RECLAMATION

Managing Water in the West

San Luis Drainage Feature Re-evaluation

Feasibility Study

Appendix D

Reverse Osmosis Analyses Reports

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

November 2007

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

San Luis Drainage Feature Re-evaluation

Feasibility Study

Appendix D

Reverse Osmosis Analyses Reports

- **RRR Reverse Osmosis Pilot Report**
- **Panoche Pilot Report, Phase I**
- **Panoche Pilot Report, Phase II**
- **Final Report on Processing Agricultural Drainage Water at Panoche Water District Site DP#25, with Double Pass Preferential Precipitation RO Treatment**
- **Evaluation of Reuse Equilibrium Chemistry (feedwater to RO treatment plant)**

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Reverse Osmosis Pilot Study for Treatment of Agricultural Drainage at Westlands Water District, California

July – October 2003

1. Introduction

Purpose and Scope

This membrane desalination pilot study was conducted by the Bureau of Reclamation (Reclamation), the California Department of Water Resources (DWR), Boyle Engineering Corp. (Boyle), and Red Rock Ranch, Inc. (RRR). These cooperating partners conducted this study to evaluate desalination treatment of irrigation drainage waters using membrane filtration technologies to recover the drainage water for irrigation reuse.

The main objective of this study was to evaluate the cost and performance of the treatment process using reverse osmosis (RO) membranes and nano-filtration (NF) membranes. Product water will be used for irrigation and, therefore, does not need to meet drinking water regulations. The quality of the RO product water may be adequate for irrigation reuse. With higher concentration of total dissolved solids (TDS), the NF product water may require blending with "fresher" water that has less TDS, prior to irrigation reuse. A pilot test was conducted during the period July – October, 2003 to verify the performance and efficiency of the RO and NF membranes and to determine the pretreatment requirements on the source drainage water used by the pilot.

2. Background

The Red Rock Ranch (RRR) pilot study was conducted to support the San Luis Drain Feature Re-Evaluation (SLDFR) Project. The SLDFR is evaluating alternatives to provide drainage service to the San Luis Unit of the Central Valley Project and is preparing an Environmental

Impact Statement (EIS) on the project. The project arose from a court order issued by the Ninth Circuit Court of Appeals which directs, in part, that "Reclamation…shall without delay, provide drainage to the San Luis Unit…" (December 2000). It was estimated that drainage service will be needed for about 380,000 acres of agricultural land in the San Luis Unit. Drainage flows of between 75,000 and 150,000 acre-feet/year (AFY) are anticipated during the life of the project. One of the final In-Valley alternatives for drainage service in the EIS includes membrane treatment to recover water for irrigation reuse. Pilot tests of membrane treatment were required to provide performance and cost data to assist in the evaluation and comparison of drainage service alternatives.

Participants

A number of organizations participated in the preparation and operation of the membrane pilot:

- Reclamation's Technical Service Center (TSC) in Denver provided overall project management and technical oversight.
- Reclamation' South Central California Area Office (SCCAO) provided funding and field assistance.
- The sampling and analysis plan and laboratory services were provided by DWR.
- Boyle provided engineering services and field operation staffing.
- John Diener, owner of RRR, provided the pilot site infrastructure and staffing for additional field support.

Definition of Terms

Common terms that will be used throughout this report are defined below:

- Cations - Positive, electrically charged ions such as calcium, iron, magnesium, and sodium
- Anions - Negative, electrically charged ions such as bicarbonate, boron, chloride, nitrate, selenium, and sulfate
- Monovalent - A cation or anion with a single positive or negative charge, respectively
- Divalent - A cation or anion with two positive or negative charges, respectively
- Raw/Sump Water - Untreated water from the drainage sump
- Filtrate - Sump water that has been filtered through the media filter
- Filter Backwash - A routine cleaning procedure used to remove sediments and particles trapped by the media filter
- RO/NF Feedwater - Filtrate sent into the membrane piloting skid
- Permeate - Product water from the membrane pilot skid
- Concentrate - Waste stream from the membrane pilot skid
- Recovery - Percentage of feedwater recovered as permeate
- Clean-In-Place (CIP) - A cleaning procedure used to remove scale and foulants from the surface of the RO/NF membranes
- Antiscalant / Scale Inhibitor - Chemical treatment added to the RO/NF feed water to slow the precipitation of sparingly soluble salts, therefore, reducing the fouling potential of the feed water on the RO/NF membrane during treatment
- Programmable Logic Controller (PLC) - A device that stores pre-programmed instructions and set points, and uses them to control the equipment for which it is assigned

3.0 Water Quality

3.1 Feed Water Source

Drainage water collected from an agricultural tile drain system at RRR was used as the pilot feedwater. The collected drainage water is from the third collector system in a series of drainage of collector systems designed to allow reuse of drainage water on progressively salt tolerant crops in order to concentrate and minimize the volume of drainage water requiring disposal or treatment. This water had been first used and reused to irrigate two different sets of crops prior to being collected. The pilot retrieves this water from a covered concrete sump, Sump D.

Initially, “fresh” water from the California Aqueduct is used to irrigate the first crop. The subsurface drainage water under the first crop is collected in a reservoir, diluted with fresh water to attain an electric conductivity (EC) of approximately 5,000 microsiemens/centimeter (µS/cm), and reused for irrigation of a second of crop, mainly salt grass. Subsurface drainage water from under the salt grass is collected and stored in the covered concrete reservoir Sump D. With each successive reuse, the dissolved mineral concentrations in the drainage water increase. This is especially true for minerals not typically absorbed or absorbed in small quantities by the crops. In addition, water temperature also varies seasonally between 18°C and 28°C. Therefore, the water quality varies seasonally as a function of precipitation and irrigation flows. The pilot utilizes water from Sump D for its source water. The following table shows the general water quality analyses taken from Sump D.

Table 3.1 General Water Quality Analyses from Sump D

Dissolved Analyte	Units	7/25/2003	9/17/2003	Method Name
Arsenic	mg/L	<0.01	<0.01	EPA 200.8 (D)
Barium	mg/L	<0.5	<0.05	EPA 200.8 (D)
Bicarbonate	as $CaCO_3$	299	273	Std Method 4500-CO2 D
Boron	mg/L	22.3	21.8	EPA 200.7 (D)
Calcium	mg/L	587	616	EPA 200.7 (D)
Carbonate	as $CaCO_3$	1	<1	Std Method 4500-CO2 D
Chloride	mg/L	2,780	2,900	EPA 300.0 28D Hold
Hardness	as $CaCO_3$	2,257	2,346	Std Method 2340 B
Hydroxide	as $CaCO_3$	<1	<1	Std Method 4500-CO2 D
Iron	mg/L	-	< 0.05	EPA 200.8 (D)
Magnesium	mg/L	192	196	EPA 200.7 (D)
Manganese	mg/L	-	< 0.05	EPA 200.8 (D)
Nitrate (as N)	mg/L	403	489	EPA 300.0 28D Hold
Potassium	mg/L	5.9	6	EPA 200.7 (D)
Selenium	mg/L	0.76	1.14	EPA 200.8 (D)
Silica (SiO_2)	mg/L	29.3	32.9	EPA 200.7 (D)
Sodium	mg/L	2,890	2,680	EPA 200.7 (D)
Strontium	mg/L	-	8.55	EPA 200.8 (D)
Sulfate	mg/L	4,100	4,030	EPA 300.0 28D Hold
DOC as C	mg/L	13.6	11.9	EPA 415.1 (D)
Conductivity	µS/cm	13,860	14,020	Std Method 2510-B
pH	pH units	7.3	7.2	Std Method 2320 B
Total Alkalinity	as $CaCO_3$	300	273	Std Method 2320 B
Total Dissolved Solids	mg/L	9,070	10,900	Std Method 2540 C
UV254	absorb./cm	0.259	0.245	Std Method 5910B

3.2 Contaminants of Concern

The three main contaminants of concern are total dissolved solids (TDS), boron, and selenium. Since the product water will be used for irrigation, it does not need to meet drinking water regulations. However, the concentrations of the three contaminants of concern exceed the tolerance for agricultural use. In addition, selenium in the drainage water is regulated with respect to surface water discharges and impoundments.

4. Pilot Test Objectives

4.1 Feed Water Pretreatment Process

The principal objectives of piloting the pre-filtration system were to:

- Evaluate the water quality from a tile drain system collecting re-used irrigation water.
- Determine the appropriate pretreatment system capable of producing suitable feedwater for the membrane treatment system.
- Evaluate the effectiveness of various coagulants to assist particle removal during pretreatment.
- Demonstrate the level of effort necessary for operating a pretreatment system.

4.2 Membrane Treatment Process

The principal objectives of piloting the membrane treatment system were as followed:

- Demonstrate the ability of commercially available RO and NF membrane elements for removing TDS, selenium, and boron from agricultural drainage water.
- Determine potential long-term adverse affects on the membranes from fouling or scaling.
- Demonstrate the level of effort necessary for operating a membrane treatment system.

4.3 Testing Protocol

The following protocol was developed to confirm that the objectives listed above were attained.

- *Particle removal verification*: The feedwater for the membrane treatment system should maintain a Silt Density Index (SDI) below 4.0. The performance of the pretreatment filtration system was based on meeting this requirement on a continuous basis.

- *Fouling constituent verification*: Samples from the feedwater and concentrate streams of the membrane system were taken and analyzed to determine whether concentrations of potential membrane fouling constituents were at levels that could negatively impact membrane life and performance. It is expected that membrane fouling will not occur as long as the proper amount of scale inhibitor is injected into the RO/NF feed stream.

- *Product water quality verification*: Samples from the permeate stream of the membrane system were taken and analyzed to determine whether the RO/NF membranes are capable of producing water that is suitable for agricultural irrigation.

5. Pilot Test Description

5.1 Pilot Site and Equipment Layout

The pilot plant site was located at RRR near Five Points, California within the Westlands Water District. The site is owned and operated by RRR. This site has been widely used to house agricultural and water resource projects. During the operation of the pilot, this location was host to two independent solar evaporation pond projects funded and managed by DWR and a soil moisture study funded and managed by Cal State University of Fresno.

Red Rock Ranch provided a fenced 2-acre lot that has been graded, grubbed, and cleared. About one third of the lot has been built up approximately 4 inches above grade. All equipment on the site was situated on this above-grade pad. A buried PVC line connects Sump D, the pilot feed water source, to a 10,000-gallon storage tank inside the fenced perimeter, from which the pilot draws water. This storage tank provides surge capacity for the oversized sump pump, allowing the pump to operate intermittently. The sump pump has a capacity well over 200 gpm.

An air-conditioned trailer was provided by DWR to house laboratory/office equipment and the membrane piloting system. Inside the office space, there is a workbench for laboratory equipment, a desk, chairs, and lighting. The trailer was supplied with both 3-phase 208V single-phase 120V power at a breaker box on the north end (office side) of the trailer.

Figure 5.1 is an illustration of the site layout. Only the southeast section of the fenced lot is shown. Figure 5.2 is a block flow diagram of the pilot system.

Figure 5.1 – Pilot Site Layout

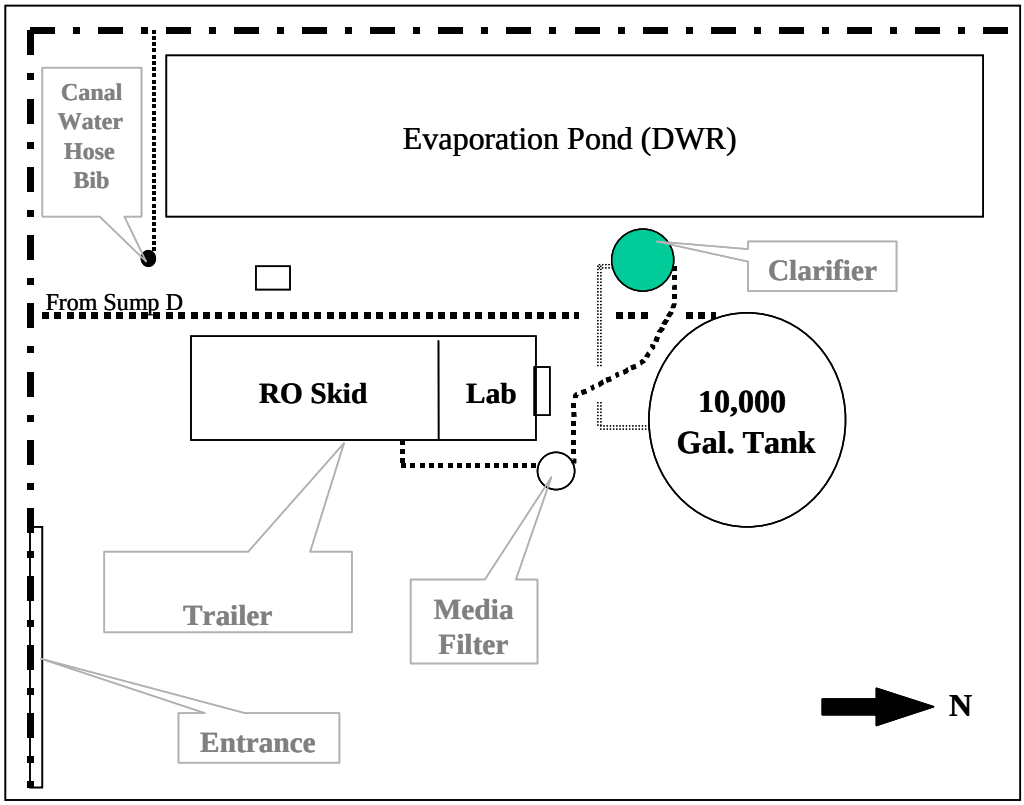
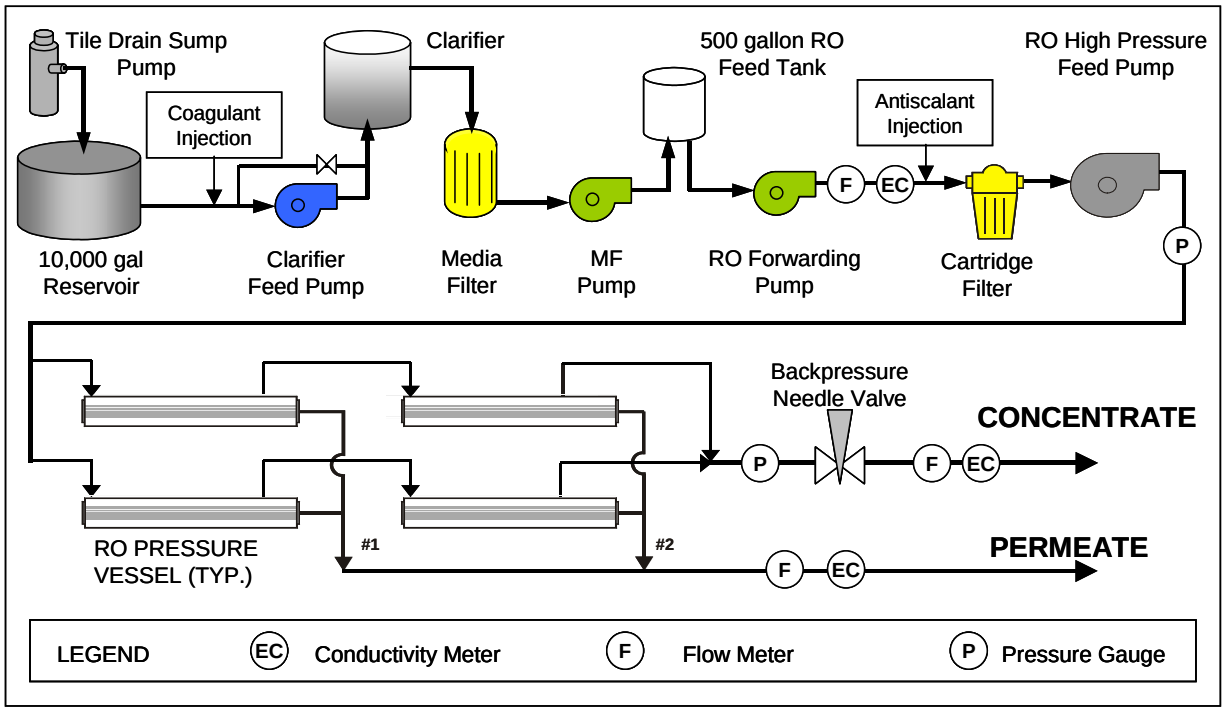


Figure 5.2 – Pilot System Flow Diagram



5.2 Pretreatment Process

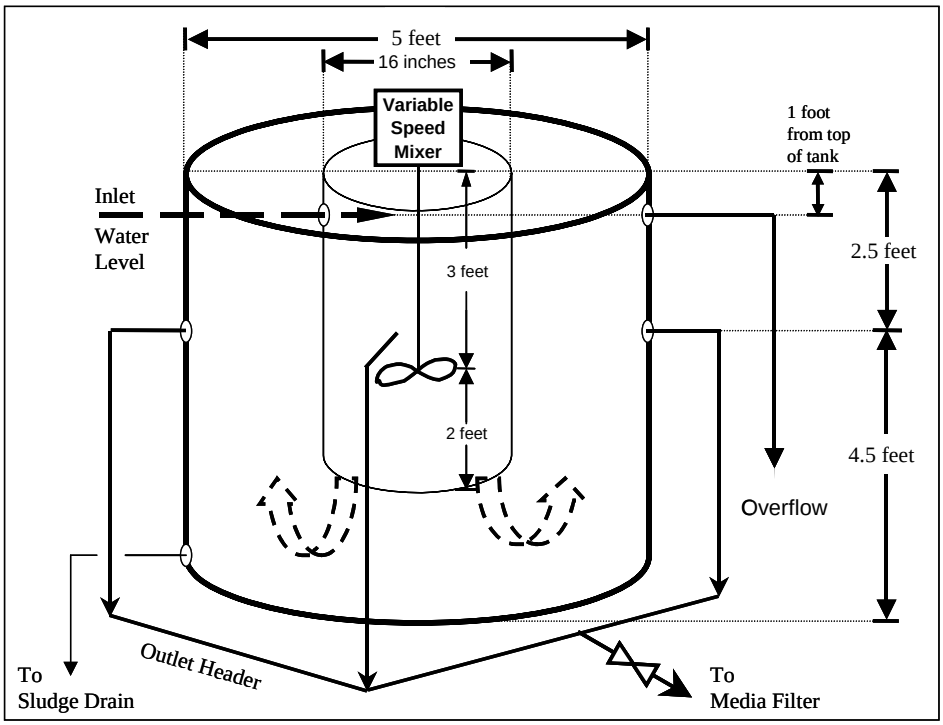
Initially, a dual media (anthracite and sand) filter was selected to serve as the primary pretreatment system. The media filter operated in a direct filtration mode with the addition of a chemical coagulant injected into the feed water stream upstream of the MF. However, the volume and fineness of the particulates in the sump water proved too difficult for the media filter to produce filtrate adequate for the use by the membrane process. As a result, a small flocculation clarifier and coagulant injection pump was installed upstream of the media filter to enhance particulate removal.

The pretreatment process consisted of coagulant enhanced flocculation followed by direct filtration through a media filter. Equipment included a clarifier, clarifier feed pump, a coagulant metering pump, media filter, filter pump, a 500-gallon filtrate holding tank, and a filtrate-forwarding pump.

5.2.1 Coagulant Enhanced Filtration - After running a series of tests using actual drainage water, the SDI tests showed that fine colloids in the drainage water would regularly breakthrough the media filter. As a result, a chemical coagulant injection system was installed upstream of the media filter. Poly aluminum chloride (PAC) coagulant was injected at various dosages, but the filter still could not operate in a direct filtration mode. The filter could not reliably produce an effluent with an SDI value less than 4.0 for more than a few hours. As a result, several types of coagulants, including PAC and ferric chloride, were jar tested. The coagulant AH-710, an inorganic aluminum based polymer, manufactured by Garratt Callahan Co., was selected.

5.2.2 Flocculation - To improve filter performance, a clarifier was installed to remove particulates in the water through flocculation and sedimentation. The clarifier was a polypropylene tank standing 7-ft. tall, 5-ft. in diameter, with a domed roof and a 3-ft. wide circular opening in the center. Suspended through the roof opening was a 5-feet long steel tube that runs into the center of the tank. A mechanical mixer was suspended within the steel tube, with the mixer impeller 3 feet below the water level. Water and coagulant enter the clarifier through the center of the steel tube. This area served as the flocculation chamber, where particulates in the water and coagulant are further mixed at lower speeds to form flocs. The water then traveled down the center of the steel tube and rose up through the area through the interspatial annulus between the steel tube and the clarifier tank wall. As the water rose up through the annulus, larger flocs formed and slowly settled to the bottom of the clarifier. Water exited the clarifier through four outlet headers surrounding the tank. The outlet headers were located 4.5 feet above the bottom of the tank. Settled sludge was manually flushed out of the clarifier through a drain valve at the bottom of the tank. Figure 5.3 represents a schematic of the clarifier.

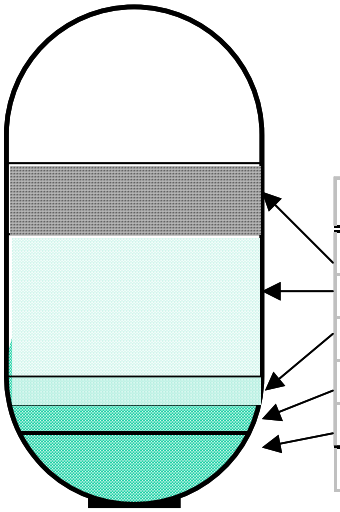
Figure 5.3 – Schematic of Clarifier System



5.2.3 Dual Media Filtration - The media filter was a 72-inch tall vertical fiberglass reinforced plastic (FRP) pressure vessel with an outer diameter of 24 inches. The dome roof and bottom sections were each 9.6 inches high, while the sidewall is 53 inches long. The inner diameter at the sidewall was approximately 22.6 inches, giving a cross sectional area of 2.76 square feet and a total vessel volume of 15.6 cubic feet.

An inlet basket covered with a fine mesh was located inside the upper inlet of the vessel to keep the media from escaping during a backwash. Slotted laterals are arranged around a central hub installed in the dished bottom of the vessel. The media filter contained several gradations of gravel, fine sand, and anthracite. Figure 5.4 illustrated the strata of media within the filter.

Figure 5.4 – Media Filter



Media	Size	Ht. (in.)	Vol (ft^3)
Anthracite	N/A	12	3.0
Silica Sand	0.4 - 0.8 mm	20	4.0
Silica Sand	1/16" x 1/32"	3	1.0
Gravel	1/8" x 1/16"	3	1.0
Gravel	1/4" x 1/8"	10	2.0
Total		48	11.0

5.3 Membrane (RO/NF) Treatment Process

The membrane treatment system used 2½" diameter reverse osmosis or nanofiltration membrane elements to remove dissolved constituents from the drainage water. The nanofiltration membranes were projected to remove mostly divalent ions, such as calcium, magnesium, sulfate, and selenium, while the reverse osmosis membranes were projected to remove both divalent and the monovalent ions, including sodium, chloride, and nitrate.

5.3.1 Membrane Elements - The membrane treatment system was a skid-mounted unit. It was equipped with two chemical injection systems, a cartridge filter module, high-pressure pump, six pressure vessels, monitoring instrumentation, and an automatic control system. The membrane elements were enclosed in four (4) three-element pressure vessels. The vessels were four-inch in diameter, and they were arranged in a 2:2 array. Based on manufacturer literature, each Hydranautic RO membrane element provided 28 square feet of surface area, while each Osmonics NF element provided 30 square feed of surface area. Table 5A lists the manufacturer and model of the membranes used in this pilot.

Table 5A – Membrane Types used during the Pilot

Membrane Type	Manufacturer	Model	Date Installed
Reverse Osmosis	Hydranautics	XLFC3	6/03/2003
Nanofiltration	Osmonics	HL2540F1072	9/19/2003

5.3.2 Ancillary Skid Equipment - Separate acid and antiscalant dosing systems were installed on the skid, each with their own 15-liter reservoir. During pilot operations, the MDC22 chemical antiscalant, manufactured by GE Betz Dearborn, was injected in the RO/NF feedwater to protect the membranes from mineral scaling. Feed water conditions did not require the use of acid injection, so the acid metering pump served as a spare for the antiscalant system.

A cartridge filter module (5 µm) was also installed to protect the membranes from particulate fouling in case of particle breakthrough from the media filter. The cartridge housing accepted three spiral wounded cartridge modules.

The high pressure RO feed pump was a centrifugal multistage pump manufactured by Tonkaflow. It was equipped with a variable frequency drive (VFD) to modulate the speed of the pump motor. Varying the pump speed will either increase/decrease the flow rate or increase/decrease the feed pressure to the membranes. The VFD was controlled manually or by the automated control system.

5.3.3 Skid Control System - An Allen Bradley SLC 500 programmable logic controller (PLC) was installed to control operations of the VFD and monitor pilot instrumentation. The PLC transmitted instrumentation data and alarm signals to a local desktop computer for data logging purposes. Using level information measured from the ultrasonic level sensors on the 10,000-gallon storage tank and on the 500-gallon RO feed tank, the PLC activated the sump pump or the media filter pump, to maintain adequate liquid level in their respective tanks. The PLC was also programmed with several alarms. If the PLC detected low flow or high-pressure conditions at the RO high pressure feed pump or a low level condition at the RO feed tank, the PLC would shut down all the pumps at the pilot site, including pumps for the pretreatment process.

5.4 Operations

For successful operation of the piloting system, operators were asked to conduct routine maintenance and system checks. The following sections describe the operation scheme for the various processes in the pilot, including daily tasks performed by the operator.

5.4.1 Tile Drainage Sump Pump - The pilot feed water was supplied from Sump D. During the course of the pilot, it was discovered that the sump water quality, as measured at the 10,000-gal storage tank, dramatically changed if the sump was drawn down too low. The high rate sump pump could draw down the sump in approximately 40 minutes, or 4,000 gallons. It was believed two problems were occurring. First, as the sump water level lowered, the pump also sucked in heavy silts and solids that typically settle at the bottom of the sump. Second, during refill, water entering the storage tank agitated any silts and solids that had settled in the storage tank itself. As a result, turbidity in the storage tank typically ran above 40 NTU during the refill stage.

To resolve these issues, several actions were taken:

1. The 10,000-gallon storage tank was drained and a high-pressure water spray gun was used to wash any remaining dirt out of the tank.
2. The PLC was programmed to activate the sump pump to refill the 10,000-gallon tank, once the tank level had fallen by 3,000 gallons. A short 3,000 gallons refill cycle prevented the sump from being overdrawn. This reduced the tank effluent turbidity after a refill cycle to approximately10 NTU.
3. The sump pump discharge valve was choked down to limit flow rate to 20 gpm. In addition, an upcomer was installed at the inlet inside the 10,000-gal storage tank. Both items helped reduce agitating the settled dirt in the tank. Turbidity of the storage tank effluent typically fell to approximately 2.5 NTU an hour after a refill cycle completed.

4. For surveillance, the operator was instructed to take routine turbidity readings at the 10,000-gallon storage tank. The operator also drained approximately 2,000 gallons of water from the tank every month to flush out any settled silts or solids.

5.4.2 Clarifier - On a daily basis, the operator verified the flow rate entering the clarifier was 8 GPM through the rotameter installed downstream of the clarifier pump. A recirculation loop branched off the suction and discharge of the clarifier pump. By modulating a ball valve installed along this loop, the operator could control the amount of water that the clarifier pump recirculated, and thus controlling the output of the pump.

A diluted coagulant was injected just upstream of the clarifier pump suction. AH710, a proprietary cationic polymer, was diluted with RO permeate in a 10:1 ratio to make the coagulant solution. A diaphragm chemical metering pump dosed diluted coagulant at a rate of 1.4 mL of solution per gallon of feed water for a concentration of 6 mg/L. The metering pump was flow paced using a signal from a Seametrics flow totalizer installed upstream of the coagulant injection point. The operator checked the diluted coagulant storage drum on a daily basis to verify that adequate solution was available, and made additional batches of solution when necessary. The operator also routinely verified the metering pump was operating by listening for the periodic pulses and by opening the metering pump bypass valve to bleed off entrained air.

A variable speed mixer was installed at the top of the tank. It was set to a speed of 72 RPM. It was equipped with a 3-inch x 6-inch rectangular impeller. The operator visually checked whether the mixer was operating. In addition, the operator opened the drain valve every two weeks, to drain off any settled particles out of the bottom of the clarifier. The tank level would be dropped by approximately 18 inches in 15 minutes during each of these purge cycles.

5.4.3 Media Filter – After exiting the clarifier, the sump water traveled into the media filter by gravity. Due to the height of the 500-gallon RO feed tank, water leaving the media filter could not gravity flow into the RO feed tank, so a pump was installed downstream of the media filter to transfer the filtrate into the tank. Installing the pump downstream (instead of upstream) of the media filter avoided potential breakup of flocs between the clarifier and the media filter. The PLC was programmed to activate the filter pump when the RO feed tank level reached below 25% full and to stop the filter pump when the tank level reached above 75% full.

On a daily basis, the operator verified that the filter pump and RO feed tank were operating within these parameters. In addition, the operator took filter influent and effluent water samples and analyzed them for turbidity using a portable desktop turbidmeter.

To determine whether the media filter required a backwash, the operator also conducted a 15-minute SDI test (SDI_{15}) on the filter effluent. SDI_{15} values were to be maintained below 4.0. As a routine, the filter was backwashed once a week. Once a month, the operator also conducted a chlorine rinse of the media filter and RO feed tank. During this rinse, a 200-gallon solution with 50 to 60 mg/L of sodium hypochlorite was recirculated around the media filter and RO feed tank. After the chlorine rinse, the operator sent filtrate and any fluid inside the RO feed tank to drain for at least 15 minutes before sending the water back into the membrane skid. As an extra precaution, the operator also added approximately two pounds of sodium meta-bisulfite into the RO feed tank to dechlorinate the tank and protect the membranes from residual chlorine.

5.4.4 Membrane Skid - The PLC onboard the membrane skid controlled the RO high-pressure pump, maintaining a constant feed rate of 6 GPM, while the operator manually modulated the concentrate backpressure valve to set the permeate recovery to 50%. In addition, the operator verified whether the antiscalant injection system was operating and whether the antiscalant reservoir must be refilled. Although the PLC transmitted instrumentation measurements to the local desktop computer for archiving, the operator was asked to fill out a daily log sheet containing similar data. The manual data log served as a backup in case of telemetry failure, and its review helped the operator troubleshoot potential instrumentation or equipment failure.

6 Pilot Performance Evaluation

6.1 Pretreatment System

The final pretreatment system consisted of coagulation/flocculation at the clarifier followed by filtration in a multimedia filter. At the optimal settings, the clarifier operated at 8 GPM with a coagulant concentration of 6 mg/L. The media filter operated between 6.5 to 8 GPM, which corresponded to a maximum loading rate of 2.9 gpm/ft^2.

6.1.1 Media Filter – The following table illustrates the media filter performance:

Table 6a – Average Turbidity Readings

Turbidity (NTU)	Min.	Max.	Mean
Drainage Water	2.0	11.0	6.5
Storage Tank Effluent	0.3	3.0	0.7
Clarifier Effluent	4.0	4.4	4.2
Media Filter Effluent	0.2	1.61	0.4

The median of the media filter effluent turbidity measurements was 0.36 NTU. Higher turbidity values were observed to occur immediately after a filter backwash cycle. The median of the turbidity measurement sampled at the outlet of the 10,000-gallon storage tank was 0.73 NTU. Turbidity values over 10.0 NTU were observed when this tank was refilled by the sump pump, while lower values generally appeared approximately an hour after a refill cycle. These observations suggested that settling time can improve the sump water clarity and may reduce the silt load on the media filter.

SDI tests were conducted daily on the media filter effluent. This test offered a qualitative look at the amount of particulates in the sample water. To conduct a test, a continuous stream of sample water must pass through a 0.45-micron filter at a feed pressure of 30 psi for 15 minutes. Measurements were taken to determine how long it took to fill a 500 mL container at the beginning of the test and again at the end of the 15-minute test period. RO and NF membrane manufacturers typically specify that feed water SDI be below 5.0 to protect the membrane from fouling. The statistical data from the 120 SDI measurements are shown in the following table.

Table 6b – Summary of Media Filter Effluent SDI_{15}

Silt Density Index	Min	Max	Mean
Initial Time	21	36	26
Final Time	32	79	46
SDI value	0.6	4.3	2.6

The media filter was backwashed about once every week using stored sump water. The peak backwash rate was 15 gpm/ft^2 for a duration of 45 minutes. Filter runtimes as long as nine days were attained, but effluent water quality degraded rapidly starting on the eighth day. Once a month the media filter was also rinsed with 200 gallons of 50 mg/L NaOCl solution to remove any organic or algae growth. The rinse water was recirculated between the media filter and RO feed tank at a rate of 8 GPM for 15 minutes before it was drained away.

6.1.2 Coagulant Selection – As discussed in Section 5.2.1 two different coagulants were used for this pilot. During the first month of piloting the membrane skid, a poly-aluminum chloride coagulant manufactured by DelPAC was injected at a concentration of 30mg/L. The DelPAC coagulant was purchased over a year earlier to be used at another USBR project. Its performance was suspect, as the media filter would experience particle breakthrough in less than one week after a filter backwash. As temperatures increased above 105°F during the summer, the DelPAC coagulant, which was sensitive to temperature above 103°F, was spoiled when the container was exposed to sunlight. Due to its inconsistent performance and high dosing rate, other types of coagulants were jar tested.

Nine coagulants were jar tested to optimize the pretreatment system. Two rounds of jar tests were conducted using the following parameters:

- Rapid mixed between 112-170 RPM for 2 minutes
- Slow mixed between 50-60 RPM for 15-17 minutes to promote flocculate growth
- Settling time approximately 15 minutes

After the initial round of jar testing, the oil-type emulsion polymers and conventional water treatment coagulant polymers were eliminated due to poor floc growth. During the second round, an anionic metal hydroxide polymer (7030), an anionic metal hydroxide with coagulant aid (AH710), and ferric chloride were jar tested at various concentrations. The following table details the jar test results:

Table 6c – Coagulant Jar Test Results

Coagulant	Blank	$FeCl_3$	7030	7030	7030	AH710	AH710	AH710
Dosage	-	20 ppm	4 ppm	6 ppm	12 ppm	4 ppm	6 ppm	12 ppm
Initial Turbidity	2.95	2.95	2.59	1.56	2.24	2.21	1.93	1.49
Final Turbidity	2.63	10.1	1.66	2.02	2.71	2.20	2.23	2.24
Floc size	None	Med	Med	Med	Large	Large	Largest	Large
Floc Density	None	Dense	Light	Light	Med	Dense	Dense	Dense

The majority of the flocs in all the jar test samples remained suspended. Both 7030 and AH710 are proprietary polymers so its exact composition is unknown, but judging by the color of the white flocs, these polymer are likely to be aluminum based, as opposed to iron based. The blank sample and ferric chloride, a common coagulant, were tested to serve as a basis of comparison for the tested coagulants.

The AH710 generated the largest and most dense flocs. It also exhibited a noticeable amount of settled floc at the bottom of the sample jar, second only to ferric chloride. The ferric chloride produced equal amounts of floc, but required a much higher dosage. It was observed that some flocs were floating on the top of the test container containing 6 mg/L and 12 mg/L of AH710, which may be an indication of over-injection. It was determined that floc formation was best achieved at dosages between 3 mg/L to 6 mg/L. As a result, a target dosage rate of 5 mg/L was established. The cost of the AH710 was approximately $1.03 per active pound.

6.2 RO Performance Data

6.2.1 Operational Data – A total of 705 hours of operation accrued on the RO elements during this test phase. The collected raw data and other calculated values are tabulated in Appendix A. Flow, temperature, conductivity, pressure, specific flux, membrane salt rejection ratio, permeate recovery ratio, and feed water turbidity and SDI data are graphically depicted on Figures 6.1 through 6.8 in the Appendix.

Referencing Figure 6.1, feed and permeate flows were on average 23.2 L/min (6.1 gpm) and 11.5 L/min (3.0 gpm), respectively, yielding a 50% recovery of desalinated water (permeate). The total concentrate is the difference between the feed and permeate flows.

Figure 6.2 shows the water temperature of the RO feed. This measurement is taken just prior to entering the RO high-pressure feed pump. Daily feed water temperature fluctuated by as much as 4.5°C, while the average temperature dropped by approximately 2.5°C over the course of the pilot testing. Water temperature variations play a large role in a RO system. Higher temperatures tend to increase permeate production, lower RO feed pressure, and increase permeate conductivity, while the converse is true for lower water temperatures. Based on the membrane manufacturer's specification, the performance of the RO membranes fluctuates by as much as 3% for every degree Celsius change in temperature.

Figure 6.3 illustrates the electrical conductivities (EC) of the RO feed, permeate, and concentrate streams. It can be seen that the general shape of the RO feed and permeate curves match the shape of the temperature curve. EC measurements are sensitive to changing water temperatures. Unfortunately, it is believed the built-in temperature probe on each of the EC probes was not operating properly to compensate their EC readings for temperature variations. In addition, dissolved air would slowly entrain in the cavity where the conductivity probe for the concentrate stream was installed and form a bubble. The dissolved air eventually formed a large enough bubble that it would free itself from the cavity and work itself out of the system. Meanwhile, the entrained bubble caused the concentrate EC probe to read a false zero value. Taking into account this disruption in measurements, the last known valid concentrate EC value was carried forward until the next valid value was recorded as shown in Figure 6.3.

The pressure measurements of the feed and concentrate stream are shown in Figure 6.4. The yellow line on the graph represents the net driving pressure (NDP). The NDP is a calculated value used to determine the driving pressure available to force water through the membrane. It is calculated as follows:

$$\mathbf{NDP = P_f - P_p - P_o}$$

Where: P_f is the RO feed pressure,

P_p is the permeate gauge pressure, and

P_o is the osmotic pressure.

P_f is taken as the average of the feed water gauge pressure taken at the inlet of the RO system and concentrate gauge pressure taken at the outlet of the concentrate line:

$$P_f = (P_{feed} - P_{concentrate}) / 2$$

P_o is the osmotic pressure calculated from the following equation:

$$P_o = K_o * (273 + t) * \Delta C_{log} * 0.75$$

Where: K_o is the ionic conversion coefficient (psi/ppm/°C)

ΔC_{log} is the log mean average of the feed water TDS conc. (ppm)

t is the water temperature (°C)

Based on the membrane manufacturer's literature, the K_o value is dependent on the major ionic species in the water. For waters with 100% MgSO4 (divalent ions), the K_o value is 0.00002. For waters with 40% MgSO4 and 60% NaCl, the K_o value is 0.000035. For waters with 100% NaCl (monovalent ions), the K_o value is 0.00004. The drainage water is approximately 50% NaCl and 30% of mixed divalent ions predominantly sulfate, so a K_o value of 0.00003 was selected for the calculations. The 0.75 factor is the TDS:EC conversion ratio derived from analytical lab results.

The log mean average of the feedwater TDS is derived from the following:

$$\Delta C_{log} = (C_{concentrate} – C_{feed}) / Ln (C_{concentrate}/ C_{feed})$$

Where: $C_{concentrate}$ is the salinity of the concentrate stream

C_{feed} is the salinity of the feed stream at the RO inlet

Ln is the natural log function

To calculate ΔC_{log} on a real-time basis, electrical conductivity measurements were used as a surrogate to actual salinity measurements, which would have required lab analysis to facilitate.

Normalized specific flux and membrane salt rejection ratio are two primary standards of performance for an RO system. Both parameters are affected by the feed water temperature and salinity. However, salt rejection is affected to a lesser degree than the specific flux by temperature variations in the feed water. Normalized flux is defined as:

Normalize Flux = Specific Flux * TCF

Where: TCF is the temperature correction factor

Since the performance of the membrane is sensitive to temperature variation, a temperature correction factor was used to normalize values to a standard of 25°C. The TCF is calculated by the following equation:

$$TCF = 1 * EXP [k * (1 / (273 + t) - 1/298)]$$

Where: t is the feed water temperature at the inlet of the pilot skid

The membrane manufacturer recommended ‘k’ value of 2,700 for composite membranes that was used in the pilot test.

Specific flux evaluates the amount of permeate (desalted water) produced per square foot of membrane surface area over time and per unit of RO feed pressure. It is typically reported in gallons per square foot of membrane area per day (gfd) per pounds per square inch (psi), or gfd/psi. The specific flux values presented in Figure 6.5 have been normalized to a standard temperature of 25°C, therefore these values are also referred as normalized specific flux.

The salt rejection ratio describes the amount of salt that the membranes prevent from passing into the permeate stream. It is calculated as follows:

$$\text{Salt Rejection} = 1 - C_{perm} / \Delta C_{log}$$

Where: C_{perm} is the permeate salinity

ΔC_{log} is the log mean average of the feed water TDS

Again, to calculate salt rejection on a real-time basis, electrical conductivity measurements recorded by in-line instruments were used as a surrogate to actual salinity measurements, which would have required lab analysis to facilitate.

Normalized specific flux (SF) and salt rejection were monitored throughout the pilot testing to determine the condition of the RO membranes. As membranes fouled, the normalized SF dropped. A drop of 15% indicated the need to clean the membranes. Figure 6.5 is a plot of the membrane specific flux normalized to 25°C, and Figure 6.6 is a plot of the salt rejection ratio.

It should be noted that the RO membranes experienced a fouling event at approximately the 38th hour of operation, when the coagulant used in the pretreatment system spoiled. As a result, the specific flux dropped from 0.088 to less than 0.060 GFD/psi by the 45th hour. The RO membranes were given a chemical rinse to remove the foulants, and the specific flux began to climb back to 0.070 GFD/psi after the CIP.

6.2.2 Performance Overview – Water samples from the RO feed, permeate, and concentrate were collected and sent to a laboratory for analysis at the beginning and end of the RO piloting phase.

- Salt rejection by the membranes for TDS, selenium, and boron are summarized in following:

Table 6c – Analytical Lab Results, RO Salt Rejection

Membrane Rejection	Initial	Final
TDS	97.9%	98.9%
Selenium	99.9%	99.9%
Boron	51.9%	63.1%

Table 6d – Constituents from RO Permeate / Feed / Concentrate

Concentration (mg/L)	Initial	Final
TDS	263 / 9,070 / na	162 / 10,900 / 18,770
Selenium	0.001 / 0.76 / 1.58	0.001 / 1.14 / 1.94
Boron	14.6 / 22.3 / na	10.6 / 21.8 / 29.7

The initial sample was taken on 7/25/04 with a permeate recovery of 48%. The final sample was taken on 9/17/04 at a 44% recovery. Since the concentrate salinity concentration data was not available (na), the following equation was used to calculate salt rejection:

$$\text{Salt Rejection} = 1 - C_{perm} / (C_{feed} * CF)$$

Where: C_{perm} is the permeate salinity (mg/L)

C_{feed} is the feed salinity (mg/L)

CF is the concentration factor

Concentration factor is defined as follows:

$$CF = Ln (1 / (1- R)) / R$$

R is the permeate recovery factor. It is the ratio of permeate flow over feed flow.

$$R = F_{perm} / F_{feed}$$

The membrane rejection rate of all three species fell within the expected range. Manufacturer literature claims the membrane has a 99.2% salt rejection rate, using a synthetic, lab created water containing only 1500 mg/L of NaCl. The decrease in salt rejection can be attributed to the temperature variations and the different water matrix that the membranes face in a true field test.

The rejection rates for all three species (TDS, selenium, and boron) seemed to improve over time or at least by the conclusion of the pilot testing. However, this is truly not the case. First, average feed water temperature dropped due to the change in seasons from summer to fall. Lowering feed water temperature tends to tighten membranes, causing them to reject salts better. In addition, since the RO operated in a high TDS and organic water, the membranes may have begun to foul or scale, which also tends to improve salt rejection of the membrane.

- The normalized specific flux at the beginning of the pilot test was approximately 0.088 GFD/psi. After 700 hours of operation, the specific flux had fallen to a 24-hr. average of 0.070 GFD/psi, amounting to a decrease of 20.5%. This decrease typically would be a subject of concern, however there were extenuating circumstances.
  The large decrease in specific flux occurred immediately after the membranes were fouled by material that broke though the pretreatment system during the 36th hour of operations. Despite receiving a CIP, the membranes may have been permanently damaged by the episode. Discounting the membrane fouling, after the CIP the membrane specific flux recovered to 0.070 GFD/psi and remained relatively steady at that flux ($\pm$ 0.002 GFD/psi) for the remaining duration of the testing. With this in mind, the flux decrease would seem to be closer to 3%, operating over the 700-hour span.

6.2.3 Technical Issues - The RO unit experienced a few technical difficulties during the first week of testing, which affected the data as seen in Figures 6.1 - 6.5. During the second day of operation (hour 33), it was discovered that the coagulant for the media filter was spoiled, allowing high turbidity feed water to enter the RO unit. This fouled the RO membranes; slowly increasing the operating pressure and permeate EC (lower quality product water), while lowering specific flux, until operations had to be halted by the 45th hour, so a CIP could be conducted on the RO membranes to remove the foulants.

Between 82nd – 180th hours of operation, the RO unit experienced technical difficulties with its data-logging system, so data during that period were collected manually. Around the 481st hour of operation, this situation reoccurred, but it was corrected the next day.

At hour 200, the RO cartridge filter was completely plugged off, generating a spike in operating pressure. This was a result of material from the media filter having broken through to the RO unit, after the media filter was backwashed at hour 181 of operation. The materials had eventually plugged off the cartridge filters. A longer purge time after media filter backwash was instituted after this event to prevent another incident.

At runtime hour 394, the RO was temporarily idled to tighten a small leak on the concentrate line. This lead to a quick drop in operating pressure. When the RO was reactivated after the repair, the operator mistakenly set the RO feed flow rate to 20.6 LPM (5.4 GPM) as oppose to the normal operating flow rate of 24 LPM (6.4 GPM). The flow rate was corrected by hour 438.

6.3 NF Performance Data

6.3.1 Operational Data – A total of 853 hours of operation accrued on the NF elements during this test phase. The collected raw data and other calculated values are tabulated in Appendix A. Flow, temperature, conductivity, pressure, specific flux, membrane salt rejection ratio, permeate recovery ratio, and feed water turbidity and SDI data are graphically shown in the appendix.

Since the pilot testing of the NF membranes occurred after the RO membrane testing, most technical issues with the pre-treatment and system equipment had been resolved. The most significant challenge was trying to find a replacement for measuring permeate EC. Permeate EC data during the first 200 hours of operation was very sporadic until the handheld device was employed. This led to large gaps in specific flux, salt rejection, and net driving pressure charts, whose data points require permeate EC to calculate.

Referencing Figure 6.7, feed and permeate flows were on average 23 L/min (6 gpm) and 11.7 L/min (3 gpm), respectively, yielding an averaged 50% recovery of permeate. The total concentrate is the difference between the feed and permeate flows.

Figure 6.8 shows the feedwater temperature for the NF system. Daily feedwater temperature fluctuates by as much as 7.8°C, while the average temperature dropped by approximately 4°C over the course of the pilot testing. Water temperature variations also play a large role in a NF system. Based on the membrane manufacturer's specification, the performance of the NF membranes may fluctuate by as much as 3% for every change in degree Celsius.

Figure 6.9 illustrates the electrical conductivities (EC) of the NF feed, permeate, and concentrate streams. The in-line permeate EC probe installed on the piloting skid was calibrated for measuring at the low EC range, typical for RO permeate. As a result, the higher EC of the NF permeate was out of this instrument's range. Handheld EC probes were used to record NF permeate data and to supplement NF feed and concentrate EC readings. Similar to the RO data, the general shape of the NF feed curve matched the shape of the temperature curve. Unfortunately, the built-in temperature sensors on each of the inline EC probes were still unable to fully compensate their EC readings for temperature variations. The handheld probe seemed to fair better, showing lesser effects from the variations. Meanwhile, the dissolved air issue, which hampered the inline concentrate EC probe during the RO membrane testing, had been rectified.

Pressure gauge measurements from the feed and concentrate streams are displayed in Figure 6.10. The yellow line on the graph represents the net driving pressure NDP. Figure 6.11 is a plot of the calculated specific flux rate of the membrane normalized to 25°C, and Figure 6.12 illustrates the calculated membrane salt rejection ratio. The calculated values were based on the same equations used to evaluate the RO system with the exception of osmotic pressure. The osmotic pressure for the NF system was calculated from the following equation:

$$P_o = K_o * (273 + t) * (\Delta C_{log} - C_{perm}) * 0.80$$

Where: K_o is the ionic conversion coefficient (psi/ppm/°C)

t is the water temperature (°C)

ΔC_{log} is the log mean average of the feed water TDS conc. (ppm)

C_{perm} is the TDS concentration in the permeate stream

In an RO system, the TDS concentration in the permeate may be several orders of magnitude smaller than the feed or concentrate streams, so the C_{perm} term is typically ignored in the osmotic pressure equation. However, the NF permeate salinity is much higher than the RO, since NF does not reject monovalent ions as well as the RO. As a result, the osmotic pressure in the NF membrane is typically less than the RO. The 0.80 is the TDS:EC conversion ratio derived from analytical lab results.

6.3.2 NF Operational Review - The major difference between the NF and the RO membranes are:

- NF membranes are designed to remove divalent and other multi-charged ions;

- As such, the NF membranes allow more monovalent or weakly charged ions to pass from the feed to the permeate stream;
- By not removing as many ions, the NF system operates at a much lower feed pressure;
- Therefore, the specific flux of the NF is typically higher than the RO.

Table 6e – Analytical Lab Results - NF Salt Rejection

Membrane Rejection	Sample Date 9/19/04	Sample Date 10/8/04
TDS	63.7%	64.6%
Selenium	96.5%	96.8%
Boron	34%	30%

Table 6f – Constituents from NF Permeate / Feed / Concentrate

Concentration (mg/L)	Sample Date 9/19/04	Sample Date 10/8/04
TDS	6,288 / 12,510 / 18,170	5,248 / 10,888 / na
Selenium	0.064 / 1.33 / 2.49	0.047 / 1.08 / na
Boron	24 / 26.5 / 26	20 / 21 / na

The initial sample was taken 9/19/04 with the NF operating at 50% recovery; while the final sample was taken 10/8/04 with the NF operating at 48% permeate recovery.

Based on manufacturer literature, the NF membrane could reject up to 98% of $MgSO_4$ operating at a permeate recovery of 10% in a synthetic water containing 2,000 mg/L of $MgSO_4$. Similar to the RO membrane literature, the NF membranes salt rejection rate will tend to be lower when subjected to actual field tests with varying water conditions.

NF membranes are designed to reject divalent and strongly charged ions as opposed to monovalent and weakly charged ions. As expected, the NF attained acceptable rejection rate for selenium and lower rejection rate for boron and TDS as compared to the RO system. In addition, similar to the RO membranes, it was anticipated that the salt rejection ability of the NF would increase with use, as the membranes fouled, which was consistent with TDS and selenium rejection. The selenium rejection rate of 96.5% was less than the rate published by the manufacturer. However, this is expected as the test water contained over 10,000 mg/L of dissolved ions, with about 50% being divalent.

It was unexpected that the boron rejection decreased over time. A possible explanation may be found from reviewing the data. For example, the feed water boron concentration on 9/19/04 was 26.5 mg/L, while the concentrate and permeate boron concentration for the same date was 26.0 and 24.0 mg/L, respectively. Under mass balance laws, it is not possible for the boron concentration to decrease in the concentrate stream unless there was an increase in the permeate stream. It is postulated that possible source of the errors may have occurred during field sampling, lab analysis, or data entry. Moreover, NF membranes are not suited for rejecting monovalent ions, especially ones such as boron, which has a very low disassociation constant. This means only a small concentration of boron will exist as a charged ion, which is requisite for the NF to reject it.

Throughout the piloting of the NF membranes, the normalized specific flux averaged 0.37 GFD/psi with a variation of $\pm$ 13%. The NF specific flux variation was much larger than the RO specific flux variation of 6%, but this could be attributed to temperature variations. Daily temperature varied by as much as 7°C during NF testing, which translated into a 10.5% variation in specific flux. With the variation aside, after 800 hours of operation the NF specific flux did not seem to be declining. The NF membrane performed well as it maintained a 0.37 GFD/psi. Manufacturer literature described operation of their membranes at a mere 0.26 GFD/psi using less challenging water.

Table 1 - Initial General Water Analysis of the RO Piloting Test

Bryte Laboratory Analysis Results for Red Rock Ranch Project

(results in mg/L unless otherwise noted)

Collection Date:			7/25/2003	7/25/2003	7/25/2003
Sample Number:			FSZ0703B	FSZ0703B	FSZ0703B
			9828	9829	9830
Analyte		**Units**	**Location**		
			Feed	**Permeate**	**Concentrate**
	EC	µS/cm	13,860	426	
dissolved	Bicarbonate	as $CaCO_3$	299	11	
dissolved	Boron		22.3	14.6	
dissolved	Calcium		587	<1	
dissolved	Carbonate	as $CaCO_3$	1	<1	
dissolved	Chloride		2,780	75	
	Hardness	as $CaCO_3$	2,257	1	
	Hydroxide	as $CaCO_3$	<1	<1	
dissolved	Fluoride				
dissolved	Iron				
dissolved	Magnesium		192	<1	
dissolved	Nitrate	as N	403	71.2	
dissolved	Nitrite	as N			
	DOC	as C	13.6	<0.5	
dissolved	othro-phosphate	as P			
dissolved	Potassium		5.9	<0.5	
dissolved	Selenium				
dissolved	Silica		29.3	0.5	
dissolved	Sodium		2,890	75	
dissolved	Strontium				
dissolved	Sulfate		4,100	3	
	pH	pH units	7.3	7	
	T.Alk	as $CaCO_3$	300	11	
total	Arsenic		<0.01	<0.001	<0.01
total	Barium		<0.5	<0.05	<0.5
total	Calcium				
total	Iron				
total	Magnesium				
	TOC	as C			
total	Potassium				
	TDS		9,070	263	
total	Selenium		0.761	0.001	1.58
	TSS		<1	<1	
	UV254	absorb./cm	0.259	0.007	
total	Silica				
total	Sodium				
total	Strontium				
	Turbididy	NTU			

Table 2 - Final General Water Analysis of the RO Piloting Test

Bryte Laboratory Analysis Results for Red Rock Ranch Project

(results in mg/L unless otherwise noted)

Collection Date:		9/17/2003	9/17/2003	9/17/2003
Sample Number:		FSZ0903B	FSZ0903B	FSZ0903B
		1886	1887	1888

Analyte		Units	Location		
			Feed	Permeate	Concentrate
	EC	µS/cm	14,020	274	22,620
dissolved	Arsenic		< 0.01	< 0.001	< 0.02
total	Barium		< 0.5	< 0.05	< 1.0
dissolved	Bicarbonate	as $CaCO_3$	273	11	462
dissolved	Boron		21.8	10.6	29.7
dissolved	Calcium		616	2	1060
dissolved	Carbonate	as $CaCO_3$	< 1.0	< 1.0	1
dissolved	Chloride		2,900	41	4,970
dissolved	Hardness	as $CaCO_3$	2,346	5	4,039
dissolved	Hydroxide	as $CaCO_3$	< 1.0	< 1.0	< 1.0
dissolved	Fluoride				
dissolved	Iron		< 0.05	< 0.005	< 0.1
dissolved	Magnesium		196	< 1.0	338
dissolved	Manganese		< 0.05	< 0.005	< 0.1
dissolved	Nitrate		489	43.5	823
dissolved	Nitrite	as N			
	DOC	as C	11.9	< 0.5	19.4
dissolved	othro-phosphate	as P			
dissolved	Potassium		6	< 0.5	9.7
dissolved	Selenium		1.14	0.001	1.94
dissolved	Silica (SiO_2)		32.9	0.2	57.5
dissolved	Sodium		2,680	44	4,760
dissolved	Strontium		8.55	0.015	13.7
dissolved	Sulfate		4,030	4	6,840
	pH	pH units	7	5.8	7.5
	T.Alk	as $CaCO_3$	273	11	463
total	Arsenic				
total	Barium				
total	Calcium				
total	Iron				
total	Magnesium				
	TOC	as C			
total	Potassium				
	TDS		10,900	162	18,770
total	Selenium				
	TSS		< 1.0	< 1.0	< 1.0
	UV254	absorb./cm	0.245	0.005	
total	Silica				
total	Sodium				
total	Strontium				
	Turbididy	NTU			

Table 3 - Initial General Water Analysis of the NF Piloting Test

Bryte Laboratory Analysis Results for Red Rock Ranch Project

(results in mg/L unless otherwise noted)

Collection Date:		9/19/2003	9/19/2003	9/19/2003
Sample Number:		FSZ0903B	FSZ0903B	FSZ0903B
		1889	1890	1891

Analyte		Units	Location		
			Feed	Permeate	Concentrate
	EC	µS/cm	15,760	10,540	19,880
dissolved	Arsenic		< 0.01	< 0.01	< 0.02
total	Barium		< 0.5	< 0.5	< 1.0
dissolved	Bicarbonate	as $CaCO_3$	258	157	288
dissolved	Boron		26.5	24	26
dissolved	Calcium		593	100	944
dissolved	Carbonate	as $CaCO_3$	1	< 1.0	< 1.0
dissolved	Chloride		3,050	3,230	2,920
dissolved	Hardness	as $CaCO_3$	2,404	332	3,976
dissolved	Hydroxide	as $CaCO_3$	< 1.0	< 1.0	< 1.0
dissolved	Fluoride				
dissolved	Iron		< 0.05	< 0.05	< 0.1
dissolved	Magnesium		224	20	393
dissolved	Manganese		< 0.05	< 0.05	< 0.1
dissolved	Nitrate		554	636	504
dissolved	Nitrite	as N			
	DOC	as C	13.2	3.1	30.5
dissolved	othro-phosphat	as P			
dissolved	Potassium		6.7	4.9	7.7
dissolved	Selenium		1.33	0.064	2.49
dissolved	Silica (SiO_2)		35.7	32.3	37.6
dissolved	Sodium		3,350	2,210	4,190
dissolved	Strontium		8.62	1.12	14.7
dissolved	Sulfate		4,810	107	9,040
	pH	pH units	7.4	6.5	7.2
	T.Alk	as $CaCO_3$	259	157	288
total	Arsenic				
total	Barium				
total	Calcium				
total	Iron				
total	Magnesium				
	TOC	as C			
total	Potassium				
	TDS		12,510	6,288	18,170
total	Selenium				
	TSS		< 1.0	< 1.0	< 1.0
	UV254	absorb./cm	0.274		
total	Silica				
total	Sodium				
total	Strontium				
	Turbididy	NTU			

Table 4 - Final General Water Analysis of the NF Piloting Test

Bryte Laboratory Analysis Results for Red Rock Ranch Project

(results in mg/L unless otherwise noted)

Collection Date:	10/8/2003	10/8/2003
Sample Number:	FSZ1003B	FSZ1003B
	2036	2037

Analyte		Units	Location	
			Feed	Permeate
	EC	µS/cm	13,700	9,100
dissolved	Arsenic		0.01	0.008
total	Barium		< 0.5	< 0.5
dissolved	Bicarbonate	as $CaCO_3$	177	255
dissolved	Boron		21	20
dissolved	Calcium		602	94
dissolved	Carbonate	as $CaCO_3$	5	2
dissolved	Chloride		2,910	2,930
dissolved	Hardness	as $CaCO_3$	2,370	292
dissolved	Hydroxide	as $CaCO_3$	< 1	< 1
dissolved	Fluoride			
dissolved	Iron		< 0.05	0.007
dissolved	Magnesium		211	14
dissolved	Manganese		< 0.05	< .005
dissolved	Nitrate		515	561
dissolved	Nitrite	as N		
	DOC	as C	11.4	1.5
dissolved	othro-phosphate	as P		
dissolved	Potassium		5.8	3.5
dissolved	Selenium		1.08	0.047
dissolved	Silica (SiO_2)		32	29.1
dissolved	Sodium		2,830	1,860
dissolved	Strontium		8.01	1.03
dissolved	Sulfate		4,220	34
	pH	pH units	8.4	7.9
	T.Alk	as $CaCO_3$	257	170
total	Arsenic			
total	Barium			
total	Calcium			
total	Iron			
total	Magnesium			
	TOC	as C		
total	Potassium			
	TDS		10,888	5,248
total	Selenium			
	TSS		< 1	< 1
	UV254	absorb./cm	0.213	0.04
total	Silica			
total	Sodium			
total	Strontium			
	Turbididy	NTU		

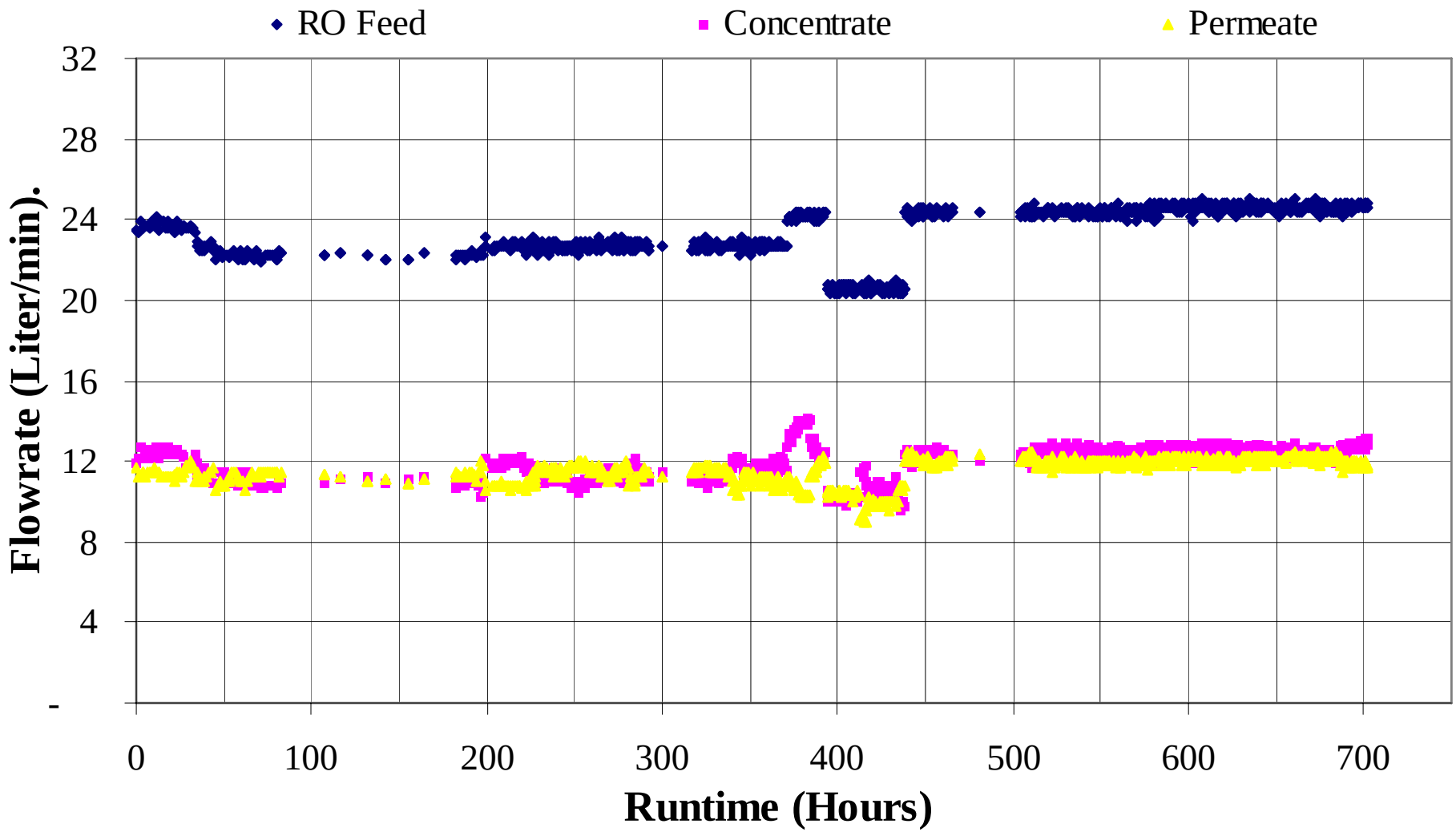


Figure 6.1 - RO System Flows

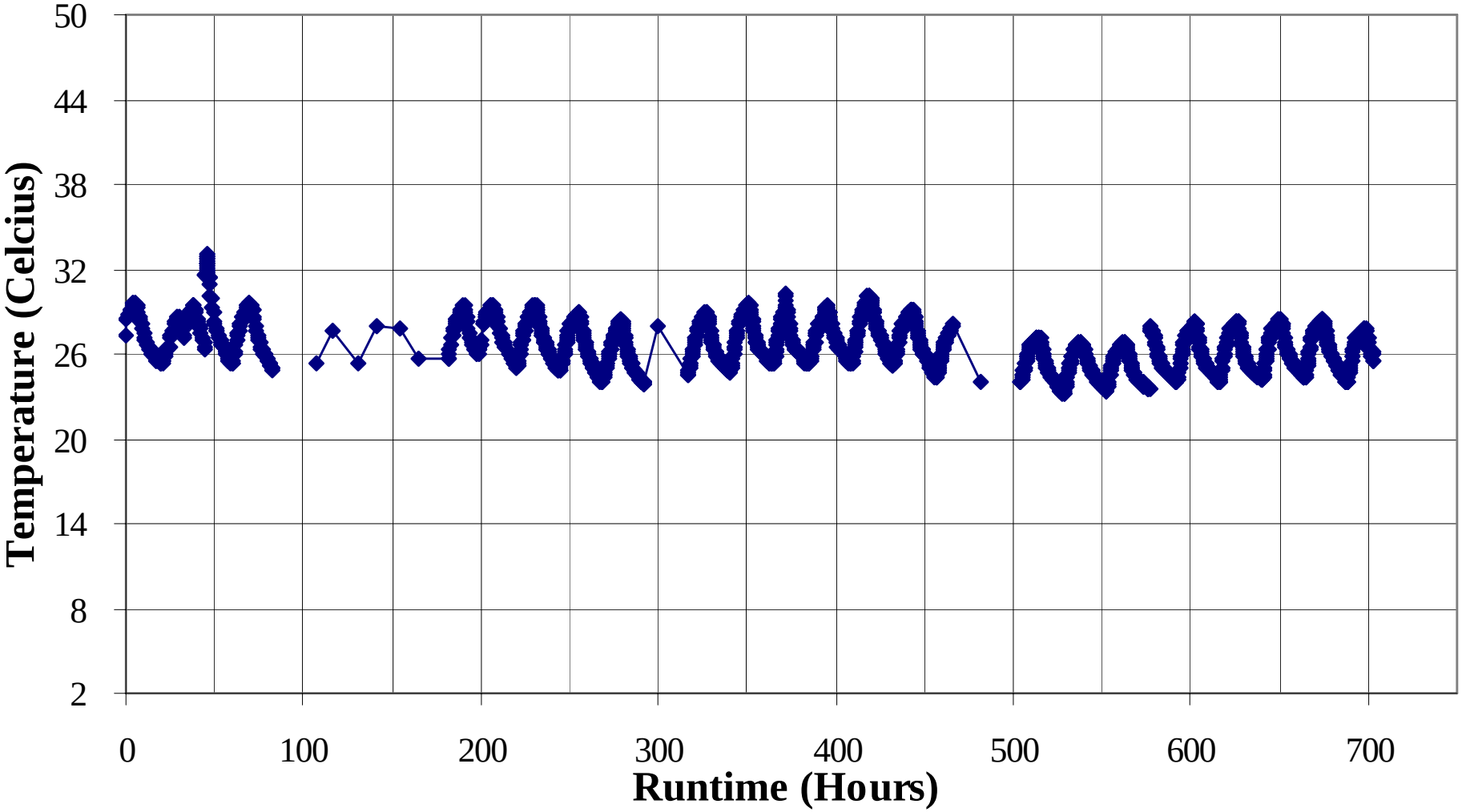


Figure 6.2 - RO Feed Water

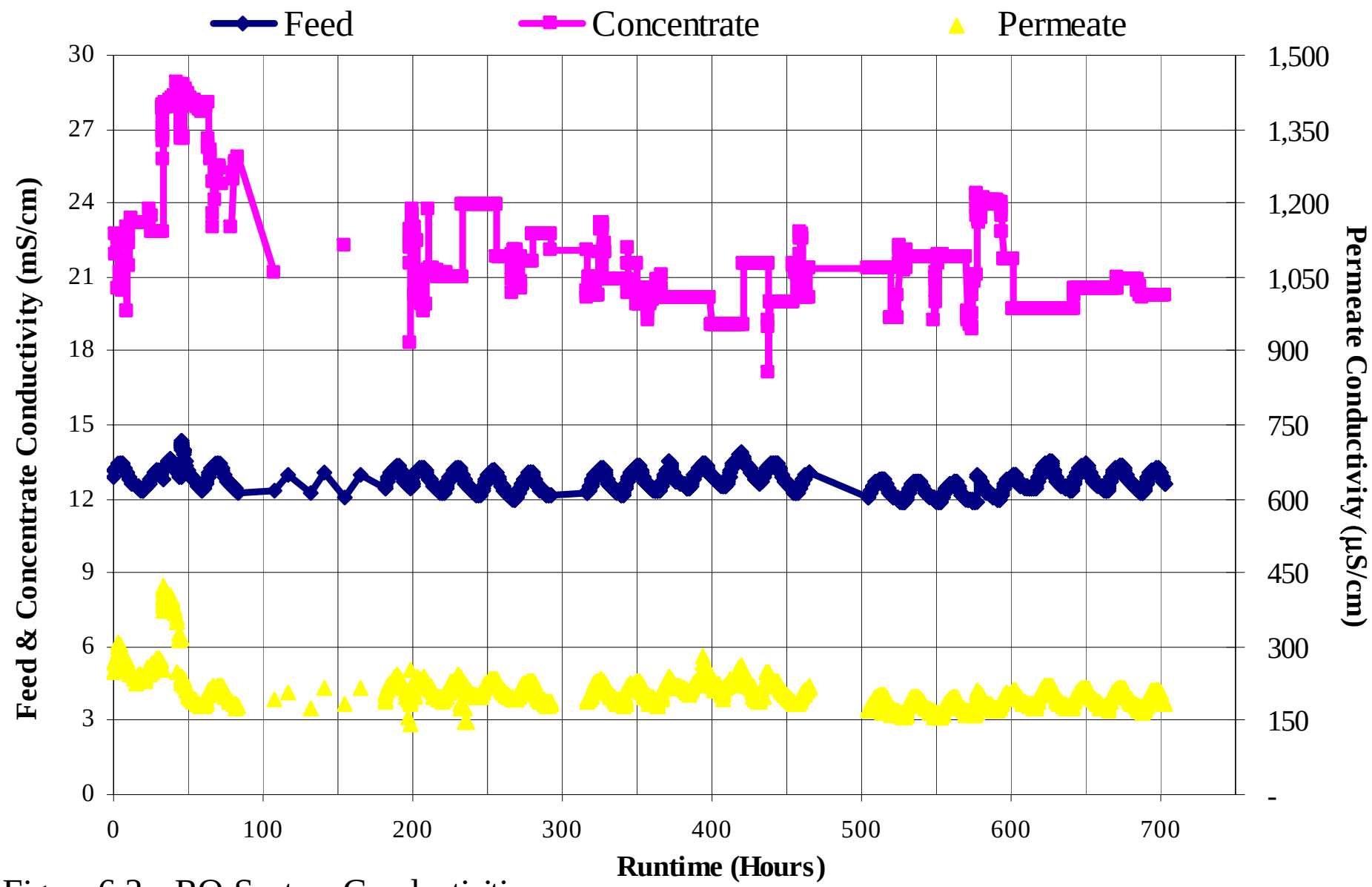


Figure 6.3 - RO System Conductivities

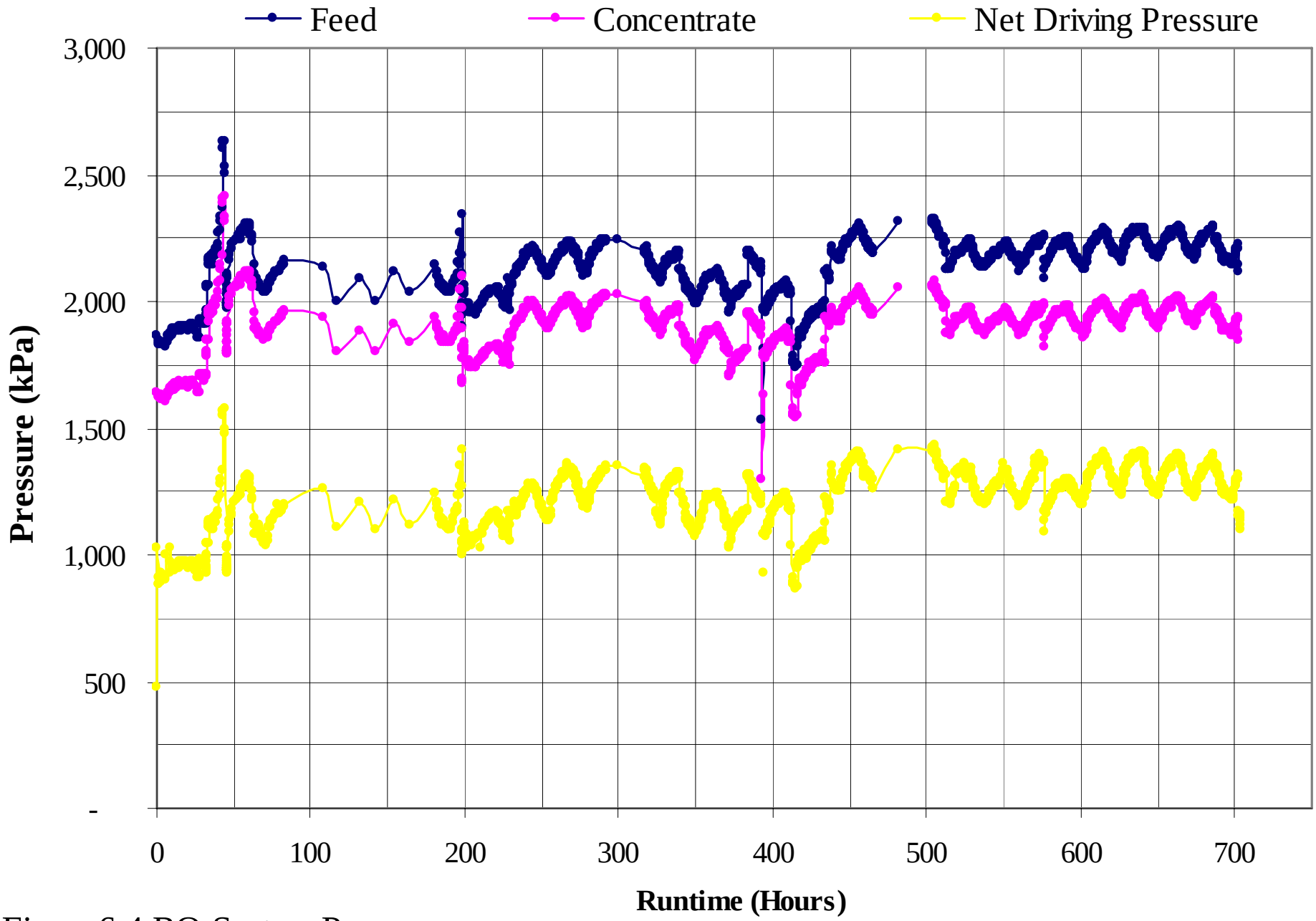


Figure 6.4 RO System Pressures

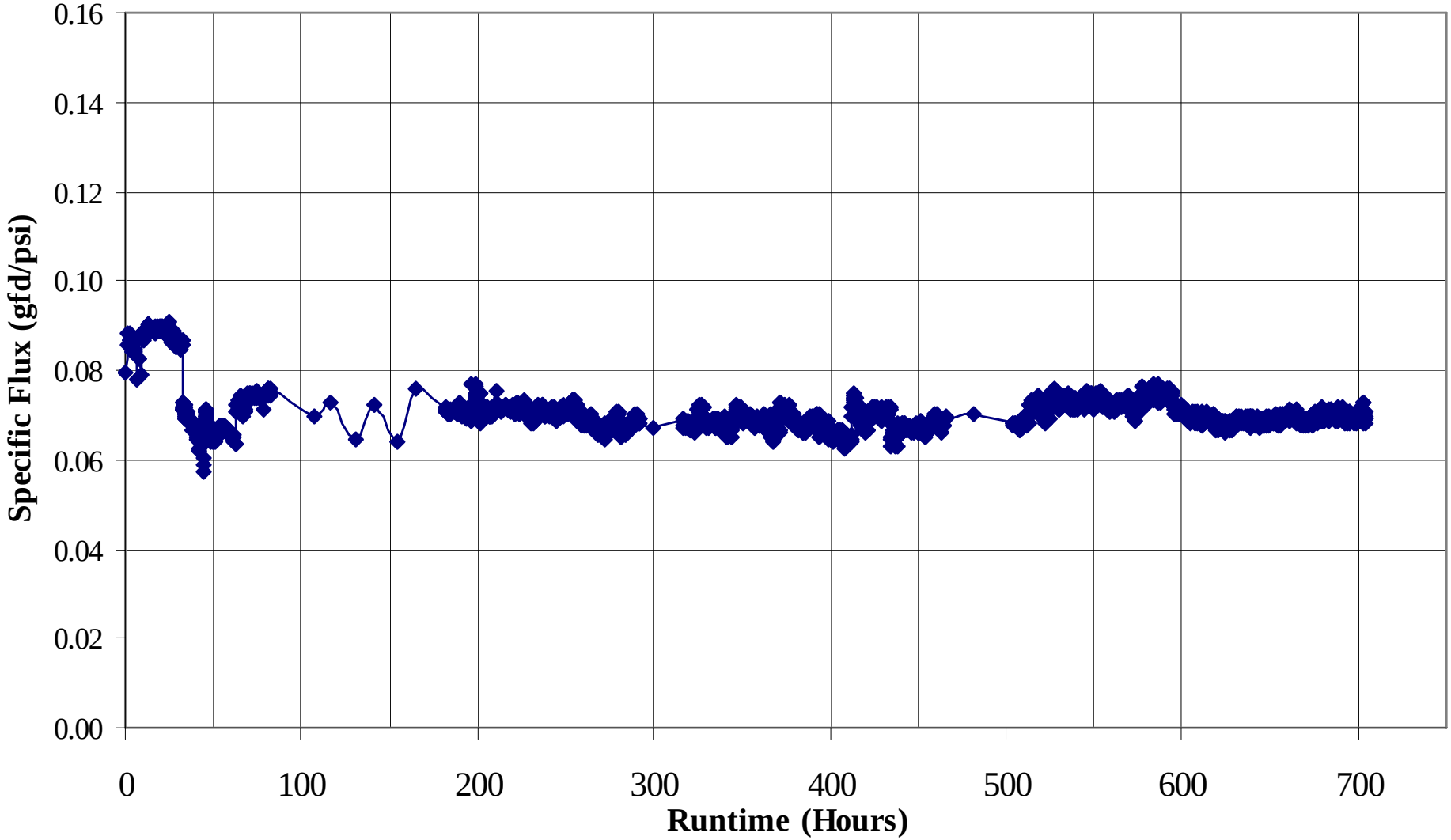


Figure 6.5 - RO Normalized Specific Flux

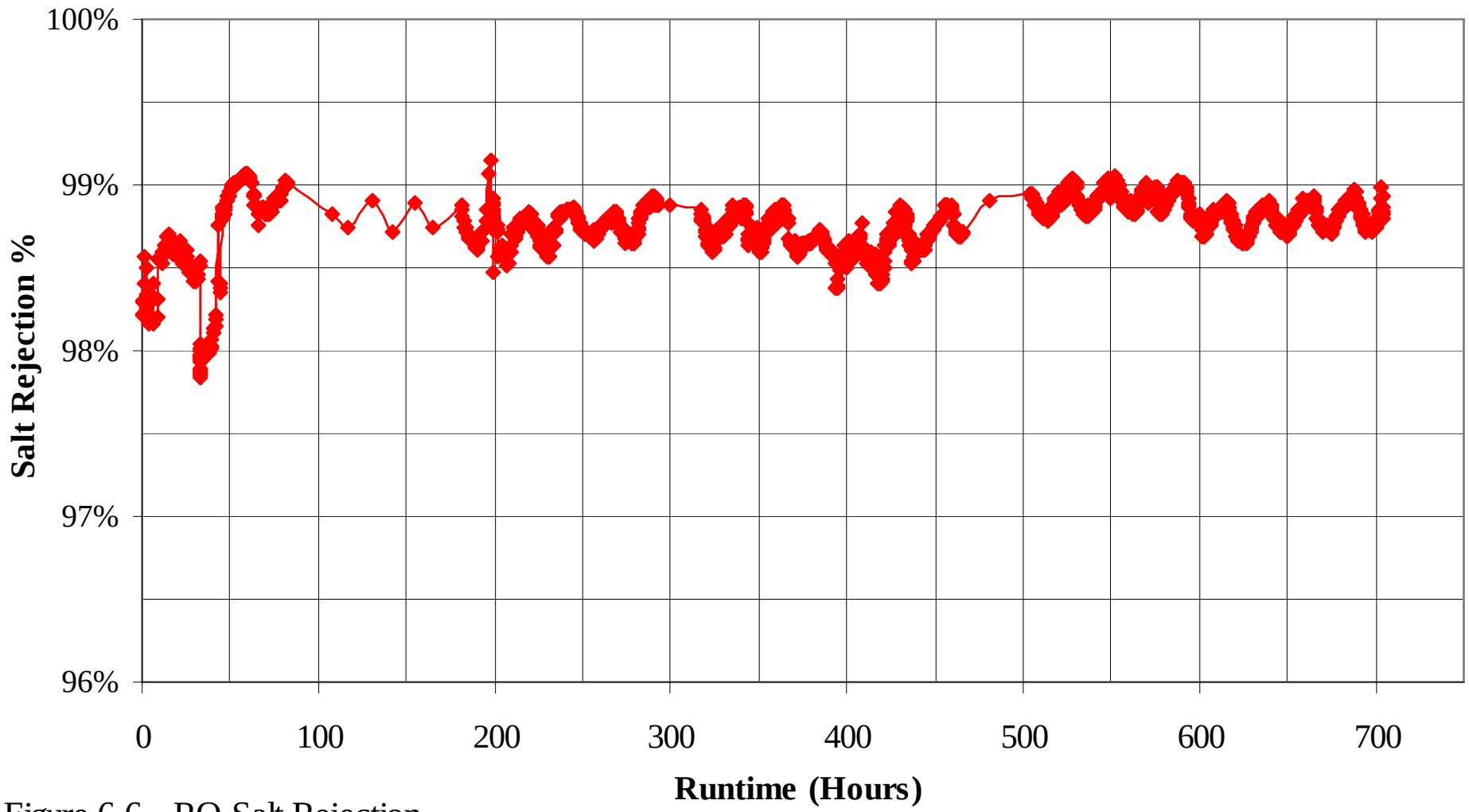


Figure 6.6 - RO Salt Rejection

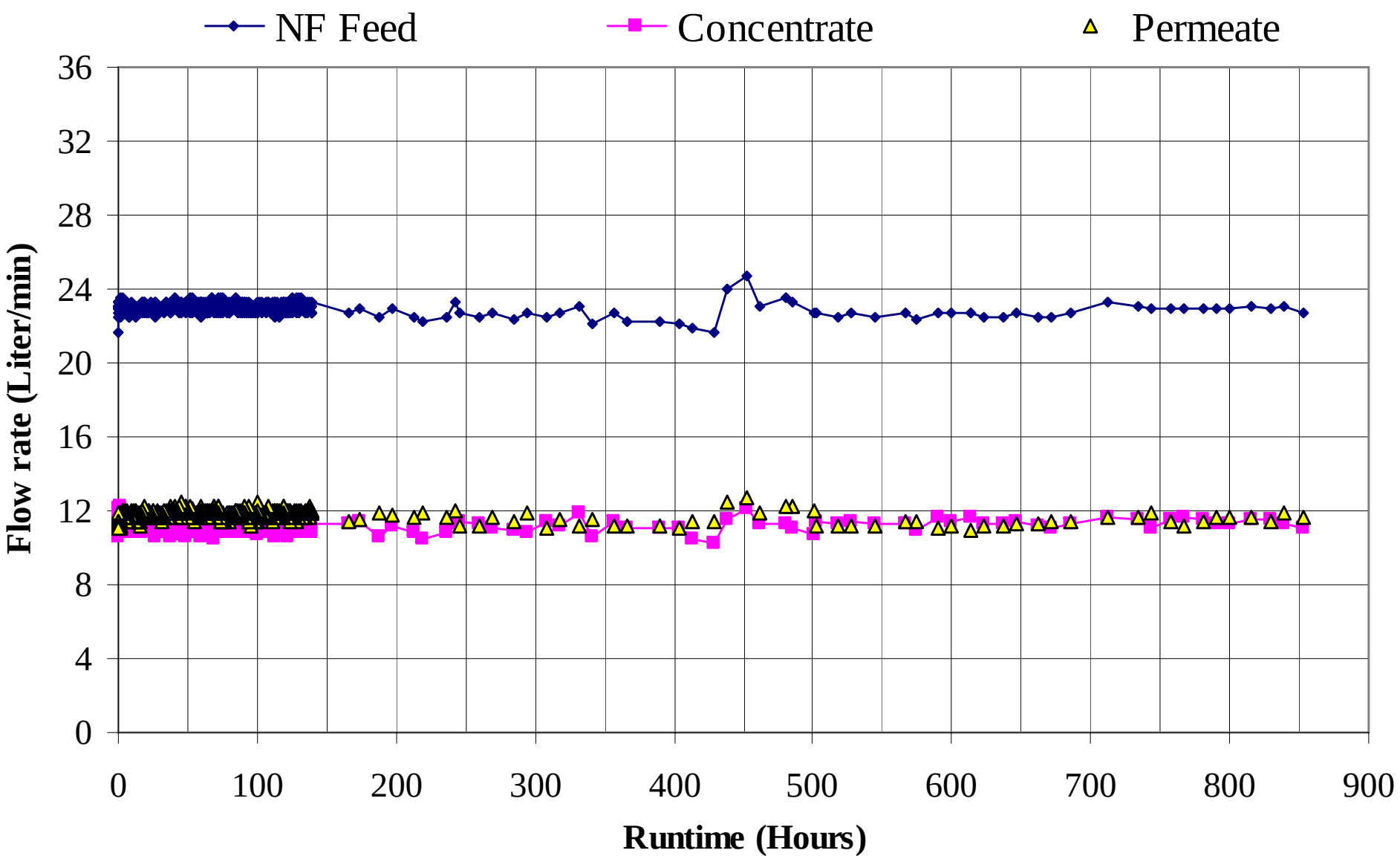


Figure 6.7 - NF System Flows

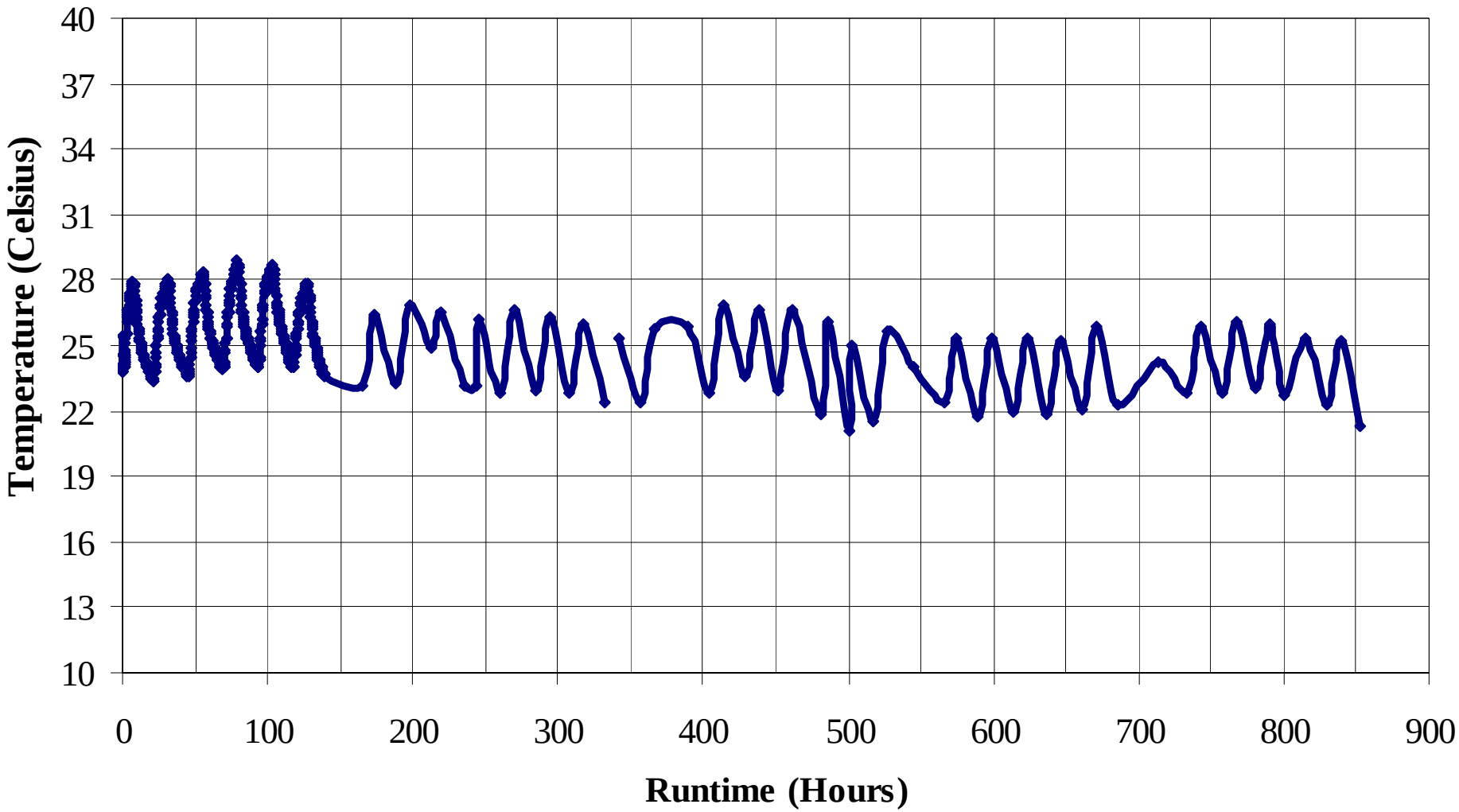
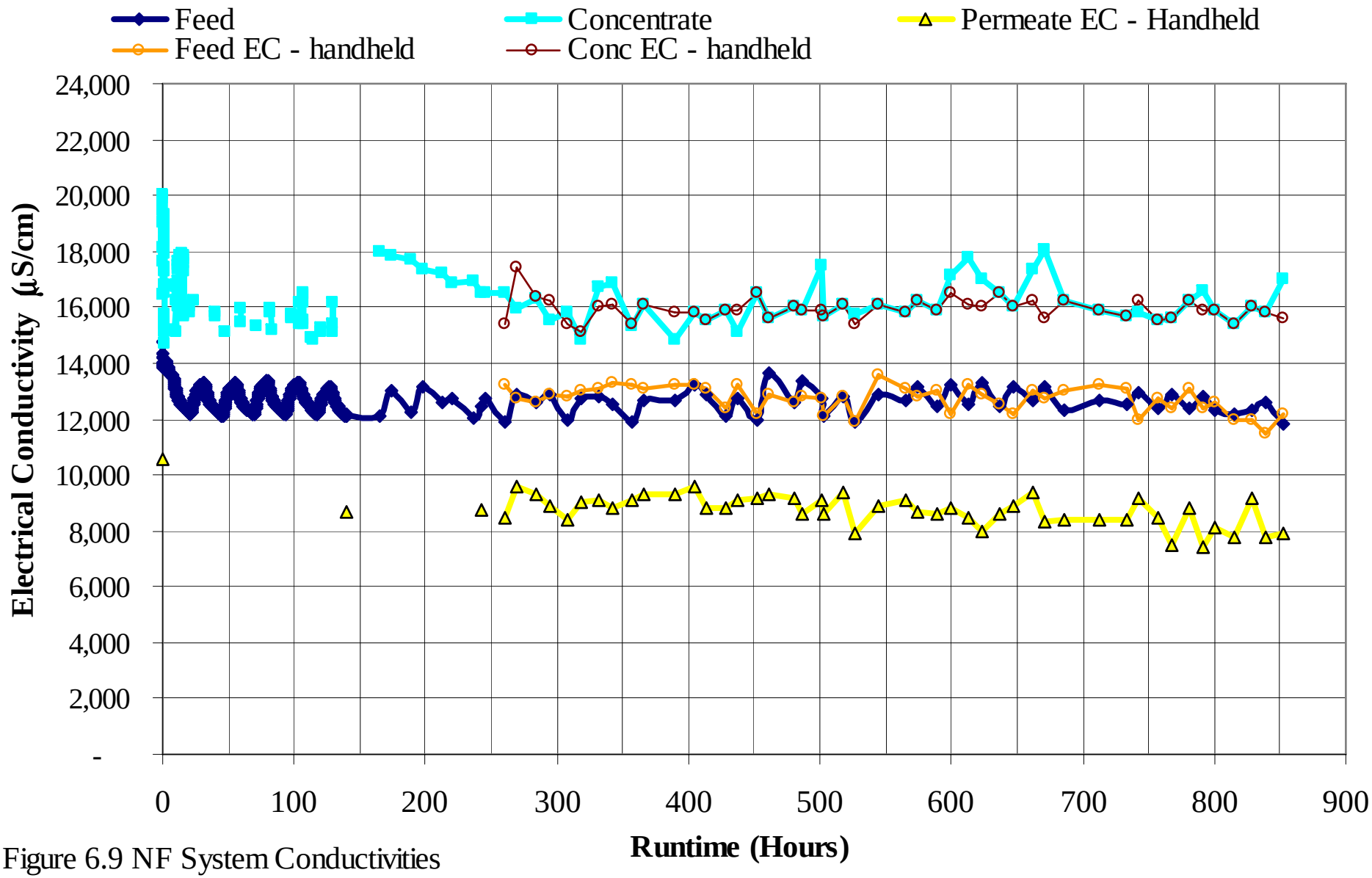


