



*THE METROPOLITAN WATER DISTRICT  
OF SOUTHERN CALIFORNIA*



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**Advisory Panel  
for the  
Potential Regional Recycled Water Supply Program**

**Report No. 1: Demonstration Plant Design**

**June 30, 2016**

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## **I. Executive Summary**

The Metropolitan Water District of Southern California (Metropolitan) and the Sanitation Districts of Los Angeles County (Sanitation Districts) are considering development of a large-scale regional indirect potable reuse program for groundwater recharge in several groundwater basins. The potential Regional Recycled Water Supply Program (Program) would begin with a proposed 1 million gallon per day (mgd) advanced water treatment demonstration plant to be located at the Sanitation Districts' Joint Water Pollution Control Plant (JWPCP) in Carson. In early 2016, Metropolitan and the Sanitation Districts convened a panel of eight key subject matter experts to provide independent review and critical input on the scope and direction of the Program during its demonstration project phase. In this initial effort, the Panel will provide input into the development of the Program's feasibility and financial assessments, as well as the design of the demonstration plant. The Advisory Panel plans to meet periodically in a workshop format to provide input on overall program feasibility and work plans; design of the demonstration plant; groundwater basins and water delivery assessments; and ideas and approaches to program implementation.

At the first workshop on March 31 and April 1, 2016, the Advisory Panel reviewed the overall program and engaged the Project Technical Team in an in-depth discussion of the demonstration plant design. The Project Technical Team consists of Metropolitan staff, Sanitation Districts staff, and consultant staff. After the team presentation, the Panel met independently to consider the proposed treatment processes and related issues regarding nitrogen and boron management as well as the procurement process and selection of demonstration unit processes.

On the second day of the workshop, the Advisory Panel presented their recommendations and comments to the Project Technical Team. The Panel also raised other issues and ideas that need to be explored for full scale treatment plant design, maximizing recycled water use, public outreach, operator training, financing and institutional framework, which will be presented in future panel reports when those topics are covered. This report summarizes the first workshop and the Advisory Panel's guidance to the team on design of the demonstration plant. Future workshops are planned for the Advisory Panel to consider other elements of the Program.

## **II. Advisory Panel Members**

The eight-member panel includes the following experts in advanced water treatment and recycled water programs:

- Richard Atwater, Co-Chair: Former Executive Director of Southern California Water Committee; expert on recycled water programs.
- Margie Nellor, Co-Chair: Nellor Environmental Associates, Inc.; expert on recycled water reuse programs, pretreatment and related regulatory issues.
- Shivaji Deshmukh: Assistant General Manager of West Basin Municipal Water District; expert on recycled water engineering and operation of advanced water treatment facilities.
- Thomas Harder: Thomas Harder and Associates (Hydrogeology); expert on Southern California's groundwater basins.

- David Jenkins: Professor Emeritus, University of California, Berkeley; expert on biological wastewater treatment processes, and water and wastewater chemistry.
- Edward Means: President, Means Consulting LLC; expert on water quality and water resources management.
- Joseph Reichenberger: Professor, Loyola Marymount University; expert on water, wastewater and recycled water systems and treatment.
- Paul Westerhoff: Professor, Arizona State University; expert on advanced water treatment processes.

### III. Methodology

The Panel will meet periodically in a workshop format to review and discuss selected topics for the Program including:

- Overall program feasibility and work plans,
- Design of the demonstration plant,
- Groundwater basins and water delivery assessments, and
- Ideas and approaches to program implementation.

Prior to each workshop, the Panel will be provided resource material and a series of questions from the Project Technical Team to allow the panelists to prepare for the issues to be raised. After a morning briefing and facilitated discussion with the team, the Panel will work independently of the team to discuss the issues and develop recommendations. Upon completion of their discussions, the Panel will provide an “out-briefing” to the team and respond to clarifying questions regarding the Panel’s comments and recommendations. The Panel will then prepare a report to Metropolitan and the Sanitation Districts documenting the issues discussed, recommendations, alternatives and other issues to be considered. The Panelists may not always reach consensus on the recommendations but will agree on the contents of each report. The Project Technical Team will consider the input received and provide written responses to the recommendations as appropriate.

