of stakeholders possessing the required expertise for successful DPR implementation. Significant collaboration will be necessary between Metropolitan and the Sanitation Districts to ensure consistency across the program's DPR concepts. Lastly, governance and agreements must be clearly defined, along with detailed plans describing how the DiPRRA will meet the extensive requirements for communication and coordination on treatment, operations, monitoring, and response. The DiPRRA must maintain real-time knowledge of treatment status and possess the capacity for rapid, well-planned remedial actions when necessary to ensure the protection of public health.

## 2 Introduction

This white paper provides an overview of the considerations for implementing DPR within the PWSC program. It summarizes the DPR regulatory requirements, highlights key considerations and research needs, and outlines the benefits and challenges associated with both forms of DPR—RWA and TWA. The paper concludes with a series of recommended actions to guide the decision-making process for optimally integrating DPR water into Metropolitan's water system, while ensuring the continued delivery of reliable, high-quality water to Metropolitan's member agencies.

### 2.1 Forms of DPR

DPR is the planned introduction of recycled water either directly into a public water system (TWA) or into a raw (untreated) water supply immediately upstream of a WTP (RWA). For Metropolitan, RWA would introduce purified water from the AWPF into the raw water supply upstream of Metropolitan's Weymouth and Diemer plants. TWA, on the other hand, would introduce purified water directly into the treated water distribution system.

## 2.2 Current Program Setting for DPR

Metropolitan and the Sanitation Districts are collaboratively developing the PWSC program, a large-scale regional recycled water program designed to reuse water currently discharged to the Pacific Ocean. The program entails constructing an AWPF to treat effluent from the Sanitation Districts' A.K. Warren Water Resource Facility (Warren Facility) in Carson, California. It also involves building a new conveyance system and associated infrastructure to use the purified water to augment regional water supplies. Recycling water from municipal wastewater facilities, such as the Warren Facility, is a critical strategy for diversifying and sustaining long-term water supplies for Metropolitan's member agencies. Technological advancements and the recent adoption of DPR regulations have created new pathways for these direct forms of water recycling, supporting a more integrated water resources plan that harnesses water currently discharged to the ocean.

The PWSC program would purify primary or secondary wastewater effluent from the Warren Facility using a membrane bioreactor (MBR) combined with advanced water treatment (AWT) processes, including reverse osmosis (RO) and an ultraviolet light/advanced oxidation process (UV/AOP). This AWPF would produce water suitable for potable reuse, including IPR through groundwater recharge, and with additional treatment, DPR through either RWA or TWA. The PWSC program would also have the flexibility to supply non-potable users with water that meets or exceeds their quality requirements.

As currently envisioned, the PWSC program would be implemented in phases, ultimately reaching a capacity of 150 million gallons per day (MGD). This capacity would depend on the availability of source water at the Warren Facility and the anticipated water demands of member agencies. A significant portion of the purified water is expected to be used for groundwater replenishment by member agencies, and a smaller portion used for DPR. Ongoing efforts are focused on determining the optimal phasing for PWSC, including evaluating the range of pathways for RWA and TWA. Further discussion on the various considerations, benefits, and challenges associated with both forms of DPR is provided later in this white paper.

## 2.3 Evolution of DPR in the PWSC Program

Initially, the PWSC program was conceived as an IPR project, with potential for DPR to be explored in the future. Regulatory requirements existed for IPR, such as groundwater replenishment, but not for DPR. Legislative efforts, including California SB 918 (2010), SB 322 (2013), and AB 574 (2017), laid the groundwork for regulations, with AB 574 mandating the development of these regulations by December 31, 2023. This mandated timeline presented an opportunity for Metropolitan to integrate DPR into the PWSC program.

In 2019, the SWRCB's Division of Drinking Water (DDW) began crafting a single regulatory package that would cover both forms of DPR—RWA and TWA. As regulatory certainty increased, the PWSC program evolved to include potential DPR applications. After extensive industry research, including funding contributions from Metropolitan, the draft DPR regulations were released in July 2023, adopted by the SWRCB in December 2023, approved by OAL in August 2024, and will be incorporated into the California Code of Regulations (CCR) Title 22 and take effect on October 1, 2024.

The new regulations require a high degree of treatment, monitoring, certified staffing, source control, and other elements to compensate for the shortened response time compared with IPR regulations. These features ensure that wastewater treated to drinking water within days or hours is safe for consumption, offering public health protection equal to or better than current drinking water standards. These regulations also open the door for potentially incorporating TWA into water reuse programs.

In 2022, Metropolitan decided to incorporate DPR into the PWSC program, beginning with a ≤ 10 percent DPR blend (25 MGD) through RWA in Phase 1. This approach would allow the program to avoid additional treatment requirements such as ozone/biological activated carbon (BAC) at lower blends. Phase 2 would increase the blend to 25 percent (up to 60 MGD), based on the combined minimum daily flows at the Weymouth and Diemer plants. This gradual adoption of DPR, starting with a low RWA blend and potentially progressing to higher blend RWA, was a prudent strategy to minimize public health risks, such as from unknown compounds that may emerge in the future. In addition, RWA would allow Metropolitan to utilize the Weymouth and Diemer plants for additional treatment and adapt conservative practices to ensure treatment exceeds regulatory requirements when incorporating a new source into the public water supply.

The recently adopted DPR regulations, however, now offer an opportunity to explore TWA as a component of the PWSC program. As part of an ongoing rephasing effort, Metropolitan is considering a smaller initial phase of the program, with capacities ranging from 30 to 115 MGD, that includes the potential to integrate TWA as the program progresses. A key benefit of this phased approach is the ability to develop TWA concepts and establish a regulatory and implementation pathway in parallel with the launch of a smaller IPR project. This strategy allows for the necessary time to gather data and support informed decision-making.

Given that the anticipated timeline for TWA development is several years, Metropolitan may consider decoupling efforts for IPR and DPR. This would allow an IPR project to be built first with a configuration that supports future program expansion, including an option to incorporate either RWA or TWA at a future time. Further analyses will be performed through the end of 2024 before a recommendation is made for a rephased program.

## 3 DPR Regulatory Overview

California's potable reuse regulations, governed by the SWRCB's DDW, are at the forefront of advancing water sustainability through the innovative treatment and reuse of wastewater. These regulations cover both IPR and DPR.

IPR regulations, detailed in California CCR Title 22, Division 4, Chapter 3 Water Recycling Criteria, Articles 5.1, 5.2, and 5.3, set rigorous standards for treatment, monitoring, and reporting for projects that recharge groundwater basins or augment surface water reservoirs with treated wastewater. Meanwhile, California's DPR regulations (California CCR Title 22, Division 4, Chapter 17 Surface Water Treatment, Article 10) specify requirements for safely introducing highly treated wastewater directly into the potable water supply. These regulations, supported by extensive scientific research and strict public health standards, exemplify California's commitment to securing its water future while ensuring the highest levels of safety and environmental stewardship.

The DPR regulations clarify the required level of treatment for RWA or TWA, specifying the need for diverse treatment mechanisms for both pathogen and chemical control, and acute and chronic risk mitigation to ensure robust public health protection. The regulations require four treatment processes for pathogen control, using three different treatment mechanisms (physical separation, chemical inactivation, and UV inactivation) for each reference organism, that is, virus, *Giardia*, and *Cryptosporidium.* They also require three treatment processes for chemical control, using three different treatment mechanisms (RO, AOP, and ozone/BAC). Alternatives to some of these requirements can be proposed for consideration, if equal or better treatment is provided and key regulatory criteria are met.

Other important elements of the DPR regulations include comprehensive requirements for treatment processes to achieve high levels of pathogen and chemical contaminant removal, continuous online monitoring, and frequent sampling and reporting to ensure the safety and reliability of the water produced. The regulations also mandate robust institutional agreements and governance frameworks captured in a "Joint Plan", which is an overarching document that defines the roles and responsibilities of all entities involved in the DPR project, such as the municipal wastewater agency and any agency that uses DPR water as a source of water supply. Developing the Joint Plan requires extensive negotiations, legal review, and ongoing management to ensure compliance.