Figure 6.8 - NF Feed Water Temperature



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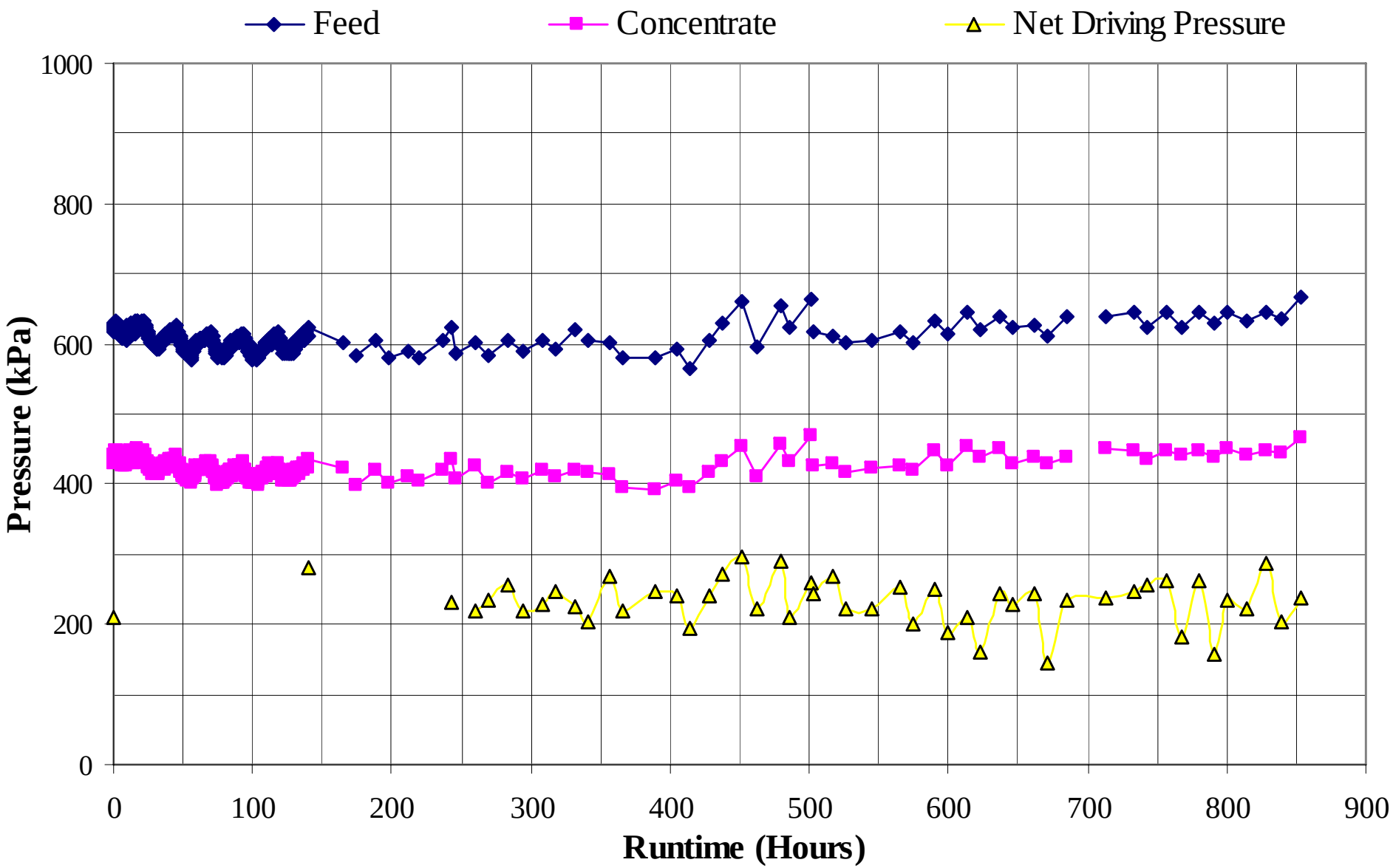

Figure 6.10 - NF System Pressures

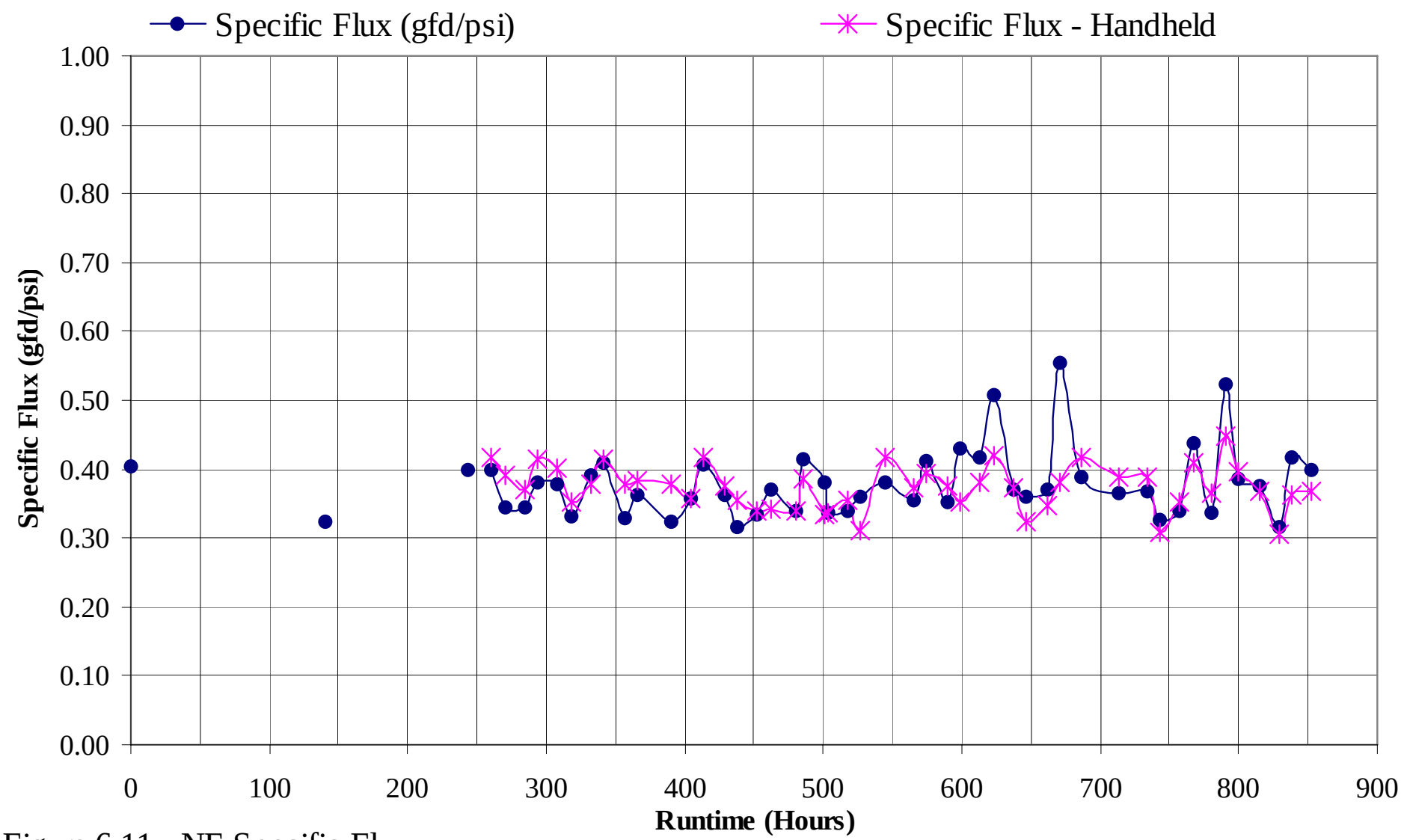

Figure 6.11 - NF Specific Flux

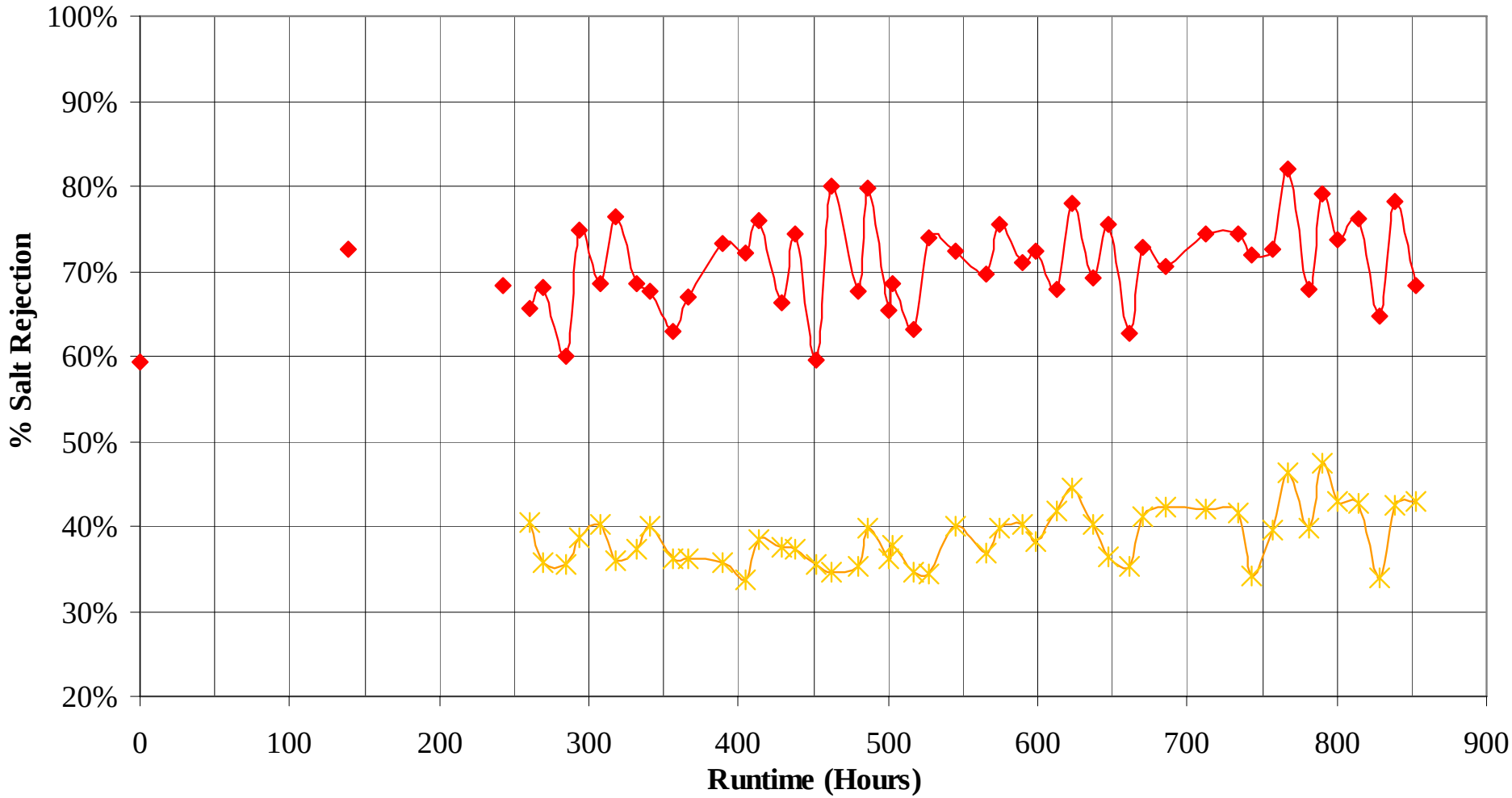

Figure 6.12 - NF Membrane Salt Rejection

Appendix D

Reverse Osmosis Analyses Reports

Panoche Pilot Report, Phase I

Reverse Osmosis Pilot Study for Treatment of Agricultural Drainage at Panoche Drainage District, California

Phase 1: August – December 2004

United States Department of Interior
Bureau of Reclamation
Technical Service Center
Environmental Services Division
Water Treatment Engineering and Research Group
Denver, CO

EXECUTIVE SUMMARY

A 3-½ month reverse osmosis (RO) pilot study was conducted at Panoche Drainage District (Panoche) located on the Westside drainage area of the San Joaquin River in Central California, about 60 miles west of Fresno. The purpose of the pilot study was to verify the performance and efficiency of the RO membranes for desalting agricultural drainage water and to determine the pretreatment requirements for the membranes. The removal of selenium and boron from the drainage water was also of interest. The RO pilot included the operation of media filtration and a brackish water RO system operating at 50 percent recovery. The RO system was fed agricultural drainage water collected from Panoche, at Drainage Point 25 (DP-25). A total of 2042 hours of operation was accrued on the RO elements and it was found that the average concentration of TDS in the product water was 153 mg/L. Divalant species (calcium, magnesium and sulfate) concentrations were reduced to below 5 mg/L in the product water. Monovalant species (sodium, chloride, and nitrate) were reduced below 50 mg/L in the product water. The average concentrations of selenium and boron in the product water were 1.1 µg/L and 11.3 mg/L, respectively.

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ACRONYMS

cfs	Cubic feet per second
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DP-25	Panoche Drainage Point 25
DWR	California Department of Water Resources
EC	Electrical conductivity
FRP	Fiberglass reinforced plastic
gpd	Gallons per day
gpm	Gallons per minute
gfd/psi	Gallons per square foot per day per pounds per square inch
kPa	Kilo-pascals
L/min	Liters per minute
µg/L	Micrograms per liter
µS/cm	Microseimans per centimeter
meq/L	Milliequivalance per liter
mg/L	Milligrams per liter
mL/min	Milliliters per minute
MMF	Multimedia filter
N	Nitrogen
NDP	Net driving pressure
NO_3	Nitrate
NTU	Nephelometric turbidity units
ORP	Oxidation-reduction potential
Panoche	Panoche Water District
PLC	Programmable logic controller
psi	Pounds per square inch
RO	Reverse osmosis
SCCAO	South Central California Area Office
SDI	Silt density index
SDI_{15}	15-minute Silt density index test
Se	Selenium
SiO_2	Silica
TDS	Total dissolved solids
TOC	Total organic carbon
TSS	Total suspended solids
VFD	Variable frequency drive

1.0 INTRODUCTION

1.1 Background

The objective of this study was to evaluate the performance of RO membranes for desalting Panoche agricultural drainage water. It is assumed that product water in a full-scale facility will be used for irrigation and, therefore, does not need to meet drinking water regulations. The quality of the RO product water may be adequate for irrigation reuse. A 3 ½ month pilot test was conducted to verify the performance and efficiency of the RO membranes and to determine the pretreatment requirements on the source drainage water used by the pilot.

A number of organizations participated in the preparation and operation of the membrane pilot test. The Bureau of Reclamation (Reclamation) Technical Service Center (TSC) provided overall project management, technical oversight, and field support. Cost sharing for operation and maintenance was provided by Panoche and Westlands Water District (Westlands). Boyle Engineering Corporation (Boyle) provided engineering services and field operation staffing. Panoche provided the pilot site infrastructure. Additional field support was provided by Reclamation's South Central California Area Office, Panoche, and Mr. Jose Lopez. The sampling and analysis plan and analytical laboratory services were provided by the California Department of Water Resources (DWR).

1.2 Pilot Location

Panoche is located on the Westside drainage area of the San Joaquin River. The pilot site can be reached from US Interstate-5 by taking the Russell Avenue exit. The pilot site is located at Drainage Point 25 (DP-25) about 1.5 miles east of Russell Avenue (Figure 1-1). Figures 1-2 and 1-3 show the pilot trailer and skid-mounted membrane treatment system.

Figure 1- 1 - Location Map, Panoche Pilot Site

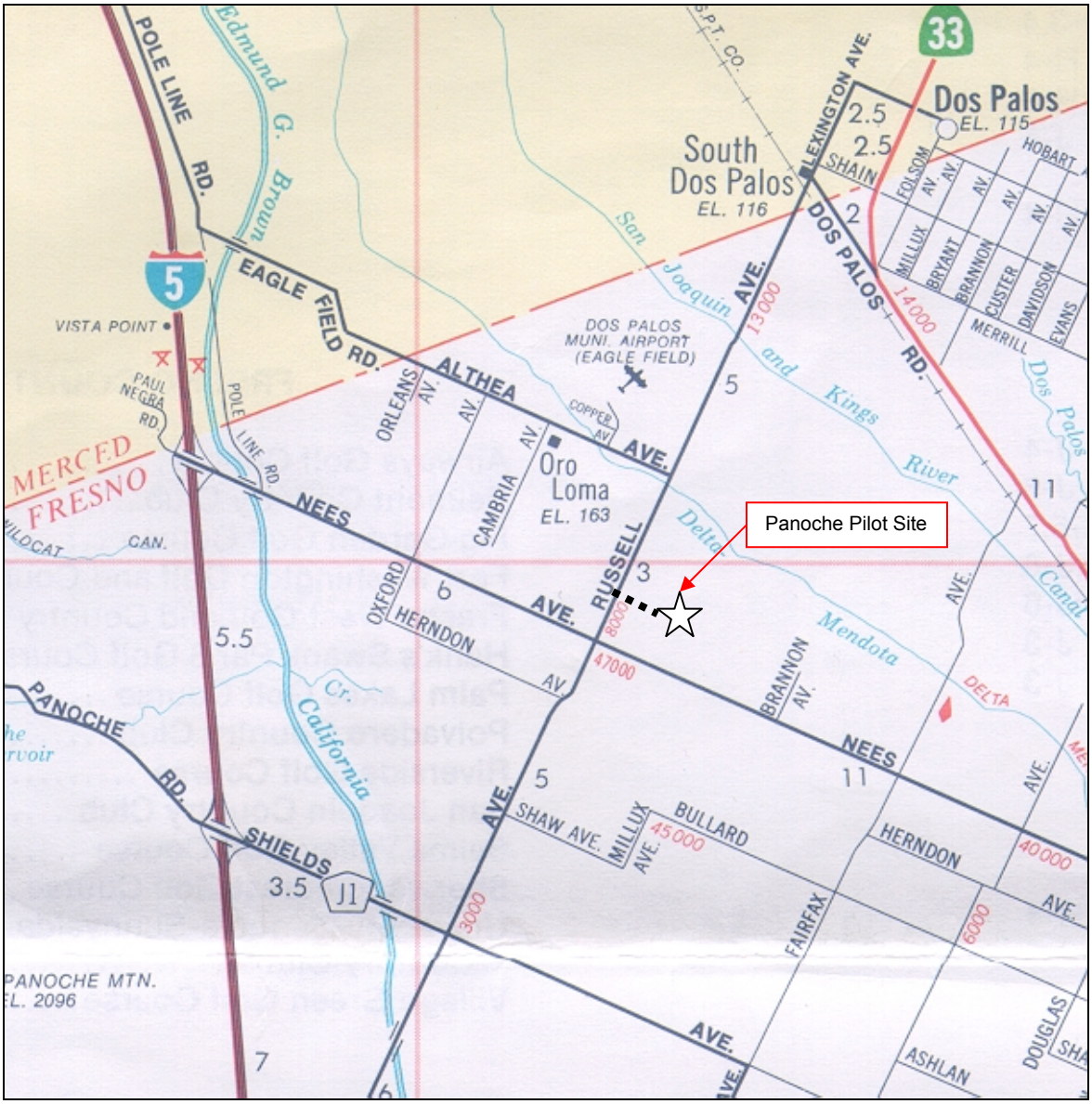


Figure 1- 2 - Panoche RO Trailer

Figure 1- 3 - RO Membrane Skid

1.3 Water Quality Data

A water quality analysis was conducted on the raw drainwater of Panoche. Table 1-1 presents an analysis of drainwater taken from up to 18 sampling sessions taken from Panoche sump DP-25 from July 11, 2001 – December 14, 2004. An expanded version of Table 1-1 presenting the results of each sampling session is given in Appendix A. The sampling was conducted by Panoche and Reclamation using BSK Labs in Fresno and Bryte Labs in West Sacramento. The major constituents of concern for the RO pilot include selenium, boron and total dissolved solids. Average total selenium concentration is 0.421 mg/L with a minimum and maximum concentration of 0.155 and 0.909 mg/L respectively. Average dissolved selenium concentration is 0.448 mg/L with a minimum and maximum concentration of 0.135 and 0.891 mg/L respectively. The average dissolved boron concentration for 6 sampling sessions is 20 mg/L with the minimum and maximum concentrations of 14.2 and 25 mg/L, respectively. Average total dissolved solids (TDS) and electrical conductivity (EC) values for the period are 7,633 mg/L and 9,507 μS/cm, respectively. The range of TDS varied from a low concentration of 5,200 mg/L to a high of 10,640 mg/L, while the range of EC varied from a low of 6,700 μS/cm to a high of 13,300 μS/cm.

The high levels of nitrate and sulfate in the feedwater should also be noted. The average dissolved nitrate concentration (total NO_3) for 18 sampling sessions is 279 mg/L with the minimum and maximum concentrations at 214 and 367 mg/L, respectively. Nitrate concentrations are high in this drainage water due to the addition of fertilizers to the soils. Other potential sources of nitrates are bi-products found in cattle urine. Average dissolved sulfate concentrations were 3,607 mg/L and ranged from 2,700 mg/L to 4,820 mg/L.

Table 1- 1 - Average Analyte Concentrations for Panoche Water District

(Drainage Point-25)
(results in mg/L unless stated otherwise)

Analyte	Units	# Samples Taken	Average	Minimum	Maximum
EC	µS/cm	18	9,507	6,700	13,300
dissolved Ammonia		4	<0.01	<0.01	0.01
dissolved Arsenic		3	0.010	0.007	0.012
dissolved Bicarbonate	as $CaCO_3$	18	223	205	242
dissolved Boron		6	20.0	14.2	25.0
dissolved Calcium		18	543	490	610
dissolved Carbonate	as $CaCO_3$	18	1	<1	2
dissolved Chloride		18	1,249	730	1,970
dissolved Hardness	as $CaCO_3$	8	2,292	1,900	2,511
dissolved Hydroxide	as $CaCO_3$	18	<1	0	<1
dissolved Iron		3	0.066	0.066	0.066
dissolved Magnesium		18	218	150	310
dissolved Manganese		3	0.02	<0.01	0.02
dissolved Nitrate	as NO_3	18	279	214	367
dissolved Organic Carbon (DOC)	as C	5	8	4	15
dissolved Potassium		4	4	3	5
dissolved Selenium		16	0.448	0.135	0.891
dissolved Silica (SiO_2)		6	30	27	32
dissolved Sodium		18	1,616	980	2,480
dissolved Strontium		1	8.24	8.24	8.24
dissolved Sulfate		18	3,607	2,700	4,820
pH	pH units	18	7.6	6.2	7.9
total Alkalinity	as $CaCO_3$	18	224	206	243
total Arsenic		4	0.012	<0.01	0.013
total Barium		6	<0.5	<0.5	<0.5
total Dissolved Solids (TDS)		18	7,633	5,200	10,640
total Iron		4	0.10	0.05	0.16
total Manganese		4	<0.05	<0.05	<0.05
total Organic Carbon (TOC)	as C	4	6.3	4	11
total Phosphorous		4	1.4	0.02	5.4
total Selenium		16	0.421	0.155	0.909
total Strontium		4	8.4	7.95	8.71
total Suspended Solids (TSS)		5	3.4	2.8	4.0
UV254	absorb./cm	5	0.156	0.108	0.191

Notes: 7/11/01 Analysis conducted by BSK Labs, Fresno, Ca
1/15/03 Analysis conducted by BSK Labs, Fresno, Ca
11/4/03 Analysis conducted by Bryte Labs, West Sacramento, CA
8/31/04 - 12/14/04 Analysis conducted by Bryte Labs

2.0 RO PILOT PLANT EQUIPMENT

The RO pilot included the operation of media filtration and a brackish water reverse osmosis unit operating at 50 percent recovery (Figure 2-1). The RO system was fed agricultural drainage water collected from the DP-25 sump. The reject concentrate from the RO was conveyed to the selenium bioreactor pilot to remove selenium and nitrate from the concentrate stream. A detailed description of the 2003-2004 selenium biotreatment pilot at Panoche is provided in a separate report. A site layout of the Panoche Selenium Biotreatment/RO pilot is given in Figure 2-2.

Figure 2- 1 - RO Pilot Process Flow Diagram

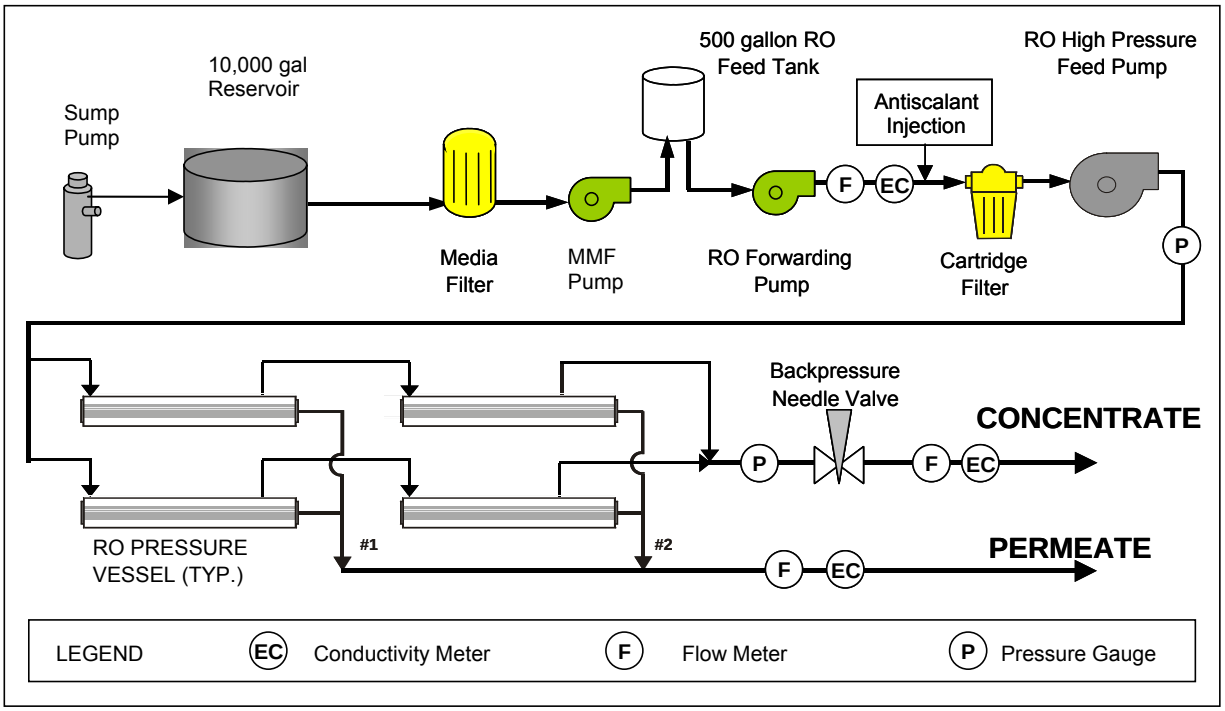
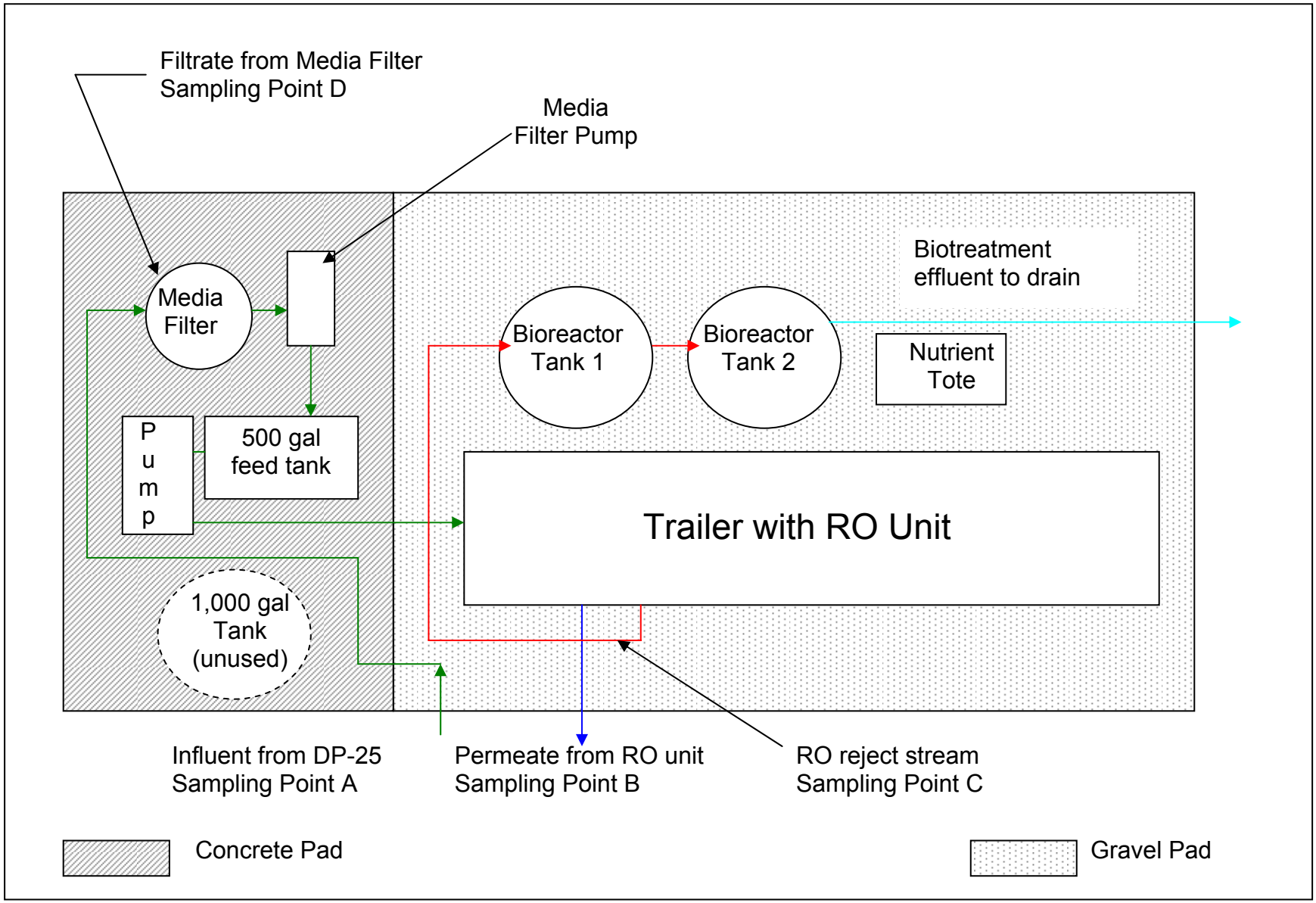
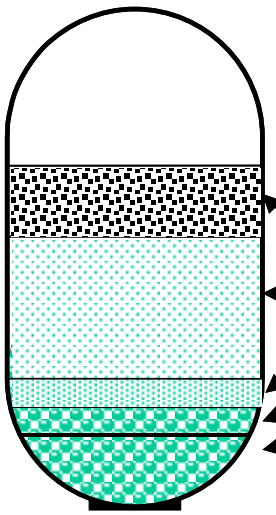


Figure 2- 2 - Diagram of Panoche RO Pilot Site (not to scale)



The media filter was a 72-inch tall vertical fiberglass reinforced plastic (FRP) pressure vessel with an outer diameter of 24 inches. The dome top and bottom sections were each 9.6 inches high, while the sidewall was 53 inches long. The inner diameter at the sidewall was approximately 22.6 inches, giving a cross sectional area of 2.76 square feet and a total vessel volume of 15.6 cubic feet. An inlet basket covered with a fine mesh was located inside the upper inlet of the vessel to keep the media from escaping during a backwash. Slotted laterals were arranged around a central hub installed in the dished bottom of the vessel. The media filter contained several gradations of gravel, fine sand, and anthracite. Figure 2.3 illustrates the strata of media within the filter.

Figure 2- 3 - Multimedia Filter Strata



Media	Size	Ht. (in.)	Vol (ft^3)
Anthracite	N/A	12	3.0
Silica Sand	0.4 - 0.8 mm	20	4.0
Silica Sand	1/16" x 1/32"	3	1.0
Gravel	1/8" x 1/16"	3	1.0
Gravel	1/4" x 1/8"	10	2.0
Total		48	11.0

The membrane treatment system used 2½" diameter RO membrane elements on a skid-mounted unit. The skid was equipped with a chemical injection system, a cartridge filter module, high-pressure pump, six pressure vessels, monitoring instrumentation, and an automatic control system. The membrane elements (Hydranautics model XLFC-1) were enclosed in four (4) three-element pressure vessels arranged in a 2:2 array. An antiscalant dosing system was installed on the skid with a 15-liter reservoir. During pilot operations, the MDC220 chemical antiscalant, manufactured by GE Betz-Dearborn, was injected in the RO feed water to protect the membranes from mineral scaling. The antiscalant consumption was 2.9 L/day (2 mL/min).

A cartridge filter module was also installed to protect the membranes from particulate fouling, should materials escape pass the media filtration system. The filter housing accepted three spiral wounded cartridge modules manufactured by Serfilco, LTD.

The high pressure RO feed pump was a centrifugal multistage pump manufactured by Tonkaflow; it was equipped with a variable frequency drive (VFD) to modulate the speed of the pump motor. Varying the pump speed either increased or decreased the flow rate, or increased or decreased the feed pressure to the membranes. The VFD was controlled manually or by the automated control system.

An Allen Bradley SLC 500 programmable logic controller (PLC) was installed to control operations of the VFD and monitor pilot instrumentation. The PLC transmitted sensor data and alarm signals to a local desktop computer for data logging purposes. Using water level information measured from the ultrasonic level sensor on the 500-gallon RO feed tank, the PLC activated the media filter pump, to maintain adequate liquid level in the tank. The PLC was also programmed with several alarms. If the PLC detected low flow or high-pressure conditions at the RO high pressure feed pump or a low level condition at the RO feed tank, the PLC would shut down all the pumps at the pilot site, including pumps for the pretreatment process.

A data transmittal system was installed on the RO skid using the Perlorica WaterEye™ remote sensing software. Sensor data transmitted to the PLC was transferred to a desktop computer loaded with the WaterEye™ software. Every 15-minutes, the WaterEye™ software queried data from the PLC and transmitted the data via phone modem to the WaterEye™ website. Real-time RO sensor data was posted on the web using colored indicators to confirm system status or to alert of potential problems. In addition, WaterEye™ created downloadable Excel workbooks of archived sensor data and custom plots viewable on the web.

3.0 PILOT OBJECTIVES, TESTING PROTOCOL AND WATER SAMPLING

3.1 Pilot Objectives

The principal objectives of piloting the pre-filtration system were to:

- Determine the appropriate pretreatment system capable of producing suitable feed water for the membrane treatment system.
- Demonstrate the ability of commercially available RO membrane elements for removing TDS, selenium, and boron from agricultural drainage water.
- Determine potential long-term adverse affects on the membranes from fouling or scaling.
- Provide data for a feasibility design of a full-scale RO treatment plant.

3.2 Testing Protocol

The following protocol was developed to confirm that the objectives listed above were obtained:

- *Particle removal verification*: The feed water for the membrane treatment system should maintain a Silt Density Index (SDI) below 4.0. The performance of the pretreatment filtration system was based on meeting this requirement on a continuous basis.
- *Fouling constituent verification*: Samples from the feed water and concentrate streams of the membrane system were taken and analyzed to determine whether concentrations of potential membrane fouling constituents were at levels that could negatively impact membrane life and performance.
- *Product water quality verification*: Samples from the permeate stream of the membrane system were taken and analyzed to determine whether the RO membranes are capable of producing water that is suitable for agricultural use (irrigation).

The onboard PLC controlled the RO high-pressure pump maintaining a constant feed rate of 6 GPM, while the operator manually modulated the concentrate backpressure valve to set the permeate recovery to 50%. In addition, the operator monitored the antiscalant injection system. Although instrumentation measurements were transmitted to the WaterEye™ website for archiving, the operator was asked to fill out a log sheet containing similar data. The manual data log served as a backup in case of telemetry failure, and its review helped the operator troubleshoot potential instrumentation or equipment failure.

To determine whether the media filter required a backwash, the operator also conducted 15-minute SDI tests (SDI_{15}) on the feedwater to the RO membranes. SDI_{15} values were to be maintained below 4.0. As a routine, the media filter was backwashed weekly.

3.2 Water Sampling

Influent and effluent sampling and analysis was conducted by Bryte Laboratories in West Sacramento, California from August 31 to December 14, 2004. Sampling was conducted weekly for major ions and monthly for a more extensive analysis (Table 3-1). Points of sample collection include the feedwater, permeate, concentrate and media filter filtrate (see Figure 2-2).

Table 3- 1 - Constituents and Frequency of Sampling

Designation	Analysis	Feed (DP-25) Sample Pt A		Permeate Sample Pt B		Concentrate Sample Pt C		Filtrate Sample Pt D	
		Wkly	Mthly	Wkly	Mthly	Wkly	Mthly	Wkly	Mthly
A	**Total Minerals:**								
	TSS		x						
B	**Dissolved Minerals:**								
	Alkalinity	x	x	x	x		x		
	Bicarbonate	x	x	x	x	x	x		
	Carbonate	x	x	x	x		x		
	Chloride	x	x		x	x	x		
	EC	x	x	x	x	x	x		
	Nitrate	x	x	x	x	x	x		
	Potassium		x		x		x		
	Sulfate	x	x		x	x	x		
	TDS	x	x	x	x	x	x		
C	**Total Metals:**								
	Arsenic		x		x		x		
	Barium		x		x		x		
	Iron		x		x		x		x
	Manganese		x		x		x		x
	Selenium	x	x	x	x	x	x		
	Strontium		x		x		x		
D	**Dissolved Metals:**								
	Boron		x		x		x		
	Calcium	x	x	x	x	x	x		
	Magnesium	x	x	x	x		x		
	Selenium	x	x	x	x	x	x		
	SiO2		x		x		x		
	Sodium	x	x	x	x	x	x		
E	**Total Nutrient:**								
	Total Phosphorus		x		x		x		
	Dissolved Nutrient:								
F1	Ammonia		x		x		x		
F2	UV254		x		x		x		
G	TOC - (wet Ox)		x		x		x		
H	DOC - (wet Ox)		x		x		x		
On-Site	DO		x						
	EC	x	x		x		x		
	ORP	x	x						
	pH	x	x		x		x		
	SDI							x	x
	Temperature	x	x		x		x		
	Turbidity	x	x	x	x	x	x		

4.0 RESULTS OF THE PANOCHE RO PILOT

4.1 Summary of System Operations

A total of 2042 hours of operation accrued on the RO elements during this test phase. The RO pilot was started on August 27, 2004 and underwent a 10-day trouble shooting and shakedown period. The pilot officially became operational September 7, 2004, and ran continuously until 09:00, October 8, 2004 (729 hours) when the high pressure RO pump broke. The pump was repaired and the RO skid became operational again at 18:00, October 18, 2004. The system ran continuously for another 1313 hours until the pilot officially ended at 11:00 on December 13, 2004.

System flow, pressures, temperature, conductivities, specific flux and salt rejection are depicted on Figures 4-1 through 4-9. Referencing Figure 4-1, feed and permeate flows were on average 23.4 L/min (6.2 gpm) and 11.3 L/min (3.0 gpm), respectively, yielding an approximate 50% recovery of desalinated water (permeate). The total concentrate flow is the difference between the feed and permeate flows.

Figure 4-2 shows the water temperature of the RO feed for the period September to December. This measurement was taken just prior to entering the RO high-pressure feed pump. Average daily feed water temperature was 21.3° C with a maximum temperature of 28.7° C reached on October 6 and a minimum temperature of 15.7 °C reached on December 4. During the period November 16 - 27, the temperature sensor malfunctioned providing readings that varied from 35° - 65° C. The erroneous temperature readings during this period would impact other reading including conductivity and specific flux. On November 27, the temperature sensor was corrected. Figure 4-3 shows the diurnal swings in daily temperature over a 7-day period from September 7 to 14. The average temperature during this period was about 23° C with daily high and low temperatures varying around 2° C about the average.

The pressure measurements of the feed and concentrate stream are shown in Figure 4-4 for the period September to December. The green and red lines refer to the feedwater pressure and concentrate pressure respectively. Average values of feedwater and concentrate pressure were 1,666 kPa (242 psi) and 1,599 kPa (232 psi). The yellow line on the graph represents the net driving pressure (NDP) which is the driving pressure to force water through the membrane. The average NDP was 1,055.6 kPa (153 psi). Figure 4-5 shows the diurnal swings in daily pressure over a 7-day period. Pressures appear to be lowest when daily temperature reaches a peak.

Figure 4-6 illustrates the electrical conductivities (EC) of the RO feed, permeate, and concentrate streams for the period September to December. Average conductivities of the feedwater, permeate and concentrate were 8,160 μS/cm, 529 μS/cm and 18,088 μS/cm respectively. Feedwater conductivities began to decrease by late October due to an increase in rainfall which provided dilution flows to the drainwater. Erroneous conductivity data appears for the period November 16 - 27. The erroneous data was caused by the faulty temperature sensor which provided incorrect temperature compensation factors to the conductivity data. Figure 4-7 shows the diurnal swings in

daily conductivity over a 7-day period. Concentrate conductivity appears to be lowest when daily temperature reaches a peak.

Specific flux is defined as the amount of permeate produced per square foot of membrane surface area over time and per unit of RO feed pressure. It is typically reported in gallons per square foot of membrane area per day (gfd) per pounds per square inch (psi), or gfd/psi. Figure 4-8 shows the specific flux values for the period September to December normalized to a standard temperature of 25°C. Average specific flux for this period is 0.082 gfd/psi. The specific flux increased when the rainy season commenced in late October. Erroneous normalized specific flux values were computed for the period November 16 to 27 due to the problems with the temperature sensor. Figure 4-9 shows the diurnal swings in daily normalized specific flux over a 7-day period. Normalized specific flux appears to be lowest when daily temperature reaches a peak.

4.2 Summary of Water Quality Analysis

Analyses of water samples were conducted by Bryte Labs, and plots of the lab analyses are provided in Figures 4-10 to 4-22. Detailed summary tables of the lab analyses are provided in Appendix A. Figures 4-10 represents the cation/anion balance while Figure 4-11 is the ratio of sum of ions to TDS. Both plots represent the quality of the chemical analysis for the pilot. For the cation/anion balance, the ratio should fall in the range of ±5%. The average cation/anion ratio is given in Table 4-1 and shows that, on average, the ±5% criteria are met for all three flow streams. For the ratio of sum of ions to TDS, values should be around 1.05 since the sum of ions should always be slightly higher than TDS. This is due to losses in bicarbonate in the TDS analysis. The sum of ions to TDS ratio for the feedwater and concentrate streams is 1.04. The product water is slightly lower at 0.97.

Table 4- 1- Average Cation/Anion Balance Ratio & Sum of Ions to TDS Ratio

Source	Cation/Anion Balance Ratio Average	Sum of Ions to TDS Ratio Average
Feedwater	-1.71%	1.04
Product Water	0.17%	0.97
Concentrate Water	-2.95%	1.04

Figures 4-12 and 4-13 show the RO feedwater species concentration in mg/L and meq/L respectively. Average TDS concentration is 7,702 mg/L and varies from a low of 6,032 mg/L on November 9 to a high of 10,640 mg/L on September 21. Average sulfate concentration is 3,612 mg/L and varies from a low of 2890 mg/L to a high of 4,820 mg/L. Average sodium and chloride concentrations are 1,633 mg/L and 1,278 mg/L respectively. Sodium varies from 1,050 mg/L to 2,480 mg/L while chloride varies from 868 mg/L to 1,970 mg/L. Average nitrate concentration is 271 mg/L and ranges from a low of 214 mg/L to a high of 367 mg/L. Other constituents analyzed are summarized in Table 4-2.

Table 4- 2 - RO Feedwater Species Concentrations

Species	Average		Minimum		Maximum	
	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	7,702		6,032		10,640	
Sulfate	3,612	75.20	2,890	60.17	4,820	100.35
Sodium	1,633	71.02	1,050	45.67	2,480	107.87
Chloride	1,278	36.06	868	24.48	1,970	55.57
Calcium	544	27.15	490	24.45	610	30.44
Bicarbonate	270	4.43	250	4.10	288	4.71
Nitrate	271	4.37	214	3.45	367	5.92
Magnesium	218	17.96	154	12.67	310	25.50

Figures 4-14 and 4-15 show the RO product water species concentration in mg/L and meq/L respectively. Average TDS concentration is 153 mg/L and varies from a low of 91 mg/L on November 9 to a high of 256 mg/L on September 21. Average sulfate concentration is 4 mg/L and varies from a low of 1 mg/L to a high of 12 mg/L. Average sodium and chloride concentrations are 43 mg/L and 37 mg/L respectively. Sodium varies from 27 mg/L to 71 mg/L while chloride varies from 22 mg/L to 68 mg/L. Average nitrate concentration is 44 mg/L and ranges from a low of 29 mg/L to a high of 67 mg/L. Other constituents analyzed are summarized in Table 4-3.

Table 4- 3 - RO Product Water Species Concentrations

Species	Average		Minimum		Maximum	
	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	153		91		256	
Sulfate	4	0.08	1	0.02	12	0.25
Sodium	43	1.87	27	1.17	71	3.09
Chloride	37	1.03	22	0.62	68	1.92
Calcium	1	0.07	1	0.05	4	0.20
Bicarbonate	12	0.20	10	0.16	16	0.26
Nitrate	44	0.71	29	0.46	67	1.08
Magnesium	1	0.09	1	0.08	2	0.16

Figures 4-16 and 4-17 show the RO concentrate water species concentration in mg/L and meq/L respectively. Average TDS concentration is 14,646 mg/L and varies from a low of 10,690 mg/L on November 9 to a high of 19,650 mg/L on September 21. Average sulfate concentration is 6,891 mg/L and varies from a low of 5,270 mg/L to a high of 9,120 mg/L. Average sodium and chloride concentrations are 3,153 mg/L and 2,439 mg/L respectively. Sodium varies from 2,080 mg/L to 4,630 mg/L while chloride varies from 1,580 mg/L to 3,600 mg/L. Average nitrate concentration is 493 mg/L and ranges from a low of 379 mg/L to a high of 646 mg/L. Other constituents analyzed are summarized in Table 4-4.

Table 4- 4 - RO Concentrate Water Species Concentrations

Species	Average		Minimum		Maximum	
	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	14,646		10,690		19,650	
Sulfate	6,891	143.46	5,270	109.72	9,120	189.88
Sodium	3,153	137.13	2,080	90.47	4,630	201.39
Chloride	2,439	68.79	1,580	44.57	3,600	101.54
Calcium	858	42.83	623	31.09	1,110	55.39
Bicarbonate	495	8.11	412	6.76	549	8.99
Nitrate	493	7.95	379	6.11	646	10.42
Magnesium	424	34.88	298	24.51	593	48.78

Total selenium concentrations are presented in Figure 4-18 and summarized in Table 4-5. The average selenium concentration in the feedwater was 437µg/L and varied from 155 µg/L to 891 µg/L. Average selenium concentrations of the product water and concentrate water were 1.06 µg/L and 850 µg/L respectively.

Table 4- 5 - Total Selenium Concentrations

Source	Average (µg/L)	Minimum (µg/L)	Maximum (µg/L)
Feedwater	437	155	891
Product Water	1.06	0.99	2.00
Concentrate Water	850	297	1690

Dissolved boron concentrations were analyzed on a monthly basis. Table 4-6 summarizes the boron concentrations for the feed, product and concentrate streams for the 4 monthly sampling events. The average boron concentration of the feedwater was 19.5 mg/L and varied from 7.90 mg/L to 14.2 mg/L. The average boron concentrations of the product water and concentrate water were 11.3 and 25.5 mg/L, respectively. In general, the Hydranautics XLFC-1 membranes were not as effective in removing boron (about 41% removal efficiency) as they were on the other constituents.

Table 4- 6 - Dissolved Boron Concentrations

Source	Average	Minimum	Maximum
Feedwater	19.5	14.2	24.0
Product Water	11.3	8.8	12.7
Concentrate Water	25.5	17.8	30.0

System pH is provided in Figure 4-19 and summarized in Table 4-7. The average pH of the feedwater was 7.63 and varied from 6.20 to 7.90. The average pH of the product water and concentrate water was 6.37 and 7.77, respectively. The product water pH varied from 5.8 to 7.5 and the concentrate water pH varied from 6.80 to 8.00.

Table 4- 7 – pH Value of the Treatment Streams

Source	Average	Minimum	Maximum
Feedwater	7.63	6.20	7.90
Product Water	6.37	5.80	7.50
Concentrate Water	7.77	6.80	8.00

The ratio of TDS to conductance is presented in Figure 4-20. Reverse osmosis treatment systems usually are equipped with sensors to measure conductance. Determination of TDS requires evaporation analysis in a lab. The TDS to conductance ratio provides a conversion factor to estimate TDS from conductance measurements. Table 4-8 gives average conversion factors for the feedwater, product water and concentrate.

Table 4- 8 - Average Ratio of TDS to Conductance

Source	Average
Feedwater	0.81
Product Water	0.61
Concentrate Water	0.88

A mass balance of ions across the membrane system (concentrate + product)/feed in meq/L is presented in Figure 4-21. In theory, the total species concentrations in the concentrate and product should equal the species concentration in the feedwater. If the ratio of (concentrate + product)/feed does not equal to 1, then this indicates that a constituent is being held within the system, perhaps in the form of scaling. Most of the constituents, with the exception of calcium, have an average mass balance between 0.90 to 1.00 (Table 4-9).

Table 4- 9 - Average Mass Balance of Dissolved Ions

Species	Average
Sodium	0.97
Calcium	0.79
Magnesium	0.97
Chloride	0.96
Bicarbonate	0.94
Sulfate	0.95
Nitrate	0.99
Selenate	0.95
TDS	0.95

A plot of membrane rejection of dissolved ions is given in Figure 4-22. Average rejection values are given in Table 4-10. Divalent species (calcium, magnesium, sulfate and selenate) have rejections of 99.8% or higher. Monovalent species (sodium and chloride) have rejections around 98.2%. Rejection of TDS is around 98.7% while rejection of bicarbonate is 96.8%. The species with the lowest rejection is nitrate at 88.6%.

Table 4- 10 - Average Rejection

Species	Average
Sodium	98.2%
Calcium	99.8%
Magnesium	99.7%
Chloride	98.1%
Bicarbonate	96.8%
Sulfate	99.9%
Nitrate	88.6%
Selenate	99.8%
TDS	98.7%

Figure 4- 1 - Panoche RO Pilot System Flows

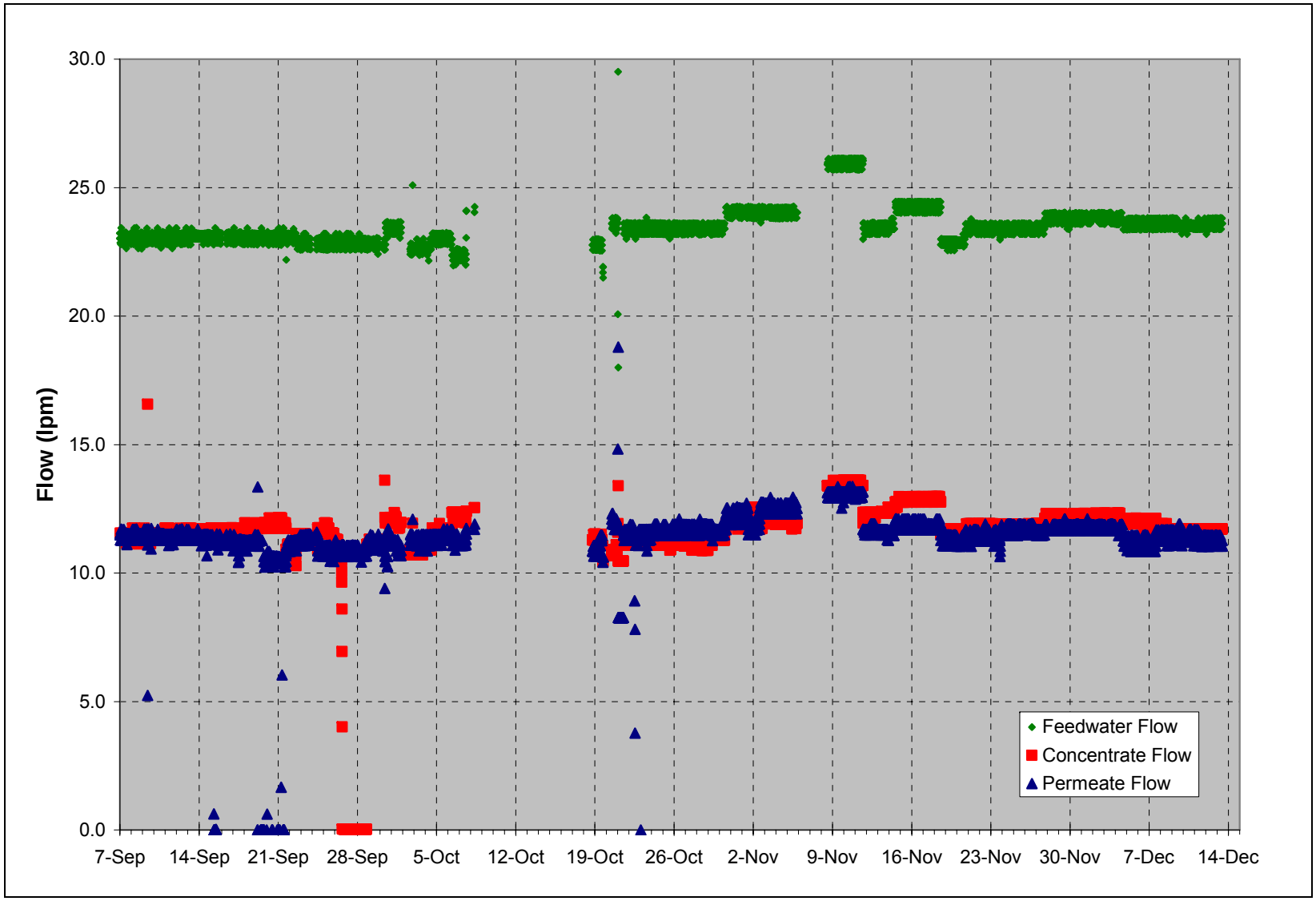


Figure 4- 2 - Feedwater Temperatures, September – December

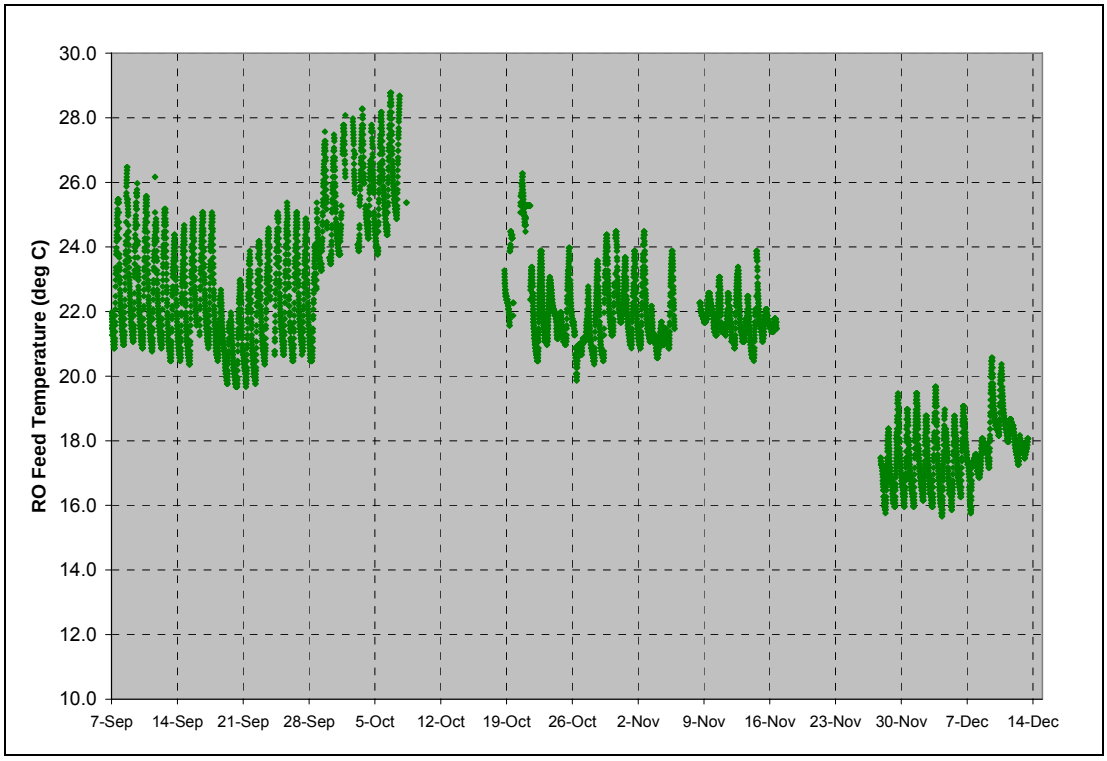


Figure 4- 3 - Feedwater Temperatures, September 7 -14

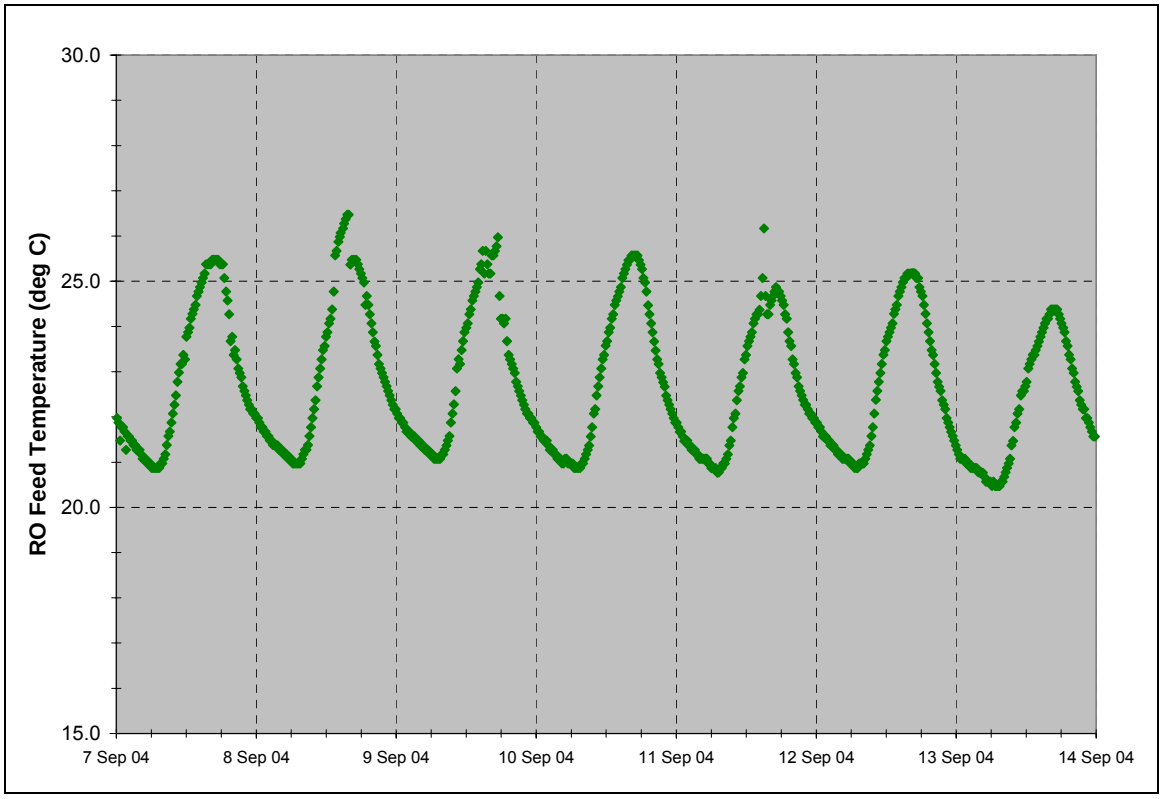


Figure 4- 4 - RO System Pressures, September – December

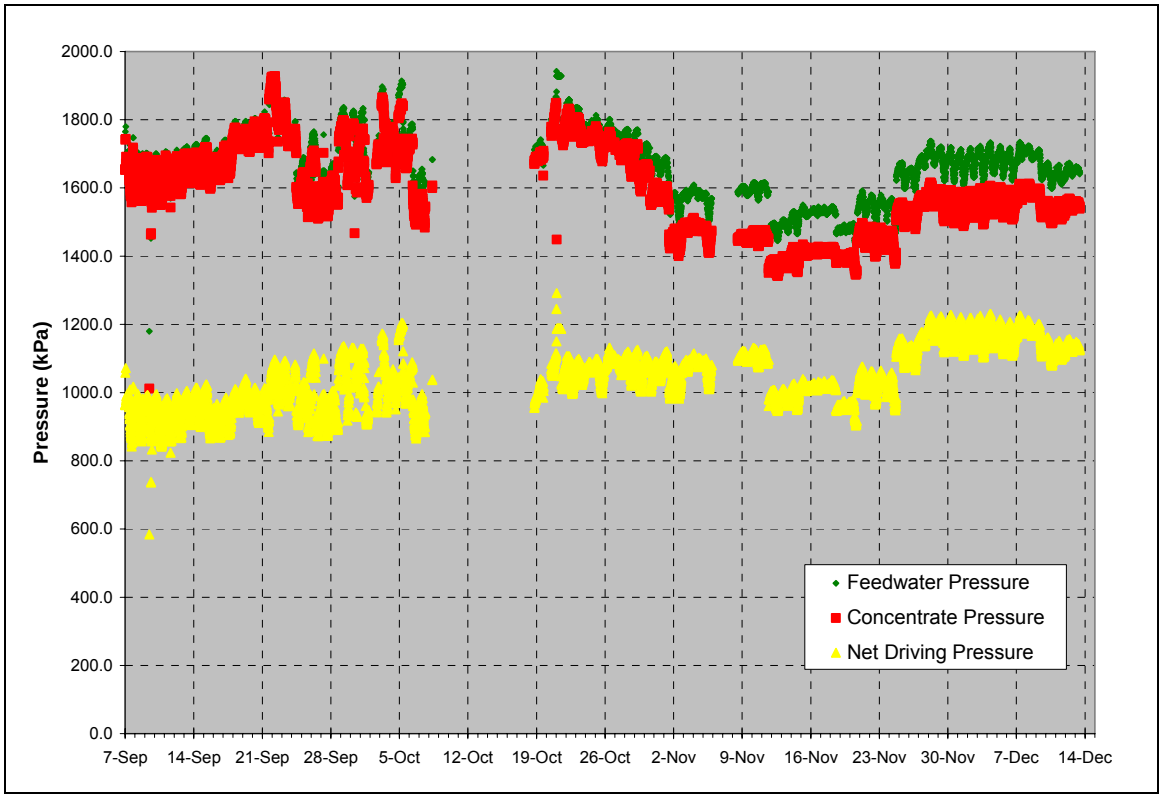


Figure 4- 5 - RO System Pressures, September 7 – 14

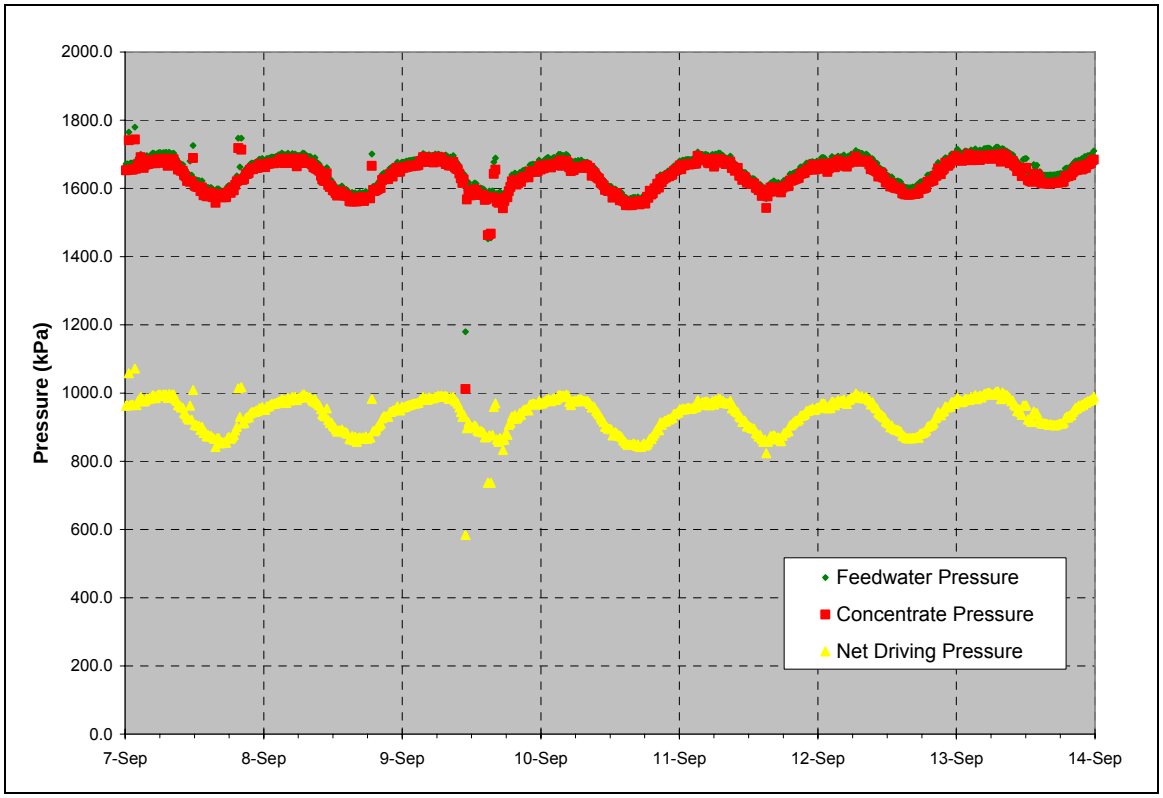


Figure 4- 6 – Conductivities, September – December

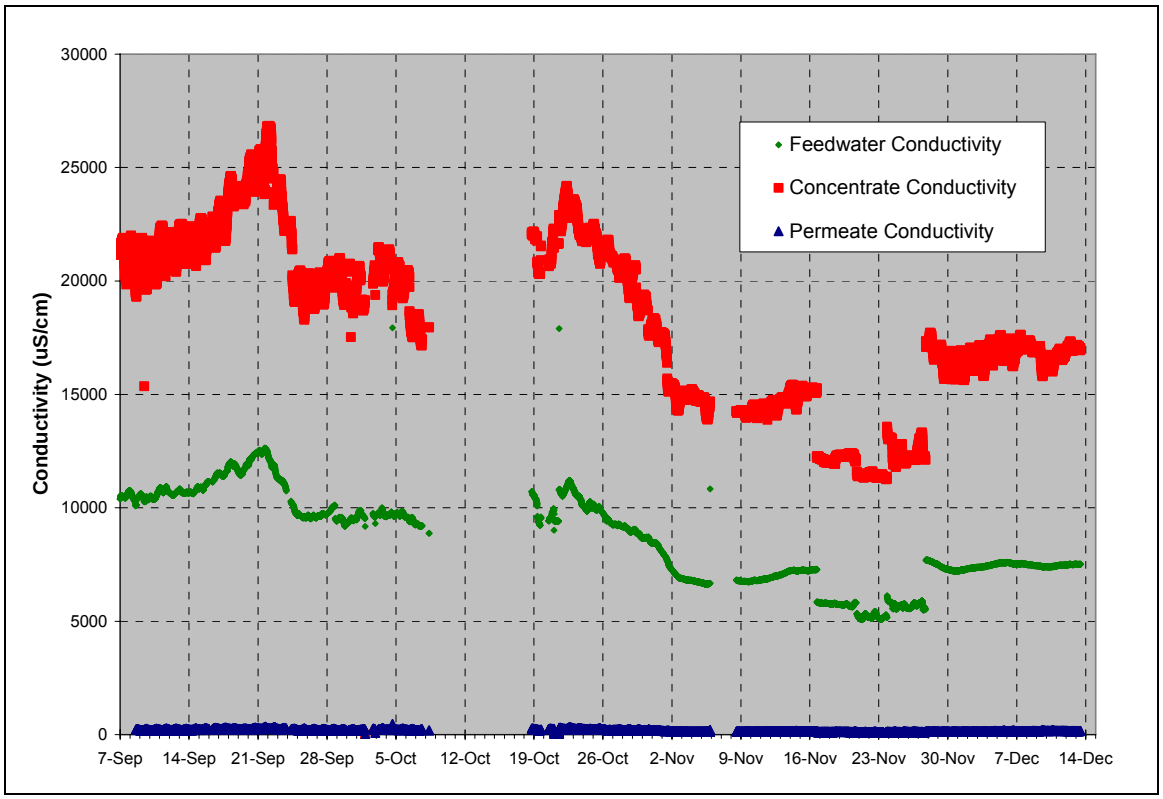


Figure 4- 7 - Conductivities September 7 -14

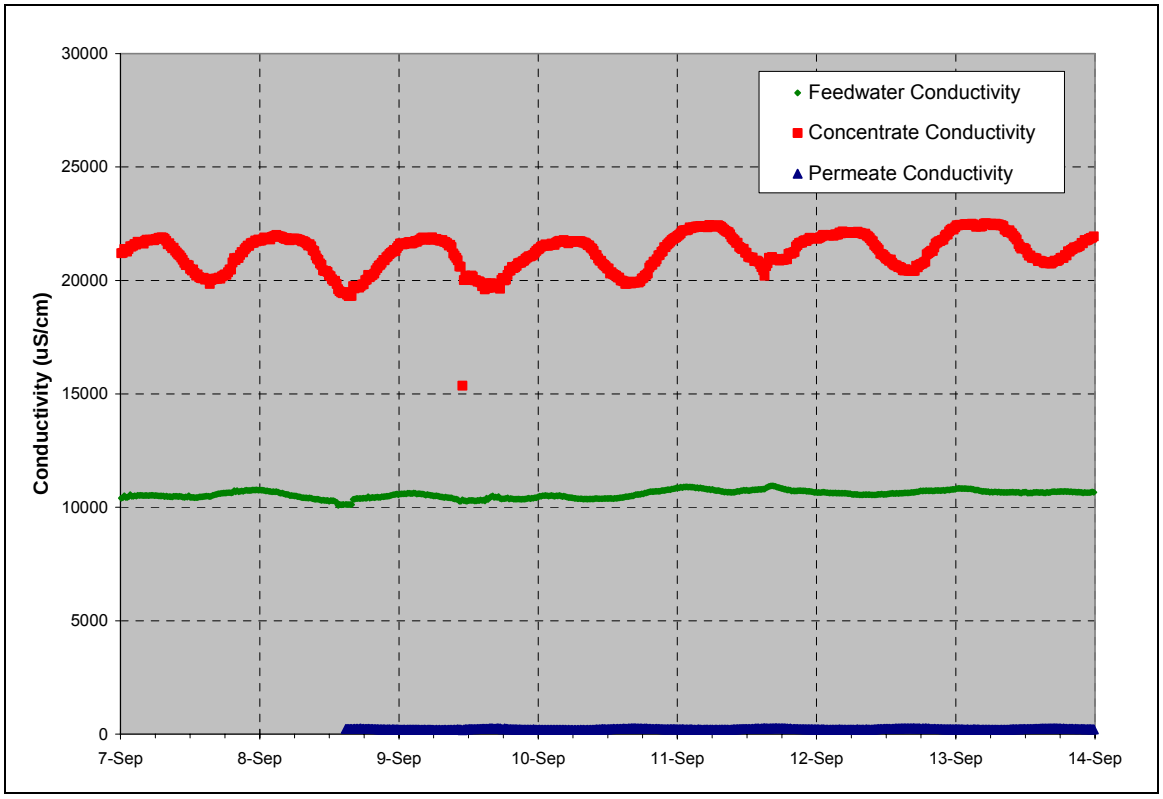


Figure 4- 8 - Normalized Specific Flux, September – December

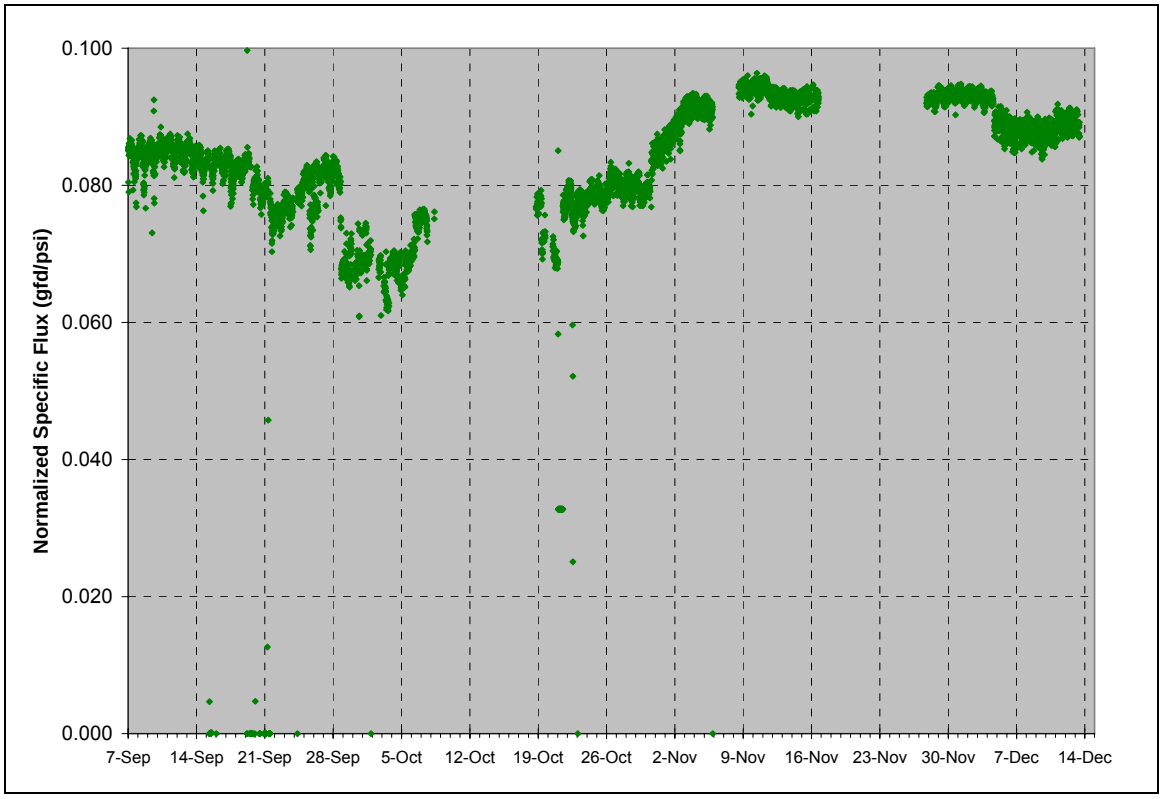


Figure 4- 9 - Normalized Specific Flux September 7 – 14

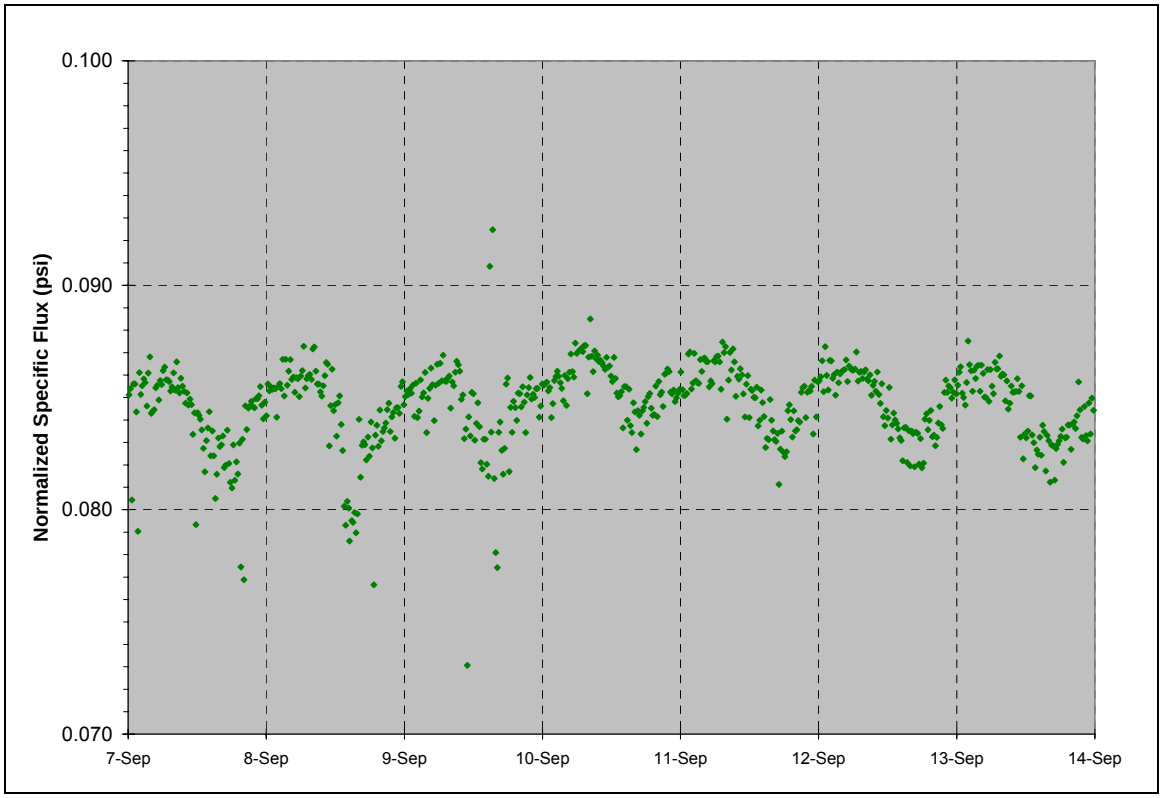


Figure 4- 10 - Cation/Anion Balance

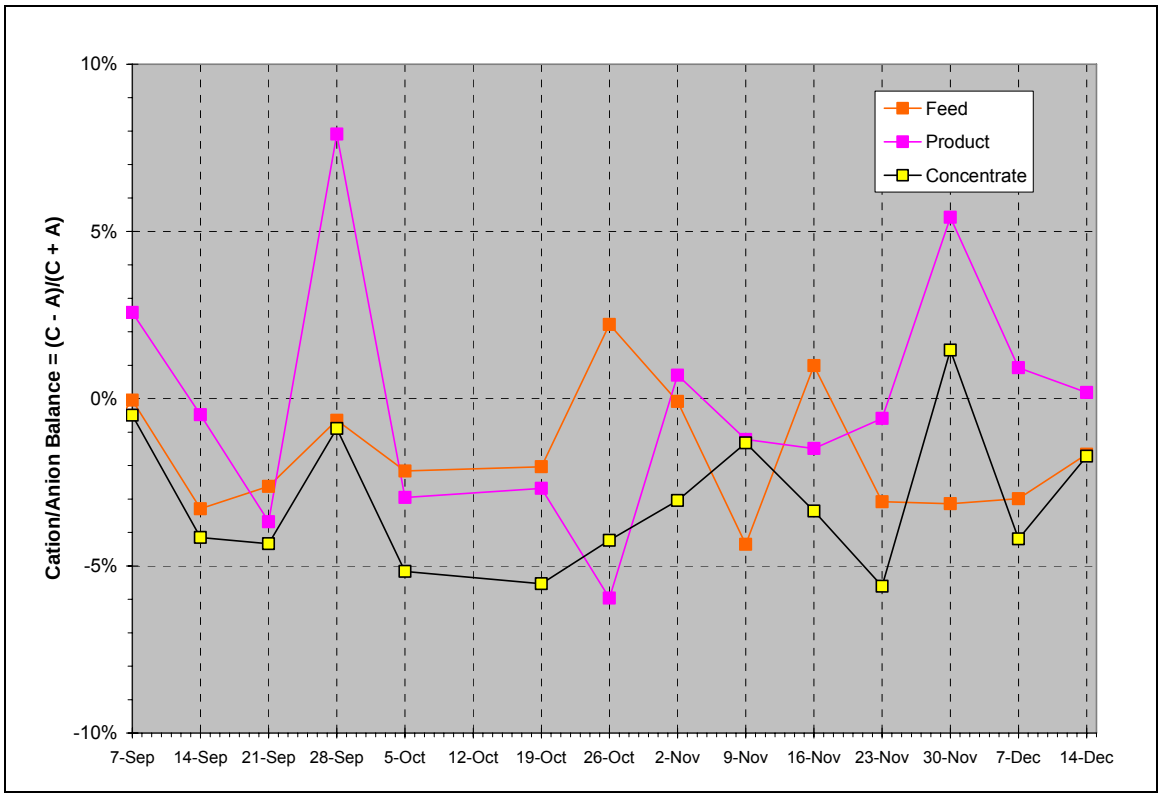


Figure 4- 11 - Ratio of Sum of Ions to TDS

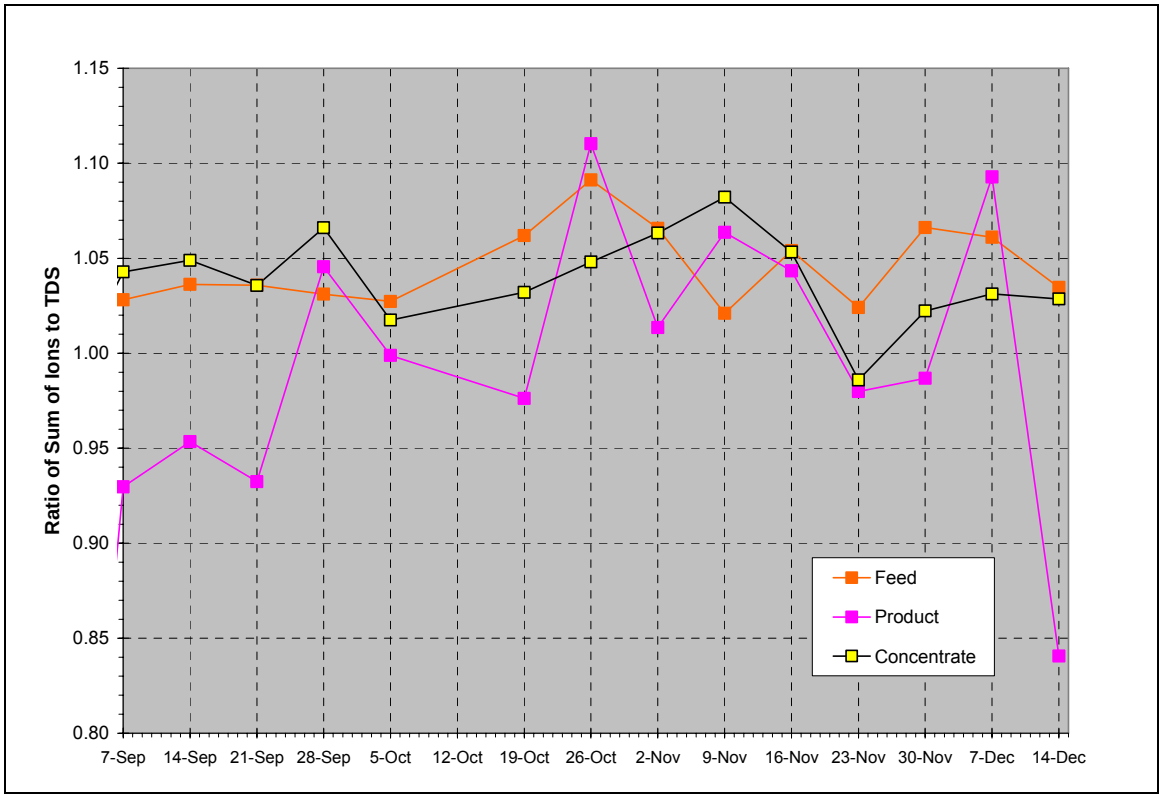


Figure 4- 12 - RO Feedwater Ionic Species Concentrations (mg/L)

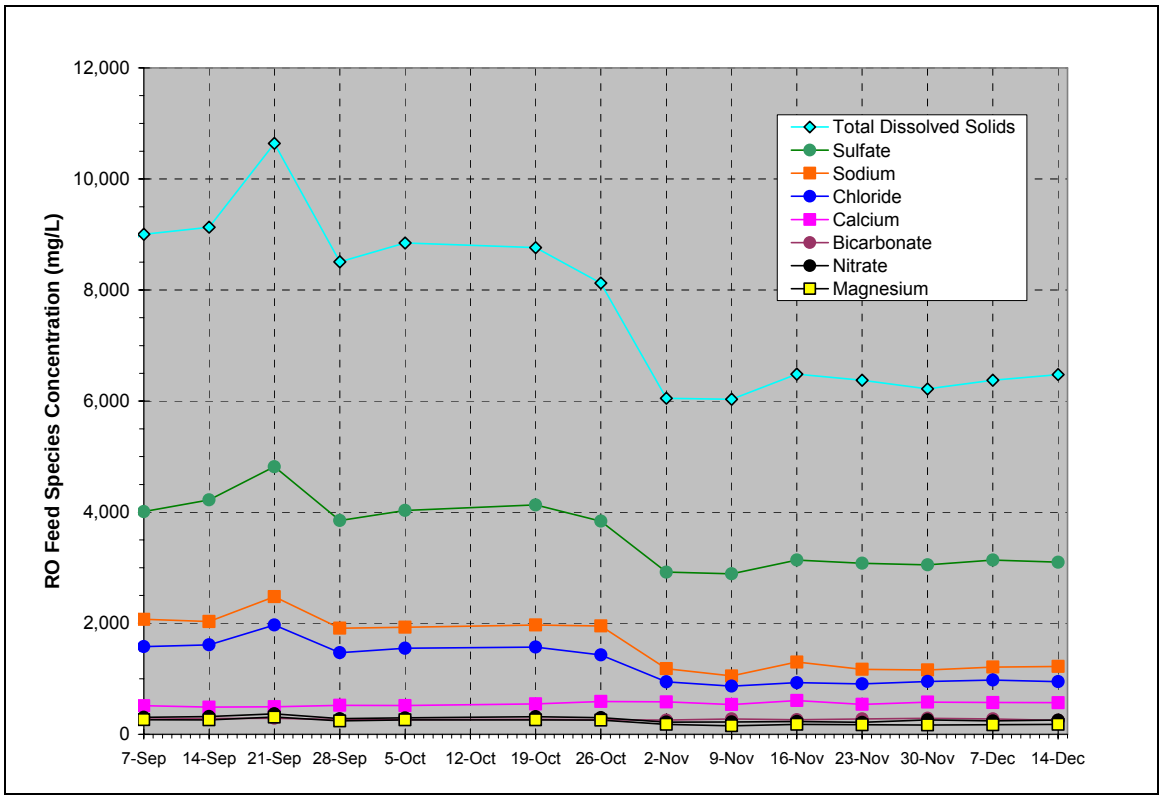


Figure 4- 13 - RO Feedwater Ionic Species Concentrations (meq/L)

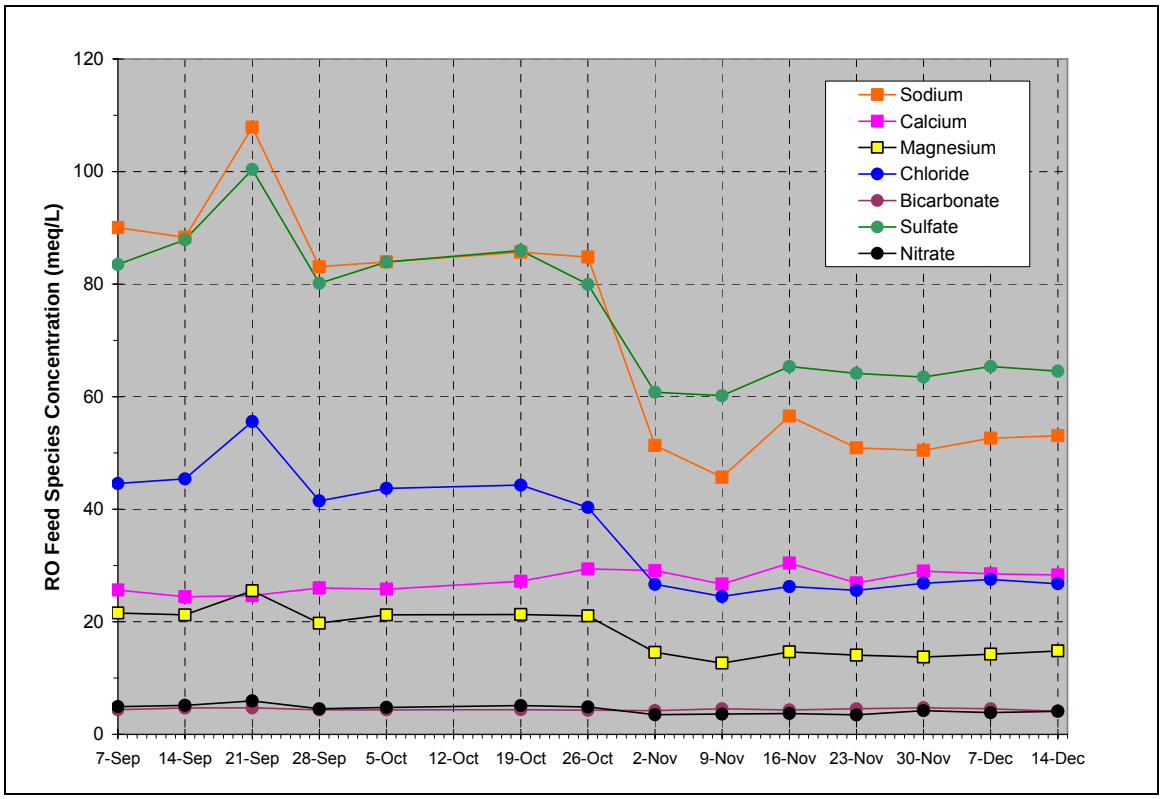


Figure 4- 14 – Ionic Species Concentrations in Product Water (mg/L)

