Jordan Valley Water Conservancy District

TECHNICAL MEMORANDUM

MEMO No: 3

SUBJECT: Cost Estimate for Disposal of Reverse Osmosis By-product
Alternative D - Discharge to Great Salt Lake

TO: Stakeholder Forum

COPIES: Richard Bay, JVWCD
Paula Doughty, KUCC
Douglas Bacon, UDEQ

FROM: Mark Atencio

DATE: April 13, 2004

EXECUTIVE SUMMARY

This alternative consists of pumping the Zone B and Lost Use Roby-product to the south arm of the Great Salt Lake in a 23.7 mile long, 10-inch diameter pipeline using three pump stations. The net present value cost for disposal of Zone B and Lost Use RO by-product is $9.7 million. This includes a capital cost of $9.3 million and an operation cost of $20,000 per year.

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 describe the net present value cost of disposing of Zone B and Lost Use RO by-product to the Great Salt Lake in a pipeline from the Zone B Lost Use Treatment Plant in West Jordan to the south arm of Great Salt Lake near Salt Air.

AUTHOR'S CREDENTIALS

I am a registered professional engineer specializing in the area of water resources. I have completed Bachelor and Master of Science degrees in civil engineering. Following graduation I have been working at Jordan Valley Water Conservancy District as a civil engineer. My current title is senior engineer, in which I fill project management and supervisory roles. I have been studying and investigating various membrane and TDS reduction treatments for eight years. I have completed a number of well drilling and construction projects. I have completed three years of pilot testing using various membrane and reverse osmosis processes. I have been filling the role of a technical

engineer for the District on the Southwest Groundwater Remediation and Treatment Project since 1999.

DESCRIPTION OF ALTERNATIVE

See the attached Drawing for a visual representation of the alternative.

This alternative consists of a 23.7 mile long, 10-inch diameter PVC pipeline constructed from the Zone B Lost Use Reverse Osmosis (RO) Plant in West Jordan to the Great Salt Lake near Salt Air. Discharge into the lake would be through a new outfall pipeline. Three pump stations would be required; one at the RO plant, the second at 7 to 8 miles from the plant, and the third at 15 to 16 miles from the plant.

SCALING CONCERNS

The RO by-product contains a high concentration of salts, consisting mostly of calcium sulfate (gypsum) and calcium carbonate (calcite IE Timpanogos Cave). The solutions are super-saturated and on the verge of precipitating. This means that if the fluid were to stop moving a scale would start to form on the interior of the pipeline. In the RO plant an antiscalant chemical prevents scale formation; however, the chemical does not last for more than approximately 24 hours.

The formation of scale or precipitation of salts is the same process that occurs in the Great Salt Lake as the tributaries to the lake bring in salts into the lake. In this case the salts are concentrated due to evaporation until the point that saturation is reached and the salts form particles (precipitation) and settle to the bottom. In order to prevent this type of scaling from occurring, the pipeline needs to be kept in continuous operation or drained.

PIPELINE MATERIAL

Polyvinyl chloride (PVC) was selected as material of choice after considering ductile iron, steel, high density polypropylene (HDPE), and PVC. This took into account the actual internal diameter of the various types of pipeline, the working pressure of the pipelines, the hydraulic characteristics of the pipeline materials (friction factor) and the construction cost. Each pipeline material option was evaluated in a large spreadsheet. A copy of this spreadsheet is attached to this memo. The limitations of the pipeline material options considered affected the number and cost of pump stations required, the pressure loss required to be overcome by a pump, pipeline construction cost, and pump station operating cost.

PIPELINE DIAMETER

Six-inch, 8-inch, 10-inch, and 12-inch diameter pipelines were evaluated in the spreadsheet identified above. The size of the pipeline options evaluated affected the pressure loss (smaller pipe = higher pressure loss), the detention time in the pipeline (larger pipe = longer time in transit), pipeline construction cost, and pump station operating cost.

PIPELINE ALIGNMENT

Multiple alignments were considered for this alternative. First, an alignment extending westward, then northward was considered. Second a northern then westward alignment was evaluated. The two alignments were of comparable length. Due to the topography the first alignment required additional pumping to move the fluid uphill, then downhill towards Great Salt Lake. Both alignments utilized property owned by Kennecott Utah Copper Corporation (KUCC) along the east and north sides of its tailings impoundment in the northwest section of Salt Lake County.

SELECTION OF PREFERRED PIPELINE OPTION

Selection of the preferred pipeline option took into account the concerns with scaling and the effects of pipeline material, diameter, and alignment on the capital and operating cost.

The alignment selected for this alternative utilizes public right-of-way and private property, most of which is owned by KUCC. The alignment generally follows an elevation contour line to the north along 1300 West and then to the west along 1300 South to the KUCC tailings impoundment. The alignment then extends to the north and west until reaching Great Salt Lake. This alignment allows for utilizing existing right–of-way corridors. This alignment stays at almost the same elevation along its length. The alignment also avoids increasing in elevation, thereby avoiding additional pumping cost and making it easier to drain the pipeline with a backup pump in the event of a power failure.