The regulations also require treatment validation studies, enhanced source control, risk management and water safety plans, emergency response plans, public notification procedures, continuous compliance monitoring, water quality response protocols and corrective actions, treatment optimization, corrosion control and stabilization plans, operator certification, and comprehensive reporting—far more extensive than existing IPR requirements.

### 3.1 Treatment Requirements and Implications

A key requirement of the DPR regulations is the need for additional treatment processes, which could be integrated at the AWPF in a TWA scenario or leveraged at existing WTPs like Weymouth or Diemer in an RWA scenario. DDW's Initial Statement of Reasons for the DPR Regulations (SBDDW-23-001, dated July 21, 2023) highlights the wide range of risk management benefits offered by different RWA scenarios, though only some of the benefits can be specifically utilized to meet DPR requirements.

RWA provides several advantages over TWA, including an extended response time buffer provided by conveyance to and through the WTPs, as well as the additional treatment at the WTPs. These benefits are unique to RWA and are not replicated in a TWA scenario.

The value of incorporating the WTP, an existing capital asset, in an RWA scenario includes the following: (1) treatment credit (i.e., chemical disinfection for pathogens using ozone and chlorine), (2) a buffer in response time and operational flexibility, (3) longitudinal mixing enhancing water quality, (4) a long history of continuous and comprehensive water quality monitoring and compliance that can be built upon, (5) robust treatment performance through the WTP that can aid in public acceptance, (6) centralized source water blending and distribution, and (7) certified and trained operations staff.

However, utilizing the WTP in the DPR process also requires significant infrastructure to convey AWPF effluent to the WTPs, thorough testing to confirm treatment efficacy, and additional compliance with DPR regulations. This includes increasing monitoring, performing corrosion control studies, overhauling WTP plans to meet DPR standards, and amending existing domestic water supply permits. The complexity of monitoring, response, and coordination increase significantly under an RWA scenario when compared to the existing processes and procedures that are currently in place at the WTPs.

In contrast, TWA may reduce the need for extensive conveyance infrastructure and avoids the challenges of integrating DPR water with existing WTPs. However, TWA introduces water directly into the treated distribution system with less of a buffer and response time, requiring more stringent treatment at the AWPF and comprehensive controls to mitigate potential water quality variability that may persist from the wastewater influent through the AWPF effluent. TWA also presents challenges such as the potential for increased nitrification (due to reduced flows in portions of the system) and operational complexities (pumped system versus the current gravity-fed system) in managing the treated water distribution system and water quality. Detailed technical studies are required to fully evaluate feasibility and identify mitigation measures for each of the challenges listed above.

### 3.2 Operator Certification Requirements and Implications

Figure 2 illustrates the minimum operator certifications required for each treatment location in an RWA scenario, which would be the most conservative due to the three distinct locations bounded by operational responsibility or geography (i.e., for the MBR, the AWT facility [AWTF], and the Weymouth or Diemer plant). In a TWA scenario, the required staffing at the Weymouth and Diemer plants would be excluded.

Per Section 64669.35(a) of the DPR regulations, any facility providing pathogen, chemical or corrosion control is a WTP as defined in Health and Safety Code section 116275(w) and subject to associated drinking water operator certification requirements. The WTP classification is determined by CCR §64413.1, and the minimum certification requirements are defined in CCR §63765. All five of Metropolitan’s WTPs are classified as T5 facilities, and treatment facilities considered by the DDW as WTPs for the DPR project would also be designated as a T5 facility. As shown in Figure 2, a key requirement for the Sanitation Districts is to have T3 and T5 certified staff operating the MBR, as this facility provides pathogen control and is therefore considered a WTP.

The regulations also specify that a chief or shift operator be onsite at all times where a pathogen or chemical control process is used. After 12 months of operation, the DiPRRA may apply for a waiver to allow alternate arrangements per an operations plan that “demonstrates an equivalent degree of operational oversight and treatment reliability” with remote operations. Lastly, the entire treatment train for the DPR project where pathogen or chemical control is provided must be overseen by a T5 chief operator and T3 shift operator for each operating shift.

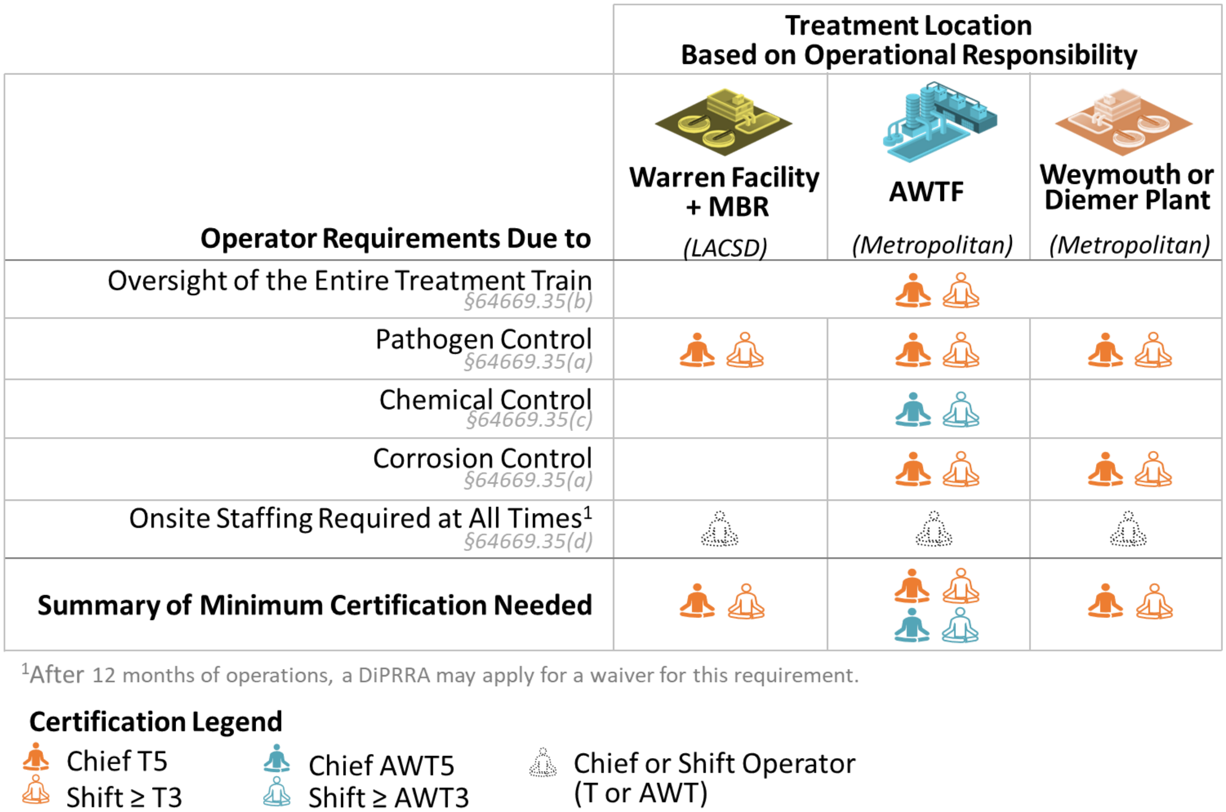


**Figure 2: Summary of Certified Operators Required in an RWA Scenario**

The regulations also require a new class of operators certified through the Advanced Water Treatment Operator (AWTO) program, jointly managed by the California-Nevada Section of the American Water Works Association and the California Water Environment Association, at DPR treatment facilities where chemical control is taking place (e.g., at the AWTF). Specifically, the regulations require that the chief operator at these facilities hold an AWT5 certification, and the shift operators hold at least an AWT3 certification.

For the PWSC program, the most extensive implementation of this regulation would require certified operators to oversee the MBR, AWTF, and WTP in an RWA scenario. To ensure a sufficient pool of certified operators, Metropolitan and the Sanitation Districts must invest in staff development, including identifying required expertise, creating job descriptions, and developing robust training, recruitment, and retention strategies for future program implementation. An aspect of the current PWSC program is the provision of appropriate facilities to attract and train staff for both Metropolitan and the Sanitation Districts to attain and maintain the required operator certifications.

