MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

BOARD ACTION

- **Board of Directors**
  Engineering and Operations Committee

August 19, 2003 Board Meeting

8-3

Subject

Authorize purchase of demonstration-scale reverse osmosis system for up to $800,000 to evaluate large-diameter reverse osmosis elements (Approp. 15301)

Description

The Desalination Research and Innovation Partnership (DRIP) is in its sixth year of an eight-year applied research effort to develop and demonstrate new technologies which reduce the cost of desalinating and disinfecting Colorado River water and other brackish sources. The DRIP is a public/private consortium formed in 1997 whose participating Southern California agencies include San Diego County Water Authority, West Basin Municipal Water District, and Orange County Water District. The overall project goal for DRIP is to develop design specifications for next-generation desalination and disinfection technologies that can economically treat large volumes of brackish water for potable and non-potable uses.

One option to lower the cost of desalinating Colorado River water and other water sources is to use large-diameter reverse osmosis (RO) elements. These experimental RO elements contain five times more surface area than other commercially available elements. The Water Quality Section's Process Development Team pilot tested these experimental elements for the past two years. Preliminary cost studies show that these large-diameter RO elements may save as much as 28 percent in capital costs ($46 million) for a 185-million- gallon-per-day (product water flow) RO plant.

In order to fully evaluate the potential performance and economic advantages of these large-diameter RO elements, a demonstration-scale RO system capable of testing these elements at 85 percent or greater water recovery is needed. Funding for this equipment is being provided by both DRIP Appropriation No. 15301 (up to $635,000) and a California Energy Commission grant ($165,000). See detailed report in **Attachment 1**.

Policy

Prior Board direction. References include Board Letter 9-8 (July 11, 2000), and Board Letter 8-9 (August 20, 2001).

California Environmental Quality Act (CEQA)

CEQA determination for Option #1:

The proposed action is categorically exempt under the provisions of CEQA and the State CEQA Guidelines. The overall activities involve the funding, design, and minor alterations of existing public facilities, along with the installation of new equipment and construction of minor appurtenant structures with negligible or no expansion of use and no possibility of significantly impacting the physical environment. The proposed action also involves basic data collection and resource evaluation activities that do not result in a serious or major disturbance to an environmental resource. This may be strictly for information gathering purposes, or as part of a study leading to an action, which a public agency has not yet approved, adopted, or funded. In addition, this proposed action involves minor modifications in the condition of land and/or vegetation that do not involve removal of healthy, mature, scenic trees. As such, the proposed action qualifies under Class 1, Class 3, Class 4, Class 6, and Class 11 Categorical Exemptions (Sections 15301, 15303, 15304, 15306, and 15311 of the State CEQA Guidelines).

The CEQA determination is: Determine that pursuant to CEQA, the proposed action qualifies under five Categorical Exemptions (Class 1, Section 15301; Class 3, Section 15303; Class 4, Section 15304; Class 6, Section 15306; and Class 11, Section 15311 of the State CEQA Guidelines).

CEQA determination for Option #2:

None required

Board Options/Fiscal Impacts

Option #1

Adopt the CEQA determination and grant the CEO authority to purchase a large-scale RO system for no greater than $800,000.

Fiscal Impact: $635,000 of budgeted capital funds and $165,000 of grant funds

Option #2

Do not authorize purchase of large-scale RO system for $800,000.

Fiscal Impact: Without this equipment Metropolitan will not be able develop lower cost technologies

Staff Recommendation

Option #1

7/21/2003
Jeff T. Wicke *Date*
Manager, Water System Operations

7/24/2003
Ronald R. Gastelum *Date*
Chief Executive Officer

Attachment 1 – Detailed Report

BLA #2358

DETAILED REPORT

Background

The Desalination Research and Innovation Partnership (DRIP) is in the sixth year of a planned eight-year applied research program to demonstrate innovative technologies to reduce the cost of desalinating various brackish waters and to demonstrate scaled-up ultraviolet (UV) technologies for potable water disinfection. Achievement of the DRIP program objectives will allow development of additional local water supplies, help mitigate the region's dependence on imported supplies, reduce damages due to corrosion and scaling of plumbing fixtures which result from the use of high-salinity water, and possibly provide or enhance potential treatment alternatives to a Bay-Delta solution. Metropolitan is focusing on the treatment of Colorado River water, and other DRIP partners are addressing brackish groundwater, municipal wastewater, and agricultural drainage water.