Selection of the a 10-inch diameter PVC pipeline with three pump stations allows for the concerns expressed in this memo to be met will obtaining the lowest capital and net present value cost.

REQUIRED FACILITIES

- 23.7 mile long, 10-inch diameter PVC pipeline
- 3 pump stations
- Outfall pipeline

LEGALITY

The legality of this alternative was considered. A review of existing information indicated that a permit for discharge of RO by-product to GSL could be issued which would be protective of Great Salt Lake.

The water quality of the RO by-product was compared against standards for the Jordan River. All of the water quality parameters of the by-product were below the Jordan River standards, with the exception of total dissolved solids (TDS) and selenium. Comparing the TDS of the by-product (8,300) to Great Salt Lake (100,000 plus) it was apparent that TDS in the by-product would not be a concern. In order to understand if the selenium concentration in the by-product would be a concern I researched the files of the Utah State Division of Water Quality. Although selenium is an essential trace element, it has the potential to cause harm to humans or wildlife at very high concentrations. There is an existing permit for a discharge from KUCC to Great Salt Lake with a 54 µg/L (ppb) selenium limitation. The files of the Division contained substantial documentation of the methods used to derive this limitation. The limit required by the Division was based on limiting selenium absorption by algae in Great Salt Lake, which algae are consumed by brine shrimp, which shrimp are then consumed by waterfowl. By limiting selenium accumulation in Great Salt Lake algae the Division of Water Quality is able to prevent reproductive failure in waterfowl that consume Great Salt Lake brine shrimp.

The files also contained concerns expressed by others regarding the permit limitations and responses to these concerns. The issue of selenium has been well researched and a permit limit was already established. The conclusion of my research was that a selenium permit limit for discharge into Great Salt Lake on a firm basis was already established. Comparing the RO by-product selenium concentration of 32-47 µg/L against an existing permit limitation of 54 µg/L indicates that Zone B and Lost Use RO by-product will meet a limit for discharge to Great Salt Lake.