### IV. Workshop on Demonstration Plant Design

The Advisory Panel met on March 31 and April 1, 2016 to review the Potential Regional Recycled Water Supply Program proposed jointly by Metropolitan and the Sanitation Districts. The focus of this first workshop, held at Metropolitan’s Headquarters, was the design of the demonstration plant. In addition to the Panel, the following members of the districts’ management and Project Technical Team participated:

Paul Brown                      Program Manager, Metropolitan  
Michael Thomas                Facilitator, Metropolitan

Metropolitan: Debra Man, Gordon Johnson, John Bednarski, Gloria Lai-Blüml, Kimberly Wilson, Evelyn Ramos, Sun Liang (by phone), Carolyn Schaffer

Sanitation Districts: Grace Hyde, Robert Ferrante, Dave Snyder, Nikos Melitas, Rob Morton, Michael Liu, Martha Tremblay, Shannon Bishop, Phil Friess

*Consulting Design Team:* James Borchartd, Eric Mills, Zakir Hirani, Bill Vogel, Shane Trussell, Adam Zacheis, Debbie Burris, Michael Adelman

**a. Project Understanding**

The Advisory Panel understands that the proposed Program would involve the development of a large-scale (up to 150 mgd) regional indirect potable reuse program. The product water would be used for groundwater recharge in several groundwater basins that are managed through different institutional agreements and are subject to different regulatory requirements. The Program will need to:

- Identify locations to deliver an uninterrupted flow of product water at the flow rate supplied by the full scale treatment plant,
- Satisfy the public that the treated water is safe to use,
- Produce and deliver water that complies with all applicable regulations,
- Produce water that provides the reliability needs of customers and is at a cost that is marketable and competitive with other sources.

The Program would begin with a proposed 1 mgd advanced water treatment demonstration plant to be located at the Sanitation Districts' Joint Water Pollution Control Plant (JWPCP) in Carson. The demonstration plant would be used to test the effectiveness of various advanced water treatment processes.

**b. Preparation for the Workshop**

To prepare for the workshop the Advisory Panel reviewed the following documents:

- Potential Regional Recycled Water Supply Program, Historical Review and 2015 Update, Working Draft, Version 1.7, Metropolitan Water District.
- Proposal Design and Operation of Demonstration Plant for Potential Regional Recycled Water Supply Program, RFP-1116, December 2015, MWH.
- Metropolitan Board Authorization for \$15 million, Potential Regional Recycled Water Supply Program, Agenda Item 8-3, 11/15/2015.
- PowerPoint Presentation to Metropolitan Board of Directors Potential Regional Recycled Water Supply Program, Supporting Agenda Item 8-3, 11/9/2015.
- Pilot Study of Advanced Treatment Processes to Recycle JWPCP Secondary Effluent – Final Report, Metropolitan and Sanitation Districts, September 28, 2012, including Appendices A – JWPCP Process Descriptions and Water Quality Data; Appendix B – Pilot Study Design Criteria, Operational Information, and Water Quality Data; Appendix C – Title 22+ Sampling Data; Appendix D – JWPCP Background and NdN.
- Request for proposal, RFP-PL-1116, Design and Operation of Demonstration Facility for Potential Regional Recycled Water Supply Program, Metropolitan, including Attachments A through F.

The Panel was also provided a series of questions in advance of the meeting regarding design of the demonstration plant including:

1. Given the multiple uses expected for the demonstration plant (including process validation and optimization, vendor equipment testing, operator training, and public outreach), what are the most

important design considerations that should be addressed? Specific considerations should consider the following:

- What is the most effective approach for integrating the technical and regulatory-related elements of the design?
  - What accommodations are needed to provide flexibility for various equipment vendor products?
  - What is the Panels' experience regarding prequalification of equipment for testing?
  - What features are needed to maximize the operator training objectives of the facility?
  - What features are needed to maximize public outreach and educational aspects of the facility?
2. What specific design considerations should be included to increase the demonstration plant's value for process validation and optimization?
- Are two complete parallel trains required? Can the trains be limited to test alternatives for biological treatment and microfiltration/ultrafiltration (MF/UF)?
  - Will the current approach evaluating various biological nitrification/denitrification (NdN) alternatives and ion exchange (IX) be sufficient to select the best overall strategy for nitrogen management?
  - Are the appropriate treatment processes being considered in the current design of the demonstration plant given the processes that are currently being utilized at the JWPCP?
  - Are there other concerns with the secondary effluent that should be addressed through the demonstration plant or process changes at the JWPCP?
  - Is the demonstration plant being configured appropriately to investigate the issue of log removal credit by various treatment processes in order to achieve regulatory approval?
  - Can the demonstration plant waste streams and brine discharges be used to evaluate full-scale impacts on JWPCP processes, secondary effluent quality, and brine management regulatory challenges?
  - How many equipment vendors or treatment processes should the demonstration plant be designed to evaluate?
  - What unit processes should be prequalified during operation of the demonstration plant?
  - Should the demonstration plant unit processes be selected based on their scalability to 150 mgd, especially the biological process?
  - Will the current approach comparing IX and reverse osmosis (RO), pH management be sufficient to select the best overall strategy for boron management?
  - What operational criteria should be considered in equipment evaluations?
  - Which existing demonstration projects implemented by other agencies serve as good examples for the proposed project?
  - How should make-up and variability of influent (JWPCP secondary effluent) to the demonstration plant be monitored and evaluated?
3. What considerations or design features should be incorporated in the demonstration plant in order to evaluate the benefits and cost-effectiveness of possible modifications at the JWPCP?
- How can the demonstration plant be used to evaluate potential changes at JWPCP?