As shown in Table 1, DRIP currently consists of eight applied research partners, of which three are located in Southern California: San Diego County Water Authority (SDCWA), West Basin Municipal Water District (WBMWD), and the Orange County Water District (OCWD). Three Northern California water agencies (Santa Clara Valley Water District, Alameda County Water District, and Sonoma County Water Agency) and the University of California are also DRIP members.

Outside Funding

A summary of DRIP-related funding received to date is shown in Table 2, and the allocation of the funding is shown in Figure 1. The partnership has received $12.8 million in outside grant funding. Of this, $3.2 million has been allocated to Metropolitan. Current DRIP funding is being provided through individual grants from the California Department of Water Resources (DWR) [$4.0 million] and California Energy Commission (CEC) [$2.0 million], and four grants from the United State Environmental Protection Agency (EPA) [$3.2 million combined]. The Board has sequentially approved funding for the program in July 1997, October 1998, July 1999, July 2000, and August 2001.

Purchase of Large-Scale Reverse Osmosis (RO) System

The overall project goal for DRIP is to develop design specifications for next-generation desalination and disinfection technologies that can economically treat large volumes (>100-million-gallon-per-day [mgd] of brackish water for potable and non-potable uses. The accomplishments of the fifth year of DRIP, and the goals for the sixth year are shown in Table 3. A major fifth-year research accomplishment was the successful development of large-diameter (up to 17-in. diameter and 60-in. long) reverse osmosis (RO) elements. These large-diameter RO elements have roughly five times more surface area than the largest commercially available RO element today and if successful, these would be the world's largest RO elements . Preliminary cost studies show that these large-diameter RO elements may save as much as 28 percent of the capital costs ($46 million) for a 185-million-gallon-per-day (product water flow) RO plant.

Pilot-Scale Testing

Water Quality Section's Process Development Team has pilot tested large-diameter elements in parallel with commercial 8-in. elements for the past two years. Because of the experimental nature of the elements, four generations of the large-diameter element were evaluated. With each new generation, the membrane manufacturer modified the element resulting in improved performance. Based on pilot-scale tests, the large-diameter elements were shown to perform similarly to the commercial 8-in. elements.

Large-Scale RO System

In order to fully realize the benefits of large-diameter RO elements, simulated full-scale testing is required. Therefore, a demonstration-scale RO system using large-scale RO elements is needed to evaluate the effects of high-water recovery (greater than 85 percent) and changing water flow conditions on full-scale membrane performance, as well as help refine cost estimates for a full-scale plant. A large-scale RO system also allows more experience with installation and removal of these large elements. A simple and efficient method for element handling will be needed as an individual 17-in. x 60-in. RO element weighs more than 300 pounds. Finally, the large-scale RO system will help in collaborative efforts with membrane manufacturers to improve membrane performance and lower the overall system cost for full-scale applications.

For demonstration-scale testing, a 0.6-0.7 mgd (permeate flow) RO system will be designed and built. The RO system will be equipped with a feed pump, a main booster pump, and pressure vessels which house the RO elements (see Figure 2). The system will be operated through a microprocessor based control system. The RO system will contain a total of 18 RO elements and be capable of achieving at least 85 percent total system water recovery. Two additional elements will be provided as spare.

Table 4 shows a breakdown of the large-scale RO system cost. Because of the large size of these experimental RO elements, the pressure vessels, which house the elements, are not readily available. Based on preliminary talks with pressure vessel manufacturers, the cost for three large-diameter vessels would be approximately $130,000-$150,000. This high cost is due to additional capital equipment that is needed to manufacture these large-diameter vessels. The cost of the RO elements will be approximately $4,000-$5,000 each. A total of 20 elements will be needed for a total cost of $80,000-$100,000. The cost of the main skid, cleaning skid, pumps, tanks, control system, monitoring equipment, piping, and valves is estimated at $450,000-$500,000. The total system cost is expected to be approximately $660,000 - $750,000. The cost of the system is being partially funded by a grant from the California Energy Commission in the amount of $165,000. The remaining balance up to $635,000 is being funded from DRIP Appropriation No. 15301.