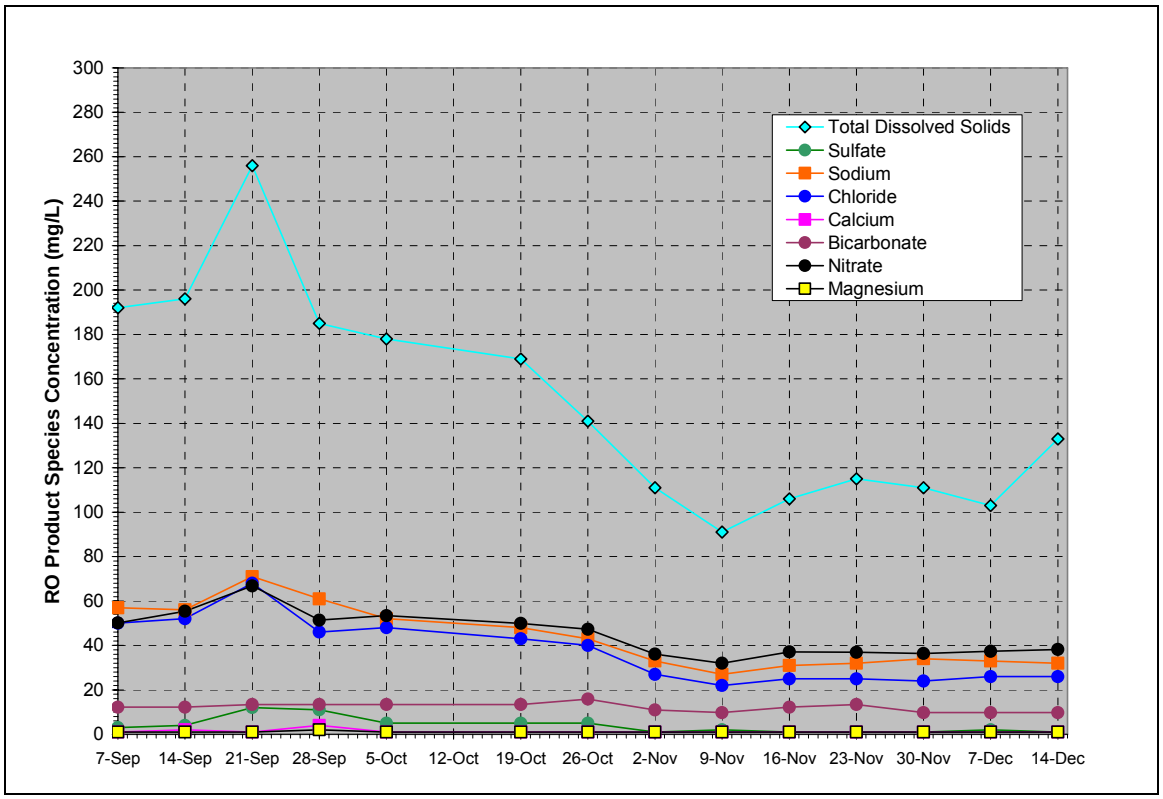


Figure 4- 15 - Ionic Species Concentrations in Product Water (meq/L)

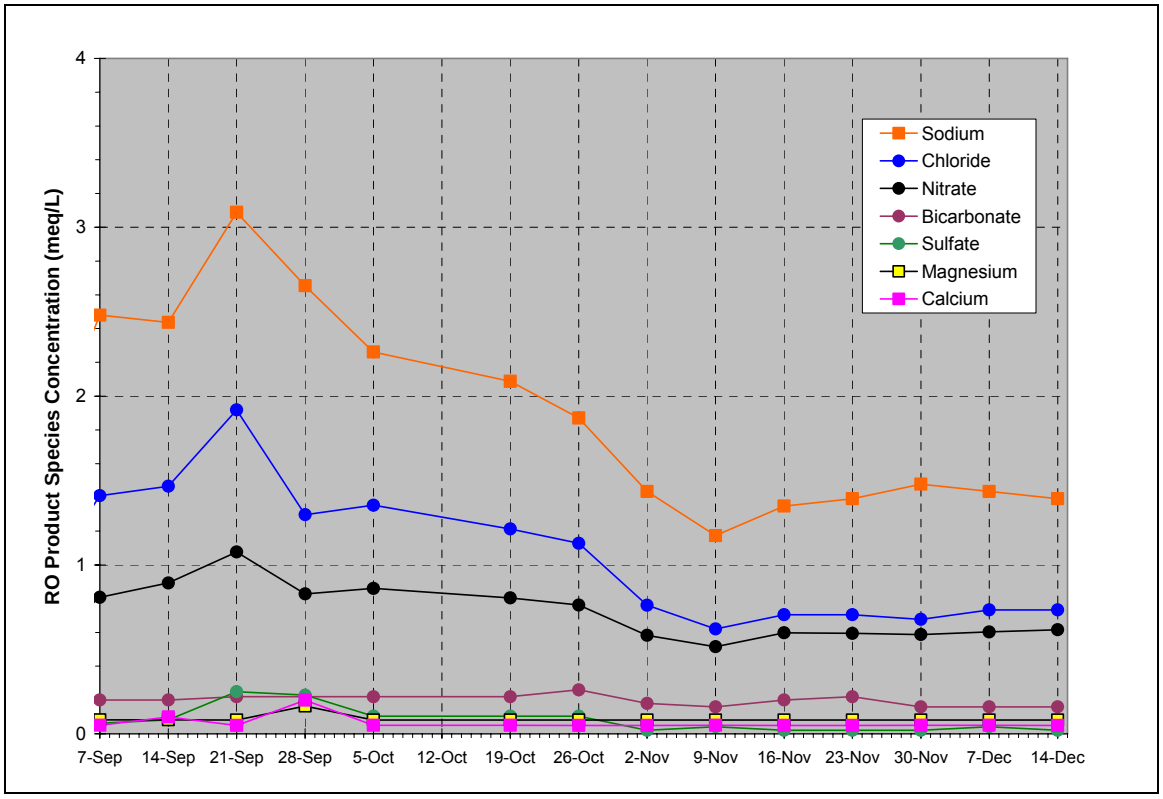


Figure 4- 16 – Ionic Species Concentrations in Concentrate Stream (mg/L)

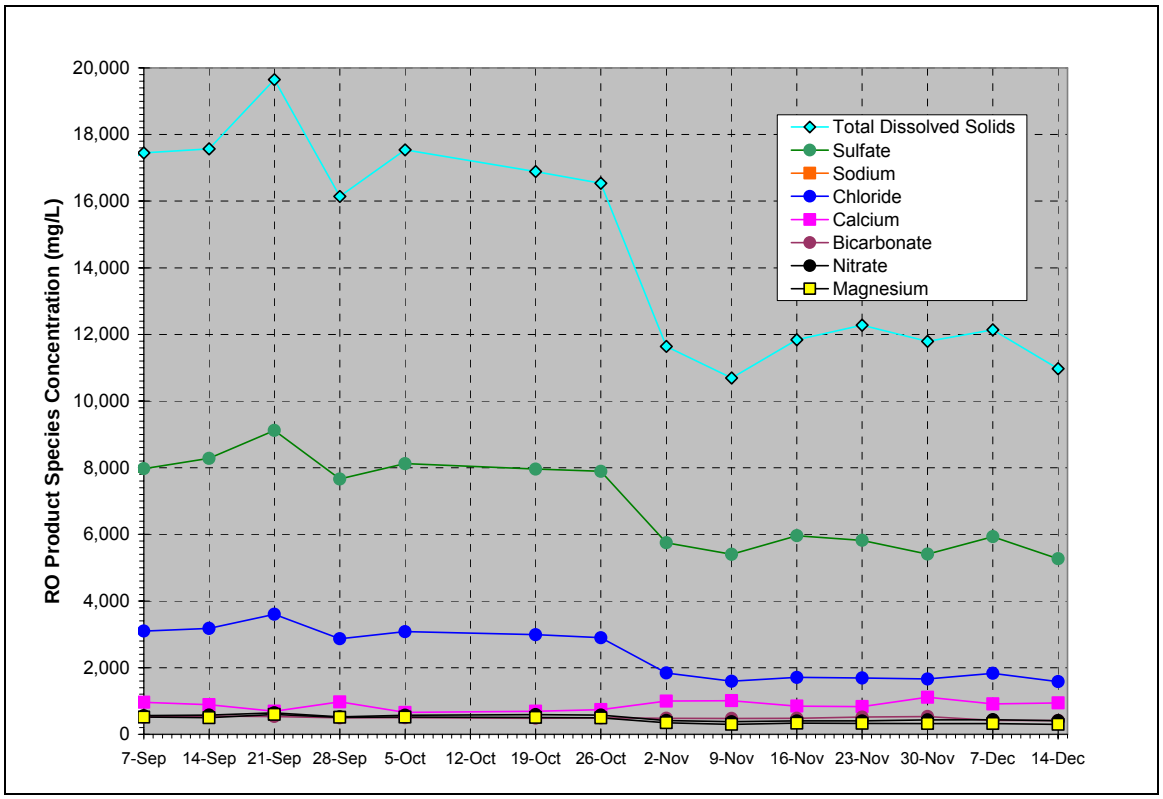


Figure 4- 17 – Ionic Species Concentrations in Concentrate Stream (meq/L)

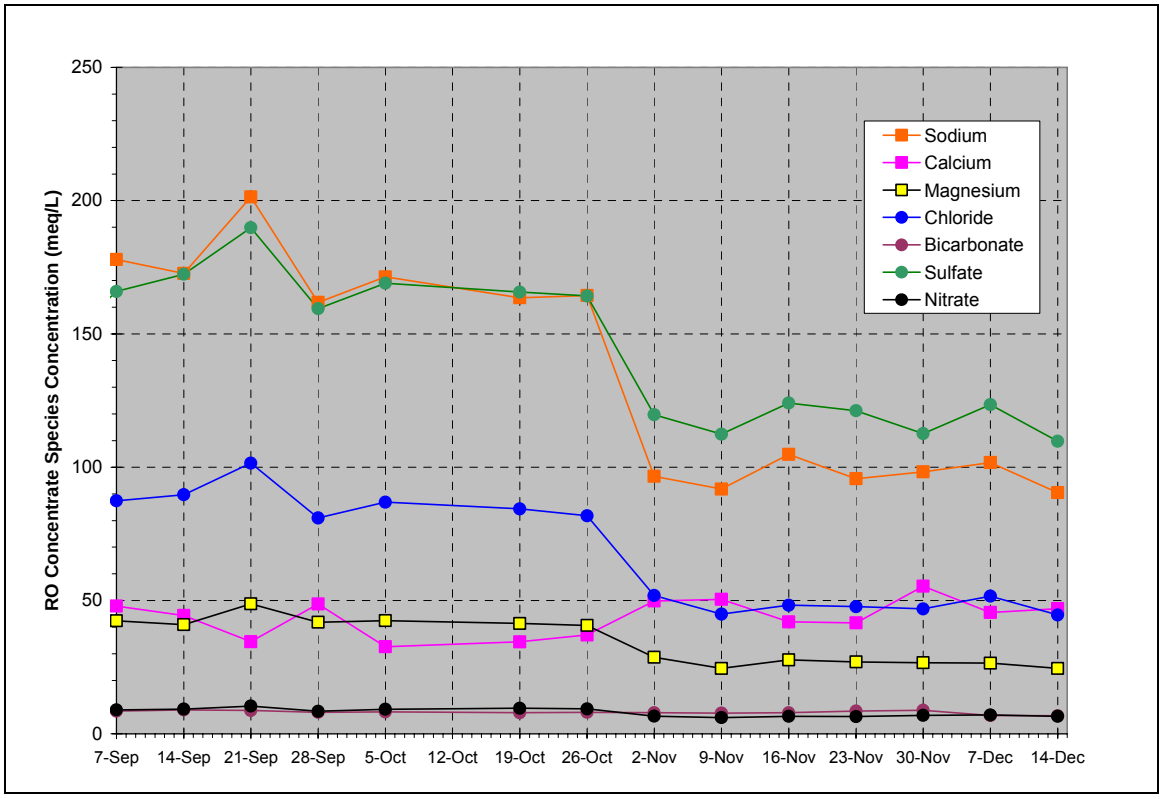


Figure 4- 18 - Total Selenium Concentrations (mg/L)

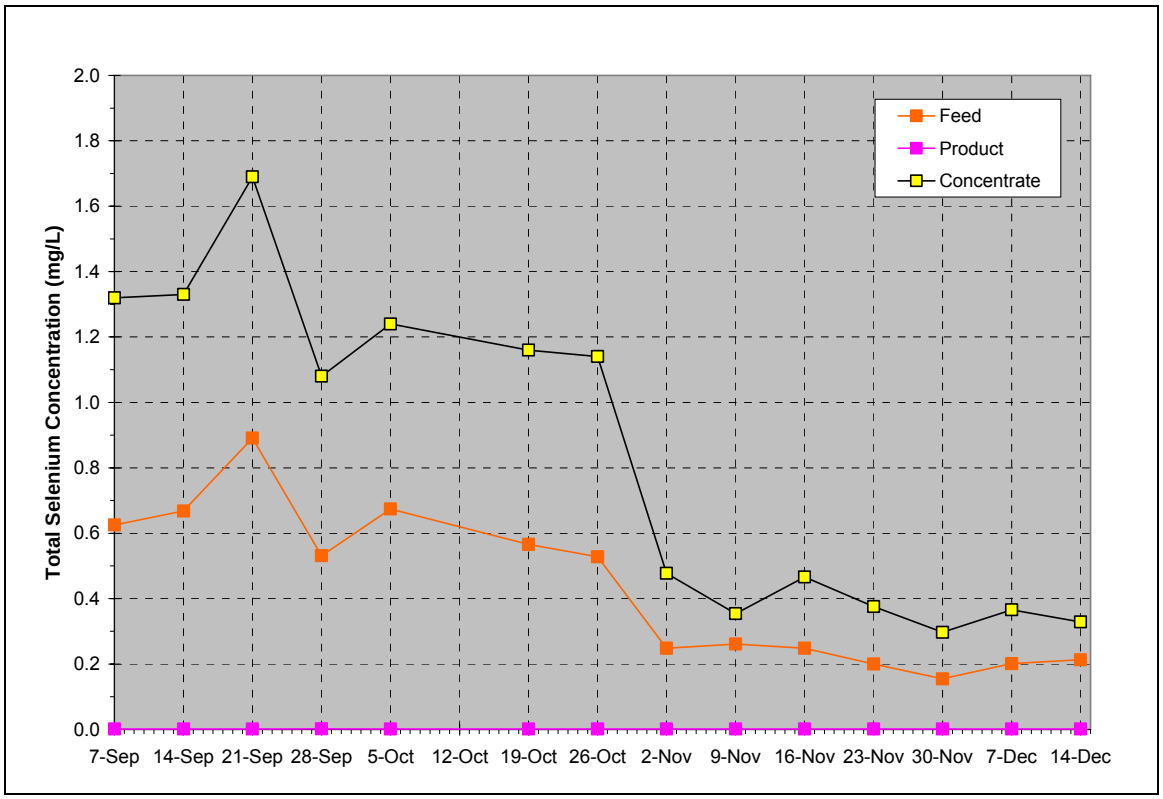


Figure 4- 19 - RO System pH

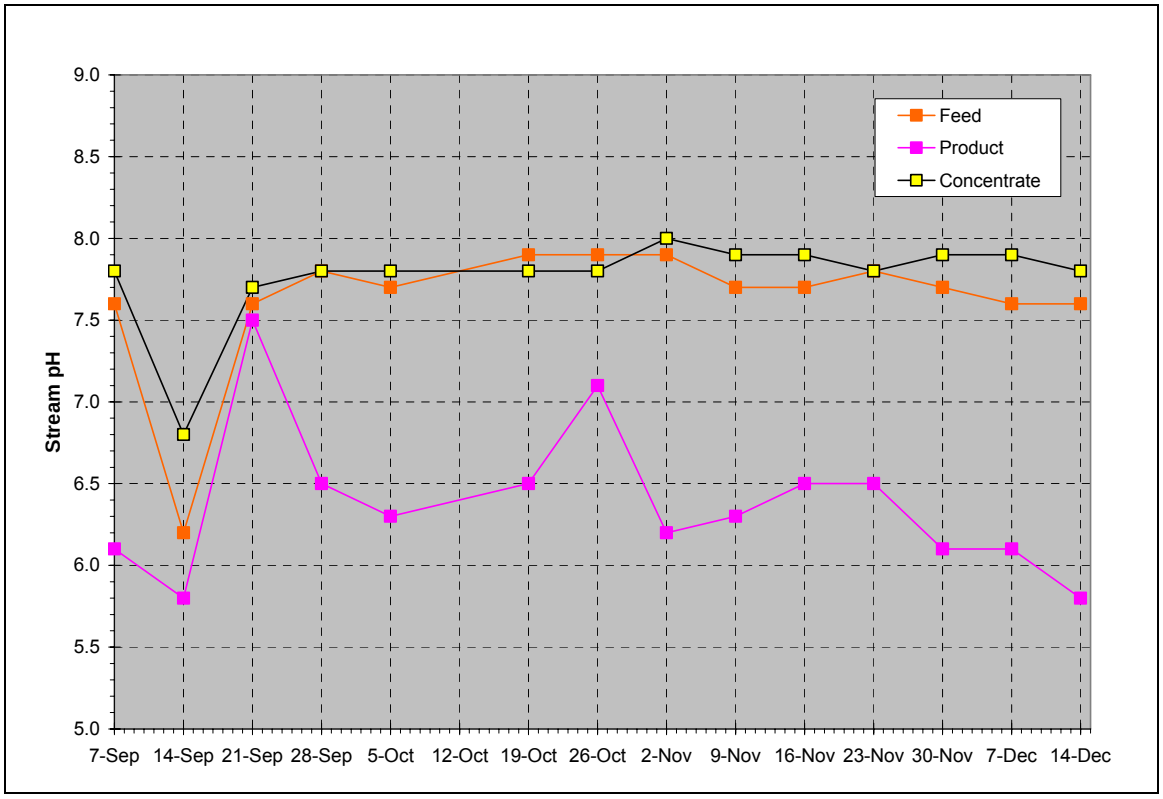


Figure 4- 20 - Ratio of TDS to Conductance

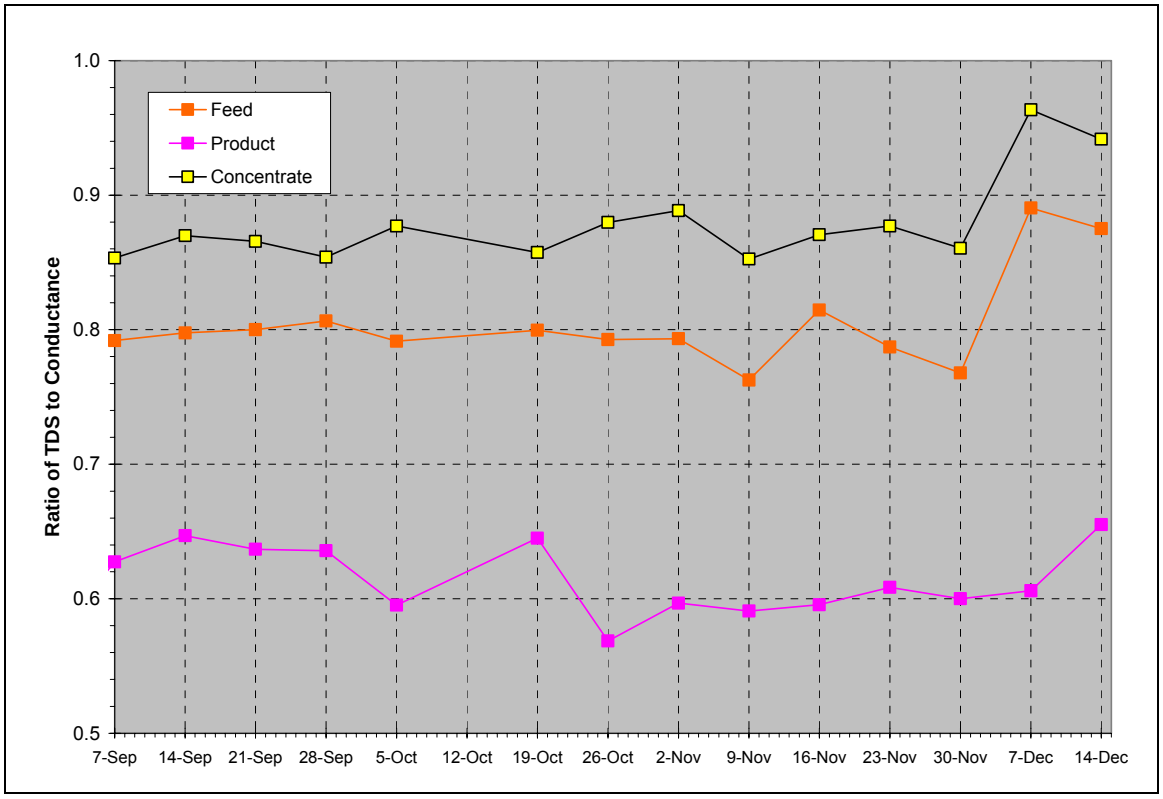


Figure 4- 21 - Mass Balance of Ions Across Membrane System

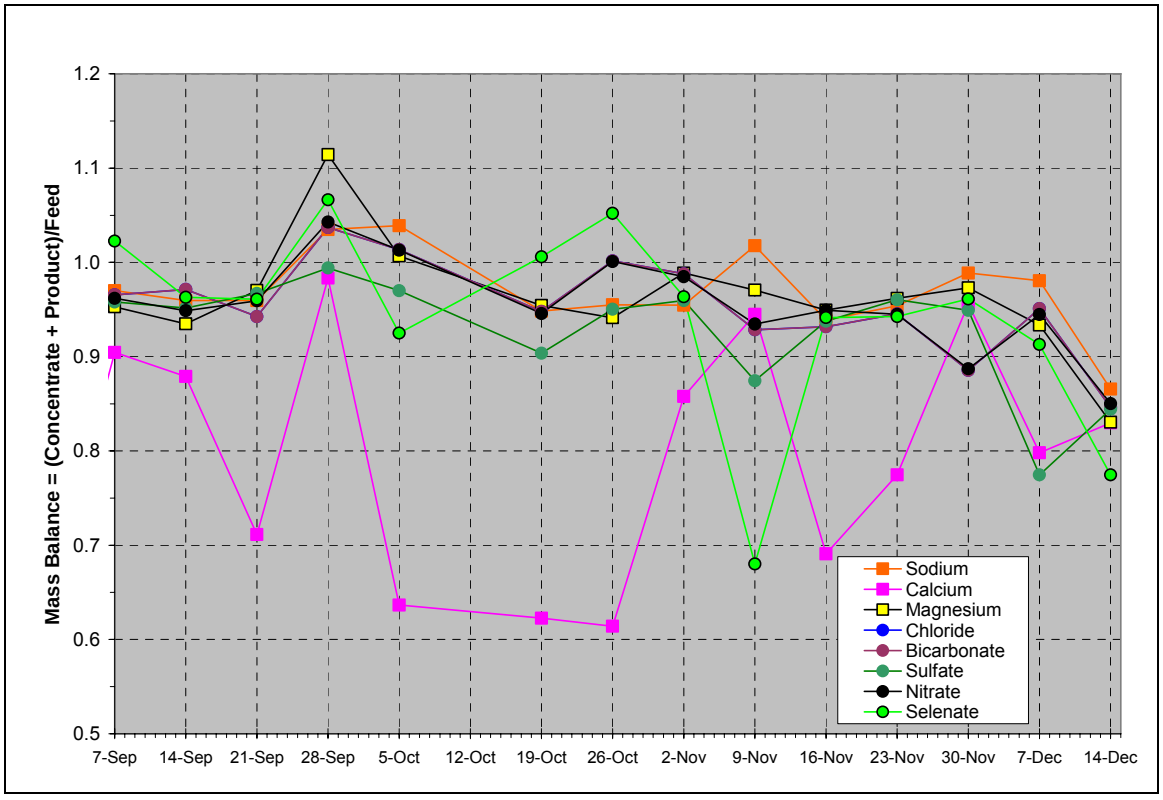
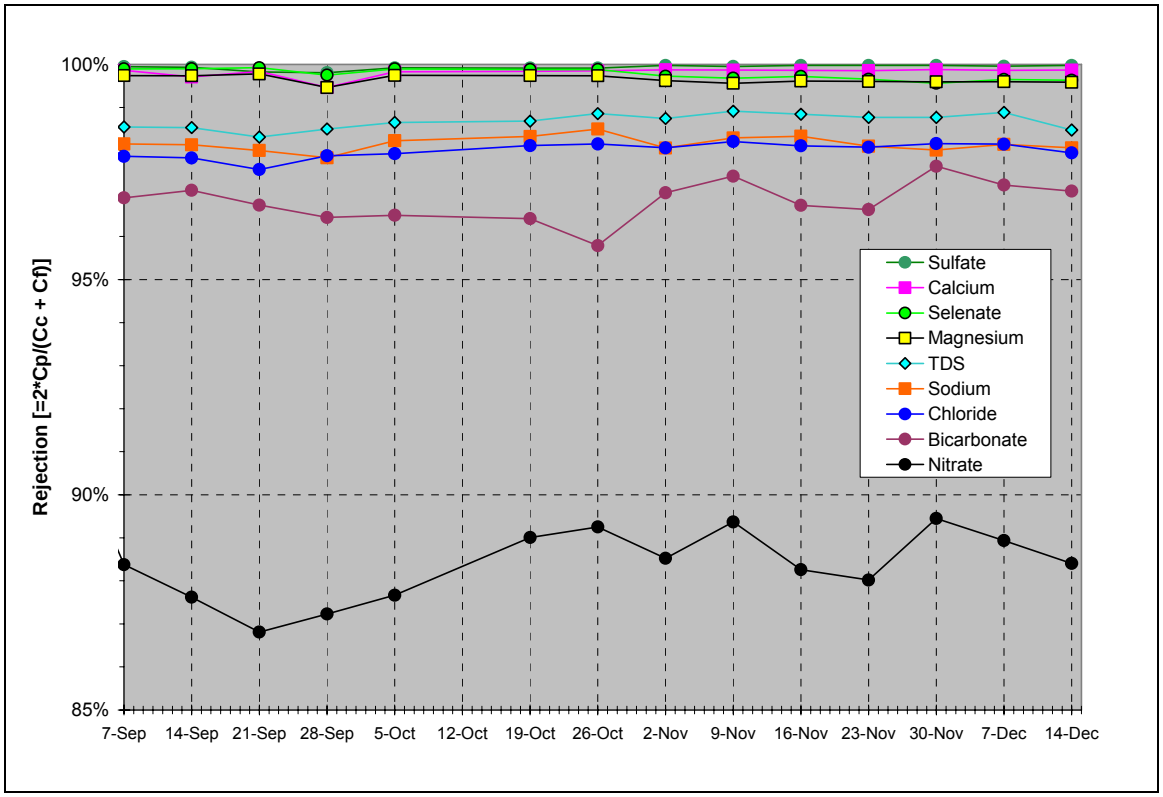


Figure 4- 22 – Rejection of Dissolved Ions



4.3 Summary of other Field Data

Other field data collected during the RO pilot included turbidity of the three process streams and Silt Density Index (SDI) of the pretreatment filtrate. Turbidity was measured on a weekly basis and is summarized in table 4-11.

Table 4- 11 - System Turbidities

Date	Feedwater (NTU)	Product (NTU)	Concentrate (NTU)
Average	0.52	0.23	0.40
Min	0.21	0.12	0.19
Max	1.80	0.55	0.95

SDI measurements of the multimedia filter effluent were measured periodically throughout the pilot. Table 4-12 summarizes the dates of the measurements, the plugging factor and the SDI_{15} values. The average SDI_{15} was 1.8 and varied from a low of 1.2 to a high of 2.6. SDI_{15} values were to be maintained below 4.0. The frequency of backwashing the multimedia filter was once per week.

Table 4- 12 - SDI Test Results

Date	Time Initial (sec)	Time Final (sec)	Plugging Factor (%)	SDI 15
9/7/04	24.0	39.0	38.46	2.6
9/14/04	26.0	33.0	21.21	1.4
9/17/04	24.0	34.0	29.41	2.0
9/18/04	25.0	33.0	24.24	1.6
9/24/04	31.7	40.9	22.45	1.5
9/25/04	24.0	33.0	27.27	1.8
9/28/04	25.0	33.0	24.24	1.6
10/2/05	24.0	36.0	33.33	2.2
10/5/04	26.0	35.0	25.71	1.7
10/18/04	25.0	35.0	28.57	1.9
10/19/05	23.0	32.0	28.13	1.9
10/23/04	26.0	36.0	27.78	1.9
10/30/04	22.0	35.0	37.14	2.5
11/2/04	27.0	33.0	18.18	1.2
11/9/04	25.0	34.0	26.47	1.8
11/14/04	24.0	34.0	29.41	2.0
11/16/04	27.0	36.0	25.00	1.7
11/19/04	26.0	34.0	23.53	1.6
12/7/04	25.0	31.0	19.35	1.3
Average			26.84	1.8
Min			18.18	1.2
Max			38.46	2.6

4.4 Membrane Autopsy

Due to the potential of scale formation of calcium carbonate or calcium sulfate on the membrane elements, an autopsy to obtain visual data on scale deposition was performed at the conclusion of the pilot test. The lead element and the trailing element (of the six elements in series) were removed from the test unit and autopsied. Results of the autopsy are presented in Appendix B. In general, no significant deterioration of the elements over the period of testing was detected. The general condition of the elements was sound, the membrane surface was intact, and the glue lines were satisfactory. No noticeable calcium sulfate or calcium carbonate scaling were detected, therefore the cause of the low calcium mass balance (in Table 4-9) remains undetermined.

5.0 CONCLUSIONS, FINDINGS AND RECOMMENDATIONS

5.1 Conclusions and Findings

The RO pilot at Panoche operated from September to December 2004. Based on the four months of pilot data, the following conclusions and findings can be made:

- The RO system was operated at a recovery of about 50%. A summary of the average feed, product and concentrate concentrations are given in Table 5-1. Based on a 50% recovery, average concentration of TDS in the product water was 153 mg/L. Divalant species (calcium, magnesium and sulfate) concentrations were reduced to below 5 mg/L in the product water. Monovalant species (sodium, chloride, and nitrate) were reduced below 50 mg/L in the product water. The average bicarbonate concentration was 12 mg/L, while the average selenium concentration was 1.1 µg/L in the product water. The average boron concentrations in the feedwater and product water were 19.5 and 11.3 mg/L, respectively. In general, the Hydranautics XLFC-1 membranes were not as effective in removing boron (about 41% removal efficiency) as they were on the other constituents. For most species, the concentrations in the concentrate stream roughly doubled from the feedwater concentration, which is expected for operation at 50% recovery.

Table 5- 1 - Average Ion Concentrations

Species	Feed	Product	Concentrate
Sodium (mg/L)	1,633	42.9	3,153
Calcium (mg/L)	544	1.3	858
Magnesium (mg/L)	218	1.1	424
Chloride (mg/L)	1,278	36.7	2,439
Bicarbonate (mg/L)	270	12.2	495
Sulfate (mg/L)	3,612	3.8	6,891
Nitrate (mg/L)	271	43.8	493
TDS (mg/L)	7,702	152.7	14,646
Boron (mg/L)	19.5	11.3	25.5
Selenium (µg/L)	437	1.1	850

- The RO system at Panoche ran for 2,042 hours with pretreatment limited to a multimedia filter and a cartridge filter. The GE Betz Dearborn, MDC22 chemical anti-scalant, appeared to avert any serious scaling problems during the 4 month pilot.

- The average SDI value for the multimedia filter filtrate, backwashed on a weekly basis was 1.8.

5.2 Future Work

The Panoche RO pilot provided valuable data for the design of future RO systems. A second RO pilot is recommended to evaluate the following:

- RO system recoveries greater than 50%: A new dendrimer-based antiscalant developed by Professional Water Technologies will be tested at a recovery of 64%.

- The RO pilot skid should be modified to provide a 2:1 array of membranes to operate at recoveries greater than 50%.

6.0 REFERENCES

Boyle Engineering (2004), *Red Rock Ranch RO Pilot Report*, Boyle Engineering Corporation, Bakersfield, CA

USBR(2004), *Selenium and Nitrate Removal from Agricultural Drainwater in the San Joaquin Valley, California, Phase II Pilot Study November 2003 – November 2004*, United States Dept. of Interior, Bureau of Reclamation, Technical Service Center, Water Treatment Engineering and Research Group.

APPENDIX A – Water Quality Data

Table A - 3
Bryte Laboratory Analysis for Panoche WD RO Pilot
11/23/04 - 12/14/04

Bryte Laboratory Analyses for Panoche WD Desalting Project
11/23/04 - 12/14/04

			Feed	Permeate	Concentrate	Filtrate	Feed	Permeate	Concentrate	Filtrate	Feed	Permeate	Concentrate	Filtrate	Feed	Permeate	Concentrate	Filtrate
			FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204
			B0982	B0983	B0984		B0996	B0997	B0998		B1057	B1058	B1059		B1089	B1090	B1075	B1091
		Collection Date:	11/23/2004	11/23/2004	11/23/2004	11/23/2004	11/30/2004	11/30/2004	11/30/2004	11/30/2004	12/7/2004	12/7/2004	12/7/2004	12/7/2004	12/14/2004	12/14/2004	12/14/2004	12/14/2004
Analyte		**Units**				None				None				None				
	EC	uS/CM	8100	189	14000		8100	185	13700		7160	170	12600		7400	203	11650	
Dissolved	Ammonia	mg/L as N													<.01	0.02	<.01	
Dissolved	Bicarbonate	mg/L as CaCO3	227	11	425		236	8	440		227	8	419		205	8	338	
Dissolved	Boron	mg/L													14.2	8.8	17.8	
Dissolved	Calcium	mg/L	539	<1	834		581	1	1110		572	1	912		567	<1	940	
Dissolved	Carbonate	mg/L	1	<1	3		1	<1	4		1	<1	3		1	<1	2	
Dissolved	Chloride	mg/L	907	25	1690		951	24	1660		976	26	1830		949	26	1580	
Dissolved	Hardness	mg/L as CaCO3																
Dissolved	Hydroxide	mg/L as CaCO3	<1	<1	<1		<1	<1	<1		<1	<1	<1		<1	<1	<1	
Dissolved	Magnesuim	mg/L	171	<1	328		167	<1	324		173	<1	322		180	<1	298	
Dissolved	Nitrate	mg/L	214	36.9	402		260	36.4	430		239	37.4	437		254	38.2	405	
Dissolved	Nitrate+Nitrite	mg/L as N																
Dissolved	Organic Carbon														4	0.1	7.7	
Dissolved	Potassium	mg/L													3.4	<.5	<10	
Dissolved	Selenium	mg/L	0.2	<.001	0.376		0.135	<.001	0.32		0.197	<.001	0.366		0.213	<.001	0.329	
Dissolved	Silica	mg/L													27.2	0.5	46.2	
Dissolved	Sodium	mg/L	1170	32	2200		1160	34	2260		1210	33	2340		1220	32	2080	
Dissolved	Sulfate	mg/L	3080	1	5820		3050	1	5410		3140	2	5930		3100	1	5270	
	pH	pH units	7.8	6.5	7.8		7.7	6.1	7.9		7.6	6.1	7.9		7.6	5.8	7.8	
Total	Alkalinity	mg/L as CaCO3	228	11	428		237	8	443		228	8	422		206	8	340	
Total	Arsenic	mg/L													<.01	<.001	<.01	
Total	Barium	mg/L													0.5	<.05	<.5	
Total	Dissolved Solids	mg/L	6376	115	12280		6220	109	11790		6376	103	12140		6476	133	10970	
Total	Iron	mg/L													<.05	<.005	<.05	0.111
Total	Manganese	mg/L													<.05	<.005	<.05	<.05
Total	Organic Carbon	mg/L as C													3.7	0.1	6.9	
Total	Phosphorous	mg/L													0.02	0.01	1.3	
Total	Selenium	mg/L	0.2	<.001	0.39		0.155	<.001	0.297		0.201	<.001	0.372		0.239	<.001	0.345	
Total	Strontium	mg/L													8.71	<.005	14.4	
Total	Suspended Solids	mg/L													2.8	<1	2.8	
	UV254 at nm	absorb/cm													0.108	0.004	0.191	

Field Measurements

Analysis	Unit of Measure	11/23/2004	11/23/2004	11/23/2004	11/23/2004	11/30/2004	11/30/2004	11/30/2004	11/30/2004	12/7/2004	12/7/2004	12/7/2004	12/7/2004	12/14/2004	12/14/2004	12/14/2004	12/14/2004
		Feed (DP25)	Permeate	Concentrate	Filtrate	Feed (DP25)	Permeate	Concentrate	Filtrate	Feed (DP25)	Permeate	Concentrate	Filtrate	Feed (DP25)	Permeate	Concentrate	Filtrate
		Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D	Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D	Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D	Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D
EC	mS/cm	8.68	0.205	13.18	X	8.68	0.206	13.18	X	7.94	0.197	13.71	X	7.93	0.21		7.85
DO	mg/L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	pH unit	8.21	9.4	8.47	X	8.21	9.4	8.47	X	7.81	8.65	7.46	X	7.92	8.64	X	7.51
ORP	mV	19	12	-21	X	19	12	-21	X	2	7	32	X	X	27	X	60
SDI	dimensionless	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temperature	C	17.1	17.9	16.4	X	17.1	17.9	16.4	X	16.8	18.1	18.3	X	18	18.2	X	17.6
Turbidity	NTU	0.61	0.17	0.95	X	0.61	0.17	0.95	X	0.25	0.18	0.19	X	0.35	0.22	X	0.22

Other Field Measurements

Measurement	Unit of Measure	11/23/2004 Feed	11/23/2004 Permeate	11/23/2004 Concentrate	11/30/2004 Feed	11/30/2004 Permeate	11/30/2004 Concentrate	12/7/2004 Feed	12/7/2004 Permeate	12/7/2004 Concentrate	12/14/2004 Feed	12/14/2004 Permeate	12/14/2004 Concentrate
Flow	L p m	23.98	12.08	12.16	23.98	12.08	12.16	23.55	11.23	12.15	23.6	11.05	11.7
Pressure	kPa	1665	974	1323	1665	974	1323	1688	1003	1347	1645		1543
Flow	gpm	6.33	3.19	3.21	6.33	3.19	3.21	6.22	2.96	3.21	6.23	2.92	3.09
Pressure	psi	241.4	141.2	191.8	241.4	141.2	191.8	244.8	145.4	195.3	238.5	0.0	223.7

APPENDIX B - Membrane Autopsy

SPIRAL WOUND MEMBRANE ELEMENT AUTOPSY

PURPOSE AND LOCATION OF AUTOPSY	
Purpose of Autopsy	Completion of Panoche RO Test – Searching for scaling or fouling
Date and Place	December 17, 2004 Reclamation Pilot Plant Laboratory, DFC, Building 56, Room 1755
Date of This Report	December 21, 2004
Names of Observers	Frank Leitz (Recorder) Ken Yokoyama

ELEMENT IDENTIFICATION	
Manufacturer	Hydranautics Water Systems
Element Type	XLFC1-2540
Serial Number	X13180
Element Dimensions	Nominal size: 2.5 inches diameter x 40 inches long Overall leaf width: 36 3/8 inches
Number of Leaves	Two
Size of Leaves (measurements of active area of leaves)	Leaf 1: width: 33 1/8", 33 1/8", 33 1/4". Avg: 33.167" length: 24 7/8", 25", 24 5/8". Avg.: 24.83" area of one side of leaf: 823.6 in.^{2} = 0.53 m^2 Leaf 2: width: 32 7/8", 33", 32 7/8". Avg: 32.917" length: 23", 23 3/8", 23 3/4". Avg.: 23.375" area of one side of leaf: 769.4 in.^{2} = 0.50 m^2 Total active area: 3,186 in.^{2} = 2.06 m^2 Note: Width is measured parallel to the product water tube, length perpendicular to it.

OPERATING HISTORY

The Panoche RO system consisted of two 3-element vessels operated in series, in effect being a single stage 6-element unit. It was operated from August 30 to December 13, with a few interruptions, logging a total of about 2352 hours. It operated at approximately 50% recovery. Details of the operation are provided in the Panoche RO System Operation Report.

DESCRIPTION OF EVENTS LEADING TO AUTOPSY

Because of the possibility of scale formation of calcium carbonate or calcium sulfate scale formation during the testing period, we decided on an autopsy to get visual data on whether there had been any scale deposition and to see what other results the testing had had on the elements. To cover the range of operating conditions, the lead element (of the six elements in series) and the trailing element were removed from the test unit and autopsied.

WET TEST DATA

Test Number	Procedure	Date	Element Rejection %	Product Flow GPD	Product Flux GFD
There are no wet test data for the elements in this group of autopsies.					

SUMMARY OF WET TEST PROCEDURE(S)

N/A

NARRATIVE DESCRIPTION OF AUTOPSY PROCEDURE

Following the test, the unit was rinsed with product water. Our original intention was to rinse and ship the elements with product water. However, a malfunction in the unit that forced shutdown of the unit prematurely left no product water available. The elements were removed, drained and shipped in the original plastic bags in which they had been supplied and a few liters of feed water containing 50 mg/L of sodium bisulfite to prevent biological growth was added to keep the membranes wet.

Each element was shipped in a single heavy bag with the top closed by an ample quantity of duct tape. The bagged element was put in the original shipping box which was relabeled to indicate the correct element number. Element X13180 was described on the box as the trailing element. However, all of the evidence indicates that it was the lead element.

We assumed that the end of the element with the chevron ring was the feed end of the element. The label containing the serial number had a flow arrow. However, the label was applied such that the arrow pointed circumferentially around the element, so the flow arrow was of no use.

The element was wiped dry and inspected. Photographs were taken at various points of the autopsy.

The outer wrap, which appears to be a shrink fit tube, was slit along the axis of the element and removed. The soft shell consisting of spirally applied white wrapping tape, about 2 inches wide, was removed. We tried to unwrap it and eventually gave up and made an axial cut through it and peeled it off.

When the tape was removed, the anti-telescoping devices (ATDs) were removed with a couple of raps of a persuader. The ATD containing the chevron ring was preserved with the ring still in the position in which we found it. The ends of the element were then examined.

The first leaf, arbitrarily selected, was unrolled and labeled “1.” After close inspection of the concave surface of the leaf, with and without the Vexar netting, samples were taken for examination by the scanning electron microscope.

Measurements were taken of the active area.

Pieces were cut for pull tests to determine the strength of the glue line.

Dye tests were run using 0.01% Congo Red solution.

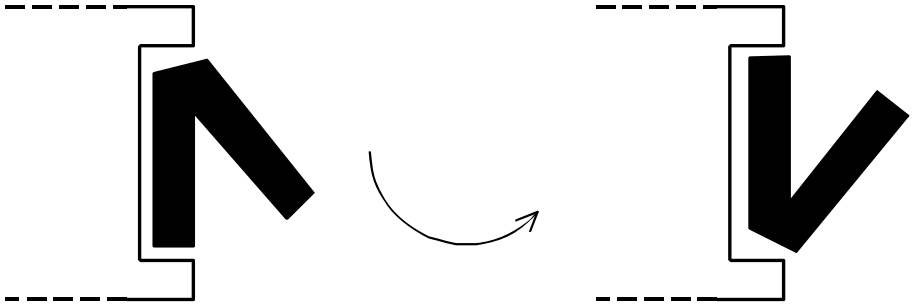
Leaf 2 was then unrolled. Measurements were taken of the active area. An unsuccessful attempt was made to collect the solids on Leaf 2.

What was left of the element was rerolled, inserted back into the shipping bag, sealed and stored in the cooler in case further investigation becomes warranted.

OBSERVATIONS DURING AUTOPSY

The shipping box was dry indicating that there had been little or no leakage of contained water during shipment.

A portion of the chevron ring was turned in its groove. The wing which normally points toward the feed end had become turned so it pointed down the length of the element as diagrammed below. About 110° had been turned. This is shown in Figure 1. In the left of this view one can see the edge of the wing in its proper position. In the center and right of the view, the ring is in the turned position. This sort of displacement of the chevron ring occurs when an element is removed from a vessel in a direction opposite to that of normal insertion and removal.



Normal Position Direction of Rotation Turned Position

The tape which forms the soft shell is still highly adhesive, witness our difficulty in removing it. There were about two layers of tape. Between the tape layers on both ends of the element was a resin filler that smoothed out the transition between the body of the element and the ATDs.

A small amount of foreign material was found on the presumed feed end. This is shown in Figure 2. There was not enough material to quantify the amount or to identify. The long dark piece appeared to be some sort of fiber.

Ken noted a strong irritating odor, which on further inhalation appeared to be ammonia.

The element was fairly tightly rolled, so there was a tendency for leaf to roll itself back up.

The glue lines are about 1 1/2 inches wide all around the leaves.

A fair amount of foreign material was found on the membrane surface and caught up in the Vexar netting. What we saw were small dark particles and a light generalized deposit. These are shown in Figures 3 to 6. Figures 3 and 4 show the feed end of the leaf where the accumulation was heaviest. The edge of the leaf is at the left of the photo. In Figure 3 the Vexar is still in place and in Figure 4 it has been removed. Figures 5 and 6 show the reject end of the leaf. These are indistinct since there was not enough contrast (or dark material) for the camera to focus on. The intensity of the deposits decreased from the feed end to the reject end. While the easily visible larger particles seemed randomly distributed, the light deposit seemed to have settled against the strands of the Vexar so that

OBSERVATIONS DURING AUTOPSY- continued

the pattern of the Vexar is clearly discernable. The intensity of the deposits decrease from the feed end to the reject end. While the easily visible larger particles seemed randomly distributed, the light deposit seemed to have settled against the strands of the Vexar so that the pattern of the can easily be seen on the membrane (Figure 4)

During pull tests, by hand, of pieces about 1 1/2 inches in width, the membrane was usually peeled with some effort from the product water collector. In a minority of cases, the membrane tore before it was completely removed.

The dye test with Congo Red produced some unusual results. In no case was either pin hole or general leakage through the dense membrane layer noted. The support side of the membrane remained unaffected by the dye. As is usually the case with TFC membranes, the dye left a pale pink stain on the membrane surface. What was unusual is that if the membrane surface was untouched before the dye was applied (by pouring), the pattern of the Vexar, and consequently of the foulant, appeared in the pattern of the dye. The dye appears to react with the foulant. If the membrane surface was cleaned before application of the dye, either with water or with water and detergent, then the membrane was evenly stained, less so when the membrane was cleaned with detergent than when it was cleaned just with deionized water. The surface of the membrane was faintly acidic. As the dye spread out over the surface, the edge of the dye puddle darkened, not to the blue that Congo Red turns below a pH of 3, but darker than it is at a pH above 5.

Nothing unusual or different was observed on the convex sides of either leaf.

We found no indication of calcium sulfate or calcium carbonate scales.

TESTS PERFORMED AFTER AUTOPSY
Test and Test Objective: SEM analysis of samples of membrane showing foreign material to ascertain physical appearance and, possibly, chemical identification of foulant materials.
Organization Performing Test: D-8340
Date:
Observations from Test:

Test and Test Objective:
Organization Performing Test:
Date:
Observations from Test:

DISCUSSION and *CONCLUSIONS*

From the presence and distribution of foreign material on the feed end and the membrane surface, it is clear that *this is the lead element* in a unit. It is not so clear whether there is enough material to affect the flux of the membrane. That really depends on what the material is and is probably better determined by examination of the performance data. However, a unit operated on this feedwater would probably need to be cleaned at some time.

We did not find any significant deterioration of the element over the period of testing. The general condition was sound, the membrane surface was intact, the glue lines were satisfactory, The white wrapping tape was still very adhesive and the ATDs were strong. The displacement of the chevron ring probably occurred when the element was removed from the vessel.

The apparent reaction between Congo Red and the foulant suggests that *the foulant may be organic*, at least in part.

We have not determined what causes the apparent loss in calcium that is observed in the analyses of the flows in and out of the unit.

The orientation of the label with the flow arrow pointing circumferentially is annoying. This may mean that it is irrelevant which way the element is inserted into a vessel. If that were the case it would be better not to have a flow arrow at all.

PHOTOGRAPHS

Figure 1. View of Turned Portion of Chevron Ring

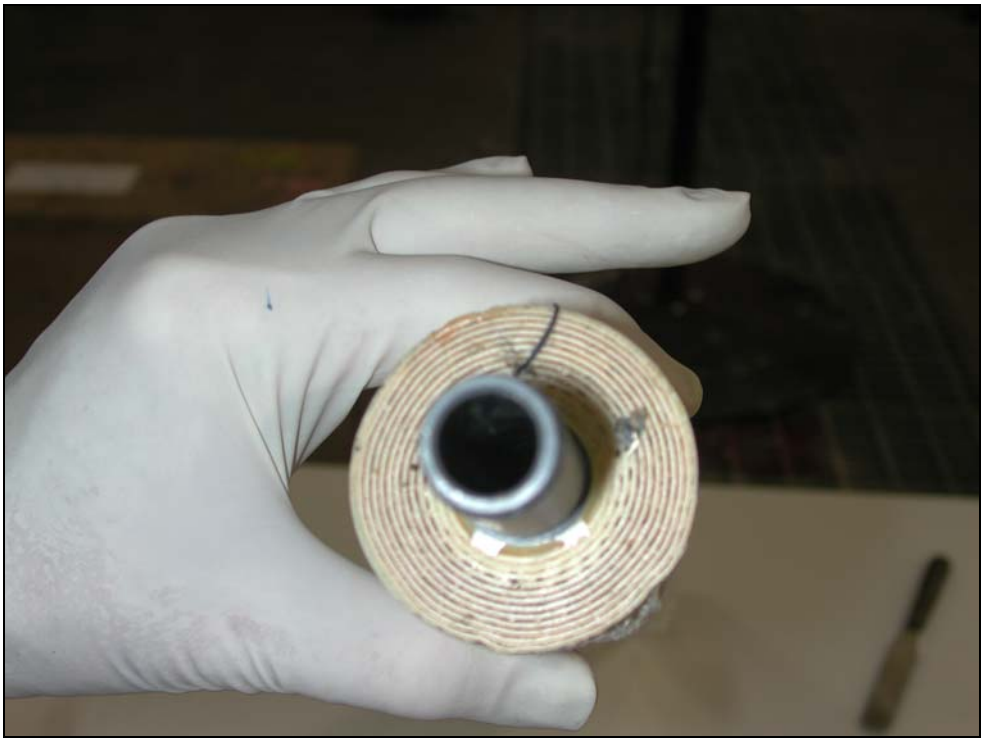


Figure 2. View of Foreign Material on Feed End of Element

PHOTOGRAPHS

Figure 3. View of Feed End of Leaf Showing Foreign Material in Vexar Spacer

Figure 4. View of Feed End of Leaf Showing Foreign Material on Membrane without Vexar

PHOTOGRAPHS

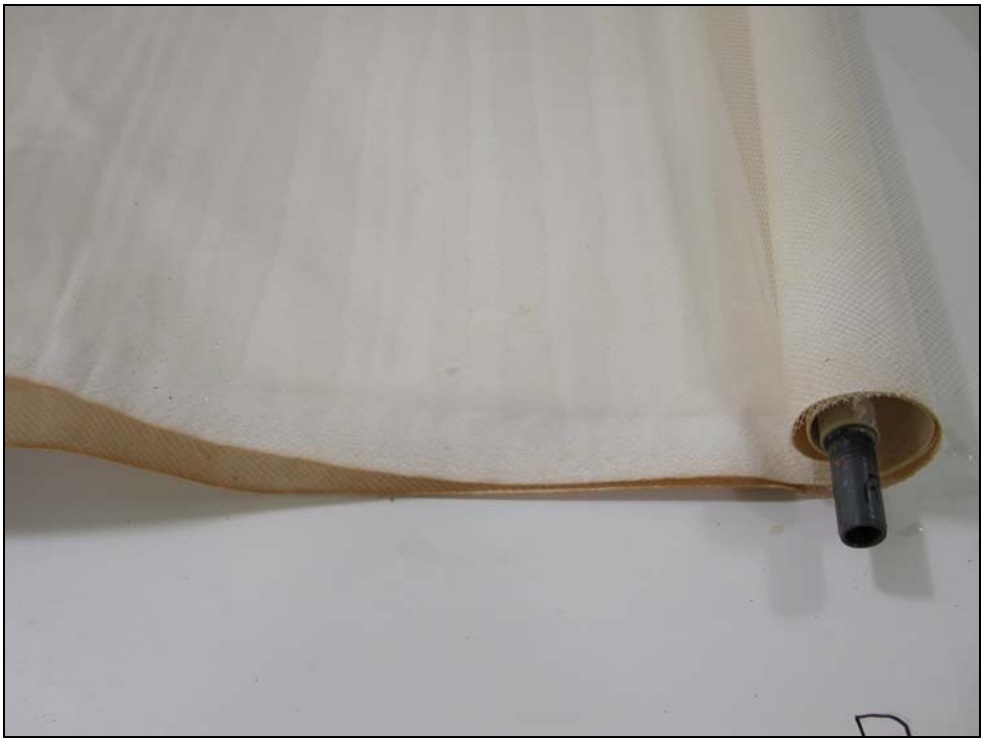


Figure 5. View of Reject End of Leaf

Figure 6. Another View of Reject End of Leaf

PURPOSE AND LOCATION OF AUTOPSY	
Purpose of Autopsy	Completion of Panoche RO Test – Searching for scaling or fouling
Date and Place	December 17, 2004 Reclamation Pilot Plant Laboratory, DFC, Building 56, Room 1755
Date of This Report	December 21, 2004
Names of Observers	Frank Leitz (Recorder) Ken Yokoyama

ELEMENT IDENTIFICATION	
Manufacturer	Hydranautics Water Systems
Element Type	XLFC1-2540
Serial Number	**X13182**
Element Dimensions	Nominal size: 2.5 inches diameter x 40 inches long Overall leaf width: 36 3/8 inches
Number of Leaves	Two
Size of Leaves (measurements of active area of leaves)	Leaf 1: width: 33", 33 1/8", 29 3/4". Avg: 31.958" length: 24 3/8", 24 5/8", 24 1/4". Avg.: 24.417" area of one side of leaf: 780.3 in.^{2} = 0.50 m^2 Leaf 2: width: 33 1/8", 33 1/4", 31 1/4". Avg: 32.542" length: 24 1/8", 24 1/4", 24 5/8". Avg.: 24.333" area of one side of leaf: 791.8 in.^{2} = 0.51 m^2 Total active area: 3,144 in.^{2} = 2.02 m^2 Note: Width is measured parallel to the product water tube, length perpendicular to it.

OPERATING HISTORY

The Panoche RO system consisted of two 3-element vessels operated in series, in effect being a single stage 6-element unit. It was operated from August 30 to December 13, with a few interruptions, logging a total of about 2,352 hours. It operated at approximately 50% recovery. Details of the operation are provided in the Panoche RO System Operation Report.

DESCRIPTION OF EVENTS LEADING TO AUTOPSY

Because of the possibility of scale formation of calcium carbonate or calcium sulfate scale formation during the testing period, we decided on an autopsy to get visual data on whether there had been any scale deposition and to see what other results the testing had had on the elements. To cover the range of operating conditions, the lead element (of the six elements in series) and the trailing element were removed from the test unit and autopsied. This element is believed to be the trailing element.

WET TEST DATA

Test Number	Procedure	Date	Element Rejection %	Product Flow GPD	Product Flux GFD
There are no wet test data for the elements in this group of autopsies.					

SUMMARY OF WET TEST PROCEDURE(S)

N/A

NARRATIVE DESCRIPTION OF AUTOPSY PROCEDURE

Following the test, the unit was rinsed with product water. Our original intention was to rinse and ship the elements with product water. However, a malfunction in the unit that forced shutdown of the unit prematurely left no product water available. The elements were removed, drained and shipped in the original plastic bags in which they had been supplied and a few liters of feed water containing 50 mg/L of sodium bisulfite to prevent biological growth was added to keep the membranes wet.

Each element was shipped in a single heavy bag with the top closed by an ample quantity of duct tape. The bagged element was put in the original shipping box which was relabeled to indicate the correct element number. Element X13182was described on the box as the lead element. However, all of the evidence indicates that it was the trailing element.

We assumed that the end of the element with the chevron ring was the feed end of the element. The label containing the serial number had a flow arrow. However, the label was applied such that the arrow pointed circumferentially around the element, so the flow arrow was of no use. This is shown in Figure 1. The element was wiped dry and inspected. Photographs were taken at various points of the autopsy.

The outer wrap, which appears to be a shrink fit tube, was slit along the axis of the element and removed. The soft shell consisting of spirally applied white wrapping tape, about 2 inches wide, was removed. Acting on the experience from the other element, we made an axial cut through it and peeled it off.

When the tape was removed, the anti-telescoping devices (ATDs) were removed with a couple of raps of a persuader. The chevron ring was removed from the ATD, inspected and strength tested. The ends of the element were then examined.

The first leaf, arbitrarily selected, was unrolled and labeled “1.” After close inspection of the concave surface of the leaf, with and without the Vexar netting, samples were taken for examination by the scanning electron microscope.

Measurements were taken of the active area.

Pieces were cut for pull tests to determine the strength of the glue line.

Dye tests were run using 0.01% Congo Red solution.

Leaf 2 was then unrolled. Measurements were taken of the active area. There was not enough material on the leaves to collect the solids.

What was left of the element was rerolled, inserted back into the shipping bag, sealed and stored in the cooler in case further investigation becomes warranted.

OBSERVATIONS DURING AUTOPSY

The shipping box was dry indicating that there had been little or no leakage of contained water during shipment.

When the bag was first opened, Ken checked for odor. There was an strong odor of ammonia.

The chevron ring was in its proper position.

The tape which forms the soft shell is still highly adhesive. There were about two layers of tape. Between the tape layers on both ends of the element was a resin filler that smoothed out the transition between the body of the element and the ATDs.

The end presumed to be the feed end was clean. This is shown in Figure 2. On the feed end, there were two wrinkles in the element. These can be seen at 10 o'clock and one o'clock in Figure 2. The wrinkle at 10 o'clock, which was the larger of the two, extended several inches into the element as shown in Figure 3. It is not clear what caused this, although one suspects such a wrinkle might result from tightening the shrink wrap too much.

The reject end was clean as well. This appears in Figure 4.

There was another strong odor of ammonia when the first leaf was unrolled.

The element was fairly tightly rolled, so there was a tendency for leaf to roll itself back up.

The glue lines are about 1 1/2 inches wide all around the leaves.

In this element very little foreign material was found either on the membrane surface or caught up in the Vexar netting. There was an occasional individually visible particle and by running a finger over the surface a visible bit of material could be accumulated. The membrane is shown in Figures 5 and 6. Figure 5 provides an overall view of the membrane, which is not sufficiently in focus to show how clean the membrane surface was. Figure 6 shows the feed end. A comparison of this photo to that of the lead end of element X13180 shows a great difference.

OBSERVATIONS DURING AUTOPSY- continued

During pull tests, by hand, of pieces about 1 1/2 inches in width the membrane was usually peeled, with some effort from the product water collector. In a minority of cases, the membrane tore before it was completely removed.

The dye test with Congo Red produced some unusual results. In no case was either pin hole or general leakage through the dense membrane layer noted. The support side of the membrane remained unaffected by the dye. As is usually the case with TFC membranes, the dye left a pale pink stain on the membrane surface. What was unusual is that if the membrane surface was untouched before the dye was applied (by pouring), the pattern of the Vexar, and consequently of the foulant, appeared in the pattern of the dye. The dye appears to react with the foulant. If the membrane surface was cleaned before application of the dye, either with water or with water and detergent, then the membrane was evenly stained, less so when the membrane was cleaned with detergent than when it was cleaned just with deionized water. The surface of the membrane was faintly acidic. As the dye spread out over the surface, the edge of the dye puddle darkened, not to the blue that Congo Red turns below a pH of 3, but darker than it is at a pH above 5.

Nothing unusual or different was observed on the convex sides of either leaf.

We found no indication of calcium sulfate or calcium carbonate scales. Since this was the trailing element, this is where scale should have been observed.

TESTS PERFORMED AFTER AUTOPSY
Test and Test Objective: SEM analysis of samples of membrane showing foreign material to ascertain physical appearance and, possibly, chemical identification of foulant materials.
Organization Performing Test: D-8340
Date:
Observations from Test:

Test and Test Objective:
Organization Performing Test:
Date:
Observations from Test:

DISCUSSION and *CONCLUSIONS*

From the almost complete absence of foreign material on the feed end and on the membrane surface, it is clear that *this is the trailing element* in a unit.

We did not find any significant deterioration of the element over the period of testing. The general condition was sound, the membrane surface was intact, the glue lines were satisfactory, The white wrapping tape was still very adhesive and the ATDs were strong. The displacement of the chevron ring probably occurred when the element was removed from the vessel.

The apparent reaction between Congo Red and the foulant suggests that *the foulant may be organic*, at least in part.

We have not determined what causes the apparent loss in calcium that is observed in the analyses of the flows in and out of the unit.

The orientation of the label with the flow arrow pointing circumferentially is annoying. This may mean that it is irrelevant which way the element is inserted into a vessel. If that were the case it would be better not to have a flow arrow at all.

PHOTOGRAPHS

Figure 1. View of Label Showing Orientation of Flow Arrow

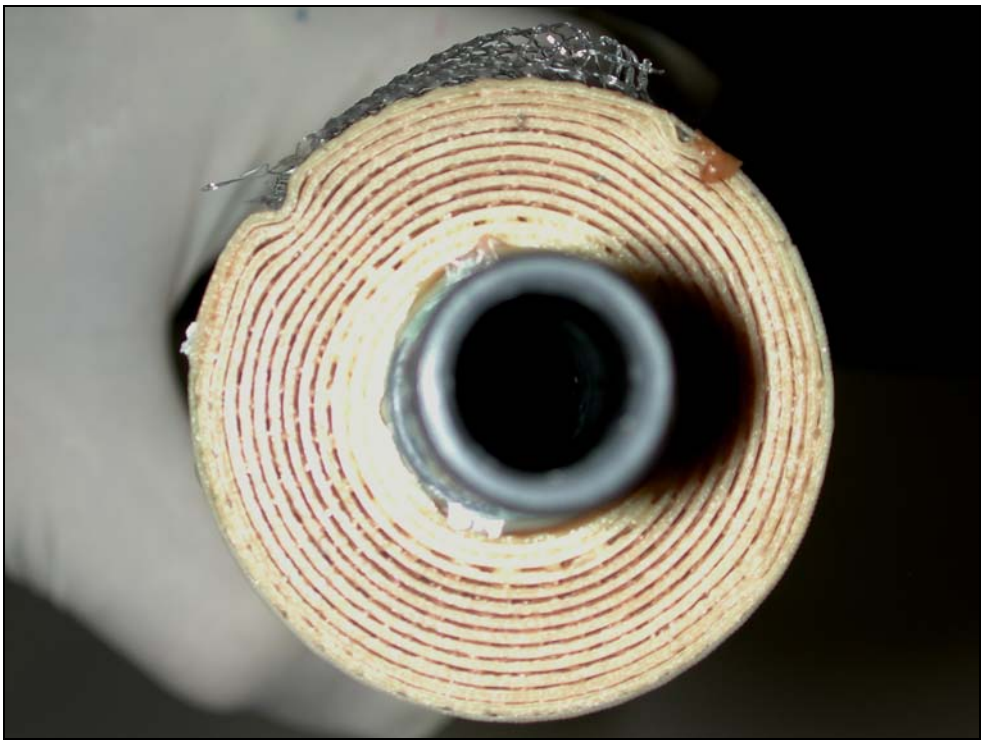


Figure 2. View of Feed End of Element Showing Wrinkles

PHOTOGRAPHS

Figure 3. View of Feed End of Element Showing Length of Larger Wrinkle

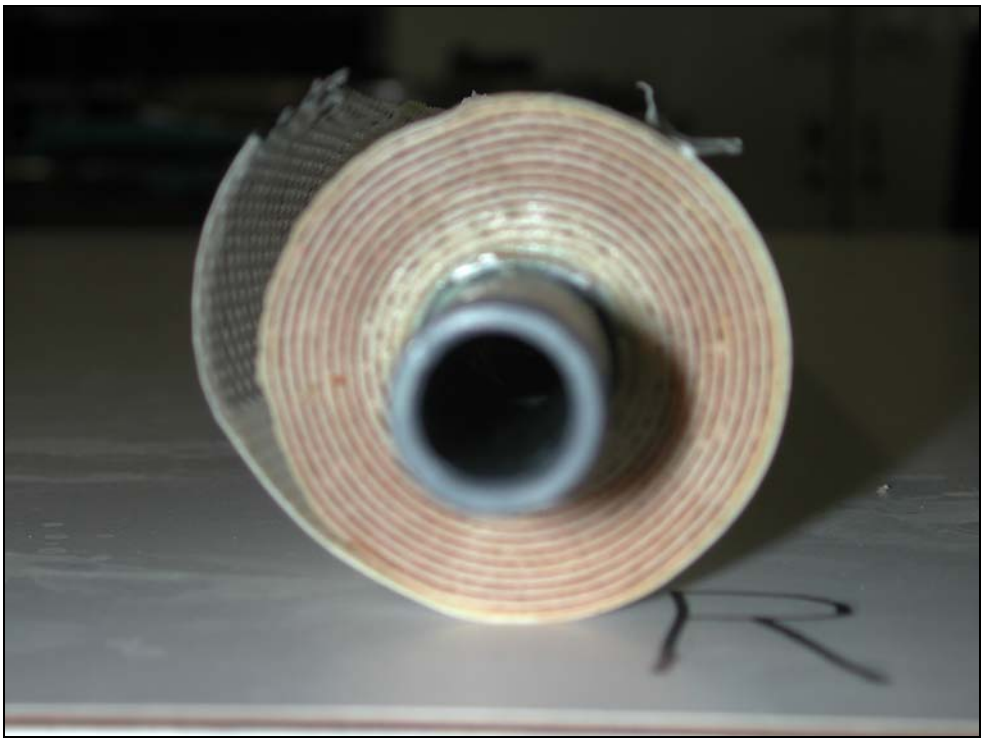


Figure 4. View of Reject End of Element

PHOTOGRAPHS

Figure 5. View of Leaf Looking toward Feed End

Figure 6. Detail of Feed End of Leaf

Appendix D

Reverse Osmosis Analyses Reports

Panoche Pilot Report, Phase II

Reverse Osmosis Pilot Study for Treatment of Agricultural Drainage at Panoche Drainage District, California

Phase 2: August – December 2005

United States Department of Interior
Bureau of Reclamation
Technical Service Center
Environmental Services Division
Water Treatment Engineering and Research Group
Denver, CO

EXECUTIVE SUMMARY

This report covers Phase 2 of the RO pilot study conducted at Panoche Drainage District (Panoche) located in the San Joaquin Valley, California. The purpose of the pilot study was to verify the performance of reverse osmosis (RO) membranes on treating agricultural drainage water. The RO pilot included the operation of media filtration and a brackish water RO system. Two separate tests were conducted during Phase 2 on the RO skid using different antiscalant/antiscalant mixtures and RO product water recoveries. The first test was conducted from August 17 to October 13, 2005 using PWT Spectraguard antiscalant, operating at a recovery of 64%. The second test was conducted from October 26 to December 12, 2005 using an antiscalant mixture of PWT Spectraguard and GE Betz Hypersperse MDC 150, operating at a recovery of 55%. The concentrate of the RO system was used as the feedwater for a separate selenium biotreatment pilot system. The results of the Phase 2 RO pilot study indicate that recoveries higher than 50% are not practical due to calcium sulfate scaling in both the RO and the downstream selenium biotreatment systems.

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ACRONYMS

CA DWR	California Department of Water Resources
cfs	Cubic feet per second
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DP-25	Panoche Drainage Point 25
EC	Electrical conductivity
FRP	Fiberglass reinforced plastic
gpd	Gallons per day
gpm	Gallons per minute
gfd/psi	Gallons per square foot per day per pounds per square inch
kPa	Kilo-pascals
L/min	Liters per minute
µg/L	Micrograms per liter
µS/cm	Microseimans per centimeter
meq/L	Milliequivalance per liter
mg/L	Milligrams per liter
mL/min	Milliliters per minute
MMF	Multimedia filter
N	Nitrogen
NDP	Net driving pressure
NO_3	Nitrate
NTU	Nephelometric turbidity units
ORP	Oxidation-reduction potential
Panoche	Panoche Water District
PWT	Professional Water Technologies
PLC	Programmable logic controller
ppm	Parts per million
psi	Pounds per square inch
RO	Reverse osmosis
SCCAO	South Central California Area Office
SDI	Silt density index
SDI_{15}	15-minute Silt density index test
Se	Selenium
SiO_2	Silica
TDS	Total dissolved solids
TOC	Total organic carbon
TSS	Total suspended solids
VFD	Variable frequency drive

1.0 INTRODUCTION

1.1 Background

The objective the Phase 2 RO pilot study was to evaluate the performance of RO membranes on San Joaquin Valley agricultural drainage water at recoveries greater than 50%, which was demonstrated in the Phase 1 pilot study. The Phase 2 RO pilot study operated at recoveries in the range of 55% to 65%.

A potential full-scale agricultural drainage treatment facility in the San Joaquin Valley would consist of RO treatment, selenium biotreatment and evaporation ponds. Drainage water would be fed first to the RO system to extract clean product water and reduce the volume of drainwater requiring further treatment and disposal. The RO product water could be used for irrigation of commercial crops. The RO concentrate stream would be discharged to evaporation ponds; however, the selenium must be removed prior to discharge to avoid negative impacts to wildlife. The biotreatment system would remove most of the selenium from the concentrate stream before discharge to the evaporation ponds.

Increasing the RO recovery would allow for the design of smaller selenium biotreatment and evaporation pond facilities. The increase in O&M costs due to running the RO at higher recoveries is considered modest compared to the significant decrease in construction and operating costs that would result from smaller selenium biotreatment and evaporation pond facilities. A four month pilot test period was dedicated to verify the performance of RO membranes at recoveries higher than 50%, which allowed for the use of different antiscalant mixtures. The test also demonstrated the impacts of operating at higher RO recoveries on the downstream treatment processes.

A number of organizations participated in the preparation and operation of the membrane pilot test. The Bureau of Reclamation (Reclamation) Technical Service Center (TSC) provided overall project management, technical oversight, and field support. Cost sharing for operation and maintenance was provided by Panoche and Westlands Water District (Westlands). Boyle Engineering Corporation (Boyle) provided engineering services and field operation staffing. Panoche provided the pilot site infrastructure. Additional field support was provided by Reclamation's South Central California Area Office, Panoche, and Mr. Jose Lopez. The sampling and analysis plan and analytical laboratory services were provided by the California Department of Water Resources (DWR).

1.2 Phase I Panoche RO Pilot Conclusions

Based on the four months of pilot data collected during the Phase I RO pilot, the following conclusions were made:

- The RO system ran successfully at a recovery of 50%. The pilot was shut down in December 2004 at the end of the four month pilot schedule. No scaling problems were encountered during the pilot and no visible calcium carbonate or calcium sulfate were detected on the elements during the membrane autopsy.

- The RO system was operated for 2,042 hours, with pretreatment limited to a multimedia filter and a cartridge filter. The GE Betz Dearborn Hypersperse MDC 220 antiscalant appeared to avert any serious scaling problems during the four month pilot.

- Full strength concentrate water from the RO pilot was fed to the selenium biotreatment pilot. No scaling problems were encountered with the selenium biotreatment pilot during the four month duration.

1.3 Pilot Location

Panoche is located on the Westside drainage area of the San Joaquin River. The pilot site can be reached from US Interstate-5 by taking the Russell Avenue exit. The pilot site is located at Drainage Point 25 (DP-25) about 1.5 miles east of Russell Avenue (Figure 1-1). Figures 1-2 and 1-3 show the pilot trailer and RO skid at Panoche.

1.4 Water Quality Data

Table 1-1 presents an analysis of raw drainwater taken from Panoche sump DP-25 from August 9, 2005 – December 6, 2005. An expanded version of Table 1-1 presenting the results of each sampling session is given in Appendix A. The sampling was conducted by Reclamation and DWR; laboratory analyses of the collected samples were performed by Bryte Laboratory in West Sacramento. Contaminants of concern included total dissolved solids (TDS), electrical conductivity (EC), calcium, sulfate, selenium and nitrate. The average TDS and EC values for the period were 11,087 mg/L and 12,627 µS/cm, respectively. The range of TDS varied from a low concentration of 6,408 mg/L to a high of 17,280 mg/L, while the range of EC varied from a low of 7,487 µS/cm to a high of 19,640 µS/cm. Average calcium concentrations were 558 mg/L and ranged from 481 mg/L to 749 mg/L. Dissolved sulfate concentrations averaged 5,206 mg/L and ranged from 3,070 mg/L to 7,410 mg/L. The average total selenium concentration was 0.961 mg/L; minimum and maximum concentrations were 0.213 and 2.200 mg/L, respectively. The average dissolved selenium concentration was 0.845 mg/L; minimum and maximum concentrations were 0.198 and 1.880 mg/L, respectively.

The average dissolved nitrate concentration (total NO_3) was 431 mg/L; the minimum and maximum concentrations were 240 and 662 mg/L, respectively. Nitrate concentrations were high in this drainage water due to the addition of fertilizers to the soils and bi-products found in cattle urine.

Figure 1-1: Location Map, Panoche Pilot Site

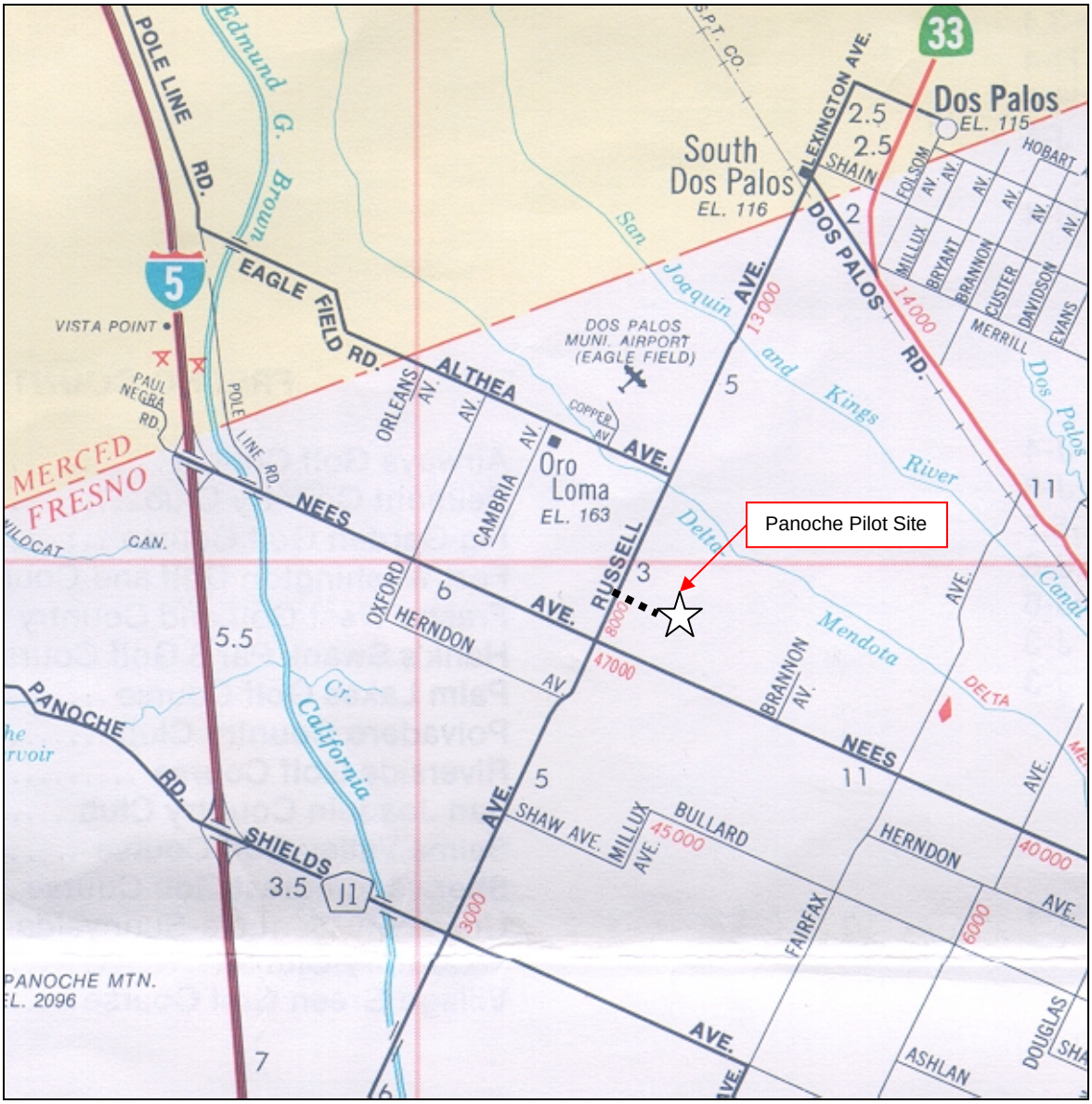


Figure 1-2: Panoche RO Trailer

Figure 1-3: RO Membrane Skid

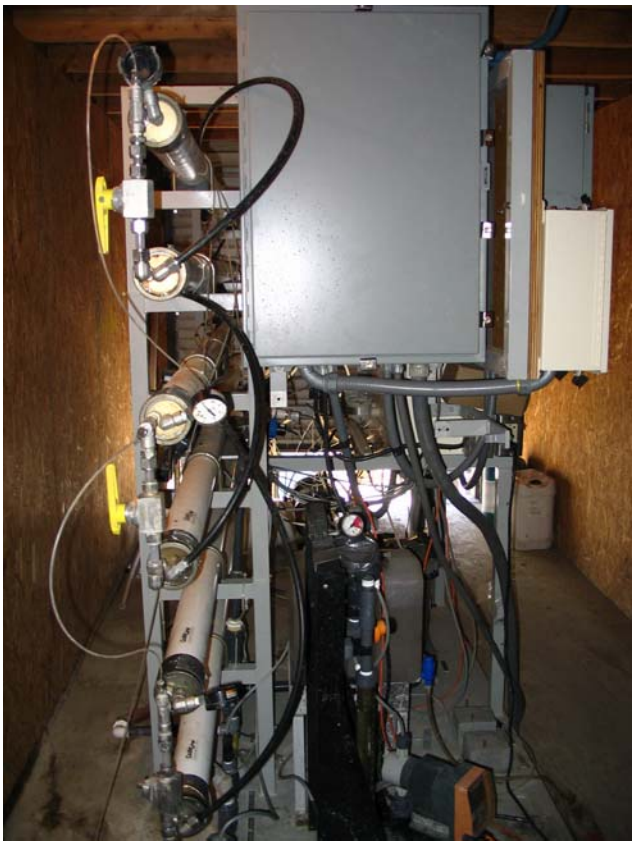


Table 1-1: Average Analyte Concentrations for Panoche Sump DP-25

(August 9 – December 6, 2005)
(results in mg/L unless stated otherwise)

Analyte		Units	# Samples Taken	Average	Minimum	Maximum
	EC	µS/cm	14	12,627	7,487	19,640
dissolved	Ammonia		5	<0.01	<0.01	0.01
dissolved	Bicarbonate	As $CaCO_3$	14	245	62	320
dissolved	Boron		5	27.1	16.3	50.5
dissolved	Calcium		14	558	481	749
dissolved	Carbonate	As $CaCO_3$	14	1	<1	3
dissolved	Chloride		14	1,970	871	3,550
dissolved	Hydroxide	As $CaCO_3$	14	<1	<1	<1
dissolved	Magnesium		14	330	177	526
dissolved	Nitrate	as NO_3	14	431	240	662
dissolved	Organic Carbon (DOC)	as C	5	6.5	4.3	8.3
dissolved	Potassium		5	6.2	3.7	8.2
dissolved	Selenium		14	0.845	0.198	1.880
dissolved	Silica (SiO_2)		5	35.6	26.1	47.9
dissolved	Sodium		14	2,585	1,180	4,720
dissolved	Sulfate		14	5,206	3,070	7,410
	pH	pH units	14	7.7	7.3	8.1
total	Alkalinity	As $CaCO_3$	14	247	62	321
total	Arsenic		5	<0.01	<0.01	0.18
total	Barium		10	<0.5	<0.5	<0.5
total	Dissolved Solids (TDS)		14	11,087	6,408	17,280
total	Iron		5	0.303	<0.05	0.738
total	Manganese		5	<0.05	<0.05	<0.05
total	Organic Carbon (TOC)	as C	5	6.1	4.2	8.0
total	Phosphorous		5	0.07	0.04	0.13
total	Selenium		14	0.961	0.213	2.200
total	Strontium		5	11.9	6.1	16.9
total	Suspended Solids (TSS)		5	<1	<1	4
	UV254	absorb./cm	5	0.214	0.106	0.322

2.0 RO PILOT PLANT EQUIPMENT

2.1 Description of the RO Skid

The equipment used for the Phase 2 RO pilot project was similar to the Phase 1 RO pilot. The RO pilot included the operation of media filtration and a brackish water RO unit (Figure 2-1). The RO system was fed agricultural drainage water collected from DP-25. The reject concentrate from the RO was conveyed to the selenium bioreactor pilot to remove selenium and nitrate from the concentrate stream. A site layout of the Panoche RO pilot is given in Figure 2-2.

The membrane treatment system used 2½ x 40 inch diameter RO membrane elements on a skid-mounted unit. The skid was equipped with a chemical injection system, a cartridge filter module, high-pressure pump, six pressure vessels, monitoring instrumentation, and an automatic control system. The membrane elements were enclosed in six pressure vessels arranged in a 2:1 array. Recovery was controlled through a concentrate back pressure needle valve. The skid also used a needle valve for the recycling of RO concentrate prior to the high pressure pump.

An antiscalant dosing system was installed on the skid with a 15-liter reservoir. A cartridge filter module was installed to protect the membranes from particulate fouling. Each pressure vessel housed three spiral wound cartridge modules manufactured by Serfilco, LTD.

The high pressure RO feed pump was a multistage centrifugal pump manufactured by Tonkaflow. It was equipped with a variable frequency drive (VFD) to modulate the speed of the pump motor. Varying the pump speed either increased or decreased the flow rate, or increased or decreased the feed pressure to the membranes. The VFD was controlled manually or by the automated control system.

An Allen Bradley SLC 500 programmable logic controller (PLC) was installed to control operations of the VFD and monitor pilot instrumentation. The PLC transmitted sensor data and alarm signals to a local desktop computer for data logging purposes. The PLC was programmed with several alarms. If the PLC detected low flow or high-pressure conditions at the RO high pressure feed pump or a low level condition at the RO feed tank, the PLC would shut down all the pumps at the pilot site, including pumps for the pretreatment process.

A data transmittal system was installed on the RO skid using the Perlorica WaterEye™ remote sensing software. Sensor data transmitted to the PLC was transferred to a desktop computer loaded with the WaterEye™ software. Every 15-minutes the WaterEye™ software queried and transmitted data from the PLC via phone modem to the WaterEye™ website. Real-time RO sensor data was posted on the Web using colored indicators to confirm system status or to provide alert for potential problems. In addition, WaterEye™ created downloadable Excel workbooks of archived sensor data and custom plots viewable on the web.

Figure 2-1: RO Pilot Process Flow Diagram

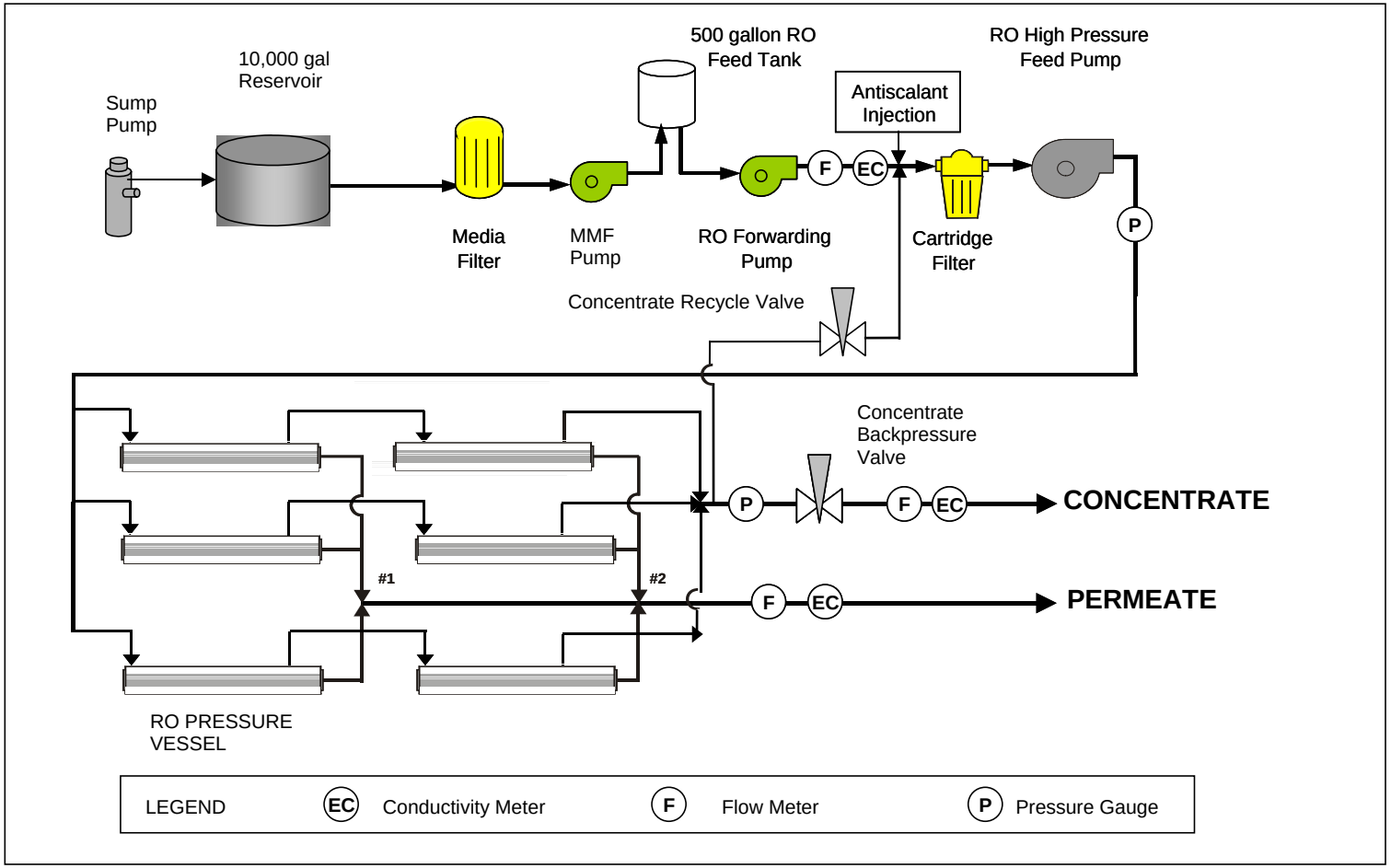
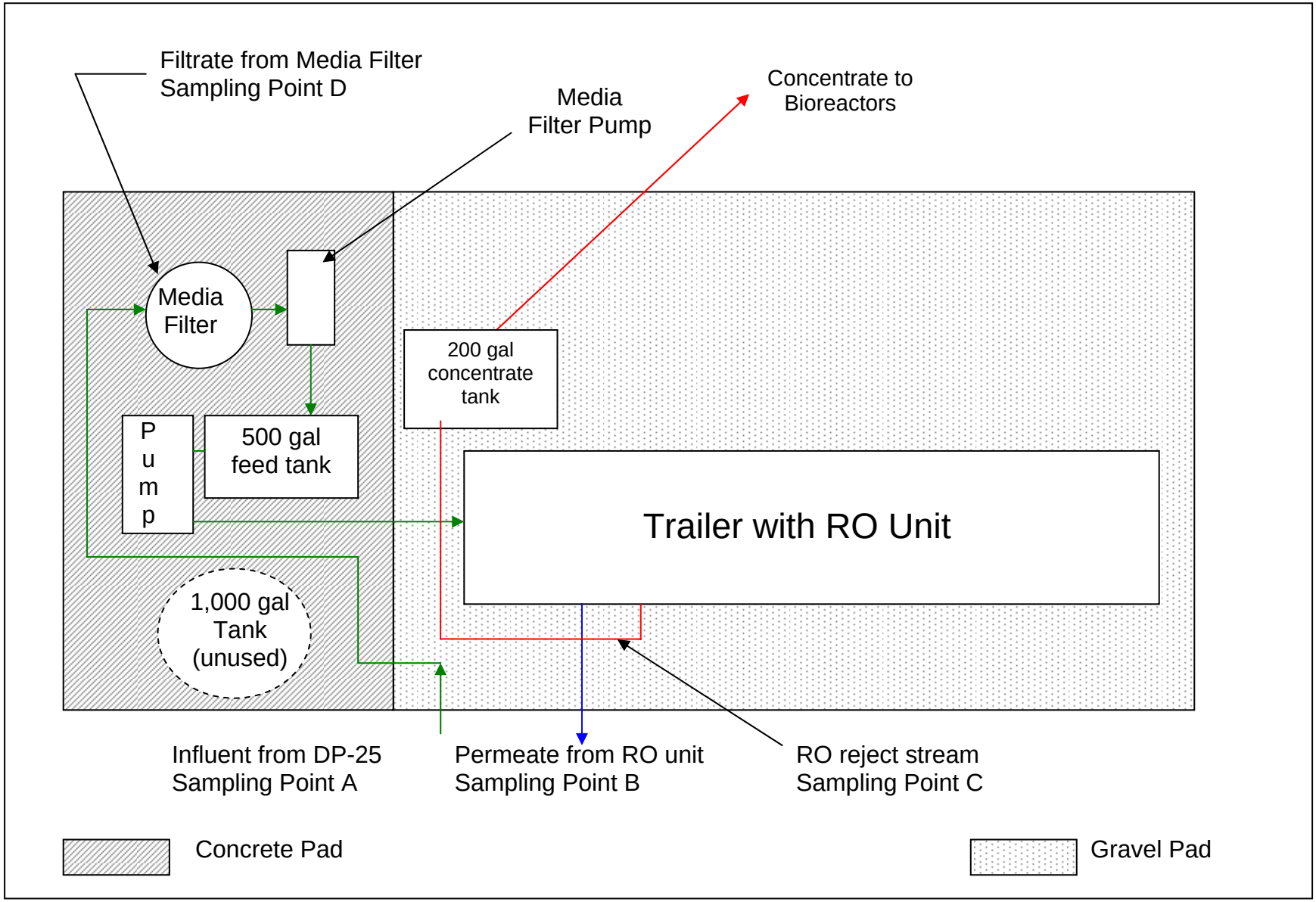


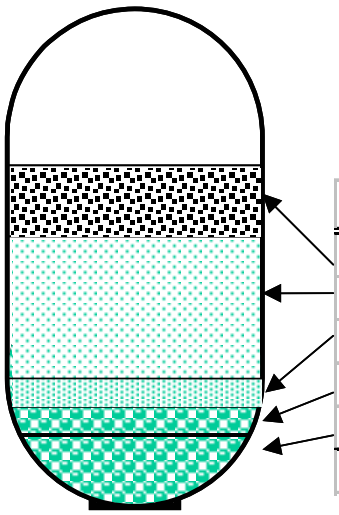
Figure 2-2: Diagram of Panoche RO Pilot Site (not to scale)



2.2 Description of the Media Filter

The media filter was a 72-inch tall vertical fiberglass reinforced plastic (FRP) pressure vessel with an outer diameter of 24 inches. The top and bottom sections of the dome were each 9.6 inches high, while the sidewall was 53 inches long. The inner diameter at the sidewall was approximately 22.6 inches, giving a cross sectional area of 2.76 square feet and a total vessel volume of 15.6 cubic feet. An inlet basket covered with a fine mesh was located inside the upper inlet of the vessel to keep the media from escaping during a backwash. Slotted laterals were arranged around a central hub installed in the dished bottom of the vessel. The media filter contained several gradations of gravel, fine sand, and anthracite. Figure 2.3 illustrates the strata of media within the filter.