- Can alterations be made to the JWPCP to provide better quality feed water for the demonstration plant?
- Would additional source control be cost-effective in improving feed water quality?
- What are the best practices for integration of wastewater treatment and advanced water treatment facilities under the operation of the two agencies?
- How should training at the demonstration plant be developed to encourage cooperation, collaboration, and teamwork?

**c. Background Presentation by Project Technical Team**

To begin the workshop the Project Technical Team presented the proposed process train selection for the demonstration plant and the background behind that selection. Items of discussion included:

1. Groundwater Quality Objectives: Staff presented the groundwater quality objectives for the various groundwater basins where the recycled water potentially could be used for groundwater replenishment. Notwithstanding the Title 22 Criteria for groundwater replenishment, the boron objective of 0.5 milligrams/Liter (mg/L) in the Main San Gabriel Basin and the nitrate objective of 3.4 mg/L in the Orange County Basin may set the water quality requirements for the product water of a full-scale project. These would impact the selection of the treatment train.
2. Secondary Effluent Water Quality: Secondary effluent water quality at the JWPCP was compared to the secondary effluent water quality at the City of Los Angeles Hyperion Water Reclamation Plant (Hyperion) and Orange County Sanitation District (OCSD) Plant 1. Both Hyperion and OCSD facilities provide secondary effluent used as feed water for advanced treatment facilities that produce product water used for indirect potable reuse projects (groundwater replenishment via surface and subsurface application). Secondary effluent from Hyperion is feed water to the West Basin Municipal Water District's Edward C. Little Water Recycling Facility (ECLWRF) and is used for the West Coast Basin Seawater Intrusion Barrier. Secondary effluent from OCSD's Plant 1 is used as feed water to the Orange County Water District's (OCWD) Groundwater Replenishment System (GWRS).
3. Nitrogen Removal: The Sanitation Districts research team has considered three approaches to nitrogen removal based on literature review, process modeling, and some pilot testing:
  - Retrofit of the JWPCP activated sludge process – biological nitrogen reduction using either membrane bioreactor (MBR) or integrated fixed film activated sludge (IFAS).
  - Adding a tertiary process for nitrification and possibly denitrification – tertiary MBR (tMBR) or tertiary biological active filter (tBAF).
  - Side stream nitrification or deammonification treatment of ammonia-rich biosolids centrate.

The Sanitation Districts nitrogen removal findings are as follows:

- An activated sludge retrofit of the JWPCP would require significant operational changes.
- Pilot testing of tBAF at JWPCP has been successful. The effect of tBAF on downstream membrane performance requires further study.
- Pilot testing of side stream treatment of centrate demonstrated ammonia removal and robust operation. Side stream treatment may also provide bioaugmentation benefits to inducing nitrification in the main stream.

The mass balance calculations prepared by the design team suggest that nitrification alone on main stream or with 25% NdN on side stream treatment will not be enough to meet the lowest basin water quality objective for nitrogen in advanced treated product water, given typical nitrogen loadings and RO rejection.

4. Source Control Overview: The Sanitation Districts source control program has been approved by the U.S Environmental Protection Agency (USEPA) and is administered under a Wastewater Ordinance that includes permitting, monitoring, inspection, enforcement, and outreach. The program regulates 2,100 industries.

