



1326 North Trinity  
San Antonio, TX 78207

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Re: Test Report on gas well sample

September 27, 2002

### **Summary**

During the field test we demonstrated that the water could be purified to the Tongue River Standards. A TDS of 227 ppm can be achieved from a starting feed water TDS 1,770 with better than 95% recovery and with blending an SAR of 1 can be achieved. Over a 10-year span the total cost of capital and operations will be \$.06 per barrel of water processes.

### **Discussion**

A test was run from a sample using a 1,000-gram EWP cell using PAC 100 material. The test was run at flows varying from 2.2 lpm and 1.6 lpm (equal to a speed of 2.2 ml/min/g-c) on the first stage. The wastewater generated from the primary purification stage was processed through the same unit to estimate the performance of wastewater recovery.

Solids were present in the sample. This were pretreated using a 30 micron pleated filter and an activated carbon (for all entrained organic compounds—which we were not sure if they were present).

We achieved the following results

Feed Conductivity	1770	ppm (EC)
Estimated Feed SAR	24	
Purified Effluent	270	ppm
Purified Effluent after waste recovery	227	ppm
Estimated SAR without blending Ca/Mg (of purified stream)	9 (1)	
Estimated SAR with blending (400 mg/l Ca/Mg)	1 (2)	
Waste Water (reject) conductivity	3,200	ppm
% Purification average	85%	
Recovery	75%	
Overall Recovery with Waste Recovery Recycle	95%	
Power Consumption—estimated	2.63	whr/gal

(1) waiting for analytical testing of samples for detailed constituent analysis.

(2) by meeting SAR the TDS level will not be met but if blend 100 mg/l Ca/Mg the SAR=2 but the TDS limit will be achieved.

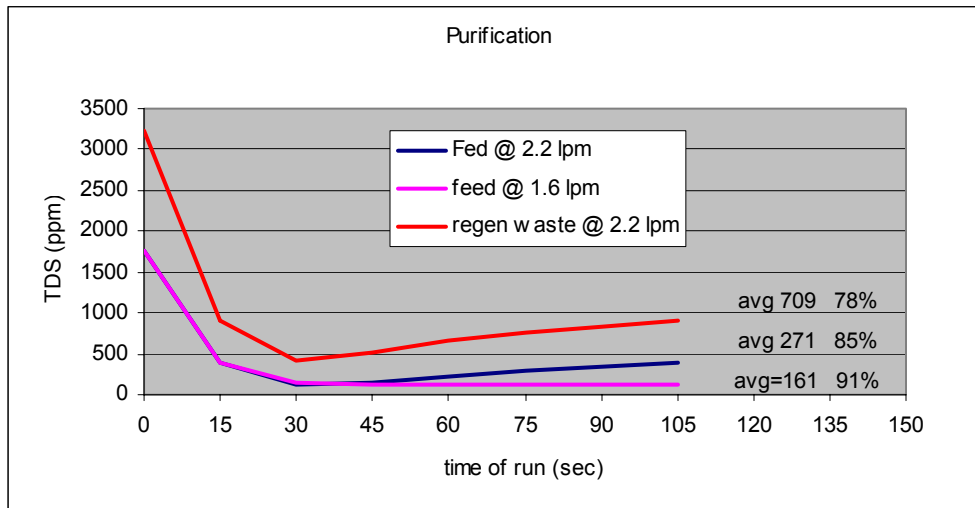
The regenerant waste (reject) was treated using the same system. The following results were achieved

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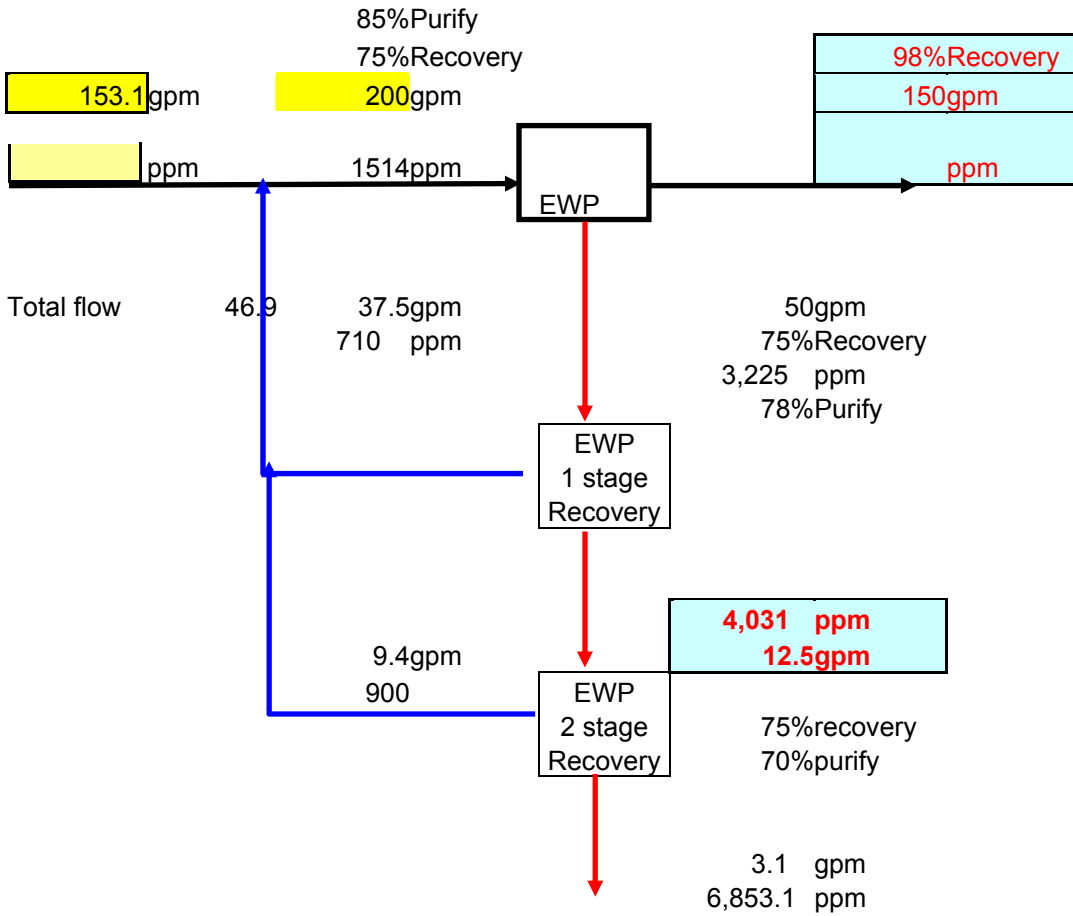
Feed Conductivity of waste water	3200	us
Purified Effluent after 1 <sup>st</sup> stage	710	us
Purified Effluent after 2 <sup>nd</sup> stage	900	us
Waste Water (reject) conductivity	7,000	us
% Recovery of waste water	94%	