### 3.3 DPR Projects and Regulations in the United States

Given the stringent nature of the DPR regulations, collaboration with other agencies pursuing DPR projects will be beneficial for Metropolitan enabling knowledge sharing, collective advocacy, and industry engagement. For example, the Los Angeles Department of Water and Power (LADWP) is exploring the potential for RWA and TWA and developing options through the Pure Water Los Angeles Master Plan (in partnership with Los Angeles Sanitation and Environment). LADWP has also nearly completed construction of a small-scale DPR Pilot Project exploring TWA at the Tom LaBonge Headworks Water Complex. This pilot will test emerging technologies and generate preliminary data to inform future potable reuse efforts.

Similarly, Santa Clara Valley Water District (Valley Water) is advancing its Potable Reuse Project, and currently evaluating the construction of a DPR pilot-scale system in parallel with development of a DPR demonstration facility to support a future potential RWA or TWA project. These initiatives would generate water quality and operational data, inform design parameters, facilitate regulatory approval, and train operators for future full-scale AWPF development.

Other California cities or agencies developing or considering DPR projects include the City of San Diego (Pure Water San Diego), the City of Santa Monica, San Francisco Public Utilities Commission, East Bay Municipal Utility District, Central Costa Contra Sanitary District, and Moulton Niguel Water District (Optimized Adaptive Sustainable Integrated Supply).

Outside of California, the implementation of DPR projects in the United States has gained momentum in recent years, with several states considering regulations and utilities leading the way for RWA approaches. States such as Colorado and Arizona are making significant progress in adopting DPR regulations. In Colorado, DPR regulations were adopted by the Colorado Water Quality Control Commission in February 2023. In 2018, the Arizona Department of Environmental Quality updated its reclaimed and gray water rules, lifting the moratorium on the direct potable reuse of reclaimed water. Ongoing rulemaking is intended to establish clear minimum standards for its DPR program, add clarity to the rules, and enhance the sustainability of the state's water supplies.

As of 2023, the only operational DPR facility in the United States is the Colorado River Municipal Water District's Big Spring DPR project in Texas, which has utilized RWA since 2013. The City of Wichita Falls, Texas, also operated a temporary DPR facility for about a year in 2014-2015, which treated over two billion gallons of wastewater effluent into drinking water in an RWA approach. There is also a growing interest in TWA projects nationwide. El Paso Water Utilities is developing the first "pipe-to-pipe" TWA facility in the U.S., anticipated to go online in 2027. It is worth noting that El Paso Water Utilities has had a groundwater recharge project since the 1980s, providing them experience with IPR for many decades before pursuing DPR.

# 4 Metropolitan's Research Approach

Metropolitan has a long history of developing in-house expertise and conducting pioneering research to protect public health while supporting the region's economy and serving 19 million people. Metropolitan's research strategy has included extensive feasibility studies, assessments of operational impacts, and collaboration with state and federal regulatory agencies to develop innovative solutions that comply with evolving regulations and address the region's unique needs.

This type of partnership is exemplified in Metropolitan's successful transition to ozone disinfection at its WTPs. Starting in the 1990s, Metropolitan collaborated with the U.S.

Environmental Protection Agency to develop a compliance strategy for the developing Stage 2 Disinfectants/Disinfection Byproducts Rule. The feasibility and suitability of ozone as an alternative to chlorine disinfection were initially confirmed through extensive bench- and pilot-scale research. Subsequently, construction of a 5.5-MGD Oxidation Demonstration Project (ODP, now known as the Water Quality Demonstration Plant or WQDP) at the Weymouth plant equipped Metropolitan with an effective research platform to establish ozone as a viable and robust disinfection technology.

As each treatment facility was retrofitted with ozone over a 14-year period (2003 to 2017), additional studies at the WQDP were conducted to enhance and optimize treatment and process robustness, provide cost-effective options, and generate site-specific water quality data. Testing at the WQDP prior to full-scale implementation has allowed Metropolitan to make informed decisions, maximizing the $1.2 billion investment in ozone disinfection at all five treatment plants

By applying the same methodical research approach to IPR and DPR, Metropolitan can address knowledge gaps, validate treatment performance, and build operational expertise. Metropolitan has been conducting bench-, pilot-, and demonstration-scale studies to evaluate the feasibility, reliability, and effectiveness of treatment for IPR, leveraging the Napolitano Center. Since commissioning the facility in 2019, Metropolitan and the Sanitation Districts have been evaluating various treatment process train configurations comprised of MBR, RO, and UV/AOP, and confirming that this train can meet IPR requirements within the scope of the PWSC program. It is anticipated that Metropolitan would make significant modifications and upgrades to the demonstration facility at the Napolitano Center to incorporate the additional treatment processes to conduct pilot- and demonstration-scale studies for DPR applications as discussed below.

## 4.1 DPR Treatment and Operations

Since 2021, Metropolitan and the Sanitation Districts have been collaborating on a comprehensive DPR research approach aimed to address knowledge gaps, validate treatment performance, and optimize operational strategies to ensure the safe and reliable production of purified water. The research program roadmap, illustrated in Figure 3, shows the progression from workshops to desktop literature reviews through various phases of testing. Metropolitan has completed several workshops, a literature review, and bench-scale testing, and is now preparing for the next phase of DPR research by identifying process trains for pilot-scale evaluation.

To support these efforts, budgeted CIP funds will be leveraged for additional testing platforms and improvements at the Napolitano Center. These improvements may include the installation of demonstration-scale ozone and biological active carbon treatment systems, along with process control instrumentation to replicate potential full-scale treatment facilities. In addition, Metropolitan will collaborate with its ISAP and DDW to develop a robust DPR test plan. This plan will focus on evaluating and validating treatment processes in alignment with the DPR regulations. This engagement with the ISAP and DDW was initiated during a recent workshop in early March 2024, which included a presentation and discussion on Metropolitan's DPR approach.

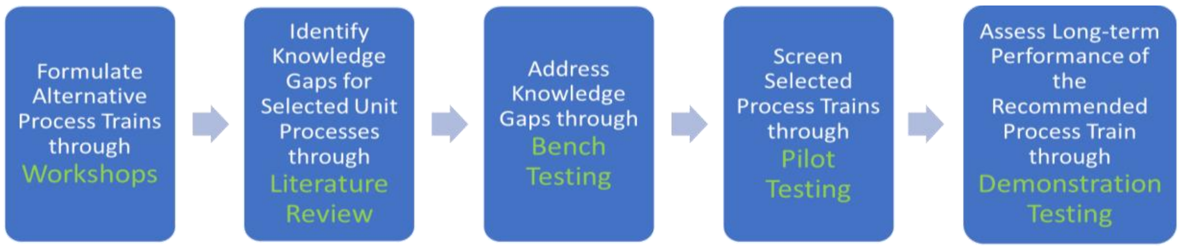


**Figure 3: Research Approach for DPR**

While the testing platforms and plans will be developed using existing resources, additional resources will be necessary to conduct the studies needed to advance DPR. Metropolitan plans to leverage existing partnerships and expand collaboration with industry associations (e.g. WateReuse California), academia, and technology providers.

A key industry initiative that has emerged is a program sponsored by WateReuse California, DPR Investment in Research Enhancing Knowledge Transfer, or DIREKT. This initiative is seeking to foster utility collaboration and leverage resources across California to promote DPR implementation. Although DIREKT is still in its draft stage, Metropolitan is interested in engaging with this knowledge-sharing effort and playing an active role in its development. While some DPR research is site-specific, whether technical or related to local stakeholder opinions, many of the findings of agencies engaged in DPR research are expected to benefit other organizations pursuing DPR. These insights could help organizations in developing their own forms of DPR implementation and enhance their water supply management, flexibility, and reliability. In short, research outcomes from Metropolitan's ongoing and planned DPR research could support DIREKT, and in turn, Metropolitan will gain from being part of the broader dialogue with other agencies on DPR planning and implementation.

