TECHNICAL MEMORANDUM

MEMO No: 1

SUBJECT: Evaluation of Disposal of Reverse Osmosis By-product
Selection of Reverse Osmosis

TO: Stakeholder Forum

COPIES: Richard Bay, JVWCD
Paula Doughty, KUCC
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FROM: Bryant Bench

DATE: April 13, 2004

EXECUTIVE SUMMARY

Reverse osmosis (RO) membrane treatment is the selected process for treating the Southwest groundwater supply to remove elevated levels of sulfate and total dissolved solids (TDS). Other potential processes including electrodialysis reversal and ion exchange would not be as efficient nor effective as RO in meeting water treatment objectives and project goals for costs, reliability, and operations. RO membrane treatment of Southwest groundwater has been successfully demonstrated with treatability studies and pilot-scale treatment investigations.

BACKGROUND

Mining activities in southwestern Salt Lake Valley have created groundwater contamination, with elevated sulfate concentrations. A 1995 federal Consent Decree negotiated by Jordan Valley Water Conservancy District (JVWCD), Kennecott Utah Copper Corporation (KUCC) and Utah Department of Environmental Quality (UDEQ), established a natural resource damage Trust Fund, which was paid by KUCC. The Consent Decree established purposes for use of the Trust Fund as:

- remediating the aquifer
- containing the contamination plumes; and
- restoring the beneficial use by producing municipal quality water through treatment.

Dr. Dianne R. Nielson, Executive Director of UDEQ, has been appointed as Trustee of the Trust Fund and of projects to accomplish the Consent Decree purposes.

JVWCD and KUCC have submitted a Joint Proposal project to the Trustee to accomplish the Consent Decree purposes. The Joint Proposal involves one reverse osmosis (RO) treatment plant and facilities to treat western Zone A deep groundwater; and one RO plant to treat eastern Zone B deep groundwater and Lost Use shallow groundwater. The Trustee held a public information and public comment period during August through November 2003.

As a result of the public comments, JVWCD withdrew its Zone B/Lost Use RO by-product water discharge permit to the Jordan River and renewed efforts to find a better disposal alternative. The Trustee established a Stakeholder Forum for southwest groundwater remediation issues in early 2004. JVWCD has sought input from the Stakeholders Forum as it considers various alternatives for disposal of Zone B/Lost Use RO by-product water.

Zone B/Lost Use by-product water is projected to have the following characteristics:

	Flow Rate	**TDS Concentration**	**Selenium Concentration**
	(cfs)	**(mg/L)**	(µg/L)
Zone B	1.24	8,300	25
Lost Use	0.51	8,200	47
Total	**1.75**		
Common Range		**8,200 -8,300**	**32-47**

PURPOSE

The purpose of this memo is to explain why reverse osmosis is the appropriate membrane process technology for treating the sulfate contaminated Southwest groundwater supply.

AUTHOR'S CREDENTIALS

Bryant Bench is a registered Professional Engineer specializing in the area of water treatment process selection and facility design. Mr. Bench holds a Bachelors degree in Civil Engineering and a Masters degree in Environmental Engineering. For the past 25 years, Mr. Bench has been working as a consulting engineer for public and private water utilities involved in the planning, design, and construction of public water treatment plants. He has provided engineering services for most of the major water

treatment plants located in the Salt Lake Valley and along the Wasatch front. Mr. Bench has engineered advanced treatment technologies for water treatment including high-rate conventional treatment, managed filtration, ozonation, ultraviolet (UV) light disinfection, and reverse osmosis and other membrane separation processes.

TREATMENT OBJECTIVES

Treatment process selection is based upon raw water quality and finished water objectives. The Southwest groundwater contains elevated levels of sulfate and total dissolved solids and requires treatment. The finished or treated water must meet drinking water standards for TDS and sulfates and must be compatible with other municipal drinking water supplies. Specific treatment process objectives for the Southwest groundwater are as follows:

- Reduce sulfate concentration from 800 mg/L to below 500 mg/L.
- Reduce TDS concentration from 1600 mg/L to 250 mg/L.
- Meet all other drinking water quality standards.
- Process and facilities must be cost effective.
- Process must be reliable.

PROCESS SELECTION

Reverse Osmosis is the selected treatment process for restoring the beneficial use of the Southwest groundwater and producing municipal drinking water. RO is a proven, established treatment technology for TDS and sulfate removal. Project advantages for RO treatment include:

- RO is very effective at removing total dissolved solids including sulfate.
- RO is much more efficient in terms of waste generation and recycle requirements compared with other ion removal technologies. An 80% (Zone B) and 85% (Lost Use) recovery rate has been successfully demonstrated for RO treatment of Southwest groundwater.
- RO costs less to construct and operate than other TDS.

Over the past year, bench-scale and pilot-scale treatment studies have been successfully conducted to demonstrate the efficacy and cost effectiveness of reverse osmosis for meeting the specific water quality and project objectives.

Alternative processes to RO for meeting project treatment objectives are limited. Two potential processes are electrodialysis reversal (EDR) and ion exchange (IE). The problem with ion exchange is that, by its name, a simple exchange of one ion for another does not result in a net reduction in TDS. It would be possible to reduce the sulfate concentration, but IE would not reduce TDS to the required treatment level of

250 mg/L. IE also generates a brine waste from media regeneration that would have to be treated for proper recycle and disposal.

Electrodialysis reversal is normally only considered when RO is not practical due to uncontrollable membrane fouling caused by a high mineral and/or silicate content in the feed water. EDR normally costs 50% more than RO and EDR recovery rates are much less efficient than for RO membranes.

Coagulation and chemical precipitation processes are also not possible for sulfate and TDS removal. A lime softening precipitation process could remove the majority of calcium and magnesium ions but such removal would not adequately reduce TDS or sulfate levels to below project goals.

Based upon the treatment objectives and the successful results of previous studies, it is clear that RO is the correct process for treating the Southwest groundwater for TDS and sulfate reduction and for producing drinking water from this supply.