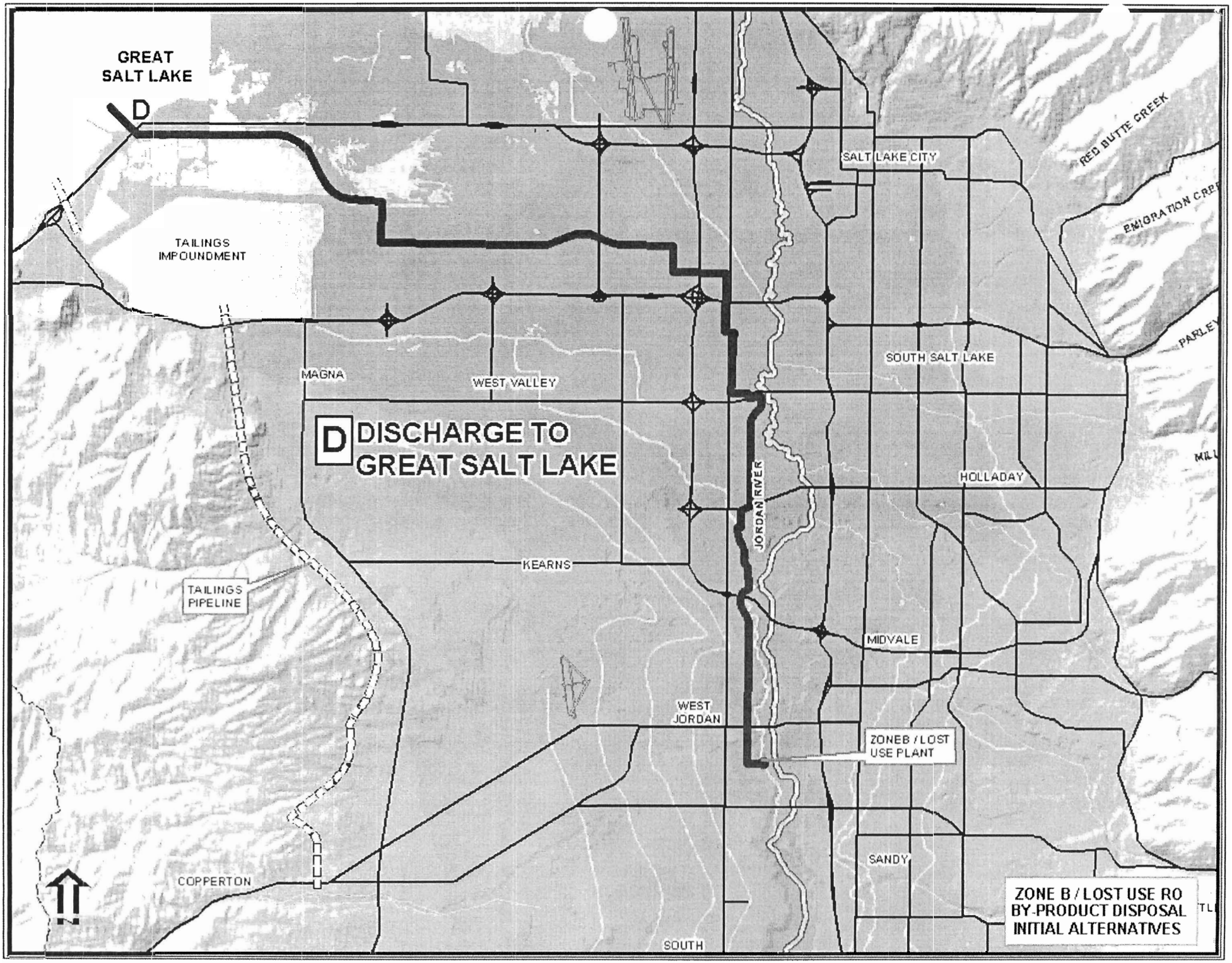
ASSUMPTIONS

- Pump Efficiency: 85%
- Motor Efficiency: 90%
- Pump Station Capital Cost: $500,000 each
- NPV interest rate: 4%
- 25 feet wide easement cost: $14.35/ foot ($50,000/acre)
- Pipeline in roadways installation cost: $47.40/ft
- Pipeline in open areas installation cost: $23.45
- Pipeline costs from two contractors and MWH Engineers
- RO plant operates 330 days per year
- Power Cost $0.055/kW hr

COST ESTIMATE

The cost estimate for this alternative took into account the size of the pipeline, number of pump stations, pumping costs, length of pipeline, length of pipeline in roadways, length of pipeline in open areas, easement acquisition costs, dewatering costs, and engineering costs. The net present value cost for disposal of Zone B and Lost Use RO by-product is $9.7 million. This includes a capital cost of $9.3 million and an operation cost of $20,000 per year.

See the attached spreadsheet for details and calculations of the cost estimate.


GREAT SALT LAKE
D
TAILINGS IMPOUNDMENT
MAGNA
WEST VALLEY
D DISCHARGE TO GREAT SALT LAKE
KEARNS
TAILINGS PIPELINE
COPPERTON
SALT LAKE CITY
RED BUTTE CREEK
EMIGRATION CREEK
SOUTH SALT LAKE
JORDAN RIVER
HOLLADAY
MIDVALE
WEST JORDAN
ZONE B / LOST USE PLANT
SANDY
SOUTH
ZONE B / LOST USE RO BY-PRODUCT DISPOSAL INITIAL ALTERNATIVES

SOUTHWEST GROUNDWATER
REVERSE OSMOSIS BY-PRODUCT DISPOSAL OPTIONS

Alternative A
Discharge to GSL

No.	Alignment Descriptions	Project Yield (AF/yr)	Pipeline Material	Pipeline Actual Inside Diameter (Inches)	Zone A Yield (AF/yr)	Zone B Yield (AF/yr)	Zone B Production Rate (cfs)	Lost Use Yield (AF/yr)	Lost Use Production Rate (cfs)	Future Shallow Wells Yield (AF/yr)	Future Shallow Wells Production Rate (cfs)
A	1300 West, 1300 South, 8000 West, KUCC	9300	PVC C-909	10.27	3500	3500	5.35	2300	3.51	0	0

By-product Flow Rate (cfs)	Number of Pipelines (#)	Pressure Rating (psi)	Pipeline Hazen Williams C-factor	Pipeline in Roadways Length (ft)	Roadway Pipeline Unit Cost ($/ft)	Pipeline In Open Field Length (ft)	Open Pipeline Unit Cost ($/ft)	Total Pipeline Length (ft)	Total Pipeline Length (miles)	Dewatering Length (ft)	Dewatering Unit Cost ($/ft)
1.74	1	200	120	90,290	47.40	34,850	23.45	125,140	23.70	42,770	2.00

Pipeline Boring & Additional Costs ($)	Easement Length Required (ft)	Easement Cost ($)	Total Pipeline Cost ($mill)	Velocity (ft/sec)	Detention Time OK? (hrs)	Max Head Loss between Pump Stations (ft)	Max Distance between Pump Stations (ft)	Max Distance between Pump Stations (miles)	Calculated Number of Pump Stations (ft)	Actual Number of Pump Stations (ft)	Total Pump Station Cost ($mill)
0.00	1,850	26,548	5.209	3.03	11.5	416	103,407	19.6	1.2	2	1.000

Total Const Cost ($mill)	Eng Cost ($mill)	20% Contingency ($mill)	**Total Capital Cost ($mill)**	Discharge Hydraulic Gradeline (ft)	Static Pump Lift (ft)	Head Loss (ft)	Total Pump Lift (ft)	Pump Size (HP)	**Annual Pumping Cost ($)**	**NPV of Pumping Costs ($mill)**	**Total NPV Cost ($mill)**
6.209	0.931	2.142	**9.283**	4,215	-267	503	236	61	**19,986**	**0.396**	**9.678**