## 4.2 Public Outreach and Acceptance

Metropolitan is spearheading the public outreach and stakeholder engagement for PWSC to build widespread support. The outreach strategy is audience-centric, incorporating a comprehensive set of activities and informational materials tailored to the diverse groups impacted by or interested in the program. The goal of Metropolitan's outreach is two-fold: first, to engage communities where potential program facilities could be constructed, and second, to inform residents in Metropolitan's service area about this potential new water supply.

Key outreach methods include: (1) tours of the demonstration facility to provide firsthand insight into the treatment process, (2) active participation in local community events to foster direct engagement, and (3) informative presentations and collaborative meetings to build awareness and address any concerns. To date, Metropolitan has reached hundreds of thousands of people through these strategies, including through social media and news stories. Additionally, the Sanitation Districts continues to perform extensive outreach to a variety of stakeholders regarding the wastewater treatment process and its critical role in furthering water recycling initiatives.

Metropolitan conducted research on public attitudes and awareness toward potable water reuse in 2022 and again in 2024. This research aimed to assess public familiarity with and support for recycled water, including the PWSC program, as well as to identify specific concerns. Research to-date indicates approximately 70 percent of the public support PWSC when provided information on the need for the program. However, support wanes when critical statements about the program are shared, especially related to the source and quality of the water. Research conducted in 2024, following adoption of the DPR regulations, assessed the public's familiarity with DPR and compared support for DPR versus IPR. While groundwater recharge was the most acceptable method of delivering purified recycled water, a majority found DPR acceptable when provided information on the need for this new water supply and its associated treatment technologies.

The research also assessed different methods of integrating DPR water into a public water supply and the results will guide Metropolitan in refining its messaging for the PWSC program. Further information on Metropolitan's public opinion research can be found in the staff presentation to the Legislation and Communications Committee on August 19, 2024.

The results of the research completed will inform the next steps in Metropolitan's public outreach efforts, which are discussed further in Section 7. By continuously assessing and adapting its public outreach to align with the evolution of the PWSC program, Metropolitan aims to build a well-informed and supportive community, which is essential for the program's successful implementation.

## 5 Considerations for DPR Implementation

Developing a DPR implementation pathway for the PWSC program must consider the key focus areas in Table 1 below. These considerations may differ in their relevance or impact depending on whether the DPR approach involves RWA or TWA. For example, the redundancy and reliability needed to achieve compliance, along with the complexity of risk contingencies, are generally greater with TWA compared with RWA. The considerations related to treatment, water quality, and system operations for both forms of DPR are further detailed in the following sections.

**Table 1: Key Considerations on Implementation Approach for the Two Forms of DPR**

| Topic Area | Focus Area | RWA | TWA |
|---|---|---|---|
| Treatment and Water Quality | Treatment Process Train Development, Optimization, and Validation | Critical | Critical |
| | WTP Impacts | Significant | Moderate |
| | Distribution System Impacts | Moderate | Critical |
| System Operations Integration | WTP Impacts | Minor | Moderate |
| | Distribution System Impacts | Minor | Critical |

**Legend**

- Critical — *Additional effort needed to characterize implications, anticipated to be significant*
- Significant — *Significant known implications*
- Moderate — *Implications anticipated to be mitigatable; evaluation needed*
- Minor — *Implications can be mitigated*

## 5.1 Treatment and Water Quality Considerations

The regulations provide a robust package to ensure the protection of public health. While some requirements are prescriptive, others require the project proponent to demonstrate the capability to meet performance standards through treatment processes and define how they will satisfy regulatory requirements. This creates key data gaps where Metropolitan must evaluate various treatment process options to determine the optimal DPR implementation approach.

### 5.1.1 Treatment Process Train Development and Validation

Addressing critical data gaps is essential for determining Metropolitan's path for DPR within the PWSC program. Research planned at the Napolitano Center will focus on answering key questions through testing anticipated to commence within the next few years through a DPR Demonstration Facility CIP.

Selection of the optimal treatment train requires filling data gaps through this testing. A key treatment research gap is identifying the optimal method to achieve 1-log chemical inactivation of *Cryptosporidium* required for pathogen control. Metropolitan's currently proposed IPR train (MBR + RO + UV/AOP with chlorine disinfection) satisfies all remaining treatment mechanisms (physical removal and UV disinfection) for each pathogen. While the prescribed DPR train includes the ozone/BAC process to meet the chemical inactivation requirement, other approaches that allow flexibility to use the low blend (≤ 10 percent) criteria to avoid ozone/BAC are worth exploring. For example, if RWA or TWA can be implemented below a 10 percent blend, alternative chemical inactivation methods, such as ozone alone, or chlorine dioxide, may offer cost or implementation advantages. Testing is needed to fully assess these options, including potential byproduct formation, operations and maintenance requirements, performance, feasibility, and cost.

Another research priority is validating or finding an alternative to ozone/BAC, which the regulations require upstream of RO when the DPR blend is greater than 10 percent. The ozone/BAC process must be validated to meet prescribed targets; however, limited data are available in the literature in this area. The regulations do allow for alternatives to be proposed that demonstrate the following elements (§64669.50(s)):

- Whether the level of public health protection provided by an alternative process is equivalent to or better than the required treatment.
- How the level of treatment performance and reliability for the proposed alternative will be measured.
- How the alternative process affects downstream treatment process(es) and distribution system water quality.
- How the alternative process affects the fate of wastewater contaminants and treatment byproducts through the treatment train.
- How the alternative affects treatment train reliability.

To identify viable alternatives, Metropolitan must characterize the prescribed treatment train's performance as a benchmark and compare it to potential alternative processes which may include a different relative placement of ozone/BAC treatment (e.g., downstream of RO treatment).

Another key consideration is the evolving science of Constituents of Emerging Concern (CECs). As research in this field advances, the possibility of detecting new contaminants ("unknown unknowns") highlights the need for a comprehensive and conservative approach. In its resolution to adopt the DPR regulations, the SWRCB recommended a coordinated effort to address CECs in drinking water and the environment. Metropolitan will continue to engage with the state and water industry to track CEC research developments and ensure the latest scientific findings are incorporated effectively into the PWSC program.

In addition to addressing key data gaps, DPR regulations require validating existing treatment processes widely used in IPR applications. Unlike IPR, where treatment efficacy for pathogens and chemical contaminants can be assumed, DPR projects must demonstrate treatment efficacy through individual process validation, and correlate this efficacy to a surrogate that can be monitored in real-time. This requires consistent treatment, identification of conservative surrogates, and real-time monitors that reliably represent performance.

While most IPR processes have viable surrogates that will successfully validate pathogen or chemical removal, comprehensive testing plans must be developed to generate the data needed for regulatory acceptance. In addition, although DPR regulations prescribe a treatment train, including ozone/BAC upstream of RO, each process must still be validated for its effectiveness in removing pathogens and chemicals. Opportunities to optimize the treatment train could arise during validation studies, potentially allowing for reductions in treatment design criteria if the data demonstrates that the required performance is still met.

Both forms of DPR require a high level of control and reliability to ensure that the purified water meets and surpasses all applicable drinking water standards and does not compromise the quality or safety of the existing water supply. Achieving DPR compliance requires robust and redundant treatment processes and a comprehensive Supervisory Control and Data Acquisition (SCADA) system for monitoring, control, and response. Per the DPR regulations, the system must alert operators to any trending degradation or significant excursions, and have the capability to halt water flow if necessary to prevent the release of inadequately treated water. Control system features to trend water degradation could utilize advanced data analytics, including machine learning capabilities, which would require rigorous testing and evaluation before a full-scale application.

Compared with RWA, TWA requires greater responsiveness or appropriately sized storage reservoirs to provide sufficient detention time, ensuring no more than 10 percent of flow enters the distribution system during an acute exposure threat. Opportunities for continuous monitoring and enhanced response tools should be explored to advance DPR initiatives.

For context, Metropolitan's WTPs use online analyzers for process monitoring, with continuous monitoring for compliance at only two locations: ozone residual for disinfection credit, and filter effluent turbidity for pathogen removal credit. Significant resources have been invested in selecting reliable continuous monitors at these critical locations. An equivalent or greater level of investment is necessary to identify optimal real-time monitoring solutions for all DPR treatment processes, ensuring prompt response to any excursions that could jeopardize compliance or public health. Evaluating compliance instruments for the full-scale AWPF will involve considering factors such as appropriate surrogates, maintenance requirements, operational costs, site-specific challenges, and sensitivity to changing water quality or environmental conditions.

