Jordan Valley Water Conservancy District

TECHNICAL MEMORANDUM

MEMO No: 14

SUBJECT: Cost Estimate for Disposal of Reverse Osmosis By-product
Alternative I.3 -
Zone B Discharge to KUCC Tailings Pipeline
Lost Use Distillation

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 RO by-product to the KUCC tailings pipeline in a 9.4 mile long, 8-inch diameter pipeline using two pump stations. The Lost Use RO by-product would be distilled at the RO treatment plant. The new present value cost for disposal of Zone B and Lost Use RO by-product is $37.7 million. This includes a capital cost of $14.5 million and an operation cost of $1,172,000 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 methods used to estimate the cost of disposing of Zone B RO by-product to the KUCC tailings pipeline and Lost Use RO by-product distilled in a distillation plant adjacent to the Zone B Lost Use Treatment Plant in West Jordan.

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 of Alternative I.3 for a visual representation of the alternative.

This alternative consists of a 9.4 mile long, 8-inch diameter PVC pipeline constructed from the Zone B Lost Use Reverse Osmosis (RO) Plant in West Jordan to the tailings pipeline. Two pump stations would be required; one at 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.

Of necessity, this pipeline would need to be drained into the Jordan River in the event of a power failure.

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

7800 South was the most direct and only pipeline alignment considered.

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 8-inch diameter PVC pipeline with two pump stations and a distillation plant allows for the concerns expressed in this memo to be met will obtaining the lowest capital and net present value cost.

DISTILLATION PLANT

Memorandum number six describes the details and cost estimate of a distillation plant.

REQUIRED FACILITIES

- 9.4 mile long, 8-inch diameter PVC pipeline

- 2 pump stations
- distillation plant

LEGALITY

The legality of this alternative was considered. The Zone B RO by-product meets the limitations of the existing KUCC GSL discharge pipeline.