The historical approach to management of the Sanitation Districts Joint Outfall System (consisting of six upstream water reclamation plants (WRPs) and the JWPCP) is to route higher salt and organic strength flows around the upstream WRPs for treatment at the JWPCP. This industrial contribution makes up about 19% of the JWPCP's influent dry weather flow.

5. Constituents of Concern: Constituents of concern identified in the pilot study that need further consideration for the demonstration plant include:
  - Boron – thought to be contributed from oil well fields
  - Nitrosamines – thought to be contributed as disinfection by-products (DBPs) or by industrial dischargers such as metal finishers
  - 1,4-dioxane – thought to be contributed via disposal of consumer products and by discharge from membrane manufacturers

The Source Control Program will continue investigating sources of these constituents.

6. Pathogen Log Reduction: The requirements for log removals of virus, *Giardia*, and *Cryptosporidium* are 12/10/10 respectively based on the Title 22 Criteria pathogen log reduction requirements for groundwater replenishment. These requirements must be met by surface and subsurface application projects using at least three treatment processes. Full advanced treatment (FAT) facilities, as defined in the Title 22 Criteria must include (1) RO that meets sodium chloride rejection and TOC performance requirements and (2) advanced oxidation process (AOP) that meets either indicator compound or 1,4-dioxane performance requirements. The two AWT facilities, OCWD's GWRS and West Basin's ECLWRF, have been approved by the Division of Drinking Water (DDW) under the 2014 Title 22 Criteria and achieve greater log reduction.
7. Proposed Treatment Process: The proposed design being considered for the demonstration plant includes two parallel process trains, each with a capacity of 0.5 mgd:
  - Train #1: MBR tertiary treatment for nitrification and denitrification, followed by MF/UF, RO, AOP, and product water chemical stabilization. Side stream IX was proposed to remove additional nitrogen and boron.
  - Train #2: Similar to Train #1 except an alternative biological nitrification and denitrification system was proposed (e.g. tBAF) in place of MBR.

The Project Technical Team is exploring options for virus removal that have not yet been approved by DDW. These options raise the following questions:



- When using MBR treatment is MF/UF required before RO? Log removals were estimated by the Design Team to be 14/10/10 with only MBR treatment prior to RO treatment.
- Can ultraviolet irradiation (UV) be substituted for MF/UF following MBR treatment? Log removals were estimated by the Design Team to be 14/12/12 with MBR and UV preceding RO.

Free chlorine and hydrogen peroxide will each be tested for the AOP.

There was significant discussion on the need for IX treatment for boron and nitrogen removal. In lieu of these treatment systems, could source control of significant industrial nitrogen and especially boron discharges be a more economical alternative?

The presentation by the Design Team included a discussion of data management and monitoring of critical control points.

The Design Team presented a “walk through” video of a hypothetical full scale, 150 mgd advanced treatment facility using the processes currently proposed for the demonstration plant. The facility occupies most of the land currently assigned to the water reclamation plant at the JWPCP.

It was clear from the presentation that schedule is a major driver for the Program. Design of the demonstration plant is proposed to be complete by the end of 2016; completion of demonstration plant construction and initial start-up is proposed by end of 2017.

**d. Key Topics for Panel Discussion**

With the information provided above as background, the Project Technical Team posed five questions to the Advisory Panel on the demonstration plant design:

- 1) Should UV-AOP and IX be tested on combined effluent from two trains?
- 2) Is the approach to nitrogen management appropriate?
- 3) Is the approach to boron management appropriate?
- 4) Is the equipment procurement strategy appropriate?
- 5) Should the demonstration plant unit processes be selected based on their scalability to 150 mgd?

**e. Panel Discussions and Recommendations**

Before addressing the specific questions on the demonstration plant design, the Advisory Panel stated the purpose of the demonstration plant is to **demonstrate** the treatment train on the JWPCP effluent rather than **piloting** new technologies. This is not a “pilot plant,” it is a “demonstration plant.” The Metropolitan Board direction in their approval letter of 11/10/2015 was that the “*demonstration project would serve as a proof of concept and would provide critical information needed for implementation of the potential regional recycled water supply program.*” The goal of the demonstration plant is to confirm source water quality; confirm treatment processes for regulatory approval and suitability for groundwater replenishment; and confirm quality of brine and waste streams. Where possible, the demonstration plant should focus on optimization of proven processes. Defining the critical control points is an important goal at demonstration scale. The Panel emphasized that although schedule is an important driver for the project, it should not be allowed to compromise the ability to garner critical data to secure public and regulatory acceptance.