### 5.1.2 Impacts on Drinking Water Treatment Plants

For RWA, blending studies would be needed to evaluate the impact of integrating DPR water with existing sources (i.e., Colorado River and State Water Project supplies) at the WTPs. AWPF effluent is expected to be highly purified water with low mineral content, which could enhance overall water quality based on current SWTR metrics. However, a comprehensive evaluation is needed to fully understand the impacts of blending on treatment effectiveness at the WTPs, including the efficacy of ozonation, coagulation, filtration, and disinfection with DPR blends.

Initial bench-scale tests have been performed to simulate RWA at the Weymouth and Diemer plants by blending up to 20 percent purified water with Metropolitan's existing source water supplies. Preliminary results indicate that blending at this level has negligible effects on conventional treatment processes, including coagulation, filtration, and total organic carbon removal. However, further studies are recommended to characterize conventional treatment performance at other RWA blend ratios, including considering factors such as seasonal variability, temperature impacts, and other variables that could influence treatment performance or specific metrics required by DPR (e.g., removal of constituents not monitored under SWTR requirements).

A Water Research Foundation study (Project 5049) entitled "Public Health Benefits and Challenges for Blending of Advanced Treated Water with Raw Water Upstream of a Surface Water Treatment Plant in DPR", examined blending of advanced treated effluent as a raw water source for conventional treatment plants. The study generally found that blending had a negligible or even beneficial effect on final water quality. Disinfection byproduct formation did increase in some instances, with results being site-specific. Given Metropolitan's significant role as a regional wholesaler of water, the need for site-specific data is critical.

Additionally, it is important to note that DPR requirements will significantly increase monitoring requirements at the WTPs and the downstream system, using more indices and monitoring parameters to ensure protection of public health. The resources needed to fully characterize treatment performance, along with routine plant monitoring and associated reporting, should be carefully evaluated.

Under current operations, WTPs typically implement operational changes such as increasing the chlorine residual and plant effluent pH to minimize nitrification in the distribution system during the warmer months. Further study is needed to understand whether such operational and chemical changes at the WTPs would be needed throughout the year with TWA, given the higher temperature of AWPF effluent, coupled with longer detention times for WTP effluent in the treated water system. The impacts on disinfection byproduct concentrations would also need to be studied. Integration of TWA could also alter (reduce) flows in other parts of the system that may exacerbate nitrification issues or reduce treatment plants below their minimum sustainable flows, requiring various upgrades to ensure operational reliability and water quality. All of these factors must be thoroughly analyzed for a TWA scenario.

### 5.1.3 Impacts on the Distribution System

Evaluating the potential impacts of DPR on distribution systems, both raw and treated water, is essential. Key considerations for treatment and water quality include (1) chemical stability of the water once blended, particularly its effect on chloramine decay, (2) impacts on biofilms and microbial control, and (3) appropriate targets to mitigate corrosion.

Evaluations for RWA are required in two areas: (1) conveyance from the AWPF to the WTPs, and (2) distribution of treated water from the WTPs. It is critical to establish the appropriate targets to ensure stability, water quality, and corrosion control within the conveyance pipeline (conveying water treated to IPR levels to the service connections) and in the treated water distribution system.

In contrast, TWA would require studies to assess blending DPR water with existing finished water supplies in the distribution system. The AWPF effluent blend in TWA could vary greatly, potentially making up 100 percent of the water served to member agencies based on the variability in demands within a particular treated water pipeline. Service connections closer to the location of the TWA introduction point would be most susceptible to variability in water quality, including diurnal changes that, although dampened, still persist through the AWPF from the wastewater influent.

DPR through TWA would introduce new water into the treated distribution system, which would also alter flow patterns and detention times, adding analytical and operational complexity. Maintaining water quality throughout the treated water distribution system is a critical focus as Metropolitan's system of large-diameter pipelines already faces challenges in maintaining water quality with reduced flows from lower demands and exacerbated by climate change. As indicated earlier, longer detention times can degrade water quality through nitrification. The introduction of TWA may intensify these issues, as other portions of the distribution system may experience further reduced flows and increased water age. To mitigate these potential impacts, the effects of TWA on water age must be analyzed, while considering measures such as installation of chlorine booster stations or other facility improvements.

A notable difference between the AWPF water and existing surface water sources (SWP and Colorado River supplies) is the anticipated higher temperature of AWPF water (median 25°C based on Napolitano Center demonstration testing versus 19°C in imported supplies over the past 10 years). Higher temperatures expected with DPR, whether RWA or TWA, may exacerbate the potential for chloramine decay and nitrification within the distribution system. This risk is especially pronounced during low-demand periods. With TWA, the combination of less flow in the treated water pipelines from the WTPs and the higher temperature AWPF effluent increases the risk of water quality deterioration, more so than with RWA.

Introducing purified water directly into the distribution system may also alter the aggressiveness and corrosivity of the water. Metropolitan currently targets specific corrosion indices at the WTP effluents to ensure the existing treated water distribution system maintains a slightly positive Langelier Saturation Index (LSI). Metropolitan also closely monitors its source water quality data and makes treatment adjustments, as necessary, to ensure that the treated effluent has sufficient alkalinity and is adjusted to optimal pH targets. These strategies help to prevent corrosion and minimize chloramine decay.

Metropolitan has participated in technical exchanges with other water utilities in the region that are actively operating water reuse facilities. These collaborations will help Metropolitan develop a robust approach for introducing purified water into existing systems. Technical studies and research are needed to identify optimal water quality targets in the distribution system that will effectively mitigate corrosion. Additionally, it will be important to evaluate any unanticipated consequences due to blending purified water with existing supplies, such as disinfection byproduct formation or reformation with trace organics and precursors of wastewater origin that may have passed through the AWPF.

Studies to evaluate these critical areas for RWA and TWA could be performed at the Napolitano Center with the addition of post-treatment testing platforms. Alternatively, the existing 5.5-MGD WQDP at the Weymouth plant could be upgraded for longer-term continuous testing to evaluate any unforeseen impacts of introducing purified water into the WTPs. These results would provide a robust dataset for the permitting process for RWA, detailing expected operational conditions, anticipated range of DPR water quality, and the final treated effluent quality following ozonation, conventional treatment, and post-stabilization and disinfection.

### 5.2 System Operations Considerations

Metropolitan's conveyance and distribution system has unique characteristics that must be carefully considered when introducing new supplies, storage facilities, pipelines, and other infrastructure to enhance reliability and resilience. One key characteristic of the system is that it primarily operates by gravity flow after the initial lift provided by pumps on the Colorado River Aqueduct and the California Aqueduct. The pumps and aqueducts move water to major reservoirs, including Lake Mathews, Lake Skinner, Diamond Valley Lake, Castaic Lake, and Silverwood Lake. These reservoirs are strategically located at elevations that ensure the necessary pressure and flow throughout the system. This gravity-fed system simplifies overall operations, compared to the complexity of systems that rely heavily on pumping.

However, Metropolitan's system does have a few pump stations within its distribution network. For example, the Greg Avenue Pumping Plant is used during severe droughts—such as those experienced in 2014-2015 and 2021-2022— to pump water in reverse up the East Valley Feeder to the Joseph Jensen Water Treatment Plant service area. Additionally, there are pump stations along the Allen-McColloch Pipeline (AMP) at OC-88/OC-88A and OC-70 service connections, where Metropolitan pumps water from the AMP to member and retail agencies in the Orange County region. Moreover, Metropolitan periodically operates the Perris Pumpback Facility to pump water from Lake Perris back to the Henry J. Mills Water Treatment Plant under certain operational, hydrologic, or water quality conditions.