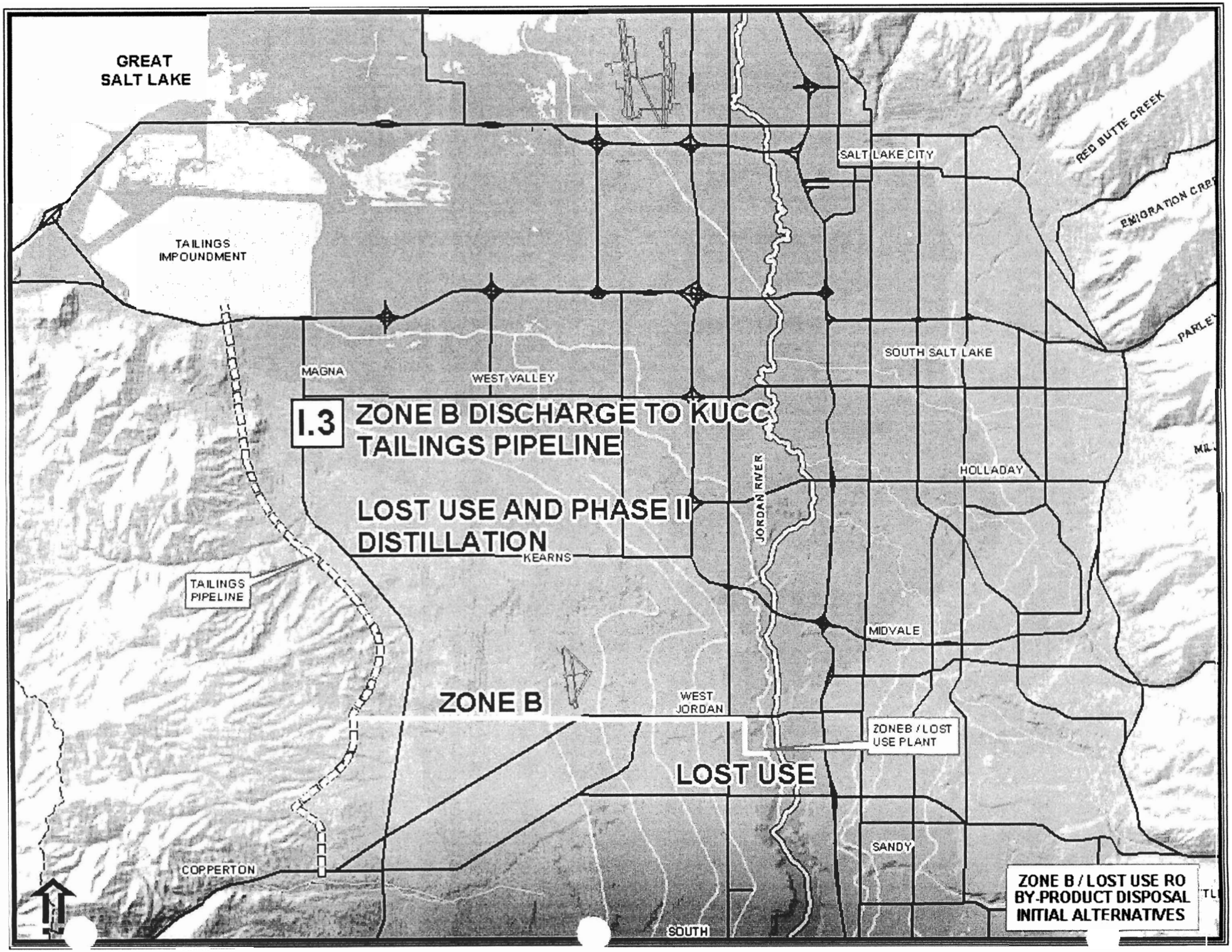
ASSUMPTIONS

- 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: $39.90/ft
- Pipeline in open areas installation cost: $18.65
- 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 $37.7 million. This includes a capital cost of $14.5 million and an operation cost of $1,172,000 per year.

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


GREAT SALT LAKE
TAILINGS IMPOUNDMENT
SALT LAKE CITY
RED BUTTE CREEK
EMIGRATION CREEK
SOUTH SALT LAKE
MAGNA
WEST VALLEY
I.3
ZONE B DISCHARGE TO KUCC TAILINGS PIPELINE
LOST USE AND PHASE II DISTILLATION
HOLLADAY
JORDAN RIVER
KEARNS
TAILINGS PIPELINE
MIDVALE
ZONE B
WEST JORDAN
ZONEB / LOST USE PLANT
LOST USE
SANDY
COPPERTON
SOUTH
ZONE B / LOST USE RO BY-PRODUCT DISPOSAL INITIAL ALTERNATIVES

SOUTHWEST GROUNDWATER
REVERSE OSMOSIS BY-PRODUCT DISPOSAL OPTIONS

Alternative I.3
Zone B Discharge to Tailings Pipeline
Lost Use Distillation

Alt. No.	Disposal Alternative	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)
I.3 ZB	Zone B to Tailings Pipeline	3500	PVC C-909	8.29	0	3500	5.35	0	0	0	0
I.3 LU	Lost Use Distillation Distillation & Totals	9300	PVC C-909	0	3500	0	0	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)
1.23	1	200	120	38,544	39.90	10,850	18.65	49,394	9.35	1,850	2.00
0.51	1	200	0	0	0.00	0	0.00	0	0.00	0	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)
0.000	0.000	0.000	1.744	3.29	4.2	416	69,018	13.1	0.7	2	1.000
0.00	0.00	0.00	0.00	#DIV/0!	#DIV/0!	415.80	0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!

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)**
2.744	0.412	0.947	**4.102**	5,385	903	298	1,201	220	**71,929**	**1.424**	**5.526**
#DIV/0!	#DIV/0!	#DIV/0!	**14.502**	4,215	-267	#DIV/0!	#DIV/0!	#DIV/0!	**1,171,929**	**23.196**	**37.698**