The Project Technical Team must establish quantitative water quality targets entering and leaving the demonstration plant, recognizing that current requirements and treatment technologies will evolve over time. Direct potable reuse may be in the not-too-distant future and this should be considered in the layout and design of the demonstration plant. Above all, the entire Program is “customer driven.” There must be a market for the product water and having a showcase demonstration project will assist in gaining and maintaining public acceptance.

The approach to some of the key questions, such as nitrogen management and boron removal, would best be implemented using a pilot study approach, (e.g., bench scale or small scale) rather than a “demonstration” approach. The Advisory Panel suggested that there could be, for example, one “demonstration” treatment train and one “exploratory” train for pilot-scale studies.

In the design of the demonstration plant, consideration should be made to provide connections for future, small-scale side stream treatment of alternative technologies. The Advisory Panel noted that piloting of alternative technologies could be done once the full scale facility was in operation.

The Advisory Panel strongly emphasized the value of a public outreach program as part of the overall Program, including the development of the demonstration plant and its operation. The Demonstration Plant is to be a showcase to build support from local agencies, regulators, political leaders and the general public. In that light, it must be odor free and noise free. All of its potentially odorous and noisy components should have sound attenuating enclosures and should not be located where the public has access to them. The Panel recommended that the demonstration plant continue to be available after the full scale plant is on-line for tours and testing alternative technologies in the future.

**1. Testing UV-AOP and IX on combined effluent from two trains**

The Advisory Panel does not recommend this. Combining the effluent produces an “artificial” water quality resulting in demonstrating something that will never exist. The AOP needs to be tested separately with water pretreated by the MBR-MF-RO or the BAF-MF-RO (if selected), because the water qualities from these pretreatment processes will be different.

The Advisory Panel recommendation is to use two 0.5 mgd UV-AOP systems, one for each train. If the budget cannot accommodate the parallel UV-AOP trains, then a single 0.5-mgd system would be satisfactory. In the latter case, it should be plumbed so that it could take effluent from one train or the other separately, and the balance of flow would bypass the AOP.

The Advisory Panel recommends small, side stream IX columns be plumbed to either treatment train.

In addition, bench-scale testing or small flow rates could be used to test the chemistry of post-stabilization and post-chlorination.

**2. Approach to nitrogen management**

Advanced treatment of the existing non-nitrified JWPCP secondary effluent, which would involve ammonia removal by RO, may not be desirable. West Basin’s ECLWRF has had operational challenges with this approach; low flux rates and/or more frequent cleaning of the MF and RO systems were required. Direct treatment of non-nitrified secondary effluent also has other

disadvantages. The Sanitation Districts' pilot plant showed that higher concentrations of TOC constituents, including chemicals of emerging concern, passed through the treatment plant because the current JWPCP biological treatment operates at a low solids retention time. The Advisory Panel recommends that RO not be relied on for ammonia removal.

The Advisory Panel discussed whether it would be possible for the JWPCP to be operated in an NdN mode. Sanitation Districts' staff evaluated this.

For a demonstration plant feed consisting of non-nitrified JWPCP effluent, the Project Technical Team's proposed approach is to size either the BAF or the MBR to achieve full NdN. Both systems could be operated in "nitrify only" mode or with carbon feed for partial or full denitrification. The advantage of testing BAF versus MBR is that the BAF footprint may be smaller than that of an MBR and the BAF operating cost may be lower than for an MBR. The BAF comes with some risk since, if the carbon dosing is not optimized and carefully paced for NdN, observations at El Paso have indicated that high levels of effluent colloidal solids can be produced that can lead to accelerated MF fouling. It is imperative to avoid process trains that might not work at demonstration scale.

The BAF could be made into a "conventional filter" by turning off the carbon feed so that it is not working in "biological" mode. There are both encouraging (San Diego) and discouraging (West Basin) examples of membrane treatment following tertiary filtration.

The Advisory Panel thought it might be appropriate to do pilot-scale BAF at the JWPCP during the design phase of the demonstration project and monitor fouling and AOC/BDOC (assimilable organic carbon/ biodegradable dissolved organic carbon) downstream of the BAF pilot system. To do this the Project Technical Team should coordinate with the Sanitation Districts to first verify that BAF is viable before taking it to demonstration scale. The demonstration plant design can always be changed or a process deleted or changed in the bid documents.