Figure 2-3: Multimedia Filter Strata



Media	Size	Ht. (in.)	Vol (ft^3)
Anthracite	N/A	12	3.0
Silica Sand	0.4 - 0.8 mm	20	4.0
Silica Sand	1/16" x 1/32"	3	1.0
Gravel	1/8" x 1/16"	3	1.0
Gravel	1/4" x 1/8"	10	2.0
Total		48	11.0

3.0 PILOT OBJECTIVES, TESTING PROTOCOL AND WATER SAMPLING

3.1 Pilot Objectives

The principal objectives of piloting the RO system were to:

- Demonstrate the ability of commercially available RO membrane elements for removing TDS from agricultural drainage water.
- Determine potential long-term adverse affects on the membranes from fouling or scaling.
- Demonstrate the effectiveness of different antiscalant mixtures to avert scaling
- Demonstrate the impacts on downstream selenium biotreatment facilities by operating the RO system at recoveries higher than 50%

3.2 Testing Protocol

The following parameters were evaluated to address the objectives listed above:

- *Particle removal verification*: The feed water for the membrane treatment system should maintain a Silt Density Index (SDI) below 4.0. The performance of the pretreatment filtration system was based on meeting this requirement on a continuous basis.
- *Fouling constituent verification*: Samples from the feed water and concentrate streams of the membrane system were taken and analyzed to determine whether concentrations of potential membrane fouling constituents were at levels that could negatively impact membrane life and performance.
- *Product water quality verification*: Samples from the permeate stream of the membrane system were analyzed to determine whether the RO membranes are capable of producing water that is suitable for irrigation of agricultural crops.

The onboard PLC controlled the RO high-pressure pump, maintaining a constant feed rate of about 6 gpm, while the operator manually modulated the concentrate backpressure valve to achieve the desired permeate recovery. The operator alsom monitored the antiscalant injection system. Although instrumentation measurements were transmitted to the WaterEye™ website for archiving, the operator filled out a log sheet containing similar data. The manual data log served as a backup in case of telemetry failure, and its review helped the operator troubleshoot potential instrumentation or equipment failure.

To determine whether the media filter required a backwash, the operator also conducted a 15-minute SDI test (SDI_{15}) on the feedwater to the RO membranes. SDI_{15} values were to be maintained below 4.0. The media filter was backwashed weekly.

3.3 Water Sampling

Analyses of influent and effluent water samples were conducted by Bryte Laboratories in West Sacramento, California. Sample analyses of major ions were conducted once a

week with more extensive analyses conducted on a monthly basis (Table 3-1). Points of sample collection included the feedwater, permeate, concentrate and media filter filtrate (see Figure 2-2).

Table 3-1: Constituents and Frequency of Sampling

Designa-tion	Analysis	Feed (DP- 25)		Permeate		Concentrate		Filtrate	
		Sample Pt A		Sample Pt B		Sample Pt C		Sample Pt D	
		Wkly	Mthly	Wkly	Mthly	Wkly	Mthly	Wkly	Mthly
A	Total Minerals:								
	TSS		X						
B	Dissolved Minerals:								
	Alkalinity	X	x	x	x		x		
	Bicarbonate	X	X	X	X	X	X		
	Carbonate	X	X	X	X		X		
	Chloride	X	X		X	X	X		
	EC	X	X	X	X	X	X		
	Nitrate	X	X	X	X	X	X		
	Potassium		X		X		X		
	Sulfate	X	X		X	X	X		
	TDS	X	X	X	X	X	X		
C	Total Metals:								
	Arsenic		X		X		X		
	Barium		X		X		X		
	Iron		X		X		X		X
	Manganese		X		X		X		X
	Selenium	X	X	X	X	X	X		
	Strontium		X		X		X		
D	Dissolved Metals:								
	Boron		X		X		X		
	Calcium	X	X	X	X	X	X		
	Magnesium	X	X	X	X		X		
	Selenium	X	X	X	X	X	X		
	SiO2		X		X		X		
	Sodium	X	X	X	X	X	X		
E	Total Nutrient:								
	Total Phosphorus		X		X		X		
	Dissolved Nutrient:								
F1	Ammonia		X		X		X		
F2	UV254		X		X		X		
G	TOC - (wet Ox)		X		X		X		
H	DOC - (wet Ox)		X		X		X		
On-Site	DO		X						
	EC	X	X	X	X	X	X		
	ORP	X	X	X	X	X	X		
	pH	X	X	X	X	X	X		
	SDI							X	X
	Temperature	X	X	X	X	X	X		
	Turbidity	X	X	X	X	X	X		

4.0 TESTING CONDITIONS

Two separate tests were conducted on the RO skid using different recoveries and antiscalants. A description of the two tests is given below.

4.1 Test 1 - Recovery at 64%

The first test was conducted from August 17 to October 13 using an antiscalant produced by Professional Water Technologies (PWT), located in Oceanside, CA. PWT claimed that their Spectraguard antiscalant would achieve recoveries in the 64% - 72% range based on their evaluation of the Panoche DP-25 raw drainwater quality. Reclamation chose to operate the RO skid at the lower 64% recovery with the option to increase recovery pending successful pilot results. PWT recommended a Spectraguard concentration of 4 ppm which converted to a dosage 0.91 ml/min at 1 part antiscalant to 9 part water mixture and an RO feed flow rate of 6 gpm. The membranes used in this test were Hydranautics model XLFC-3 RO membrane elements. Projections of membrane performance using the Hydranautics IMS Design software indicated that concentrate recycling was required for a 2:1 array RO system operating at 64% recovery. The required concentrate flow was calculated to be 2.5 gpm.

4.2 Test 2 - Recovery at 55%

The second test was conducted from October 26 to December 12 using an antiscalant mixture of PWT Spectraguard and GE Betz Dearborn Hypersperse MDC 150. PWT speculated that a combination of the dendrimer based Spectraguard and the phosphanate based MDC 150 could better control calcium sulfate scale than if dosed alone. In theory, MDC 150 would control the growth of calcium carbonate while the Spectaguard controlled the growth of calcium sulfate. Antiscalant concentrations were based on recommendations by PWT and model runs using the GE Betz Argo Analyzer software. Antiscalant concentrations were 4 ppm for the Spectraguard and 6 ppm for the MDC 150. Spectraguard was diluted to a ratio of 1 part antiscalant to 9 parts water while the MDC 150 was diluted to 1 part antiscalant to 6 parts water. The combined dosage of the antiscalant mixture was 2 mL/min at an RO feed flow rate of 6 gpm.

Recovery for the second test was limited to about 55% with the option to increase recovery pending successful pilot results. Membranes used in this test were Koch TFC 2540 HR elements. Projections of membrane performance using the Koch RO Pro 7.0 software indicated that concentrate recycling was not required for a 2:1 array RO system operating at 55% recovery.

5.0 RESULTS OF THE PHASE II RO PILOT

5.1 Summary of Test 1: Recovery at 64%

5.1.1 Summary of System Operations - A total of 1,357 hours of operation were accrued on the RO elements during Test 1. On August 17, the system was started at 64% recovery and 2.5 gpm of concentrate recycle. The pilot officially became operational on August 17, 2005, and ran at 64% recovery until October 13, 2005.

The RO pilot ran from August to late September without apparent signs of problems. Periods of intermittent shutdowns occurred from August 20-22 and August 23-24 for equipment maintenance and repair. Additional periods of missing data in September were due to problems with the Panoche data transmittal computer. On September 26, the Panoche computer was brought to Reclamation's Frenso office for diagnostics and was determined infected with a virus. The virus was causing frequent lockups of the computer modem during the Watereye dial out process. The computer remained in Fresno for repairs and quarantine until October 12. Upon reactivation of the data collection system, Reclamation engineers observed a 10% increase in RO feed pressure and a 20% decrease in feedwater flow. As a precautionary measure, recovery was reduced to 27% on October 13 and the skid continued to run until the following week when scaling problems forced its shutdown. An inspection of the system on October 25, 2005 revealed significant salt deposits on the RO elements (see Section 5.3).

5.1.2 Summary of System Data - System flow, temperature, conductivities, and pressures of Test 1 are depicted on Figures 5-1 through 5-4. An analysis of the Bryte Laboratories water chemistry data is provided in Appendix B (Section B.1). Referencing Figure 5-1, feed and permeate flows were on average 23.4 L/min (6.2 gpm) and 14.9 L/min (3.9 gpm), respectively, yielding an approximate recovery of 64%. Sensor recorded concentrate flow data is not given since the concentrate flow sensor encountered scaling problems after the start of the pilot. The sensor paddlewheel kept rescaling despite several cleanings by field staff. Therefore, the concentrate flow shown is the computed difference between the feed and permeate flows. The data gap between September 26 and October 12 represents the shutdown of the Watereye system due to problems with the Panoche computer. On October 13, RO feed flow was found to have decreased to 18.3 L/min (20% decrease from pilot startup).

Figure 5-2 shows the water temperature of the RO feed for the period August to October. This measurement was taken at a point just prior to the RO high-pressure feed pump. The average daily feed water temperature was 23.0 °C, with a maximum temperature of 29.0 °C reached on August 21 and a minimum temperature of 20.0 °C reached on September 25.

Figure 5-3 illustrates the EC of the RO feed and permeate streams for the period August to October. Concentrate conductivities are not shown due to problems with the conductivity sensor. The average conductivities of the feedwater and permeate were 9,435 µS/cm and 207 µS/cm, respectively.

The pressure measurement of the feed stream is shown in Figure 5-4 for the period August to October. The average feedwater pressure was 2,076 kPa (301 psi). The red

line on the graph represents the net driving pressure (NDP) which is the net pressure required to force water through the membrane. The average NDP was 1,640 kPa (238 psi). On October 13, the feedwater pressure reached a maximum of 2,507 kPa (364 psi), a 20% increase over the average feed pressure. The NDP also reached a maximum on October 13 at 2,112 kPa (306 psi).

5.2 Summary of Test 2: Recovery at 55%

5.2.1 Summary of System Operations - On October 25 and 26, a clean-in-place using citric acid and tetra sodium EDTA was performed on the RO skid. In addition, eighteen new Koch RO elements were installed in the six pressure vessels. On October 26, Test 2 was started at 55% recovery, without concentrate recycle. A combined antiscalant mixture of 4 ppm of Spectraguard and 6 ppm of MCD 150 was applied to control calcium sulfate deposition. A total of 865 hours of operation was accrued on the RO elements during Test 2. Pilot test 2 began on October 26, 2005, and was completed on December 12, 2005.

The RO system operated at 55% recovery from October 26 to mid-November without major problems. Starting on November 8, the feedwater EC started to drop, which corresponded with a drop in the VFD (variable frequency drive) speed. The VFD adjusts the speed of the high pressure pump motor to maintain a constant flow through the system as feedwater salinity and RO osmotic pressure varies. The feedwater EC and VFD speed continued to drop until November 21, when field staff reported that the VFD speed had dropped to 31 Hz and the RO feedwater pressure had dropped to below 1300 kPa. Prior to November 8, the RO VFD speed was 43 Hz and the feedwater pressure was 2200 kPa. The drop in VFD speed and feedwater pressure brought about two concerns. The first concern was that the RO pump would experience harmonic resonance vibrations if the VFD speed remained in the low 30 Hz range. During the Phase 1 pilot, the RO high pressure pump had failed after running at the resonance frequency for a brief period. The second concern was that the continuing drop in feedwater pressure may have been caused by a damaged RO element or leaking pressure vessel. On November 21, the RO system was shut down until an engineer could arrive on site the following week.

On November 30, a Reclamation engineer arrived at Panoche to inspect the RO system. A visual inspection of the Koch membranes revealed no punctures and no significant leaks with the RO pressure vessels or system plumbing. Therefore, decreasing feed pressures were not likely attributed to damaged elements or leaks. As with the Phase 1 pilot, problems with decreasing VFD speeds were remedied with a recycle line. The recycle line would convey part of the discharge from the RO high pressure pump back to the inlet of the pump. The recycle flow was adjusted with a needle valve and set to 4.5 gpm to obtain a VFD speed of 38.3 Hz. The RO system was restarted at 15:43 on November 30.

After periods of intermittent shutdown from December 1 to December 2, the skid ran smoothly until 15:35 December 7 when a decrease in RO feed flow was observed. Feedwater flow continued to diminish until December 12 when the RO pilot was shut down permanently. On January 10, Boyle inspected the system and found the system had failed due to calcium sulfate scaling. Section 5.3 provides more details on the scaling problems of Test 2.

5.2.2 Summary of System Data - System flow, temperature, conductivities, and pressures of Test 2 are depicted on Figures 5-5 through 5-8. A summary of the of the Bryte Laboratories water chemistry data is provided in Appendix B (Section B.2).

Referencing Figure 5-5, feed and permeate flows were on average 22.8 L/min (6.0 gpm), 12.5 L/min (3.3 gpm), and 10.3 L/min (2.7 gpm) respectively, yielding an approximate 55% recovery. Problems with scaling of the concentrate flow sensor were resolved by replacing the paddlewheel meter. From November 21-30, feedwater flow was decreased to 8.0 L/min (2.1 gpm) and recovery set to 0% as a precautionary measure. Feed flow was reestablished at 22.8 L/min on November 30 and remained at that level until December 7. At 15:00 on December 7, concentrate flows began to rapidly drop until no flow was registered at 07:30 December 8. The loss of concentrate flow readings possibly indicated the commencement of scaling of the flow sensor and the concentrate plumbing. On December 10, both feedwater and permeate flows rapidly dropped until the skid was finally shut down on December 12.

Figure 5-6 shows the water temperature of the RO feed for the period October to December. Average daily feed water temperature was 20.5° C with a maximum temperature of 31.8 °C reached on November 12 and a minimum temperature of 15.0 °C reached on November 27.

Figure 5-7 illustrates the EC of the RO feed and permeate streams for the period August to October. Concentrate EC values are not shown due to problems with the conductivity sensor. From October 26 to November 8, feedwater EC ranged from 20,000 to 17,000 µS/cm. Starting on November 9, feedwater EC rapidly dropped until it reached a low of 12,300 µS/cm on November 12. Feedwater EC remained in the 12,000 to 15,200 µS/cm range until late November. In early December, feedwater EC dropped to the 8,200 to 7200 µS/cm range. Figure 5-7 compares the feedwater EC sensor data with Bryte Laboratory results and field measurements to verify that the rapid drop in EC values was correct.

A plot of RO feed pressure and NDP for the period October to December is shown in Figure 5-8. The trends for feedwater pressure and NDP closely correspond with the trends in feedwater EC values. From October 26 to November 8, RO feedwater pressure is shown to range from 2,500 to 2,200 kPa (363 to 319 psi). Starting on November 9, feedwater pressure rapidly dropped and reached a low of 1,277 kPa (185 psi) on November 21, when the skid was temporarily shut down due to concerns with resonance frequency VFD speeds and low RO feedwater pressures. Reductions in RO feedwater pressure could be attributed to reductions in feedwater EC since the November 30 inspection found no damage to the membrane elements or pressure vessels. When the system was restarted on November 30, RO feedwater pressures remained in the 1,200 to 1,380 kPa (174 to 200 psi) range until December 9. On December 9, the feedwater pressure rapidly increased due to the onset of scale in the concentrate plumbing. Feedwater pressure continued to increase to 1784 kPa (259 psi) until the system was finally shut down on December 12. The percent increase in feedwater pressure from 01:40 December 8 to 11:00 December 12 was 43% (1240 kPa to 1784 kPa).

Figure 5-1: RO Pilot Test 1, RO System Flows

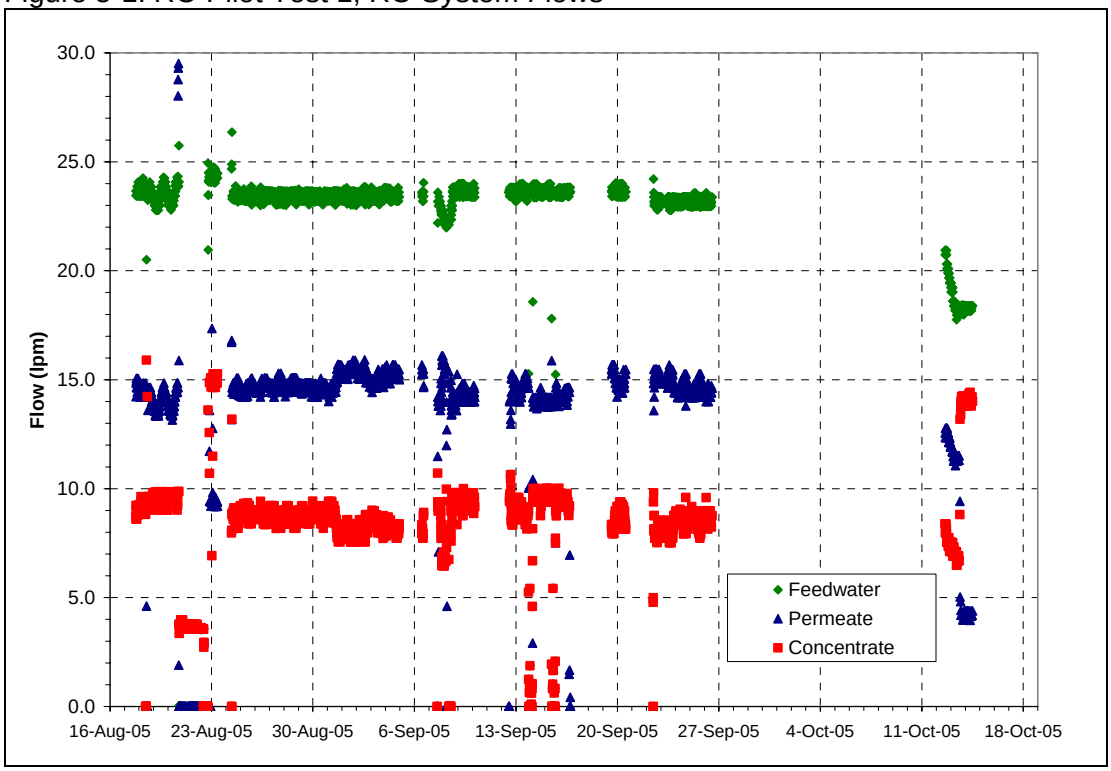


Figure 5-2: RO Pilot Test 1, Feedwater Temperature (Aug – Oct)

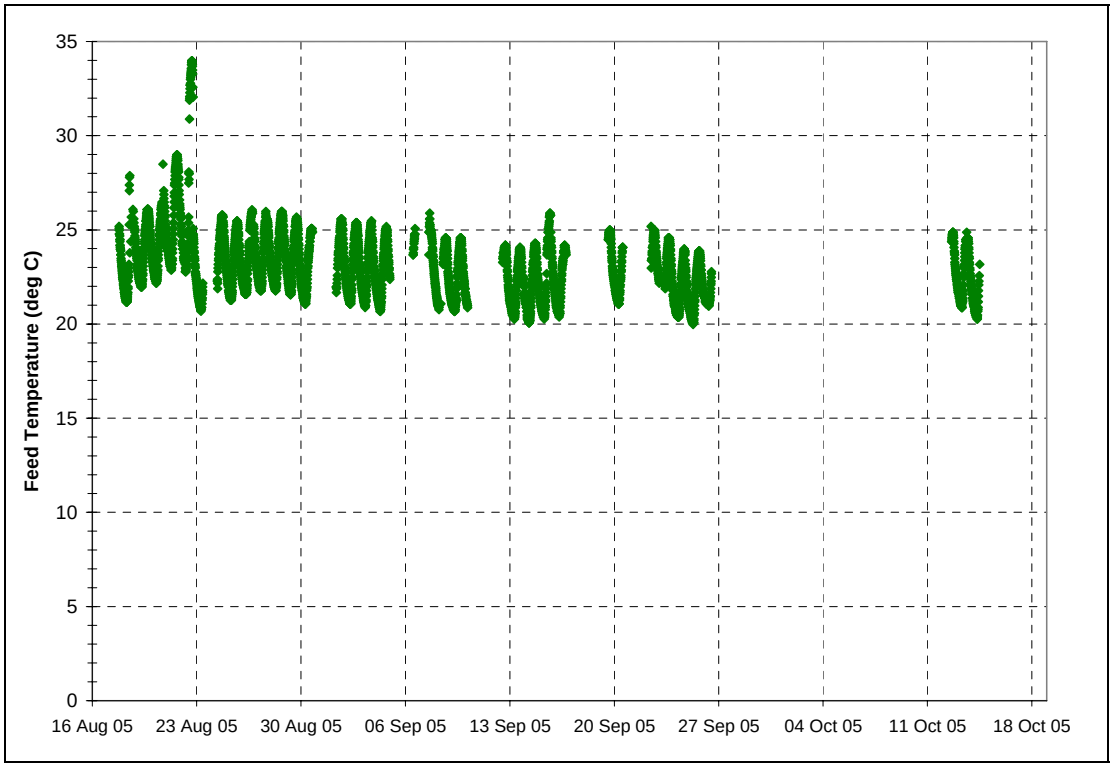


Figure 5-3: RO Pilot Test 1, Conductivities (Aug – Oct)

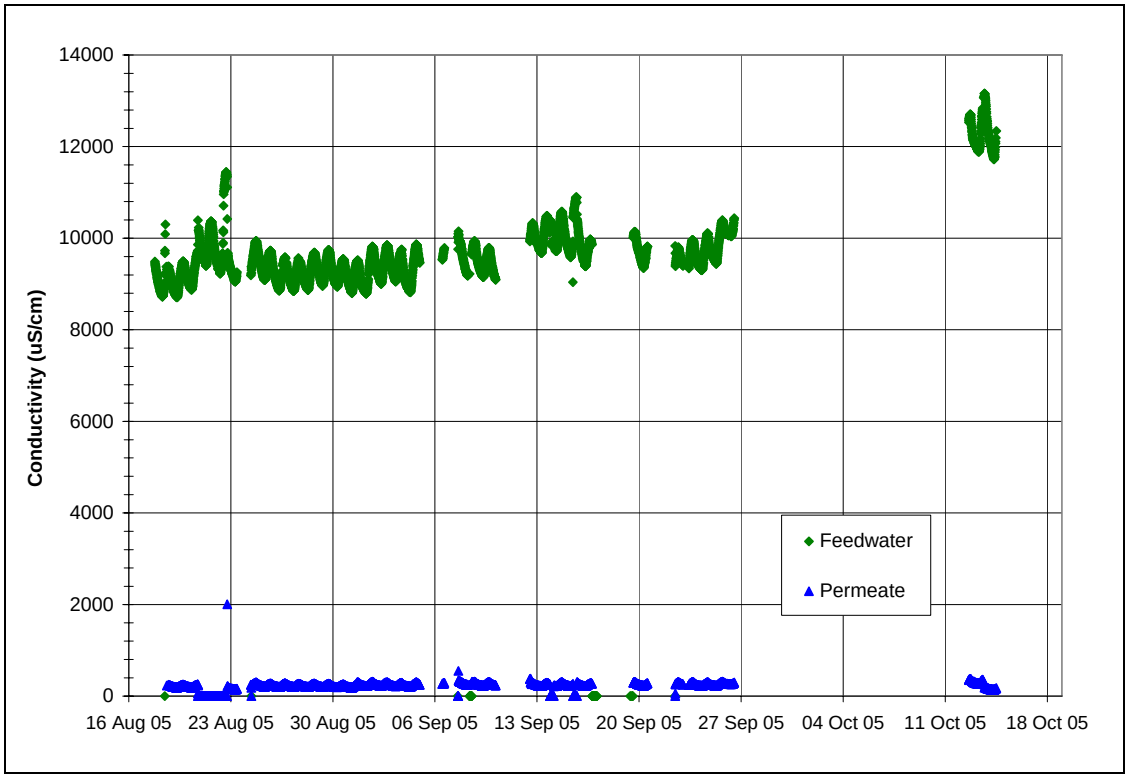


Figure 5-4: RO Pilot Test 1, Pressures (Aug – Oct)

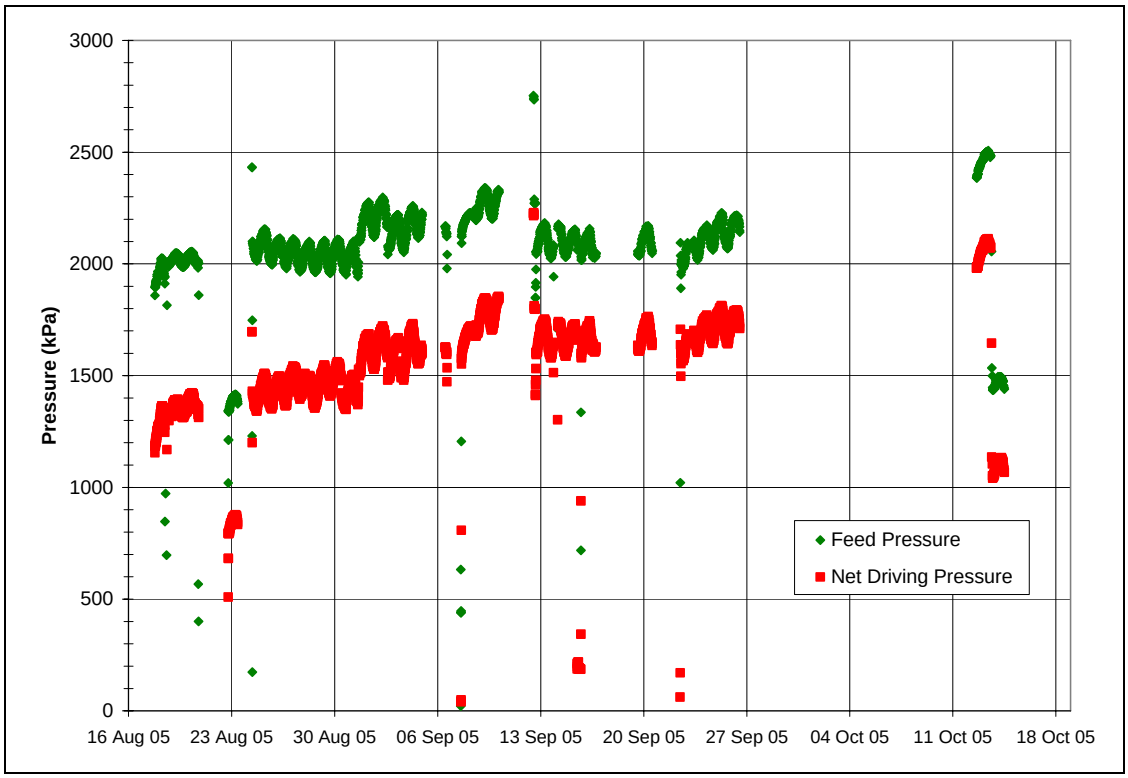


Figure 5-5: RO Pilot Test 2, RO System Flows (Oct – Dec)

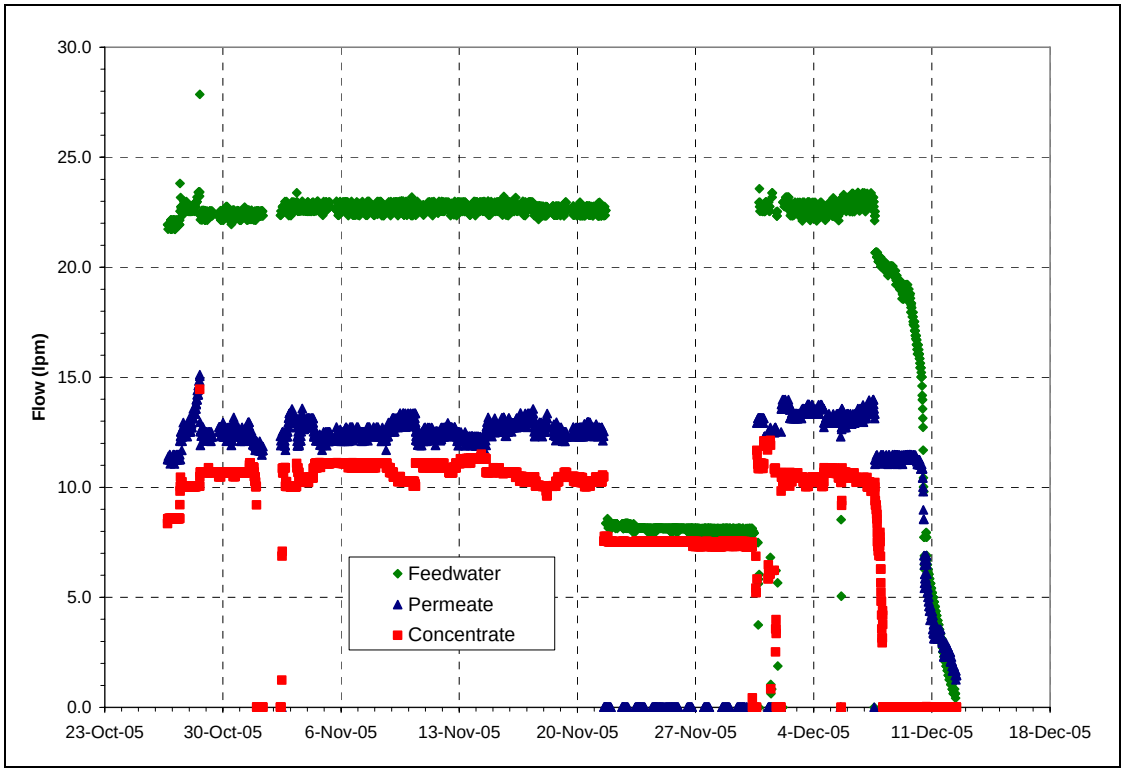


Figure 5-6: Pilot Test 2, Feedwater Temperatures (Oct – Dec)

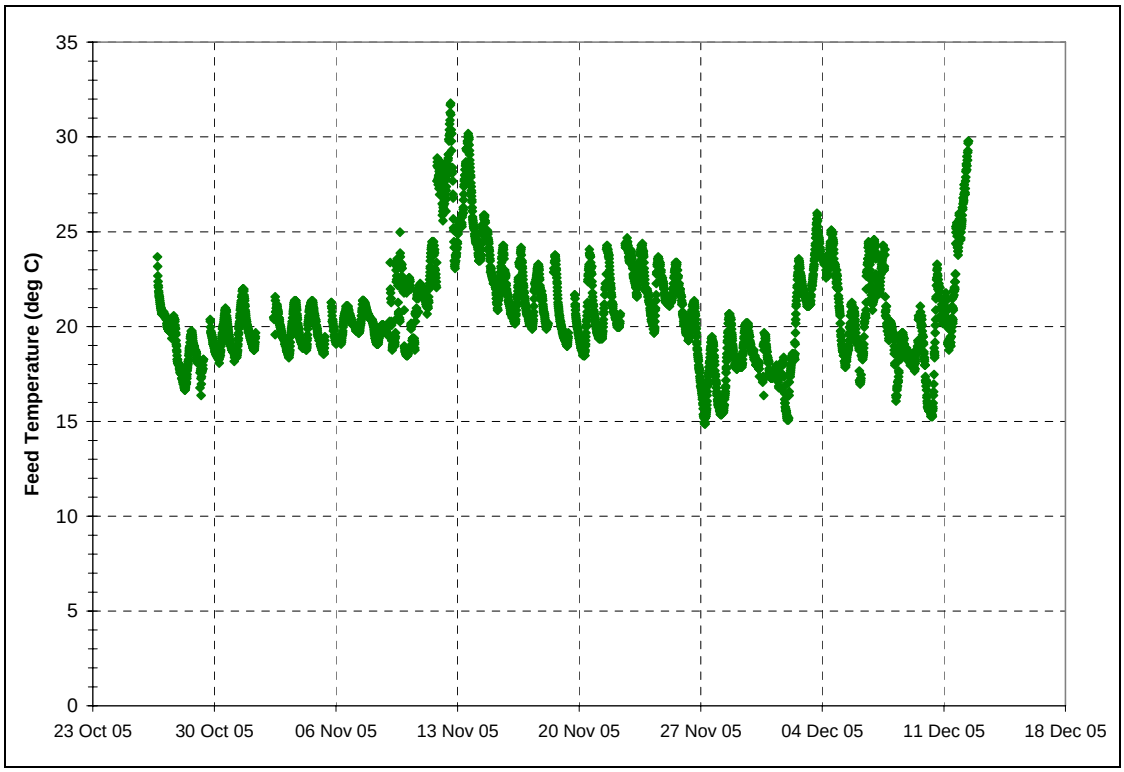


Figure 5-7: RO Pilot Test 2, Conductivities (Oct – Dec)

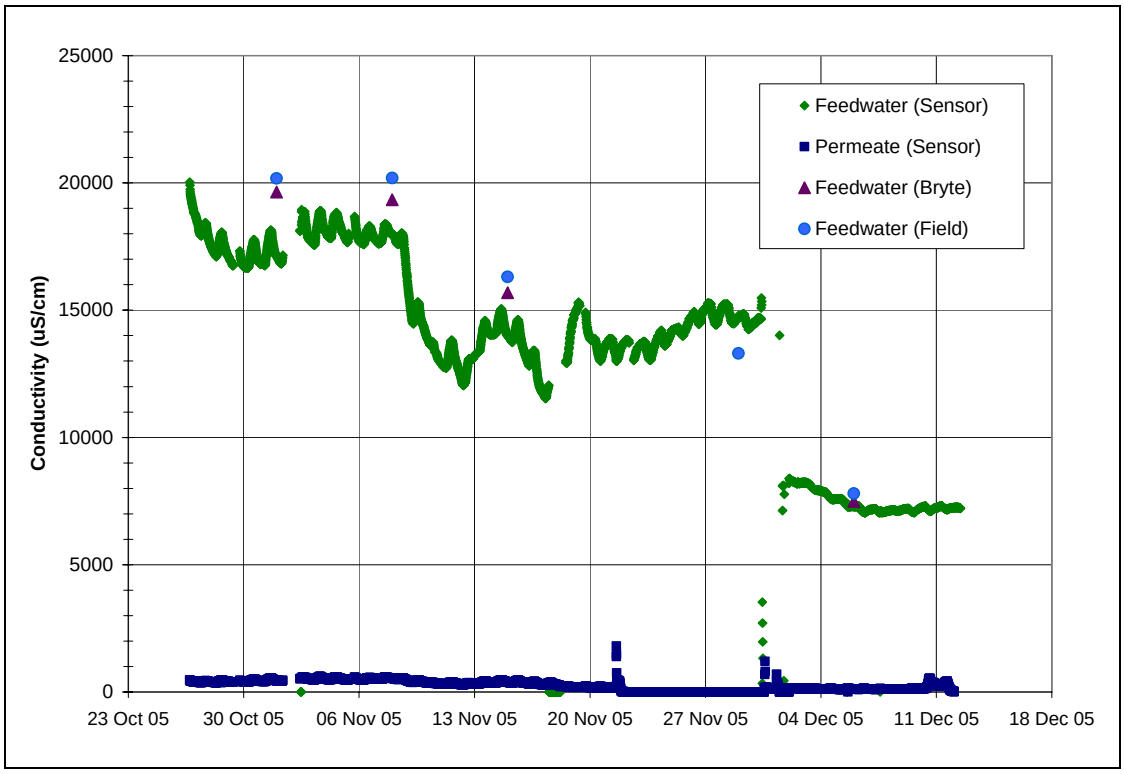
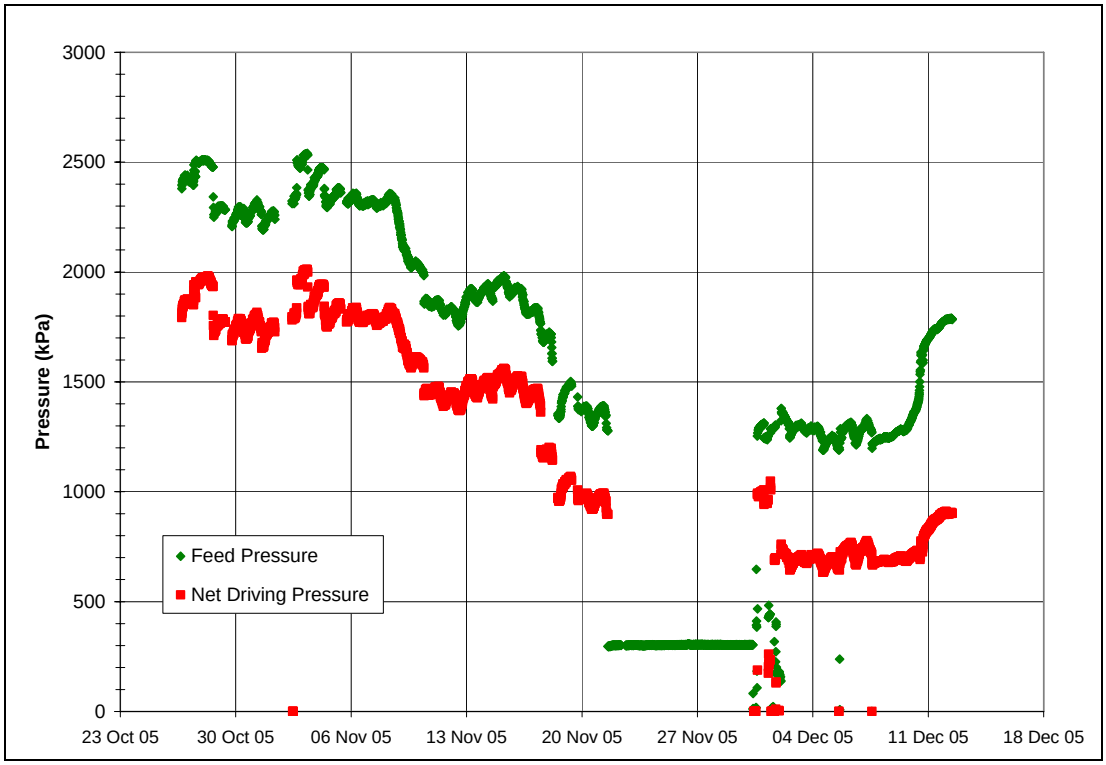


Figure 5-8: RO Pilot Test 2, Pressures (Oct – Dec)



6. Problems Encountered in the Phase II RO Pilot

Both tests of the Phase 2 RO pilot encountered problems with scaling which ultimately forced the shutdown of the system. Scaling problems were also experienced with the downstream selenium biotreatment system that used RO concentrate for feedwater. This section discusses the problems experienced with both pilots caused by operating the RO system at recoveries higher than 50%.

6.1 Problems with Test 1

During Test 1, the RO system had been operating at a recovery of 64% from late August to mid-October. On October 13, a 10% increase in feed pressure and a 20% decrease in feedwater flow prompted concerns of scaling in the RO system. Recovery was decreased as a precautionary measure, and a complete shutdown of the pilot occurred the following week. On October 25, a Reclamation engineer visited Panoche to remove the RO elements, inspect the system and conduct a clean-in-place. The system was restarted to generate permeate water required for the clean-in-place process. Permeate flow production was restricted to 3.8 L/min (1 gpm) due to system scaling. Figures 6-1 to 6-4 show salt deposition on elements from RO vessels 6, 4 and 2. Test 1 indicated that recoveries at 64% were not sustainable due to scaling even with the dendrimer based PWT Spectraguard antiscalant.

6.2 Problems with Test 2

A RO clean-in-place was conducted on October 25-26 and the pilot was restarted on October 26. The RO recovery was decreased from 64% to 55% due to the scaling problems that occurred during Test 1. Also, a 6 ppm concentration of MDC 150 antiscalant was used as a supplement to Spectraguard to control calcium sulfate scaling. With the exception of a 9-day shutdown period in late November, the pilot appeared to run smoothly from October 26 to December 7. Starting on December 7, the concentrate flow meter began to gradually fail indicating the commencement of possible scaling in the system. RO feedwater pressure increased 43% during the period from December 8 - 12. The RO system was finally shut down at 11:00 December 12. An inspection of the RO system by Boyle on January 10 revealed salt deposits on the vessel 6 elements. The most significant find of the inspection occurred when the concentrate hose from the RO skid to the 200 gallon concentrate tank was disconnected. Field staff discovered that the concentrate hose was packed solid with calcium sulfate scale (Figure 6-5). The plugging of the concentrate pipeline lead to the rapid drop in system flows and increases in pressure during the December 8 to 12 period. Test 2 indicated that recoveries at 55% could still lead to scaling. In addition, the supplement of phosphanate to a dendrimer based antiscalant did not prevent calcium sulfate problems.

6.3 Problems with Selenium Biotreatment

From August 17 to September 2, full strength RO concentrate from Test 1 was used as the feedwater to the selenium biotreatment pilot. Starting on August 22, the gear pump to Bioreactor 1 was becoming jammed at a frequency of every 1 to 2 days. Inspection of the gear pump revealed scaling on the pump internals. The majority of the scale could not be dissolved by a vinegar solution and could only be removed by scraping. Scaling problems continued despite thorough cleanings and replacement with two new gear pumps. With the constant shutdown of the bioreactors, it was decided on September 2 to dilute the concentrate water with raw drainwater before feeding the bioreactors. The concentrate was diluted with raw drainwater in the 200 gallon concentrate tank at a 50-50 mixture.

On September 6, field staff reported that water from Bioreactor 1 was flowing out of its overflow pipe. Since the Bioreactor 1 flow path is from the top to the bottom of the tank, it was speculated that the GAC media at the top of the tank had been scaled by the RO concentrate, thus restricting flow through the bed. The biotreatment contractor (Zenon Environmental) visited the pilot site on September 7 and reported that the top layer of GAC in Bioreactor 1 had solidified. Bioreactor 1 was flushed for ½ hour, while the carbon was broken up manually with an angle iron. After flushing and breaking up the carbon, the bioreactor stopped overflowing. On the recommendation of Zenon, dilution of the RO concentrate continued.

On October 27, field staff again observed that Bioreactor 1 was overflowing. On November 2, Bioreactor 1 was flushed again and normal flow restored. Figure 5-6 shows a solidified lump of GAC recovered during the flushing procedure. With the restoration of flow in Bioreactor 1 and the reduction of RO recovery to 55%, full strength RO concentrate was again fed to the bioreactors. However, it was observed that the selenium-removal performance of Bioreactor 1 had not improved and had been impaired since early September. Zenon attributed the reduction in performance to the scaling of the GAC media and potential adverse impacts of scaling on the bacterial culture. In January 2006, Reclamation contracted Zenon to replace the GAC media and re-inoculate Bioreactor 1.

Figure 6-1: Salt deposits on tail RO element in Vessel 6

Figure 6-2; Salt deposits on tail element in Vessel 6

Figure 6-3: Salt deposits on tail RO element in Vessel 4

Figure 6-4: Salt deposits from Vessel 2 collected in plastic bag

Figure 6-5: Calcium sulfate scaling in concentrate hose

Figure 6-6: Solidified GAC

7.0 CONCLUSIONS AND FINDINGS

The Phase 2 RO pilot at Panoche operated from August to December 2005. Two separate tests were conducted on the RO skid using different antiscalants/antiscalant mixtures and RO recoveries. Based on the results of the two tests, the following conclusions and findings are presented:

- In Test 1 the RO system was operated at a recovery of 64%. The RO skid ran for 1,357 hours before scaling forced its shutdown.

- In Test 2 the RO system was operated at a recovery of 55%. The RO skid ran for 865 hours before scaling forced its shutdown.

- Neither the dendrimer based PWT Spectraguard antiscalant nor the mixture of Spectraguard and the phosphanate based GE-Betz Hypersperse MDC 150 could avert scaling problems at a recovery of 55%.

- A recovery of 64% in Test 1 produced a RO concentrate stream supersaturated in calcium sulfate that scaled the GAC of the downstream selenium biotreatment pilot. Additionly, the gear pump to Bioreactor 1 of the selenium biotreatment pilot scaled every 1-2 days. The severity of scaling required replacement of the GAC media and re-inoculation of Bioreactor 1.

- The Phase 2 RO pilot at Panoche encountered scaling problems that were not encountered during the Phase 1 pilot which operated at 50% recovery. Scaling problems with the selenium biotreatment system were also not encountered during the Phase 1 RO pilot.

- Due to the scaling problem with the RO and selenium biotreatment systems, RO recoveries higher than 50% are not recommended for the design of a full-scale treatment system for the San Luis Drainage Feasibility Study.

8.0 REFERENCES

Boyle Engineering (2004), *Red Rock Ranch RO Pilot Report*, Boyle Engineering Corporation, Bakersfield, CA

Reclamation(2005), *Reverse Osmosis Pilot Study for Treatment of Agricultural Drainwater in the San Joaquin Valley, California, Phase I Pilot Study conducted at Panoche Water District August 2004 – December 2004*, Draft Report, United States Dept. of Interior, Bureau of Reclamation, Technical Service Center, Water Treatment Engineering and Research Group.

APPENDIX A

Bryte Laboratories Results

Table A - 3
Bryte Laboratory Analysis for Panoche WD RO Pilot
11/23/04 - 12/14/04

Bryte Laboratory Analyses for Panoche WD Desalting Project
11/23/04 - 12/14/04

			Feed	Permeate	Concentrate	Filtrate	Feed	Permeate	Concentrate	Filtrate	Feed	Permeate	Concentrate	Filtrate	Feed	Permeate	Concentrate	Filtrate
			FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1104	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204	FWA1204
			B0982	B0983	B0984		B0996	B0997	B0998		B1057	B1058	B1059		B1089	B1090	B1075	B1091
		Collection Date:	11/23/2004	11/23/2004	11/23/2004	11/23/2004	11/30/2004	11/30/2004	11/30/2004	11/30/2004	12/7/2004	12/7/2004	12/7/2004	12/7/2004	12/14/2004	12/14/2004	12/14/2004	12/14/2004
Analyte		**Units**				None				None				None				
	EC	uS/CM	8100	189	14000		8100	185	13700		7160	170	12600		7400	203	11650	
Dissolved	Ammonia	mg/L as N													<.01	0.02	<.01	
Dissolved	Bicarbonate	mg/L as CaCO3	227	11	425		236	8	440		227	8	419		205	8	338	
Dissolved	Boron	mg/L													14.2	8.8	17.8	
Dissolved	Calcium	mg/L	539	<1	834		581	1	1110		572	1	912		567	<1	940	
Dissolved	Carbonate	mg/L	1	<1	3		1	<1	4		1	<1	3		1	<1	2	
Dissolved	Chloride	mg/L	907	25	1690		951	24	1660		976	26	1830		949	26	1580	
Dissolved	Hardness	mg/L as CaCO3																
Dissolved	Hydroxide	mg/L as CaCO3	<1	<1	<1		<1	<1	<1		<1	<1	<1		<1	<1	<1	
Dissolved	Magnesuim	mg/L	171	<1	328		167	<1	324		173	<1	322		180	<1	298	
Dissolved	Nitrate	mg/L	214	36.9	402		260	36.4	430		239	37.4	437		254	38.2	405	
Dissolved	Nitrate+Nitrite	mg/L as N																
Dissolved	Organic Carbon														4	0.1	7.7	
Dissolved	Potassium	mg/L													3.4	<.5	<10	
Dissolved	Selenium	mg/L	0.2	<.001	0.376		0.135	<.001	0.32		0.197	<.001	0.366		0.213	<.001	0.329	
Dissolved	Silica	mg/L													27.2	0.5	46.2	
Dissolved	Sodium	mg/L	1170	32	2200		1160	34	2260		1210	33	2340		1220	32	2080	
Dissolved	Sulfate	mg/L	3080	1	5820		3050	1	5410		3140	2	5930		3100	1	5270	
	pH	pH units	7.8	6.5	7.8		7.7	6.1	7.9		7.6	6.1	7.9		7.6	5.8	7.8	
Total	Alkalinity	mg/L as CaCO3	228	11	428		237	8	443		228	8	422		206	8	340	
Total	Arsenic	mg/L													<.01	<.001	<.01	
Total	Barium	mg/L													0.5	<.05	<.5	
Total	Dissolved Solids	mg/L	6376	115	12280		6220	109	11790		6376	103	12140		6476	133	10970	
Total	Iron	mg/L													<.05	<.005	<.05	0.111
Total	Manganese	mg/L													<.05	<.005	<.05	<.05
Total	Organic Carbon	mg/L as C													3.7	0.1	6.9	
Total	Phosphorous	mg/L													0.02	0.01	1.3	
Total	Selenium	mg/L	0.2	<.001	0.39		0.155	<.001	0.297		0.201	<.001	0.372		0.239	<.001	0.345	
Total	Strontium	mg/L													8.71	<.005	14.4	
Total	Suspended Solids	mg/L													2.8	<1	2.8	
	UV254 at nm	absorb/cm													0.108	0.004	0.191	

Field Measurements

Analysis	Unit of Measure	11/23/2004	11/23/2004	11/23/2004	11/23/2004	11/30/2004	11/30/2004	11/30/2004	11/30/2004	12/7/2004	12/7/2004	12/7/2004	12/7/2004	12/14/2004	12/14/2004	12/14/2004	12/14/2004
		Feed (DP25)	Permeate	Concentrate	Filtrate	Feed (DP25)	Permeate	Concentrate	Filtrate	Feed (DP25)	Permeate	Concentrate	Filtrate	Feed (DP25)	Permeate	Concentrate	Filtrate
		Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D	Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D	Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D	Sample Pt A	Sample Pt B	Sample Pt C	Sample Pt D
EC	mS/cm	8.68	0.205	13.18	X	8.68	0.206	13.18	X	7.94	0.197	13.71	X	7.93	0.21		7.85
DO	mg/L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	pH unit	8.21	9.4	8.47	X	8.21	9.4	8.47	X	7.81	8.65	7.46	X	7.92	8.64	X	7.51
ORP	mV	19	12	-21	X	19	12	-21	X	2	7	32	X	X	27	X	60
SDI	dimensionless	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temperature	C	17.1	17.9	16.4	X	17.1	17.9	16.4	X	16.8	18.1	18.3	X	18	18.2	X	17.6
Turbidity	NTU	0.61	0.17	0.95	X	0.61	0.17	0.95	X	0.25	0.18	0.19	X	0.35	0.22	X	0.22

Other Field Measurements

Measurement	Unit of Measure	11/23/2004 Feed	11/23/2004 Permeate	11/23/2004 Concentrate	11/30/2004 Feed	11/30/2004 Permeate	11/30/2004 Concentrate	12/7/2004 Feed	12/7/2004 Permeate	12/7/2004 Concentrate	12/14/2004 Feed	12/14/2004 Permeate	12/14/2004 Concentrate
Flow	L p m	23.98	12.08	12.16	23.98	12.08	12.16	23.55	11.23	12.15	23.6	11.05	11.7
Pressure	kPa	1665	974	1323	1665	974	1323	1688	1003	1347	1645		1543
Flow	gpm	6.33	3.19	3.21	6.33	3.19	3.21	6.22	2.96	3.21	6.23	2.92	3.09
Pressure	psi	241.4	141.2	191.8	241.4	141.2	191.8	244.8	145.4	195.3	238.5	0.0	223.7

APPENDIX B

Analysis of Water Chemistry Data

B.1 Summary of Water Quality Analysis – Test 1

Analysis of water samples was conducted by Bryte Labs, and plots of the lab analysis for Test 1 (August 17 – October 14, 2005) are provided in Figures B-1 to B-11. Detailed summary tables of the lab results are provided in Appendix A. Figure B-1 represents the cation/anion balance while Figure B-2 is the ratio of sum of ions to TDS. Both plots represent the quality of the lab data for the pilot. For the cation/anion balance, the ratio should fall in the range of ±5%. The average cation/anion ratio is given in Table B-1 and shows that, on average, the ±5% criteria are met for all three flow streams. The raw data in Figure B-1 shows an erratic data point for the concentrate for September 6. For the ratio of sum of ions to TDS, values should be around 1.05 since the sum of ions should always be slightly higher than TDS. This is due to losses in bicarbonate in the TDS analysis. The average sum of ions to TDS ratio for the feedwater and concentrate streams is 1.06. The product water is slightly lower with an average of 0.95. The raw data in Figure B-2 shows erratic data points for the concentrate stream.

Table B- 1- Average Cation/Anion Balance Ratio & Sum of Ions to TDS Ratio

Source	Cation/Anion Balance Ratio Average	Sum of Ions to TDS Ratio Average
Feedwater	-4.07%	1.06
Product Water	-2.67%	0.95
Concentrate Water	-3.45%	1.06

Figures B-3 and B-4 show the RO feedwater species concentration in mg/L and meq/L respectively. Average TDS concentration is 10,728 mg/L and varies from a low of 8,280 mg/L on August 30 to a high of 14,620 mg/L on October 4. Average sulfate concentration is 5,203 mg/L and varies from a low of 4,000 mg/L to a high of 7,150 mg/L. Average sodium and chloride concentrations are 2,378 mg/L and 1,840 mg/L respectively. Sodium varies from 1,780 mg/L to 3,370 mg/L while chloride varies from 1,280 mg/L to 2,660 mg/L. Average nitrate concentration is 414 mg/L and ranges from a low of 312 mg/L to a high of 549 mg/L. Other constituents analyzed are summarized in Table B-2.

Table B- 2 - RO Feedwater Species Concentration

	Average		Minimum		Maximum	
Species	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	10,728		8,280		14,620	
Sulfate	5,203	108.32	4,000	83.28	7,150	148.86
Sodium	2,378	103.42	1,780	77.43	3,370	146.59
Chloride	1,840	51.90	1,280	36.10	2,660	75.03
Calcium	576	28.74	481	24.00	749	37.38
Bicarbonate	319	5.22	238	3.90	390	6.39
Nitrate	414	6.68	312	5.03	549	8.85
Magnesium	319	26.24	237	19.50	458	37.68

Figures B-5 and B-6 show the RO product water species concentration in mg/L and meq/L respectively. Average TDS concentration is 215 mg/L and varies from a low of 170 mg/L on August 30 to a high of 252 mg/L on August 23. Average sulfate concentration is 10 mg/L and varies from a low of 6 mg/L to a high of 31 mg/L. Average sodium and chloride concentrations are 60 mg/L and 53 mg/L respectively. Sodium varies from 46 mg/L to 71 mg/L while chloride varies from 39 mg/L to 65 mg/L. Average nitrate concentration is 63 mg/L and ranges from a low of 53 mg/L to a high of 76 mg/L. Other constituents analyzed are summarized in Table B-3.

Table B- 3 - RO Product Water Species Concentration

	Average		Minimum		Maximum	
Species	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	215		170		252	
Sulfate	10	0.21	6	0.12	31	0.65
Sodium	60	2.59	46	2.00	71	3.09
Chloride	53	1.48	39	1.10	65	1.83
Calcium	1	0.07	1	0.05	4	0.20
Bicarbonate	12	0.19	9	0.15	13	0.22
Nitrate	63	1.02	53	0.85	76	1.23
Magnesium	1	0.09	1	0.08	2	0.16

Figures B-7 and B-8 show the RO concentrate water species concentration in mg/L and meq/L respectively. Average TDS concentration is 23,670 mg/L and varies from a low of 22,280 mg/L on September 20 to a high of 26,040 mg/L on October 4. Average sulfate concentration is 11,725 mg/L and varies from a low of 10,900 mg/L to a high of 13,100 mg/L. Average sodium and chloride concentrations are 5,504 mg/L and 3,865 mg/L respectively. Sodium varies from 4,820 mg/L to 6,460 mg/L while chloride varies from 1,820 mg/L to 4,840 mg/L. Average nitrate concentration is 868 mg/L and ranges from a low of 806 mg/L to a high of 968 mg/L. Other constituents analyzed are summarized in Table B-4.

Table B- 4 - RO Concentrate Water Species Concentration

	Average		Minimum		Maximum	
Species	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	23,670		22,280		26,040	
Sulfate	11,725	244.11	10,900	226.94	13,100	272.74
Sodium	5,504	239.40	4,820	209.66	6,460	280.99
Chloride	3,865	109.02	1,820	51.34	4,840	136.52
Calcium	1,070	53.39	518	25.85	1,390	69.36
Bicarbonate	730	11.96	610	9.99	881	14.44
Nitrate	868	14.00	806	13.00	968	15.61
Magnesium	747	61.44	681	56.02	853	70.17

Total selenium concentration is presented in Figure B-9 and summarized in Table B-5. Average selenium of the feedwater is 0.877 mg/L and varied from 0.429 mg/L to 2.2 mg/L. Average selenium concentration of the product water and concentrate water is 0.002 mg/L and 1.745 mg/L respectively.

Table B- 5 - Total Selenium Concentration

Source	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
Feedwater	0.877	0.429	2.200
Product Water	0.002	0.001	0.002
Concentrate Water	1.745	1.230	2.420

System pH is provided in Figure B-10 and summarized in Table B-7. Average pH of the feedwater is 7.48 and varied from 7.30 to 7.60. Average pH of the product water and concentrate water is 6.14 and 7.68 respectively. The product water varied from 6.1 to 6.2 and the concentrate water varied from 7.60 to 7.80.

Table B- 6 - System pH

Source	Average	Minimum	Maximum
Feedwater	7.48	7.30	7.60
Product Water	6.14	6.10	6.20
Concentrate Water	7.68	7.60	7.80

A plot of rejection is given in Figure B-11. Average rejection values are given in Table B-8. Divalent species (calcium, magnesium, sulfate and selenate), have rejections of around 99.8% or higher. Monovalent species (sodium and chloride) have rejections around 98.1% or higher. Rejection of TDS is around 98.7% while rejection of bicarbonate is 97.8%. The species with the lowest rejection is nitrate at 90.1%.

Table B- 7 - Average Rejection

Species	Average
Sodium	98.5%
Calcium	99.8%
Magnesium	99.8%
Chloride	98.1%
Bicarbonate	97.8%
Sulfate	99.9%
Nitrate	90.1%
Selenate	99.9%
TDS	98.7%

Figure B- 1 - Cation/Anion Balance (Test 1)

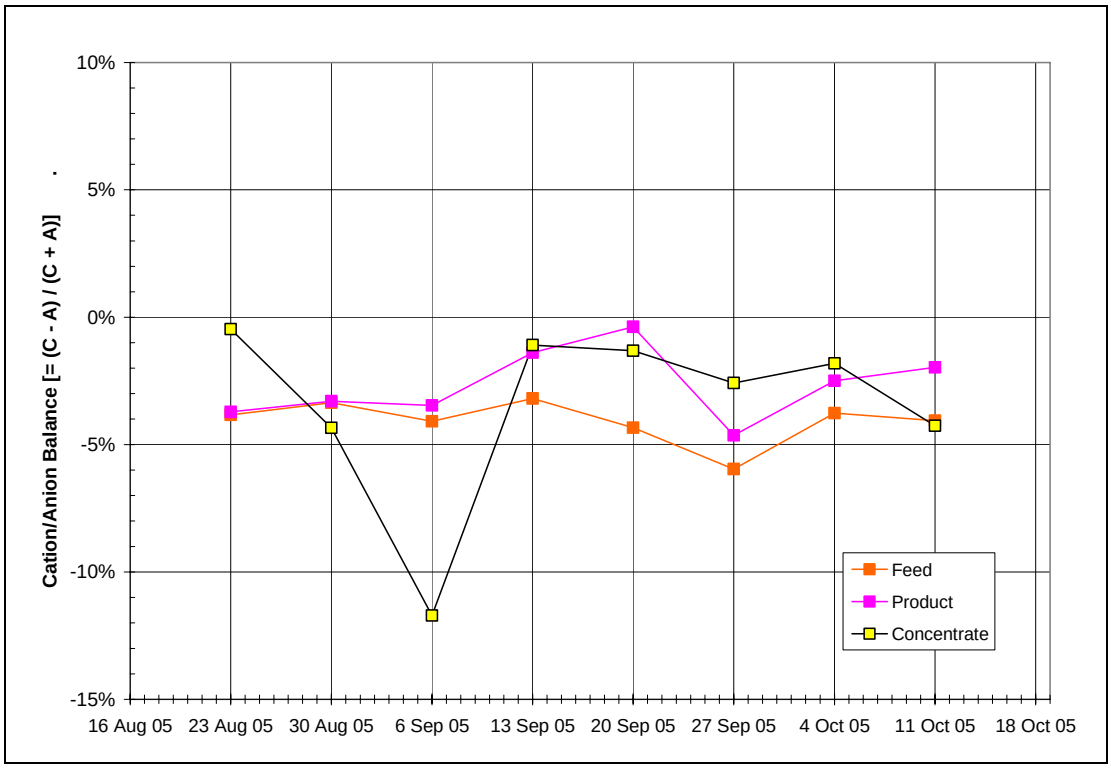


Figure B- 2 - Ratio of Sum of Ions to TDS (Test 1)

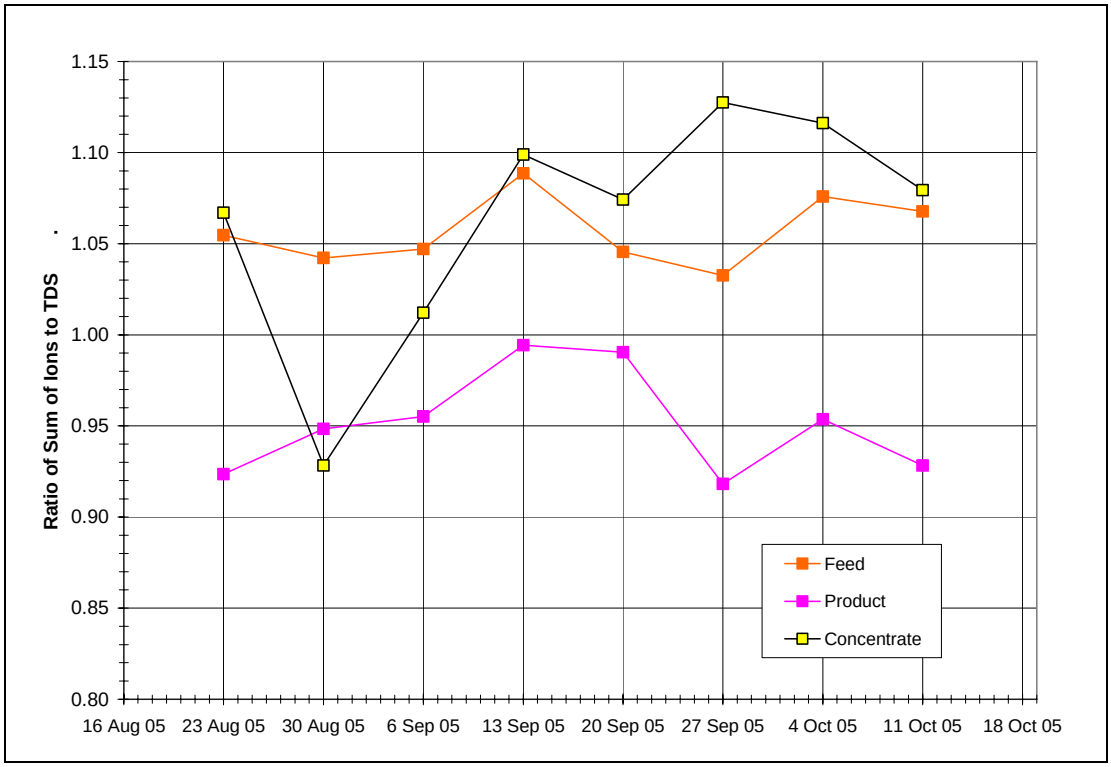


Figure B- 3 - RO Feed Species Concentrations (mg/L, Test 1)

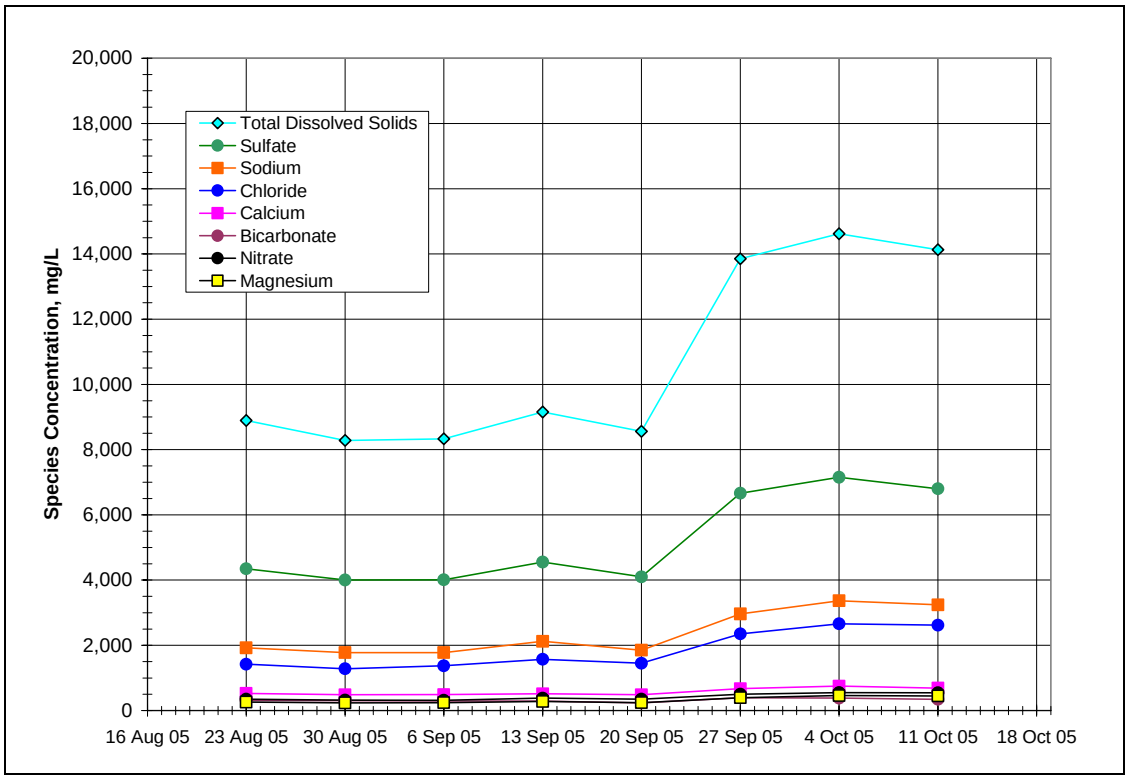


Figure B- 4 - RO Feed Species Concentrations (meq/L, Test 1)

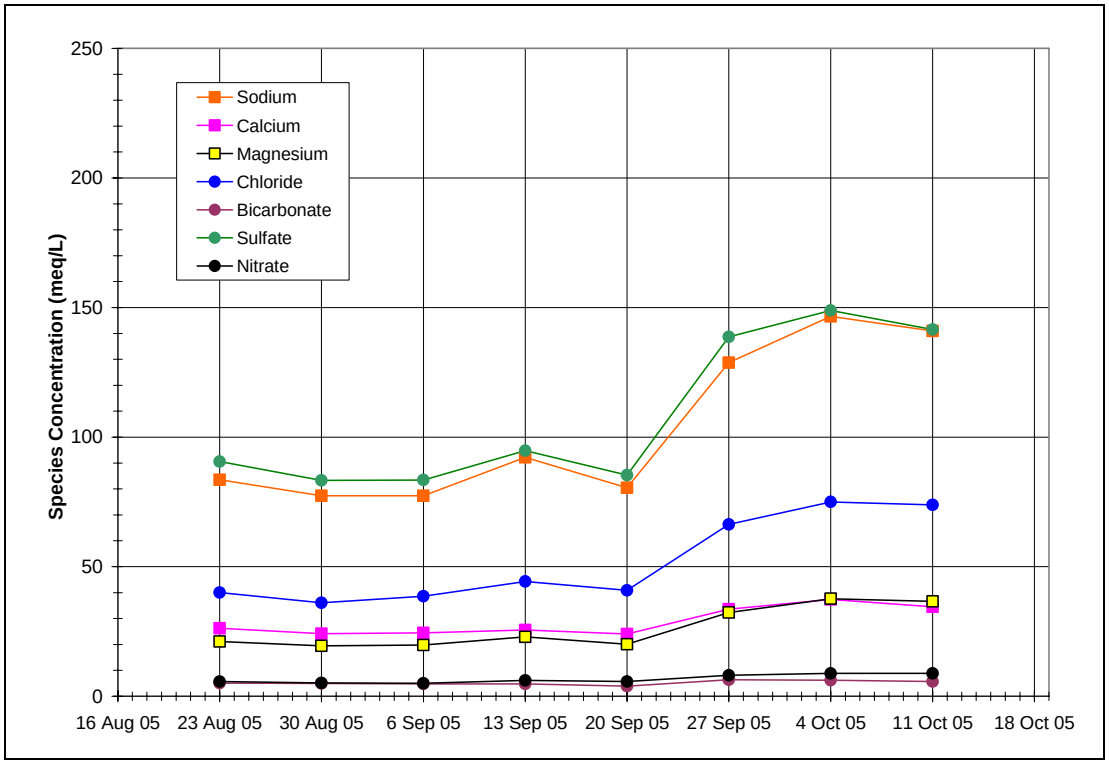


Figure B- 5 - RO Product Species Concentrations (mg/L, Test 1)

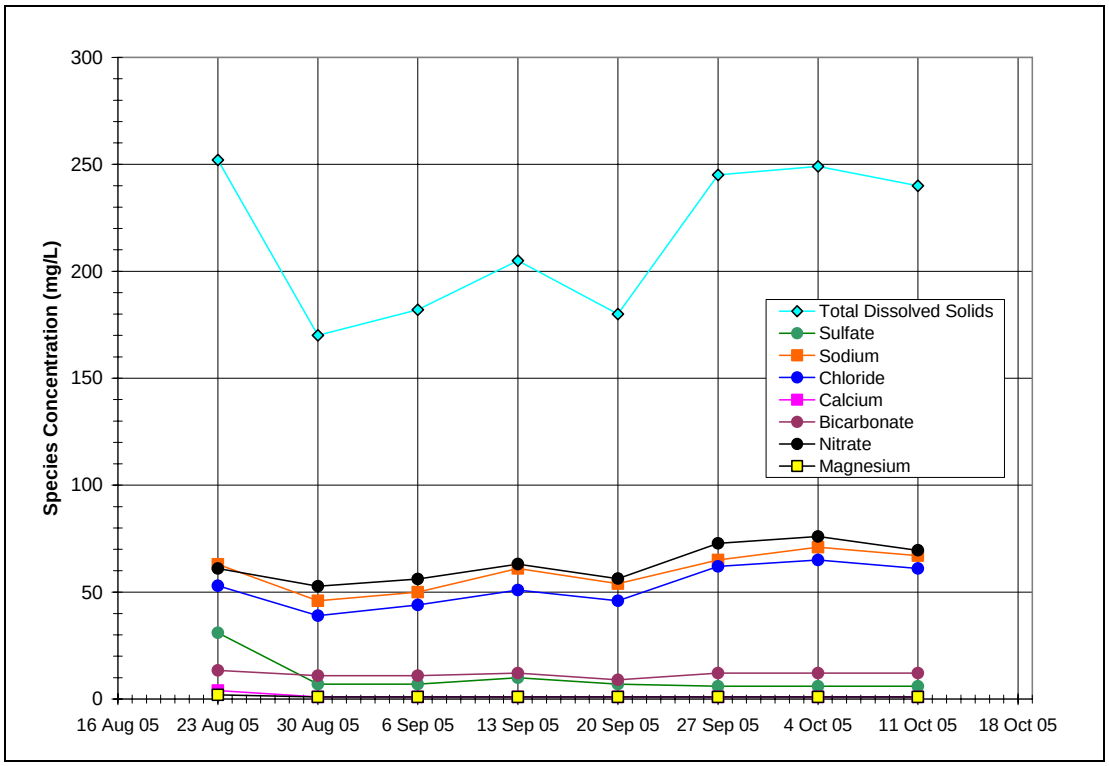


Figure B- 6 - RO Product Species Concentrations (meq/L, Test 1)

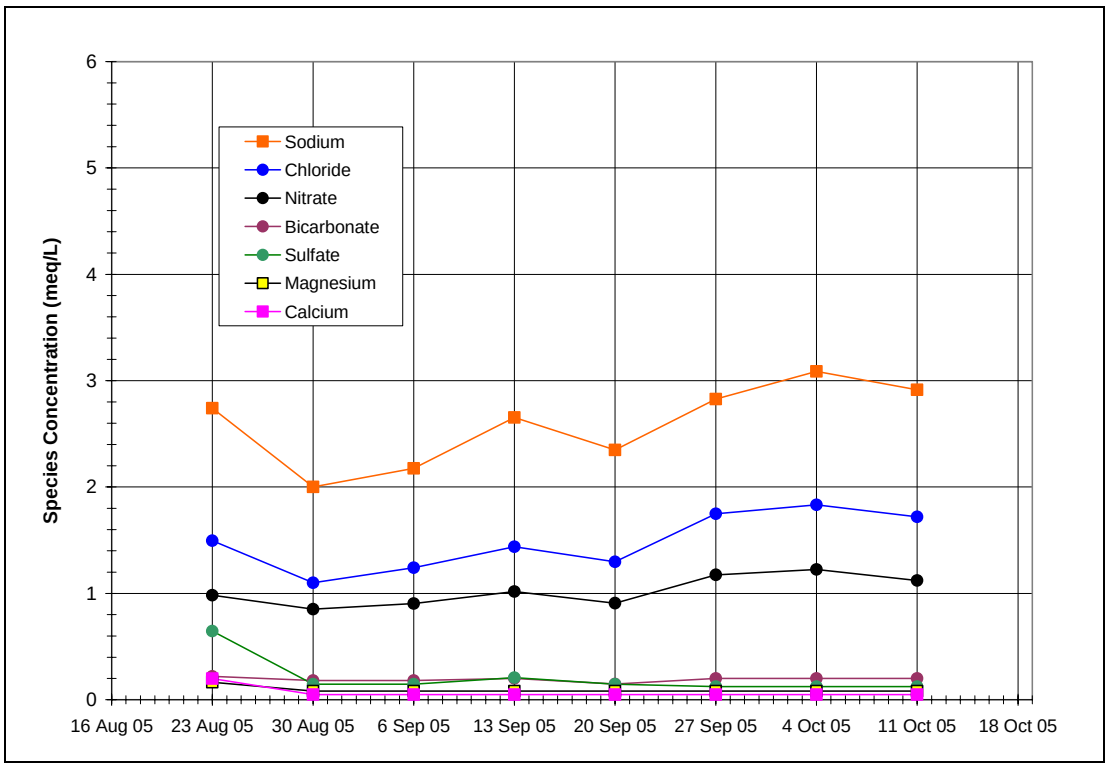


Figure B- 7 - RO Concentrate Species Concentrations (mg/L, Test 1)

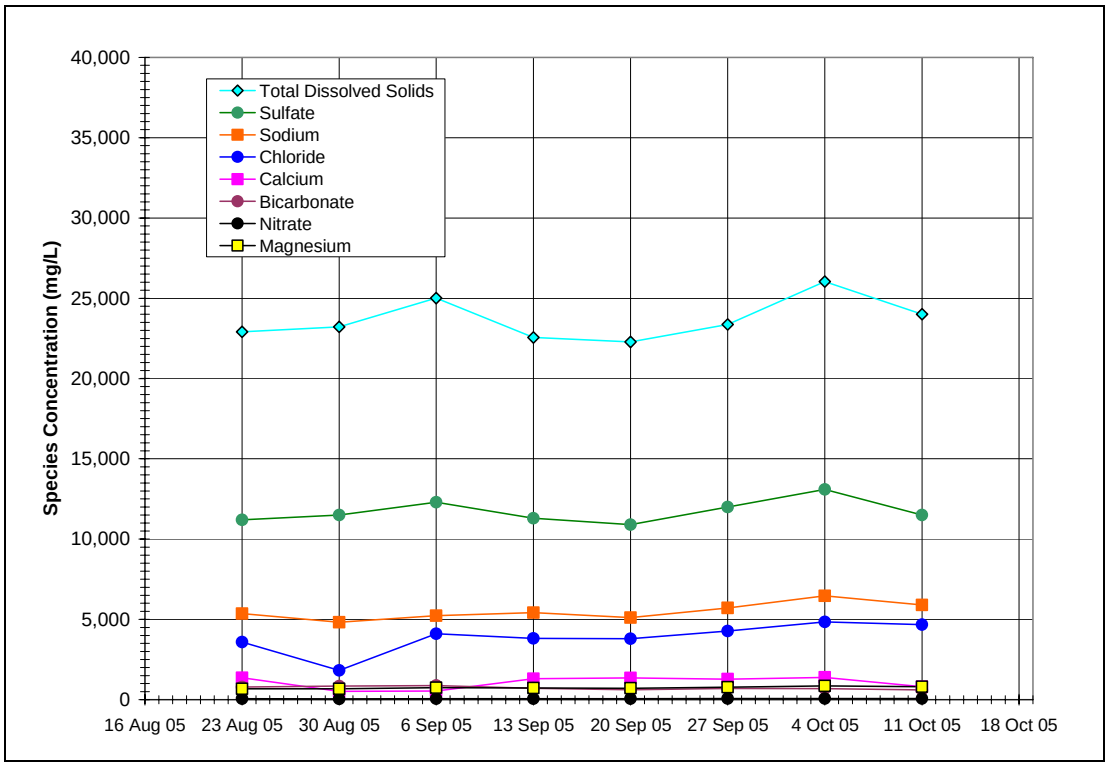


Figure B- 8 - RO Concentrate Species Concentrations (meq/L, Test 1)

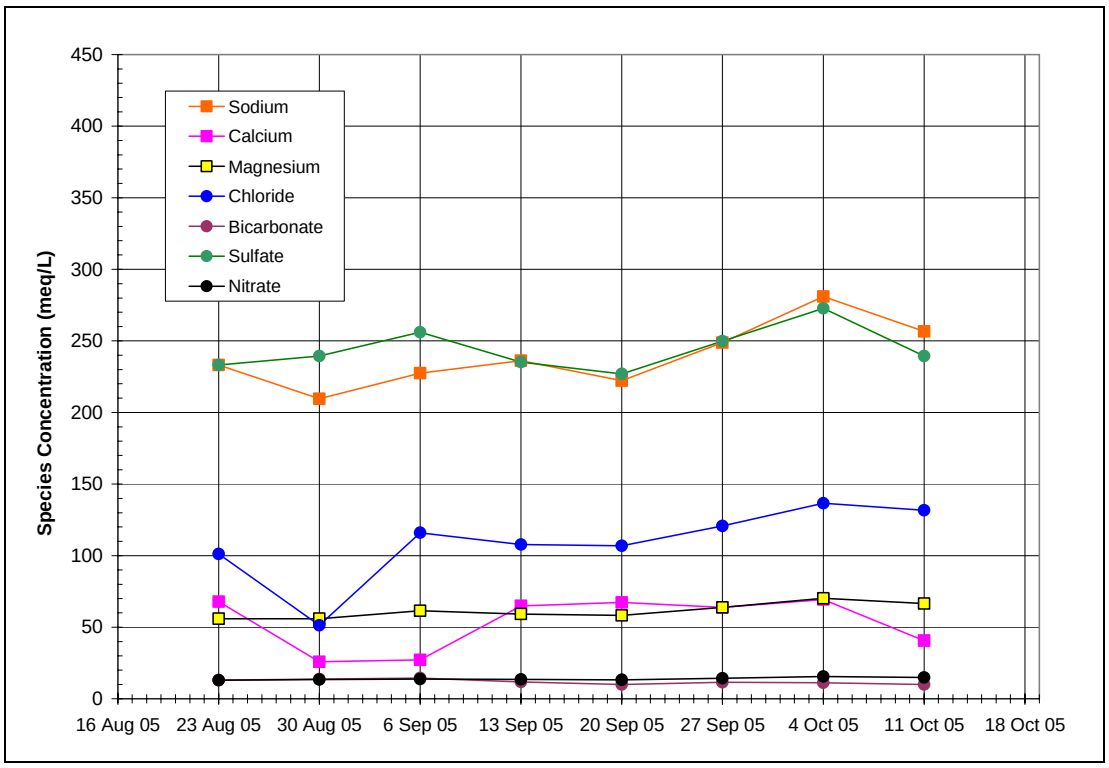


Figure B- 9 - Total Selenium Concentrations (mg/L, Test 1)

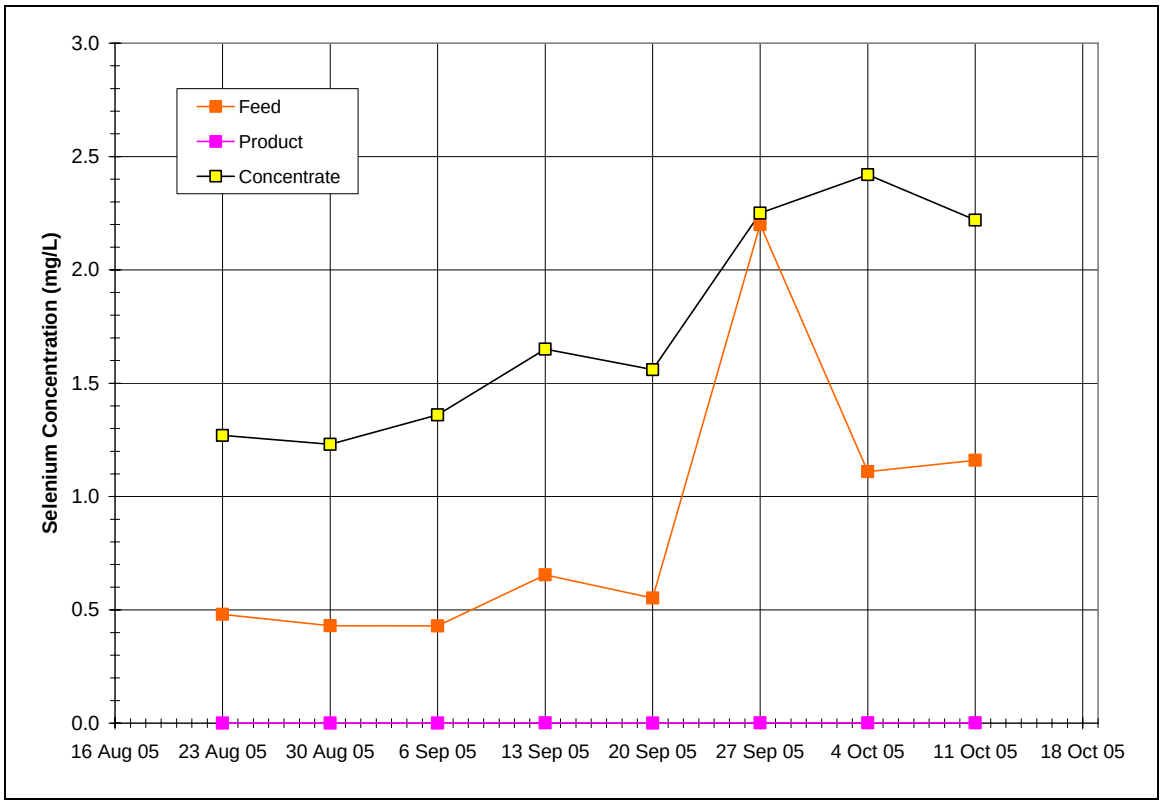


Figure B- 10 - RO System pH (Test 1)

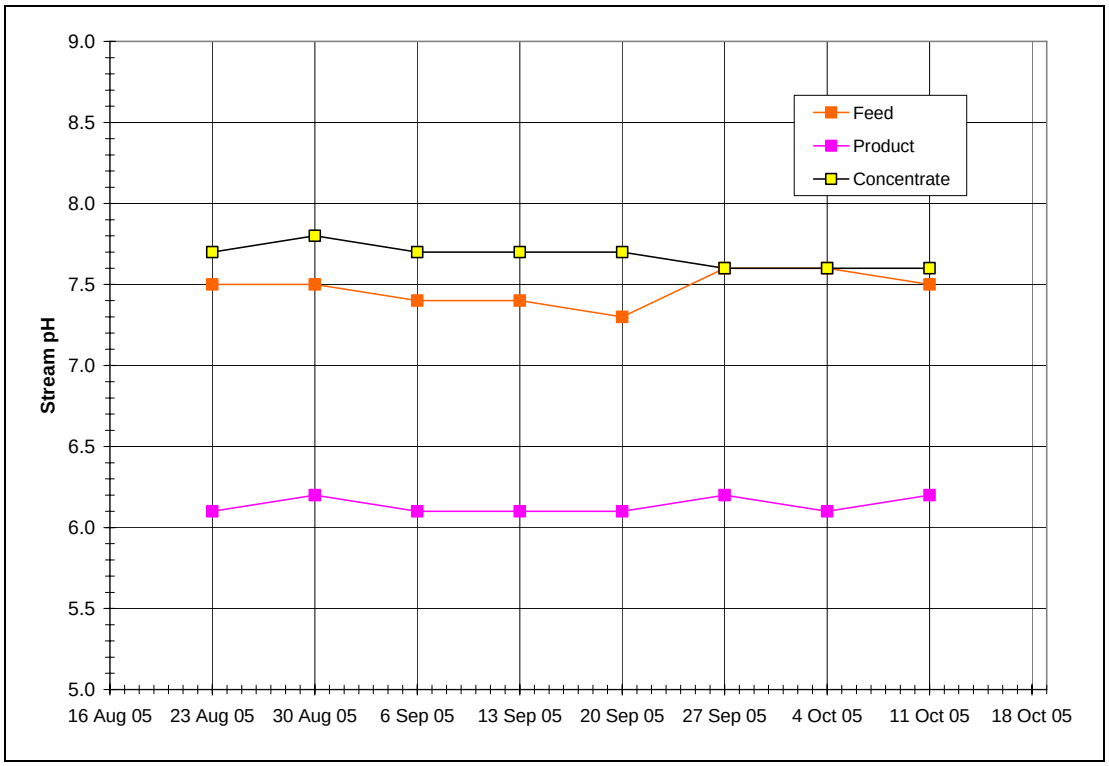
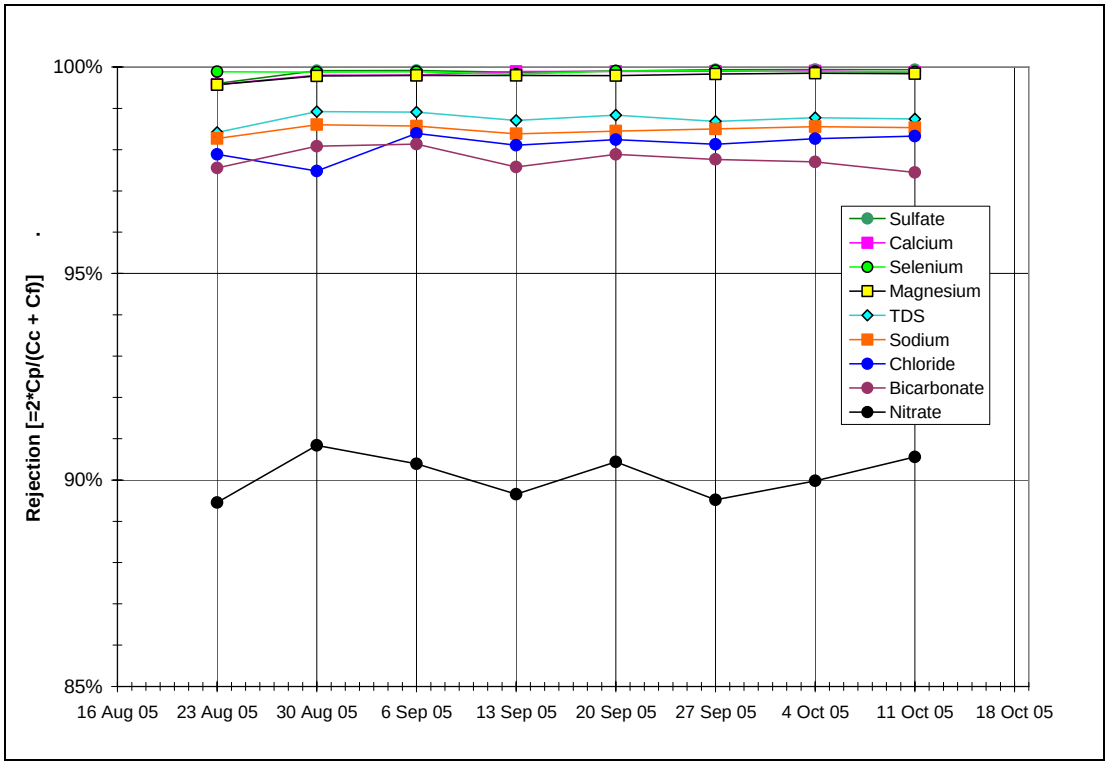


Figure B- 11 – Rejection of Dissolved Ions (Test 1)



B.2 Summary of Water Quality Analyses – Test 2

Analyses of water samples were conducted by Bryte Laboratories, and plots of the lab analyses for Test 2 (October 26 – December 12, 2005) are provided in Figures B-12 to B-22. Detailed summary tables of the lab results are provided in Appendix A. Figure B-12 represents the cation/anion balance while Figure B-13 is the ratio of sum of ions to TDS. Both plots represent the quality of the lab data for the pilot. The average cation/anion ratio is given in Table B-9 and shows that, on average, the ±5% criteria are met for all three flow streams. The sum of ions to TDS ratio for the feedwater and concentrate streams is 1.05 and 1.03 respectively. The product water is slightly lower at 0.93. The raw data given in Figure B-13 shows some erratic data in the product stream.

Table B- 9- Average Cation/Anion Balance Ratio & Sum of Ions to TDS Ratio

Source	Cation/Anion Balance Ratio Average	Sum of Ions to TDS Ratio Average
Feedwater	-0.51%	1.05
Product Water	-0.19%	0.93
Concentrate Water	-1.53%	1.03

Figures B-14 and B-15 show the RO feedwater species concentration in mg/L and meq/L respectively. Average TDS concentration is 11,996 mg/L and varies from a low of 6,376 mg/L to a high of 17,280 mg/L. Average sulfate concentration is 5,334 mg/L and varies from a low of 3,100 mg/L to a high of 7,410 mg/L. Average sodium and chloride concentrations are 2,996 mg/L and 2,281 mg/L respectively. Sodium varies from 1,210 mg/L to 4,720 mg/L while chloride varies from 949 mg/L to 3,550 mg/L. Average nitrate concentration is 468 mg/L and ranges from a low of 239 mg/L to a high of 662 mg/L. Other constituents analyzed are summarized in Table B-10.

Table B- 10 - RO Feedwater Species Concentration

	Average		Minimum		Maximum	
Species	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	11,996		6,376		17,280	
Sulfate	5,334	111.05	3,100	64.54	7,410	154.28
Sodium	2,996	130.32	1,210	52.63	4,720	205.31
Chloride	2,281	64.34	949	26.77	3,550	100.13
Calcium	564	28.16	544	27.15	587	29.29
Bicarbonate	294	4.81	250	4.10	317	5.19
Nitrate	468	7.55	239	3.85	662	10.68
Magnesium	357	29.34	173	14.23	526	43.27

Figures B-16 and B-17 show the RO product water species concentration in mg/L and meq/L respectively. Average TDS concentration is 266 mg/L and varies from a low of 103 mg/L to a high of 395 mg/L. Average sulfate concentration is 5 mg/L and varies from a low of 1 mg/L to a high of 9 mg/L. Average sodium and chloride concentrations are 75 mg/L and 66 mg/L respectively. Sodium varies from 32 mg/L to 118 mg/L while chloride varies from 26 mg/L to 106 mg/L. Average nitrate concentration is 73 mg/L and ranges from a low of 37 mg/L to a high of 107 mg/L. Other constituents analyzed are summarized in Table B-11.

Table B- 11 - RO Product Water Species Concentration

	Average		Minimum		Maximum	
Species	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	266		103		395	
Sulfate	5	0.11	1	0.02	9	0.19
Sodium	75	3.27	32	1.39	118	5.13
Chloride	66	1.86	26	0.73	106	2.99
Calcium	1	0.05	1	0.05	1	0.05
Bicarbonate	18	0.29	10	0.16	23	0.38
Nitrate	73	1.18	37	0.60	107	1.73
Magnesium	1	0.08	1	0.08	1	0.08

Figures B-18 and B-19 show the RO concentrate water species concentration in mg/L and meq/L respectively. Average TDS concentration is 23,582 mg/L and varies from a low of 10,970 mg/L to a high of 35,280 mg/L. Average sulfate concentration is 10,300 mg/L and varies from a low of 5,270 mg/L to a high of 15,500 mg/L. Average sodium and chloride concentrations are 5,742 mg/L and 4,530 mg/L respectively. Sodium varies from 2,080 mg/L to 9,320 mg/L while chloride varies from 1,580 mg/L to 7,430 mg/L. Average nitrate concentration is 858 mg/L and ranges from a low of 405 mg/L to a high of 1,250 mg/L. Other constituents analyzed are summarized in Table B-12.