Another critical aspect of Metropolitan's system that must be considered is the SWP-dependent portions of the service area. This area is in the northern portion of the system, which is also the highest portion of the system, and is served by Metropolitan primarily through the SWP. It is difficult to move other supplies in Metropolitan's gravity-fed system to these higher elevations. During severe droughts, base SWP supplies can be as low as 100,000 acre-feet, while demands in the SWP Dependent Area can reach 500,000 to 600,000 acre-feet. This disparity puts considerable strain on Metropolitan's storage resources that support the SWP Dependent Area. As such, introducing new supplies, storage, pipelines, and other facilities to bolster the reliability and resilience of this area is crucial.

Given these system characteristics, it is essential to carefully evaluate the optimal approach to integrate DPR into Metropolitan's existing system, whether through RWA or TWA. Each approach presents unique challenges and opportunities that must be thoroughly assessed to ensure successful integration into the system. Anticipated system operations impacts with respect to the drinking water treatment plants and distribution systems for both forms of DPR are explored below.

### 5.2.1 Impacts on the Drinking Water Treatment Plants

DPR through RWA has the potential to impact Weymouth and Diemer plant operations, particularly when integrating a new PWSC pumping system into a primarily gravity-fed network. For example, if PWSC pump trips result in abrupt flow changes at the WTPs, this could require contactors or basins to be added or removed from service to respond appropriately and mitigate treatment impacts. However, if appropriate surge tanks or reservoirs are utilized as a buffer, this could absorb the effects of multiple pump trips, helping to maintain consistent and stable flows to the Weymouth and Diemer plants.

In a TWA scenario, directly introducing AWPF effluent into the treated water system would reduce reliance on Weymouth, Diemer, or Jensen plants to meet system demands. These facilities would need to run at lower flows, a situation already made more challenging by recent swings in SWP availability, which have led to these plants running at lower flows than what they were originally designed for. A high contribution of TWA water to the treated water system could exacerbate these low-flow conditions and the associated operational issues (e.g., turndown limitations) at the WTPs.

### 5.2.2 Impacts on Distribution Systems

DPR through RWA introduces operational complexity to the raw water conveyance system. Managing pump trips and resulting water pressure fluctuations will require careful planning and additional operational effort. One mitigation strategy would be to utilize a small reservoir, such as Live Oak Reservoir in La Verne, as a buffer. The reservoir could absorb the effects of multiple pump trips, and also be used to blend purified water with SWP supplies when necessary.

Existing infrastructure also offers opportunities to streamline the implementation of low-blend RWA (≤ 10 percent DPR blend). For example, repurposing the Azusa Pipeline (owned by the San Gabriel Valley Municipal Water District) to deliver DPR water to the Weymouth plant would simplify integration of RWA and reduce the need for constructing an additional new conveyance pipeline.

As part of a TWA option for the PWSC program, the potential integration of new pump stations would introduce various operational challenges. In a TWA scenario, PWSC pumps would be directly connected to the primarily gravity-fed pipelines of the current treated water system to supply water from the AWPF to existing feeders at higher hydraulic grades. Power interruptions and pressure or flow fluctuations can cause pumps to trip offline, which could instantly change the pressure and flow in the pipeline, requiring management of pressure surges throughout the system. Many existing gravity-fed pipelines and other structures may require reinforcement to withstand these pressure surges, increasing cost and implementation time. Such pressure fluctuations require operators to make real-time system adjustments to maintain stable operations. Metropolitan's protocol involves deploying staff to the field to manually check and restart pumps when they go offline. Mitigation would be needed to minimize the impact of these fluctuations on the existing treated water system. Operational complexity is also expected to increase further with new drought-related pumping facilities being designed and constructed on the Sepulveda Feeder, Inland Feeder, and potentially other pipelines.

One potential solution to mitigate these impacts would be to pump AWPF effluent to the finished water reservoirs at the Weymouth or Diemer plants, or to Garvey Reservoir in Monterey Park. This approach allows these reservoirs to help manage pump trips more effectively, providing a more stable supply source for the current gravity-fed system and facilitating better water quality management. However, this option would not reduce conveyance costs and would forgo the benefit of additional treatment and buffering at the WTPs.

A comprehensive assessment of hydraulics, storage, pressures, surge capacity, and blending capability is needed to ensure successful integration of TWA into Metropolitan's existing, predominantly gravity-fed distribution system. Given the potential need for additional pumping of TWA water, planning and designing new pump stations, surge protection, and pressure control facilities will be critical. Infrastructure improvements are needed to ensure hydraulic resilience with increased operating pressures and surges associated with a TWA project.

An evaluation of existing demands in the Central Pool will be required to determine the viability of conveying TWA product into the existing system. This analysis should focus on how much additional TWA flow could be added based on the tie-in locations (e.g., introduction at higher pressure grades may serve greater demands). The tie-in facilities would, at a minimum, require a control valve and flow meter, and ultimately a temporary shutdown of the existing Metropolitan feeder to complete the tie-in. The location and size of these connection tie-in facilities need careful evaluation. An example of potential locations is shown in Figure 4.

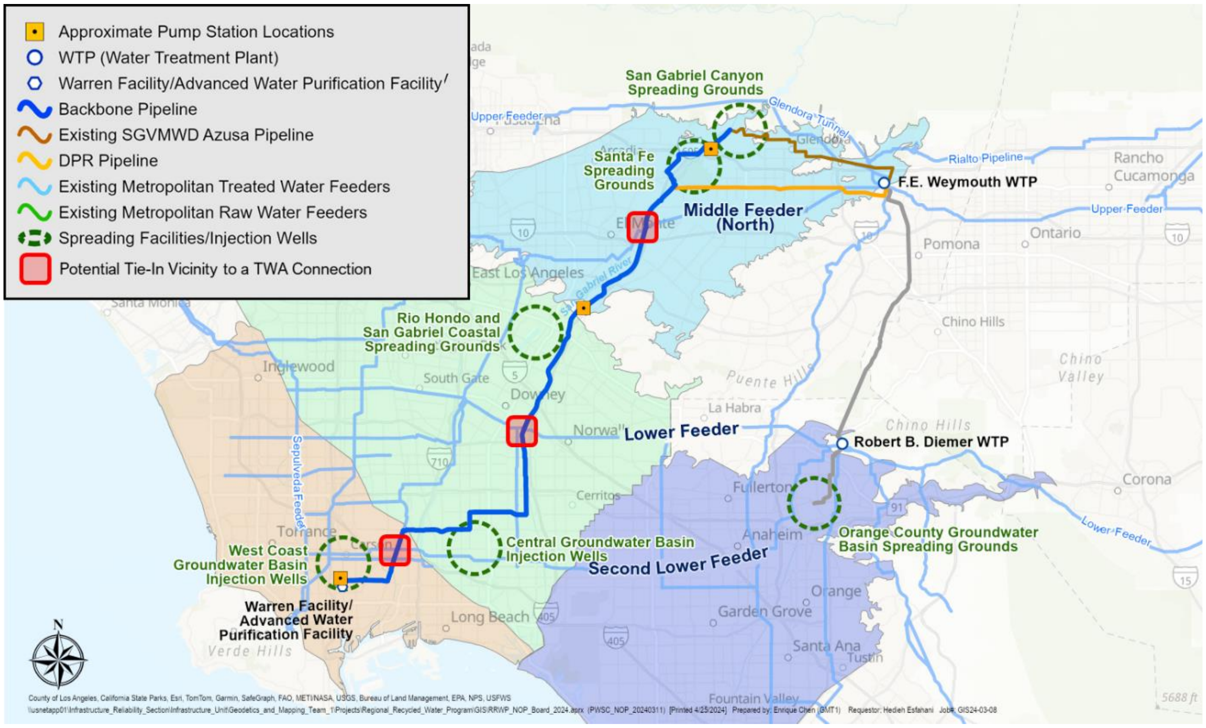


**Figure 4: Potential Treated Water Feeder Tie-In Locations along the PWSC Backbone Pipeline**

In summary, integrating DPR into Metropolitan's system may be achieved through either RWA or TWA. From a system operations integration perspective, RWA initially appears to offer a more reliable and seamless transition, as the impacts of pump trips and associated pressure surges can be mitigated. Overall, while the integration of RWA will impact distribution system operations, these impacts can be effectively mitigated through strategic use of an existing reservoir and pipeline infrastructure. TWA will require detailed hydraulic analyses to address the operational complexities introduced by pumping, assess the scope of mitigation measures, and ensure continued reliable and efficient operation of Metropolitan's system. Further technical studies are needed to assess optimal pathways for integration of either form of DPR.