If, after collecting data from operating the existing BAF, it appears that the BAF is not an acceptable alternative, there could be two MBR trains. The MBR trains could use, respectively, technologies from the two major MBR manufacturers, with the possibility of one nitrifying only and the other operating in NdN mode.

Ideally, demonstration scale should focus on optimization rather than high-level process selection. Optimizing MBR for this application can be done readily using the proposed approach.

The total nitrogen load in the JWPCP secondary effluent and ultimately to the demonstration plant would be reduced if side stream centrate nitrogen removal was added at the JWPCP. This might result in lower costs for nitrification and nitrogen removal in the demonstration plant.

### **3. Approach to boron management**

The boron water quality objective for the groundwater basins potentially being recharged through the Program ranges from 0.5 mg/L (Main San Gabriel Basin) to 1.5 mg/L (West Coast Basin). The DDW has set a Notification Level of 1.0 mg/L for boron. A preliminary assumption was made that the boron water quality objective for the Main San Gabriel Basin would be a driver for product water quality. The water quality objective for boron was set in the early 1970s based on

maintaining existing groundwater water quality (non-degradation). Boron, in the concentrations noted above, has no known human health implication. The World Health Organization has relaxed their boron guideline and the USEPA has made a determination not to regulate boron with a national primary drinking water regulation (i.e., MCL) because it is not likely to occur at levels of concern in surface and ground water systems and, as such, does not present a meaningful opportunity for health risk reduction.

It is possible for Regional Water Quality Control Boards (RWQCBs) to establish site specific water quality objectives that could be less stringent than those adopted into Basin Plans. For example, the Santa Ana RWQCB adopted an amendment to its Basin Plan that allowed for higher objectives for total dissolved solids (TDS) and nitrate to promote water recycling. To be eligible for the higher objectives (maximum benefit objectives), wastewater dischargers were required to commit to implement specific projects and programs to reduce salts and nitrogen, (such as construction of brine lines and groundwater desalters, recharge of storm water and recycled water, etc.), otherwise the original, more stringent objectives applied. The use of recycled water is a benefit to the people of the State by reducing the need for imported water.

Legally a basin objective is not necessarily a hard limit on the concentration of the product water. RWQCBs have the authority to set discharge limits at the water quality objective if they believe it is necessary to protect groundwater quality and prevent degradation. However, the State Anti-degradation Policy (SWRCB Resolution 68-16) allows a lowering of water quality if the change is consistent with maximum benefit to the people of the State and will not unreasonably affect present and anticipated uses of water (including drinking) and will not result in water quality less than prescribed in policies. In addition, permit limits for groundwater replenishment projects are set to ensure that groundwater does not contain concentrations of chemicals in amounts that adversely affect beneficial uses or degrade water quality. The RWQCBs overseeing the affected groundwater basins would have to make regulatory accommodations for boron (whether via a change in the Basin Plan objective, the permit limit established taking into consideration available assimilative capacity in the groundwater, blending with recharge sources for surface application, or blending with native groundwater).

After further consideration of source control options for boron, it may be worth having a discussion with the State Board and affected RWQCBs to discuss this matter. Boron removal is very costly. Furthermore, IX for boron removal may cause additional operational and permit challenges at the JWPCP with product and brine management and ocean discharge (salt, pH, etc.).

The Project Technical Team should confirm that the 0.5 mg/L boron concentration is a real hurdle. The team should talk to the State Board, RWQCBs, DDW (drinking water and recycling staffs), and the groundwater basin managers to set water quality targets before eliminating boron removal from the demonstration plant scope. The basin managers will need to understand the cost and financing implications of any boron decision. If there is concurrence, the Advisory Panel recommends making boron a smaller point of emphasis in the demonstration plant work and, possibly, consider eliminating it from the scope. If boron is an issue, pretreatment, point-of-discharge treatment, and/or source control should be investigated first.

There are likely much less expensive ways of doing recharge in the Main San Gabriel Basin compared to large-scale IX for boron removal at the JWPCP. This should include discussions with the RWQCBs and DDW of the use of diluent water (as defined in the regulations) to reduce the boron concentration reaching the groundwater table. If required, point of discharge IX on a smaller flow might be more cost-effective for specific basins.

Any testing of boron IX should be done at a small scale, e.g. on a side stream. This is more “pilot scale” work than “demonstration” work and it could potentially be separate from the demonstration plant scope.