Table B- 12 - RO Concentrate Water Species Concentration

	Average		Minimum		Maximum	
Species	(mg/L)	(meq/L)	(mg/L)	(meq/L)	(mg/L)	(meq/L)
Total Dissolved Solids	23,582		10,970		35,280	
Sulfate	10,300	214.45	5,270	109.72	15,500	322.71
Sodium	5,742	249.76	2,080	90.47	9,320	405.40
Chloride	4,530	127.77	1,580	44.57	7,430	209.57
Calcium	979	48.87	655	32.68	1,210	60.38
Bicarbonate	540	8.85	412	6.76	645	10.57
Nitrate	858	13.84	405	6.53	1,250	20.16
Magnesium	705	57.98	298	24.51	1,040	85.55

Total selenium concentration is presented in Figure B-20 and summarized in Table B-13. Average selenium of the feedwater is 1.575 mg/L and varied from 0.201 mg/L to 4.130 mg/L. Average selenium concentration of the product water and concentrate water is 0.002 mg/L and 2.417 mg/L respectively.

Table B- 13 - Total Selenium Concentration

Source	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
Feedwater	1.575	0.201	4.130
Product Water	0.002	0.001	0.004
Concentrate Water	2.417	0.329	4.210

System pH is provided in Figure B-21 and summarized in Table B-14. Average pH of the feedwater is 7.86 and varied from 7.60 to 8.10. Average pH of the product water and concentrate water is 6.84 and 7.94 respectively. The product water varied from 5.8 to 7.5 and the concentrate water varied from 7.80 to 8.10.

Table B- 14 - System pH

Source	Average	Minimum	Maximum
Feedwater	7.86	7.60	8.10
Product Water	6.84	5.80	7.50
Concentrate Water	7.94	7.80	8.10

A plot of rejection is given in Figure B-22. Average rejection values are given in Table B-15. Divalent species (calcium, magnesium, sulfate and selenate), have rejections of around 99.8% or higher. Monovalent species (sodium and chloride) have rejections around 98.1% or higher. Rejection of TDS is around 98.5% while rejection of bicarbonate is 95.9%. The species with the lowest rejection is nitrate at 88.9%.

Table B- 15 - Average Rejection

Species	Average
Sodium	98.2%
Calcium	99.9%
Magnesium	99.8%
Chloride	98.1%
Bicarbonate	95.9%
Sulfate	99.9%
Nitrate	88.9%
Selenate	99.8%
TDS	98.5%

Figure B- 12 - Cation/Anion Balance (Test 2)

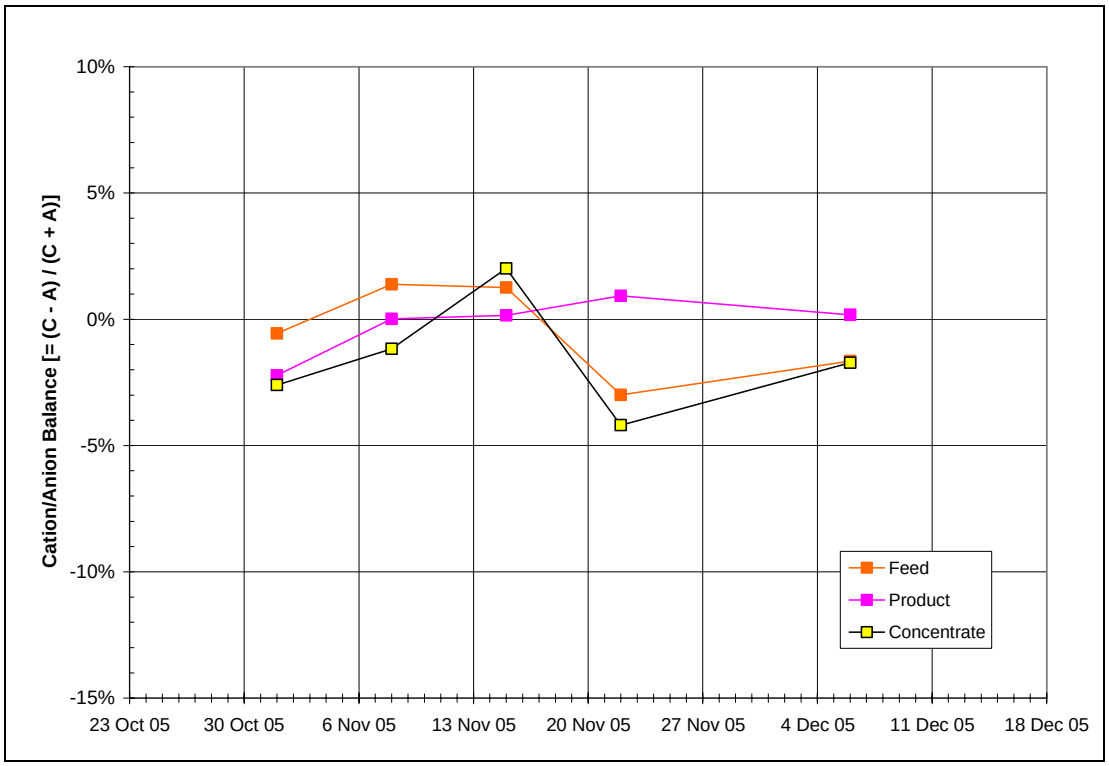


Figure B- 13 - Ratio of Sum of Ions to TDS (Test 2)

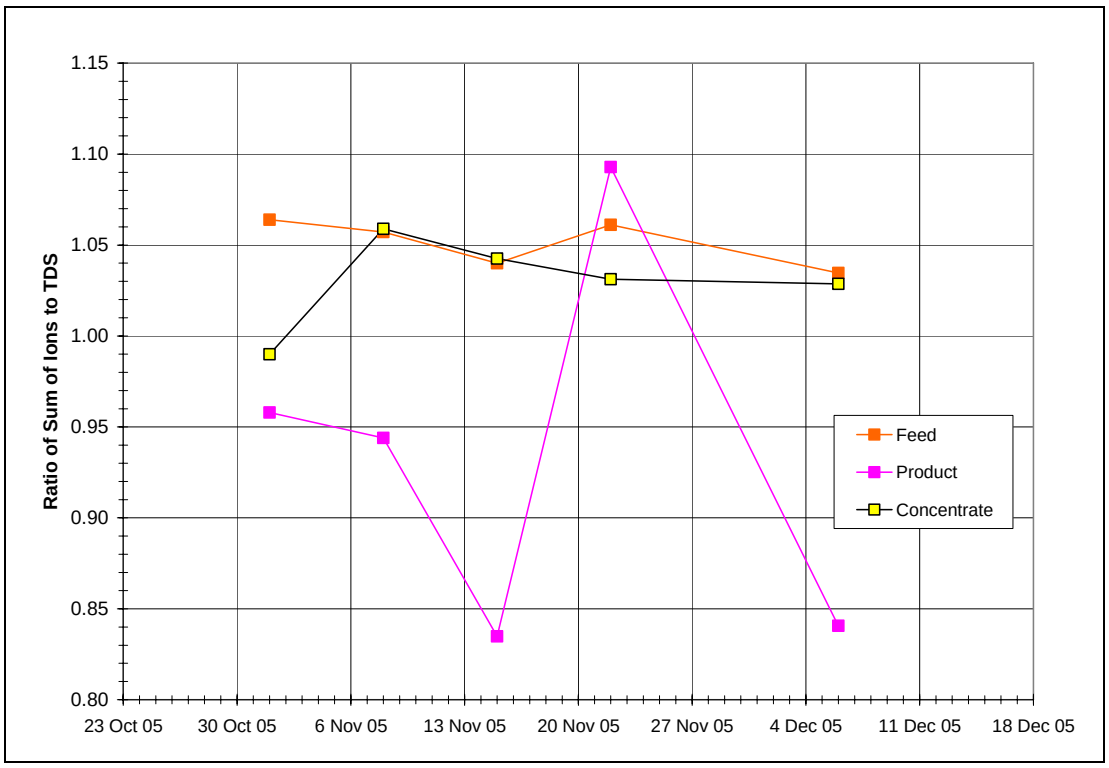


Figure B- 14 - RO Feed Species Concentration (mg/L, Test 2)

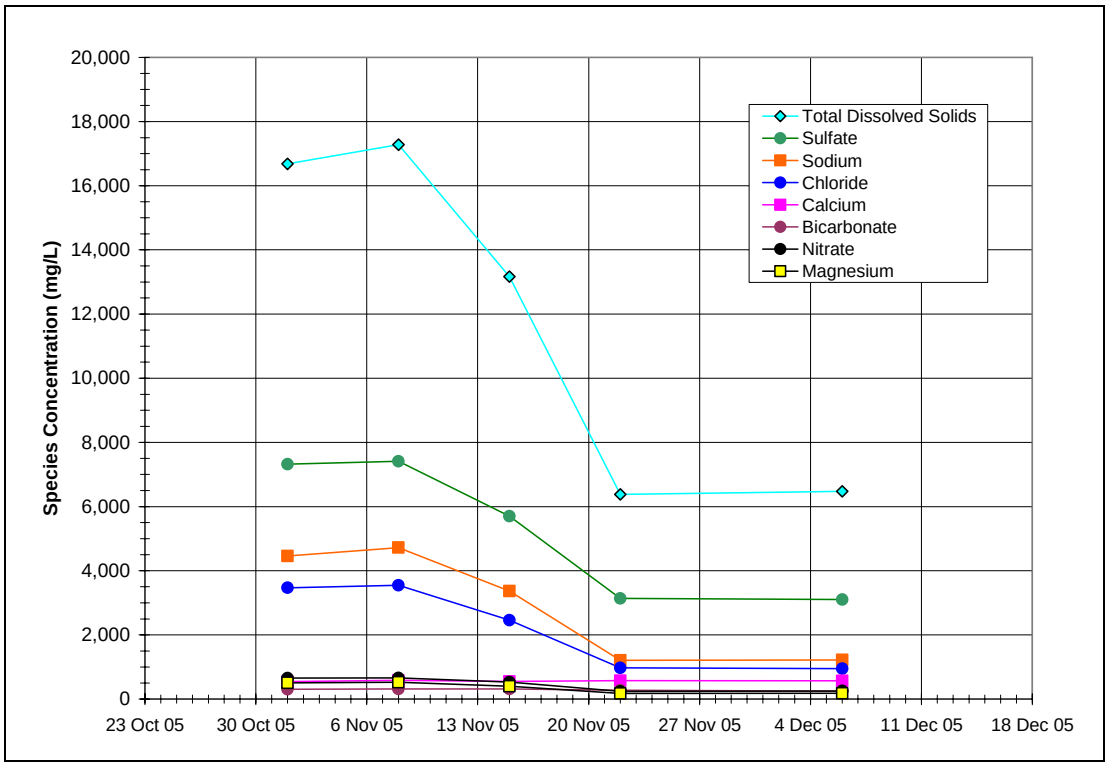


Figure B- 15 - RO Feed Species Concentration (meq/L, Test 2)

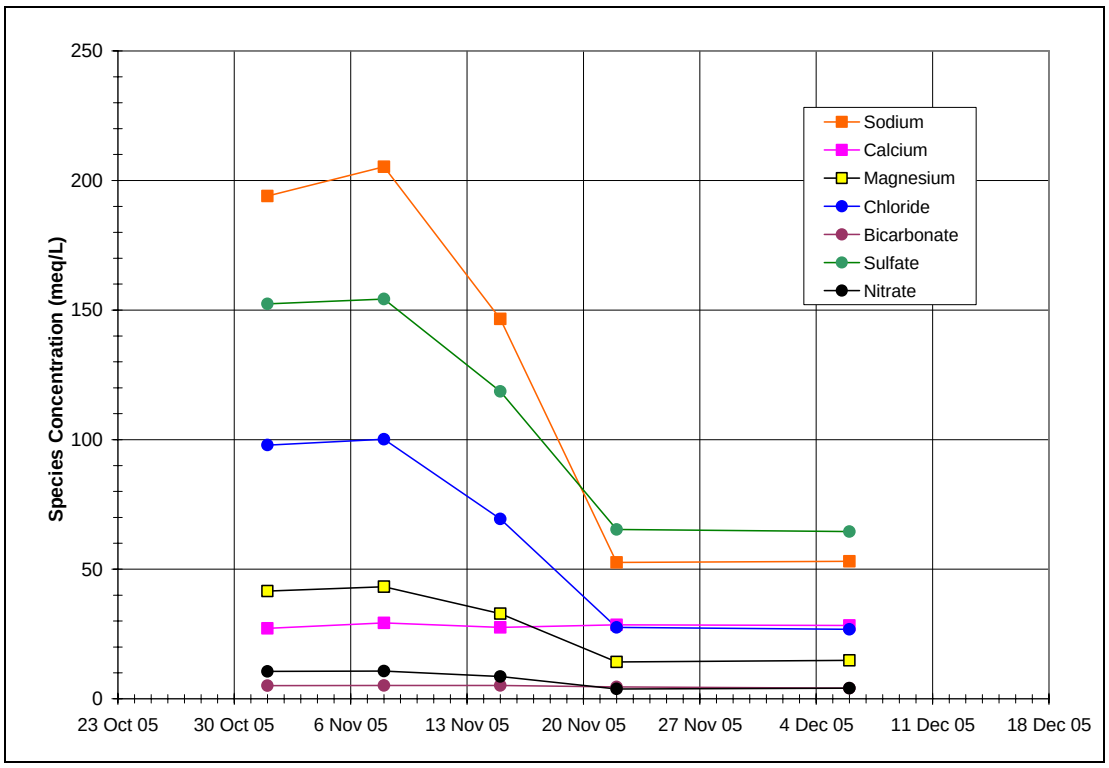


Figure B- 16 - RO Product Species Concentration (mg/L, Test 2)

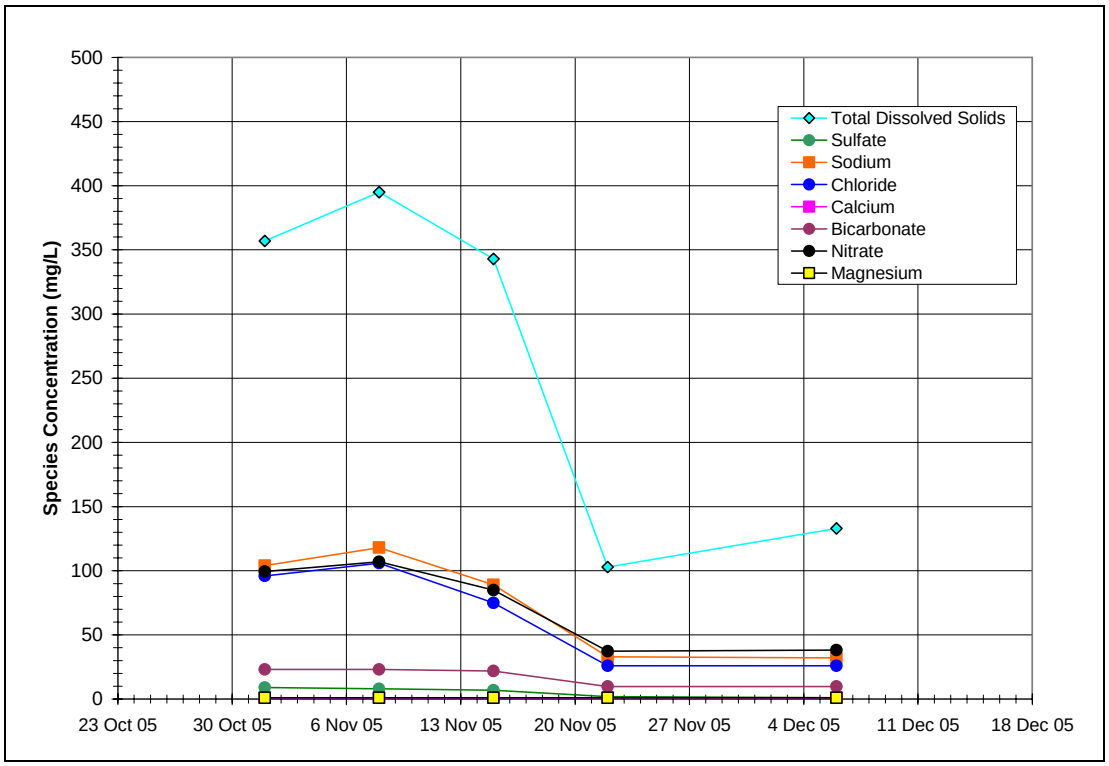


Figure B- 17 - RO Product Species Concentration (meq/L, Test 2)

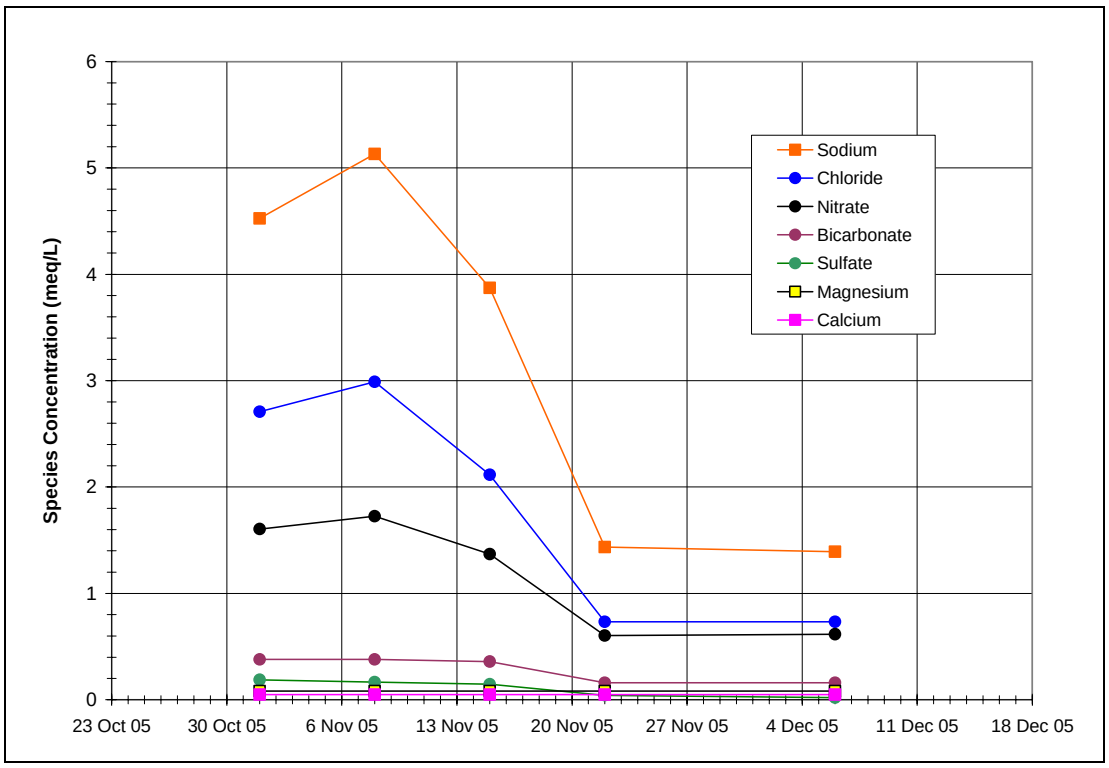


Figure B- 18 - RO Concentrate Species Concentration (mg/L, Test 2)

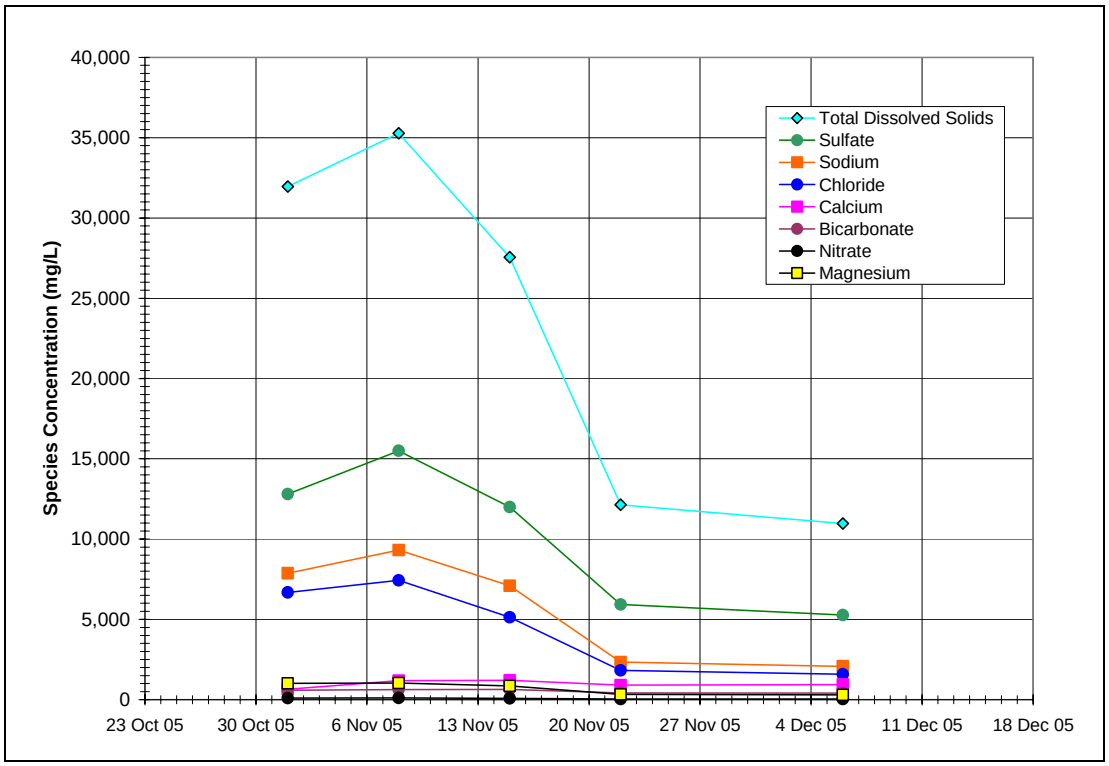


Figure B- 19 - RO Concentrate Species Concentration (meq/L, Test 2)

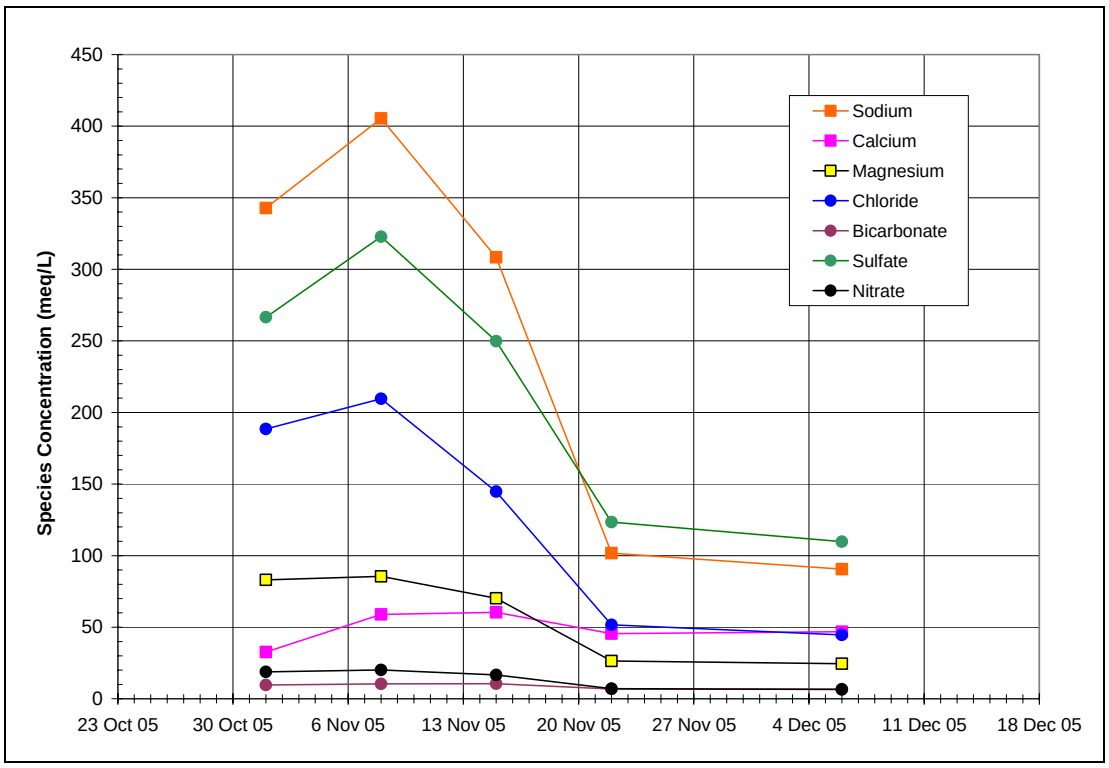


Figure B- 20 - Total Selenium Concentration (mg/L, Test 2)

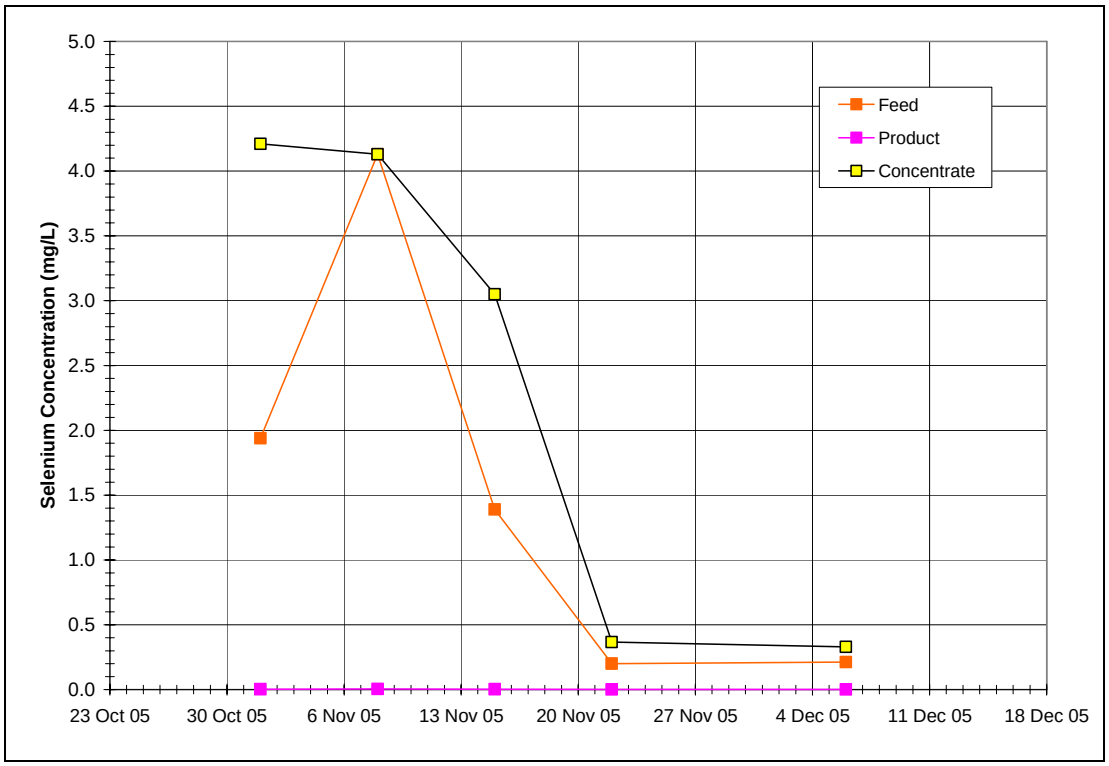


Figure B- 21 - RO System pH (Test 2)

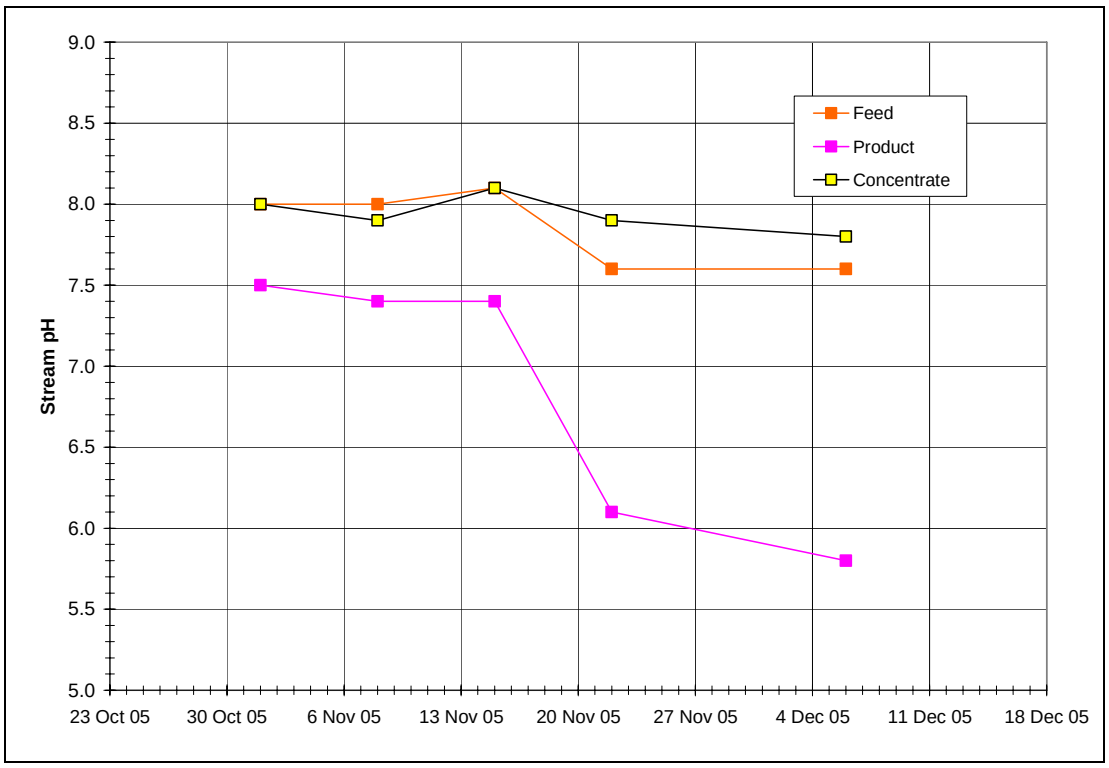
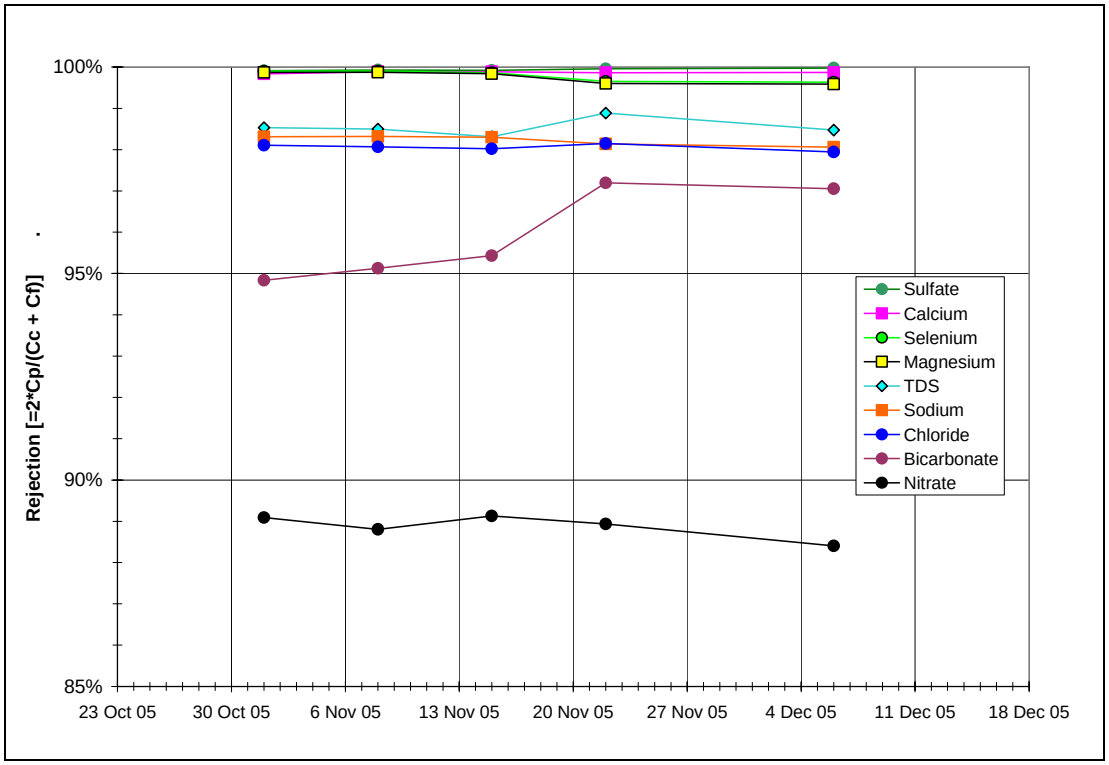


Figure B- 22 – Rejection (Test 2)



Appendix D

Reverse Osmosis Analyses Reports

Final Report on Processing Agricultural Drainage Water at Panoche Water District Site DP#25, with Double Pass Preferential Precipitation RO Treatment

Final Report on Processing Agricultural Drainage Water at Panoche Water District Site DP#25 with Double Pass Preferential-Precipitation Reverse Osmosis (DP^3RO^{TM})

USBR Contract Number: 04PG810313

Summary

PCI Membrane Systems was contracted to automate, monitor, and troubleshoot the DP^3RO^{TM} system located at Panoche Drainage District site DP#25, located in the San Joaquin Valley, in California. The system produced 1000's of gallons, water having low conductivity, from Calcium Sulfate saturated agricultural drainage water, and operated unattended for as much as a week. However, equipment and programming issues, and communication problems with this remote site, restricted our ability to fulfill the test objectives with continuous running not extended beyond a week at a single time.

Notwithstanding the difficulties maintaining operation of the system for extended periods, the membranes did perform stably at a first stage system recovery of 35%, RO system recovery of 85% with an overall recovery as high as 88%.

Rejection of salts in the tubular membrane system were stable measured over short continuous running periods. However step changes were seen during shutdown periods possibly due to membrane hydrolysis of the cellulose acetate membranes with the high pH and warm site temperatures.

Based on the performance of the membrane system and assuming a membrane life of 12 months, a full scale 250 gpm system running at 85% overall recovery would cost around $2.0 – $2.5m. Operating costs would be approximately $1215/AF. This cost does not include any credit for the recovered value of the treated water. Straight line 20 year depreciation on the capital cost would add $210/AF to the overall treatment cost. There would be a significant recovery of recycleable high quality water to off-set a part of this cost.

Background

Irrigation Drainage Water in the San Joachim Valley presents a significant water treatment challenge. The drainage water contains high levels of calcium sulfate at or almost at saturation levels, selenium and boron. These contaminants restrict the ability to reuse this water for further irrigation purposes and present treatment challenges to any water treatment process that might be adopted. The water quality at the test site at

typically contains levels of calcium 540 ppm, sulfate 3800 ppm, Boron 18 ppm, Selenium at 0.5 ppm with conductivities 9.3 dS/m[1].

Application of Membrane technologies to Drainage Water:

Reverse Osmosis technology gives an opportunity to produce a good quality filtrate stream for irrigation, and a smaller volume of more highly saline "reject". The presence of calcium sulfate in the drainwater, at or near saturation levels, limits the recovery of water available in a spiral RO system. As the feed water is dewatered, the calcium salts begin to precipitate out as the concentration of salts in the retained portion rises. Crystals form on the membrane surface reducing filtration rates blocking the feed channels. Precipitation can be inhibited by the addition of "anti-scalants" but still only 50% recovery at most can be achieved.

In addition to concentration of the salts, RO will also retain almost all the Selenium, but only 50% of the boron. The high level of Boron in the filtered water would require removal by further treatment or dilution with sufficient fresh irrigation water before the filtrate could be reused for unrestricted irrigation purposes. Since water districts in the Grassland Area already dilute their fresh irrigation water supplies with recycled untreated drainwater to the point of their tolerance of boron, a boron-removal step after the membrane process would probably be required for irrigation recycling.

Preferential Precipitation and Membrane Technology

WaterTech Partners developed the DP^{3}RO^{TM} process as an enhancement to a process developed and patented in the early 1980's by Howard Herrigal of the Resources Conservation Company (US Patent No 4,207,183). The original process seeded the feed stream to a tubular reverse osmosis plant containing high levels of sparsely soluble salts and used the principle of preferential precipitation to successfully avoid fouling of the membrane surface during concentration with the salts precipitating on the seed crystals rather than the membrane surface. The use of large enough diameter tubular membranes enable the recycling of the high suspended solids feed stream without fear of blocking up the pathways through the membrane. A simplified flow diagram of the Herrigal process is shown in Figure 1 below.

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[1] Enzweiller, RJ, Strasser, J. Full Scale Demonstration of Agricultural Drainage Water Recycling Process Using Membrane Technology , Californian Bay Delta Authority Ecosystem Restoration Program Grant ERP-02-P44 May 2004

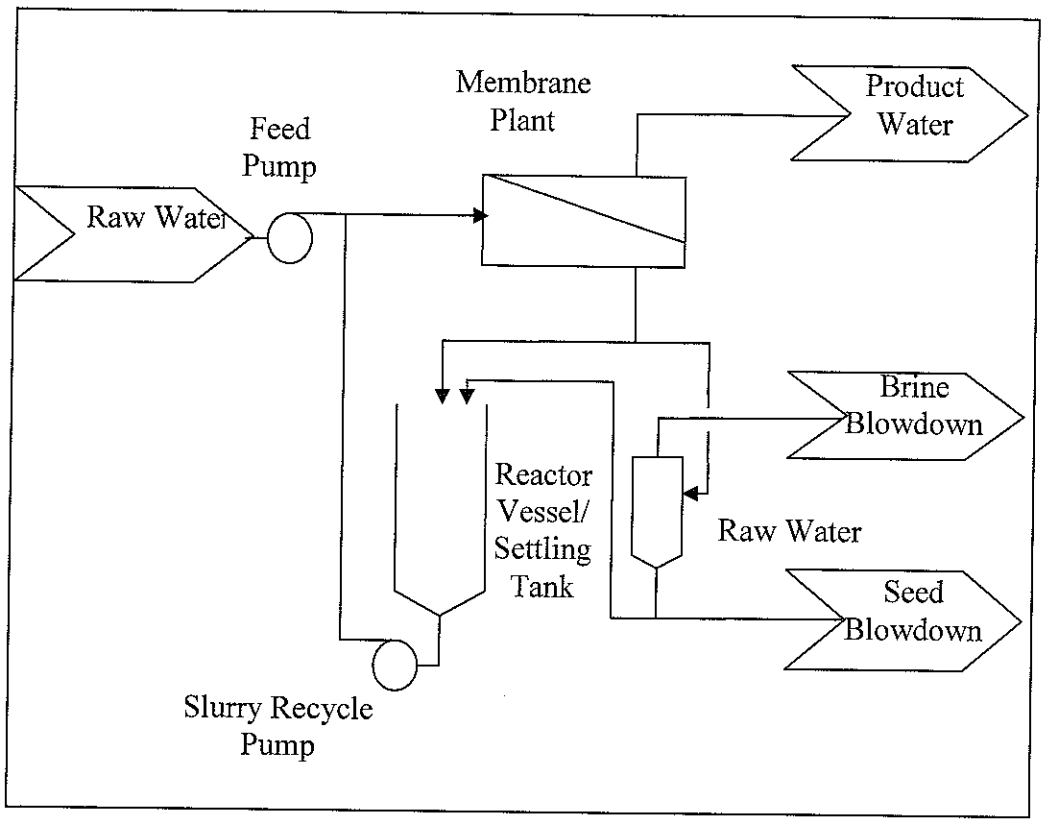

Figure 1 Simplified flow diagram of the Herrigal Process

The DP^{3}RO^{TM} took this principle one step further with the aim of improving water recovery rates and reducing system capital and operating costs. The process has four key steps:

Crystallization: The agricultural water is at nearly the saturation point with dissolved calcium sulfate. By adding calcium sulfate crystals to the feed water, nucleation is initiated.

Nanofiltration (NF): Nanofiltration further concentrates the dissolved calcium sulfate by removing some of the water and other dissolved salts with ½" diameter tubular membranes, the dissolved calcium sulfate precipitates on the seed crystals and not on the tubular membrane. A portion of the concentrate from the NF tubular plant is recycled to the NF feed-mixed with fresh incoming feed for further nucleation of dissolved calcium sulfate. The remainder is directed to a cascading weir to retain crystals in the slurry circuit and allow concentrated brine to be removed from the process.

Reverse Osmosis (RO): The brackish permeate from the tubular plant, is further treated by a Reverse Osmosis (RO) spiral membrane plant. The reject from the spiral RO returns to the NF tubular membrane plant. Permeate; the product water generated, typically has conductivities less than 500 micro siemens.

Hydrocyclone: As crystal size and quantity of crystals increase in the NF slurry circuit, they must be removed. A pump sends the slurry to a hydrocylcone when the suspended solids in the circuit reach a specified level. The over-flow is sent back to the slurry-circuit, while the under-flow is sent to a static filter. The brine is allowed to drain- out, while the gypsum is captured for reuse, and/or can be used for agricultural land treatment.

The objective of the two step membrane process was to use the first lower pressure, higher flux nanofiltration plant to concentrate the sparsely soluble salts, creating the desired precipitation of calcium sulfate, and using a more economical spiral reverse osmosis plant to concentrate the mono-valent salts present in the nanofiltration system filtrate. System recoveries were also increased by returning the reject stream from the reverse osmosis plant to the feed of the nanofiltration system, allowing for even more recovery of the precipitating salts. The reject stream from the second stage reverse osmosis plant would be at a high TDS level, but the effect of this high osmotic solution on flux rates on the first step process would be reduced by use of the nanofiltration membrane.

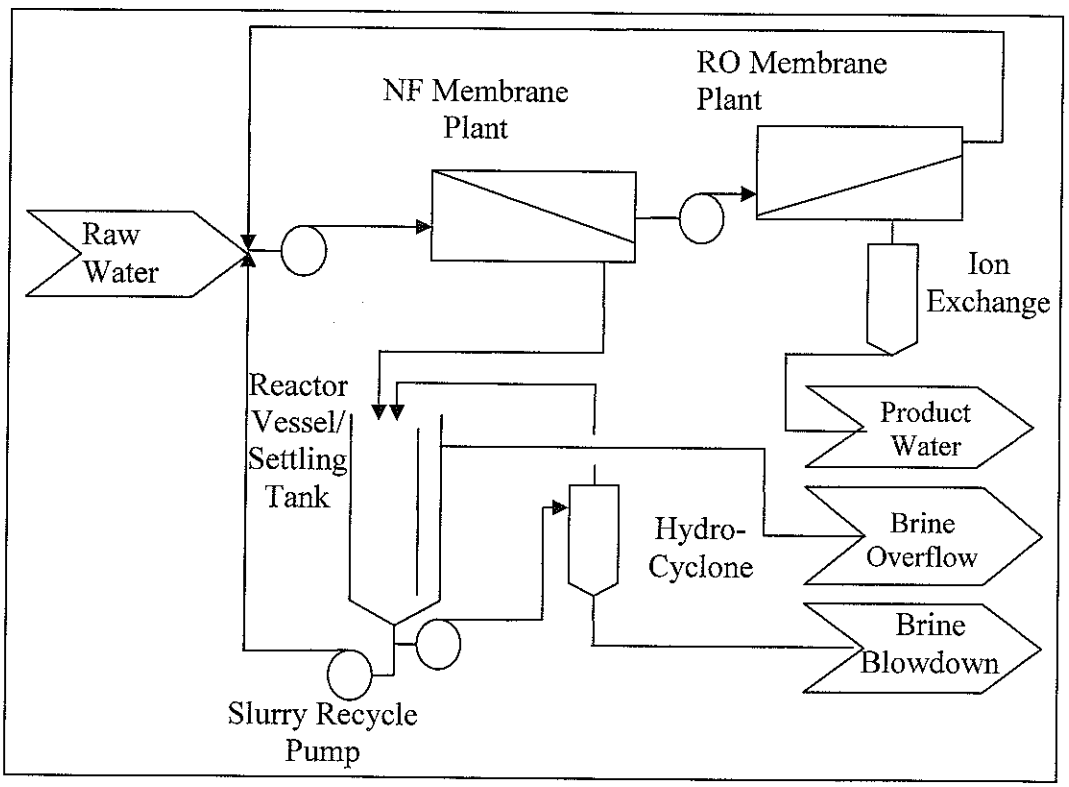

Figure 2 Simplified Process Diagram of the DP^{3}RO^{TM} process tested in 2003

[The Ion Exchange step in the process originally tested and shown above was to test the ability to remove boron from the final RO Permeate. Boron removal was successfully proven in that test and did not form a part of this pilot program.]

WaterTech Partners operated the pilot unit used in this program manually, for intermittent periods during 2002-2003. The system at that time used the PCI AFC30 membrane in the first "Nanofiltration" step. The results of this work are detailed in the report of that work by Watertech Partners[1].

During that work the membrane system was operated in both a taper and parallel flow design. The taper design ran with two parallel paths feeding into a second single path. Variations in each path length were made during the trial. The conclusions from the work undertaken during 2003 concluded that it was possible to operate a process with a calcium sulfate saturated feed stream at conductivities in the 8dS/m range with recoveries of above 85%, producing a filtered water at conductivities less than 0.5dS/m, Selenium less than 0.01 ppm and Boron prior to Ion Exchange treatment at 14 ppm.

However there were two critical problems with the use of AFC30 membrane in that process. There was unexplained build up of irreversible fouling of the AFC30 membrane over the test period of the membrane which appeared particularly severe in the higher cross flow velocity part of the array. Secondly, after the trial was completed and membranes inspected, the thin film of the membrane showed significant signs of damage which was put down to the abrasive effect of the seed crystals on the membrane surface. This manifested itself in deteriorating rejections during the test period. The test period lasted for a total of 150 hours.

It was found necessary to undertake a regular flush of the tubular membrane system in order to maintain flux rates on a day to day basis as pressure rises of 100 – 150 psi would occur over a 24 hour period in order for filtration capacity to be maintained.

Thus although the process worked, the life of the tubular membrane would have been too short to allow for a feasible process to be adopted at a large scale. It had been planned to continue testing with a more automated unattended system under this USBR program, but with the unsuitability of the AFC30 membrane, the program was delayed. PCI and Watertech Partners investigated the use of an alternative non thin film cellulose acetate Reverse Osmosis Membrane for use in the tubular part of the process. This type of membrane had been successfully used in the treatment of mine tailings using the Herrigal process for 3000 hours of operation[2]. Such an approach had the drawback of being a tighter reverse osmosis membrane and it was feared that the lower flux rates would make any final treatment prohibitively more expensive due to the higher potential operating pressure and lower filtration rates that might be expected.

A preliminary test however concluded that although the flux rates were lower, the water quality obtained from tighter RO membrane meant that a higher recovery was achievable in the second step RO system before a risk of precipitation of the sparsely soluble salts would occur. With the AFC30 membranes the recovery on the RO system was tested at 50%. The cellulose acetate membrane would allow the second stage process to run at 80% or higher recovery. With a lower reject volume from that process returning back to

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[2] Juby GJG, Schuffe CF and Van Leewen J, Desalination of Calcium Sulfate Scaling Mine Water: Design and Operation of the SPARRO Process, Water SA Vol 22 No 2 April 1996

the feed of the tubular plant, the overall system capacity could be maintained with the same tubular filtration area as less filtrate needed to be produced from the tubular system. Following preliminary testing of the Cellulose Acetate Membrane it was determined to proceed with this project.

In the winter/spring of 2004/2005, PCI installed the components for automating the system, and supplied the "operating logic", from which the USBR wrote the PLC-program to control the plant.

In late April 2005 the system began processing agricultural water.

Events/Problems

The plant operated from April 25th-April 29th. The system processed 8634 gallons of agricultural water at 85% recovery. The system shut down with a "Low Crystals Alarm" on April 29th. This was caused by the TSS-meter probe cleaning sequence (pressurized air is used to clean the probe surface) was set too high and too frequent. This was corrected on May 4th, and the plant restarted by Milford, OH personnel.

(Data was collected manually at the site since the computer data-logger and communication software were not functioning until January of 2006.)

The plant operated from May 4th until the weekend of May 7th. Shortly thereafter, the NF pump failed after the plant was re-started. Repairs, and logistics of removing and replacing the pump, delayed re-starting the plant for over one month.

During July the plant was operated for short periods. Apparently with problems, however the information during this time period was not logged.

August 1st, 2005 Panoche was revisited by the Milford office personnel and determined that Sulfuric acid, used for pH adjustment, was over-dosed to the feed tank-pH of zero in the NF feed tank! The cellulose membranes were destroyed and the spiral membranes were filled with calcium sulfate crystals. All membranes needed replacement.

From August until Dec 12th, 2006 the system sat idle. New Fluid Systems spiral RO membrane elements (4" and 2.5" diameter low pressure elements) needed to be ordered, and the shipment was several months out. Also the NF feed pump was repaired again at the same time. It took many weeks to remove the old membranes, disassemble piping, clean out plumbing and reinstall all the new membranes and secure all piping. The system was repaired during September 19th-23rd, October 17th-October 21st. The pH probe was moved to the feed tank and the communications problem was also addressed at this time, but was not resolved.

December 13th the plant was restarted and ran until December 21st, 2006. The system processed 9,700 gallons of agricultural drainage water at 80% recovery. The pH probe was removed from the feed tank location and returned to the suction side of the NF feed

pump-the pH probe reading was inaccurate because of low voltage interference in the fiberglass tank. It was decided to not use pH control.

The system shut down on January 21st due to water in the air compressor lines. System restarted on Jan 26th and ran until Feb 2nd, 2006. Once again NF feed pump failed and was sent out for repairs.

System restarted on April 12th. Data shows system operating less than 40% recovery due to NF plant not running to controlled set points.
System alarmed again on April 28th; high pressure alarm.

May, 2006; plant de-commissioned.

Results

The system operated for a total of 30 days; 23 days at an overall recovery >= 80%, the remaining seven days at an overall recovery of <=40% when equipment was not properly running.

Total RO permeate generated for the 30 days of operation was 66636 gallons.
The median value for RO permeate conductivity for the manually collected data is 850 micro-siemens/cm.

Conclusions

1. The membrane process could be run with minimal sort term membrane fouling occurring without water flushes at stable operating pressures.
2. Short term fouling of the membrane did not occur
3. Membrane Rejection was stable for periods of continuous running but the membrane lost rejection during periods of shutdown, perhaps through hydrolisation of the cellulose acetate.
4. Membrane life could not be established due to the mechanical and operational difficulties encountered.

Projected Full Scale System Costs

Based on the information from this test program and the earlier work by Watertech Partners, estimations can be made to estimate the capital and running cost of a scaled up treatment plant.

For a DP3RO Process to treat 250gpm of influent water at an influent conductivity of 9 dS/m, there would be a capital cost of about $2.1m inclusive of all mechanical and electrical equipment for the first stage tubular plant, second stage RO plant, solids recovery system . Price excludes ion exchange equipment for boron removal, building, installation and start up costs and assumes a recovered water volume of 85% of the influent flow.

Operating Cost based on 8500 hours operation per year $1215/Acre Foot.

Operating Cost Assumptions:
Feed pressure 600 psi on the first stage system
Average Flux 20 lmh
85% recovery
1 year tubular membrane life
5 year spiral life
Energy cost at $0.08/kWh.
2000 hours man hours/year for operation @ $40/hr
Maintenance 5% of capital cost
Credit of $75/tonne of gypsum produced after 20% reused for SAR adjustment.

No value is given to the recovered water volume. Assuming that this water is reused for irrigation purposes and the water no longer extracted from the Central valley Aquifer has a value of $800/AF, then the cost of treating the wastewater would be reduced by 85% of $800/AF giving a further credit of $680/AF, resulting in a nett treatment cost of $535/AF.

A reduction of 5% in the operating recovery to 80% would reduce operating cost by $65/AF but result in less recovered value, giving a nett treatment cost of $515/AF. Capital savings investment would be about $150,000.

A $2m investment cost would equate to $255/AF additional cost based on a 20 year straight line depreciation.

Attachments:

- Data Log for Jan-April, 2006
- Alarm log for Jan-April, 2006
- Graphs
  - April – May 2005 Manually Logged Data
  - December 2005 Manually Logged Data
  - April – Dec 2005 Manually Logged Data
  - Conductivities – April 2006 – Computer logged data
  - Conductivities Jan 2006 – Computer logged data
  - Membrane % Passage – April – May 2005
  - Membrane % Passage – Jan 2006
  - Membrane % Passage – April 2006

Tables of manually logged data.

Panoche computer logged data with flux rate and % recovery of NF & RO

DATE	TIME	MARKER	Desup TSS	STS NF TK Conduct	STS_ feed rate GPM	STS_pH	STS NF Inlet PSI	ST NF TK TSS	ST Temp F	ST NF outlet Flow gpm	ST NF CONT	ST RO_PRES	STS RO_FEED GPM	ST RO_PRESSUR	ST RO C	ST RO PERM GPM	ST 14	ST RAW Conduct	ST Imh@500 p	NF Perm GPM	NF % RCY	RO % RCY
1/26/2006	14:21:07.0	B	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U		0.00	#DIV/0!	#DIV/0!
1/26/2006	14:24:01.7	E	11.38	16.67	7.93	7.27	495.31	2.20	62.00	5.12	4.12	12.05	0.00	13.35	0.01	0.01	3.38	8.94	24.78	2.81	35.4350567	#DIV/0!
1/26/2006	14:24:45.3	B	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	#DIV/0!	0	#DIV/0!	#DIV/0!
1/26/2006	14:39:46.104		11.38	16.85	7.92	7.27	493.40	2.09	62.62	5.15	4.18	150.30	5.41	160.45	0.26	4.74	3.33	8.85	24.52	2.77	34.9747475	87.61553
1/26/2006	14:54:46.910		11.06	16.85	7.83	7.26	491.72	1.93	63.25	5.17	4.24	150.99	5.45	161.75	0.32	4.63	3.34	8.72	24.51	2.76	34.8045397	84.95413
1/26/2006	15:09:47.795		11.00	17.41	7.93	7.26	492.18	1.91	63.68	5.17	4.26	8.24	0.00	9.08	0.68	0.01	3.32	8.61	24.49	2.76	34.8045397	#DIV/0!
1/26/2006	15:24:48.721		10.97	17.79	7.93	7.26	493.55	1.89	64.15	5.19	4.33	148.47	5.49	161.06	0.34	4.61	3.35	8.76	24.25	2.74	34.5523328	83.97086
1/26/2006	15:39:49.486		11.04	18.31	7.94	7.26	496.76	1.90	64.52	5.21	4.45	17.70	0.00	19.00	0.60	0.00	3.35	8.65	24.00	2.73	34.3828715	#DIV/0!
1/26/2006	15:54:50.261		11.00	18.66	7.96	7.26	497.75	1.89	64.88	5.21	4.53	140.84	5.41	151.90	0.28	4.62	3.33	8.77	24.13	2.75	34.5477387	85.39741
1/26/2006	16:09:51.186		10.95	18.97	7.93	7.26	497.90	1.91	65.16	5.24	4.69	153.35	5.40	165.64	0.41	4.58	3.34	8.75	23.60	2.69	33.9218159	84.81481
1/26/2006	16:24:51.902		10.86	19.43	7.93	7.25	506.37	1.90	65.48	5.19	4.78	9.69	0.00	10.61	0.57	0.01	3.33	8.68	23.63	2.74	34.5523329	#DIV/0!
1/26/2006	16:39:52.677		10.94	19.82	7.96	7.25	510.34	1.88	65.71	5.18	4.87	153.43	5.44	163.42	0.41	4.60	3.34	8.76	23.79	2.78	34.9246231	84.55882
1/26/2006	16:54:53.532		10.94	20.03	7.91	7.25	527.43	1.89	65.98	5.05	4.97	39.83	0.00	41.58	0.47	0.00	3.32	8.75	23.68	2.86	36.1567636	#DIV/0!
1/26/2006	17:09:54.187		10.81	20.46	7.95	7.25	515.45	1.88	66.19	5.16	5.01	123.67	5.47	136.03	1.00	4.61	3.35	8.66	23.47	2.77	34.8427673	84.27788
1/26/2006	17:24:55.013		10.86	20.77	7.94	7.25	515.98	1.90	66.36	5.22	5.12	160.60	5.49	172.20	0.48	4.58	3.33	8.76	23.02	2.72	34.256927	83.06011
1/26/2006	17:39:55.718		10.95	21.16	7.92	7.25	523.77	1.88	66.51	5.17	5.23	15.26	0.00	16.33	0.53	0.00	3.33	8.64	22.93	2.75	34.7222222	#DIV/0!
1/26/2006	17:54:56.703		10.87	21.48	7.95	7.25	515.98	1.89	66.70	5.24	5.31	149.16	5.22	160.45	0.40	4.48	3.33	8.77	22.94	2.71	34.0880503	85.82375
1/26/2006	18:09:57.479		10.97	21.74	7.89	7.25	531.01	1.90	66.80	5.17	5.43	164.95	5.38	175.94	0.56	4.58	3.31	8.75	22.37	2.72	34.4740177	85.13011
1/26/2006	18:24:58.414		10.93	22.29	7.91	7.25	523.00	1.91	66.96	5.26	5.48	9.16	0.00	9.99	0.54	0.00	3.34	8.67	22.13	2.65	33.5018963	#DIV/0!
1/26/2006	18:39:59.189		10.87	22.45	7.92	7.25	525.29	1.89	67.06	5.27	5.57	159.38	5.44	172.50	0.51	4.39	3.33	8.75	22.03	2.65	33.459596	80.69853
1/26/2006	18:54:59.985		10.81	22.74	7.89	7.25	526.44	1.89	67.15	5.30	5.69	29.91	0.00	31.59	0.55	0.01	3.34	8.75	21.49	2.59	32.8263825	#DIV/0!
1/26/2006	19:10:00.870		10.81	23.05	7.90	7.25	536.74	1.90	67.26	5.24	5.75	130.85	5.31	144.12	1.00	4.58	3.31	8.66	21.64	2.66	33.6708861	86.25235
1/26/2006	19:25:01.836		10.95	23.17	7.90	7.25	554.59	1.88	67.26	5.07	5.81	163.81	5.24	178.00	0.58	4.36	3.35	8.78	22.29	2.83	35.8227848	83.20611
1/26/2006	19:40:02.711		11.01	23.54	7.88	7.25	575.95	1.88	67.35	4.91	5.81	15.64	0.00	16.88	0.57	0.00	3.31	8.64	22.52	2.97	37.6903553	#DIV/0!
1/26/2006	19:55:03.506		10.97	23.80	7.89	7.25	580.00	1.89	67.43	4.92	5.82	156.56	5.24	172.05	0.47	4.32	3.30	8.78	22.36	2.97	37.6425856	82.44275
1/26/2006	20:10:04.161		10.92	24.26	7.90	7.25	566.26	1.90	67.52	5.10	5.90	169.15	5.38	178.45	0.62	4.43	3.28	8.75	21.60	2.8	35.443038	82.34201
1/26/2006	20:25:04.967		10.96	24.67	7.89	7.24	564.69	1.91	67.58	5.15	5.97	10.22	0.00	11.08	0.59	0.00	3.30	8.67	21.18	2.74	34.7275032	#DIV/0!
1/26/2006	20:40:05.722		11.01	24.85	7.86	7.24	578.24	1.90	67.61	5.05	6.05	166.17	5.39	178.07	0.58	4.47	3.29	8.76	21.22	2.81	35.7506361	82.93135
1/26/2006	20:55:06.537		11.03	25.32	7.85	7.24	582.28	1.91	67.70	5.07	6.15	174.72	5.46	183.95	0.63	4.47	3.31	8.77	20.85	2.78	35.4140127	81.86813
1/26/2006	21:10:07.252		11.18	25.64	7.85	7.24	584.57	1.91	67.77	5.09	6.21	7.55	0.00	8.47	0.61	0.01	3.28	8.66	20.62	2.76	35.1592357	#DIV/0!
1/26/2006	21:25:08.008		11.03	25.94	7.82	7.24	587.17	1.91	67.80	5.11	6.28	169.15	5.39	184.71	0.64	4.40	3.30	8.77	20.16	2.71	34.6547315	81.63265
1/26/2006	21:40:08.623		10.97	26.20	7.83	7.24	613.34	1.91	67.83	4.94	6.34	22.74	0.00	23.96	0.63	0.00	3.32	8.75	20.58	2.89	36.9093231	#DIV/0!
1/26/2006	21:55:09.458		11.26	26.45	7.86	7.26	614.25	1.91	67.90	4.99	6.37	155.41	5.35	168.76	0.47	4.36	3.30	8.79	20.41	2.87	36.5139949	81.49533
1/26/2006	22:10:10.333		11.31	26.77	7.85	7.26	618.60	1.94	67.89	5.02	6.40	169.38	5.17	182.96	0.67	4.22	3.28	8.77	19.98	2.83	36.0509554	81.62476
1/26/2006	22:25:11.209		11.13	27.25	7.85	7.25	625.62	1.93	67.96	5.02	6.44	12.28	0.00	13.12	0.65	0.00	3.30	8.67	19.76	2.83	36.0509554	#DIV/0!
1/26/2006	22:40:12.034		11.11	27.50	7.81	7.26	631.04	1.94	67.93	5.03	6.49	163.04	5.15	178.76	0.59	4.30	3.29	8.77	19.24	2.78	35.5953905	83.49515
1/26/2006	22:55:12.769		11.05	27.76	7.84	7.26	631.27	1.93	67.98	5.07	6.54	172.58	5.14	185.93	0.69	4.33	3.30	8.77	19.16	2.77	35.3316327	84.24125
1/26/2006	23:10:13.675		11.10	28.01	7.80	7.24	659.04	1.92	67.98	4.93	6.56	8.09	0.00	8.77	0.67	0.01	3.28	8.68	19.02	2.87	36.7948718	#DIV/0!
1/26/2006	23:25:14.730		11.11	28.27	7.79	7.25	665.37	1.93	67.95	4.96	6.57	173.72	5.41	186.31	0.68	4.41	3.30	8.78	18.58	2.83	36.3286264	81.51571
1/26/2006	23:40:15.516		11.27	28.68	7.81	7.25	666.36	1.94	68.02	5.03	6.55	24.87	0.00	26.70	0.68	0.00	3.30	8.71	18.22	2.78	35.5953905	#DIV/0!
1/26/2006	23:55:16.341		11.21	28.91	7.79	7.26	674.98	1.97	68.04	5.01	6.59	154.12	5.45	166.93	0.49	4.53	3.32	8.77	17.99	2.78	35.6867779	83.11927
1/27/2006	00:10:17.196		11.32	29.37	7.81	7.26	680.86	1.94	68.01	5.02	6.62	173.95	5.37	185.85	0.70	4.37	3.31	8.77	17.90	2.79	35.7234315	81.37803
1/27/2006	00:25:17.951		11.14	29.78	7.79	7.24	679.94	1.95	68.06	5.08	6.64	11.52	0.00	12.51	0.70	0.01	3.31	8.67	17.41	2.71	34.78819	#DIV/0!
1/27/2006	00:40:18.707		11.25	29.78	0.00	7.24	1.14	1.93	67.92	0.13	6.67	4.35	0.00	4.96	0.70	0.01	-0.01	8.84	-498.03	-0.13	#DIV/0!	#DIV/0!
1/27/2006	00:55:19.462		11.20	29.81	0.00	7.25	0.61	1.94	67.81	0.07	6.67	2.37	0.00	3.05	0.70	0.00	0.01	8.85	-501.17	-0.07	#DIV/0!	#DIV/0!
1/27/2006	01:10:20.147		11.14	29.82	0.00	7.25	0.38	1.94	67.73	0.06	6.67	1.68	0.00	1.98	0.68	0.00	-0.01	8.84	-688.57	-0.06	#DIV/0!	#DIV/0!
1/27/2006	01:25:20.732		11.03	29.83	0.00	7.25	0.31	1.95	67.60	0.05	6.67	1.14	0.00	1.53	0.01	0.00	0.00	8.85	-704.40	-0.05	#DIV/0!	#DIV/0!
1/27/2006	01:40:21.547		11.13	29.88	0.00	7.26	0.31	1.93	67.55	0.05	6.67	0.84	0.00	1.30	0.01	0.01	-0.01	8.85	-704.40	-0.05	#DIV/0!	#DIV/0!
1/27/2006	01:55:22.222		11.17	29.86	0.00	7.27	0.31	1.94	67.41	0.04	6.67	0.76	0.00	1.07	0.01	0.01	-0.01	8.85	-563.52	-0.04	#DIV/0!	#DIV/0!
1/27/2006	02:10:23.088		11.14	29.89	0.00	7.27	0.15	1.94	67.35	0.04	6.68	0.69	0.00	0.99	0.01	0.01	-0.01	8.85	-1164.62	-0.04	#DIV/0!	#DIV/0!
1/27/2006	02:25:23.923		11.24	29.89	0.00	7.28	0.15	1.93	67.20	0.04	6.68	0.69	0.00	0.99	0.01	0.01	0.00	8.86	-1164.62	-0.04	#DIV/0!	#DIV/0!
1/27/2006	02:40:24.678		11.08	29.89	0.00	7.28	0.15	1.93	67.09	0.04	6.68	0.69	0.00	1.07	0.01	0.02	-0.01	8.85	-1164.62	-0.04	#DIV/0!	#DIV/0!
1/27/2006	02:55:25.384		11.11	29.89	0.00	7.28	0.15	1.94	67.00	0.04	6.68	0.69	0.00	0.92	0.01	0.01	0.00	8.85	-1164.62	-0.04	#DIV/0!	#DIV/0!
1/27/2006	03:10:26.299		11.10	29.92	0.00	7.28	0.15	1.94	66.90	0.04	6.68	0.61	0.00	0.99	0.01	0.01	-0.01	8.86	-1164.62	-0.04	#DIV/0!	#DIV/0!
1/27/2006	03:25:26.964		10.99	29.92	0.00	7.28	0.08	1.92	66.73	0.04	6.68	0.53	0.00	0.99	0.01	0.01	0.00	8.86	-2183.65	-0.04	#DIV/0!	#DIV/0!
1/27/2006	03:40:27.709		11.03	29.92	0.00	7.29	0.08	1.93	66.64	0.02	6.68	0.61	0.00	0.99	0.01	0.01	0.00	8.87	-1091.83	-0.02	#DIV/0!	#DIV/0!
1/27/2006	03:55:28.314		10.99	29.95	0.00	7.29	0.00	1.93	66.50	0.01	6.68	0.61	0.00	1.07	0.01	0.01	-0.01	8.86	#DIV/0!	-0.01	#DIV/0!	#DIV/0!
1/27/2006	04:10:29.280		11.01	29.93	0.00	7.29	0.00	1.94	66.36	0.00	6.68	0.69	0.00	0.99	0.01	0.01	0.00	8.87	#DIV/0!	0	#DIV/0!	#DIV/0!
1/27/2006	04:25:30.025		11.00	29.96	0.00	7.29	0.00	1.92	66.29	0.00	6.69	0.61	0.00	0.99	0.01	0.01	0.00	8.87	#DIV/0!	0	#DIV/0!	#DIV/0!
1/27/2006	04:40:30.800		11.04	30.01	7.89	7.27	643.55	1.94	66.01	4.86	6.69	0.69	0.00	0.99	0.01	0.01	3.32	8.78	20.56	3.03	38.4030418	#DIV/0!
1/27/2006	04:55:31.686		11.29	29.93	7.86	7.27	659.19	1.95	65.89	4.91	7.12	179.98	5.34	189.36	0.59	4.46	3.29	8.80	19.54	2.95	37.5318066	83.5206
1/27/2006	05:10:32.341		11.39	29.92	7.84	7.28	674.91	1.96	65.81	4.80	7.36	180.67	5.43	181.81	0.68	4.24	3.32	8.82	19.67	3.04	38.7755102	78.08471
1/27/2006	05:25:32.395		11.38	30.19	7.85	7.29	677.27	1.96	65.86	4.81	7.35	9.92	0.00	11.22	0.68	0.01	3.30	8.74	19.60	3.04	38.7261146	#DIV/0!
1/27/2006	05:40:32.529		11.38	30.43	7.82	7.27	681.47	1.97	65.87	4.83	7.33	182.73	5.43	195.85	0.69	4.33	3.29	8.83	19.16	2.99	38.2352941	79.74217
1/27/2006	05:55:32.574		11.38	31.02	7.80	7.26	685.74	1.98	65.98	4.84	7.31	32.20	0.00	34.56	0.71	0.01	3.30	8.81	18.85	2.98	37.9487179	#DIV/0!
1/27/2006	06:10:32.638		11.38	31.38	7.80	7.28	689.33	1.98	66.06	4.85	7.36	158.24	5.15	173.72	0.55	4.34	3.30	8.81	18.69	2.95	37.8205128	84.27184
1/27/2006	06:25:32.682		11.38	31.74	7.78	7.28	694.06	2.01	66.13	4.87	7.42	183.87	5.38	195.16	0.71	4.30	3.29	8.82	18.31	2.91	37.403599	79.92565
1/27/2006	06:40:32.726		11.38	32.17	7.82	7.26	698.86	2.00	66.18	4.87	7.47	16.71	0.00	18.31	0.73	0.01	3.34	8.79	18.44	2.95	37.7237852	#DIV/0!
1/27/2006	06:55:32.750		11.38	32.47	7.80	7.27	703.06	2.02	66.22	4.89	7.52	173.72	5.17	189.21	0.58	4.24	3.34	8.84	18.08	2.91	37.3076923	82.01161

1/27/2006 07:10:32.754	11.38	32.84	7.78	7.28	705.12	2.01	66.33	4.90	7.59	182.50	5.28	199.51	0.74	4.20	3.30	8.83	17.84	2.88	37.0179949	79.39509
1/27/2006 07:25:32.809	11.38	33.26	7.77	7.27	709.93	2.01	66.36	4.91	7.63	12.05	0.00	13.12	0.75	0.00	3.30	8.74	17.59	2.86	36.8082368	#DIV/0!
1/27/2006 07:40:32.843	11.38	33.39	7.78	7.27	712.75	2.03	66.45	4.92	7.70	181.43	5.37	194.09	0.68	4.25	3.32	8.84	17.52	2.86	36.7609254	79.14339
1/27/2006 07:55:32.857	11.38	33.79	7.78	7.27	706.87	2.05	66.56	5.00	7.74	188.30	5.30	202.56	0.77	4.18	3.33	8.82	17.18	2.78	35.7326478	78.86792
1/27/2006 08:10:32.901	11.38	34.46	7.83	7.25	657.74	2.03	66.66	5.42	7.83	7.78	0.00	8.85	0.77	0.01	3.31	8.76	16.00	2.41	30.7790549	#DIV/0!
1/27/2006 08:25:32.905	11.39	34.43	7.81	7.27	659.42	2.05	66.77	5.43	8.01	194.25	5.34	205.23	0.80	4.31	3.30	8.82	15.76	2.38	30.4737516	80.71161
1/27/2006 08:40:32.950	11.37	34.54	7.83	7.25	661.02	2.05	66.91	5.43	8.19	21.36	0.00	23.12	0.78	0.01	3.30	8.82	15.86	2.4	30.651341	#DIV/0!
1/27/2006 08:55:32.984	11.37	34.54	7.83	7.26	660.87	2.05	67.00	5.43	8.24	154.80	5.23	168.08	1.00	4.35	3.29	8.79	15.86	2.4	30.651341	83.174
1/27/2006 09:10:33.028	11.38	34.42	7.84	7.27	660.18	2.05	67.11	5.41	8.26	194.40	5.23	206.30	0.88	4.23	3.30	8.82	16.08	2.43	30.994898	80.87954
1/27/2006 09:25:33.473	11.38	34.36	7.82	7.25	659.88	2.03	67.25	5.42	8.23	9.38	0.00	10.68	0.82	0.00	3.31	8.71	15.88	2.4	30.6905371	#DIV/0!
1/27/2006 09:40:33.527	11.29	34.36	7.84	7.26	658.81	2.03	67.31	5.42	8.23	198.06	5.29	210.80	0.77	4.46	3.31	8.82	16.04	2.42	30.8673469	84.31002
1/27/2006 09:55:33.571	11.28	34.43	7.83	7.24	658.66	2.02	67.46	5.42	8.17	34.33	0.00	36.39	0.84	0.00	3.30	8.79	15.98	2.41	30.7790549	#DIV/0!
1/27/2006 10:10:33.595	11.38	34.39	7.82	7.28	659.27	2.03	67.57	5.42	8.17	8.93	0.15	10.45	0.85	0.05	3.33	8.74	15.90	2.4	30.6905371	33.33333
1/27/2006 10:25:33.609	11.23	34.23	7.83	7.24	656.37	2.01	67.64	5.44	8.15	198.46	5.41	210.27	0.86	4.30	3.33	8.80	15.90	2.39	30.5236271	79.48244
1/27/2006 10:40:33.624	11.32	34.35	7.81	7.24	658.12	2.00	67.81	5.43	8.13	9.99	0.00	10.99	0.86	0.00	2.33	8.72	15.79	2.38	30.4737516	#DIV/0!
1/27/2006 10:55:33.668	11.29	35.61	7.83	7.24	666.36	2.09	68.15	5.46	8.14	190.59	5.40	201.88	0.77	4.40	2.35	8.84	15.53	2.37	30.2681992	81.46148
1/27/2006 11:10:33.832	11.30	36.47	7.83	7.23	673.08	2.06	68.38	5.48	8.33	39.44	0.00	42.11	0.87	0.00	2.36	8.83	15.25	2.35	30.0127714	#DIV/0!
1/27/2006 11:25:33.856	11.38	37.27	7.80	7.23	678.87	2.09	68.60	5.50	8.50	5.67	0.00	6.71	0.88	0.00	2.36	8.80	14.80	2.3	29.4871795	#DIV/0!
1/27/2006 11:40:33.891	11.39	37.92	7.83	7.23	682.76	2.12	68.71	5.51	8.71	205.77	5.45	219.73	0.97	4.36	2.34	8.84	14.84	2.32	29.6296296	80
1/27/2006 11:55:33.945	11.38	38.59	5.67	7.26	428.78	2.15	68.86	4.75	9.06	9.92	0.00	10.91	0.90	0.00	0.00	8.05	9.37	0.92	16.2257486	#DIV/0!
1/27/2006 12:10:33.988	11.38	38.31	7.05	7.23	528.95	2.14	68.85	5.69	9.54	5.04	0.00	5.87	0.90	0.01	0.00	8.45	11.23	1.36	19.2607801	#DIV/0!
1/27/2006 12:25:33.993	11.38	38.26	7.06	7.23	527.20	2.15	68.96	5.68	10.15	218.97	5.42	232.78	1.00	4.21	0.00	7.93	11.43	1.38	19.5467422	77.67528
1/27/2006 12:40:34.027	11.38	38.02	7.06	7.23	525.75	2.16	68.97	5.69	10.67	7.17	0.00	8.01	0.95	0.01	-0.01	8.04	11.38	1.37	19.4050992	#DIV/0!
1/27/2006 12:55:34.071	11.33	37.74	7.08	7.23	523.61	2.15	69.06	5.69	10.84	179.98	5.53	196.23	0.90	4.43	0.00	8.02	11.59	1.39	19.6327684	80.1085
1/27/2006 13:10:34.156	11.38	37.49	7.06	7.23	523.38	2.16	69.11	5.68	10.94	29.45	0.00	31.51	1.00	0.01	-0.01	8.04	11.52	1.38	19.5467422	#DIV/0!
1/27/2006 13:25:34.190	11.37	37.15	7.06	7.23	523.61	2.16	69.18	5.67	10.91	6.18	0.00	7.02	1.00	0.00	0.01	7.92	11.59	1.39	19.6883853	#DIV/0!
1/27/2006 13:40:34.244	11.34 E	37.46 E	7.06 E	7.23 E	523.61 E	2.18 E	69.25 E	5.68 E	10.74 E	9.08 E	0.00 E	10.30 E	1.00 E	0.00 E	0.00 E	7.86 E	11.51	1.38	19.5467422	#DIV/0!
1/27/2006 13:55:34.258	11.38	37.11	7.08	7.24	539.25	2.15	69.18	5.29	10.70	9.00	0.00	10.15	1.00	0.01	0.00	8.74	14.50	1.79	25.2824859	#DIV/0!
1/27/2006 14:10:34.313	11.39	36.66	7.92	7.23	623.10	2.16	69.08	5.61	10.71	1.37	0.00	1.68	1.00	0.01	-0.01	8.65	16.19	2.31	29.1666667	#DIV/0!
1/27/2006 14:25:34.387	11.38	35.39	7.06	7.25	512.47	2.13	68.99	5.64	10.07	7.32	0.00	7.93	0.01	0.01	-0.01	8.80	12.10	1.42	20.1133144	#DIV/0!
1/27/2006 14:40:34.481	11.38	36.20	7.30	7.30	602.96	2.18	69.23	5.07	9.90	1.60	0.00	4.81	0.01	0.27	-0.01	8.84	16.15	2.23	30.5479452	#DIV/0!
1/27/2006 14:46:03.2 B	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	#DIV/0!	0	#DIV/0!	#DIV/0!
1/27/2006 15:01:04.175	11.38	35.80	7.07	7.23	516.75	2.18	69.35	5.63	2.33	3.13	0.00	3.66	0.03	0.00	0.00	8.80	12.17	1.44	20.3677511	#DIV/0!
1/27/2006 15:16:04.249	11.38	35.64	7.08	7.23	511.41	2.19	69.41	5.65	0.72	8.39	0.00	9.61	0.01	0.03	-0.01	8.00	12.21	1.43	20.1977401	#DIV/0!
1/27/2006 15:31:04.263	11.38	35.52	7.08	7.23	510.49	2.18	69.47	5.65	0.76	1.91	0.00	2.21	0.02	0.00	-0.01	8.01	12.23	1.43	20.1977401	#DIV/0!
1/27/2006 15:46:04.277	11.38	35.32	7.08	7.22	510.11	2.18	69.58	5.64	0.69	5.65	0.00	6.18	0.07	0.01	-0.01	7.92	12.33	1.44	20.3389831	#DIV/0!
1/27/2006 16:01:04.311	11.38	35.22	7.06	7.25	510.49	2.20	69.64	5.64	0.64	8.16	0.00	9.23	0.04	0.07	0.00	7.91	12.15	1.42	20.1133144	#DIV/0!
1/27/2006 16:16:04.355	11.38	35.06	7.09	7.23	508.58	2.21	69.70	5.63	0.69	2.67	0.00	3.05	0.06	0.00	0.00	7.98	12.54	1.46	20.5923636	#DIV/0!
1/27/2006 16:31:04.400	11.38	34.92	7.06	7.23	508.20	2.19	69.75	5.64	0.66	8.32	0.00	9.54	0.02	0.02	0.01	7.96	12.20	1.42	20.1133144	#DIV/0!
1/27/2006 16:46:04.444	11.38	34.73	7.09	7.22	507.97	2.20	69.83	5.65	0.78	1.68	0.00	2.06	0.01	0.00	0.00	7.91	12.38	1.44	20.3102962	#DIV/0!
1/27/2006 17:01:04.468	11.38	34.65	7.07	7.23	507.97	2.20	69.87	5.63	0.69	3.59	0.00	4.12	0.15	0.00	-0.01	7.93	12.38	1.44	20.3677511	#DIV/0!
1/27/2006 17:16:04.492	11.38	34.51	7.06	7.23	506.90	2.19	69.87	5.63	0.68	8.47	0.00	9.46	0.03	0.03	0.01	7.96	12.32	1.43	20.2549575	#DIV/0!
1/27/2006 17:31:04.536	11.38	34.38	7.07	7.22	506.52	2.20	69.87	5.63	0.79	2.21	0.00	2.59	0.06	0.00	-0.01	7.94	12.42	1.44	20.3677511	#DIV/0!
1/27/2006 17:46:04.561	11.39	34.33	7.08	7.20	506.29	2.21	69.83	5.64	0.76	6.26	0.00	6.94	0.06	0.00	0.00	7.91	12.42	1.44	20.3389831	#DIV/0!
1/27/2006 18:01:04.725	11.39	34.22	7.08	7.24	507.82	2.21	69.81	5.65	0.89	4.43	0.00	7.25	1.00	0.54	0.00	7.98	12.30	1.43	20.1977401	#DIV/0!
1/27/2006 18:16:04.779	11.39	34.11	7.07	7.23	505.46	2.20	69.75	5.64	0.57	2.75	0.00	3.13	0.14	0.00	-0.01	7.99	12.36	1.43	20.2263083	#DIV/0!
1/27/2006 18:31:04.823	11.38	34.01	7.07	7.23	506.37	2.21	69.75	5.63	0.78	8.55	0.00	9.61	0.03	0.03	-0.01	7.98	12.42	1.44	20.3677511	#DIV/0!
1/27/2006 18:46:04.858	11.39	33.94	7.08	7.23	504.54	2.20	69.69	5.63	0.93	1.75	0.00	2.29	0.04	0.00	-0.01	8.00	12.55	1.45	20.480228	#DIV/0!
1/27/2006 19:01:04.862	11.38	33.83	7.08	7.23	504.84	2.21	69.66	5.64	0.73	4.04	0.00	4.58	0.34	0.01	0.00	7.97	12.46	1.44	20.3389831	#DIV/0!
1/27/2006 19:16:04.886	11.39	33.77	7.08	7.23	505.84	2.21	69.54	5.63	0.51	8.16	0.00	9.31	0.04	0.04	0.00	8.01	12.52	1.45	20.480228	#DIV/0!
1/27/2006 19:31:04.940	11.39	33.68	7.08	7.23	504.31	2.21	69.47	5.65	0.69	2.08	0.00	2.59	0.22	0.00	0.00	7.98	12.38	1.43	20.1977401	#DIV/0!
1/27/2006 19:46:04.954	11.38	33.61	7.08	7.27	505.07	2.21	69.40	5.64	0.49	8.39	0.00	9.31	0.02	0.03	0.00	7.85	12.45	1.44	20.3389831	#DIV/0!
1/27/2006 20:01:05.018	11.38	33.56	7.07	7.23	506.37	2.22	69.34	5.63	0.70	1.53	0.00	1.91	0.01	0.01	0.01	8.00	12.42	1.44	20.3677511	#DIV/0!
1/27/2006 20:16:05.053	11.38	33.49	7.08	7.24	503.47	2.21	69.28	5.64	0.51	3.05	0.00	3.51	0.21	0.01	-0.01	7.97	12.58	1.45	20.4513399	#DIV/0!
1/27/2006 20:31:05.067	11.38	33.37	7.08	7.24	503.85	2.22	69.20	5.64	0.43	8.24	0.00	9.46	0.02	0.03	0.00	8.03	12.48	1.44	20.3389831	#DIV/0!
1/27/2006 20:46:05.081	11.38	33.37	7.08	7.24	503.78	2.23	69.12	5.64	0.58	1.68	0.00	2.14	0.04	0.01	-0.01	7.99	12.48	1.44	20.3389831	#DIV/0!
1/27/2006 21:01:05.115	11.38	33.32	7.07	7.23	503.32	2.23	69.06	5.66	0.52	5.11	0.00	5.80	0.49	0.01	0.00	7.96	12.23	1.41	19.9434229	#DIV/0!
1/27/2006 21:16:05.159	11.39	33.22	7.06	7.27	502.48	2.23	68.99	5.65	0.47	8.09	0.00	9.31	0.05	0.08	0.00	7.98	12.26	1.41	19.9716714	#DIV/0!
1/27/2006 21:31:05.164	11.40	33.16	7.07	7.24	511.79	2.24	68.91	5.58	0.61	2.52	0.00	3.05	0.17	0.01	-0.01	8.00	12.71	1.49	21.0749646	#DIV/0!
1/27/2006 21:46:05.178	11.37	33.08	7.08	7.24	501.49	2.23	68.80	5.68	0.39	8.24	0.00	9.46	0.01	0.03	0.00	7.99	12.19	1.4	19.7740113	#DIV/0!
1/27/2006 22:01:05.252	11.38	32.97	7.10	7.24	499.73	2.23	68.77	5.69	0.54	1.45	0.00	1.83	0.01	0.01	0.01	8.05	12.32	1.41	19.8591549	#DIV/0!
1/27/2006 22:16:05.306	11.39	32.97	7.07	7.24	493.93	2.23	68.67	5.72	0.38	3.74	0.00	4.43	0.17	0.01	-0.01	8.00	11.94	1.35	19.0947666	#DIV/0!
1/27/2006 22:31:05.350	11.38	32.82	7.08	7.24	484.32	2.23	68.53	5.80	0.37	8.01	0.00	9.31	0.02	0.03	-0.01	8.02	11.54	1.28	18.079096	#DIV/0!
1/27/2006 22:46:05.375	11.38	32.67	7.10	7.24	467.31	2.27	68.45	5.93	0.32	1.98	0.00	2.52	0.21	0.01	-0.01	8.05	10.93	1.17	16.4788732	#DIV/0!
1/27/2006 23:01:05.379	11.38	32.38	7.10	7.22	468.07	2.29	68.44	5.86	0.30	6.03	0.00	6.94	0.03	0.01	-0.01	8.01	11.38	1.22	17.1830986	#DIV/0!
1/27/2006 23:16:05.403	11.38	32.03	7.10	7.35	444.11	2.25	68.31	6.06	0.29	4.04	0.00	6.94	1.00	0.59	0.00	8.08	10.23	1.04	14.6478873	#DIV/0!
1/27/2006 23:31:05.427	11.39	31.67	7.11	7.24	441.98	2.29	68.18	6.05	0.25	2.67	0.00	3.13	0.22	0.01	-0.01	8.04	10.47	1.06	14.9085795	#DIV/0!
1/27/2006 23:46:05.441	11.39	31.25	7.10	7.24	435.03	2.25	68.06	6.08	0.22	8.32	0.00	9.61	0.01	0.03	-0.01	8.03	10.24	1.02	14.3661972	#DIV/0!
1/28/2006 00:01:05.475	11.38	30.81	7.10	7.24	436.94	2.29	67.90	6.09	0.26	1.60	0.00	2.14	0.03	0.01	0.00	8.02	10.10	1.01	14.2253521	#DIV/0!
1/28/2006 00:16:05.499	11.38	30.35	7.12	7.24	428.78	2.25	67.81	6.09	0.23	4.04	0.00	4.81	0.49	0.01	-0.01	8.03	10.49	1.03	14.4662921	#DIV/0!
1/28/2006 00:31:05.724	11.38	29.94	7.11	7.24	434.27	2.28	67.70	6.08	0.28	7.93	0.00	9.23	0.02	0.05	-0.01	7.99	10.36	1.03	14.4866385	#DIV/0!
1/28/2006 00:46:05.748	11.38	29.53	7.12	7.24	418.71	2.27	67.57	6.07	0.26	2.06	0.00	2.59	0.21	0.01	-0.01	8.06	10.95	1.05	14.747191	#DIV/0!
1/28/2006 01:01:05.792	11.38	29.13	7.12	7.24	414.74	2.27	67.54	6.06	0.30	8.24	0.00	9.46	0.01	0.03	0.00	8.03	11.16	1.06	14.8876404	#DIV/0!
1/28/2006 01:16:05.837	11.38	28.74	7.11	7.24	426.26	2.30	67.40	6.04	0.30	1.37	0.00	1.91	0.01	0.01	-0.01	7.99	10.96	1.07	15.0482264	#DIV/0!