Update on Ultraviolet Light Disinfection

As part of DRIP, Metropolitan's applied research on UV disinfection technology has included work at the laboratory bench-, pilot-, and demonstration-scale (5 mgd). This work has shown that UV is an effective disinfectant against hard-to-disinfect organisms such as *Cryptosporidium* and *Giardia*. However, research has also shown that UV is not a stand-alone disinfection technology. The most efficient and cost-effective location for installation of UV technology is downstream of conventional treatment (i.e., predisinfection/oxidation followed by coagulation, flocculation, sedimentation and filtration).

Current research activities are investigating the full-scale aspects of UV disinfection. Projects are currently focused on gaining knowledge on effects of long-term UV usage on distribution-system water quality, how UV dose can be measured and predicted in full-scale reactors, and how to best integrate UV with other disinfectants at the treatment plant.

DRIP Closure Strategy

The DRIP program is approaching the end of the 8-year schedule. Staff recommends that Metropolitan formally end DRIP in June 2005. At that time, final reports for Metropolitan's research will be delivered to both the Board and funding agencies with no additional work forthcoming. Research for individual DRIP partners may extend beyond this date, though no new funding will be obtained. Additional focused research may be pursued with individual DRIP partners on a case-by-case basis, if warranted.

As such, the next steps for implementation are:

1. Obtain authorization from the Board for CEO to purchase a demonstration-scale reverse osmosis (RO) system for up to $800,000 to evaluate large-diameter RO elements.
2. Obtain $813,000 final board appropriation in early 2004 to complete the internal funding target of $7.35 million. This remaining funding will aid in the development of design criteria for large-scale desalting plants at one or more of Metropolitan's facilities.
3. Cease external fundraising efforts for the DRIP partnership in 2003. Metropolitan's total external DRIP-related fundraising was $12.8 million, of which $3.2 million directly compensated Metropolitan—roughly
   44 percent of the original $7.35 million external funding target. The primary reason for this reduced funding resulted from additional distribution of external funding to the DRIP partners.

4. Deliverables to Metropolitan and the Board will include:
    - Process design criteria for a large-scale reverse osmosis desalting facility treating Colorado River water;
    - Process design criteria for a large-scale UV disinfection facility treating any blend of Colorado River water and California State project water and,
    - A desalination and disinfection benchmarking cost study.
5. Initiate a new capital project to site the potential Colorado River water desalting facility either along Metropolitan's conveyance system or within its service area.

TABLE 1

DESALINATION RESEARCH AND INNOVATION PARTNERSHIP

PARTICIPANTS AS OF AUGUST 2003

- Metropolitan Water District of Southern California
- Orange County Water District
- San Diego County Water Authority
- West Basin Municipal Water District
- Alameda County Water District
- Sonoma County Water Agency
- Santa Clara Valley Water District
- University of California

Funding Partners

Current

- California Energy Commission (CEC)
- California Department of Water Resources (DWR)
- U.S. Environmental Protection Agency (EPA)

Previous

- U.S. Bureau of Reclamation (USBR)
- American Water Works Association Research Foundation (AWWARF)
- Southern California Edison (SCE)
- Electric Power Research Institute (EPRI)

TABLE 2

GRANT MONEY TO PARTNERSHIP
(AS OF AUGUST 2003)

Year	External Funding				Internal Funding
	Funding Source	Total Award	DRIP Related	MWD Portion	
1997		$ -	$ -	$ -	$ 246,200
1998	AWWARF	$ 100,000	$ 100,000	$ 100,000	$ 576,200
	SCE/EPRI	$ 460,000	$ 150,000	$ 150,000	$ -
1999	CEC PIER I	$ 2,889,678	$ 1,330,493	$ 653,993	$ 1,834,200
	DWR Prop 204	$ 65,000	$ 65,000	$ -	$ -
	USBR	$ 98,436	$ 98,436	$ 98,436	$ -
2000	CEC PIER II	$ 2,000,000	$ 2,000,000	$ 800,000	$ 2,276,200
2001	EPA I	$ 475,100	$ 475,100	$ 118,775	$ 1,604,000
	DWR Prop 13	$ 4,000,000	$ 4,000,000	$ 694,420	$ -
2002	EPA II	$ 1,838,597	$ 1,838,597	$ 280,900	$ -
	EPA III	$ 470,500	$ 470,500	$ 270,500	$ -
2003	EPA IV	$ 433,700	$ 433,700	TBD	$ -
	Total	**$ 12,831,011**	**$ 10,961,826**	**$ 3,167,024**	**$ 6,536,800**