#### **4. Equipment procurement strategy**

Ideally the time allowed for prequalification testing for wastewater treatment should be one year to account for effects of seasonal water quality variation. However this is not possible considering the project schedule.

The Project Technical Team intends to “decouple” the demonstration study phase from the full-scale vendor prequalification phase. The demonstration study phase would demonstrate a given technology for each process; when it comes to procurement for full scale, an experience clause would be used for selection of the full-scale equipment supplier. It is important to not give the impression that equipment suppliers selected for the demonstration plant will be the only suppliers considered for full-scale.

If MF/UF is upstream of RO, suppliers should be comfortable doing qualification-based procurement for RO systems. The suppliers may not be comfortable going straight from MBR to RO. The Advisory Panel recommends that an area be set aside for vendor skids, installed and operated by the suppliers for short periods of time to validate their equipment. Appropriate turnouts should be designed into the demonstration plant to facilitate this. It could be specified that every supplier who wants to bid on the full-scale facility should be required to provide a skid and to validate their equipment.

The overall strategy should be to get as many vendors as possible to bid on the demonstration project and the full-scale plant. Transparency will be very important. Any process for selecting vendors should be clear and defensible. The process of procurement should be well documented and follow Metropolitan and Sanitation Districts procedures.

OCWD experience has shown that continuity of personnel is important for procurement. Having Metropolitan and Sanitation Districts staff involved throughout the process, from demonstration plant to full-scale construction, should be a priority. The procurement strategy selected must allow all qualified suppliers to bid and Metropolitan and the Sanitation Districts must carefully vet all of suppliers that ultimately end up furnishing equipment. The Advisory Panel recommends that an integrated procurement process for both the demonstration plant and full-scale plant be developed.

#### **5. Selecting demonstration plant unit processes based on scalability to 150 mgd**

The Advisory Panel reviewed the proposed demonstration plant processes and determined they would generally be scalable to a 150 mgd treatment plant as shown below:

Process	Scalability
Stabilization	Readily scalable even from bench-scale
UV-AOP (ultraviolet-advanced oxidation process)	Advisory Panel is not concerned about the risk of scaling from 1-mgd units to 10-mgd or larger units. There could be hydraulic changes that may affect the relationship between equipment sizing and dose, but this responsibility should be borne by the AOP suppliers. (As an aside, the Advisory Panel believes the extra equalization tank shown in the proposed process train at the demonstration plant will not be required.)
IX (ion exchange)	Readily scalable even from very small columns
RO (reverse osmosis)	Readily scalable from demonstration scale, as long as the appropriate elements are selected
MF/UF (microfiltration/ultrafiltration)	Readily scalable from demonstration scale
MBR (membrane bioreactor)	Readily scalable from demonstration scale
BAF (biologically active filter)	Scalability from demonstration to full-scale is unclear
Anammox (anaerobic ammonium oxidation)	There is no evidence on the scalability since this process has not been used at anything approaching 60 to 150 mgd. This would be a pilot project that is not ready for inclusion in the demonstration plant. Anammox may have applicability for side stream nitrogen removal from the centrate at the JWPCP. Reducing the overall nitrogen load to the AWT facility would be beneficial.

**ACRONYMS**

ANAMMOX	anaerobic ammonium oxidation
AOC	assimilable organic carbon
AOP	advanced oxidation process
AWT	Advanced Water Treatment
BAF	biologically active filter
BDOC	biodegradable dissolved organic carbon
BOD	biological oxygen demand
DBP	disinfection byproduct
DDW	Division of Drinking Water
ECLWRD	Edward C. Little Water Recycling Facility
FAT	Full Advanced Treatment
GWRS	Groundwater Replenishment System
IFAS	Integrated Fixed-Film Activated Sludge
IX	ion exchange
JWPCP	Joint Water Pollution Control Plant
MBR	membrane bioreactor
MCL	maximum contaminant level
MF	microfiltration
mg/L	milligrams per liter
MGD	million gallons per day
NdN	nitrification and denitrification
NF	nanofiltration
NPDES	National Pollutant Discharge Elimination System
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
O&M	operation and maintenance
PV	photovoltaic
RO	reverse osmosis
RRT	response retention time
RWQCB	Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
tBAF	tertiary biologically aerated filter

## Potential Regional Recycled Water Supply Program

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tMBR	tertiary membrane bioreactor
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
UF	ultrafiltration
USEPA	United States Environmental Protection Agency
UV	ultraviolet (disinfection)
WRP	water reclamation plant