1/28/2006 01:31:05.851	11.39	28.38	7.13	7.24	418.17	2.29	67.38	6.02	0.27	2.98	0.00	3.59	0.24	0.00	-0.01	7.97	11.59	1.11	15.5680224	#DIV/0!
1/28/2006 01:46:05.855	11.38	28.05	7.11	7.24	418.78	2.28	67.26	6.02	0.24	8.01	0.00	9.46	0.01	0.04	-0.01	8.06	11.37	1.09	15.3305204	#DIV/0!
1/28/2006 02:01:05.919	11.39	27.72	7.12	7.24	419.47	2.31	67.19	6.01	0.26	1.91	0.00	2.37	0.04	0.01	0.00	8.07	11.56	1.11	15.5898876	#DIV/0!
1/28/2006 02:16:05.943	11.38	27.40	7.13	7.21	416.88	2.28	67.11	6.00	0.25	5.57	0.00	6.49	0.03	0.01	-0.01	8.03	11.84	1.13	15.8485273	#DIV/0!
1/28/2006 02:31:05.987	11.38	27.13	7.12	7.28	418.25	2.31	67.02	6.00	0.28	3.89	0.00	6.56	0.34	0.47	-0.01	8.07	11.69	1.12	15.7303371	#DIV/0!
1/28/2006 02:46:05.992	11.38	26.83	7.11	7.24	419.47	2.31	66.99	5.98	0.23	2.29	0.00	2.98	0.21	0.01	0.00	7.99	11.76	1.13	15.8931083	#DIV/0!
1/28/2006 03:01:06.016	11.38	26.58	7.11	7.24	404.75	2.28	66.91	5.98	0.23	8.24	0.00	9.54	0.01	0.03	-0.01	8.03	12.19	1.13	15.8931083	#DIV/0!
1/28/2006 03:16:06.060	11.38	26.34	7.14	7.24	415.88	2.30	66.85	5.97	0.25	1.45	0.00	2.06	0.01	0.01	-0.01	7.98	12.29	1.17	16.3865546	#DIV/0!
1/28/2006 03:31:06.064	11.38	26.10	7.12	7.24	412.68	2.30	66.87	5.96	0.22	3.89	0.00	4.73	0.19	0.01	-0.01	8.05	12.28	1.16	16.2921348	#DIV/0!
1/28/2006 03:46:06.098	11.38	25.87	7.11	7.26	417.26	2.32	66.85	5.96	0.26	7.71	0.00	9.31	0.01	0.06	-0.01	8.05	12.04	1.15	16.1744023	#DIV/0!
1/28/2006 04:01:06.142	11.38	25.69	7.14	7.25	419.01	2.33	66.76	5.95	0.24	2.06	0.00	2.59	0.14	0.01	0.00	8.07	12.40	1.19	16.6666667	#DIV/0!
1/28/2006 04:16:06.147	11.39	25.48	7.13	7.25	402.69	2.32	66.73	5.95	0.24	8.24	0.00	9.46	0.01	0.03	-0.01	8.05	12.60	1.18	16.5497896	#DIV/0!
1/28/2006 04:31:06.161	11.38	25.25	7.13	7.25	408.94	2.33	66.73	5.94	0.25	1.30	0.00	1.68	0.01	0.01	-0.01	8.05	12.71	1.19	16.6900421	#DIV/0!
1/28/2006 04:46:06.195	11.38	25.07	7.13	7.25	412.53	2.32	66.64	5.94	0.23	2.75	0.00	3.51	0.33	0.01	-0.01	8.00	12.60	1.19	16.6900421	#DIV/0!
1/28/2006 05:01:06.219	11.38	24.90	7.14	7.24	399.18	2.32	66.64	5.93	0.26	7.93	0.00	9.38	0.01	0.05	-0.01	7.99	13.24	1.21	16.9467787	#DIV/0!
1/28/2006 05:16:06.243	11.38	24.72	7.13	7.25	397.34	2.35	66.59	5.92	0.26	1.83	0.00	2.37	0.02	0.01	-0.01	8.00	13.30	1.21	16.970547	#DIV/0!
1/28/2006 05:31:06.308	11.38	24.55	7.12	7.27	406.81	2.33	66.56	5.93	0.23	5.49	0.00	6.49	0.01	0.01	0.00	8.05	12.78	1.19	16.7134831	#DIV/0!
1/28/2006 05:46:06.322	11.38	24.41	7.12	7.28	412.53	2.33	66.50	5.93	0.28	3.36	0.00	5.87	0.07	0.43	-0.01	8.00	12.60	1.19	16.7134831	#DIV/0!
1/28/2006 06:01:06.336	11.38	24.23	7.12	7.25	396.81	2.35	66.50	5.91	0.25	2.37	0.00	2.98	0.23	0.01	0.00	8.08	13.32	1.21	16.994382	#DIV/0!
1/28/2006 06:16:06.400	11.39	24.12	7.14	7.25	405.26	2.33	66.47	5.91	0.24	8.24	0.00	9.54	0.01	0.04	-0.01	8.03	13.25	1.23	17.2268908	#DIV/0!
1/28/2006 06:31:06.424	11.38	23.97	7.12	7.25	406.73	2.35	66.42	5.90	0.24	1.45	0.00	1.98	0.01	0.01	0.00	8.05	13.10	1.22	17.1348315	#DIV/0!
1/28/2006 06:46:06.438	11.38	23.86	7.13	7.24	403.98	2.33	66.39	5.90	0.26	3.89	0.00	4.73	0.01	0.01	0.00	7.98	13.30	1.23	17.2510519	#DIV/0!
1/28/2006 07:01:06.513	11.38	23.72	7.13	7.25	403.68	2.35	66.35	5.89	0.24	7.63	0.00	9.08	0.01	0.08	0.00	8.10	13.42	1.24	17.3913043	#DIV/0!
1/28/2006 07:16:06.557	11.39	23.61	7.12	7.25	400.78	2.35	66.39	5.89	0.21	2.06	0.00	2.75	0.10	0.01	0.00	8.04	13.40	1.23	17.2752809	#DIV/0!
1/28/2006 07:31:06.611	11.39	23.50	7.13	7.25	407.87	2.35	66.32	5.88	0.23	7.78	0.00	9.31	0.01	0.03	0.00	8.00	13.38	1.25	17.5315568	#DIV/0!
1/28/2006 07:46:06.645	11.38	23.39	7.12	7.25	404.06	2.35	66.36	5.89	0.24	1.37	0.00	1.75	0.01	0.01	-0.01	8.01	13.29	1.23	17.2752809	#DIV/0!
1/28/2006 08:01:06.679	11.38	23.28	7.14	7.25	393.30	2.35	66.29	5.88	0.22	2.90	0.00	3.59	0.23	0.01	-0.01	8.07	13.99	1.26	17.6470588	#DIV/0!
1/28/2006 08:16:06.714	11.38	23.18	7.15	7.25	408.87	2.37	66.32	5.87	0.21	8.01	0.00	9.31	0.01	0.05	-0.01	8.03	13.67	1.28	17.9020979	#DIV/0!
1/28/2006 08:31:06.728	11.38	23.10	7.12	7.25	401.24	2.36	66.32	5.87	0.24	1.83	0.00	2.37	0.03	0.01	0.00	8.00	13.61	1.25	17.5561798	#DIV/0!
1/28/2006 08:46:06.772	11.38	23.02	7.14	7.22	399.71	2.37	66.30	5.86	0.24	5.72	0.00	6.71	0.01	0.00	-0.01	8.00	13.99	1.28	17.9271709	#DIV/0!
1/28/2006 09:01:07.057	11.39	22.94	7.13	7.41	393.53	2.37	66.42	5.88	0.30	3.20	0.00	5.87	0.08	0.45	0.00	8.03	13.67	1.25	17.5315568	#DIV/0!
1/28/2006 09:16:07.111	11.38	22.82	7.15	7.24	393.45	2.38	66.42	5.86	0.23	2.52	0.00	3.05	0.26	0.01	-0.01	8.02	14.32	1.29	18.041958	#DIV/0!
1/28/2006 09:31:07.155	11.38	22.77	7.13	7.24	401.46	2.36	66.45	5.86	0.23	8.09	0.00	9.46	0.01	0.04	0.00	8.03	13.82	1.27	17.8120617	#DIV/0!
1/28/2006 09:46:07.169	11.38	22.69	7.14	7.24	402.99	2.36	66.50	5.86	0.26	1.60	0.00	2.06	0.01	0.00	0.00	8.00	13.87	1.28	17.9271709	#DIV/0!
1/28/2006 10:01:07.223	11.38	22.64	7.13	7.24	403.98	2.37	66.56	5.85	0.22	4.12	0.00	4.81	0.01	0.01	-0.01	7.95	13.84	1.28	17.9523142	#DIV/0!
1/28/2006 10:16:07.288	11.38	22.57	7.14	7.25	407.03	2.38	66.61	5.86	0.23	7.63	0.00	9.16	0.01	0.07	0.00	8.05	13.73	1.28	17.9271709	#DIV/0!
1/28/2006 10:31:07.312	11.38	22.53	7.14	7.24	408.56	2.36	66.73	5.85	0.23	2.14	0.00	2.75	0.24	0.00	0.00	8.00	13.79	1.29	18.0672269	#DIV/0!
1/28/2006 10:46:07.356	11.38	22.47	7.13	7.24	406.73	2.38	66.85	5.83	0.22	8.24	0.00	9.46	0.01	0.04	-0.01	7.95	13.96	1.3	18.2328191	#DIV/0!
1/28/2006 11:01:07.410	11.38	22.45	7.12	7.24	389.26	2.38	66.91	5.85	0.28	1.45	0.00	1.91	0.01	0.01	0.01	7.94	14.25	1.27	17.8370787	#DIV/0!
1/28/2006 11:16:07.444	11.38	22.39	7.12	7.24	393.84	2.38	67.05	5.84	0.23	3.13	0.00	3.74	0.03	0.01	0.00	7.96	14.19	1.28	17.9775281	#DIV/0!
1/28/2006 11:31:07.468	11.38	22.36	7.14	7.24	403.60	2.38	67.11	5.82	0.25	7.93	0.00	9.31	0.01	0.05	0.00	7.96	14.28	1.32	18.487395	#DIV/0!
1/28/2006 11:46:07.483	11.38	22.34	7.13	7.23	399.86	2.36	67.19	5.81	0.25	1.75	0.00	2.29	0.03	0.01	-0.01	7.97	14.42	1.32	18.513324	#DIV/0!
1/28/2006 12:01:07.527	11.39	22.32	7.12	7.25	407.64	2.40	67.26	5.82	0.24	5.95	0.00	6.71	0.01	0.00	-0.01	8.00	13.93	1.3	18.258427	#DIV/0!
1/28/2006 12:16:07.541	11.39	22.27	7.14	7.35	391.17	2.38	67.32	5.85	0.33	4.20	0.00	6.87	0.07	0.47	-0.01	7.84	14.40	1.29	18.0672269	#DIV/0!
1/28/2006 12:31:07.585	11.38	22.25	7.13	7.23	398.41	2.38	67.37	5.83	0.24	2.59	0.00	3.20	0.03	0.01	-0.01	7.92	14.25	1.3	18.2328191	#DIV/0!
1/28/2006 12:46:07.589	11.38	22.21	7.12	7.23	390.55	2.39	67.46	5.83	0.23	7.93	0.00	9.31	0.01	0.04	0.01	7.97	14.43	1.29	18.1179775	#DIV/0!
1/28/2006 13:01:07.644	11.38	22.21	7.12	7.23	404.75	2.39	67.57	5.82	0.24	1.68	0.00	2.14	0.03	0.01	-0.01	7.93	14.03	1.3	18.258427	#DIV/0!
1/28/2006 13:16:07.718	11.39	22.18	7.12	7.23	404.29	2.38	67.67	5.83	0.23	3.97	0.00	4.73	0.01	0.00	-0.01	7.97	13.94	1.29	18.1179775	#DIV/0!
1/28/2006 13:31:07.742	11.38	22.15	7.13	7.23	397.80	2.39	67.73	5.83	0.25	7.63	0.00	9.08	0.01	0.08	0.00	7.96	14.27	1.3	18.2328191	#DIV/0!
1/28/2006 13:46:07.776	11.39	22.13	7.13	7.23	402.99	2.39	67.84	5.82	0.27	2.06	0.00	2.52	0.21	0.00	0.00	8.01	14.20	1.31	18.3730715	#DIV/0!
1/28/2006 14:01:07.800	11.39	22.13	7.13	7.23	397.88	2.39	67.87	5.82	0.23	8.01	0.00	9.31	0.01	0.04	-0.01	7.94	14.38	1.31	18.3730715	#DIV/0!
1/28/2006 14:16:07.875	11.38	22.10	7.13	7.23	405.43	2.39	68.01	5.82	0.26	1.45	0.00	1.91	0.01	0.00	0.01	7.99	14.11	1.31	18.3730715	#DIV/0!
1/28/2006 14:31:08.079	11.38	22.13	7.11	7.23	394.06	2.39	68.04	5.82	0.23	2.98	0.00	3.51	0.01	0.01	0.00	8.00	14.30	1.29	18.1434599	#DIV/0!
1/28/2006 14:46:08.384	11.38	22.11	7.12	7.23	396.35	2.39	68.12	5.82	0.22	7.93	0.00	9.16	0.01	0.05	0.01	8.00	14.32	1.3	18.258427	#DIV/0!
1/28/2006 15:01:08.448	11.38	22.08	7.12	7.23	403.91	2.41	68.24	5.81	0.28	1.68	0.00	2.29	0.07	0.01	0.00	7.97	14.16	1.31	18.3988764	#DIV/0!
1/28/2006 15:16:08.492	11.38	22.08	7.14	7.22	397.12	2.39	68.24	5.81	0.25	5.80	0.00	6.56	0.01	0.01	-0.01	7.98	14.63	1.33	18.627451	#DIV/0!
1/28/2006 15:31:08.516	11.38	22.11	7.13	7.24	404.75	2.39	68.30	5.82	0.27	5.34	0.00	7.55	0.01	0.33	-0.01	7.96	14.14	1.31	18.3730715	#DIV/0!
1/28/2006 15:46:08.560	11.38	22.11	7.12	7.23	386.89	2.41	68.36	5.82	0.25	2.67	0.00	3.05	0.01	0.00	-0.01	7.91	14.67	1.3	18.258427	#DIV/0!
1/28/2006 16:01:08.595	11.38	22.11	7.12	7.23	395.67	2.39	68.39	5.81	0.24	8.24	0.00	9.38	0.01	0.05	-0.01	8.00	14.46	1.31	18.3988764	#DIV/0!
1/28/2006 16:16:08.629	11.39	22.11	7.14	7.23	399.02	2.39	68.39	5.81	0.24	1.68	0.00	2.06	0.01	0.01	-0.01	7.99	14.56	1.33	18.627451	#DIV/0!
1/28/2006 16:31:08.673	11.38	22.11	7.12	7.23	394.67	2.41	68.44	5.81	0.23	3.97	0.00	4.58	0.01	0.01	0.00	7.96	14.50	1.31	18.3988764	#DIV/0!
1/28/2006 16:46:08.707	11.38	22.10	7.12	7.24	392.16	2.39	68.45	5.81	0.26	7.71	0.00	9.08	0.01	0.08	0.00	7.98	14.59	1.31	18.3988764	#DIV/0!
1/28/2006 17:01:08.751	11.39	22.08	7.13	7.23	394.37	2.39	68.45	5.81	0.24	1.98	0.00	2.59	0.23	0.00	-0.01	8.00	14.62	1.32	18.513324	#DIV/0!
1/28/2006 17:16:08.786	11.39	22.10	7.13	7.23	389.49	2.42	68.44	5.81	0.22	7.93	0.00	9.31	0.01	0.04	0.00	7.98	14.80	1.32	18.513324	#DIV/0!
1/28/2006 17:31:08.830	11.38	22.12	7.12	7.23	405.97	2.41	68.48	5.79	0.27	1.45	0.00	1.75	0.01	0.00	0.00	7.97	14.31	1.33	18.6797753	#DIV/0!
1/28/2006 17:46:08.844	11.38	22.11	7.12	7.23	396.81	2.42	68.44	5.81	0.22	2.90	0.00	3.43	0.01	0.00	-0.01	8.02	14.42	1.31	18.3988764	#DIV/0!
1/28/2006 18:01:08.898	11.39	22.11	7.13	7.23	403.68	2.41	68.50	5.82	0.24	8.16	0.00	9.46	0.01	0.05	-0.01	8.04	14.17	1.31	18.3730715	#DIV/0!
1/28/2006 18:16:08.922	11.38	22.08	7.12	7.23	385.60	2.41	68.45	5.81	0.26	1.98	0.00	2.29	0.04	0.01	0.00	7.99	14.84	1.31	18.3988764	#DIV/0!
1/28/2006 18:31:08.986	11.38	22.14	7.13	7.23	396.66	2.44	68.50	5.81	0.28	5.42	0.00	6.18	0.01	0.01	-0.01	8.01	14.53	1.32	18.513324	#DIV/0!
1/28/2006 18:46:09.021	11.38	22.13	7.13	7.31	402.69	2.41	68.44	5.81	0.25	6.33	0.00	8.16	0.01	0.20	0.00	8.01	14.32	1.32	18.513324	#DIV/0!
1/28/2006 19:01:09.025	11.38	22.11	7.14	7.23	402.46	2.41	68.44	5.80	0.26	2.37	0.00	3.05	0.01	0.01	0.01	7.96	14.54	1.34	18.767507	#DIV/0!
1/28/2006 19:16:09.029	11.38	22.11	7.14	7.23	393.76	2.42	68.39	5.80	0.25	7.86	0.00	9.31	0.01	0.04	0.00	7.94	14.86	1.34	18.767507	#DIV/0!
1/28/2006 19:31:09.043	11.38	22.11	7.13	7.23	404.90	2.42	68.38	5.81	0.25	1.53	0.00	2.06	0.01	0.00	0.00	8.01	14.24	1.32	18.513324	#DIV/0!
1/28/2006 19:46:09.057	11.40	22.10	7.14	7.23	406.27	2.43	68.38	5.81	0.22	3.74	0.00	4.50	0.01	0.01	0.01	8.00	14.30	1.33	18.627451	#DIV/0!

1/28/2006 20:01:09.111	11.38	22.11	7.14	7.24	395.13	2.41	68.35	5.80	0.23	7.71	0.00	9.08	0.01	0.06	-0.01	8.02	14.81	1.34	18.767507	#DIV/0!
1/28/2006 20:16:09.166	11.38	22.13	7.12	7.23	389.56	2.41	68.31	5.81	0.27	1.98	0.00	2.44	0.22	0.00	-0.01	8.03	14.69	1.31	18.3988764	#DIV/0!
1/28/2006 20:31:09.230	11.38	22.11	7.13	7.23	389.94	2.44	68.28	5.81	0.21	8.01	0.00	9.31	0.01	0.03	-0.01	8.03	14.78	1.32	18.513324	#DIV/0!
1/28/2006 20:46:09.264	11.38	22.11	7.12	7.23	405.51	2.44	68.24	5.81	0.24	1.30	0.00	1.68	0.01	0.00	0.00	8.06	14.11	1.31	18.3988764	#DIV/0!
1/28/2006 21:01:09.318	11.38	22.13	7.13	7.23	404.29	2.44	68.22	5.81	0.27	2.75	0.00	3.28	0.01	0.00	-0.01	8.03	14.26	1.32	18.513324	#DIV/0!
1/28/2006 21:16:09.373	11.38	22.10	7.14	7.23	406.65	2.44	68.21	5.81	0.22	8.01	0.00	9.31	0.01	0.05	-0.01	8.00	14.28	1.33	18.627451	#DIV/0!
1/28/2006 21:31:09.427	11.38	22.11	7.13	7.23	394.29	2.44	68.16	5.80	0.26	1.68	0.00	2.14	0.02	0.00	0.00	8.07	14.73	1.33	18.6535764	#DIV/0!
1/28/2006 21:46:09.461	11.38	22.08	7.14	7.22	395.44	2.42	68.15	5.82	0.22	5.42	0.00	6.18	0.01	0.00	-0.01	7.97	14.58	1.32	18.487395	#DIV/0!
1/28/2006 22:01:09.515	11.38	22.09	7.11	7.35	405.05	2.43	68.10	5.81	0.25	6.64	0.00	8.39	0.01	0.16	-0.01	8.05	14.02	1.3	18.2841069	#DIV/0!
1/28/2006 22:16:09.529	11.38	22.07	7.12	7.24	397.50	2.44	68.02	5.81	0.25	2.37	0.00	2.90	0.01	0.01	0.00	7.94	14.39	1.31	18.3988764	#DIV/0!
1/28/2006 22:31:09.594	11.38	22.10	7.13	7.24	388.11	2.44	68.02	5.81	0.24	7.93	0.00	9.31	0.01	0.04	-0.01	8.02	14.85	1.32	18.513324	#DIV/0!
1/28/2006 22:46:09.618	11.38	22.07	7.13	7.24	396.51	2.46	67.98	5.81	0.25	1.53	0.00	1.98	0.01	0.01	0.00	8.04	14.54	1.32	18.513324	#DIV/0!
1/28/2006 23:01:09.632	11.38	22.07	7.12	7.24	403.91	2.44	67.82	5.80	0.23	3.66	0.00	4.27	0.01	0.01	0.00	8.00	14.27	1.32	18.5393258	#DIV/0!
1/28/2006 23:16:09.676	11.39	22.04	7.13	7.24	398.79	2.46	67.93	5.80	0.22	7.78	0.00	9.16	0.01	0.06	-0.01	7.92	14.57	1.33	18.6535764	#DIV/0!
1/28/2006 23:31:09.690	11.38	22.03	7.13	7.23	401.46	2.46	67.89	5.80	0.23	1.91	0.00	2.37	0.22	0.01	0.01	7.96	14.47	1.33	18.6535764	#DIV/0!
1/28/2006 23:46:09.704	11.38	22.06	7.14	7.16	406.95	2.46	67.86	5.80	0.23	7.93	0.00	9.00	0.01	0.03	0.00	7.92	14.38	1.34	18.767507	#DIV/0!
1/29/2006 00:00:14.8 E	11.39	22.04	7.13	7.23	399.10	2.44	67.83	5.80	0.26	1.68	0.00	2.21	0.06	0.00	0.01	8.02	14.55	1.33	18.6535764	#DIV/0!
1/29/2006 00:00:15.1 B	11.39	22.04	7.13	7.23	399.10	2.44	67.83	5.80	0.26	1.68	0.00	2.21	0.06	0.00	0.01	8.02	14.55	1.33	18.6535764	#DIV/0!
1/29/2006 00:01:09.709	11.39	22.03	7.12	7.23	405.20	2.49	67.81	5.81	0.28	1.30	0.00	1.68	0.01	0.00	0.00	8.10	14.12	1.31	18.3988764	#DIV/0!
1/29/2006 00:16:09.773	11.38	22.04	7.12	7.23	400.63	2.44	67.77	5.80	0.25	2.75	0.00	3.36	0.01	0.01	0.01	8.01	14.39	1.32	18.5393258	#DIV/0!
1/29/2006 00:31:09.847	11.38	22.06	7.10	7.24	392.46	2.46	67.73	5.80	0.23	7.93	0.00	9.31	0.01	0.05	0.00	8.05	14.47	1.3	18.3098592	#DIV/0!
1/29/2006 00:46:09.881	11.39	22.00	7.12	7.23	403.22	2.46	67.72	5.80	0.30	1.68	0.00	2.14	0.01	0.01	0.00	8.05	14.30	1.32	18.5393258	#DIV/0!
1/29/2006 01:01:09.885	11.38	22.04	7.12	7.22	407.42	2.46	67.67	5.79	0.23	5.19	0.00	6.03	0.01	0.01	-0.01	8.08	14.26	1.33	18.6797753	#DIV/0!
1/29/2006 01:16:09.940	11.38	22.03	7.13	7.24	403.83	2.47	67.60	5.81	0.25	7.10	0.00	8.70	0.01	0.13	-0.01	8.11	14.28	1.32	18.513324	#DIV/0!
1/29/2006 01:31:09.994	11.38	22.00	7.12	7.23	399.63	2.46	67.60	5.80	0.23	2.37	0.00	2.90	0.01	0.00	0.01	8.06	14.43	1.32	18.5393258	#DIV/0!
1/29/2006 01:46:10.028	11.39	22.03	7.13	7.23	395.06	2.48	67.51	5.80	0.22	8.01	0.00	9.38	0.01	0.04	0.00	8.09	14.70	1.33	18.6535764	#DIV/0!
1/29/2006 02:01:10.082	11.38	22.02	7.13	7.23	399.86	2.47	67.46	5.80	0.25	1.37	0.00	1.83	0.01	0.01	-0.01	8.07	14.53	1.33	18.6535764	#DIV/0!
1/29/2006 02:16:10.116	11.38	22.03	7.12	7.23	397.88	2.47	67.43	5.81	0.24	3.36	0.00	4.20	0.01	0.01	-0.01	8.05	14.38	1.31	18.3988764	#DIV/0!
1/29/2006 02:31:10.171	11.38	22.02	7.13	7.23	406.04	2.47	67.40	5.81	0.23	7.55	0.00	9.08	0.01	0.06	0.01	8.00	14.20	1.32	18.513324	#DIV/0!
1/29/2006 02:46:10.195	11.38	22.03	7.13	7.24	395.06	2.47	67.37	5.80	0.23	1.83	0.00	2.37	0.21	0.01	-0.01	8.13	14.70	1.33	18.6535764	#DIV/0!
1/29/2006 03:01:10.229	11.38	22.01	7.12	7.42	400.40	2.48	67.32	5.80	0.24	7.55	0.00	8.62	0.01	0.01	-0.01	8.03	14.40	1.32	18.5393258	#DIV/0!
1/29/2006 03:16:10.273	11.38	21.99	7.14	7.24	393.38	2.49	67.26	5.79	0.26	1.30	0.00	1.68	0.01	0.01	-0.01	8.08	14.99	1.35	18.907563	#DIV/0!
1/29/2006 03:31:10.377	11.38	21.96	7.12	7.24	393.84	2.47	67.29	5.80	0.22	2.59	0.00	3.20	0.01	0.01	-0.01	8.00	14.64	1.32	18.5393258	#DIV/0!
1/29/2006 03:46:10.412	11.38	21.96	7.12	7.24	398.57	2.47	67.26	5.81	0.22	7.93	0.00	9.38	0.01	0.05	0.00	8.03	14.35	1.31	18.3988764	#DIV/0!
1/29/2006 04:01:10.446	11.38	21.92	7.12	7.24	400.17	2.48	67.19	5.80	0.25	1.53	0.00	2.06	0.01	0.01	0.00	8.07	14.41	1.32	18.5393258	#DIV/0!
1/29/2006 04:16:10.500	11.38	21.92	7.12	7.25	398.57	2.48	67.19	5.80	0.24	5.11	0.00	5.87	0.01	0.01	-0.01	7.97	14.46	1.32	18.5393258	#DIV/0!
1/29/2006 04:31:10.524	11.38	21.87	7.13	7.32	397.96	2.47	67.19	5.80	0.22	7.25	0.00	8.93	0.01	0.11	-0.01	8.01	14.80	1.33	18.6535764	#DIV/0!
1/29/2006 04:46:10.568	11.38	21.87	7.13	7.24	405.28	2.47	67.12	5.80	0.20	2.21	0.00	2.75	0.01	0.01	0.01	8.07	14.33	1.33	18.6535764	#DIV/0!
1/29/2006 05:01:10.572	11.38	21.89	7.12	7.24	389.33	2.48	67.12	5.79	0.20	7.78	0.00	9.31	0.01	0.03	-0.01	8.05	14.92	1.33	18.6797753	#DIV/0!
1/29/2006 05:16:10.607	11.38	21.84	7.13	7.24	391.24	2.49	67.12	5.79	0.28	1.37	0.00	1.91	0.01	0.01	-0.01	7.92	14.96	1.34	18.7938289	#DIV/0!
1/29/2006 05:31:10.661	11.38	21.84	7.12	7.24	397.12	2.49	67.06	5.80	0.23	3.36	0.00	4.12	0.01	0.01	-0.01	8.04	14.52	1.32	18.5393258	#DIV/0!
1/29/2006 05:46:10.715	11.38	21.85	7.13	7.26	397.12	2.49	67.05	5.80	0.23	7.63	0.00	9.23	0.01	0.05	0.00	7.99	14.63	1.33	18.6535764	#DIV/0!
1/29/2006 06:01:10.729	11.38	21.84	7.14	7.24	407.95	2.49	67.06	5.79	0.26	1.68	0.00	2.21	0.18	0.01	0.00	8.05	14.45	1.35	18.907563	#DIV/0!
1/29/2006 06:16:10.793	11.38	21.87	7.13	7.17	394.67	2.49	67.05	5.79	0.24	6.94	0.00	7.93	0.01	0.01	-0.01	8.05	14.83	1.34	18.7938289	#DIV/0!
1/29/2006 06:31:10.808	11.38	21.82	7.13	7.24	399.63	2.47	67.03	5.80	0.25	1.07	0.00	1.53	0.01	0.01	0.01	7.96	14.53	1.33	18.6535764	#DIV/0!
1/29/2006 06:46:10.862	11.38	21.81	7.13	7.24	391.32	2.49	67.02	5.79	0.25	2.44	0.00	3.05	0.01	0.01	0.00	7.99	14.96	1.34	18.7938289	#DIV/0!
1/29/2006 07:01:10.906	11.38	21.80	7.13	7.24	403.60	2.49	67.00	5.80	0.22	7.78	0.00	9.31	0.01	0.05	0.00	8.00	14.39	1.33	18.6535764	#DIV/0!
1/29/2006 07:16:10.970	11.38	21.78	7.14	7.24	405.74	2.49	67.00	5.80	0.25	1.45	0.00	2.06	0.01	0.00	0.01	8.02	14.42	1.34	18.767507	#DIV/0!
1/29/2006 07:31:10.984	11.38	21.76	7.12	7.23	396.81	2.51	67.02	5.80	0.23	4.65	0.00	5.42	0.01	0.01	-0.01	8.08	14.53	1.32	18.5393258	#DIV/0!
1/29/2006 07:46:10.989	11.38	21.76	7.13	7.29	406.27	2.49	66.97	5.80	0.22	7.32	0.00	8.93	0.01	0.11	0.00	8.00	14.30	1.33	18.6535764	#DIV/0!
1/29/2006 08:01:11.043	11.38	21.77	7.14	7.24	407.11	2.49	67.02	5.80	0.21	2.06	0.00	2.59	0.07	0.01	-0.01	7.98	14.37	1.34	18.767507	#DIV/0!
1/29/2006 08:16:11.097	11.38	21.73	7.12	7.24	403.66	2.51	67.05	5.80	0.20	8.09	0.00	9.38	0.01	0.05	-0.01	8.05	14.28	1.32	18.5393258	#DIV/0!
1/29/2006 08:31:11.141	11.39	21.71	7.13	7.24	400.17	2.49	66.99	5.80	0.26	1.37	0.00	1.68	0.01	0.01	0.00	7.99	14.52	1.33	18.6535764	#DIV/0!
1/29/2006 08:46:11.175	11.38	21.74	7.14	7.24	390.25	2.52	67.03	5.79	0.23	3.59	0.00	4.27	0.01	0.00	0.00	8.03	15.11	1.35	18.907563	#DIV/0!
1/29/2006 09:01:11.240	11.39	21.71	7.12	7.24	392.61	2.51	67.08	5.79	0.23	7.93	0.00	9.31	0.01	0.06	-0.01	8.05	14.79	1.33	18.6797753	#DIV/0!
1/29/2006 09:16:11.314	11.39	21.74	7.12	7.24	401.77	2.49	67.12	5.79	0.23	1.91	0.00	2.37	0.17	0.00	-0.01	7.99	14.46	1.33	18.6797753	#DIV/0!
1/29/2006 09:31:11.358	11.39	21.71	7.13	7.17	408.56	2.51	67.17	5.80	0.27	6.87	0.00	7.78	0.01	0.01	0.01	7.93	14.22	1.33	18.6535764	#DIV/0!
1/29/2006 09:46:11.362	11.39	21.73	7.11	7.24	405.97	2.51	67.32	5.79	0.26	1.37	0.00	1.68	0.01	0.01	-0.01	7.94	14.20	1.32	18.5654008	#DIV/0!
1/29/2006 10:01:11.426	11.38	20.94	0.00	7.24	0.46	2.46	67.02	0.11	0.11	0.84	0.00	1.14	0.01	0.00	-0.01	8.37	-1044.36	-0.11	#DIV/0!	#DIV/0!
1/29/2006 10:16:11.491	11.38	20.85	0.00	7.24	0.38	2.46	66.94	0.07	0.10	0.69	0.00	0.99	0.01	0.01	-0.01	8.39	-804.50	-0.07	#DIV/0!	#DIV/0!
1/29/2006 10:31:11.905	11.40	21.59	7.87	7.24	579.69	2.51	67.26	5.15	4.33	0.76	0.00	0.99	0.01	0.00	0.00	7.78	20.49	2.72	34.5616264	#DIV/0!
1/29/2006 10:46:12.040	11.38	21.20	7.86	7.24	582.36	2.51	67.23	5.11	3.89	0.76	0.00	0.99	0.01	0.02	-0.01	8.71	20.62	2.75	34.9872774	#DIV/0!
1/29/2006 11:01:12.044	11.38	21.60	7.87	7.24	586.48	2.49	67.35	5.11	3.69	0.76	0.00	0.99	0.01	0.00	-0.01	8.74	20.55	2.76	35.0698856	#DIV/0!
1/29/2006 11:16:12.419	11.38	21.75	7.86	7.23	587.93	2.49	67.44	5.10	3.65	0.76	0.00	0.99	0.01	0.00	-0.01	8.73	20.50	2.76	35.1145038	#DIV/0!
1/29/2006 11:31:13.234	11.39	21.87	7.86	7.24	591.29	2.48	67.52	5.10	3.66	0.76	0.00	0.99	0.01	0.00	0.01	8.74	20.39	2.76	35.1145038	#DIV/0!
1/29/2006 11:46:13.468	11.39	22.32	7.86	7.23	591.36	2.49	67.66	5.10	3.67	0.84	0.00	0.99	0.01	0.00	-0.01	8.72	20.38	2.76	35.1145038	#DIV/0!
1/29/2006 12:01:13.493	11.38	22.75	7.85	7.23	594.87	2.49	67.81	5.10	3.70	0.76	0.00	0.99	0.01	0.00	-0.01	8.77	20.19	2.75	35.0318471	#DIV/0!
1/29/2006 12:16:13.527	11.38	22.71	7.84	7.23	596.93	2.49	67.84	5.08	3.74	0.69	0.00	0.92	0.01	0.02	0.00	8.68	20.18	2.76	35.2040816	#DIV/0!
1/29/2006 12:31:13.571	11.38	23.05	7.82	7.23	600.37	2.49	67.93	5.07	3.78	0.84	0.00	0.92	0.01	0.00	-0.01	8.49	20.00	2.75	35.1662404	#DIV/0!
1/29/2006 12:46:13.615	11.38	23.31	7.80	7.23	602.43	2.47	68.07	5.07	3.82	0.69	0.00	0.99	0.01	0.00	0.00	8.46	19.79	2.73	35	#DIV/0!
1/29/2006 13:01:13.639	11.38	23.58	7.79	7.23	605.48	2.49	68.21	5.07	3.87	0.61	0.00	0.92	0.01	0.01	0.00	8.50	19.62	2.72	34.9165597	#DIV/0!
1/29/2006 13:16:13.673	11.38	23.81	7.80	7.23	608.83	2.51	68.31	5.05	3.91	0.76	0.00	0.92	0.01	0.01	0.01	8.46	19.73	2.75	35.2564103	#DIV/0!
1/29/2006 13:31:13.738	11.38	24.11	7.77	7.23	611.81	2.49	68.38	5.06	3.96	0.69	0.00	0.84	0.01	0.00	0.01	8.51	19.34	2.71	34.8777349	#DIV/0!
1/29/2006 13:46:13.752	11.38	24.33	7.77	7.23	608.99	2.51	68.51	5.11	4.00	0.69	0.00	0.99	0.01	0.00	0.00	8.49	19.08	2.66	34.2342342	#DIV/0!

1/29/2006 14:01:13.806	11.39	24.64	7.82	7.23	618.68	2.49	68.60	5.08	4.03	0.69	0.00	0.84	0.01	0.00	0.00	8.50	19.34	2.74	35.0383632	#DIV/0!
1/29/2006 14:16:13.830	11.38	24.89	7.84	7.23	619.52	2.51	68.71	5.09	4.06	0.69	0.00	0.99	0.01	0.01	-0.01	8.48	19.39	2.75	35.0765306	#DIV/0!
1/29/2006 14:31:13.914	11.38	25.13	7.82	7.23	624.55	2.51	68.83	5.07	4.10	0.69	0.00	0.84	0.01	0.01	0.00	8.51	19.23	2.75	35.1682404	#DIV/0!
1/29/2006 14:46:14.069	11.38	25.38	7.82	7.23	626.15	2.49	68.86	5.08	4.13	0.69	0.00	0.99	0.01	0.00	-0.01	8.48	19.11	2.74	35.0383632	#DIV/0!
1/29/2006 15:01:14.113	11.38	25.58	7.80	7.23	631.11	2.51	69.00	5.06	4.16	0.76	0.00	0.99	0.01	0.00	-0.01	8.52	18.96	2.74	35.1282051	#DIV/0!
1/29/2006 15:16:14.157	11.38	25.80	7.77	7.23	632.41	2.51	69.12	5.06	4.20	0.84	0.00	0.92	0.01	0.01	-0.01	8.46	18.71	2.71	34.8777349	#DIV/0!
1/29/2006 15:31:14.211	11.38	26.05	7.77	7.23	633.86	2.51	69.17	5.07	4.22	0.69	0.00	0.84	0.01	0.00	0.01	8.50	18.60	2.7	34.7490347	#DIV/0!
1/29/2006 15:46:14.416	11.38	26.28	7.77	7.23	637.67	2.52	69.25	5.05	4.25	0.69	0.00	0.92	0.01	0.00	-0.01	8.49	18.63	2.72	35.006435	#DIV/0!
1/29/2006 16:01:14.440	11.38	26.49	7.77	7.23	636.30	2.53	69.32	5.09	4.28	0.69	0.00	0.92	0.01	0.00	-0.01	8.49	18.39	2.68	34.4916345	#DIV/0!
1/29/2006 16:16:14.514	11.38	26.66	7.77	7.23	642.71	2.52	69.37	5.04	4.30	0.69	0.00	0.92	0.01	0.00	0.00	8.48	18.55	2.73	35.1351351	#DIV/0!
1/29/2006 16:31:14.548	11.38	26.95	7.77	7.23	642.79	2.52	69.40	5.06	4.33	0.69	0.00	0.84	0.01	0.00	0.00	8.48	18.41	2.71	34.8777349	#DIV/0!
1/29/2006 16:46:14.613	11.38	27.17	7.80	7.23	647.06	2.52	69.43	5.06	4.36	0.69	0.00	0.92	0.01	0.00	0.01	8.46	18.49	2.74	35.1282051	#DIV/0!
1/29/2006 17:01:14.657	11.38	27.39	7.81	7.23	649.81	2.54	69.47	5.07	4.38	0.69	0.00	0.92	0.01	0.00	0.00	8.45	18.42	2.74	35.0832266	#DIV/0!
1/29/2006 17:16:14.701	11.39	27.57	7.79	7.23	656.06	2.52	69.49	5.07	4.40	0.69	0.00	0.84	0.01	0.00	-0.01	8.46	18.11	2.72	34.9165597	#DIV/0!
1/29/2006 17:31:14.745	11.40	27.81	7.78	7.23	659.42	2.54	69.46	5.05	4.42	0.61	0.00	0.99	0.01	0.00	-0.01	8.46	18.08	2.73	35.0899743	#DIV/0!
1/29/2006 17:46:14.769	11.38	27.88	0.16	7.23	25.18	2.54	69.38	1.64	4.43	0.69	0.00	0.92	0.01	0.00	-0.01	8.47	-256.70	-1.48		#DIV/0!
1/29/2006 18:01:14.784	11.38	28.18	7.79	7.23	661.17	2.54	69.32	5.06	4.51	0.69	0.00	0.99	0.01	0.00	0.00	8.46	18.03	2.73	35.0449294	#DIV/0!
1/29/2006 18:16:14.808	11.38	28.35	7.78	7.23	662.85	2.54	69.28	5.07	4.55	0.61	0.00	0.84	0.01	0.00	-0.01	8.45	17.86	2.71	34.8329049	#DIV/0!
1/29/2006 18:31:14.872	11.38	28.60	7.80	7.23	669.87	2.54	69.21	5.06	4.56	0.61	0.00	0.84	0.01	0.00	0.01	8.47	17.86	2.74	35.1282051	#DIV/0!
1/29/2006 18:46:14.926	11.38	28.77	7.78	7.23	671.85	2.54	69.12	5.06	4.56	0.61	0.00	0.99	0.01	0.00	0.00	8.49	17.68	2.72	34.9614396	#DIV/0!
1/29/2006 19:01:14.970	11.38	28.98	7.82	7.23	673.76	2.54	69.11	5.07	4.57	0.61	0.00	0.76	0.01	0.02	-0.01	8.48	17.83	2.75	35.1862404	#DIV/0!
1/29/2006 19:16:15.005	11.38	29.13	7.78	7.23	678.65	2.55	69.00	5.05	4.57	0.69	0.00	0.92	0.01	0.01	-0.01	8.52	17.57	2.73	35.0899743	#DIV/0!
1/29/2006 19:31:15.079	11.38	29.34	7.78	7.23	680.86	2.54	68.96	5.07	4.58	0.69	0.00	0.84	0.01	0.00	-0.01	8.49	17.38	2.71	34.8329049	#DIV/0!
1/29/2006 19:46:15.233	11.38	29.52	7.77	7.23	686.43	2.55	68.91	5.05	4.59	0.69	0.00	0.99	0.01	0.01	-0.01	8.53	17.31	2.72	35.006435	#DIV/0!
1/29/2006 20:01:15.348	11.38	29.72	7.77	7.23	688.26	2.55	68.85	5.05	4.60	0.61	0.00	0.84	0.01	0.00	0.01	8.49	17.26	2.72	35.006435	#DIV/0!
1/29/2006 20:16:15.362	11.38	29.87	7.78	7.24	692.38	2.55	68.76	5.05	4.60	0.69	0.00	0.92	0.01	0.00	-0.01	8.51	17.22	2.73	35.0899743	#DIV/0!
1/29/2006 20:31:15.386	11.38	30.09	7.77	7.23	696.12	2.55	68.71	5.05	4.60	0.61	0.00	0.84	0.01	0.00	0.00	8.49	17.06	2.72	35.006435	#DIV/0!
1/29/2006 20:46:15.440	11.38	30.24	7.79	7.24	684.51	2.55	68.64	5.10	4.62	0.61	0.00	0.84	0.01	0.00	-0.01	8.51	16.92	2.69	34.5314506	#DIV/0!
1/29/2006 21:01:15.454	11.38	30.45	7.80	7.23	700.47	2.54	68.57	5.07	4.62	0.61	0.00	0.84	0.01	0.00	-0.01	8.49	17.02	2.73	35	#DIV/0!
1/29/2006 21:16:15.478	11.38	30.63	7.79	7.23	706.49	2.57	68.53	5.05	4.62	0.61	0.00	0.76	0.01	0.00	0.01	8.51	16.94	2.74	35.1732991	#DIV/0!
1/29/2006 21:31:15.563	11.38	30.81	7.78	7.24	709.82	2.55	68.48	5.04	4.63	0.53	0.00	0.92	0.01	0.00	0.00	8.47	16.86	2.74	35.218509	#DIV/0!
1/29/2006 21:46:15.627	11.38	31.05	7.10	7.24	451.44	2.57	68.42	6.15	4.63	7.86	0.00	9.38	0.01	0.05	0.01	8.53	9.19	0.95	13.3802817	#DIV/0!
1/29/2006 22:01:15.671	11.38	31.91	7.09	7.24	445.56	2.57	68.65	6.12	4.78	1.07	0.00	1.68	0.01	0.01	-0.01	8.82	9.51	0.97	13.6812412	#DIV/0!
1/29/2006 22:16:15.725	11.38	32.40	7.08	7.24	455.41	2.57	68.82	6.12	0.17	3.36	0.00	3.89	0.01	0.01	-0.01	8.81	9.21	0.96	13.559322	#DIV/0!
1/29/2006 22:31:15.790	11.38	31.55	7.09	7.23	448.23	2.57	68.85	6.11	0.18	7.71	0.00	9.23	0.01	0.05	-0.01	8.39	9.55	0.98	13.8222849	#DIV/0!
1/29/2006 22:46:15.854	11.38	31.10	7.09	7.24	447.47	2.57	68.57	6.09	0.17	1.45	0.00	2.06	0.01	0.00	0.00	8.00	9.76	1	14.1043724	#DIV/0!
1/29/2006 23:01:15.898	11.38	30.62	7.09	7.21	444.80	2.59	68.50	6.08	0.22	5.42	0.00	6.41	0.01	0.00	-0.01	8.00	9.92	1.01	14.2454161	#DIV/0!
1/29/2006 23:16:15.952	11.38	30.15	7.09	7.29	450.22	2.59	68.44	6.08	0.25	2.82	0.00	5.19	0.01	0.28	0.00	7.99	9.80	1.01	14.2454161	#DIV/0!
1/29/2006 23:31:16.006	11.39	29.72	7.10	7.24	448.84	2.57	68.38	6.04	0.24	2.29	0.00	2.90	0.01	0.00	-0.01	7.97	10.31	1.06	14.9295775	#DIV/0!
1/29/2006 23:46:16.061	11.38	29.32	7.11	7.24	427.10	2.59	68.25	6.04	0.22	7.86	0.00	9.31	0.01	0.02	0.00	7.97	10.94	1.07	15.0492264	#DIV/0!
1/30/2006 00:01:16.075	11.39	28.91	7.09	7.24	434.88	2.60	68.22	6.02	0.22	1.14	0.00	1.68	0.01	0.01	-0.01	7.98	10.75	1.07	15.0916784	#DIV/0!
1/30/2006 00:16:16.109	11.40	28.54	7.10	7.24	444.11	2.60	68.13	6.00	0.22	3.36	0.00	4.12	0.01	0.01	0.00	7.96	10.82	1.1	15.4929577	#DIV/0!
1/30/2006 00:31:16.123	11.38	28.21	7.09	7.25	439.99	2.60	68.04	6.00	0.23	7.48	0.00	9.00	0.01	0.04	-0.01	8.01	10.82	1.09	15.3737659	#DIV/0!
1/30/2006 00:46:16.177	11.38	27.86	7.10	7.24	438.39	2.59	67.96	5.99	0.25	1.53	0.00	2.14	0.01	0.00	-0.01	8.03	11.06	1.11	15.6338028	#DIV/0!
1/30/2006 01:01:16.191	11.38	27.57	7.11	7.14	432.52	2.62	67.95	5.98	0.23	7.71	0.00	8.93	0.01	0.02	0.00	8.03	11.41	1.13	15.8931083	#DIV/0!
1/30/2006 01:16:16.246	11.39	27.26	7.10	7.24	425.50	2.61	67.84	5.97	0.21	0.99	0.00	1.37	0.01	0.01	0.00	8.01	11.60	1.13	15.915493	#DIV/0!
1/30/2006 01:31:16.270	11.39	26.97	7.11	7.24	419.24	2.59	67.81	5.95	0.23	2.14	0.00	2.90	0.01	0.00	-0.01	8.00	12.08	1.16	16.3150492	#DIV/0!
1/30/2006 01:46:16.304	11.39	26.73	7.10	7.24	428.32	2.59	67.67	5.95	0.24	7.40	0.00	8.93	0.01	0.04	0.00	8.06	11.73	1.15	16.1971831	#DIV/0!
1/30/2006 02:01:16.308	11.38	26.49	7.10	7.24	417.56	2.60	67.67	5.94	0.23	1.22	0.00	1.68	0.01	0.01	0.00	7.98	12.13	1.16	16.3380282	#DIV/0!
1/30/2006 02:16:16.362	11.39	26.23	7.10	7.23	431.53	2.60	67.58	5.94	0.26	4.20	0.00	5.11	0.01	0.01	-0.01	8.11	11.74	1.16	16.3380282	#DIV/0!
1/30/2006 02:31:16.377	11.39	26.01	7.10	7.28	424.43	2.62	67.49	5.93	0.22	4.20	0.00	6.10	0.01	0.14	0.01	8.00	12.04	1.17	16.4788732	#DIV/0!
1/30/2006 02:46:16.411	11.37	25.81	7.10	7.24	421.76	2.60	67.43	5.92	0.25	1.75	0.00	2.37	0.01	0.00	-0.01	8.10	12.22	1.18	16.6197183	#DIV/0!
1/30/2006 03:01:16.415	11.38	25.54	7.10	7.24	428.93	2.60	67.41	5.91	0.21	7.40	0.00	8.85	0.01	0.04	0.01	8.05	12.12	1.19	16.7605634	#DIV/0!
1/30/2006 03:16:16.449	11.38	25.36	7.09	7.24	412.30	2.60	67.35	5.90	0.23	0.99	0.00	1.45	0.01	0.01	0.01	8.03	12.61	1.19	16.7842031	#DIV/0!
1/30/2006 03:31:16.453	11.39	25.15	7.10	7.24	415.12	2.62	67.29	5.90	0.22	2.67	0.00	3.43	0.01	0.01	0.01	8.04	12.62	1.2	16.9014085	#DIV/0!
1/30/2006 03:46:16.748	11.38	25.00	7.09	7.24	430.61	2.62	67.23	5.90	0.23	6.49	0.00	8.24	0.01	0.08	0.01	8.09	12.07	1.19	16.7842031	#DIV/0!
1/30/2006 04:01:16.782	11.38	24.82	7.12	7.24	411.00	2.60	67.19	5.89	0.23	1.37	0.00	1.91	0.01	0.00	0.01	8.05	13.07	1.23	17.2752809	#DIV/0!
1/30/2006 04:16:16.836	11.38	24.66	7.15	7.19	417.49	2.60	67.12	5.88	0.21	6.26	0.00	7.17	0.01	0.00	-0.01	8.05	13.29	1.27	17.7622378	#DIV/0!
1/30/2006 04:31:16.870	11.38	24.46	7.10	7.24	416.88	2.60	67.09	5.88	0.22	0.84	0.00	1.30	0.01	0.01	-0.01	8.00	12.78	1.22	17.1830986	#DIV/0!
1/30/2006 04:46:16.895	11.38	24.38	7.10	7.24	427.41	2.60	67.03	5.88	0.20	1.91	0.00	2.59	0.01	0.01	0.00	8.04	12.47	1.22	17.1830986	#DIV/0!
1/30/2006 05:01:16.949	11.38	24.19	7.08	7.25	423.36	2.62	66.99	5.88	0.23	7.25	0.00	8.85	0.01	0.04	-0.01	8.02	12.38	1.2	16.9491525	#DIV/0!
1/30/2006 05:16:16.963	11.38	24.08	7.10	7.24	419.93	2.62	66.93	5.85	0.22	1.22	0.00	1.75	0.01	0.01	-0.01	8.06	13.00	1.25	17.6056338	#DIV/0!
1/30/2006 05:31:17.007	11.38	23.96	7.11	7.25	409.09	2.60	66.94	5.86	0.23	3.81	0.00	4.81	0.01	0.01	-0.01	8.11	13.34	1.25	17.580872	#DIV/0!
1/30/2006 05:46:17.031	11.38	23.83	7.09	7.27	414.05	2.62	66.88	5.86	0.20	6.56	0.00	8.32	0.01	0.09	-0.01	8.00	12.97	1.23	17.348378	#DIV/0!
1/30/2006 06:01:17.055	11.38	23.71	7.11	7.24	415.43	2.62	66.83	5.87	0.19	1.68	0.00	2.37	0.01	0.01	-0.01	8.07	13.04	1.24	17.440225	#DIV/0!
1/30/2006 06:16:17.100	11.38	23.62	7.11	7.25	421.45	2.62	66.76	5.86	0.21	7.55	0.00	8.85	0.01	0.04	0.00	8.04	12.95	1.25	17.580872	#DIV/0!
1/30/2006 06:31:17.134	11.38	23.50	7.11	7.25	414.59	2.63	66.77	5.85	0.21	0.99	0.00	1.60	0.01	0.01	0.00	8.07	13.27	1.26	17.721519	#DIV/0!
1/30/2006 06:46:17.198	11.38	23.40	7.11	7.25	420.77	2.62	66.68	5.85	0.20	2.75	0.00	3.43	0.01	0.01	-0.01	7.96	13.08	1.26	17.721519	#DIV/0!
1/30/2006 07:01:17.232	11.38	23.28	7.12	7.25	421.00	2.62	66.67	5.85	0.21	7.10	0.00	8.70	0.01	0.05	0.00	8.04	13.17	1.27	17.8370787	#DIV/0!
1/30/2006 07:16:17.256	11.38	23.20	7.10	7.25	422.60	2.62	66.62	5.84	0.21	1.37	0.00	2.06	0.01	0.01	-0.01	8.07	13.02	1.26	17.7464789	#DIV/0!
1/30/2006 07:31:17.301	11.38	23.12	7.12	7.19	423.67	2.62	66.59	5.84	0.20	5.65	0.00	6.56	0.01	0.01	0.01	8.07	13.19	1.28	17.9775281	#DIV/0!
1/30/2006 07:46:17.315	11.38	23.01	7.18	7.50	461.66	2.63	66.64	6.01	0.29	1.14	0.00	3.28	0.01	0.24	-0.01	8.03	11.07	1.17	16.2952646	#DIV/0!
1/30/2006 08:01:17.319	11.38	22.88	7.11	7.25	412.30	2.62	66.62	5.83	0.20	2.06	0.00	2.75	0.01	0.01	0.00	8.05	13.56	1.28	18.0028129	#DIV/0!
1/30/2006 08:16:17.363	11.39	22.86	7.12	7.24	411.84	2.63	66.65	5.83	0.20	7.25	0.00	8.85	0.01	0.05	-0.01	8.00	13.68	1.29	18.1179775	#DIV/0!

1/30/2006 08:31:17.407	11.38	22.78	7.10	7.24	411.31	2.62	66.70	5.82	0.21	1.30	0.00	1.68	0.01	0.00	-0.01	8.02	13.59	1.28	18.028169	#DIV/0!
1/30/2006 08:46:17.442	11.39	22.71	7.12	7.23	411.46	2.63	66.71	5.82	0.20	3.66	0.00	4.43	0.01	0.01	0.00	8.00	13.80	1.3	18.258427	#DIV/0!
1/30/2006 09:01:17.516	11.38	22.62	7.12	7.25	409.25	2.63	66.73	5.82	0.20	6.64	0.00	8.24	0.01	0.09	-0.01	8.04	13.87	1.3	18.258427	#DIV/0!
1/30/2006 09:16:17.550	11.38	22.58	7.10	7.24	409.40	2.63	66.77	5.82	0.20	1.68	0.00	2.37	0.01	0.01	0.00	8.03	13.65	1.28	18.028169	#DIV/0!
1/30/2006 09:31:17.594	11.38	22.53	7.10	7.24	411.69	2.63	66.82	5.81	0.19	7.40	0.00	8.85	0.01	0.04	0.00	8.00	13.68	1.29	18.1690141	#DIV/0!
1/30/2006 09:46:17.608	11.38	22.45	7.11	7.24	414.05	2.63	66.90	5.81	0.21	0.99	0.00	1.45	0.01	0.01	-0.01	7.98	13.71	1.3	18.2841069	#DIV/0!
1/30/2006 10:01:17.642	11.38	22.40	7.10	7.24	408.87	2.63	66.90	5.81	0.21	2.75	0.00	3.43	0.01	0.00	-0.01	8.00	13.78	1.29	18.1690141	#DIV/0!
1/30/2006 10:16:17.667	11.38	22.36	7.11	7.24	400.55	2.63	66.99	5.81	0.20	7.25	0.00	8.85	0.01	0.05	0.00	7.96	14.17	1.3	18.2841069	#DIV/0!
1/30/2006 10:31:17.721	11.38	22.29	7.11	7.24	399.86	2.65	67.02	5.80	0.21	1.37	0.00	1.98	0.01	0.01	-0.01	8.05	14.31	1.31	18.4247539	#DIV/0!
1/30/2006 10:46:17.805	11.38	22.25	7.11	7.21	418.63	2.63	67.11	5.80	0.20	5.19	0.00	6.26	0.01	0.01	0.00	7.99	13.67	1.31	18.4247539	#DIV/0!
1/30/2006 11:01:17.859	11.39	22.20	7.09	7.59	412.45	2.63	67.12	5.85	0.22	2.14	0.00	4.20	0.01	0.33	-0.01	8.00	13.13	1.24	17.4894217	#DIV/0!
1/30/2006 11:16:17.914	11.39	22.16	7.11	7.24	410.93	2.63	67.19	5.80	0.20	2.14	0.00	2.67	0.01	0.01	-0.01	7.96	13.92	1.31	18.4247539	#DIV/0!
1/30/2006 11:31:17.958	11.38	22.10	7.10	7.24	407.80	2.63	67.26	5.80	0.19	7.48	0.00	8.77	0.01	0.05	0.00	7.98	13.92	1.3	18.3098592	#DIV/0!
1/30/2006 11:46:18.012	11.38	22.04	7.11	7.24	412.60	2.65	67.35	5.80	0.22	1.37	0.00	1.75	0.01	0.00	-0.01	7.93	13.87	1.31	18.4247539	#DIV/0!
1/30/2006 12:01:18.036	11.38	22.06	7.12	7.23	410.32	2.63	67.46	5.80	0.20	3.59	0.00	4.27	0.01	0.00	0.00	8.02	14.05	1.32	18.5393258	#DIV/0!
1/30/2006 12:16:18.080	11.38	22.03	7.12	7.24	406.04	2.63	67.55	5.79	0.22	7.10	0.00	8.62	0.01	0.06	-0.01	8.00	14.31	1.33	18.6797753	#DIV/0!
1/30/2006 12:31:18.125	11.38	22.02	7.08	7.24	406.88	2.65	67.61	5.78	0.22	1.68	0.00	2.29	0.01	0.00	0.00	8.03	13.95	1.3	18.3615819	#DIV/0!
1/30/2006 12:46:18.159	11.38	21.97	7.11	7.24	410.39	2.63	67.67	5.78	0.21	7.40	0.00	8.85	0.01	0.04	0.00	7.95	14.15	1.33	18.7060478	#DIV/0!
1/30/2006 13:01:18.173	11.38	21.99	7.10	7.24	413.14	2.65	67.80	5.78	0.22	1.14	0.00	1.53	0.01	0.01	-0.01	7.98	13.95	1.32	18.5915493	#DIV/0!
1/30/2006 13:16:18.197	11.38	21.93	7.09	7.24	400.70	2.65	67.89	5.78	0.21	2.67	0.00	3.28	0.01	0.00	-0.01	7.94	14.28	1.31	18.4767278	#DIV/0!
1/30/2006 13:31:18.221	11.38	21.96	7.10	7.24	406.42	2.65	67.98	5.79	0.19	7.55	0.00	8.93	0.01	0.05	-0.01	7.95	14.08	1.31	18.4507042	#DIV/0!
1/30/2006 13:46:18.285	11.38	21.89	7.11	7.23	404.75	2.63	68.09	5.78	0.21	1.45	0.00	1.91	0.01	0.00	0.01	7.98	14.35	1.33	18.7060478	#DIV/0!
1/30/2006 14:01:18.330	11.38	21.93	7.11	7.23	397.73	2.65	68.16	5.78	0.20	5.11	0.00	5.87	0.01	0.00	-0.01	7.96	14.60	1.33	18.7060478	#DIV/0!
1/30/2006 14:16:18.895	11.38	21.90	7.08	7.24	414.89	2.65	68.27	5.78	0.25	3.97	0.00	6.03	0.01	0.26	0.00	7.88	13.68	1.3	18.3615819	#DIV/0!
1/30/2006 14:31:18.999	11.38	21.91	7.11	7.23	397.12	2.65	68.36	5.77	0.20	1.91	0.00	2.52	0.01	0.00	-0.01	7.96	14.74	1.34	18.8466948	#DIV/0!
1/30/2006 14:46:19.193	11.38	21.89	7.10	7.24	407.19	2.65	68.47	5.77	0.20	7.48	0.00	8.77	0.01	0.04	-0.01	7.93	14.26	1.33	18.7323944	#DIV/0!
1/30/2006 15:01:19.238	11.39	21.92	7.10	7.23	406.73	2.65	68.53	5.77	0.21	1.37	0.00	1.75	0.01	0.00	-0.01	7.94	14.28	1.33	18.7323944	#DIV/0!
1/30/2006 15:16:19.292	11.40	21.90	7.09	7.23	400.09	2.65	68.59	5.76	0.20	3.59	0.00	4.12	0.01	0.00	-0.01	7.89	14.52	1.33	18.7588152	#DIV/0!
1/30/2006 15:31:19.356	11.38	21.89	7.11	7.23	405.38	2.65	68.65	5.77	0.21	7.25	0.00	8.62	0.01	0.05	0.00	7.94	14.44	1.34	18.8466948	#DIV/0!
1/30/2006 15:46:19.380	11.39	21.88	7.11	7.23	413.67	2.65	68.73	5.77	0.21	1.68	0.00	2.21	0.01	0.01	-0.01	7.94	14.15	1.34	18.8466948	#DIV/0!
1/30/2006 16:01:19.384	11.39	21.84	7.11	7.25	414.44	2.67	68.77	5.77	0.19	7.32	0.00	8.24	0.01	0.02	0.00	7.86	14.12	1.34	18.8466948	#DIV/0!
1/30/2006 16:16:19.418	11.37	21.86	7.11	7.23	406.42	2.65	68.77	5.76	0.20	1.22	0.00	1.53	0.01	0.00	-0.01	7.95	14.51	1.35	18.9873418	#DIV/0!
1/30/2006 16:31:19.443	11.38	21.85	7.11	7.23	403.91	2.65	68.76	5.77	0.22	2.52	0.00	3.05	0.01	0.00	-0.01	7.91	14.49	1.34	18.8466948	#DIV/0!
1/30/2006 16:46:19.457	11.39	21.86	7.11	7.23	407.49	2.65	68.77	5.77	0.23	7.48	0.00	8.93	0.01	0.05	0.00	7.90	14.36	1.34	18.8466948	#DIV/0!
1/30/2006 17:01:19.481	11.38	21.89	7.10	7.23	412.91	2.65	68.82	5.77	0.26	1.53	0.00	1.98	0.01	0.00	-0.01	7.92	14.07	1.33	18.7323944	#DIV/0!
1/30/2006 17:16:19.505	11.38	21.88	7.10	7.23	410.09	2.67	68.80	5.77	0.23	4.96	0.00	5.49	0.01	0.00	0.00	7.93	14.16	1.33	18.7323944	#DIV/0!
1/30/2006 17:31:19.549	11.38	21.89	7.11	7.24	395.90	2.67	68.82	5.77	0.24	6.41	0.00	7.93	0.01	0.13	0.00	7.98	14.78	1.34	18.8466948	#DIV/0!
1/30/2006 17:46:19.594	11.38	21.92	7.11	7.23	398.11	2.65	68.79	5.78	0.24	1.75	0.00	2.29	0.01	0.01	-0.01	7.93	14.59	1.33	18.7060478	#DIV/0!
1/30/2006 18:01:19.618	11.38	21.85	7.11	7.23	413.29	2.65	68.71	5.76	0.20	7.55	0.00	8.83	0.01	0.04	0.01	7.93	14.27	1.35	18.9873418	#DIV/0!
1/30/2006 18:16:19.642	11.38	21.80	7.10	7.23	404.67	2.67	68.74	5.77	0.22	1.22	0.00	1.68	0.01	0.00	0.00	7.96	14.35	1.33	18.7323944	#DIV/0!
1/30/2006 18:31:19.706	11.38	21.80	7.09	7.24	414.36	2.67	68.70	5.77	0.23	3.43	0.00	4.12	0.01	0.00	-0.01	7.99	13.91	1.32	18.6177715	#DIV/0!
1/30/2006 18:46:19.720	11.38	21.71	7.12	7.23	402.08	2.65	68.64	5.76	0.22	7.63	0.00	8.85	0.01	0.06	0.00	7.97	14.77	1.36	19.1011236	#DIV/0!
1/30/2006 19:01:19.875	11.38	21.73	7.12	7.23	405.58	2.65	68.60	5.77	0.21	1.60	0.00	1.98	0.01	0.00	-0.01	7.98	14.54	1.35	18.9606742	#DIV/0!
1/30/2006 19:16:20.129	11.38	21.74	7.11	7.18	405.51	2.65	68.64	5.77	0.19	6.33	0.00	7.25	0.01	0.00	-0.01	7.98	14.43	1.34	18.8466948	#DIV/0!
1/30/2006 19:31:20.193	11.38	21.71	7.11	7.24	395.74	2.67	68.51	5.78	0.22	1.07	0.00	1.53	0.01	0.00	0.00	7.93	14.68	1.33	18.7060478	#DIV/0!
1/30/2006 19:46:20.228	11.38	21.73	7.09	7.24	397.80	2.67	68.50	5.76	0.21	2.59	0.00	3.13	0.01	0.00	-0.01	7.99	14.60	1.33	18.7588152	#DIV/0!
1/30/2006 20:01:20.232	11.39	21.69	7.11	7.23	411.31	2.67	68.50	5.77	0.20	7.63	0.00	8.93	0.01	0.05	0.00	7.92	14.23	1.34	18.8466948	#DIV/0!
1/30/2006 20:16:20.316	11.39	21.70	7.11	7.24	405.97	2.67	68.42	5.76	0.22	1.45	0.00	1.83	0.01	0.00	0.00	8.03	14.52	1.35	18.9873418	#DIV/0!
1/30/2006 20:31:20.390	11.38	21.71	7.10	7.23	406.50	2.67	68.38	5.76	0.20	4.04	0.00	4.81	0.01	0.00	0.00	8.02	14.40	1.34	18.8732394	#DIV/0!
1/30/2006 20:46:20.454	11.38	21.71	7.11	7.25	408.64	2.65	68.38	5.76	0.21	7.17	0.00	8.62	0.01	0.07	-0.01	7.94	14.43	1.35	18.9873418	#DIV/0!
1/30/2006 21:01:20.489	11.38	21.70	7.11	7.24	402.15	2.68	68.35	5.76	0.20	1.75	0.00	2.29	0.01	0.00	0.00	7.87	14.66	1.35	18.9873418	#DIV/0!
1/30/2006 21:16:20.533	11.38	21.71	7.09	7.24	406.04	2.65	68.31	5.77	0.19	7.55	0.00	8.93	0.01	0.04	0.00	8.00	14.20	1.32	18.6177715	#DIV/0!
1/30/2006 21:31:20.557	11.38	21.68	7.10	7.24	414.82	2.67	68.27	5.77	0.24	1.30	0.00	1.68	0.01	0.00	-0.01	7.98	14.00	1.33	18.7323944	#DIV/0!
1/30/2006 21:46:20.601	11.38	21.73	7.11	7.24	412.45	2.67	68.24	5.77	0.22	3.05	0.00	3.74	0.01	0.00	0.01	8.00	14.19	1.34	18.8466948	#DIV/0!
1/30/2006 22:01:20.635	11.38	21.70	7.08	7.24	405.36	2.65	68.22	5.77	0.19	7.55	0.00	8.93	0.01	0.05	0.00	7.98	14.11	1.31	18.5028249	#DIV/0!
1/30/2006 22:16:20.690	11.39	21.66	7.11	7.24	399.86	2.67	68.16	5.76	0.23	1.53	0.00	2.06	0.01	0.00	0.00	8.04	14.74	1.35	18.9873418	#DIV/0!
1/30/2006 22:31:20.744	11.38	21.70	7.11	7.20	408.26	2.67	68.09	5.77	0.24	5.65	0.00	6.56	0.01	0.00	-0.01	7.97	14.33	1.34	18.8466948	#DIV/0!
1/30/2006 22:46:20.798	11.38	21.70	7.12	7.25	416.49	2.68	68.02	6.01	0.32	1.45	0.00	3.89	0.01	0.34	-0.01	7.96	11.64	1.11	15.5898876	#DIV/0!
1/30/2006 23:01:20.812	11.40	21.68	7.11	7.24	408.03	2.68	67.99	5.77	0.22	2.29	0.00	2.82	0.01	0.01	0.00	7.98	14.34	1.34	18.8466948	#DIV/0!
1/30/2006 23:16:20.846	11.38	21.67	7.10	7.24	404.14	2.68	67.95	5.77	0.21	7.48	0.00	8.85	0.01	0.05	0.00	8.04	14.37	1.33	18.7323944	#DIV/0!
1/30/2006 23:31:20.921	11.39	21.66	7.12	7.24	406.12	2.67	67.90	5.77	0.25	1.37	0.00	1.83	0.01	0.01	-0.01	8.06	14.52	1.35	18.9606742	#DIV/0!
1/30/2006 23:46:20.955	11.38	21.64	7.12	7.23	410.01	2.67	67.87	5.77	0.19	3.97	0.00	4.81	0.01	0.00	0.00	7.96	14.38	1.35	18.9606742	#DIV/0!
1/31/2006 00:01:20.959	11.39	21.62	7.11	7.24	407.42	2.67	67.81	5.77	0.23	7.32	0.00	8.77	0.01	0.06	-0.01	8.02	14.36	1.34	18.8466948	#DIV/0!
1/31/2006 00:16:20.983	11.39	21.63	7.10	7.24	407.49	2.67	67.75	5.77	0.21	1.75	0.00	2.29	0.01	0.00	-0.01	8.01	14.25	1.33	18.7323944	#DIV/0!
1/31/2006 00:31:21.057	11.39	21.64	7.11	7.24	408.33	2.67	67.72	5.77	0.20	7.55	0.00	9.08	0.01	0.04	-0.01	8.04	14.33	1.34	18.8466948	#DIV/0!
1/31/2006 00:46:21.071	11.38	21.62	7.11	7.24	398.18	2.68	67.61	5.77	0.25	1.30	0.00	1.68	0.01	0.00	0.00	8.04	14.70	1.34	18.8466948	#DIV/0!
1/31/2006 01:01:21.126	11.38	21.62	7.12	7.24	407.26	2.68	67.55	5.77	0.22	2.82	0.00	3.36	0.01	0.00	0.00	8.00	14.48	1.35	18.9606742	#DIV/0!
1/31/2006 01:16:21.170	11.38	21.62	7.11	7.24	418.33	2.67	67.49	5.77	0.22	7.48	0.00	8.93	0.01	0.05	-0.01	8.00	13.99	1.34	18.8466948	#DIV/0!
1/31/2006 01:31:21.204	11.38	21.62	7.11	7.24	412.91	2.68	67.44	5.76	0.26	1.45	0.00	2.06	0.01	0.01	0.01	8.02	14.28	1.35	18.9873418	#DIV/0!
1/31/2006 01:46:21.288	11.38	21.57	7.12	7.21	405.05	2.68	67.38	5.77	0.19	5.11	0.00	6.10	0.01	0.01	-0.01	7.97	14.56	1.35	18.9606742	#DIV/0!
1/31/2006 02:01:21.333	11.38	21.59	7.10	7.28	406.73	2.68	67.31	5.79	0.20	3.13	0.00	6.10	0.01	0.48	-0.01	8.02	14.07	1.31	18.4507042	#DIV/0!
1/31/2006 02:16:21.387	11.38	21.57	7.10	7.24	409.40	2.68	67.26	5.77	0.20	2.06	0.00	2.75	0.01	0.01	0.00	8.07	14.19	1.33	18.7323944	#DIV/0!
1/31/2006 02:31:21.461	11.38	21.57	7.11	7.24	407.42	2.70	67.19	5.76	0.19	7.40	0.00	8.93	0.01	0.04	-0.01	8.06	14.26	1.33	18.7060478	#DIV/0!
1/31/2006 02:46:21.505	11.39	21.54	7.10	7.24	408.94	2.70	67.14	5.78	0.25	1.30	0.00	1.91	0.01	0.01	0.00	8.03	14.10	1.32	18.5915493	#DIV/0!

1/31/2006 03:01:21.529	11.38	21.53	7.11	7.25	417.33	2.68	67.11	5.77	0.25	3.74	0.00	4.58	0.01	0.00	0.00	8.07	14.02	1.34	18.8466948	#DIV/0!
1/31/2006 03:16:21.574	11.38	21.51	7.11	7.27	407.87	2.68	67.06	5.77	0.21	7.40	0.00	8.93	0.01	0.06	0.00	8.03	14.35	1.34	18.8466948	#DIV/0!
1/31/2006 03:31:21.578	11.38	21.53	7.11	7.24	411.61	2.68	66.97	5.78	0.26	1.60	0.00	2.21	0.01	0.00	-0.01	8.11	14.11	1.33	18.7060478	#DIV/0!
1/31/2006 03:46:21.662	11.38	21.50	7.10	7.25	408.33	2.70	66.97	5.77	0.22	7.40	0.00	8.93	0.01	0.04	-0.01	8.05	14.23	1.33	18.7323944	#DIV/0!
1/31/2006 04:01:21.706	11.38	21.50	7.11	7.24	406.27	2.70	66.90	5.77	0.32	1.07	0.00	1.53	0.01	0.01	0.00	8.06	14.40	1.34	18.8466948	#DIV/0!
1/31/2006 04:16:21.730	11.38	21.53	7.11	7.24	414.21	2.68	66.83	5.78	0.23	2.75	0.00	3.43	0.01	0.00	-0.01	8.03	14.02	1.33	18.7060478	#DIV/0!
1/31/2006 04:31:21.754	11.38	21.48	7.11	7.25	404.75	2.70	66.80	5.77	0.21	7.63	0.00	9.00	0.01	0.05	-0.01	8.08	14.46	1.34	18.8466948	#DIV/0!
1/31/2006 04:46:21.819	11.38	21.50	7.12	7.25	399.79	2.70	66.74	5.78	0.24	1.37	0.00	1.91	0.01	0.00	0.01	8.03	14.64	1.34	18.8202247	#DIV/0!
1/31/2006 05:01:21.863	11.38	21.46	7.11	7.32	399.40	2.68	66.71	5.78	0.23	4.88	0.00	5.80	0.01	0.01	-0.01	8.06	14.54	1.33	18.7060478	#DIV/0!
1/31/2006 05:16:21.887	11.38	21.48	7.12	7.34	408.33	2.70	66.64	5.78	0.22	4.43	0.00	7.02	0.01	0.33	-0.01	8.06	14.33	1.34	18.8202247	#DIV/0!
1/31/2006 05:31:21.981	11.40	21.45	7.11	7.25	408.41	2.70	66.65	5.77	0.22	2.14	0.00	2.75	0.01	0.00	-0.01	8.10	14.33	1.34	18.8466948	#DIV/0!
1/31/2006 05:46:22.036	11.39	21.44	7.10	7.25	407.49	2.70	66.58	5.77	0.19	7.55	0.00	9.08	0.01	0.04	0.00	8.09	14.25	1.33	18.7323944	#DIV/0!
1/31/2006 06:01:22.040	11.38	21.40	7.11	7.25	406.81	2.70	66.56	5.77	0.24	1.07	0.00	1.68	0.01	0.01	0.00	8.06	14.39	1.34	18.8466948	#DIV/0!
1/31/2006 06:16:22.064	11.39	21.38	7.10	7.24	407.80	2.70	66.48	5.77	0.23	3.36	0.00	4.20	0.01	0.01	0.00	8.04	14.24	1.33	18.7323944	#DIV/0!
1/31/2006 06:31:22.078	11.38	21.41	7.09	7.25	411.84	2.70	66.47	5.78	0.22	7.25	0.00	8.85	0.01	0.05	-0.01	8.11	13.89	1.31	18.4767278	#DIV/0!
1/31/2006 06:46:22.092	11.39	21.39	7.10	7.25	418.40	2.71	66.44	5.77	0.25	1.68	0.00	2.37	0.01	0.01	-0.01	8.08	13.88	1.33	18.7323944	#DIV/0!
1/31/2006 07:01:22.146	11.39	21.37	7.10	7.25	413.37	2.70	66.39	5.77	0.21	7.55	0.00	9.16	0.01	0.04	0.01	8.13	14.05	1.33	18.7323944	#DIV/0!
1/31/2006 07:16:22.181	11.38	21.38	7.09	7.25	404.67	2.70	66.36	5.77	0.24	0.99	0.00	1.60	0.01	0.01	-0.01	8.11	14.25	1.32	18.6177715	#DIV/0!
1/31/2006 07:31:22.245	11.38	21.37	7.12	7.25	406.42	2.70	66.30	5.77	0.22	2.44	0.00	3.20	0.01	0.01	-0.01	8.13	14.51	1.35	18.9608742	#DIV/0!
1/31/2006 07:46:22.299	11.38	21.30	7.10	7.25	419.17	2.70	66.29	5.77	0.20	7.40	0.00	9.00	0.01	0.05	-0.01	8.12	13.86	1.33	18.7323944	#DIV/0!
1/31/2006 08:01:22.363	11.38	21.27	7.10	7.25	408.71	2.71	66.29	5.77	0.23	1.53	0.00	2.06	0.01	0.01	0.01	8.12	14.21	1.33	18.7323944	#DIV/0!
1/31/2006 08:16:22.377	11.38	21.28	7.10	7.22	416.11	2.70	66.29	5.76	0.20	4.96	0.00	5.95	0.01	0.01	-0.01	8.07	14.06	1.34	18.8732394	#DIV/0!
1/31/2006 08:31:22.412	11.38	21.24	7.11	7.33	402.69	2.71	66.33	5.77	0.23	5.65	0.00	7.86	0.01	0.20	-0.01	8.07	14.53	1.34	18.8466948	#DIV/0!
1/31/2006 08:46:22.466	11.38	21.24	7.09	7.25	410.47	2.70	66.33	5.76	0.23	1.91	0.00	2.52	0.01	0.01	-0.01	8.09	14.15	1.33	18.7588152	#DIV/0!
1/31/2006 09:01:22.530	11.39	21.23	7.11	7.25	409.17	2.71	66.39	5.77	0.19	7.63	0.00	9.08	0.01	0.04	-0.01	8.07	14.30	1.34	18.8466948	#DIV/0!
1/31/2006 09:16:22.564	11.38	21.21	7.11	7.25	403.22	2.70	66.44	5.76	0.20	1.37	0.00	1.83	0.01	0.00	0.00	8.07	14.62	1.35	18.9873418	#DIV/0!
1/31/2006 09:31:22.638	11.39	21.20	7.08	7.24	402.91	2.70	66.50	5.76	0.20	3.74	0.00	4.43	0.01	0.00	-0.01	7.98	14.31	1.32	18.6440678	#DIV/0!
1/31/2006 09:46:22.693	11.39	21.18	7.12	7.25	404.36	2.71	66.59	5.76	0.21	7.63	0.00	9.08	0.01	0.07	-0.01	8.04	14.69	1.36	19.1011236	#DIV/0!
1/31/2006 10:01:22.747	11.38	21.16	7.11	7.24	419.17	2.70	66.62	5.76	0.21	1.68	0.00	2.21	0.01	0.00	-0.01	8.08	14.07	1.35	18.9873418	#DIV/0!
1/31/2006 10:16:22.791	11.38	21.16	7.12	7.25	409.86	2.70	66.71	5.76	0.20	7.71	0.00	9.23	0.01	0.04	-0.01	8.02	14.49	1.36	19.1011236	#DIV/0!
1/31/2006 10:31:22.815	11.38	21.18	7.11	7.24	408.48	2.70	66.87	5.76	0.21	1.22	0.00	1.68	0.01	0.00	0.01	8.00	14.43	1.35	18.9873418	#DIV/0!
1/31/2006 10:46:22.890	11.38	21.19	7.12	7.25	402.46	2.70	66.94	5.76	0.21	2.98	0.00	3.43	0.01	0.01	0.01	7.99	14.76	1.36	19.1011236	#DIV/0!
1/31/2006 11:01:22.914	11.38	21.19	7.11	7.24	418.78	2.70	67.03	5.75	0.23	7.71	0.00	9.00	0.01	0.05	0.01	8.05	14.18	1.36	19.1279887	#DIV/0!
1/31/2006 11:16:22.948	11.38	21.20	7.11	7.24	396.58	2.70	67.19	5.75	0.21	1.60	0.00	2.06	0.01	0.00	-0.01	8.00	14.98	1.36	19.1279887	#DIV/0!
1/31/2006 11:31:23.002	11.38	21.19	7.12	7.23	409.32	2.71	67.28	5.75	0.20	4.65	0.00	5.49	0.01	0.00	-0.01	8.04	14.62	1.37	19.241573	#DIV/0!
1/31/2006 11:46:23.006	11.38	21.20	7.11	7.28	411.76	2.71	67.32	5.76	0.21	7.02	0.00	8.47	0.01	0.12	-0.01	7.91	14.32	1.35	18.9873418	#DIV/0!
1/31/2006 12:01:23.020	11.38	21.21	7.10	7.24	406.42	2.71	67.46	5.75	0.21	2.06	0.00	2.59	0.01	0.00	-0.01	7.96	14.51	1.35	19.0140845	#DIV/0!
1/31/2006 12:16:23.045	11.38	21.17	7.11	7.24	413.67	2.70	67.57	5.75	0.19	7.71	0.00	9.08	0.01	0.04	0.00	7.93	14.36	1.36	19.1279887	#DIV/0!
1/31/2006 12:31:23.099	11.38	21.20	7.11	7.24	418.02	2.70	67.73	5.74	0.23	1.30	0.00	1.75	0.01	0.00	-0.01	8.01	14.31	1.37	19.2686357	#DIV/0!
1/31/2006 12:46:23.153	11.38	21.20	7.10	7.24	409.09	2.71	67.83	5.75	0.20	3.43	0.00	4.04	0.01	0.00	-0.01	7.93	14.41	1.35	19.0140845	#DIV/0!
1/31/2006 13:01:23.167	11.38	21.23	7.10	7.24	415.66	2.71	68.01	5.75	0.21	7.93	0.00	9.08	0.01	0.06	-0.01	7.95	14.18	1.35	19.0140845	#DIV/0!
1/31/2006 13:16:23.191	11.38	21.24	7.09	7.24	406.42	2.71	68.10	5.74	0.21	1.68	0.00	2.21	0.01	0.00	0.00	7.89	14.51	1.35	19.0409027	#DIV/0!
1/31/2006 13:31:23.195	11.38	21.26	7.09	7.17	413.37	2.71	68.19	5.74	0.18	6.87	0.00	7.55	0.01	0.00	0.00	7.91	14.28	1.35	19.0409027	#DIV/0!
1/31/2006 13:46:23.240	11.38	21.26	7.11	7.23	412.76	2.71	68.30	5.71	0.23	1.22	0.00	1.60	0.01	0.00	0.01	7.87	14.81	1.4	19.6905767	#DIV/0!
1/31/2006 14:01:23.564	11.38	21.24	7.09	7.23	402.99	2.72	68.33	5.74	0.22	2.59	0.00	3.20	0.01	0.00	-0.01	7.85	14.63	1.35	19.0409027	#DIV/0!
1/31/2006 14:16:23.608	11.38	21.27	7.10	7.23	412.68	2.71	68.42	5.74	0.21	7.93	0.00	9.08	0.01	0.05	-0.01	7.88	14.39	1.36	19.1549296	#DIV/0!
1/31/2006 14:31:23.713	11.38	21.27	7.11	7.23	417.33	2.71	68.45	5.74	0.21	1.60	0.00	1.98	0.01	0.00	-0.01	7.96	14.34	1.37	19.2686357	#DIV/0!
1/31/2006 14:46:23.827	11.38	21.30	7.09	7.23	401.31	2.71	68.54	5.73	0.19	4.27	0.00	5.04	0.01	0.00	-0.01	7.89	14.80	1.36	19.1819464	#DIV/0!
1/31/2006 15:01:23.891	11.39	21.28	7.12	7.26	395.74	2.71	68.57	5.74	0.22	7.32	0.00	8.85	0.01	0.07	0.00	7.90	15.23	1.38	19.3820225	#DIV/0!
1/31/2006 15:16:23.935	11.38	21.28	7.11	7.23	414.05	2.71	68.62	5.73	0.21	1.98	0.00	2.29	0.01	0.00	0.00	7.88	14.56	1.38	19.4092827	#DIV/0!
1/31/2006 15:31:23.970	11.38	21.30	7.10	7.23	407.87	2.71	68.71	5.73	0.20	7.93	0.00	9.08	0.01	0.05	0.00	7.80	14.67	1.37	19.2957746	#DIV/0!
1/31/2006 15:46:24.034	11.38	21.34	7.12	7.23	400.55	2.70	68.80	5.73	0.22	1.45	0.00	1.75	0.01	0.00	-0.01	7.92	15.16	1.39	19.5224719	#DIV/0!
1/31/2006 16:01:24.078	11.38	21.34	7.09	7.23	407.19	2.71	68.85	5.73	0.21	3.59	0.00	4.04	0.01	0.00	-0.01	7.93	14.59	1.36	19.1819464	#DIV/0!
1/31/2006 16:16:24.132	11.38	21.35	7.11	7.23	404.06	2.71	68.86	5.73	0.22	7.86	0.00	9.00	0.01	0.05	0.00	7.83	14.92	1.38	19.4092827	#DIV/0!
1/31/2006 16:31:24.146	11.38	21.35	7.10	7.23	411.61	2.71	68.94	5.74	0.39	1.68	0.00	2.21	0.01	0.00	0.00	7.93	14.43	1.36	19.1549296	#DIV/0!
1/31/2006 16:46:24.181	11.38	21.38	7.11	7.25	413.37	2.71	68.94	5.73	0.23	5.87	0.00	6.64	0.01	0.00	-0.01	7.90	14.58	1.38	19.4092827	#DIV/0!
1/31/2006 17:01:24.205	11.38	21.41	7.10	7.41	407.34	2.72	68.96	5.83	0.33	2.88	0.00	5.67	0.01	0.57	0.00	7.81	13.62	1.27	17.8873239	#DIV/0!
1/31/2006 17:16:24.219	11.38	21.44	7.10	7.23	416.72	2.72	68.97	5.74	0.22	2.37	0.00	2.82	0.01	0.00	-0.01	7.92	14.25	1.36	19.1549296	#DIV/0!
1/31/2006 17:31:24.263	11.38	21.39	7.11	7.23	415.12	2.72	68.96	5.74	0.19	7.86	0.00	9.16	0.01	0.05	-0.01	7.91	14.41	1.37	19.2686357	#DIV/0!
1/31/2006 17:46:24.267	11.39	21.42	7.11	7.24	398.95	2.72	68.94	5.74	0.25	1.45	0.00	1.83	0.01	0.00	-0.01	7.91	15.00	1.37	19.2686357	#DIV/0!
1/31/2006 18:01:24.271	11.39	21.41	7.10	7.23	411.69	2.72	68.88	5.74	0.21	3.74	0.00	4.50	0.01	0.00	0.00	7.94	14.43	1.36	19.1549296	#DIV/0!
1/31/2006 18:16:24.306	11.39	21.42	7.09	7.24	408.03	2.72	68.89	5.74	0.22	7.86	0.00	9.08	0.01	0.06	0.00	7.90	14.45	1.35	19.0409027	#DIV/0!
1/31/2006 18:31:24.350	11.38	21.43	7.09	7.24	399.18	2.71	68.82	5.75	0.21	1.75	0.00	2.37	0.01	0.00	-0.01	7.99	14.66	1.34	18.899859	#DIV/0!
1/31/2006 18:46:24.394	11.39	21.46	7.11	7.24	416.42	2.72	68.76	5.74	0.22	7.86	0.00	9.23	0.01	0.04	-0.01	7.96	14.37	1.37	19.2686357	#DIV/0!
1/31/2006 19:01:24.408	11.38	21.46	7.09	7.23	407.95	2.71	68.65	5.74	0.25	1.30	0.00	1.68	0.01	0.00	-0.01	7.96	14.45	1.35	19.0409027	#DIV/0!
1/31/2006 19:16:24.442	11.38	21.48	7.09	7.24	411.54	2.72	68.57	5.74	0.24	2.98	0.00	3.51	0.01	0.00	0.00	8.01	14.33	1.35	19.0409027	#DIV/0!
1/31/2006 19:31:24.497	11.39	21.48	7.11	7.24	401.62	2.72	68.50	5.75	0.22	7.78	0.00	9.08	0.01	0.05	-0.01	8.03	14.79	1.36	19.1279887	#DIV/0!
1/31/2006 19:46:24.521	11.39	21.48	7.10	7.24	407.80	2.72	68.50	5.75	0.23	1.60	0.00	2.06	0.01	0.01	0.00	7.97	14.46	1.35	19.0140845	#DIV/0!
1/31/2006 20:01:24.545	11.38	21.50	7.10	7.26	399.56	2.72	68.38	5.75	0.20	5.11	0.00	5.95	0.01	0.00	0.00	8.02	14.76	1.35	19.0140845	#DIV/0!
1/31/2006 20:16:24.609	11.38	21.46	7.10	7.41	409.86	2.72	68.31	5.75	0.23	6.03	0.00	7.93	0.01	0.21	-0.01	8.01	14.39	1.35	19.0140845	#DIV/0!
1/31/2006 20:31:24.653	11.38	21.49	7.11	7.24	411.23	2.72	68.25	5.75	0.23	2.06	0.00	2.52	0.01	0.00	-0.01	8.01	14.44	1.36	19.1279887	#DIV/0!
1/31/2006 20:46:24.688	11.38	21.46	7.09	7.24	404.14	2.74	68.21	5.75	0.18	7.63	0.00	9.08	0.01	0.04	0.01	8.01	14.48	1.34	18.899859	#DIV/0!
1/31/2006 21:01:24.692	11.38	21.49	7.11	7.24	418.86	2.72	68.15	5.75	0.23	1.45	0.00	1.91	0.01	0.01	-0.01	8.00	14.18	1.36	19.1279887	#DIV/0!
1/31/2006 21:16:24.756	11.38	21.45	7.09	7.24	402.30	2.72	68.13	5.75	0.24	3.66	0.00	4.27	0.01	0.00	-0.01	8.00	14.55	1.34	18.899859	#DIV/0!