## 6 Summary of Benefits and Challenges of DPR

Several benefits and challenges of both forms of DPR have been described in earlier sections of this white paper. Table 2 below outlines some of the key benefits (components that can be leveraged) and challenges (aspects requiring further research and analyses) associated with the two forms of DPR as they pertain to Metropolitan. Each form of DPR has its own unique considerations, as well as some that are common to both.

**Table 2: Benefits and Challenges of RWA and TWA**

| Form(s) of DPR | Benefits | Challenges |
|---|---|---|
| **Both Raw and Treated Water Augmentation** | • Provides a reliable means to augment the region's water supply<br>• Maximizes the use of treated wastewater that would otherwise be discharged to the ocean<br>• Offers Metropolitan flexibility in water delivery based on demands, as well as opportunities for regional collaboration<br>• Applies newly adopted, groundbreaking regulations that will further advance potable reuse development in the state<br>• Member agency specific agreements not required as water delivery is integrated within Metropolitan's system | • Extensive treatment process evaluations needed to demonstrate regulatory compliance<br>• Public acceptance requires ongoing proactive and intentional outreach and education<br>• Highly integrated, automated response systems needed for real-time monitoring and control, especially for diverting water when acute risks are detected<br>• Higher levels of operator certification (including Advanced Water Treatment certification) required at all treatment facilities<br>• Proactive operational responses needed for influent water quality changes (e.g., illicit chemical discharges and spikes)<br>• Level of treatment needed may exceed regulatory requirements to maintain existing treated water distribution system quality and consistent with Metropolitan's Pump-In Policy |
| **Raw Water Augmentation** | • Leverages additional treatment, disinfection and dilution credit, blending, and mixing provided by WTPs<br>• Offers buffer time and operational flexibility through WTPs and the conveyance system<br>• Builds on extensive database of comprehensive water quality monitoring to assess WTP effluent or distribution system changes<br>• Long history of robust treatment performance through WTPs can aid in public acceptance<br>• WTPs provide centralized hydraulic blending and distribution points for more seamless system integration | • Significant infrastructure (conveyance, pump stations) and energy required to convey purified water from AWPF to WTP<br>• Impacts on WTPs must be thoroughly analyzed, including extensive demonstration testing prior to serving blended water to the public<br>• Amendments to domestic water supply permits required for existing WTPs<br>• Additional resources required for monitoring, reporting, and plans at the WTPs and AWPF<br>• Treatment and conveyance needed even in years with excess SWP water supplies (assuming DPR provides a base flow to the WTPs)<br>• Agencies that take AWPF effluent as a raw water source before treatment at Metropolitan's WTPs, (e.g., along the backbone |

| Form(s) of DPR | Benefits | Challenges |
|---|---|---|
| **Raw Water Augmentation** *(continued)* | • Utilizes experienced and trained operations staff with Water Treatment (T5) certification | pipeline) must perform additional treatment at their own facilities, if needed, participate in the Joint Plan, and comply with other DPR plans (e.g., corrosion control and stabilization plan, monitoring plan) |
| **Treated Water Augmentation** | • May require less conveyance infrastructure; backbone pipeline or smaller separate pipeline and could connect to one or more existing feeders closer to the AWPF<br>• Lower energy resources required due to shorter conveyance for pumping<br>• Avoids need to evaluate DPR water blending impacts on WTPs, and other DPR-related complexities at the WTPs (e.g., plans, reporting, monitoring)<br>• Does not require additional treatment at the WTPs<br>• Demonstration testing can be performed at the Napolitano Center with deliveries for industrial and IPR demands before being permitted as a TWA project | • May incur additional costs associated with hydraulic improvements to operate the treated water system as a pumped system instead of a gravity-fed system<br>• Potentially higher treatment cost of DPR water treated to TWA levels for agencies that would only use the water for IPR<br>• Requires greater monitoring, controls, storage buffers, and other mitigation to address potential risks due to shorter response time before purified wastewater enters the treated water distribution system<br>• Strong need for building public acceptance, demonstrating agency capability, and establishing a proven track record (both for the industry and for PWSC) before TWA implementation<br>• Greater perceived and/or actual risk from illicit chemical discharges and spikes<br>• Higher variations in water quality at the distribution system entry point due to differences between treated water quality and AWPF effluent<br>• Requires treatment at the AWPF to minimize impact on distribution system water quality in terms of disinfectant concentration and corrosion control<br>• Higher risk of nitrification due to lower flow and longer detention times in other parts of the treated water distribution system<br>• Potential to exacerbate low-flow constraints at existing WTPs |

RWA would introduce purified water into the raw water supply upstream of Metropolitan's Weymouth and Diemer plants. In contrast, TWA would introduce purified water directly into the treated water distribution system, reducing the response time buffer provided by conveyance to and through a WTP, as well as the additional treatment provided by the WTP. Both forms of DPR require focused research on treatment process selection, water quality impacts, as well as hydraulic and operational effects on both new or existing distribution systems.

In a TWA scenario, upgrades to existing infrastructure may be required to manage pressure fluctuations and maintain water quality within the treated water distribution system. Introducing new water sources into the distribution system—whether directly or indirectly—can alter flow patterns, detention times, and water chemistry. This requires a thorough evaluation of existing practices and the development of new operating, monitoring, and response protocols. These steps are crucial to ensure disinfectant residual stability, effective corrosion control, and the mitigation of any unanticipated impacts from blending a new source into a public water supply.

# 7 Recommended Next Steps

To advance the implementation of DPR within the PWSC program, Metropolitan has identified next steps to guide water quality and technical research, partnerships and outreach, and operational and workforce readiness in the coming years. Many of these efforts, which are applicable to both forms of DPR, are already in place to support the originally planned program phases. Assessing TWA implementation would require accelerating some of these next steps to inform decision-making in a reasonable timeline synchronized with the program's development.

While the initial DPR research focus to date has been on RWA for the original Phase 1 of the program, much of the research applies to both forms of DPR, and an overall research plan to be developed will encompass efforts for both RWA and TWA. A key component of the research needed will utilize the budgeted DPR CIP which will install additional process trains to gain data and inform decisions on the optimal means to achieve treatment, water quality, and regulatory compliance goals. It is anticipated that these testing platforms will be complete in late 2026, following design and construction, in parallel with development of the testing plan. In conjunction with assessing feasibility of treatment processes, critical input will be needed on hydraulics, operations, and system integration through a series of technical evaluations. These studies are expected to take several years to complete.

It is anticipated that the preliminary information needed to determine which form of DPR may be the appropriate approach for Metropolitan to increase regional supply reliability would be available in the next five years. During this time, Metropolitan would conduct additional demonstration-scale DPR testing, environmental studies, and other technical analyses—adapting to the needs of the project as it further evolves.

Importantly, developing a comprehensive DPR Research Plan and executing the recommended next steps will require significant staffing, equipment, and facility resources, including engagement with industry associations. While existing staff and CIP funds are being leveraged to maximize data generation to inform decision making, it is anticipated that additional resources will be needed to complete all of the initiatives that are outlined within this white paper.

Metropolitan has taken a leadership role in advancing DPR over the last few years, including engaging with regulators and industry on key considerations for practical regulations that are flexible and enable water supply development, while also being protective of public health. Metropolitan, in conjunction with the SWRCB's $4.5 million, provided $975,000 to the Water Research Foundation in 2018 to fund several projects that informed the development of DPR regulations. Metropolitan also regularly engages with a variety of partners, the program's ISAP, and regulators—as well as the public to assess opinions and level of acceptance of DPR.

Key research and areas of focus related to water quality and technical research, partnerships and outreach, and operational and workforce readiness are described below. This list reflects initial focus areas and will be further developed and expanded through a comprehensive DPR Research Plan for PWSC, which will also detail resource requirements and implementation timelines.