TBD = to be determined

TABLE 3

DESALINATION RESEARCH AND INNOVATION PARTNERSHIP ACCOMPLISHMENTS AND GOALS

Project Tasks	Fifth Year Accomplishments	Sixth Year Goals
Raise Money/Obtain Partners	• Received $470,500 in the U.S. Environmental Protection Agency's FY 2002 budget	• Cease all external fund-raising efforts • Obtain final board appropriation • Receive $433,700 in the U.S. Environmental Protection Agency's FY 2003 budget
Treatment Evaluations	• Developed large-scale (17-in. diameter) RO membrane module for treatment of Colorado River water • Completed the design a 0.5 - 1.0 mgd RO demonstration unit • Evaluated a scaled-up (3 mgd) UV system for pathogen inactivation • Conducted bench-scale testing of non-thermal technologies for brine minimization • Conducted a study of the performance and economics of an electrodialysis reversal (EDR) process for desalination of municipal wastewater (SDCWA) • Conducted bench-scale testing for desalination of agricultural drainage water (UC Riverside)	• Demonstrate large-scale desalination and ultraviolet light (UV) technologies for Colorado River water and municipal wastewater • Evaluate membrane scale and biofouling control options • Conduct pilot testing of new membranes and electrotechnologies for desalination of brackish groundwater, municipal wastewater, and agricultural drainage water • Conduct pilot-scale testing of non-thermal technologies for brine minimization

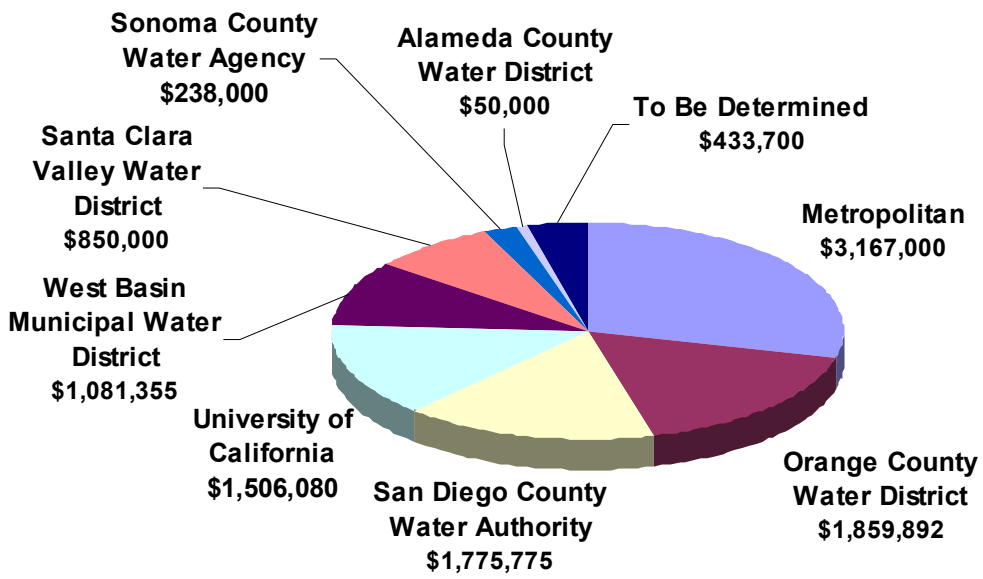
TABLE 4

COST BREAKDOWN FOR LARGE-SCALE RO SYSTEM

Item	Cost
Pressure vessels	$130,000 - $150,000
Reverse osmosis elements	$ 80,000 - $100,000
Skid, pumps, tanks, valves, etc.	$450,000 - $500,000
Total Cost	**$660,000 - $750,000**

FIGURE 1

GRANT MONEY TO PARTNERSHIP
(as of August 2003)



Total DRIP-Related Grant Funding = $10,962,000

FIGURE 2

LARGE-SCALE RO SYSTEM SCHEMATIC