1/31/2006 21:31:24.780	11.39	21.52	7.11	7.24	421.38	2.72	68.01	5.75	0.22	7.48	0.00	9.00	0.01	0.06	-0.01	8.08	14.10	1.36	19.1279887	#DIV/0!
1/31/2006 21:46:24.824	11.39	21.48	7.11	7.24	409.78	2.72	67.98	5.76	0.21	1.68	0.00	2.21	0.01	0.01	-0.01	8.03	14.39	1.35	18.9873418	#DIV/0!
1/31/2006 22:01:24.859	11.38	21.46	7.10	7.24	412.66	2.73	67.87	5.75	0.22	7.71	0.00	9.23	0.01	0.04	0.00	8.07	14.29	1.35	19.0140845	#DIV/0!
1/31/2006 22:16:24.893	11.39	21.43	7.11	7.24	414.74	2.72	67.81	5.76	0.26	1.30	0.00	1.68	0.01	0.00	0.01	7.98	14.22	1.35	18.9873418	#DIV/0!
1/31/2006 22:31:24.947	11.38	21.49	7.10	7.24	416.57	2.73	67.81	5.75	0.22	2.67	0.00	3.36	0.01	0.01	-0.01	8.04	14.15	1.35	19.0140845	#DIV/0!
1/31/2006 22:46:24.961	11.38	21.42	7.10	7.24	421.00	2.72	67.69	5.75	0.23	7.71	0.00	9.08	0.01	0.05	-0.01	8.03	14.00	1.35	19.0140845	#DIV/0!
1/31/2006 23:01:25.025	11.38	21.45	7.10	7.24	413.37	2.73	67.63	5.75	0.19	1.60	0.00	1.98	0.01	0.01	0.01	8.00	14.26	1.35	19.0140845	#DIV/0!
1/31/2006 23:16:25.059	11.38	21.45	7.11	7.23	421.07	2.73	67.54	5.75	0.22	4.73	0.00	5.49	0.01	0.01	-0.01	8.03	14.11	1.36	19.1279887	#DIV/0!
1/31/2006 23:31:25.104	11.38	21.45	7.09	7.26	411.76	2.73	67.49	5.75	0.24	7.02	0.00	8.62	0.01	0.12	0.00	8.02	14.21	1.34	18.899859	#DIV/0!
1/31/2006 23:46:25.168	11.38	21.41	7.09	7.24	403.98	2.72	67.43	5.76	0.22	1.98	0.00	2.59	0.01	0.01	0.00	8.01	14.38	1.33	18.7588152	#DIV/0!
2/1/2006 00:01:25.222	11.38	21.37	7.11	7.24	415.05	2.73	67.38	5.75	0.21	7.55	0.00	9.23	0.01	0.04	-0.01	8.05	14.31	1.36	19.1279887	#DIV/0!
2/1/2006 00:16:25.266	11.38	21.39	7.09	7.24	420.61	2.73	67.31	5.75	0.24	1.37	0.00	1.68	0.01	0.01	-0.01	8.01	13.91	1.34	18.899859	#DIV/0!
2/1/2006 00:31:25.290	11.38	21.38	7.10	7.24	421.99	2.73	67.29	5.76	0.22	3.66	0.00	4.27	0.01	0.01	-0.01	8.02	13.87	1.34	18.8732394	#DIV/0!
2/1/2006 00:46:25.355	11.38	21.37	7.10	7.28	410.24	2.73	67.26	5.75	0.19	7.55	0.00	9.08	0.01	0.07	-0.01	8.00	14.37	1.35	19.0140845	#DIV/0!
2/1/2006 01:01:25.399	11.38	21.37	7.10	7.24	420.77	2.74	67.19	5.76	0.23	1.60	0.00	2.21	0.01	0.01	0.00	8.02	13.91	1.34	18.8732394	#DIV/0!
2/1/2006 01:16:25.423	11.38	21.36	7.08	7.16	403.60	2.73	67.12	5.76	0.20	6.94	0.00	8.01	0.01	0.01	0.00	8.08	14.28	1.32	18.6440678	#DIV/0!
2/1/2006 01:31:25.437	11.38	21.37	7.11	7.25	409.63	2.73	67.09	5.76	0.22	1.22	0.00	1.68	0.01	0.00	-0.01	8.03	14.39	1.35	18.9873418	#DIV/0!
2/1/2006 01:46:25.491	11.38	21.31	7.10	7.25	422.14	2.73	67.06	5.76	0.20	2.44	0.00	3.05	0.01	0.01	0.01	8.02	13.86	1.34	18.8732394	#DIV/0!
2/1/2006 02:01:25.536	11.38	21.34	7.09	7.25	421.15	2.73	67.03	5.76	0.22	7.55	0.00	9.08	0.01	0.05	0.00	8.03	13.79	1.33	18.7588152	#DIV/0!
2/1/2006 02:16:25.540	11.38	21.33	7.10	7.24	402.91	2.74	66.99	5.76	0.23	1.45	0.00	1.98	0.01	0.01	-0.01	8.06	14.52	1.34	18.8732394	#DIV/0!
2/1/2006 02:31:25.604	11.38	21.34	7.09	7.23	412.53	2.74	66.99	5.75	0.19	4.27	0.00	5.19	0.01	0.01	0.00	8.02	14.19	1.34	18.899859	#DIV/0!
2/1/2006 02:46:25.638	11.38	21.31	7.10	7.36	412.68	2.74	66.93	5.76	0.23	7.25	0.00	8.93	0.01	0.10	0.00	8.08	14.18	1.34	18.8732394	#DIV/0!
2/1/2006 03:01:25.662	11.38	21.28	7.12	7.25	422.83	2.73	66.93	5.75	0.23	1.83	0.00	2.37	0.01	0.01	-0.01	8.01	14.15	1.37	19.241573	#DIV/0!
2/1/2006 03:16:25.687	11.38	21.27	7.10	7.25	412.45	2.75	66.85	5.76	0.20	7.55	0.00	9.23	0.01	0.04	-0.01	8.03	14.19	1.34	18.8732394	#DIV/0!
2/1/2006 03:31:25.731	11.39	21.28	7.10	7.25	402.30	2.74	66.85	5.76	0.23	1.22	0.00	1.68	0.01	0.01	-0.01	8.07	14.55	1.34	18.8732394	#DIV/0!
2/1/2006 03:46:25.785	11.38	21.27	7.09	7.25	412.99	2.75	66.80	5.76	0.23	3.28	0.00	4.04	0.01	0.01	0.00	8.07	14.06	1.33	18.7588152	#DIV/0!
2/1/2006 04:01:25.809	11.38	21.24	7.10	7.26	418.78	2.74	66.80	5.76	0.20	7.71	0.00	9.00	0.01	0.05	0.01	7.98	13.97	1.34	18.8732394	#DIV/0!
2/1/2006 04:16:25.823	11.38	21.24	7.12	7.25	418.10	2.75	66.74	5.76	0.22	1.53	0.00	2.14	0.01	0.01	0.00	8.11	14.21	1.36	19.1011236	#DIV/0!
2/1/2006 04:31:25.827	11.37	21.24	7.08	7.26	411.92	2.74	66.77	5.76	0.20	6.41	0.00	7.25	0.01	0.01	-0.01	8.08	14.00	1.32	18.6440678	#DIV/0!
2/1/2006 04:46:25.862	11.39	21.24	7.10	7.25	417.72	2.74	66.71	5.75	0.23	0.99	0.00	1.60	0.01	0.01	0.00	8.12	14.11	1.35	19.0140845	#DIV/0!
2/1/2006 05:01:25.916	11.38	21.20	7.11	7.25	417.94	2.75	66.71	5.75	0.21	2.37	0.00	2.90	0.01	0.01	-0.01	8.05	14.21	1.36	19.1279887	#DIV/0!
2/1/2006 05:16:25.970	11.38	21.22	7.12	7.25	423.06	2.75	66.65	5.76	0.20	7.48	0.00	9.16	0.01	0.05	-0.01	8.14	14.04	1.36	19.1011236	#DIV/0!
2/1/2006 05:31:26.014	11.39	21.19	7.09	7.24	408.79	2.75	66.65	5.76	0.21	1.37	0.00	1.91	0.01	0.01	0.01	8.11	14.21	1.33	18.7588152	#DIV/0!
2/1/2006 05:46:26.028	11.38	21.18	7.10	7.24	413.44	2.75	66.56	5.76	0.21	4.43	0.00	5.34	0.01	0.01	-0.01	8.10	14.15	1.34	18.8732394	#DIV/0!
2/1/2006 06:01:26.103	11.37	21.16	7.10	7.27	410.32	2.74	66.53	5.76	0.21	7.25	0.00	8.77	0.01	0.07	-0.01	8.03	14.26	1.34	18.8732394	#DIV/0!
2/1/2006 06:16:26.157	11.38	21.15	7.11	7.25	419.09	2.74	66.56	5.76	0.23	1.68	0.00	2.37	0.01	0.01	0.00	8.05	14.07	1.35	18.9873418	#DIV/0!
2/1/2006 06:31:26.191	11.38	21.15	7.09	7.25	411.38	2.74	66.50	5.71	0.19	7.55	0.00	9.08	0.01	0.04	0.00	8.06	14.65	1.38	19.4640339	#DIV/0!
2/1/2006 06:46:26.225	11.38	21.15	7.10	7.25	415.73	2.76	66.50	5.75	0.23	1.14	0.00	1.83	0.01	0.01	0.00	8.01	14.18	1.35	19.0140845	#DIV/0!
2/1/2006 07:01:26.279	11.38	21.15	7.09	7.25	404.90	2.76	66.47	5.76	0.22	3.20	0.00	3.89	0.01	0.01	-0.01	8.03	14.35	1.33	18.7588152	#DIV/0!
2/1/2006 07:16:26.444	11.38	21.13	7.10	7.25	421.23	2.75	66.45	5.76	0.23	7.48	0.00	9.16	0.01	0.05	0.00	8.08	13.89	1.34	18.8732394	#DIV/0!
2/1/2006 07:31:26.458	11.38	21.08	7.11	7.25	406.12	2.75	66.47	5.76	0.25	1.45	0.00	2.06	0.01	0.01	0.01	8.09	14.52	1.35	18.9873418	#DIV/0!
2/1/2006 07:46:26.492	11.38	21.11	7.10	7.18	415.43	2.74	66.45	5.76	0.19	5.95	0.00	6.94	0.01	0.01	-0.01	8.06	14.09	1.34	18.8732394	#DIV/0!
2/1/2006 08:01:26.556	11.38	21.08	7.79	7.25	660.26	2.76	66.38	3.83	0.28	0.99	0.00	1.53	0.01	0.01	-0.01	8.11	26.19	3.96	50.8344031	#DIV/0!
2/1/2006 08:16:26.601	11.38	21.06	7.10	7.25	410.16	2.75	66.42	5.75	0.20	2.14	0.00	2.75	0.01	0.01	-0.01	8.06	14.37	1.35	19.0140845	#DIV/0!
2/1/2006 08:31:26.645	11.38	21.05	7.09	7.25	406.12	2.76	66.44	5.74	0.21	7.48	0.00	9.08	0.01	0.05	-0.01	8.08	14.52	1.35	19.0409027	#DIV/0!
2/1/2006 08:46:26.709	11.38	21.05	7.10	7.25	422.37	2.76	66.51	5.75	0.22	1.37	0.00	1.83	0.01	0.00	-0.01	8.04	13.96	1.35	19.0140845	#DIV/0!
2/1/2006 09:01:26.723	11.38	21.02	7.10	7.25	410.85	2.76	66.59	5.75	0.19	4.12	0.00	4.96	0.01	0.01	-0.01	7.96	14.35	1.35	19.0140845	#DIV/0!
2/1/2006 09:16:26.777	11.38	21.01	7.11	7.25	410.93	2.76	66.68	5.75	0.23	7.40	0.00	8.85	0.01	0.08	-0.01	8.06	14.45	1.36	19.1279887	#DIV/0!
2/1/2006 09:31:26.812	11.38	21.05	7.11	7.24	416.49	2.76	66.71	5.75	0.20	1.68	0.00	2.21	0.01	0.01	0.00	8.05	14.26	1.36	19.1279887	#DIV/0!
2/1/2006 09:46:26.866	11.38	21.04	7.10	7.25	420.84	2.76	66.79	5.74	0.20	7.55	0.00	9.08	0.01	0.04	-0.01	8.05	14.11	1.36	19.1549296	#DIV/0!
2/1/2006 10:01:26.890	11.38	21.02	7.10	7.24	415.43	2.75	66.91	5.74	0.22	1.30	0.00	1.68	0.01	0.00	-0.01	7.99	14.30	1.36	19.1549296	#DIV/0!
2/1/2006 10:16:26.914	11.38	21.06	7.11	7.24	420.77	2.76	67.00	5.74	0.20	2.82	0.00	3.43	0.01	0.01	-0.01	8.01	14.22	1.37	19.2686357	#DIV/0!
2/1/2006 10:31:26.958	11.37	21.02	7.11	7.24	421.53	2.76	67.08	5.74	0.23	7.63	0.00	9.16	0.01	0.06	-0.01	8.00	14.19	1.37	19.2686357	#DIV/0!
2/1/2006 10:46:27.003	11.39	21.02	7.11	7.24	418.17	2.76	67.19	5.74	0.23	1.68	0.00	2.21	0.01	0.01	-0.01	8.00	14.31	1.37	19.2686357	#DIV/0!
2/1/2006 11:01:27.037	11.38	21.04	7.09	7.27	419.39	2.76	67.26	5.74	0.21	6.03	0.00	6.87	0.01	0.00	-0.01	8.03	14.06	1.35	19.0409027	#DIV/0!
2/1/2006 11:16:27.091	11.38	20.98	7.11	7.38	419.85	2.76	67.32	5.96	0.34	1.91	0.00	4.88	0.01	0.55	-0.01	8.06	11.96	1.15	16.1744023	#DIV/0!
2/1/2006 11:31:27.135	11.38	21.05	7.10	7.24	412.22	2.76	67.41	5.74	0.21	2.14	0.00	2.75	0.01	0.01	0.00	8.05	14.41	1.36	19.1549296	#DIV/0!
2/1/2006 11:46:27.199	11.38	21.04	7.11	7.24	413.60	2.76	67.48	5.74	0.21	7.71	0.00	9.16	0.01	0.04	0.00	8.03	14.47	1.37	19.2686357	#DIV/0!
2/1/2006 12:01:27.204	11.38	20.98	7.09	7.24	413.21	2.76	67.60	5.74	0.23	1.37	0.00	1.75	0.01	0.00	0.01	7.97	14.27	1.35	19.0409027	#DIV/0!
2/1/2006 12:16:27.228	11.38	21.02	7.11	7.24	411.61	2.75	67.72	5.72	0.21	3.74	0.00	4.35	0.01	0.00	0.01	8.00	14.75	1.39	19.5499297	#DIV/0!
2/1/2006 12:31:27.262	11.38	21.05	7.09	7.24	411.99	2.75	67.80	5.73	0.24	7.40	0.00	8.93	0.01	0.05	0.00	7.99	14.42	1.36	19.1819464	#DIV/0!
2/1/2006 12:46:27.326	11.40	21.04	7.10	7.23	421.53	2.75	67.89	5.73	0.22	1.98	0.00	2.44	0.01	0.01	0.00	7.85	14.19	1.37	19.2957746	#DIV/0!
2/1/2006 13:01:27.370	11.38	21.06	7.10	7.24	408.18	2.76	68.01	5.73	0.19	7.93	0.00	9.31	0.01	0.04	0.00	7.89	14.66	1.37	19.2957746	#DIV/0!
2/1/2006 13:16:27.404	11.38	21.11	7.11	7.24	400.24	2.76	68.04	5.73	0.22	1.30	0.00	1.68	0.01	0.00	0.01	7.91	15.06	1.38	19.4092827	#DIV/0!
2/1/2006 13:31:27.439	11.38	21.10	7.09	7.24	405.58	2.76	68.16	5.73	0.22	2.82	0.00	3.36	0.01	0.00	0.00	7.98	14.64	1.36	19.1819464	#DIV/0!
2/1/2006 13:46:27.473	11.37	21.09	7.08	7.23	410.24	2.77	68.28	5.73	0.19	7.78	0.00	9.00	0.01	0.05	0.01	7.86	14.37	1.35	19.0677966	#DIV/0!
2/1/2006 14:01:27.477	11.38	21.12	7.08	7.24	422.14	2.77	68.39	5.73	0.22	1.60	0.00	1.98	0.01	0.00	0.00	7.96	13.97	1.35	19.0677966	#DIV/0!
2/1/2006 14:16:27.511	11.38	21.13	7.10	7.24	420.61	2.76	68.48	5.72	0.20	5.26	0.00	5.95	0.01	0.00	0.00	7.87	14.33	1.36	19.4366197	#DIV/0!
2/1/2006 14:31:27.575	11.38	21.16	7.11	7.32	416.11	2.77	68.64	5.73	0.25	5.42	0.00	7.55	0.01	0.25	0.00	7.93	14.48	1.38	19.4092827	#DIV/0!
2/1/2006 14:46:27.790	11.38	21.16	7.10	7.24	410.70	2.77	68.80	5.72	0.23	2.37	0.00	2.75	0.01	0.00	-0.01	7.89	14.67	1.38	19.4366197	#DIV/0!
2/1/2006 15:01:27.814	11.38	21.20	7.12	7.24	420.31	2.76	68.83	5.72	0.20	7.93	0.00	9.23	0.01	0.05	0.00	7.92	14.55	1.4	19.6629213	#DIV/0!
2/1/2006 15:16:27.848	11.38	21.16	7.08	7.24	418.86	2.77	69.03	5.72	0.28	1.45	0.00	1.75	0.01	0.00	-0.01	7.89	14.18	1.36	19.2090395	#DIV/0!
2/1/2006 15:31:27.902	11.38	21.19	7.09	7.24	400.40	2.76	69.12	5.72	0.22	3.59	0.00	4.12	0.01	0.00	0.00	7.91	14.94	1.37	19.3229901	#DIV/0!
2/1/2006 15:46:27.947	11.38	21.24	7.10	7.24	410.93	2.76	69.20	5.72	0.22	7.93	0.00	9.00	0.01	0.06	-0.01	7.83	14.67	1.38	19.4366197	#DIV/0!

2/1/2006 16:01:27.971	11.38	21.24	7.10	7.24	412.53	2.76	69.32	5.73	0.26	1.91	0.00	2.06	0.01	0.00	-0.01	7.96	14.50	1.37	19.2957746	#DIV/0!
2/1/2006 16:16:28.035	11.38	21.25	7.11	7.28	422.29	2.77	69.40	5.72	0.23	7.55	0.00	8.47	0.01	0.01	-0.01	7.85	14.38	1.39	19.5499297	#DIV/0!
2/1/2006 16:31:28.079	11.38	21.31	7.08	7.23	413.60	2.77	69.47	5.72	0.32	1.37	0.00	1.68	0.01	0.00	0.00	7.90	14.36	1.36	19.2090395	#DIV/0!
2/1/2006 16:46:28.123	11.38	21.30	7.09	7.24	411.54	2.77	69.54	5.72	0.25	2.82	0.00	3.20	0.01	0.00	-0.01	7.92	14.54	1.37	19.3229801	#DIV/0!
2/1/2006 17:01:28.178	11.38	21.34	7.09	7.23	403.91	2.76	69.57	5.72	0.19	7.93	0.00	9.00	0.01	0.05	-0.01	7.93	14.81	1.37	19.3229801	#DIV/0!
2/1/2006 17:16:28.232	11.38	21.34	7.10	7.24	410.47	2.76	69.61	5.72	0.23	1.60	0.00	1.98	0.01	0.00	-0.01	7.95	14.68	1.38	19.4366197	#DIV/0!
2/1/2006 17:31:28.286	11.38	21.39	7.10	7.23	403.60	2.77	69.61	5.72	0.21	4.58	0.00	5.19	0.01	0.00	-0.01	7.91	14.93	1.38	19.4366197	#DIV/0!
2/1/2006 17:46:28.300	11.38	21.39	7.11	7.24	415.27	2.77	69.61	5.72	0.23	7.25	0.00	8.70	0.01	0.09	-0.01	7.92	14.62	1.39	19.5499297	#DIV/0!
2/1/2006 18:01:28.344	11.38	21.42	7.11	7.23	412.07	2.77	69.61	5.72	0.25	1.98	0.00	2.52	0.01	0.00	-0.01	7.94	14.73	1.39	19.5499297	#DIV/0!
2/1/2006 18:16:28.389	11.38	21.39	7.09	7.24	414.69	2.77	69.54	5.72	0.21	7.86	0.00	9.16	0.01	0.04	0.00	7.93	14.42	1.37	19.3229801	#DIV/0!
2/1/2006 18:31:28.443	11.38	21.45	7.09	7.24	411.99	2.77	69.54	5.72	0.27	1.37	0.00	1.68	0.01	0.00	-0.01	7.93	14.52	1.37	19.3229801	#DIV/0!
2/1/2006 18:46:28.467	11.38	21.42	7.10	7.24	423.13	2.76	69.52	5.72	0.25	3.43	0.00	4.04	0.01	0.00	-0.01	8.05	14.24	1.38	19.4366197	#DIV/0!
2/1/2006 19:01:28.501	11.38	21.46	7.10	7.24	406.42	2.78	69.46	5.73	0.26	7.86	0.00	9.23	0.01	0.06	0.00	7.97	14.72	1.37	19.2957746	#DIV/0!
2/1/2006 19:16:28.535	11.38	21.43	7.10	7.24	420.46	2.78	69.38	5.72	0.25	1.68	0.00	2.14	0.01	0.00	-0.01	8.00	14.33	1.38	19.4366197	#DIV/0!
2/1/2006 19:31:28.560	11.38	21.49	7.09	7.20	405.97	2.77	69.38	5.73	0.22	6.33	0.00	7.02	0.01	0.00	-0.01	8.02	14.63	1.36	19.1819464	#DIV/0!
2/1/2006 19:46:28.624	11.39	21.50	7.71	7.24	735.87	2.77	69.28	2.82	0.29	1.14	0.00	1.68	0.01	0.00	0.00	7.96	30.21	5.09	66.0181582	#DIV/0!
2/1/2006 20:01:28.658	11.39	21.52	7.10	7.24	424.12	2.77	69.23	5.73	0.22	2.44	0.00	2.90	0.01	0.00	0.01	7.99	14.11	1.37	19.2957746	#DIV/0!
2/1/2006 20:16:28.722	11.38	21.50	7.09	7.24	419.70	2.78	69.17	5.73	0.21	7.86	0.00	9.08	0.01	0.05	0.00	7.98	14.15	1.36	19.1819464	#DIV/0!
2/1/2006 20:31:28.766	11.39	21.52	7.10	7.24	420.00	2.78	69.15	5.74	0.24	1.37	0.00	1.98	0.01	0.00	0.00	8.02	14.14	1.36	19.1549296	#DIV/0!
2/1/2006 20:46:28.821	11.39	21.56	7.11	7.24	421.76	2.78	69.06	5.73	0.21	4.20	0.00	4.96	0.01	0.00	0.00	7.96	14.29	1.38	19.4092827	#DIV/0!
2/1/2006 21:01:28.895	11.38	21.53	7.10	7.25	416.11	2.78	68.99	5.73	0.25	7.63	0.00	8.93	0.01	0.06	0.01	7.98	14.38	1.37	19.2957746	#DIV/0!
2/1/2006 21:16:28.928	11.38	21.53	7.09	7.24	416.49	2.77	68.94	5.74	0.25	1.83	0.00	2.29	0.01	0.00	-0.01	8.01	14.16	1.35	19.0409027	#DIV/0!
2/1/2006 21:31:28.983	11.38	21.54	7.09	7.24	411.15	2.77	68.85	5.73	0.21	7.86	0.00	9.23	0.01	0.04	-0.01	8.01	14.45	1.36	19.1819464	#DIV/0!
2/1/2006 21:46:29.027	11.38	21.52	7.09	7.24	415.20	2.77	68.83	5.74	0.25	1.37	0.00	1.68	0.01	0.00	-0.01	8.02	14.20	1.35	19.0409027	#DIV/0!
2/1/2006 22:01:29.082	11.38	21.56	7.09	7.24	419.39	2.79	68.79	5.74	0.23	3.05	0.00	3.74	0.01	0.00	-0.01	7.98	14.06	1.35	19.0409027	#DIV/0!
2/1/2006 22:16:29.116	11.38	21.55	7.10	7.24	415.73	2.78	68.76	5.74	0.22	7.83	0.00	9.16	0.01	0.05	0.00	7.97	14.29	1.36	19.1549296	#DIV/0!
2/1/2006 22:31:29.160	11.38	21.50	7.10	7.24	405.74	2.78	68.70	5.74	0.25	1.60	0.00	2.06	0.01	0.00	0.00	7.93	14.64	1.36	19.1549296	#DIV/0!
2/1/2006 22:46:29.184	11.38	21.54	7.09	7.22	426.26	2.78	68.65	5.74	0.21	5.26	0.00	6.10	0.01	0.00	0.00	8.04	13.83	1.35	19.0409027	#DIV/0!
2/1/2006 23:01:29.208	11.38	21.52	7.10	7.29	412.53	2.78	68.64	5.75	0.25	5.11	0.00	7.48	0.01	0.30	-0.01	8.02	14.29	1.35	19.0140845	#DIV/0!
2/1/2006 23:16:29.243	11.38	21.52	7.10	7.24	417.49	2.79	68.54	5.75	0.23	2.06	0.00	2.52	0.01	0.00	-0.01	8.00	14.12	1.35	19.0140845	#DIV/0!
2/1/2006 23:31:29.287	11.39	21.50	7.10	7.24	422.60	2.78	68.48	5.74	0.22	7.86	0.00	9.08	0.01	0.05	0.00	8.02	14.05	1.36	19.1549296	#DIV/0!
2/1/2006 23:46:29.341	11.39	21.55	7.07	7.24	408.87	2.79	68.44	5.74	0.22	1.37	0.00	1.83	0.01	0.00	-0.01	8.09	14.21	1.33	18.8118812	#DIV/0!
2/2/2006 00:01:29.405	11.38	21.53	7.10	7.24	415.50	2.79	68.39	5.73	0.23	3.97	0.00	4.58	0.01	0.01	-0.01	8.03	14.40	1.37	19.2957746	#DIV/0!
2/2/2006 00:16:29.429	11.38	21.54	7.11	7.24	410.24	2.79	68.35	5.74	0.21	7.55	0.00	9.00	0.01	0.06	-0.01	8.09	14.58	1.37	19.2686357	#DIV/0!
2/2/2006 00:31:29.464	11.38	21.53	7.09	7.24	426.57	2.79	68.25	5.74	0.23	1.68	0.00	2.21	0.01	0.01	-0.01	8.05	13.82	1.35	19.0409027	#DIV/0!
2/2/2006 00:46:29.528	11.38	21.53	7.10	7.25	419.39	2.79	68.22	5.74	0.23	7.71	0.00	9.31	0.01	0.04	-0.01	8.04	14.16	1.36	19.1549296	#DIV/0!
2/2/2006 01:01:29.592	11.38	21.52	7.08	7.25	416.42	2.79	68.19	5.74	0.23	1.30	0.00	1.68	0.01	0.01	0.00	8.05	14.05	1.34	18.9265537	#DIV/0!
2/2/2006 01:16:29.646	11.38	21.53	7.08	7.24	421.00	2.78	68.12	5.74	0.20	2.52	0.00	3.05	0.01	0.01	-0.01	8.09	13.90	1.34	18.9265537	#DIV/0!
2/2/2006 01:31:29.690	11.38	21.52	7.10	7.24	416.65	2.79	68.04	5.74	0.19	7.78	0.00	9.08	0.01	0.05	0.00	8.06	14.26	1.36	19.1549296	#DIV/0!
2/2/2006 01:46:29.755	11.38	21.50	7.10	7.24	416.27	2.78	68.02	5.75	0.24	1.37	0.00	2.06	0.01	0.01	0.01	8.09	14.16	1.35	19.0140845	#DIV/0!
2/2/2006 02:01:29.789	11.38	21.49	7.10	7.25	419.24	2.79	67.99	5.74	0.20	4.65	0.00	5.49	0.01	0.00	0.00	8.11	14.17	1.36	19.1549296	#DIV/0!
2/2/2006 02:16:29.823	11.38	21.52	7.09	7.29	414.28	2.80	68.01	5.74	0.23	6.94	0.00	8.62	0.01	0.12	-0.01	7.99	14.23	1.35	19.0409027	#DIV/0!
2/2/2006 02:31:29.857	11.39	21.44	7.09	7.24	422.60	2.79	67.96	5.74	0.23	2.08	0.00	2.59	0.01	0.00	-0.01	7.93	13.95	1.35	19.0409027	#DIV/0!
2/2/2006 02:46:29.881	11.39	21.46	7.09	7.24	421.23	2.79	67.89	5.73	0.21	7.71	0.00	9.08	0.01	0.05	0.01	8.00	14.10	1.36	19.1819464	#DIV/0!
2/2/2006 03:01:29.906	11.38	21.46	7.10	7.24	411.76	2.79	67.84	5.74	0.25	1.30	0.00	1.83	0.01	0.00	0.00	8.06	14.42	1.36	19.1549296	#DIV/0!
2/2/2006 03:16:29.930	11.39	21.48	7.10	7.24	425.86	2.79	67.83	5.75	0.21	3.36	0.00	4.12	0.01	0.00	-0.01	8.11	13.84	1.35	19.0140845	#DIV/0!
2/2/2006 03:31:29.984	11.38	21.48	7.09	7.25	419.17	2.79	67.81	5.75	0.22	7.71	0.00	9.16	0.01	0.06	0.00	7.96	13.96	1.34	18.899859	#DIV/0!
2/2/2006 03:46:29.998	11.39	21.45	7.11	7.24	411.08	2.79	67.75	5.74	0.23	1.68	0.00	2.21	0.01	0.01	-0.01	8.09	14.55	1.37	19.2686357	#DIV/0!
2/2/2006 04:01:30.062	11.38	21.42	7.10	7.17	411.99	2.79	67.78	5.75	0.19	6.64	0.00	7.55	0.01	0.00	0.00	8.11	14.31	1.35	19.0140845	#DIV/0!
2/2/2006 04:16:30.097	11.38	21.42	7.11	7.25	428.78	2.79	67.77	5.74	0.25	1.30	0.00	1.68	0.01	0.01	0.00	8.04	13.95	1.37	19.2686357	#DIV/0!
2/2/2006 04:31:30.141	11.38	21.41	7.08	7.24	416.85	2.79	67.72	5.74	0.21	2.44	0.00	3.05	0.01	0.01	-0.01	8.10	14.05	1.34	18.9265537	#DIV/0!
2/2/2006 04:46:30.185	11.38	21.44	7.09	7.25	420.00	2.79	67.72	5.74	0.22	7.55	0.00	9.16	0.01	0.05	0.01	8.06	14.04	1.35	19.0409027	#DIV/0!
2/2/2006 05:01:30.229	11.39	21.37	7.07	7.25	412.91	2.80	67.72	5.74	0.24	1.37	0.00	1.83	0.01	0.00	-0.01	8.07	14.07	1.33	18.8118812	#DIV/0!
2/2/2006 05:16:30.253	11.38	21.39	7.09	7.25	425.12	2.79	67.64	5.74	0.21	4.43	0.00	5.26	0.01	0.01	0.00	8.08	13.87	1.35	19.0409027	#DIV/0!
2/2/2006 05:31:30.267	11.39	21.38	7.09	7.24	411.61	2.79	67.63	5.74	0.25	7.25	0.00	8.85	0.01	0.07	-0.01	8.08	14.32	1.35	19.0409027	#DIV/0!
2/2/2006 05:46:30.292	11.38	21.39	7.11	7.24	427.25	2.80	67.63	5.74	0.21	1.83	0.00	2.37	0.01	0.01	-0.01	8.13	14.00	1.37	19.2686357	#DIV/0!
2/2/2006 06:01:30.316	11.38	21.37	7.09	7.25	409.78	2.79	67.63	5.75	0.22	7.63	0.00	9.16	0.01	0.04	0.00	8.07	14.28	1.34	18.899859	#DIV/0!
2/2/2006 06:16:30.330	11.38	21.37	7.08	7.24	418.63	2.81	67.60	5.74	0.25	1.30	0.00	1.68	0.01	0.01	-0.01	8.06	13.98	1.34	18.9265537	#DIV/0!
2/2/2006 06:31:30.384	11.39	21.34	7.09	7.25	425.57	2.80	67.58	5.74	0.22	3.28	0.00	3.97	0.01	0.00	0.00	8.07	13.85	1.35	19.0409027	#DIV/0!
2/2/2006 06:46:30.398	11.39	21.38	7.10	7.25	415.58	2.79	67.54	5.73	0.23	7.78	0.00	9.16	0.01	0.05	0.00	8.12	14.40	1.37	19.2957746	#DIV/0!
2/2/2006 07:01:30.433	11.38	21.35	7.09	7.25	426.49	2.80	67.51	5.75	0.23	1.53	0.00	2.06	0.01	0.01	0.00	8.09	13.72	1.34	18.899859	#DIV/0!
2/2/2006 07:16:30.457	11.38	21.31	7.10	7.20	424.28	2.80	67.46	5.74	0.25	5.80	0.00	6.79	0.01	0.01	0.01	8.08	14.00	1.36	19.1549296	#DIV/0!
2/2/2006 07:31:30.501	11.38	21.35	7.17	7.52	470.28	2.81	67.46	5.84	0.30	1.68	0.00	4.81	0.01	0.44	0.01	8.13	12.35	1.33	18.5495119	#DIV/0!
2/2/2006 07:46:30.535	11.38	21.30	7.09	7.24	422.90	2.81	67.46	5.75	0.26	2.14	0.00	2.75	0.01	0.01	-0.01	7.98	13.84	1.34	18.899859	#DIV/0!
2/2/2006 08:01:30.589	11.38	21.31	7.09	7.25	428.93	2.81	67.43	5.74	0.21	7.55	0.00	9.08	0.01	0.05	0.00	8.10	13.75	1.35	19.0409027	#DIV/0!
2/2/2006 08:16:30.603	11.38	21.28	7.09	7.24	424.43	2.80	67.46	5.74	0.22	1.37	0.00	1.91	0.01	0.01	-0.01	8.01	13.89	1.35	19.0409027	#DIV/0!
2/2/2006 08:31:30.648	11.38	21.34	7.10	7.25	429.08	2.80	67.38	5.74	0.22	4.20	0.00	4.96	0.01	0.00	0.00	8.00	13.84	1.36	19.1549296	#DIV/0!
2/2/2006 08:46:30.702	11.38	21.31	7.09	7.27	409.40	2.80	67.41	5.74	0.25	7.48	0.00	8.85	0.01	0.06	0.00	8.05	14.40	1.35	19.0409027	#DIV/0!
2/2/2006 09:01:30.756	11.38	21.30	7.10	7.24	415.81	2.80	67.41	5.74	0.25	1.68	0.00	2.29	0.01	0.01	-0.01	8.09	14.28	1.36	19.1549296	#DIV/0!
2/2/2006 09:16:30.800	11.38	21.32	7.09	7.24	417.49	2.80	67.46	5.73	0.23	7.63	0.00	9.08	0.01	0.04	0.00	8.11	14.23	1.36	19.1819464	#DIV/0!
2/2/2006 09:31:30.834	11.38	21.30	7.08	7.24	420.00	2.81	67.54	5.73	0.24	1.30	0.00	1.68	0.01	0.00	0.00	8.20	14.04	1.35	19.0677966	#DIV/0!
2/2/2006 09:46:30.849	11.38	21.28	7.10	7.25	417.72	2.82	67.60	5.74	0.24	2.80	0.00	3.43	0.01	0.01	-0.01	8.13	14.22	1.36	19.1549296	#DIV/0!
2/2/2006 10:01:30.883	11.38	21.31	7.11	7.24	426.95	2.81	67.63	5.74	0.22	7.93	0.00	9.31	0.01	0.05	-0.01	8.07	14.01	1.37	19.2686357	#DIV/0!
2/2/2006 10:16:30.907	11.38	21.30	7.09	7.24	426.95	2.80	67.69	5.74	0.21	1.68	0.00	2.06	0.01	0.00	-0.01	8.10	13.81	1.35	19.0409027	#DIV/0!

2/2/2006 10:31:30.961	11.38	21.26	7.10	7.22	409.40	2.81	67.75	5.73	0.21	5.26	0.00	6.10	0.01	0.00	0.00	8.12	14.61	1.37	19.2957746	#DIV/0!
2/2/2006 10:46:30.975	11.38	21.26	7.10	7.29	427.94	2.81	67.81	5.75	0.25	4.81	0.00	7.32	0.01	0.33	-0.01	8.07	13.78	1.35	19.0140845	#DIV/0!
2/2/2006 11:01:31.030	11.38	21.26	7.09	7.24	415.88	2.81	67.83	5.73	0.22	2.14	0.00	2.75	0.01	0.00	0.01	8.09	14.28	1.36	19.1819464	#DIV/0!
2/2/2006 11:16:31.054	11.38	21.28	7.09	7.24	429.08	2.81	67.95	5.73	0.21	7.93	0.00	9.31	0.01	0.05	-0.01	7.94	13.84	1.36	19.1819464	#DIV/0!
2/2/2006 11:31:31.088	11.38	21.28	7.10	7.25	414.51	2.80	68.02	5.73	0.29	1.37	0.00	1.83	0.01	0.00	0.00	8.06	14.43	1.37	19.2957746	#DIV/0!
2/2/2006 11:46:31.142	11.38	21.28	7.11	7.25	417.33	2.82	68.16	5.73	0.20	3.66	0.00	4.27	0.01	0.00	-0.01	8.03	14.44	1.38	19.4092827	#DIV/0!
2/2/2006 12:01:31.166	11.39	21.28	7.09	7.25	427.18	2.82	68.28	5.74	0.21	7.63	0.00	9.00	0.01	0.06	-0.01	8.01	13.80	1.35	19.0409027	#DIV/0!
2/2/2006 12:16:31.180	11.39	21.26	7.09	7.24	419.47	2.83	68.35	5.72	0.22	1.75	0.00	2.14	0.01	0.00	0.01	8.04	14.26	1.37	19.3229901	#DIV/0!
2/2/2006 12:31:31.215	11.38	21.31	7.09	7.24	405.20	2.81	68.51	5.73	0.20	7.86	0.00	9.08	0.01	0.04	0.00	8.00	14.66	1.36	19.1819464	#DIV/0!
2/2/2006 12:46:31.239	11.39	21.26	7.09	7.24	419.17	2.82	68.67	5.72	0.23	1.37	0.00	1.68	0.01	0.00	0.00	7.98	14.27	1.37	19.3229901	#DIV/0!
2/2/2006 13:01:31.283	11.38	21.31	7.09	7.24	416.49	2.81	68.74	5.72	0.22	2.59	0.00	3.13	0.01	0.00	0.01	7.97	14.37	1.37	19.3229901	#DIV/0!
2/2/2006 13:16:31.297	11.38	21.31	7.09	7.24	425.50	2.81	68.83	5.72	0.20	7.78	0.00	9.00	0.01	0.05	-0.01	8.04	14.06	1.37	19.3229901	#DIV/0!
2/2/2006 13:31:31.351	11.39	21.32	7.10	7.24	414.89	2.80	68.93	5.72	0.22	1.68	0.00	1.91	0.01	0.00	0.00	8.06	14.53	1.38	19.4366197	#DIV/0!
2/2/2006 13:46:31.396	11.38	21.35	7.10	7.24	420.31	2.82	69.02	5.73	0.21	4.81	0.00	5.34	0.01	0.00	0.01	7.98	14.24	1.37	19.2957746	#DIV/0!
2/2/2006 14:01:31.420	11.38	21.38	7.09	7.27	415.88	2.82	69.11	5.74	0.21	7.17	0.00	8.55	0.01	0.10	-0.01	7.95	14.18	1.35	19.0409027	#DIV/0!
2/2/2006 14:16:31.454	11.38	21.31	7.08	7.24	414.21	2.82	69.18	5.72	0.24	2.06	0.00	2.44	0.01	0.00	-0.01	8.01	14.34	1.36	19.2090395	#DIV/0!
2/2/2006 14:31:31.488	11.38	21.38	7.09	7.24	426.79	2.82	69.23	5.73	0.22	7.93	0.00	9.00	0.01	0.04	-0.01	7.97	13.92	1.36	19.1819464	#DIV/0!
2/2/2006 14:46:31.582	11.38	21.41	7.09	7.24	414.74	2.83	69.32	5.73	0.28	1.45	0.00	1.68	0.01	0.00	-0.01	7.97	14.32	1.36	19.1819464	#DIV/0!
2/2/2006 15:01:31.667	11.38	21.38	7.09	7.24	419.17	2.81	69.37	5.73	0.83	3.28	0.00	3.81	0.01	0.00	0.00	7.96	14.17	1.36	19.1819464	#DIV/0!
2/2/2006 15:16:31.691	11.38	21.42	7.08	7.24	416.11	2.84	69.44	5.73	0.21	7.78	0.00	9.00	0.01	0.06	-0.01	8.04	14.17	1.35	19.0677966	#DIV/0!
2/5/2006 00:00:25.7 B	11.38	21.34	0.00	7.60	1.07	2.95	64.10	0.00	0.10	0.38	0.00	0.84	0.01	0.01	-0.01	8.48	0	0	#DIV/0!	#DIV/0!
2/5/2006 00:01:40.512	11.38	21.32	0.00	7.60	0.98	2.95	64.12	0.00	0.10	0.38	0.00	0.84	0.01	0.01	-0.01	8.48	0	0	#DIV/0!	#DIV/0!
2/5/2006 00:16:40.517	11.38	21.31	0.00	7.61	0.99	2.95	64.07	0.00	0.10	0.31	0.00	0.76	0.01	0.01	-0.01	8.50	0	0	#DIV/0!	#DIV/0!
4/13/2006 11:05:50.672	11.38	24.04	0.00	7.25	2.14	1.43	67.40	0.00	5.70	0.46	0.00	0.46	0.01	0.02	0.01	9.74	0	0	#DIV/0!	#DIV/0!
4/13/2006 11:20:50.706	11.38	24.04	0.00	7.25	2.14	1.40	67.41	0.00	5.70	0.46	0.00	0.53	0.01	0.00	-0.01	9.73	0	0	#DIV/0!	#DIV/0!
4/13/2006 11:35:50.720	11.39	23.91	7.09	7.24	528.65	1.43	67.43	4.96	6.51	145.34	5.46	161.59	0.28	4.42	2.81	9.53	17.59645	2.13	30.0423131	80.95238
4/13/2006 11:50:50.734	11.38	23.56	7.04	7.23	597.09	1.44	67.80	4.93	9.32	19.23	0.00	20.75	0.51	0.00	2.80	9.23	15.43322	2.11	29.9715909	#DIV/0!
4/13/2006 12:05:50.749	11.39	23.39	7.02	7.24	625.62	1.43	67.95	4.90	9.72	123.83	5.28	140.61	1.00	4.43	2.80	9.33	14.79923	2.12	30.1994302	83.90152
4/13/2006 18:48:57.5 B	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00 U	0.00	#DIV/0!	0	#DIV/0!	#DIV/0!
4/13/2006 19:03:57.681	11.38	23.62	7.14	7.22	406.88	1.55	70.79	6.19	12.23	5.57	0.00	6.10	1.00	0.00	2.43	9.81	10.19697	0.95	13.3053221	#DIV/0!
4/13/2006 19:18:57.686	11.38	23.32	7.13	7.25	407.11	1.56	70.77	6.19	11.21	256.50	5.37	270.24	1.00	4.25	2.45	9.82	10.08393	0.94	13.1837307	79.14339
4/13/2006 19:33:57.730	11.38	23.25	7.14	7.22	409.25	1.55	70.74	6.19	11.06	6.41	0.00	6.87	1.00	0.00	2.45	9.81	10.13792	0.95	13.3053221	#DIV/0!
4/13/2006 19:48:57.754	11.38	22.95	7.14	7.22	410.93	1.51	70.63	6.19	11.01	3.20	0.00	3.59	1.00	0.00	2.45	9.81	10.09647	0.95	13.3053221	#DIV/0!
4/13/2006 20:03:57.798	11.38	22.66	7.14	7.22	408.10	1.52	70.50	6.18	10.28	232.24	5.45	245.90	1.00	4.22	2.41	9.82	10.2735	0.96	13.4453782	77.43119
4/13/2006 20:18:57.842	11.38	23.13	7.13	7.22	399.86	1.52	70.74	6.18	10.09	6.33	0.00	6.87	1.00	0.00	0.00	9.81	10.37599	0.95	13.3239832	#DIV/0!
4/13/2006 20:33:57.897	11.38	24.19	7.15	7.22	422.98	1.58	71.43	6.23	9.85	214.62	5.42	228.05	1.00	4.27	0.00	9.82	9.499085	0.92	12.8671329	78.78229
4/13/2006 20:48:57.951	11.39	23.56	7.13	7.22	406.42	1.52	71.05	6.22	9.87	17.32	0.00	17.78	1.00	0.00	-0.01	9.56	9.778677	0.91	12.7629734	#DIV/0!
4/13/2006 21:03:57.985	11.38	22.94	7.13	7.22	417.87	1.50	70.60	6.22	9.85	8.09	0.00	8.32	1.00	0.00	0.01	8.94	9.510733	0.91	12.7629734	#DIV/0!
4/13/2006 21:18:57.999	11.38	23.02	7.20	7.22	418.55	1.52	70.57	6.17	9.77	272.83	5.40	280.92	1.00	4.71	0.01	9.28	10.74741	1.03	14.3055556	87.22222
4/13/2006 21:33:58.003	11.38	22.94	7.18	7.22	411.15	1.53	70.28	6.19	9.65	26.86	0.00	27.62	1.00	0.01	0.00	9.81	10.51595	0.99	13.7883008	#DIV/0!
4/13/2006 21:48:58.047	11.38	22.61	7.17	7.21	415.73	1.52	70.07	6.17	9.68	10.68	0.00	10.91	1.00	0.00	0.00	9.81	10.50515	1	13.9470014	#DIV/0!
4/13/2006 22:03:58.072	11.38	21.99	7.17	7.22	410.93	1.51	69.83	6.18	9.61	225.91	5.45	236.36	1.00	4.76	-0.01	9.81	10.52158	0.99	13.8075314	87.33945
4/13/2006 22:18:58.136	11.38	22.77	7.16	7.22	414.13	1.51	69.95	6.21	9.24	56.69	0.00	58.06	1.00	0.00	-0.01	9.83	10.01845	0.95	13.2681564	#DIV/0!
4/13/2006 22:33:58.170	11.38	22.26	7.17	7.22	411.08	1.49	69.63	6.20	9.21	12.36	0.00	12.74	1.00	0.00	0.01	9.83	10.30527	0.97	13.5285914	#DIV/0!
4/13/2006 22:48:58.214	11.39	21.85	7.16	7.22	404.59	1.50	69.40	6.19	9.13	7.71	0.00	7.93	1.00	0.01	-0.01	9.81	10.47057	0.97	13.547486	#DIV/0!
4/13/2006 23:03:58.238	11.39	22.49	7.15	7.22	408.87	1.51	69.58	6.20	8.89	286.18	5.39	294.35	1.00	4.66	0.00	9.83	10.14734	0.95	13.2867133	86.4564
4/13/2006 23:18:58.273	11.38	22.05	7.17	7.22	410.39	1.51	69.29	6.20	8.83	14.72	0.00	15.03	1.00	0.00	0.00	9.80	10.32259	0.97	13.5285914	#DIV/0!
4/13/2006 23:33:58.277	11.39	21.70	7.15	7.33	410.54	1.50	69.05	6.19	8.78	9.99	0.00	10.38	1.00	0.02	-0.01	9.32	10.21244	0.96	13.4265734	#DIV/0!
4/13/2006 23:48:58.281	11.39	21.97	7.15	7.22	407.72	1.51	69.12	6.19	8.64	282.37	5.44	290.46	1.00	4.71	0.00	9.28	10.28308	0.96	13.4265734	86.58088
4/14/2006 00:03:58.335	11.39	21.77	7.15	7.22	403.68	1.49	68.91	6.19	8.55	17.47	0.00	17.93	1.00	0.00	-0.01	9.83	10.38599	0.96	13.4265734	#DIV/0!
4/14/2006 00:18:58.359	11.38	21.37	7.17	7.22	403.75	1.50	68.71	6.19	8.55	9.08	0.00	9.46	1.00	0.00	0.00	9.86	10.60052	0.98	13.6680614	#DIV/0!
4/14/2006 00:33:58.393	11.39	21.73	7.15	7.22	418.55	1.49	68.83	6.19	8.45	264.29	5.34	273.14	1.00	4.69	-0.01	9.86	10.017	0.96	13.4265734	87.82772
4/14/2006 00:48:58.438	11.39	21.99	7.14	7.23	421.84	1.47	68.80	6.20	8.34	21.06	0.00	21.74	1.00	0.00	0.00	9.85	9.731816	0.94	13.1652661	#DIV/0!
4/14/2006 01:03:58.492	11.38	21.27	7.14	7.22	418.63	1.46	68.44	6.19	8.32	8.47	0.00	8.85	1.00	0.00	0.01	9.85	9.910762	0.95	13.3053221	#DIV/0!
4/14/2006 01:18:58.526	11.39	21.20	7.13	7.23	413.29	1.48	68.45	6.19	8.32	242.69	5.44	252.08	0.98	4.72	-0.01	9.86	9.933144	0.94	13.1837307	86.76471
4/14/2006 01:33:58.550	11.38	21.54	7.17	7.23	409.55	1.48	68.45	6.19	8.20	29.53	0.00	30.37	1.00	0.01	-0.01	9.74	10.4504	0.98	13.6680614	#DIV/0!
4/14/2006 01:48:58.574	11.38	21.35	7.17	7.22	413.29	1.49	68.36	6.19	8.16	10.76	0.00	11.22	1.00	0.01	-0.01	9.36	10.35583	0.98	13.6680614	#DIV/0!
4/14/2006 02:03:58.629	11.38	21.05	7.15	7.22	415.96	1.51	68.19	6.18	8.18	200.81	5.50	210.88	1.00	4.83	-0.01	9.84	10.18436	0.97	13.5664336	87.81818
4/14/2006 02:18:58.673	11.38	21.24	7.15	7.22	420.69	1.47	68.16	6.19	8.09	51.80	0.00	52.87	1.00	0.01	0.00	9.86	9.968045	0.96	13.4265734	#DIV/0!
4/14/2006 02:33:58.697	11.38	21.06	7.16	7.23	411.76	1.48	68.10	6.19	8.07	11.67	0.00	12.05	1.00	0.00	-0.01	9.85	10.28825	0.97	13.547486	#DIV/0!
4/14/2006 02:48:58.741	11.38	20.68	7.14	7.23	417.72	1.47	67.93	6.17	8.06	7.93	0.00	8.24	1.00	0.01	0.01	9.84	10.14145	0.97	13.5854342	#DIV/0!
4/14/2006 03:03:58.775	11.39	21.00	7.15	7.28	419.24	1.47	68.01	6.20	7.98	270.92	5.33	278.93	1.00	4.71	-0.01	9.83	9.896342	0.95	13.2867133	88.36773
4/14/2008 03:18:58.800	11.38	20.98	7.14	7.22	412.22	1.47	68.02	6.19	7.94	14.04	0.00	14.50	1.00	0.01	-0.01	9.65	10.06487	0.95	13.3053221	#DIV/0!
4/14/2006 03:33:58.844	11.38	20.46	7.15	7.23	410.85	1.46	67.80	6.18	7.91	6.94	0.00	7.25	1.00	0.01	0.01	9.77	10.31103	0.97	13.5664336	#DIV/0!
4/14/2006 03:48:58.868	11.38	20.91	7.16	7.23	415.58	1.46	67.95	6.18	7.91	257.95	5.33	266.27	1.00	4.69	-0.01	9.85	10.29877	0.98	13.6871508	87.9925
4/14/2006 04:03:58.922	11.38	20.91	7.16	7.23	421.61	1.47	67.92	6.19	7.88	16.25	0.00	16.94	1.00	0.01	0.01	9.75	10.04788	0.97	13.547486	#DIV/0!
4/14/2006 04:18:58.966	11.38	20.64	7.15	7.18	414.74	1.48	67.78	6.18	7.82	9.99	0.00	10.38	1.00	0.00	-0.01	9.86	10.21432	0.97	13.5664336	#DIV/0!
4/14/2006 04:33:59.010	11.38	20.50	7.17	7.23	410.54	1.49	67.73	6.18	7.80	253.07	5.46	261.39	0.99	4.74	-0.01	9.86	10.53158	0.99	13.8075314	86.81319
4/14/2006 04:48:59.085	11.38	20.54	7.14	7.23	414.05	1.43	67.60	6.19	7.78	22.81	0.00	23.58	1.00	0.00	0.00	9.86	10.02039	0.95	13.3053221	#DIV/0!
4/14/2006 05:03:59.129	11.38	20.29	7.14	7.23	420.77	1.43	67.54	6.18	7.76	8.62	0.00	9.00	1.00	0.01	0.00	9.77	9.96415	0.96	13.4453782	#DIV/0!
4/14/2006 05:18:59.153	11.38	20.16	7.12	7.23	412.53	1.43	67.43	6.17	7.77	227.13	5.40	234.99	0.86	4.73	0.00	9.47	10.05731	0.95	13.3426966	87.59259
4/14/2006 05:33:59.177	11.40	20.71	7.16	7.20	415.20	1.45	67.69	6.19	7.71	31.97	0.00	32.88	1.00	0.01	-0.01	9.74	10.20301	0.97	13.547486	#DIV/0!
4/14/2006 05:48:59.211	11.38	20.32	7.15	7.23	417.49	1.45	67.51	6.17	7.71	10.68	0.00	11.29	1.00	0.00	0.00	9.87	10.25165	0.98	13.7062937	#DIV/0!
4/14/2006 06:03:59.246	11.39	20.13	7.14	7.23	421.07	1.43	67.38	6.18	7.71	10.68	0.00	11.06	1.00	0.01	-0.01	9.87	9.957051	0.96	13.4453782	#DIV/0!

4/14/2006 06:18:59.310	11.38	20.44	7.14	7.23	405.66	1.43	67.51	6.19	7.67	61.88	0.00	63.17	1.00	0.01	0.00	9.88	10.22763	0.95	13.3053221	#DIV/0!
4/14/2006 06:33:59.364	11.38	20.33	7.15	7.23	407.57	1.43	67.48	6.18	7.67	11.52	0.00	12.05	1.00	0.01	0.00	9.84	10.39401	0.97	13.5664336	#DIV/0!
4/14/2006 06:48:59.408	11.38	19.91	7.15	7.21	416.27	1.43	67.29	6.18	7.64	9.54	0.00	9.92	1.00	0.01	-0.01	9.85	10.17678	0.97	13.5664336	#DIV/0!
4/14/2006 07:03:59.432	11.39	20.35	7.15	7.23	415.81	1.43	67.46	6.18	7.65	254.90	5.44	263.68	1.00	4.69	0.00	9.87	10.18804	0.97	13.5664336	86.21324
4/14/2006 07:18:59.487	11.38	20.16	7.13	7.23	414.44	1.43	67.32	6.18	7.64	14.42	0.00	14.95	1.00	0.00	0.01	9.87	10.01096	0.95	13.3239832	#DIV/0!
4/14/2006 07:33:59.541	11.40	19.76	7.15	7.23	404.06	1.44	67.19	6.17	7.60	7.40	0.00	7.63	1.00	0.01	-0.01	9.74	10.59239	0.98	13.7062937	#DIV/0!
4/14/2006 07:48:59.565	11.38	20.05	7.15	7.23	422.83	1.44	67.40	6.17	7.61	253.22	5.45	262.23	1.00	4.74	-0.01	9.81	10.12218	0.98	13.7062937	86.97248
4/14/2006 08:03:59.609	11.38	20.16	7.15	7.20	414.74	1.43	67.38	6.18	7.57	18.54	0.00	19.30	1.00	0.00	-0.01	9.88	10.21432	0.97	13.5664336	#DIV/0!
4/14/2006 08:18:59.643	11.38	19.78	7.15	7.23	405.74	1.44	67.29	6.17	7.56	10.88	0.00	11.06	1.00	0.01	0.00	9.77	10.54853	0.98	13.7062937	#DIV/0!
4/14/2006 08:33:59.698	11.39	19.67	7.14	7.23	413.67	1.42	67.23	6.18	7.54	236.67	5.46	247.50	0.86	4.70	0.00	9.85	10.13517	0.96	13.4453782	86.08059
4/14/2006 08:48:59.742	11.38	20.07	7.14	7.23	411.99	1.40	67.35	6.18	7.54	24.49	0.00	25.25	1.00	0.01	-0.01	9.87	10.1765	0.96	13.4453782	#DIV/0!
4/14/2006 09:03:59.786	11.39	19.69	7.14	7.23	412.07	1.43	67.19	6.18	7.52	9.31	0.00	9.84	1.00	0.00	0.00	9.84	10.17452	0.96	13.4453782	#DIV/0!
4/14/2006 09:18:59.810	11.39	19.49	7.14	7.23	404.21	1.42	67.17	6.17	7.53	209.35	5.37	218.36	0.96	4.73	-0.01	9.47	10.48041	0.97	13.5854342	88.08194
4/14/2006 09:33:59.834	11.38	20.05	7.14	7.23	420.31	1.43	67.38	6.18	7.52	38.68	0.00	39.67	1.00	0.01	0.00	9.86	9.975055	0.96	13.4453782	#DIV/0!
4/14/2006 09:48:59.859	11.38	19.63	7.13	7.23	421.68	1.43	67.31	6.17	7.52	10.76	0.00	11.22	1.00	0.00	-0.01	9.88	9.942647	0.96	13.4642356	#DIV/0!
4/14/2006 10:03:59.883	11.38	19.31	7.14	7.23	422.06	1.42	67.19	6.17	7.51	10.38	0.00	10.99	1.00	0.04	-0.01	9.88	10.03717	0.97	13.5854342	#DIV/0!
4/14/2006 10:18:59.927	11.38	20.00	7.15	7.22	404.59	1.43	67.54	6.20	7.50	91.10	0.00	92.24	1.00	0.00	0.00	9.89	10.25468	0.95	13.2867133	#DIV/0!
4/14/2006 10:33:59.991	11.39	19.60	7.14	7.20	419.24	1.41	67.41	6.16	7.52	13.12	0.00	13.58	1.00	0.00	-0.01	9.88	10.20886	0.98	13.7254902	#DIV/0!
4/14/2006 10:49:00.045	11.38	19.42	7.14	7.23	414.89	1.41	67.41	6.17	7.49	10.53	0.00	10.99	1.00	0.01	-0.01	9.87	10.21063	0.97	13.5854342	#DIV/0!
4/14/2006 11:04:00.050	11.38	19.61	7.16	7.23	422.60	1.44	67.60	6.18	7.50	252.48	5.41	260.93	1.00	4.71	0.00	9.88	10.12769	0.98	13.6871508	87.061
4/14/2006 11:19:00.074	11.38	19.70	7.16	7.22	412.22	1.43	67.75	6.18	7.48	15.49	0.00	15.95	1.00	0.01	-0.01	9.88	10.38271	0.98	13.6871508	#DIV/0!
4/14/2006 11:34:00.118	11.38	19.30	7.16	7.23	406.12	1.42	67.61	6.16	7.47	8.24	0.00	8.32	1.00	0.00	0.00	9.88	10.75374	1	13.9664804	#DIV/0!
4/14/2006 11:49:00.172	11.39	19.50	7.14	7.23	416.49	1.45	67.92	6.17	7.48	245.52	5.45	254.06	0.95	4.72	-0.01	9.89	10.1714	0.97	13.5854342	86.6055
4/14/2006 12:04:00.206	11.39	19.75	7.15	7.23	409.55	1.44	68.10	6.17	7.48	21.13	0.00	21.74	1.00	0.00	-0.01	9.87	10.4504	0.98	13.7062937	#DIV/0!
4/14/2006 12:19:00.261	11.39	19.38	7.15	7.23	560.31	1.44	68.06	5.00	7.46	8.77	0.00	9.00	1.00	0.00	-0.01	9.75	16.75807	2.15	30.0699301	#DIV/0!
4/14/2006 12:34:00.325	11.38	19.22	7.16	7.23	413.06	1.44	68.18	6.16	7.46	232.62	5.37	241.09	0.83	4.76	-0.01	9.75	10.57306	1	13.9664804	88.6406
4/14/2006 12:49:00.339	11.38	19.65	7.15	7.23	424.35	1.42	68.44	6.17	7.46	27.01	0.00	27.85	1.00	0.00	-0.01	9.85	10.08592	0.98	13.7062937	#DIV/0!
4/14/2006 13:04:00.393	11.38	19.39	7.16	7.23	416.57	1.43	68.48	6.17	7.47	10.15	0.00	10.45	1.00	0.00	0.00	9.75	10.37913	0.99	13.8268156	#DIV/0!
4/14/2006 13:19:00.407	11.39	19.24	7.15	7.23	415.73	1.41	68.50	6.15	7.48	201.80	5.41	211.03	1.00	4.81	-0.01	9.83	10.50515	1	13.986014	88.90943
4/14/2006 13:34:00.451	11.38	19.55	7.15	7.23	408.10	1.43	68.76	6.16	7.48	41.50	0.00	42.50	1.00	0.00	0.01	9.50	10.59455	0.99	13.8461538	#DIV/0!
4/14/2006 13:49:00.466	11.38	19.41	7.15	7.22	422.22	1.44	68.71	6.16	7.50	11.37	0.00	11.75	1.00	0.00	0.01	9.11	10.24024	0.99	13.8461538	#DIV/0!
4/14/2006 14:04:00.500	11.38	19.02	7.17	7.24	417.41	1.44	68.51	6.15	7.50	8.47	0.00	9.31	1.00	0.09	0.00	9.85	10.67213	1.02	14.2259414	#DIV/0!
4/14/2006 14:19:00.554	11.39	19.49	7.15	7.22	419.70	1.44	68.74	6.16	7.49	255.44	5.38	263.83	1.00	4.72	0.00	9.87	10.30173	0.99	13.8461538	87.73234
4/14/2006 14:34:00.668	11.38	19.27	7.14	7.14	417.94	1.41	68.65	6.16	7.52	13.28	0.00	13.73	1.00	0.00	-0.01	9.87	10.24061	0.98	13.7254902	#DIV/0!
4/14/2006 14:49:00.893	11.39	18.94	7.15	7.23	405.51	1.44	68.51	6.15	7.51	10.53	0.00	10.99	1.00	0.00	-0.01	9.68	10.76991	1	13.986014	#DIV/0!
4/14/2006 15:04:00.907	11.38	18.23	7.14	7.22	415.20	1.44	68.67	6.15	7.51	256.12	5.36	264.13	1.00	4.74	0.00	9.87	10.41338	0.99	13.8655462	88.43284
4/14/2006 15:19:00.921	11.38	18.42	7.16	7.22	418.48	1.46	68.80	6.17	7.52	16.63	0.00	17.24	1.00	0.00	0.00	9.76	10.33176	0.99	13.8268156	#DIV/0!
4/14/2006 15:34:00.995	11.39	18.97	7.16	7.22	408.48	1.46	68.56	6.16	7.51	8.47	0.00	8.85	1.00	0.00	-0.01	9.85	10.69161	1	13.9664804	#DIV/0!
4/14/2006 15:49:01.090	11.38	19.13	7.15	7.22	421.84	1.45	68.79	6.15	7.52	244.68	5.37	252.61	0.95	4.70	-0.01	9.85	10.353	1	13.986014	87.52328
4/14/2006 16:04:01.264	11.38	19.38	7.14	7.22	418.10	1.47	68.71	6.17	7.54	19.68	0.00	20.37	1.00	0.01	-0.01	9.88	10.13224	0.97	13.5854342	#DIV/0!
4/14/2006 16:19:01.278	11.38	19.19	7.15	7.22	409.55	1.46	68.71	6.16	7.52	8.24	0.00	8.62	1.00	0.00	0.00	9.77	10.55704	0.99	13.8461538	#DIV/0!
4/14/2006 16:34:01.322	11.39	19.01	7.14	7.22	415.58	1.47	68.71	6.16	7.52	228.58	5.36	237.05	0.83	4.72	-0.01	9.09	10.28677	0.98	13.7254902	88.0597
4/14/2006 16:49:01.357	11.38	19.37	7.15	7.22	425.80	1.45	68.79	6.16	7.54	28.00	0.00	28.69	1.00	0.01	-0.01	9.83	10.15414	0.99	13.8461538	#DIV/0!
4/14/2006 17:04:01.381	11.39	18.98	7.14	7.22	413.75	1.45	68.64	6.15	7.56	9.92	0.00	10.22	1.00	0.01	0.01	9.88	10.44987	0.99	13.8655462	#DIV/0!
4/14/2006 17:19:01.395	11.38	19.02	7.15	7.22	415.05	1.46	68.67	6.16	7.56	200.96	5.40	208.21	1.00	4.79	0.01	9.90	10.41714	0.99	13.8461538	88.7037
4/14/2006 17:34:01.469	11.38	19.42	7.14	7.27	418.78	1.46	68.85	6.16	7.56	43.18	0.00	44.33	1.00	0.01	-0.01	9.83	10.22007	0.98	13.7254902	#DIV/0!
4/14/2006 17:49:01.543	11.38	19.20	7.14	7.22	417.18	1.47	68.71	6.16	7.61	11.67	0.00	12.05	1.00	0.01	0.01	9.90	10.25927	0.98	13.7254902	#DIV/0!
4/14/2006 18:04:01.558	11.39	18.80	7.14	7.22	407.95	1.47	68.56	6.15	7.59	7.17	0.00	7.48	1.00	0.00	0.00	9.77	10.59844	0.99	13.8655462	#DIV/0!
4/14/2006 18:19:01.582	11.38	18.31	7.14	7.22	406.88	1.48	68.77	6.17	7.56	256.81	5.45	265.20	1.00	4.71	-0.01	9.88	10.41164	0.97	13.5854342	86.42202
4/14/2006 18:34:01.586	11.38	19.26	7.15	7.22	415.96	1.50	68.71	6.16	7.61	13.12	0.00	13.58	1.00	0.00	-0.01	9.84	10.39435	0.99	13.8461538	#DIV/0!
4/14/2006 18:49:01.610	11.39	18.75	7.14	7.23	416.65	1.47	68.39	6.15	7.60	10.45	0.00	10.99	1.00	0.00	0.00	9.86	10.37714	0.99	13.8655462	#DIV/0!
4/14/2006 19:04:01.624	11.39	19.06	7.15	7.23	419.39	1.47	68.56	6.15	7.61	260.40	5.47	268.25	1.00	4.75	0.01	9.90	10.41348	1	13.986014	86.83729
4/14/2006 19:19:01.638	11.38	19.29	7.12	7.23	418.71	1.51	68.60	6.17	7.62	16.56	0.00	17.17	1.00	0.01	0.01	9.85	9.908868	0.95	13.3426966	#DIV/0!
4/14/2006 19:34:01.652	11.39	18.90	7.15	7.23	416.80	1.50	68.41	6.16	7.60	8.62	0.00	9.00	1.00	0.00	-0.01	9.92	10.3734	0.99	13.8461538	#DIV/0!
4/14/2006 19:49:01.687	11.39	19.08	7.14	7.22	419.39	1.50	68.50	6.15	7.63	245.82	5.45	254.60	0.94	4.70	0.00	9.93	10.30934	0.99	13.8655462	86.23853
4/14/2006 20:04:01.691	11.38	19.26	7.16	7.23	420.46	1.53	68.50	6.16	7.62	20.07	0.00	20.68	1.00	0.01	0.00	9.89	10.38698	1	13.9664804	#DIV/0!
4/14/2006 20:19:01.705	11.39	19.08	7.14	7.22	425.68	1.52	68.38	6.16	7.61	8.55	0.00	8.85	1.00	0.00	-0.01	9.77	10.04969	0.98	13.7254902	#DIV/0!
4/14/2006 20:34:01.719	11.39	18.82	7.13	7.22	416.11	1.51	68.22	6.15	7.63	227.66	5.33	237.81	0.80	4.71	-0.01	9.90	10.28565	0.98	13.7447405	88.36773
4/14/2006 20:49:01.743	11.38	19.09	7.14	7.23	418.33	1.50	68.30	6.16	7.65	28.38	0.00	29.14	1.00	0.01	0.00	9.89	10.23107	0.98	13.7254902	#DIV/0!
4/14/2006 21:04:01.747	11.38	18.90	7.14	7.20	418.86	1.49	68.12	6.16	7.65	10.45	0.00	10.83	1.00	0.01	0.00	9.92	10.21812	0.98	13.7254902	#DIV/0!
4/14/2006 21:19:01.772	11.39	18.82	7.13	7.22	424.43	1.53	68.09	6.15	7.65	195.93	5.38	206.99	1.00	4.79	0.00	9.92	10.08402	0.98	13.7447405	89.03346
4/14/2006 21:34:01.786	11.39	19.26	7.14	7.22	425.57	1.51	68.22	6.17	7.62	47.30	0.00	48.52	1.00	0.01	0.01	9.88	9.954387	0.97	13.5854342	#DIV/0!
4/14/2006 21:49:01.810	11.39	19.06	7.14	7.23	408.94	1.51	68.07	6.16	7.66	11.75	0.00	12.05	1.00	0.00	-0.01	9.91	10.46599	0.98	13.7254902	#DIV/0!
4/14/2006 22:04:01.874	11.38	18.79	7.14	7.23	427.48	1.52	67.96	6.15	7.66	7.55	0.00	7.93	1.00	0.00	0.00	9.79	10.11424	0.99	13.8655462	#DIV/0!
4/14/2006 22:19:01.888	11.39	19.26	7.16	7.22	413.98	1.52	68.06	6.16	7.64	257.65	5.40	266.50	1.00	4.69	-0.01	9.91	10.54956	1	13.9664804	86.85185
4/14/2006 22:34:01.902	11.38	19.04	7.14	7.23	414.66	1.54	67.89	6.15	7.69	13.43	0.00	13.96	1.00	0.01	-0.01	9.93	10.42694	0.99	13.8655462	#DIV/0!
4/14/2006 22:49:01.927	11.38	18.76	7.13	7.22	419.24	1.54	67.73	6.15	7.67	7.17	0.00	7.46	1.00	0.01	-0.01	9.92	10.20886	0.98	13.7447405	#DIV/0!
4/14/2006 23:04:01.941	11.39	19.01	7.14	7.23	419.39	1.55	67.80	6.15	7.70	250.10	5.40	259.02	0.94	4.66	-0.01	9.92	10.30934	0.99	13.8655462	86.2963
4/14/2006 23:19:02.015	11.38	19.20	7.16	7.23	414.05	1.57	67.81	6.17	7.69	17.24	0.00	17.78	1.00	0.01	-0.01	9.91	10.4423	0.99	13.8268156	#DIV/0!
4/14/2006 23:34:02.029	11.39	18.73	7.14	7.20	418.71	1.55	67.60	6.16	7.67	9.69	0.00	10.22	1.00	0.00	-0.01	9.92	10.22178	0.98	13.7254902	#DIV/0!
4/14/2006 23:49:02.033	11.38	18.62	7.12	7.23	413.14	1.55	67.48	6.15	7.66	242.85	5.33	251.62	0.87	4.76	0.00	9.92	10.25388	0.97	13.6235955	89.30582
4/15/2006 00:04:02.058	11.38	19.17	7.15	7.23	429.62	1.56	67.61	6.16	7.68	21.82	0.00	22.74	1.00	0.01	-0.01	9.92	10.06386	0.99	13.8461538	#DIV/0!
4/15/2006 00:19:02.082	11.39	18.75	7.15	7.23	425.35	1.55	67.35	6.15	7.68	8.93	0.00	9.31	1.00	0.01	-0.01	9.90	10.26756	1	13.986014	#DIV/0!
4/15/2006 00:34:02.096	11.38	18.65	7.15	7.23	418.25	1.58	67.26	6.15	7.68	220.04	5.32	229.11	0.72	4.77	-0.01	9.92	10.44186	1	13.986014	89.66165

4/15/2006 00:49:02.110	11.39	19.08	7.14	7.29	429.92	1.55	67.34	6.16	7.67	32.81	0.00	33.80	1.00	0.00	-0.01	9.92	9.955251	0.98	13.7254902	#DIV/0!
4/15/2006 01:04:02.124	11.38	18.91	7.15	7.24	427.33	1.55	67.28	6.16	7.70	10.53	0.00	10.99	1.00	0.00	-0.01	9.90	10.11779	0.99	13.8461538	#DIV/0!
4/15/2006 01:19:02.148	11.39	18.47	7.16	7.23	429.85	1.55	67.03	6.16	7.70	10.61	0.00	11.06	1.00	0.01	-0.01	9.86	10.16007	1	13.9664804	#DIV/0!
4/15/2006 01:34:02.162	11.38	19.22	7.15	7.23	422.52	1.56	67.20	6.16	7.66	71.87	0.00	73.40	1.00	0.01	-0.01	9.91	10.23297	0.99	13.8461538	#DIV/0!
4/15/2006 01:49:02.177	11.38	18.77	7.13	7.23	423.74	1.56	67.00	6.16	7.71	12.44	0.00	12.97	1.00	0.00	-0.01	9.91	9.997377	0.97	13.6044881	#DIV/0!
4/15/2006 02:04:02.191	11.38	18.50	7.12	7.24	413.52	1.56	66.87	6.16	7.68	10.91	0.00	11.37	1.00	0.01	-0.01	9.90	10.13885	0.96	13.4831461	#DIV/0!
4/15/2006 02:19:02.215	11.38	19.00	7.15	7.24	423.59	1.59	67.03	6.17	7.70	257.27	5.43	266.65	0.97	4.70	0.01	9.91	10.10402	0.98	13.7062937	86.55617
4/15/2006 02:34:02.219	11.39	19.00	7.14	7.24	422.60	1.58	66.96	6.16	7.69	15.18	0.00	15.87	1.00	0.01	-0.01	9.94	10.12769	0.98	13.7254902	#DIV/0!
4/15/2006 02:49:02.233	11.38	18.81	7.13	7.24	420.00	1.58	66.80	6.15	7.69	8.09	0.00	8.62	1.00	0.01	0.00	9.92	10.19038	0.98	13.7447405	#DIV/0!
4/15/2006 03:04:02.257	11.38	18.59	7.14	7.24	416.27	1.59	66.73	6.15	7.71	245.29	5.38	254.98	0.88	4.67	0.01	9.73	10.38861	0.99	13.8655462	86.80297
4/15/2006 03:19:02.282	11.38	19.11	7.13	7.24	421.99	1.59	66.80	6.16	7.70	18.84	0.00	19.68	1.00	0.01	0.00	8.97	10.03884	0.97	13.6044881	#DIV/0!
4/15/2006 03:34:02.286	11.38	18.64	7.15	7.24	415.81	1.60	66.61	6.16	7.67	8.32	0.00	8.85	1.00	0.01	-0.01	9.88	10.3981	0.99	13.8461538	#DIV/0!
4/15/2006 03:49:02.310	11.38	18.46	7.14	7.24	416.19	1.59	66.50	6.15	7.68	231.48	5.42	240.33	0.73	4.73	0.00	9.51	10.38861	0.99	13.8655462	87.26937
4/15/2006 04:04:02.324	11.38	18.84	7.14	7.24	433.05	1.59	66.56	6.16	7.66	28.08	0.00	28.99	1.00	0.01	0.01	9.91	9.883296	0.98	13.7254902	#DIV/0!
4/15/2006 04:19:02.348	11.38	18.70	7.13	7.24	431.53	1.61	66.45	6.15	7.68	10.45	0.00	11.14	1.00	0.01	0.00	9.93	9.918109	0.98	13.7447405	#DIV/0!
4/15/2006 04:34:02.352	11.38	18.52	7.13	7.24	430.00	1.59	66.36	6.15	7.69	185.24	5.04	195.62	1.00	4.75	0.00	9.84	9.953399	0.98	13.7447405	94.24603
4/15/2006 04:49:02.377	11.39	18.92	7.14	7.24	427.48	1.59	66.39	6.16	7.67	51.65	0.00	53.18	1.00	0.01	0.00	9.55	10.01207	0.98	13.7254902	#DIV/0!
4/15/2006 05:04:02.651	11.38	18.73	7.15	7.24	431.91	1.61	66.33	6.16	7.70	11.37	0.00	12.05	1.00	0.01	-0.01	9.92	10.0105	0.99	13.8461538	#DIV/0!
4/15/2006 05:19:02.725	11.39	18.52	7.14	7.22	418.71	1.62	66.22	6.16	7.69	8.85	0.00	9.46	1.00	0.01	0.00	9.48	10.22178	0.98	13.7254902	#DIV/0!
4/15/2006 05:34:02.770	11.38	18.70	7.15	7.24	432.36	1.59	66.09	6.16	7.69	251.24	5.42	261.16	0.93	4.65	-0.01	9.31	10.00008	0.99	13.8461538	85.79336
4/15/2006 05:49:02.794	11.38	18.69	7.13	7.24	417.11	1.61	66.09	6.15	7.69	13.96	0.00	14.72	1.00	0.01	-0.01	9.93	10.26099	0.98	13.7447405	#DIV/0!
4/15/2006 06:04:02.858	11.38	18.43	7.14	7.24	428.02	1.60	65.98	6.15	7.67	7.48	0.00	8.09	1.00	0.01	-0.01	9.80	10.10148	0.99	13.8655462	#DIV/0!
4/15/2006 06:19:02.902	11.38	18.60	7.13	7.24	425.50	1.60	65.98	6.15	7.70	256.20	5.42	264.90	0.88	4.70	-0.01	9.48	10.05866	0.98	13.7447405	86.71587
4/15/2006 06:34:02.916	11.39	18.90	7.15	7.24	425.50	1.61	66.01	6.16	7.67	19.07	0.00	20.07	1.00	0.01	-0.01	9.92	10.1613	0.99	13.8461538	#DIV/0!
4/15/2006 06:49:02.950	11.38	18.55	7.09	7.50	456.32	1.63	65.87	6.44	7.65	9.16	0.00	10.15	1.00	0.03	0.01	9.93	6.220963	0.65	9.16784203	#DIV/0!
4/15/2006 07:04:02.975	11.39	18.41	7.14	7.24	433.20	1.63	65.81	6.15	7.65	229.65	5.39	238.80	0.72	4.68	-0.01	9.94	9.980689	0.99	13.8655462	86.82746
4/15/2006 07:19:03.019	11.39	18.90	7.14	7.24	425.57	1.64	65.90	6.16	7.63	26.02	0.00	27.16	1.00	0.01	-0.01	9.91	10.05701	0.98	13.7254902	#DIV/0!
4/15/2006 07:34:03.033	11.38	18.50	7.13	7.16	415.73	1.64	65.81	6.16	7.67	10.53	0.00	10.99	1.00	0.01	-0.01	9.95	10.19	0.97	13.6044881	#DIV/0!
4/15/2006 07:49:03.077	11.38	18.19	7.14	7.24	425.27	1.61	65.69	6.16	7.67	185.55	5.41	198.06	1.00	4.76	0.01	9.95	10.0641	0.98	13.7254902	87.98521
4/15/2006 08:04:03.121	11.39	18.83	7.13	7.24	418.94	1.63	65.87	6.16	7.63	51.50	0.00	53.10	0.98	0.01	-0.01	9.95	10.11192	0.97	13.6044881	#DIV/0!
4/15/2006 08:19:03.166	11.38	18.46	7.14	7.24	424.12	1.63	65.81	6.15	7.65	11.37	0.00	11.98	1.00	0.01	0.01	9.93	10.19437	0.99	13.8655462	#DIV/0!
4/15/2006 08:34:03.210	11.38	18.25	7.13	7.23	426.87	1.62	65.81	6.15	7.66	8.85	0.00	9.31	1.00	0.01	0.00	9.69	10.02638	0.98	13.7447405	#DIV/0!
4/15/2006 08:49:03.224	11.38	18.77	7.14	7.24	426.26	1.63	66.10	6.16	7.65	259.02	5.45	267.95	0.95	4.71	0.00	9.80	10.04073	0.98	13.7254902	86.42202
4/15/2006 09:04:03.268	11.38	18.55	7.14	7.24	424.12	1.61	65.95	6.16	7.63	14.80	0.00	15.49	1.00	0.00	0.00	9.86	10.08139	0.98	13.7254902	#DIV/0!
4/15/2006 09:19:03.292	11.38	18.33	7.14	7.24	433.05	1.63	66.03	6.14	7.62	7.78	0.00	8.32	1.00	0.00	-0.01	9.33	10.085	1	14.0056022	#DIV/0!
4/15/2006 09:34:03.387	11.38	18.40	7.14	7.24	414.44	1.63	66.06	6.14	7.63	246.66	5.39	255.89	0.88	4.68	-0.01	9.31	10.53785	1	14.0056022	86.82746
4/15/2006 09:49:03.451	11.38	18.61	7.15	7.23	426.79	1.63	66.19	6.15	7.63	18.54	0.00	19.30	1.00	0.00	0.00	9.82	10.23292	1	13.986014	#DIV/0!
4/15/2006 10:04:03.465	11.38	18.40	7.12	7.29	433.51	1.66	66.16	6.14	7.63	10.22	0.00	10.91	1.00	0.01	0.00	9.84	9.872809	0.98	13.7640449	#DIV/0!
4/15/2006 10:19:03.519	11.38	18.27	7.14	7.24	427.71	1.66	66.24	6.14	7.65	238.80	5.33	247.43	0.75	4.76	0.00	9.32	10.21091	1	14.0056022	89.30582
4/15/2006 10:34:03.553	11.38	18.62	7.14	7.24	433.05	1.65	66.36	6.15	7.65	27.85	0.00	28.84	1.00	0.00	-0.01	9.86	9.984146	0.99	13.8655462	#DIV/0!
4/15/2006 10:49:03.578	11.39	18.51	7.13	7.23	419.62	1.65	66.39	6.14	7.64	9.99	0.00	10.45	1.00	0.01	-0.01	9.83	10.30369	0.99	13.884993	#DIV/0!
4/15/2006 11:04:03.602	11.39	18.23	7.13	7.24	415.81	1.64	66.42	6.13	7.66	198.21	5.41	208.36	1.00	4.78	-0.01	9.82	10.50313	1	14.0252454	88.3549
4/15/2006 11:19:03.636	11.39	18.72	7.14	7.24	434.35	1.65	66.62	6.14	7.66	47.99	0.00	49.36	1.00	0.01	-0.01	9.90	10.05481	1	14.0056022	#DIV/0!
4/15/2006 11:34:03.670	11.39	18.51	7.13	7.24	427.71	1.68	66.68	6.13	7.65	11.52	0.00	12.21	1.00	0.00	-0.01	9.90	10.21091	1	14.0252454	#DIV/0!
4/15/2006 11:49:03.694	11.38	18.21	7.12	7.24	418.33	1.67	66.68	6.13	7.67	7.86	0.00	8.32	1.00	0.01	-0.01	9.89	10.33546	0.99	13.9044944	#DIV/0!
4/15/2006 12:04:03.728	11.38	18.68	7.13	7.23	425.96	1.68	66.94	6.13	7.67	255.89	5.35	264.36	0.97	4.69	-0.01	9.86	10.25286	1	14.0252454	87.66355
4/15/2006 12:19:03.743	11.38	18.46	7.12	7.25	420.92	1.66	66.96	6.13	7.67	13.89	0.00	14.50	1.00	0.00	0.00	9.87	10.27187	0.99	13.8044844	#DIV/0!
4/15/2006 12:34:03.787	11.39	18.35	7.12	7.23	424.05	1.66	67.05	6.14	7.70	7.55	0.00	8.01	1.00	0.01	-0.01	9.77	10.09306	0.98	13.7640449	#DIV/0!
4/15/2006 12:49:03.831	11.38	18.47	7.15	7.23	415.35	1.67	67.19	6.13	7.69	257.80	5.35	265.81	0.93	4.74	-0.01	9.90	10.72506	1.02	14.2657343	88.59813
4/15/2006 13:04:03.915	11.38	18.72	7.12	7.23	420.31	1.70	67.35	6.13	7.71	18.54	0.00	19.30	1.00	0.01	-0.01	9.88	10.28678	0.99	13.9044944	#DIV/0!
4/15/2006 13:19:03.929	11.39	18.28	7.13	7.23	433.05	1.67	67.25	6.12	7.71	10.99	0.00	11.37	1.00	0.00	-0.01	9.88	10.18585	1.01	14.1654979	#DIV/0!
4/15/2006 13:34:03.984	11.38	18.27	7.12	7.23	424.51	1.67	67.38	6.12	7.71	243.08	5.35	252.61	0.85	4.74	0.01	9.89	10.28788	1	14.0449438	88.59813
4/15/2006 13:49:04.038	11.38	18.83	7.12	7.23	414.97	1.68	67.60	6.12	7.72	24.19	0.00	25.02	1.00	0.00	-0.01	9.85	10.52439	1	14.0449438	#DIV/0!
4/15/2006 14:04:04.082	11.38	18.34	7.14	7.23	432.14	1.68	67.46	6.13	7.73	9.77	0.00	10.22	1.00	0.00	-0.01	9.83	10.2073	1.01	14.1456583	#DIV/0!
4/15/2006 14:19:04.116	11.39	18.31	7.13	7.23	432.06	1.73	67.55	6.11	7.74	215.69	5.43	223.47	0.75	4.74	0.01	9.86	10.31027	1.02	14.3057504	87.29282
4/15/2006 14:34:04.130	11.38	18.88	7.13	7.23	430.46	1.75	67.87	6.12	7.73	36.93	0.00	38.07	1.00	0.00	-0.01	9.44	10.24713	1.01	14.1654979	#DIV/0!
4/15/2006 14:49:04.175	11.38	18.82	7.12	7.31	424.73	1.72	67.81	6.26	7.76	11.06	0.00	11.52	1.00	0.00	0.01	9.74	8.842993	0.86	12.0786517	#DIV/0!
4/15/2006 15:04:04.219	11.38	18.27	7.13	7.23	420.61	1.73	67.67	6.11	7.78	10.83	0.00	11.37	1.00	0.01	0.01	9.65	10.59094	1.02	14.3057504	#DIV/0!
4/15/2006 15:19:04.243	11.39	18.83	7.14	7.22	422.67	1.74	67.92	6.12	7.73	95.52	0.00	96.74	1.00	0.00	0.00	9.86	10.53932	1.02	14.2857143	#DIV/0!
4/15/2006 15:34:04.307	11.38	18.58	7.12	7.23	433.43	1.74	67.89	6.12	7.80	13.28	0.00	13.89	1.00	0.01	0.00	9.88	10.07615	1	14.0449438	#DIV/0!
4/15/2006 15:49:04.361	11.38	18.41	7.13	7.23	432.75	1.74	67.81	6.12	7.81	10.30	0.00	10.83	1.00	0.01	-0.01	9.75	10.19291	1.01	14.1654979	#DIV/0!
4/15/2006 16:04:04.466	11.38	18.55	7.11	7.23	427.94	1.74	67.88	6.11	7.81	262.00	5.38	270.24	1.00	4.71	0.00	9.19	10.20542	1	14.0646976	87.54847
4/15/2006 16:19:04.500	11.38	18.85	7.12	7.23	426.03	1.75	67.92	6.12	7.85	16.40	0.00	17.09	1.00	0.01	-0.01	9.86	10.25117	1	14.0449438	#DIV/0!
4/15/2006 16:34:04.564	11.38	18.54	7.13	7.23	428.09	1.75	67.93	6.11	7.84	8.55	0.00	9.00	1.00	0.01	0.00	9.88	10.40588	1.02	14.3057504	#DIV/0!
4/15/2006 16:49:04.598	11.38	18.62	7.13	7.23	421.38	1.75	68.04	6.11	7.83	249.10	5.25	257.88	0.92	4.66	-0.01	9.87	10.57158	1.02	14.3057504	88.7619
4/15/2006 17:04:04.622	11.38	18.94	7.13	7.23	424.96	1.80	68.15	6.12	7.87	20.29	0.00	21.21	1.00	0.00	0.00	9.88	10.37976	1.01	14.1654979	#DIV/0!
4/15/2006 17:19:04.657	11.38	18.61	7.13	7.23	416.57	1.75	68.01	6.11	7.87	8.62	0.00	9.16	1.00	0.00	-0.01	9.77	10.69365	1.02	14.3057504	#DIV/0!
4/15/2006 17:34:04.701	11.38	18.47	7.11	7.23	431.60	1.77	67.96	6.11	7.87	238.27	5.48	246.43	0.79	4.78	0.00	9.80	10.11888	1	14.0646976	87.22628
4/15/2006 17:49:04.735	11.38	18.90	7.12	7.23	425.35	1.78	68.09	6.12	7.88	30.29	0.00	31.20	1.00	0.01	-0.01	9.88	10.26755	1	14.0449438	#DIV/0!
4/15/2006 18:04:04.749	11.38	18.70	7.13	7.21	431.98	1.77	68.02	6.11	7.89	10.30	0.00	10.83	1.00	0.00	0.00	9.88	10.31218	1.02	14.3057504	#DIV/0!
4/15/2006 18:19:04.793	11.38	18.30	7.12	7.23	423.21	1.77	67.84	6.10	7.90	198.06	5.46	206.53	1.00	4.79	0.00	9.87	10.52587	1.02	14.3258427	87.72894
4/15/2006 18:34:04.798	11.38	19.11	7.14	7.23	432.82	1.79	68.16	6.11	7.89	51.12	0.00	52.49	1.00	0.00	0.00	9.88	10.39307	1.03	14.4257703	#DIV/0!
4/15/2006 18:49:04.852	11.39	18.83	7.13	7.23	425.27	1.83	68.07	6.11	7.91	11.98	0.00	12.44	1.00	0.01	-0.01	9.76	10.47488	1.02	14.3057504	#DIV/0!
4/15/2006 19:04:04.886	11.38	18.47	7.12	7.23	422.52	1.79	67.92	6.10	7.94	7.93	0.00	8.32	1.00	0.00	0.00	9.83	10.54306	1.02	14.3258427	#DIV/0!

4/18/2006 02:19:16.977	11.38	18.46	7.12	7.24	451.97	2.51	66.07	6.08	8.08	7.25	0.00	7.78	1.00	0.01	0.01	9.79	10.04934	1.04	14.6067416	#DIV/0!
4/18/2006 02:34:17.042	11.38	18.72	7.13	7.24	450.75	2.48	65.86	6.09	8.08	253.99	5.46	263.98	0.91	4.64	-0.01	9.96	10.07654	1.04	14.5862553	84.98168
4/18/2006 02:49:17.146	11.38	18.76	7.10	7.24	454.34	2.51	66.04	6.08	8.07	13.43	0.00	14.19	1.00	0.01	0.00	9.92	9.80467	1.02	14.3661972	#DIV/0!
4/18/2006 03:04:17.180	11.38	18.43	7.12	7.24	454.11	2.51	65.90	6.09	8.06	7.02	0.00	7.71	1.00	0.01	-0.01	9.94	9.905809	1.03	14.4862921	#DIV/0!
4/18/2006 03:19:17.194	11.38	18.57	7.12	7.24	446.10	2.49	65.77	6.08	8.06	262.89	5.36	273.06	0.94	4.69	0.01	9.94	10.18157	1.04	14.6067416	87.5
4/18/2006 03:34:17.219	11.38	18.81	7.12	7.21	455.86	2.49	65.81	6.08	8.06	14.19	0.00	15.03	1.00	0.01	0.00	9.91	9.963585	1.04	14.6067416	#DIV/0!
4/18/2006 03:49:17.253	11.38	18.42	7.12	7.25	448.62	2.49	65.74	6.07	8.02	10.30	0.00	11.22	1.00	0.01	0.00	9.84	10.22173	1.05	14.747191	#DIV/0!
4/18/2006 04:04:17.287	11.38	18.55	7.11	7.24	451.74	2.49	65.64	6.08	8.02	257.11	5.45	266.50	0.90	4.67	0.01	9.94	9.857779	1.03	14.4866385	85.68807
4/18/2006 04:19:17.341	11.38	18.53	7.13	7.24	455.10	2.49	65.54	6.09	8.01	15.18	0.00	16.10	1.00	0.01	0.01	9.90	9.880224	1.04	14.5862553	#DIV/0!
4/18/2006 04:34:17.395	11.38	18.24	7.11	7.24	440.83	2.50	65.52	6.08	8.01	10.38	0.00	11.22	1.00	0.01	0.00	9.58	10.20422	1.03	14.4866385	#DIV/0!
4/18/2006 04:49:17.409	11.38	18.70	7.11	7.24	441.60	2.49	65.61	6.08	8.01	248.80	5.39	259.71	0.84	4.61	0.01	6.22	10.18643	1.03	14.4866385	85.52876
4/18/2006 05:04:17.454	11.38	18.54	7.11	7.24	456.24	2.51	65.51	6.08	8.01	15.26	0.00	16.17	1.00	0.01	-0.01	9.90	9.859583	1.03	14.4866385	#DIV/0!
4/18/2006 05:19:17.518	11.38	18.32	7.11	7.23	449.30	2.51	65.45	6.09	7.99	8.62	0.00	9.31	1.00	0.01	-0.01	9.53	9.914654	1.02	14.3459916	#DIV/0!
4/18/2006 05:34:17.602	11.37	18.31	7.11	7.24	446.48	2.49	65.37	6.08	8.00	250.40	5.33	259.86	0.82	4.66	-0.01	9.15	10.07509	1.03	14.4866385	87.42964
4/18/2006 05:49:17.656	11.38	18.55	7.12	7.24	450.75	2.49	65.37	6.10	8.00	16.17	0.00	17.24	1.00	0.01	0.01	9.91	9.88276	1.02	14.3258427	#DIV/0!
4/18/2006 06:04:17.711	11.38	18.34	7.13	7.24	444.34	2.52	65.34	6.10	7.98	8.32	0.00	9.08	1.00	0.01	-0.01	9.65	10.12361	1.03	14.4460028	#DIV/0!
4/18/2006 06:19:17.755	11.38	18.27	7.12	7.24	451.51	2.51	65.25	6.08	7.98	244.45	5.39	255.74	0.77	4.62	0.01	9.18	10.05958	1.04	14.6067416	85.71429
4/18/2006 06:34:17.789	11.38	18.64	7.12	7.24	451.44	2.51	65.32	6.09	7.97	19.00	0.00	20.07	1.00	0.01	0.00	9.92	9.964396	1.03	14.4862921	#DIV/0!
4/18/2006 06:49:17.823	11.38	18.31	7.10	7.24	454.49	2.51	65.20	6.09	7.96	8.32	0.00	9.16	1.00	0.01	0.00	9.91	9.705342	1.01	14.2253521	#DIV/0!
4/18/2006 07:04:17.867	11.38	18.20	7.13	7.24	450.83	2.52	65.19	6.08	7.97	236.67	5.38	247.50	0.71	4.67	-0.01	9.92	10.17162	1.05	14.7265077	86.80297
4/18/2006 07:19:17.902	11.37	18.59	7.10	7.29	448.84	2.52	65.18	6.09	7.94	22.05	0.00	23.04	1.00	0.01	0.01	9.90	9.827513	1.01	14.2253521	#DIV/0!
4/18/2006 07:34:17.976	11.38	18.42	7.12	7.24	450.37	2.52	65.25	6.09	7.93	8.77	0.00	9.61	1.00	0.01	-0.01	9.81	9.98807	1.03	14.4662921	#DIV/0!
4/18/2006 07:49:18.040	11.38	18.06	7.12	7.24	446.56	2.51	65.13	6.09	7.94	226.98	5.38	238.12	0.63	4.65	-0.01	9.90	10.07329	1.03	14.4662921	86.43123
4/18/2006 08:04:18.084	11.38	18.70	7.09	7.24	456.86	2.53	65.32	6.09	7.91	29.91	0.00	31.05	1.00	0.01	0.00	9.90	9.5594	1	14.1043724	#DIV/0!
4/18/2006 08:19:18.118	11.38	18.19	7.10	7.24	442.13	2.49	65.23	6.08	7.92	9.92	0.00	10.61	1.00	0.00	-0.01	9.82	10.07544	1.02	14.3661972	#DIV/0!
4/18/2006 08:34:18.143	11.38	18.12	7.10	7.24	450.45	2.52	65.29	6.08	7.94	6.71	0.00	7.25	0.97	0.01	-0.01	9.88	9.889341	1.02	14.3661972	#DIV/0!
4/18/2006 08:49:18.157	11.38	18.70	7.11	7.23	452.12	2.52	65.51	6.09	7.90	86.75	0.00	88.43	0.90	0.01	-0.01	9.90	9.852813	1.02	14.3459916	#DIV/0!
4/18/2006 09:04:18.191	11.38	18.49	7.11	7.24	447.78	2.54	65.54	6.08	7.91	12.36	0.00	13.12	1.00	0.01	-0.01	9.89	10.04584	1.03	14.4866385	#DIV/0!
4/18/2006 09:19:18.225	11.38	18.13	7.09	7.24	453.80	2.52	65.48	6.08	7.90	6.87	0.00	7.48	0.97	0.01	0.01	9.88	9.720099	1.01	14.2454161	#DIV/0!
4/18/2006 09:34:18.279	11.38	18.36	7.14	7.24	450.98	2.54	65.57	6.08	7.91	250.25	5.33	260.93	0.85	4.65	-0.01	9.86	10.26508	1.06	14.8459384	87.24203
4/18/2006 09:49:18.324	11.38	18.55	7.11	7.24	453.35	2.54	65.66	6.08	7.90	16.86	0.00	17.62	1.00	0.01	0.00	9.66	9.922415	1.03	14.4866385	#DIV/0!
4/18/2006 10:04:18.338	11.38	18.14	7.13	7.32	452.43	2.52	65.60	6.10	7.90	10.30	0.00	10.89	0.99	0.01	-0.01	9.88	9.942592	1.03	14.4460028	#DIV/0!
4/18/2006 10:19:18.372	11.38	18.03	7.13	7.24	439.61	2.53	65.67	6.08	7.90	237.58	5.35	247.43	0.71	4.68	0.00	9.89	10.43123	1.05	14.7265077	87.47664
4/18/2006 10:34:18.456	11.38	18.54	7.11	7.24	456.93	2.52	65.84	6.10	7.87	24.57	0.00	25.56	1.00	0.01	0.00	9.88	9.653515	1.01	14.2053446	#DIV/0!
4/18/2006 10:49:18.480	11.38	18.12	7.12	7.24	449.00	2.54	65.78	6.08	7.88	10.76	0.00	11.37	1.00	0.01	0.00	9.86	10.11581	1.04	14.6067416	#DIV/0!
4/18/2006 11:04:18.514	11.39	18.03	7.10	7.23	448.92	2.55	65.86	6.08	7.87	218.68	5.41	227.13	0.61	4.68	0.01	9.77	9.923046	1.02	14.3661972	86.50647
4/18/2006 11:19:18.559	11.38	18.50	7.11	7.24	449.68	2.54	66.09	6.07	7.86	32.43	0.00	33.49	1.00	0.01	0.01	9.86	10.10052	1.04	14.6272855	#DIV/0!
4/18/2006 11:34:18.623	11.38	18.35	7.12	7.23	450.37	2.55	66.12	6.08	7.87	10.22	0.00	10.83	1.00	0.01	0.01	9.86	10.08504	1.04	14.6067416	#DIV/0!
4/18/2006 11:49:18.657	11.38	17.96	7.11	7.24	448.62	2.54	66.06	6.06	7.87	208.97	5.36	218.28	0.76	4.75	-0.01	9.84	10.22173	1.05	14.7679325	88.6194
4/18/2006 12:04:18.671	11.38	18.47	7.11	7.24	443.43	2.54	66.32	6.06	7.85	35.93	0.00	37.31	1.00	0.01	0.00	9.92	10.34137	1.05	14.7679325	#DIV/0!
4/18/2006 12:19:18.705	11.38	18.34	7.11	7.23	456.40	2.55	66.39	6.07	7.87	10.91	0.00	11.44	1.00	0.00	-0.01	9.88	9.951797	1.04	14.6272855	#DIV/0!
4/18/2006 12:34:18.720	11.38	17.94	7.09	7.24	439.46	2.54	66.32	6.07	7.88	201.50	5.41	213.40	1.00	4.73	0.00	9.92	10.13665	1.02	14.3864598	87.43068
4/18/2006 12:49:18.734	11.39	18.62	7.10	7.23	447.70	2.54	66.68	6.07	7.85	39.75	0.00	41.12	1.00	0.01	0.01	9.94	10.04764	1.03	14.5070423	#DIV/0!
4/18/2006 13:04:18.788	11.39	18.27	7.14	7.30	442.74	2.54	66.65	6.20	7.87	11.29	0.00	12.05	1.00	0.00	-0.01	9.92	9.272415	0.94	13.1652661	#DIV/0!
4/18/2006 13:19:18.862	11.39	18.13	7.11	7.23	447.70	2.55	66.71	6.06	7.90	194.48	5.50	205.00	1.00	4.74	-0.01	9.92	10.24274	1.05	14.7679325	86.18182
4/18/2006 13:34:18.906	11.39	18.64	7.12	7.23	443.50	2.54	66.97	6.08	7.85	62.87	0.00	64.55	0.96	0.00	-0.01	9.92	10.24126	1.04	14.6067416	#DIV/0!
4/18/2006 13:49:18.971	11.39	18.50	7.11	7.23	454.80	2.55	67.05	6.06	7.93	11.90	0.00	12.66	1.00	0.01	-0.01	9.90	10.08283	1.05	14.7679325	#DIV/0!
4/18/2006 14:04:18.985	11.38	18.13	7.11	7.23	440.99	2.55	67.05	6.10	7.94	10.66	0.00	11.22	0.98	0.01	0.00	9.89	10.00245	1.01	14.2053446	#DIV/0!
4/18/2006 14:19:19.049	11.39	18.37	7.11	7.23	453.65	2.54	67.28	6.06	7.94	259.71	5.27	268.94	0.94	4.72	-0.01	9.90	10.10839	1.05	14.7679325	89.56357
4/18/2006 14:34:19.113	11.38	18.52	7.12	7.23	449.15	2.55	67.41	6.06	7.95	16.40	0.00	17.17	1.00	0.01	0.01	9.68	10.3069	1.06	14.8876404	#DIV/0!
4/18/2006 14:49:19.167	11.38	18.20	7.12	7.23	439.61	2.55	67.38	6.05	7.95	9.31	0.00	9.77	1.00	0.01	-0.01	9.91	10.62992	1.07	15.0280899	#DIV/0!
4/18/2006 15:04:19.222	11.38	18.47	7.12	7.23	444.80	2.57	67.72	6.08	7.96	252.23	5.36	261.77	0.91	4.66	0.00	9.81	10.21133	1.04	14.6067416	86.9403
4/18/2006 15:19:19.296	11.38	18.54	7.11	7.23	455.84	2.55	67.73	6.05	7.96	15.87	0.00	16.63	1.00	0.01	0.00	9.88	10.15341	1.06	14.9085795	#DIV/0!
4/18/2006 15:34:19.360	11.38	18.18	7.11	7.23	448.92	2.55	67.66	6.04	7.97	8.09	0.00	8.82	1.00	0.01	-0.01	9.90	10.40947	1.07	15.0492264	#DIV/0!
4/18/2006 15:49:19.414	11.38	18.29	7.12	7.23	437.93	2.57	67.86	6.04	7.96	256.58	5.34	265.05	0.95	4.69	-0.01	9.88	10.77043	1.08	15.1685393	87.82772
4/18/2006 16:04:19.469	11.38	18.52	7.12	7.23	439.84	2.55	68.01	6.05	7.99	18.08	0.00	18.84	1.00	0.01	-0.01	9.79	10.62436	1.07	15.0280899	#DIV/0!
4/18/2006 16:19:19.563	11.38	18.34	5.52	7.25	333.41	2.57	68.01	4.38	7.97	10.68	0.00	11.29	1.00	0.01	0.00	9.82	14.93276	1.14	20.6521739	#DIV/0!
4/18/2006 16:34:19.637	11.38	18.58	7.12	7.23	441.06	2.55	68.19	5.93	8.20	256.81	5.33	266.12	0.97	4.66	0.01	9.62	11.7832	1.19	16.7134831	87.42964
4/18/2006 16:49:19.691	11.38	18.69	7.11	7.23	451.51	2.55	68.25	5.87	8.78	18.46	0.00	19.23	1.00	0.00	0.01	9.82	11.99411	1.24	17.440225	#DIV/0!
4/18/2006 17:04:19.746	11.39	18.41	7.13	7.22	431.98	2.57	68.22	5.88	9.11	9.54	0.00	9.99	1.00	0.00	-0.01	9.36	12.63747	1.25	17.5315568	#DIV/0!
4/18/2006 17:19:19.790	11.38	18.93	7.12	7.23	430.38	2.55	68.50	5.94	9.26	282.75	5.36	292.06	1.00	4.64	-0.01	9.80	11.97412	1.18	16.5730337	88.56716
4/18/2006 17:34:19.834	11.38	18.77	7.12	7.23	449.61	2.57	68.47	5.91	9.60	15.34	0.00	16.10	1.00	0.01	-0.01	9.86	11.75339	1.21	16.994382	#DIV/0!
4/18/2006 17:49:19.878	11.38	18.48	7.13	7.23	441.75	2.59	68.38	5.91	9.69	8.24	0.00	8.70	1.00	0.00	-0.01	9.89	12.06138	1.22	17.1107994	#DIV/0!
4/18/2006 18:04:19.922	11.38	18.38	7.12	7.20	446.02	2.55	68.82	5.92	9.66	130.77	0.00	132.37	1.00	0.00	-0.01	9.88	11.75008	1.2	16.8539326	#DIV/0!
4/18/2006 18:19:19.936	11.38	19.09	7.12	7.16	442.82	2.57	68.64	5.93	9.78	14.57	0.00	15.26	1.00	0.00	-0.01	9.84	11.73636	1.19	16.7134831	#DIV/0!
4/18/2006 18:34:19.961	11.38	18.82	7.12	7.23	445.03	2.57	68.67	5.92	9.80	211.87	5.53	219.81	1.00	4.74	-0.01	9.43	11.77622	1.2	16.8539326	85.71429
4/18/2006 18:49:19.995	11.38	19.65	7.11	7.22	443.12	2.57	68.84	5.94	9.69	60.65	0.00	62.18	1.00	0.00	-0.01	9.32	11.5313	1.17	16.4556962	#DIV/0!
4/18/2006 19:04:20.009	11.39	19.36	7.14	7.23	448.25	2.57	68.85	5.94	9.79	13.12	0.00	13.73	1.00	0.00	-0.01	9.86	11.74402	1.2	16.8067227	#DIV/0!
4/18/2006 19:19:20.053	11.39	19.13	7.11	7.22	438.24	2.57	68.77	5.93	9.83	247.65	5.41	256.58	1.00	4.66	0.00	9.79	11.75936	1.18	16.5963432	86.13678
4/18/2006 19:34:20.087	11.38	19.66	7.12	7.23	445.03	2.57	68.85	5.95	9.73	40.28	0.00	41.50	1.00	0.01	-0.01	9.89	11.48181	1.17	16.4325843	#DIV/0!
4/18/2006 19:49:20.142	11.39	19.30	7.11	7.23	450.37	2.57	68.74	5.94	9.78	11.44	0.00	12.05	1.00	0.00	-0.01	9.83	11.34567	1.17	16.4556962	#DIV/0!
4/18/2006 20:04:20.156	11.38	19.19	7.12	7.23	444.11	2.57	68.67	5.94	9.76	262.30	5.34	272.30	0.97	4.64	-0.01	9.88	11.60393	1.18	16.5730337	86.89139
4/18/2006 20:19:20.190	11.39	19.81	7.11	7.23	449.53	2.58	68.79	5.95	9.69	29.76	0.00	30.82	1.00	0.00	-0.01	9.87	11.26972	1.16	16.3150492	#DIV/0!
4/18/2006 20:34:20.204	11.38	19.43	7.11	7.30	444.65	2.59	68.59	5.92	9.76	10.99	0.00	11.52	1.00	0.00	0.01	9.90	11.68808	1.19	16.7369902	#DIV/0!