### 7.1 Water Quality and Technical Research

While DPR regulations have been adopted, there is a strong need to understand how best to address the regulatory requirements in the most practical and cost-effective manner while being fully protective of public health. Key water quality, treatment, and operational research and studies needed to develop the PWSC program for DPR are listed below.

1. **Develop a comprehensive DPR Research Plan that encompasses both RWA and TWA.**
   - Outline priority research questions, methodologies, timelines, and resource requirements.
   - Incorporate the latest scientific and technological advances, including reviews of literature and project reports from consultants.
   - Prioritize studies and investigations to address key questions that will inform decision making.

2. **Conduct bench-, pilot-, and demonstration-scale testing for both RWA and TWA.**
   - Address research gaps and validate treatment process performance.
   - Design and construct DPR treatment technologies, leveraging the budgeted DPR Demonstration Testing CIP to make required modifications to the Napolitano Center.
   - Identify additional staffing and budgetary needs to conduct research to advance DPR development and integration into PWSC.

3. **Leverage the partnership with the Sanitation Districts to develop a DPR project.**
   - Apply the Sanitation Districts' robust source control/pretreatment program and investigate enhanced source control options to reduce contaminant loading.
   - Characterize improvements in RO concentrate quality, RO membrane performance, and UV/AOP treatment efficiency with ozone/BAC+MF or alternative processes (e.g., MBR).
   - Collaborate with the Sanitation Districts in developing the DPR Research Plan to explore mutually beneficial treatment options and monitoring strategies.

4. **Rehabilitate the WQDP at the Weymouth plant for state-of-the-art DPR testing capabilities.**
   - Identify and prioritize needed refurbishment and upgrades to existing equipment and facilities.
   - Modify existing CIPs as necessary to fund the required upgrades.
   - Utilize the WQDP to perform blending and technical studies for RWA and integration with Metropolitan's WTPs.

5. **Conduct technical and conceptual studies for TWA development.**
   - Perform technical studies and environmental assessments, and prepare a PWSC CEQA addendum that includes TWA.
   - Evaluate system hydraulics in the treated water system and identify necessary improvements and facilities for reliable pumped system operations.
   - Assess demands for purified water in the Central Pool, identify optimal tie-in locations, assess changes in operating criteria, and develop conceptual facility design information.

### 7.2 Partnerships and Outreach

The growing industry interest in DPR offers several key opportunities for collaboration, both locally and nationally, to support project planning. Metropolitan and other agencies can mutually benefit from these partnerships and through engaging the public and our regulatory community. Key opportunities are listed below.

1. **Establish partnerships with leading research institutions and industry experts.**
   - Collaborate on DPR research and share knowledge and best practices through industry initiatives such as DIREKT.
   - Leverage Water Research Foundation and other relevant organizations and agencies on DPR research (e.g., ozone/BAC, low molecular weight compounds) to guide regulatory collaboration and technology acceptance.
   - Participate in the development of industry standards and guidance documents for DPR implementation.

2. **Develop a program for online monitoring validation for DPR.**
   - Engage with industry to comprehensively evaluate vendor instruments and technologies at the Napolitano Center.
   - Collaborate with partner agencies and industry organizations to share information and lessons learned.
   - Conduct a survey of IPR facilities to assess critical control points and gather insights on experience with continuous monitoring of surrogates used for compliance.

3. **Continue engaging with regulators and ISAP to refine approach for regulatory approval.**
   - Review research plans, share findings, and seek input on regulatory implications.
   - Consider expanding ISAP expertise to address RWA- and TWA-related issues.
   - Develop a pathway for regulatory acceptance, including collaborating with partners on an approach for a Joint Plan required for DPR implementation.

4. **Develop a comprehensive DPR communication and outreach strategy.**
    - Develop new communication tools that convey the benefits and safety of PWSC and DPR, addressing concerns or misconceptions identified in research.
    - Provide comprehensive information on how DPR integrates with the PWSC program to secure a sustainable water future.
    - Share resources with other agencies for public communication concerning regional potable reuse projects and to build broad public support and trust in DPR.
    - Coordinate with the Sanitation Districts to explore opportunities to enhance source control and related public messaging in outreach efforts.
    - Continue to engage stakeholders (e.g., member agencies, elected officials, media, general public) through tours, events, workshops, etc.

### 7.3 Operational and Workforce Readiness

Metropolitan must be fully prepared to take on the responsibilities of operating and maintaining a regional purified water system if the program is approved. Staffing, governance, and operational integration are key elements for establishing operational readiness, from initial planning through implementation. Key elements of readiness are listed below.

1. **Assess the operational staffing, training, and certification needs for DPR and develop workforce readiness.**
    - Identify a core working group to develop Metropolitan's goals and objectives for PWSC workforce development.
    - Develop a workforce development plan to build the necessary skills and competencies, including AWTO certification.
    - Plan and implement a PWSC workforce training center in Carson to develop a skilled operations workforce for both Metropolitan and the Sanitation Districts for DPR applications.
    - Create an internal structure to optimize collaboration between operations, engineering, research, testing, and other technical evaluations for DPR development.

2. **Collaborate with the Sanitation Districts on coordinated operations of the potable reuse treatment train.**
    - Coordinate operational responsibilities at the Napolitano Center and individual agency perspectives to establish fully integrated treatment operations.
    - Develop operating scenarios between agencies and assess response protocols to ultimately formulate a detailed operating agreement between Metropolitan and the Sanitation Districts for a DPR project.
    - Clarify regulatory requirements associated with joint operations, including consideration of MBR as a water treatment process in a DPR project.

3. **Develop a pathway for reliable operations, monitoring, and control systems for DPR.**
    - Identify resource needs for managing the increased complexity of operations, monitoring, and reporting.
    - Establish partnerships between Operations, SCADA, and IT on necessary architecture and network structure for data analytics, automation, and machine learning for DPR.

- Develop strategies to meet regulatory requirements for integrated operations of all treatment facilities in the DPR project.

4. **Develop frameworks for key plans required for DPR implementation.**
   - Identify the comprehensive plans and protocols needed for DPR (e.g., Joint Plan, Monitoring Plan, Operations Plan, Engineering Report, Water Safety Plan, Incident Response Plans).
   - Prioritize plan development based on key data gaps and critical paths for program development.
   - Identify how a DPR project would be incorporated into Metropolitan's emergency response and business continuity plans, and engage appropriate stakeholders in discussions for long-range planning.

## 8 Conclusion

As the scope of the PWSC program becomes more defined through current rephasing analyses, including opportunities for TWA, Metropolitan will further refine its planning efforts for the program. In particular, the focused resources needed to implement DPR as part of the PWSC program will be thoroughly evaluated and discussed with the Board. Given the considerations presented in this white paper, collaboration with the Sanitation Districts, member agencies, industry associations, the program's ISAP, regulators, and other key stakeholders will be essential to advancing DPR as part of the PWSC program. A crucial next step in this process will be the development of a DPR Research Plan tailored for PWSC.

DPR offers a significant opportunity to enhance the regional benefits of PWSC. Each form of DPR—RWA and TWA—brings distinct advantages. RWA will leverage the benefits of existing WTPs, including additional detention time provided by the conveyance system, which provides a response buffer to manage any excursions. It will also build upon extensive experience and monitoring history of the existing Weymouth and Diemer plants, while providing centralized blending and distribution points that align with current operations. Conversely, TWA would minimize the conveyance infrastructure needed to connect to the treated water distribution system and reduce the energy required to deliver purified water. However, integrating a pumped system to the existing gravity-fed distribution system would require further evaluation and potentially significant system improvements. Both forms of DPR will require extensive research on treatment requirements, water quality, monitoring and response tools, system integration, facility needs, and other factors critical to ensuring reliable operations and protection of the public's water supply.

Metropolitan has a long-standing history of delivering reliable, high-quality water supplies to its member agencies. As we explore the integration of DPR as a new source of supply, we are committed to upholding this mission through comprehensive planning, rigorous research and development, strategic partnerships, and ensuring successful implementation if the PWSC program is approved.