Note that the regeneration cycle is automatic and also last 105 seconds.  
The following graph summarizes the test data during an operating cycle that spans 105 seconds.



The following is a process flow diagram

***Huber Mass Balance***



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**Capital Cost**

The equipment cost is estimated as follows:

Main Unit	\$800,000
Waste Recovery Units	\$400,000
Total	\$1,200,000

Operating Cost

Electrical @2.63 Whr/gal & \$.06/kwhr	\$16,588	per year
Cell replacement after 5 years (600 cells)	300,000	

**Comparison against RO**

Evaluation done over 10 years of useful life

	RO	EWP
Equipment Cost Main Unit	\$600,000	\$800,000
Membrane or cell replacement	1,200,000	300,000 (1)
Electricity Cost	1,892,258	165,888 (2)
Waste Processing Cost	2,000,000	400,000 (3)
Hazardous Cleaning Chemicals	?	0
Total estimated cost	5,692,258	1,615,888
Cost per barrel of pure water	30¢	6¢

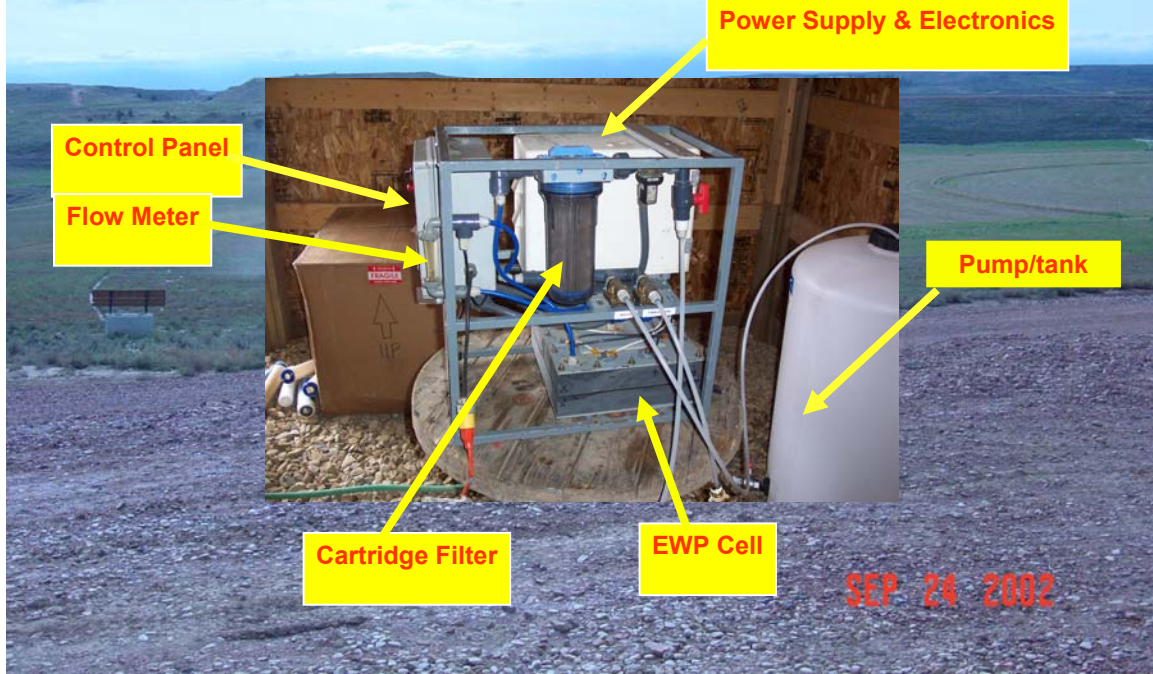
1. Estimated life of 5 years for EWP and replacement of membrane each year
2. RO power use estimated at 30 hr/gal based on experimental data collected by Sabrex on feed water
3. Waste processing cost based on the number of people now needs to use pivot to spray water, wastewater ponds and personnel. Estimated at \$200,000 per year.

  
Robert Atlas

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# EWP System Major Components during field test



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