4/18/2006 20:49:20.288	11.39	19.39	7.12	7.23	453.80	2.57	68.57	5.94	9.73	276.11	5.37	285.34	1.00	4.63	0.01	9.91	11.35815	1.18	16.5730337	86.21974
4/18/2006 21:04:20.292	11.39	19.93	7.12	7.23	454.95	2.57	68.84	5.96	9.70	24.49	0.00	25.41	1.00	0.00	-0.01	9.81	11.13546	1.16	16.2921348	#DIV/0!
4/18/2006 21:19:20.317	11.38	19.39	7.10	7.23	438.93	2.59	68.36	5.95	9.74	9.92	0.00	10.45	1.00	0.01	0.00	9.88	11.44238	1.15	16.1971831	#DIV/0!
4/18/2006 21:34:20.391	11.38	19.78	7.11	7.23	434.73	2.59	68.53	6.02	9.71	276.95	5.37	286.87	1.00	4.61	0.00	9.90	10.95017	1.09	15.3305204	85.8473
4/18/2006 21:49:20.425	11.38	19.89	7.11	7.23	449.76	2.59	68.36	5.96	9.72	21.13	0.00	22.05	1.00	0.01	0.00	9.90	11.16685	1.15	16.1744023	#DIV/0!
4/18/2006 22:04:20.499	11.38	19.55	7.12	7.23	455.86	2.59	68.22	5.96	9.76	9.08	0.00	9.61	1.00	0.01	0.00	9.72	11.11323	1.16	16.2921348	#DIV/0!
4/18/2006 22:19:20.524	11.38	19.85	7.13	7.23	442.51	2.60	68.22	5.95	9.72	282.06	5.41	291.45	1.00	4.59	-0.01	9.49	11.64589	1.18	16.5497696	84.84288
4/18/2006 22:34:20.608	11.38	19.99	7.11	7.23	450.29	2.59	68.19	5.96	9.68	17.62	0.00	18.46	1.00	0.01	0.01	9.92	11.15371	1.15	16.1744023	#DIV/0!
4/18/2006 22:49:20.622	11.39	19.71	7.10	7.23	456.40	2.60	68.01	5.96	9.72	10.91	0.00	11.52	1.00	0.01	0.00	9.65	10.9087	1.14	16.056338	#DIV/0!
4/18/2006 23:04:20.666	11.38	19.88	7.11	7.24	447.47	2.59	67.83	5.97	9.69	289.01	5.37	298.39	1.00	4.60	-0.01	9.11	11.1264	1.14	16.0337553	85.66108
4/18/2006 23:19:20.680	11.39	20.01	7.10	7.24	456.55	2.59	67.84	5.96	9.69	15.79	0.00	16.48	1.00	0.01	-0.01	9.93	10.90512	1.14	16.056338	#DIV/0!
4/18/2006 23:34:20.704	11.38	19.76	7.10	7.23	455.94	2.62	67.70	5.97	9.72	9.08	0.00	9.61	1.00	0.01	-0.01	9.73	10.82392	1.13	15.915493	#DIV/0!
4/18/2006 23:49:20.719	11.38	20.02	7.09	7.24	446.56	2.59	67.60	5.99	9.68	291.52	5.33	301.06	1.00	4.59	0.00	9.31	10.75788	1.1	15.5148096	86.11632
4/19/2006 00:04:20.753	11.38	20.00	7.11	7.24	454.03	2.60	67.57	5.99	9.66	14.88	0.00	15.72	1.00	0.01	-0.01	9.88	10.77326	1.12	15.7524613	#DIV/0!
4/19/2006 00:19:20.787	11.38	19.70	7.10	7.24	459.14	2.62	67.40	5.98	9.69	7.93	0.00	8.62	1.00	0.01	-0.01	9.97	10.65336	1.12	15.7746479	#DIV/0!
4/19/2006 00:34:20.841	11.38	20.28	7.11	7.24	460.67	2.60	67.41	5.99	9.50	284.50	5.36	294.73	1.00	4.56	0.00	9.92	10.61798	1.12	15.7524613	85.07463
4/19/2006 00:49:20.905	11.38	19.89	7.10	7.24	460.36	2.60	67.28	5.99	9.63	13.58	0.00	14.42	1.00	0.01	-0.01	9.93	10.53026	1.11	15.6338028	#DIV/0!
4/19/2006 01:04:20.970	11.38	19.82	7.10	7.24	453.80	2.62	67.15	5.98	9.70	7.17	0.00	7.78	1.00	0.01	0.00	9.96	10.77872	1.12	15.7746479	#DIV/0!
4/19/2006 01:19:21.024	11.38	20.52	7.11	7.24	456.02	2.62	67.26	6.00	9.48	83.31	0.00	85.37	1.00	0.01	0.01	9.84	10.63048	1.11	15.6118143	#DIV/0!
4/19/2006 01:34:21.048	11.38	20.07	7.10	7.22	462.12	2.60	66.99	5.99	9.60	12.21	0.00	12.89	1.00	0.01	0.01	9.92	10.49016	1.11	15.6338028	#DIV/0!
4/19/2006 01:49:21.062	11.38	19.55	7.12	7.24	450.90	2.62	66.79	6.01	9.63	148.39	0.52	164.72	1.00	4.40	0.00	9.95	10.75119	1.11	15.5898876	846.1538
4/19/2006 02:04:21.136	11.38	20.37	7.10	7.24	462.50	2.62	66.97	5.99	9.56	56.99	0.00	58.82	1.00	0.01	0.00	9.84	10.48154	1.11	15.6338028	#DIV/0!
4/19/2006 02:19:21.191	11.39	19.92	7.11	7.24	455.41	2.62	66.71	5.99	9.54	11.90	0.00	12.66	1.00	0.01	-0.01	9.94	10.74062	1.12	15.7524613	#DIV/0!
4/19/2006 02:34:21.215	11.39	19.66	7.10	7.24	457.08	2.62	66.64	5.99	9.59	222.32	5.39	234.38	0.72	4.63	0.00	9.67	10.60583	1.11	15.6338028	85.89981
4/19/2006 02:49:21.239	11.38	20.43	7.10	7.22	460.59	2.63	66.77	6.00	9.50	45.55	0.00	47.00	1.00	0.01	-0.01	9.38	10.43018	1.1	15.4929577	#DIV/0!
4/19/2006 03:04:21.303	11.39	19.87	7.10	7.24	459.60	2.62	66.50	6.00	9.51	11.22	0.00	11.98	1.00	0.01	-0.01	9.95	10.45265	1.1	15.4929577	#DIV/0!
4/19/2006 03:19:21.357	11.39	19.60	7.11	7.24	460.75	2.62	66.38	5.99	9.55	232.01	5.48	243.76	0.88	4.65	0.00	9.73	10.61614	1.12	15.7524613	84.85401
4/19/2006 03:34:21.402	11.38	20.37	7.10	7.24	458.99	2.63	66.51	6.01	9.48	38.68	0.00	40.05	1.00	0.01	-0.01	9.16	10.37139	1.09	15.3521127	#DIV/0!
4/19/2006 03:49:21.466	11.38	19.86	7.12	7.24	461.05	2.63	66.30	6.01	9.48	10.68	0.00	11.44	1.00	0.01	-0.01	9.12	10.5145	1.11	15.5898876	#DIV/0!
4/19/2006 04:04:21.500	11.38	19.62	7.10	7.24	461.13	2.63	66.21	5.99	9.48	241.25	5.46	251.70	0.75	4.62	0.01	9.37	10.51268	1.11	15.6338028	84.61538
4/19/2006 04:19:21.584	11.39	20.27	7.11	7.24	462.42	2.63	66.32	6.02	9.41	33.19	0.00	34.56	1.00	0.01	0.00	9.95	10.29446	1.09	15.3305204	#DIV/0!
4/19/2006 04:34:21.608	11.38	20.05	7.12	7.24	462.27	2.63	66.22	6.01	9.43	10.76	0.00	11.44	1.00	0.01	-0.01	9.94	10.48675	1.11	15.5898876	#DIV/0!
4/19/2006 04:49:21.633	11.38	19.51	7.12	7.24	461.66	2.62	66.03	6.01	9.43	243.00	5.39	254.22	0.75	4.65	-0.01	9.89	10.50061	1.11	15.5898876	86.27087
4/19/2006 05:04:21.687	11.38	20.25	7.11	7.24	462.58	2.63	66.16	6.01	9.39	33.11	0.00	34.49	1.00	0.01	-0.01	9.98	10.38531	1.1	15.4711674	#DIV/0!
4/19/2006 05:19:21.731	11.39	19.69	7.11	7.23	461.43	2.63	66.03	6.01	9.38	10.38	0.00	11.14	1.00	0.01	-0.01	9.89	10.4112	1.1	15.4711674	#DIV/0!
4/19/2006 05:34:21.745	11.38	19.56	7.11	7.24	460.98	2.63	65.87	6.00	9.35	241.78	5.39	252.23	0.76	4.60	0.00	9.95	10.5161	1.11	15.6118143	85.34323
4/19/2006 05:49:21.779	11.38	20.18	7.11	7.24	463.11	2.65	66.01	6.02	9.34	33.72	0.00	34.94	1.00	0.01	0.00	9.98	10.27912	1.09	15.3305204	#DIV/0!
4/19/2006 06:04:21.814	11.39	19.82	7.11	7.24	462.04	2.63	65.95	6.01	9.33	10.38	0.00	11.06	1.00	0.01	-0.01	9.98	10.39745	1.1	15.4711674	#DIV/0!
4/19/2006 06:19:21.858	11.38	19.45	7.12	7.24	462.42	2.63	65.77	6.00	9.34	238.27	5.34	248.72	0.73	4.64	-0.01	9.97	10.5778	1.12	15.7303371	86.89139
4/19/2006 06:34:21.902	11.38	20.20	7.04	7.56	508.20	2.63	66.00	6.18	9.28	37.16	0.00	38.68	1.00	0.01	-0.01	9.86	7.390564	0.86	12.2159091	#DIV/0!
4/19/2006 06:49:21.946	11.38	19.68	7.11	7.24	464.56	2.63	65.81	6.00	9.30	10.38	0.00	11.14	1.00	0.01	0.01	9.95	10.43506	1.11	15.6118143	#DIV/0!
4/19/2006 07:04:21.980	11.38	19.42	7.11	7.25	464.18	2.63	65.74	6.01	9.30	222.25	5.39	234.30	1.00	4.68	-0.01	9.86	10.34952	1.1	15.4711674	86.82746
4/19/2006 07:19:21.995	11.38	20.10	7.11	7.25	464.87	2.63	65.87	6.01	9.26	40.05	0.00	41.58	1.00	0.01	-0.01	9.99	10.33415	1.1	15.4711674	#DIV/0!
4/19/2006 07:34:22.049	11.38	19.65	7.11	7.24	462.27	2.63	65.78	6.01	9.24	10.76	0.00	11.67	1.00	0.01	-0.01	9.99	10.39228	1.1	15.4711674	#DIV/0!
4/19/2006 07:49:22.093	11.38	19.46	7.10	7.24	462.42	2.65	65.75	6.01	9.24	235.60	5.38	246.81	0.78	4.68	-0.01	9.98	10.29446	1.09	15.3521127	86.96885
4/19/2006 08:04:22.147	11.38	20.27	7.10	7.21	464.18	2.65	66.07	6.02	9.20	37.00	0.00	38.53	1.00	0.01	0.00	9.98	10.16134	1.08	15.2112676	#DIV/0!
4/19/2006 08:19:22.181	11.38	19.75	7.09	7.26	462.58	2.65	65.89	6.01	9.19	11.37	0.00	11.98	1.00	0.01	-0.01	9.97	10.19649	1.08	15.2327221	#DIV/0!
4/19/2006 08:34:22.226	11.38	19.42	7.10	7.24	461.89	2.65	65.96	6.01	9.18	234.30	5.38	244.68	0.80	4.67	0.01	9.94	10.30628	1.09	15.3521127	86.80297
4/19/2006 08:49:22.270	11.38	20.05	7.12	7.24	464.18	2.65	66.15	6.01	9.15	38.45	0.00	39.67	1.00	0.00	-0.01	9.96	10.4436	1.11	15.5898876	#DIV/0!
4/19/2006 09:04:22.314	11.38	19.57	7.11	7.24	462.81	2.65	66.09	6.00	9.16	10.91	0.00	11.60	1.00	0.01	0.00	9.93	10.47452	1.11	15.6118143	#DIV/0!
4/19/2006 09:19:22.398	11.38	19.42	7.03	7.25	528.11	2.67	66.10	5.97	9.17	232.24	5.36	242.24	0.76	4.66	-0.01	9.84	8.765875	1.06	15.0782361	86.9403
4/19/2006 09:34:22.422	11.38	20.05	7.11	7.24	464.18	2.65	66.41	6.00	9.13	36.62	0.00	37.92	1.00	0.01	0.00	9.97	10.4436	1.11	15.6118143	#DIV/0!
4/19/2006 09:49:22.457	11.38	19.50	7.11	7.24	464.26	2.65	66.33	6.00	9.14	10.99	0.00	11.60	1.00	0.00	0.00	9.97	10.4418	1.11	15.6118143	#DIV/0!
4/19/2006 10:04:22.521	11.38	19.43	7.10	7.24	461.20	2.65	66.42	5.99	9.13	236.06	5.36	245.75	0.77	4.66	0.00	9.94	10.51108	1.11	15.6338028	86.9403
4/19/2006 10:19:22.595	11.38	20.25	7.09	7.24	463.95	2.67	66.85	6.00	9.08	39.98	0.00	41.28	1.00	0.00	-0.01	9.57	10.26051	1.09	15.3737659	#DIV/0!
4/19/2006 10:34:22.599	11.39	19.63	7.09	7.23	463.87	2.65	66.67	5.99	9.13	11.14	0.00	11.75	1.00	0.01	-0.01	9.95	10.35643	1.1	15.5148096	#DIV/0!
4/19/2006 10:49:22.663	11.38	19.29	7.10	7.24	461.20	2.65	66.73	5.98	9.13	218.05	5.36	230.03	1.00	4.70	0.00	9.97	10.60578	1.12	15.7746479	87.68657
4/19/2006 11:04:22.688	11.38	19.96	7.10	7.23	464.94	2.65	67.02	5.99	9.13	43.79	0.00	45.09	1.00	0.00	-0.01	9.96	10.42653	1.11	15.6338028	#DIV/0!
4/19/2006 11:19:22.732	11.38	19.61	7.10	7.24	464.56	2.67	67.05	5.98	9.13	11.60	0.00	12.05	1.00	0.00	-0.01	9.79	10.52907	1.12	15.7746479	#DIV/0!
4/19/2006 11:34:22.746	11.39	19.37	7.11	7.23	463.95	2.65	67.14	5.99	9.11	228.52	5.39	236.44	0.82	4.68	0.01	9.40	10.54291	1.12	15.7524613	86.82746
4/19/2006 11:49:22.780	11.38	19.98	7.10	7.23	460.29	2.67	67.46	5.98	9.10	40.28	0.00	41.58	1.00	0.00	0.01	9.95	10.62675	1.12	15.7746479	#DIV/0!
4/19/2006 12:04:22.824	11.38	19.77	7.12	7.23	464.94	2.67	67.51	5.98	9.11	11.60	0.00	12.13	1.00	0.00	-0.01	9.81	10.70833	1.14	16.011236	#DIV/0!
4/19/2006 12:19:22.899	11.39	19.58	7.11	7.24	461.13	2.67	67.60	6.00	9.14	234.30	5.45	244.37	0.85	4.72	-0.01	9.34	10.51268	1.11	15.6118143	86.6055
4/19/2006 12:34:22.933	11.38	20.17	7.11	7.23	465.17	2.65	67.89	5.99	9.12	47.46	0.00	48.75	1.00	0.00	-0.01	9.22	10.51526	1.12	15.7524613	#DIV/0!
4/19/2006 12:49:22.957	11.38	19.76	7.10	7.23	461.66	2.67	67.89	5.97	9.13	11.90	0.00	12.51	1.00	0.00	-0.01	9.90	10.65981	1.13	15.915493	#DIV/0!
4/19/2006 13:04:22.971	11.38	19.77	7.07	7.23	491.49	2.68	68.10	5.76	9.33	234.99	5.35	245.59	0.92	4.71	0.00	9.93	11.64047	1.31	18.5289958	88.03738
4/19/2006 13:19:23.035	11.38	20.17	7.10	7.23	458.08	2.67	68.38	5.86	9.81	42.73	0.00	43.95	1.00	0.00	-0.01	9.94	11.82209	1.24	17.4647887	#DIV/0!
4/19/2006 13:34:23.059	11.38	19.60	7.10	7.52	465.25	2.67	68.35	6.02	10.24	11.83	0.00	12.36	1.00	0.00	-0.01	9.91	10.13797	1.08	15.2112676	#DIV/0!
4/19/2006 13:49:23.144	11.38	19.96	7.09	7.23	495.61	2.68	68.53	5.59	10.41	279.93	5.41	289.54	1.00	4.63	0.00	9.78	13.21798	1.5	21.1565585	85.58226
4/19/2006 14:04:23.188	11.38	20.71	7.10	7.23	461.28	2.68	68.94	5.83	10.53	28.23	0.00	29.14	1.00	0.00	0.00	9.79	12.02411	1.27	17.8873239	#DIV/0!
4/19/2006 14:19:23.252	11.38	20.13	7.10	7.23	455.86	2.68	68.79	5.85	10.75	10.99	0.00	11.67	1.00	0.00	0.01	9.85	11.97546	1.25	17.6056338	#DIV/0!
4/19/2006 14:34:23.306	11.38	20.18	7.10	7.23	456.86	2.68	68.97	5.83	10.72	305.18	5.44	313.80	1.00	4.61	0.01	9.39	12.14044	1.27	17.8873239	84.74265
4/19/2006 14:49:23.331	11.38	20.57	7.10	7.54	458.14	2.68	69.17	5.95	10.73	22.43	0.00	23.27	1.00	0.00	0.01	9.85	10.93872	1.15	16.1971831	#DIV/0!
4/19/2006 15:04:23.405	11.38	20.17	7.10	7.23	461.89	2.68	69.18	5.87	10.84	9.99	0.00	10.53	1.00	0.00	-0.01	9.46	11.63002	1.23	17.3239437	#DIV/0!

4/19/2006 15:19:23.449	11.38	20.79	7.11	7.23	483.48	2.68	69.57	5.72	10.76	319.68	5.43	328.45	1.00	4.63	-0.01	9.35	12.55596	1.39	19.5499297	85.26703
4/19/2006 15:34:23.523	11.38	20.90	7.10	7.23	450.37	2.68	69.64	5.87	10.77	19.68	0.00	20.45	1.00	0.00	0.01	9.89	11.9275	1.23	17.3239437	#DIV/0!
4/19/2006 15:49:23.547	11.38	20.29	7.10	7.23	457.24	2.68	69.54	5.88	10.87	10.76	0.00	11.29	1.00	0.00	-0.01	9.90	11.65278	1.22	17.1830986	#DIV/0!
4/19/2006 16:04:23.652	11.38	21.13	7.09	7.23	460.36	2.70	69.99	5.89	10.73	315.71	5.34	324.86	1.00	4.61	-0.01	9.85	11.38407	1.2	16.9252468	86.32959
4/19/2006 16:19:23.776	11.38	20.90	7.10	7.23	448.23	2.68	69.95	6.00	10.95	16.86	0.00	17.62	1.00	0.00	-0.01	9.87	10.7178	1.1	15.4829577	#DIV/0!
4/19/2006 16:34:23.800	11.38	20.77	7.10	7.23	445.18	2.70	70.02	5.82	11.14	232.85	5.55	242.39	1.00	4.69	0.01	9.81	12.55706	1.28	18.028169	84.5045
4/19/2006 16:49:23.814	11.38	21.43	7.10	7.23	463.11	2.67	70.24	5.81	11.30	100.56	0.00	102.54	1.00	0.00	0.00	9.43	12.1652	1.29	18.1690141	#DIV/0!
4/19/2006 17:04:23.828	11.38	21.29	7.10	7.23	456.17	2.68	70.36	5.82	11.55	14.50	0.00	15.11	1.00	0.00	-0.01	8.92	12.25454	1.28	18.028169	#DIV/0!
4/19/2006 17:19:23.853	11.38	21.16	7.09	7.23	472.80	2.68	70.42	5.65	11.73	284.35	5.39	293.74	1.00	4.66	0.01	8.92	13.30144	1.44	20.3102962	86.4564
4/19/2006 17:34:23.927	11.39	21.96	7.09	7.23	465.25	2.70	70.65	5.67	11.89	52.19	0.00	53.56	1.00	0.00	-0.01	8.93	13.32956	1.42	20.0282087	#DIV/0!
4/19/2006 17:49:24.001	11.39	21.81	7.08	7.23	499.66	2.70	70.76	5.33	12.32	13.66	0.00	14.27	1.00	0.00	0.00	8.92	15.29598	1.75	24.7175141	#DIV/0!
4/19/2006 18:04:24.065	11.38	21.97	7.09	7.23	465.86	2.70	70.88	5.71	12.54	342.34	5.37	351.34	1.00	4.60	-0.01	8.96	12.93712	1.38	19.4640339	85.66108
4/19/2006 18:19:24.090	11.39	22.36	7.09	7.23	461.66	2.70	71.00	5.75	12.77	24.72	0.00	25.48	1.00	0.00	-0.01	8.90	12.67641	1.34	18.889859	#DIV/0!
4/19/2006 18:34:24.134	11.39	22.04	7.09	7.23	452.20	2.71	70.92	5.78	12.96	10.91	0.00	11.37	1.00	0.00	-0.01	8.88	12.65186	1.31	18.4767278	#DIV/0!
4/19/2006 18:49:24.158	11.38	22.75	7.10	7.23	455.48	2.70	71.20	5.77	12.88	352.41	5.38	362.63	1.00	4.52	0.00	9.89	12.75252	1.33	18.7323944	84.01487
4/19/2006 19:04:24.202	11.39	22.46	7.10	7.23	452.89	2.68	70.98	5.79	13.05	18.31	0.00	19.00	1.00	0.00	0.01	9.89	12.63259	1.31	18.4507042	#DIV/0!
4/19/2006 19:19:24.266	11.38	21.84	7.11	7.23	449.15	2.68	70.77	5.80	13.17	9.38	0.00	10.30	1.00	0.00	-0.01	9.86	12.73778	1.31	18.4247539	#DIV/0!
4/19/2006 19:34:24.321	11.38	23.11	7.11	7.22	449.76	2.70	71.17	5.81	13.01	133.44	0.00	135.88	1.00	0.00	-0.01	9.87	12.6234	1.3	18.2841069	#DIV/0!
4/19/2006 19:49:24.395	11.38	22.72	7.10	7.23	444.50	2.70	71.02	5.86	13.15	15.18	0.00	15.64	1.00	0.00	0.00	9.90	12.18327	1.24	17.4647887	#DIV/0!
4/19/2006 20:04:24.469	11.38	22.17	7.08	7.23	459.14	2.70	70.76	5.82	13.17	290.38	5.30	300.30	1.00	4.66	-0.01	9.76	11.98503	1.26	17.7966102	87.92453
4/19/2006 20:19:24.523	11.38	23.17	7.11	7.23	465.02	2.71	71.11	5.82	12.98	59.74	0.00	61.11	1.00	0.00	0.00	9.86	12.11524	1.29	18.1434589	#DIV/0!
4/19/2006 20:34:24.577	11.38	22.57	7.10	7.23	453.04	2.70	70.71	5.84	13.17	13.43	0.00	13.96	1.00	0.00	-0.01	9.90	12.14641	1.26	17.7464789	#DIV/0!
4/19/2006 20:49:24.622	11.38	22.48	7.10	7.23	449.23	2.70	70.65	5.88	13.14	320.97	5.38	330.59	1.00	4.61	-0.01	9.85	11.86055	1.22	17.1830986	85.68773
4/19/2006 21:04:24.656	11.38	23.53	7.10	7.23	458.30	2.71	70.92	5.86	12.96	39.06	0.00	40.44	1.00	0.01	-0.01	9.89	11.81641	1.24	17.4647887	#DIV/0!
4/19/2006 21:19:24.700	11.38	22.68	7.10	7.24	451.74	2.71	70.50	5.84	13.11	12.05	0.00	12.59	1.00	0.00	-0.01	9.84	11.21459	1.16	16.3380282	#DIV/0!
4/19/2006 21:34:24.764	11.38	22.84	7.07	7.23	450.22	2.71	70.47	5.88	13.02	332.11	5.27	342.34	1.00	4.53	0.00	9.65	11.54346	1.19	16.8316832	85.95825
4/19/2006 21:49:24.839	11.38	23.39	7.10	7.23	460.29	2.70	70.51	5.90	12.97	26.17	0.00	27.08	1.00	0.00	-0.01	9.94	11.3858	1.2	16.9014085	#DIV/0!
4/19/2006 22:04:24.853	11.39	22.83	7.10	7.23	457.85	2.70	70.22	5.93	13.10	10.83	0.00	11.37	1.00	0.00	-0.01	9.75	11.16031	1.17	16.4788732	#DIV/0!
4/19/2006 22:19:24.887	11.38	22.75	7.11	7.23	454.34	2.70	70.05	5.94	13.08	336.87	5.36	349.13	1.00	4.52	0.00	9.30	11.24653	1.17	16.4556962	84.32836
4/19/2006 22:34:24.911	11.38	23.29	7.10	7.26	452.43	2.71	70.10	5.98	12.95	22.89	0.00	23.80	1.00	0.00	0.00	9.94	10.81136	1.12	15.7746479	#DIV/0!
4/19/2006 22:49:24.955	11.38	22.73	7.09	7.23	440.30	2.71	69.83	5.93	13.03	10.15	0.00	10.68	1.00	0.01	0.00	9.81	11.50587	1.16	16.3610719	#DIV/0!
4/19/2006 23:04:24.989	11.38	22.98	7.09	7.23	454.03	2.70	69.75	5.91	12.87	343.79	5.44	354.09	1.00	4.52	0.00	9.54	11.3504	1.18	16.6431594	83.08824
4/19/2006 23:19:25.004	11.38	23.45	7.07	7.22	476.23	2.71	69.84	5.79	12.84	20.83	0.00	21.74	1.00	0.01	-0.01	9.84	11.73835	1.28	18.1046676	#DIV/0!
4/19/2006 23:34:25.058	11.38	22.90	7.07	7.23	447.39	2.71	69.58	5.92	12.92	11.06	0.00	11.75	1.00	0.00	-0.01	9.97	11.22601	1.15	16.2859123	#DIV/0!
4/19/2006 23:49:25.122	11.39	23.22	7.10	7.23	449.07	2.71	69.49	5.90	12.76	356.68	5.34	366.29	1.00	4.54	-0.01	10.00	11.67027	1.2	16.9014085	85.01873
4/20/2006 00:04:25.166	11.39	23.32	7.10	7.23	459.45	2.71	69.40	5.93	12.75	18.39	0.00	19.15	1.00	0.01	0.00	9.98	11.12145	1.17	16.4788732	#DIV/0!
4/20/2006 00:19:25.210	11.39	22.80	7.10	7.23	461.51	2.71	69.18	5.87	12.84	9.46	0.00	9.99	1.00	0.00	-0.01	10.00	11.63959	1.23	17.3239437	#DIV/0!
4/20/2006 00:34:25.225	11.38	23.61	7.08	7.23	467.15	2.71	69.34	5.88	12.65	340.58	5.36	351.19	1.00	4.48	-0.01	10.00	11.2186	1.2	16.9491525	83.58209
4/20/2006 00:49:25.279	11.38	23.39	7.10	7.23	478.60	2.71	69.18	5.83	12.65	15.56	0.00	16.33	1.00	0.01	0.01	9.99	11.58897	1.27	17.8873239	#DIV/0!
4/20/2006 01:04:25.313	11.39	22.51	7.12	7.23	465.17	2.71	68.71	5.89	12.73	8.24	0.00	8.70	1.00	0.00	-0.01	9.95	11.54801	1.23	17.2752809	#DIV/0!
4/20/2006 01:19:25.377	11.39	23.42	7.10	7.20	469.44	2.71	68.97	5.87	12.54	151.60	0.00	153.69	1.00	0.01	0.00	9.97	11.44297	1.23	17.3239437	#DIV/0!
4/20/2006 01:34:25.431	11.38	23.39	7.09	7.23	465.17	2.71	68.94	5.92	12.55	13.89	0.00	14.65	1.00	0.01	-0.01	8.90	10.98469	1.17	16.5021157	#DIV/0!
4/20/2006 01:49:25.476	11.38	22.71	7.10	7.25	485.55	2.72	68.62	5.93	12.63	215.69	5.13	225.99	1.00	4.61	-0.01	9.96	10.97573	1.17	16.4788732	89.86355
4/20/2006 02:04:25.540	11.38	23.51	7.10	7.23	464.87	2.71	68.71	5.93	12.48	77.36	0.00	79.42	1.00	0.01	-0.01	9.96	10.99178	1.17	16.4788732	#DIV/0!
4/20/2006 02:19:25.574	11.38	23.13	7.09	7.23	468.99	2.71	68.57	5.91	12.54	13.20	0.00	13.81	1.00	0.00	0.00	9.95	10.98834	1.18	16.6431594	#DIV/0!
4/20/2006 02:34:25.608	11.39	22.61	7.08	7.23	463.87	2.72	68.30	5.91	12.53	270.08	5.33	281.07	1.00	4.63	-0.01	9.96	11.01548	1.17	16.5254237	86.86679
4/20/2006 02:49:25.632	11.39	23.48	7.03	7.23	755.09	2.71	68.51	3.19	12.35	54.32	0.00	55.92	1.00	0.01	-0.01	9.96	22.20988	3.84	54.6230441	#DIV/0!
4/20/2006 03:04:25.687	11.38	23.03	7.10	7.23	472.11	2.72	68.38	5.90	12.42	12.21	0.00	13.05	1.00	0.00	0.00	9.94	11.10074	1.2	16.9014085	#DIV/0!
4/20/2006 03:19:25.731	11.39	22.51	7.09	7.23	466.85	2.72	68.10	5.92	12.41	292.52	5.29	302.05	1.00	4.56	-0.01	9.92	10.94516	1.17	16.5021157	86.20038
4/20/2006 03:34:25.795	11.39	23.42	7.10	7.23	478.98	2.71	68.36	5.88	12.24	41.28	0.00	42.57	1.00	0.01	-0.01	9.84	11.12388	1.22	17.1830986	#DIV/0!
4/20/2006 03:49:25.849	11.38	22.77	7.09	7.23	475.17	2.73	67.98	5.89	12.30	11.60	0.00	12.28	1.00	0.00	0.01	9.79	11.02925	1.2	16.9252468	#DIV/0!
4/20/2006 04:04:25.893	11.39	22.49	7.11	7.23	469.06	2.73	67.90	5.92	12.28	306.55	5.34	317.24	1.00	4.56	-0.01	9.47	11.07981	1.19	16.7369902	85.39326
4/20/2006 04:19:25.948	11.38	23.23	7.10	7.22	469.29	2.72	68.02	5.94	12.11	31.28	0.00	32.58	1.00	0.01	0.00	9.91	10.79519	1.16	16.3380282	#DIV/0!
4/20/2006 04:34:26.002	11.39	22.64	7.11	7.25	468.83	2.72	67.81	5.93	12.23	10.83	0.00	11.44	1.00	0.01	-0.01	9.71	10.99209	1.18	16.5963432	#DIV/0!
4/20/2006 04:49:26.076	11.38	22.52	7.09	7.23	468.07	2.72	67.80	5.93	12.19	308.77	5.34	319.60	1.00	4.52	-0.01	9.35	10.82333	1.16	16.3610719	84.64419
4/20/2006 05:04:26.110	11.38	23.25	7.09	7.24	471.05	2.73	67.87	5.94	12.06	27.24	0.00	28.46	1.00	0.01	-0.01	9.92	10.66215	1.15	16.2200282	#DIV/0!
4/20/2006 05:19:26.225	11.39	22.48	7.09	7.24	472.11	2.73	67.63	5.91	12.14	10.61	0.00	11.22	1.00	0.01	-0.01	9.92	10.91573	1.18	16.6431594	#DIV/0!
4/20/2006 05:34:26.299	11.38	22.47	7.10	7.24	468.68	2.72	67.55	5.93	12.09	317.62	5.31	328.53	1.00	4.54	0.00	9.97	10.90243	1.17	16.4788732	85.49806
4/20/2006 05:49:26.353	11.39	23.13	7.10	7.23	470.44	2.74	67.60	5.95	11.98	24.95	0.00	26.02	1.00	0.01	-0.01	9.96	10.67597	1.15	16.1971831	#DIV/0!
4/20/2006 06:04:26.377	11.38	22.47	7.08	7.23	468.99	2.72	67.41	5.92	12.05	10.22	0.00	10.83	1.00	0.01	-0.01	9.97	10.8021	1.16	16.3841808	#DIV/0!
4/20/2006 06:19:26.431	11.39	22.56	7.08	7.24	469.29	2.73	67.35	5.93	11.96	313.04	5.32	324.25	1.00	4.49	0.00	9.97	10.70213	1.15	16.2429379	84.3985
4/20/2006 06:34:26.486	11.38	22.93	7.10	7.24	471.12	2.73	67.38	5.97	11.91	23.04	0.00	24.19	1.00	0.01	0.00	9.96	10.47516	1.13	15.915493	#DIV/0!
4/20/2006 06:49:26.550	11.39	22.40	7.08	7.24	477.15	2.73	67.25	5.91	11.95	9.46	0.00	10.07	1.00	0.01	-0.01	9.64	10.7089	1.17	16.5254237	#DIV/0!
4/20/2006 07:04:26.594	11.38	22.34	7.09	7.24	465.55	2.73	67.19	5.97	11.89	314.18	5.31	324.64	1.00	4.52	0.00	9.46	10.50668	1.12	15.796897	85.12241
4/20/2006 07:19:26.598	11.38	22.95	7.09	7.24	475.17	2.74	67.26	5.93	11.80	20.60	0.00	21.59	1.00	0.01	0.00	9.97	10.66161	1.16	16.3610719	#DIV/0!
4/20/2006 07:34:26.622	11.38	22.15	7.09	7.24	475.70	2.73	67.09	5.89	11.86	9.38	0.00	9.99	1.00	0.01	-0.01	9.97	11.01696	1.2	16.9252468	#DIV/0!
4/20/2006 07:49:26.677	11.38	22.51	7.11	7.24	468.09	2.73	67.25	5.98	11.75	317.77	5.28	327.99	1.00	4.48	-0.01	9.96	10.58821	1.13	15.8931083	84.84848
4/20/2006 08:04:26.881	11.38	22.90	7.09	7.23	473.18	2.75	67.32	5.95	11.72	20.83	0.00	21.74	1.00	0.00	0.01	9.91	10.52185	1.14	16.0789845	#DIV/0!
4/20/2006 08:19:26.885	11.39	22.14	7.08	7.24	473.72	2.75	67.19	5.92	11.77	9.31	0.00	9.92	1.00	0.01	0.00	9.95	10.69424	1.16	16.3841808	#DIV/0!
4/20/2006 08:34:26.909	11.38	22.40	7.10	7.23	472.50	2.73	67.34	5.94	11.83	323.87	5.33	334.02	1.00	4.56	0.00	9.96	10.72186	1.16	16.3380282	85.55347
4/20/2006 08:49:26.934	11.38	22.84	7.09	7.23	473.72	2.76	67.54	5.93	11.58	19.00	0.00	19.91	1.00	0.01	-0.01	9.94	10.69424	1.16	16.3610719	#DIV/0!
4/20/2006 09:04:26.988	11.38	22.04	7.10	7.23	472.11	2.73	67.37	5.93	11.63	9.00	0.00	9.61	1.00	0.00	-0.01	9.95	10.82322	1.17	16.4788732	#DIV/0!
4/20/2006 09:19:27.062	11.39	22.32	7.09	7.23	472.50	2.73	67.57	5.92	11.52	330.28	5.22	339.51	1.00	4.56	-0.01	9.88	10.81429	1.17	16.5021157	87.35632
4/20/2006 09:34:27.086	11.38	22.54	7.09	7.24	463.04	2.74	67.72	6.00	11.49	18.23	0.00	19.00	1.00	0.00	-0.01	9.95	10.28068	1.09	15.3737659	#DIV/0!

4/20/2006 09:49:27.130	11.39	21.99	7.10	7.23	469.83	2.74	67.61	5.92	11.58	10.68	0.00	11.29	1.00	0.00	0.00	9.96	10.9687	1.18	16.6197183	#DIV/0!
4/20/2006 10:04:27.155	11.39	22.42	7.05	7.23	466.93	2.74	67.83	5.93	11.46	324.48	5.29	333.79	1.00	4.55	-0.01	9.94	10.47563	1.12	15.8865248	86.01134
4/20/2006 10:19:27.199	11.38	22.65	7.09	7.24	471.81	2.75	68.02	5.94	11.45	16.78	0.00	17.47	1.00	0.00	-0.01	9.90	10.64497	1.15	16.2200282	#DIV/0!
4/20/2006 10:34:27.223	11.38	21.84	7.09	7.23	470.21	2.74	67.83	5.92	11.49	9.46	0.00	9.99	1.00	0.00	0.00	9.96	10.86695	1.17	16.5021157	#DIV/0!
4/20/2006 10:49:27.237	11.38	22.57	7.09	7.23	470.36	2.74	68.19	5.93	11.39	325.93	5.29	335.93	1.00	4.55	0.00	9.97	10.77064	1.16	16.3610719	86.01134
4/20/2006 11:04:27.291	11.38	22.27	7.10	7.23	472.50	2.74	68.22	5.94	11.41	15.56	0.00	16.33	1.00	0.00	0.01	9.96	10.72186	1.16	16.3380282	#DIV/0!
4/20/2006 11:19:27.315	11.38	22.05	7.09	7.23	471.12	2.76	68.33	5.92	11.45	8.47	0.00	9.00	1.00	0.00	-0.01	9.94	10.84596	1.17	16.5021157	#DIV/0!
4/20/2006 11:34:27.360	11.38	22.47	7.07	7.23	470.44	2.74	68.59	5.92	11.34	328.37	5.32	338.29	1.00	4.56	-0.01	9.63	10.67597	1.15	16.2659123	85.71429
4/20/2006 11:49:27.404	11.38	22.35	7.09	7.23	454.95	2.75	68.65	5.97	11.43	15.18	0.00	15.87	1.00	0.00	0.00	9.31	10.75148	1.12	15.796897	#DIV/0!
4/20/2006 12:04:27.438	11.38	22.02	7.07	7.56	475.09	2.75	68.70	5.91	11.43	8.93	0.00	9.84	1.00	0.00	-0.01	9.68	10.6634	1.16	16.407355	#DIV/0!
4/20/2006 12:19:27.492	11.38	22.99	7.10	7.23	474.48	2.75	69.20	5.80	11.56	107.04	0.00	109.03	1.00	0.00	-0.01	9.95	11.96573	1.3	18.3098592	#DIV/0!
4/20/2006 12:34:27.496	11.38	22.33	7.07	7.23	499.73	2.75	69.09	5.80	12.12	14.34	0.00	15.03	1.00	0.00	0.01	9.89	12.84682	1.47	20.7920792	#DIV/0!
4/20/2006 12:49:27.531	11.39	22.10	7.08	7.23	483.33	2.76	69.14	5.73	12.36	290.38	5.30	300.07	1.00	4.58	0.00	9.53	12.19843	1.35	19.0677966	86.41509
4/20/2006 13:04:27.555	11.38	23.14	7.11	7.23	475.93	2.77	69.67	5.81	12.55	41.81	0.00	43.03	1.00	0.00	-0.01	9.40	11.92928	1.3	18.2841069	#DIV/0!
4/20/2006 13:19:27.559	11.38	22.32	7.08	7.23	476.46	2.76	69.43	5.78	12.80	12.66	0.00	13.12	1.00	0.00	0.01	9.93	11.91601	1.3	18.3615819	#DIV/0!
4/20/2006 13:34:27.613	11.38	22.26	7.09	7.23	474.02	2.75	69.64	5.79	12.75	326.92	5.40	337.15	1.00	4.55	0.00	9.88	11.97734	1.3	18.3356841	84.25926
4/20/2006 13:49:27.637	11.38	23.02	7.10	7.23	473.64	2.75	70.01	5.83	12.71	30.52	0.00	31.59	1.00	0.00	-0.01	9.91	11.71033	1.27	17.8873239	#DIV/0!
4/20/2006 14:04:27.681	11.38	22.48	7.07	7.23	483.18	2.77	69.89	5.73	12.91	11.90	0.00	12.36	1.00	0.00	0.00	9.77	12.11183	1.34	18.9533239	#DIV/0!
4/20/2006 14:19:27.716	11.38	22.47	7.07	7.23	472.88	2.75	70.10	5.81	12.80	339.74	5.30	349.36	1.00	4.58	0.01	9.44	11.6368	1.26	17.8217822	86.41509
4/20/2006 14:34:27.730	11.38	23.22	7.08	7.23	480.20	2.77	70.36	5.83	12.77	27.77	0.00	28.61	1.00	0.00	-0.01	9.89	11.36846	1.25	17.6553672	#DIV/0!
4/20/2006 14:49:27.734	11.38	22.51	7.09	7.23	491.04	2.76	70.24	5.63	12.87	11.37	0.00	11.83	1.00	0.00	-0.01	9.91	12.98523	1.46	20.5923836	#DIV/0!
4/20/2006 15:04:27.778	11.38	23.28	7.07	7.23	475.24	2.77	70.76	5.75	12.90	362.71	5.33	371.48	1.00	4.57	-0.01	9.87	12.13039	1.32	18.6704385	85.74109
4/20/2006 15:19:27.782	11.38	23.52	7.07	7.23	525.98	2.77	70.95	5.44	13.31	22.35	0.00	23.04	1.00	0.00	-0.01	9.81	13.53419	1.63	23.0551627	#DIV/0!
4/20/2006 15:34:27.786	11.38	23.00	7.08	7.23	475.24	2.76	70.73	5.75	13.50	11.14	0.00	11.60	1.00	0.00	0.00	9.87	12.22229	1.33	18.7853107	#DIV/0!
4/20/2006 15:49:27.881	11.39	24.06	7.10	7.23	465.71	2.77	71.20	5.81	13.46	137.48	0.00	139.85	1.00	0.00	-0.01	9.78	12.09729	1.29	18.1690141	#DIV/0!
4/20/2006 16:04:27.945	11.39	22.23	7.10	7.23	482.80	2.71	70.53	5.63	13.82	16.25	0.00	16.86	1.00	0.00	-0.01	9.79	13.29731	1.47	20.7042254	#DIV/0!
4/20/2006 16:19:27.999	11.39	16.65	7.11	7.24	453.57	2.37	67.48	5.68	13.90	325.02	5.22	334.94	1.00	4.52	-0.01	9.78	13.7891	1.43	20.1125176	86.58004
4/20/2006 16:34:28.033	11.39	15.03	7.14	7.24	448.54	1.64	66.15	5.68	11.74	46.54	0.00	47.76	1.00	0.00	-0.01	9.78	14.21561	1.46	20.4481793	#DIV/0!
4/20/2006 16:49:28.078	11.38	12.43	2.70	7.25	488.06	1.08	65.09	0.00	11.14	12.74	0.00	13.28	1.00	0.00	0.00	9.78	24.16041	2.7	100	#DIV/0!
4/20/2006 17:04:28.122	11.38	11.76	0.00	7.25	5.87	0.96	64.88	0.00	11.16	7.25	0.00	7.63	1.00	0.00	0.00	10.03	0	0	#DIV/0!	#DIV/0!
4/20/2006 17:19:28.166	11.39	11.80	0.00	7.25	3.13	0.97	65.05	0.00	11.16	5.34	0.00	5.49	0.01	0.00	-0.01	10.06	0	0	#DIV/0!	#DIV/0!

Date	Time	Militim	Transl	TagName	TagValue	T	ThreshVal	T	ThreshLabl	S	D	UserId	A	Dscription
4/12/2006	15:07:26	989	InAlm	DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/12/2006 3:07:26 PM - SYSTEM FAULT
4/12/2006	15:07:26	9	InAlm	DERIVED ALARM\NF STAT 47	1.0000000000	D	0.0000000000	0		1	Y		1	4/12/2006 3:07:26 PM - NF FEED PRESSURE LOW
4/12/2006	15:10:56	541	RmAcl	DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/12/2006 3:10:56 PM Ack - SYSTEM FAULT
4/12/2006	15:10:56	561	RmAcl	DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		6	4/12/2006 3:10:56 PM Ack - NF FEED PRESSURE LOW
4/12/2006	15:10:56	821	OutAl	DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/12/2006 3:10:56 PM OutAl - SYSTEM FAULT
4/12/2006	15:10:57	873	OutAl	DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		2	4/12/2006 3:10:57 PM OutAl - NF FEED PRESSURE LOW
4/12/2006	19:43:56	324	InAlm	DERIVED ALARM\HYD STAT 110	1.0000000000	D	0.0000000000	0		1	Y		1	4/12/2006 7:43:56 PM - INPUT ERROR - CHECK TIMINGS
4/12/2006	19:44:17	184	OutAl	DERIVED ALARM\HYD STAT 110	0.0000000000	D	0.0000000000	0		0	Y		2	4/12/2006 7:44:17 PM OutAl - INPUT ERROR - CHECK TIMINGS
4/12/2006	19:44:22	381	InAlm	DERIVED ALARM\HYD STAT 110	1.0000000000	D	0.0000000000	0		1	Y		1	4/12/2006 7:44:22 PM - INPUT ERROR - CHECK TIMINGS
4/12/2006	19:45:41	295	OutAl	DERIVED ALARM\HYD STAT 110	0.0000000000	D	0.0000000000	0		0	Y		2	4/12/2006 7:45:41 PM OutAl - INPUT ERROR - CHECK TIMINGS

Date	Time	Militim	Trans	T	TagName	TagValue	T	ThreshVal	T	ThreshLabl	S	D	UserId	A	Description
4/11/2006	17:29:21	866	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 5:29:21 PM OutAl - SYSTEM FAULT
4/11/2006	17:29:21	876	OutAl		DERIVED ALARM\NF STAT 13	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 5:29:21 PM OutAl - NF FEED PUMP RUN FAULT
4/11/2006	17:31:01	620	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 5:31:01 PM - SYSTEM FAULT
4/11/2006	17:31:01	650	InAlm		DERIVED ALARM\NF STAT 47	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 5:31:01 PM - NF FEED PRESSURE LOW
4/11/2006	17:34:24	101	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 5:34:24 PM Ack - SYSTEM FAULT
4/11/2006	17:34:24	171	RmAc		DERIVED ALARM\NF STAT 97	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 5:34:24 PM Ack - NF FEED TANK TSS LOW LIMIT
4/11/2006	17:34:24	191	RmAc		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 5:34:24 PM Ack - NF FEED PRESSURE LOW
4/11/2006	17:34:24	211	RmAc		DERIVED ALARM\NF STAT 13	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 5:34:24 PM Ack - NF FEED PUMP RUN FAULT
4/11/2006	17:34:24	231	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 5:34:24 PM OutAl - SYSTEM FAULT
4/11/2006	17:34:24	251	OutAl		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 5:34:24 PM OutAl - NF FEED PRESSURE LOW
4/11/2006	17:36:05	887	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 5:36:05 PM - SYSTEM FAULT
4/11/2006	17:36:05	917	InAlm		DERIVED ALARM\NF STAT 47	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 5:36:05 PM - NF FEED PRESSURE LOW
4/11/2006	17:39:08	10	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 5:39:08 PM Ack - SYSTEM FAULT
4/11/2006	17:39:08	30	RmAc		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 5:39:08 PM Ack - NF FEED PRESSURE LOW
4/11/2006	17:39:09	842	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 5:39:09 PM OutAl - SYSTEM FAULT
4/11/2006	17:39:10	893	OutAl		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 5:39:10 PM OutAl - NF FEED PRESSURE LOW
4/11/2006	18:51:36	842	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 6:51:36 PM - SYSTEM FAULT
4/11/2006	18:51:36	862	InAlm		DERIVED ALARM\NF STAT 94	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 6:51:36 PM - SLURRY PUMP NOT STARTED AFTER NF FEED PUMP STARTED
4/11/2006	18:53:07	733	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 6:53:07 PM Ack - SYSTEM FAULT
4/11/2006	18:53:07	753	RmAc		DERIVED ALARM\NF STAT 94	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 6:53:07 PM Ack - SLURRY PUMP NOT STARTED AFTER NF FEED PUMP STARTED
4/11/2006	18:53:08	184	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 6:53:08 PM OutAl - SYSTEM FAULT
4/11/2006	18:53:08	204	OutAl		DERIVED ALARM\NF STAT 94	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 6:53:08 PM OutAl - SLURRY PUMP NOT STARTED AFTER NF FEED PUMP STARTED
4/11/2006	18:55:11	671	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 6:55:11 PM - SYSTEM FAULT
4/11/2006	18:55:11	701	InAlm		DERIVED ALARM\NF STAT 94	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 6:55:11 PM - SLURRY PUMP NOT STARTED AFTER NF FEED PUMP STARTED
4/11/2006	19:05:37	671	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:05:37 PM Ack - SYSTEM FAULT
4/11/2006	19:05:37	691	RmAc		DERIVED ALARM\NF STAT 94	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:05:37 PM Ack - SLURRY PUMP NOT STARTED AFTER NF FEED PUMP STARTED
4/11/2006	19:05:38	523	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:05:38 PM OutAl - SYSTEM FAULT
4/11/2006	19:05:38	543	OutAl		DERIVED ALARM\NF STAT 94	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:05:38 PM OutAl - SLURRY PUMP NOT STARTED AFTER NF FEED PUMP STARTED
4/11/2006	19:12:08	273	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 7:12:08 PM - SYSTEM FAULT
4/11/2006	19:13:06	627	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:13:06 PM Ack - SYSTEM FAULT
4/11/2006	19:13:07	438	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:13:07 PM OutAl - SYSTEM FAULT
4/11/2006	19:17:05	270	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 7:17:05 PM - SYSTEM FAULT
4/11/2006	19:17:06	322	InAlm		DERIVED ALARM\NF STAT 47	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 7:17:06 PM - NF FEED PRESSURE LOW
4/11/2006	19:19:12	603	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:19:12 PM Ack - SYSTEM FAULT
4/11/2006	19:19:12	623	RmAc		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:19:12 PM Ack - NF FEED PRESSURE LOW
4/11/2006	19:19:12	773	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:19:12 PM OutAl - SYSTEM FAULT
4/11/2006	19:19:12	793	OutAl		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:19:12 PM OutAl - NF FEED PRESSURE LOW
4/11/2006	19:20:54	560	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 7:20:54 PM - SYSTEM FAULT
4/11/2006	19:20:54	580	InAlm		DERIVED ALARM\NF STAT 47	1.0000000000	D	0.0000000000	0		1	Y		1	4/11/2006 7:20:54 PM - NF FEED PRESSURE LOW
4/11/2006	19:23:22	593	RmAc		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:23:22 PM Ack - SYSTEM FAULT
4/11/2006	19:23:22	603	RmAc		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		6	4/11/2006 7:23:22 PM Ack - NF FEED PRESSURE LOW
4/11/2006	19:23:23	13	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:23:23 PM OutAl - SYSTEM FAULT
4/11/2006	19:23:23	33	OutAl		DERIVED ALARM\NF STAT 47	0.0000000000	D	0.0000000000	0		0	Y		2	4/11/2006 7:23:23 PM OutAl - NF FEED PRESSURE LOW

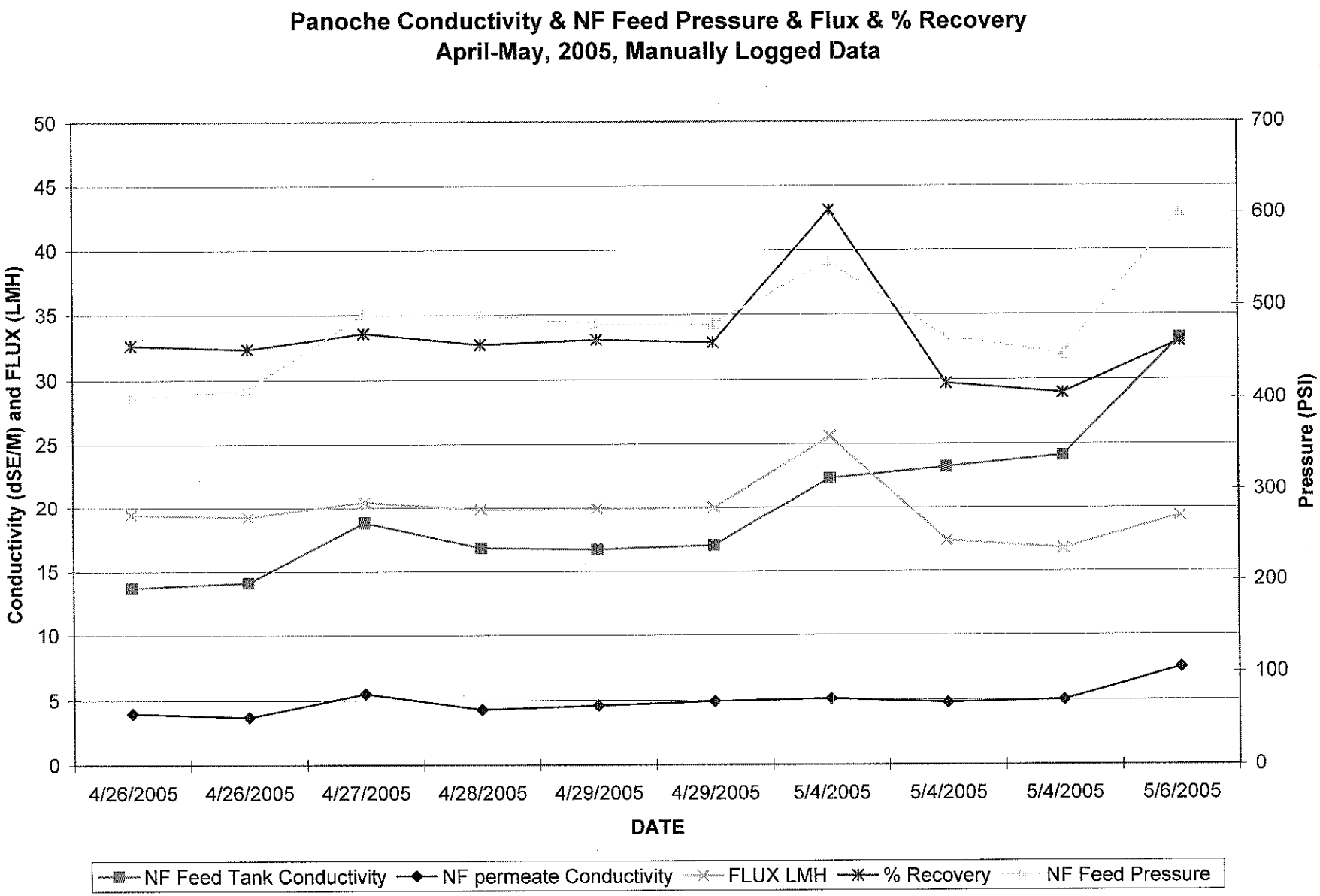
Date	Time	Militim	Trans	T	TagName	TagValue	T	ThreshVal	T	ThreshLabl	S	D	UserId	A	Description
4/13/2006	03:35:56	466	InAlm		DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 3:35:56 AM - SYSTEM FAULT
4/13/2006	03:35:57	458	InAlm		DERIVED ALARM\NF STAT 13	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 3:35:57 AM - NF FEED PUMP RUN FAULT
4/13/2006	11:29:56	80	OutAl		DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y		2	4/13/2006 11:29:56 AM OutAl - SYSTEM FAULT
4/13/2006	11:29:56	100	OutAl		DERIVED ALARM\NF STAT 13	0.0000000000	D	0.0000000000	0		0	Y		2	4/13/2006 11:29:56 AM OutAl - NF FEED PUMP RUN FAULT
4/13/2006	18:49:00	752	InAlm		DERIVED ALARM\DTANK STAT 97	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 6:49:00 PM - D-TANK TSS LOW LEVEL
4/13/2006	20:31:58	535	InAlm		DERIVED ALARM\RO TANK STAT 27	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 8:31:58 PM - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:00	628	OutAl		DERIVED ALARM\RO TANK STAT 27	0.0000000000	D	0.0000000000	0		0	Y		2	4/13/2006 8:32:00 PM OutAl - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:01	679	InAlm		DERIVED ALARM\RO TANK STAT 27	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 8:32:01 PM - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:02	731	OutAl		DERIVED ALARM\RO TANK STAT 27	0.0000000000	D	0.0000000000	0		0	Y		2	4/13/2006 8:32:02 PM OutAl - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:03	782	InAlm		DERIVED ALARM\RO TANK STAT 27	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 8:32:03 PM - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:05	825	OutAl		DERIVED ALARM\RO TANK STAT 27	0.0000000000	D	0.0000000000	0		0	Y		2	4/13/2006 8:32:05 PM OutAl - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:06	817	InAlm		DERIVED ALARM\RO TANK STAT 27	1.0000000000	D	0.0000000000	0		1	Y		1	4/13/2006 8:32:06 PM - RO REJECT TANK LOW LEVEL WARNING
4/13/2006	20:32:08	920	OutAl		DERIVED ALARM\RO TANK STAT 27	0.0000000000	D	0.0000000000	0		0	Y		2	4/13/2006 8:32:08 PM OutAl - RO REJECT TANK LOW LEVEL WARNING

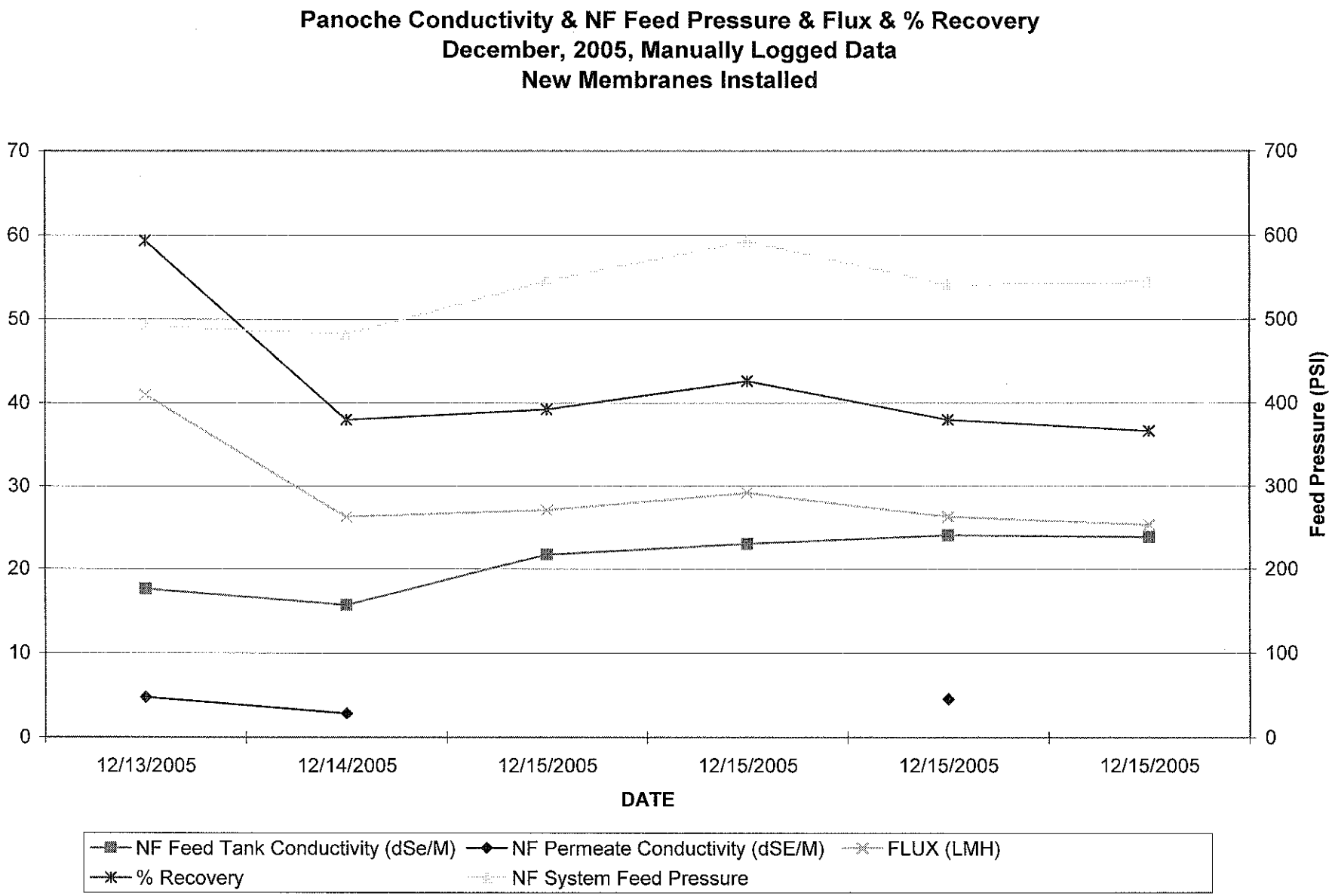
Date	Time	Militim	Transl	TagName	TagValue	T	ThreshVal	T	ThreshLabl	S	D	UserId	A	Description
4/17/2006	06:55:35	219	Acked	DERIVED_ALARM\RO_TANK_STAT_27	0.0000000000	D	0.0000000000	0		0	Y		5	4/17/2006 6:55:35 AM Ack - RO REJECT TANK LOW LEVEL WARNING
4/17/2006	06:55:35	739	Acked	DERIVED_ALARM\DTANK_STAT_97	0.0000000000	D	0.0000000000	0		0	Y		5	4/17/2006 6:55:35 AM Ack - D-TANK TSS LOW LEVEL

Date	Time	Millim	Trans1	TagName					TagValue	T	ThreshVal	T	ThreshLabl	S	D	UserId	A	Dscription
4/19/2006	16:09:35	630	InAlm	DERIVED	ALARM\NF	STAT	45		1.0000000000	D	0.0000000000	0		1	Y	1	1	4/19/2006 4:09:35 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM
4/19/2006	16:09:36	592	OutAl	DERIVED	ALARM\NF	STAT	45		0.0000000000	D	0.0000000000	0		0	Y	2	4/19/2006 4:09:36 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/19/2006	17:08:14	881	InAlm	DERIVED	ALARM\NF	STAT	45		1.0000000000	D	0.0000000000	0		1	Y	1	1	4/19/2006 5:08:14 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM
4/19/2006	17:08:15	932	OutAl	DERIVED	ALARM\NF	STAT	45		0.0000000000	D	0.0000000000	0		0	Y	2	4/19/2006 5:08:15 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	

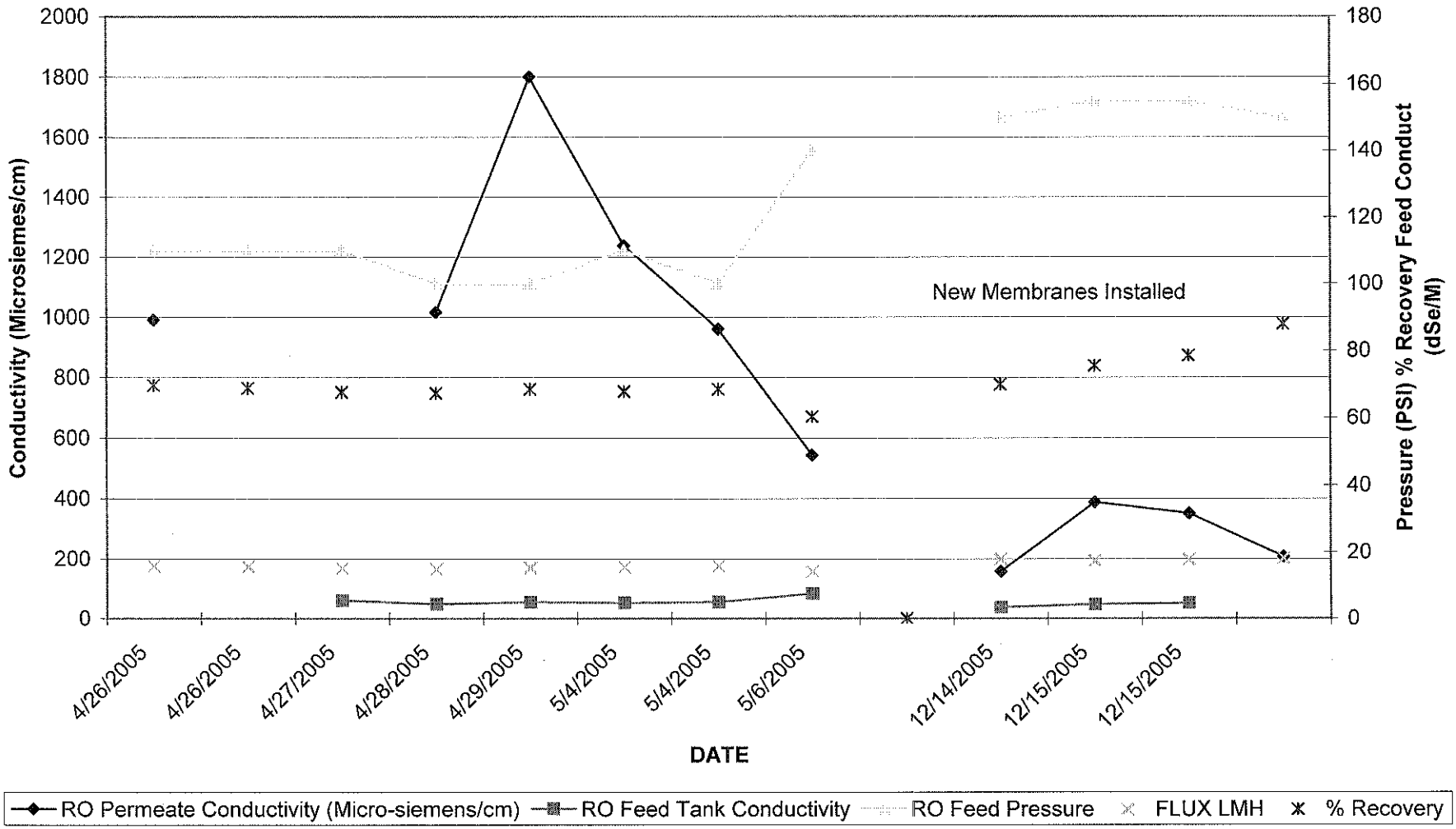
Date	Time	Militim	Transl	TagName	TagValue	T	ThreshVal	T	ThreshLabl	S	D	Userid	A	Dscription
4/20/2006	16:38:51	562	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:38:51 PM - SYSTEM FAULT	
4/20/2006	16:38:51	632	InAlm	DERIVED ALARMNF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:38:51 PM - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:39:02	929	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:39:02 PM OutAl - SYSTEM FAULT	
4/20/2006	16:39:02	949	OutAl	DERIVED ALARMNF STAT 97	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:39:02 PM OutAl - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:40:12	208	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:40:12 PM - SYSTEM FAULT	
4/20/2006	16:40:12	228	InAlm	DERIVED ALARMNF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:40:12 PM - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:40:23	645	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:40:23 PM OutAl - SYSTEM FAULT	
4/20/2006	16:40:24	716	OutAl	DERIVED ALARMNF STAT 97	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:40:24 PM OutAl - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:41:57	0	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:41:57 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:41:58	992	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:41:58 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:42:10	258	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:42:10 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:42:11	310	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:42:11 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:42:21	745	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:42:21 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:42:22	796	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:42:22 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:44:19	985	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:44:19 PM - SYSTEM FAULT	
4/20/2006	16:44:21	36	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:44:21 PM OutAl - SYSTEM FAULT	
4/20/2006	16:45:06	792	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:45:06 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:45:07	843	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:45:07 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:45:42	73	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:45:42 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:45:43	124	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:45:43 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:46:04	875	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:46:04 PM - SYSTEM FAULT	
4/20/2006	16:46:05	927	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:46:05 PM OutAl - SYSTEM FAULT	
4/20/2006	16:46:40	316	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:46:40 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:46:41	368	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:46:41 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:47:26	32	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:47:26 PM - SYSTEM FAULT	
4/20/2006	16:47:27	84	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:47:27 PM OutAl - SYSTEM FAULT	
4/20/2006	16:48:57	544	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:48:57 PM - SYSTEM FAULT	
4/20/2006	16:48:58	545	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:48:58 PM OutAl - SYSTEM FAULT	
4/20/2006	16:49:44	371	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:49:44 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:49:45	412	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:49:45 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:50:41	383	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:50:41 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:50:42	434	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:50:42 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:51:14	561	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:51:14 PM - SYSTEM FAULT	
4/20/2006	16:51:15	612	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:51:15 PM OutAl - SYSTEM FAULT	
4/20/2006	16:52:57	449	InAlm	DERIVED ALARMNF STAT 45	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:52:57 PM - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:52:58	500	OutAl	DERIVED ALARMNF STAT 45	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:52:58 PM OutAl - NF FEED PRESSURE HIGH HIGH LIMIT ALARM	
4/20/2006	16:53:42	113	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:53:42 PM - SYSTEM FAULT	
4/20/2006	16:53:43	164	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:53:43 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:11	95	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:11 PM - SYSTEM FAULT	
4/20/2006	16:54:12	146	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:12 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:12	166	InAlm	DERIVED ALARMNF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:12 PM - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:13	198	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:13 PM - SYSTEM FAULT	
4/20/2006	16:54:14	249	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:14 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:14	269	OutAl	DERIVED ALARMNF STAT 97	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:14 PM OutAl - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:15	301	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:15 PM - SYSTEM FAULT	
4/20/2006	16:54:16	292	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:16 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:17	344	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:17 PM - SYSTEM FAULT	
4/20/2006	16:54:17	364	InAlm	DERIVED ALARMNF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:17 PM - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:18	455	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:18 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:18	475	OutAl	DERIVED ALARMNF STAT 97	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:18 PM OutAl - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:19	398	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:19 PM - SYSTEM FAULT	
4/20/2006	16:54:20	388	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:20 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:20	408	InAlm	DERIVED ALARMNF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:20 PM - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:21	439	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:21 PM - SYSTEM FAULT	
4/20/2006	16:54:22	491	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:22 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:23	592	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:23 PM - SYSTEM FAULT	
4/20/2006	16:54:23	613	OutAl	DERIVED ALARMNF STAT 97	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:23 PM OutAl - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:24	594	InAlm	DERIVED ALARMNF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:24 PM - NF FEED TANK TSS LOW LIMIT	
4/20/2006	16:54:25	585	OutAl	DERIVED ALARMSYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	2	4/20/2006 4:54:25 PM OutAl - SYSTEM FAULT	
4/20/2006	16:54:26	637	InAlm	DERIVED ALARMSYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/20/2006 4:54:26 PM - SYSTEM FAULT	

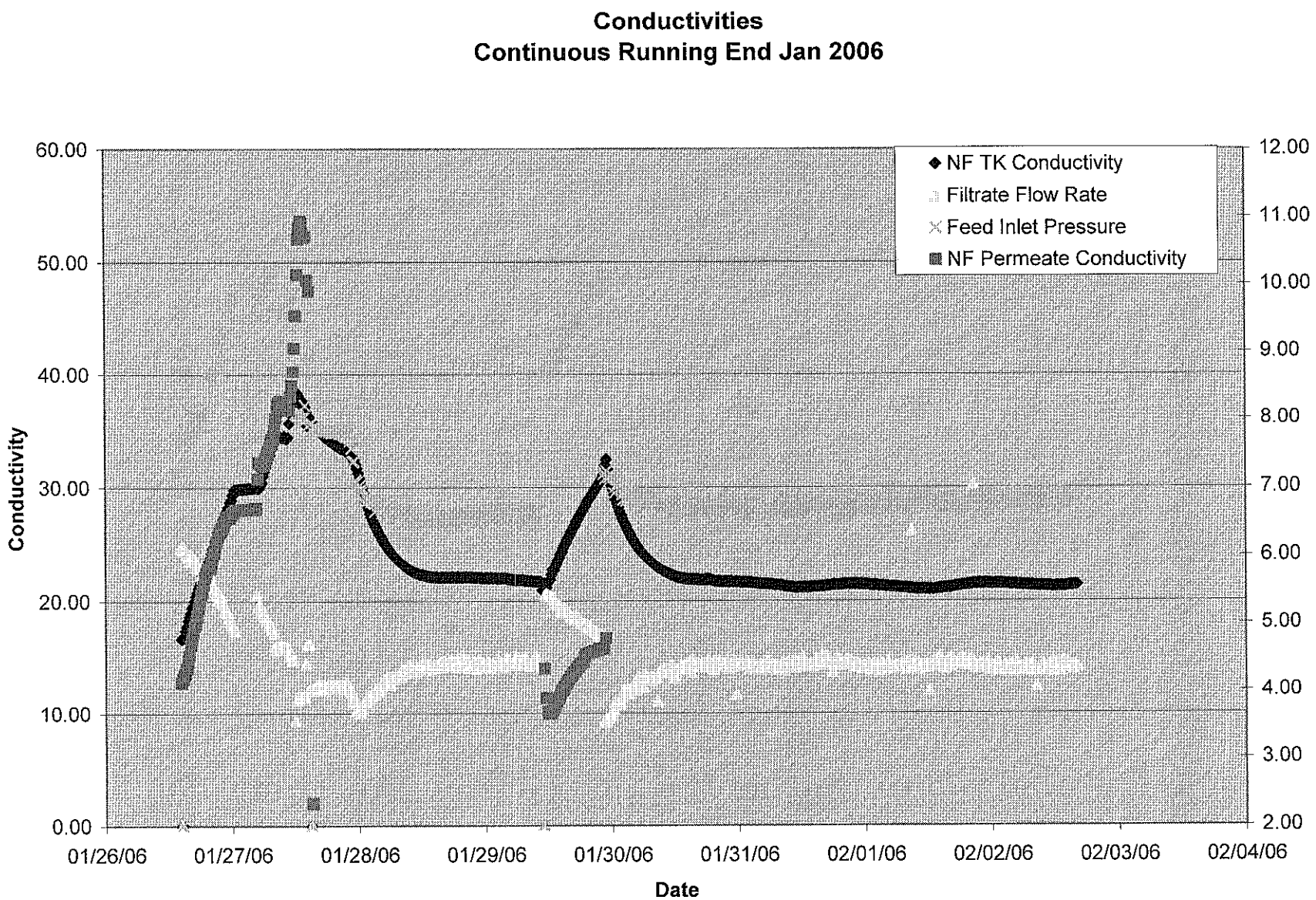
Date	Time	Militim	Transl	TagName	TagValue	T	ThreshVal	T	ThreshLabl	S	D	UserId	A	Dscription
4/26/2006	17:23:21	583	InAlm	DERIVED ALARM\NF STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/26/2006 5:23:21 PM - NF FEED TANK TSS LOW LIMIT	
4/26/2006	17:23:21	633	InAlm	DERIVED ALARM\DTANK STAT 97	1.0000000000	D	0.0000000000	0		1	Y	1	4/26/2006 5:23:21 PM - D-TANK TSS LOW LEVEL	
4/26/2006	17:23:21	653	InAlm	DERIVED ALARM\SYS STATUS 4	1.0000000000	D	0.0000000000	0		1	Y	1	4/26/2006 5:23:21 PM - SYSTEM FAULT	
4/26/2006	17:23:21	4	RmAc	DERIVED ALARM\SYS STATUS 4	0.0000000000	D	0.0000000000	0		0	Y	6	4/26/2006 5:23:21 PM Ack - SYSTEM FAULT	
4/26/2006	17:23:21	24	RmAc	DERIVED ALARM\DTANK STAT 97	0.0000000000	D	0.0000000000	0		0	Y	6	4/26/2006 5:23:21 PM Ack - D-TANK TSS LOW LEVEL	
4/26/2006	17:23:21	44	RmAc	DERIVED ALARM\NF STAT 97	0.0000000000	D	0.0000000000	0		0	Y	6	4/26/2006 5:23:21 PM Ack - NF FEED TANK TSS LOW LIMIT	

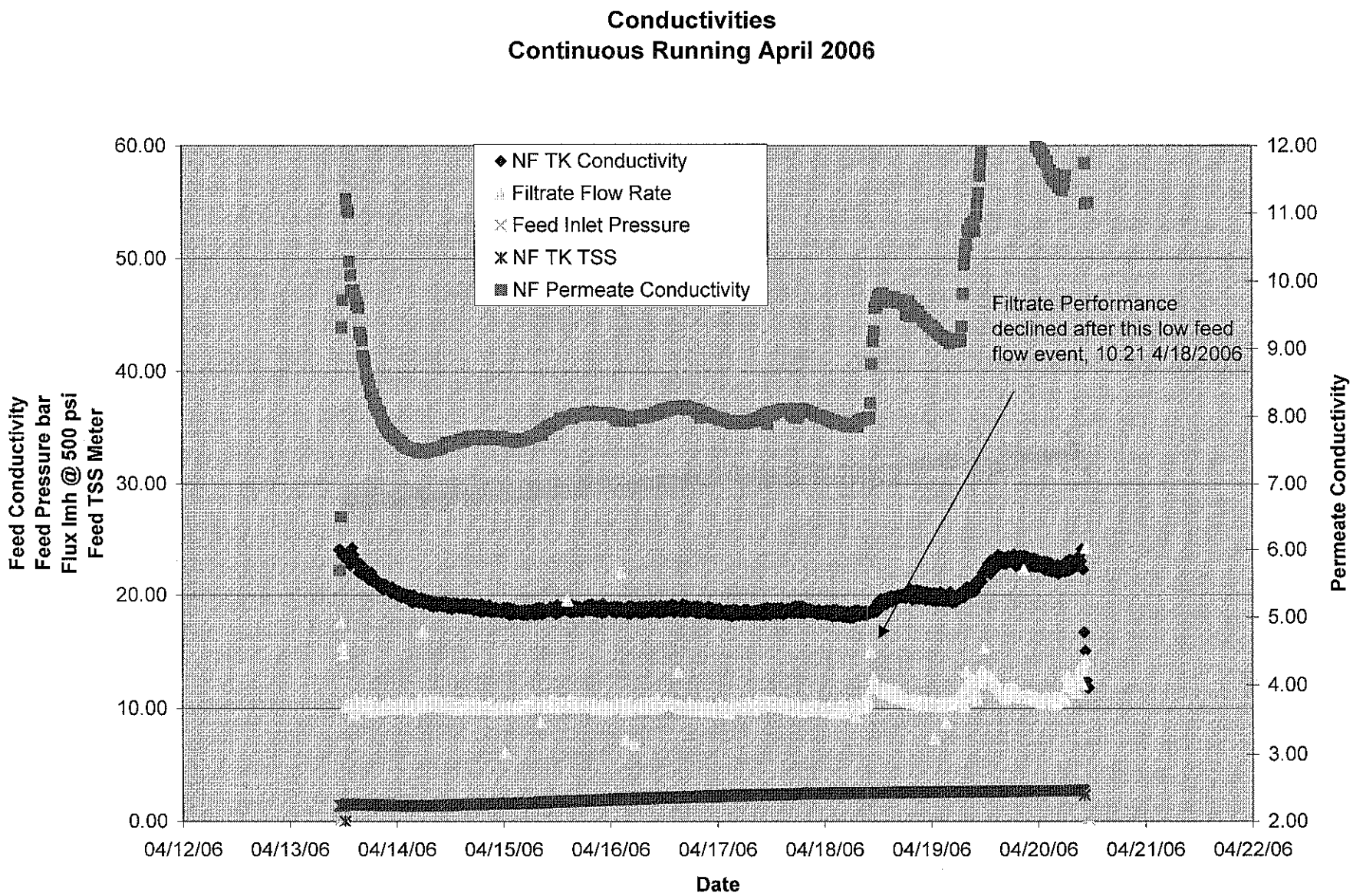

Panoche Conductivity & NF Feed Pressure & Flux & % Recovery
April-May, 2005, Manually Logged Data
Conductivity (dSE/M) and FLUX (LMH)
Pressure (PSI)
0
5
10
15
20
25
30
35
40
45
50
0
100
200
300
400
500
600
700
4/26/2005
4/26/2005
4/27/2005
4/28/2005
4/29/2005
4/29/2005
5/4/2005
5/4/2005
5/4/2005
5/6/2005
DATE
NF Feed Tank Conductivity
NF permeate Conductivity
FLUX LMH
% Recovery
NF Feed Pressure


Panoche Conductivity & NF Feed Pressure & Flux & % Recovery
December, 2005, Manually Logged Data
New Membranes Installed
70
60
50
40
30
20
10
0
700
600
500
400
300
200
100
0
Feed Pressure (PSI)
12/13/2005
12/14/2005
12/15/2005
12/15/2005
12/15/2005
12/15/2005
DATE
NF Feed Tank Conductivity (dSe/M)
NF Permeate Conductivity (dSE/M)
FLUX (LMH)
% Recovery
NF System Feed Pressure

Panoche RO System, Conductivity, Feed Pressure, Flux, & % Recovery
Manually Logged Data
April-Dec. 2005




Conductivities
Continuous Running End Jan 2006
NF TK Conductivity
Filtrate Flow Rate
Feed Inlet Pressure
NF Permeate Conductivity
Conductivity
60.00
50.00
40.00
30.00
20.00
10.00
0.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
01/26/06
01/27/06
01/28/06
01/29/06
01/30/06
01/31/06
02/01/06
02/02/06
02/03/06
02/04/06
Date


Conductivities
Continuous Running April 2006
NF TK Conductivity
Filtrate Flow Rate
Feed Inlet Pressure
NF TK TSS
NF Permeate Conductivity
Filtrate Performance declined after this low feed flow event, 10:21 4/18/2006
Feed Conductivity
Feed Pressure bar
Flux lmh @ 500 psi
Feed TSS Meter
Permeate Conductivity
Date
60.00
50.00
40.00
30.00
20.00
10.00
0.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
04/12/06
04/13/06
04/14/06
04/15/06
04/16/06
04/17/06
04/18/06
04/19/06
04/20/06
04/21/06
04/22/06

PANOCHE NANOFILTRATION DATA SHEET

PAGE# 1

DATE 4/26/2005

Target Operating Parameters		
	Feed Flow	7
	NF Recovery	28
	RO Recovery	70
	Slurry Flow (gpm)	4.5

Number of Modules on Line	10
Configuration	2x5
Membrane Area	26 m2

		RAW FEED			NANOFILTRATION SYSTEM															SLURRY RECYCLE Desup TK			BRINE	
					NF FEED CONDITIONS								PRESSURES		PERM	NF REJECT								
DATE	TIME	ABB meter TOTAL	Ca++ EL	EC	FLOW RATE	FLOW TOTAL.	pH	EC	CONE TSS	Royce Meter	Ca++ EL	Temp	STAGE 1 IN	STAGE 1 OUT	EC	FLOW RATE	FLOW TOTAL.	Ca++ EL	CONE TSS	Royce Meter	Ca++ EL.	BRINE FLOW	CONE TSS
		Gallons		dSe/M	GPM	Gallons		dSe/M	mls/L	TSS		°F	PSI	PSI	dSe/M	gpm	Gallons		mls/L	TSS		TOTAL	mls/L
4/26/2005	2045	123000		8.88	6.8	269642	6.99	13.7	25	1910		62.8	400		4	4.58	139814		33	5980		8335	
4/26/2005	2220	123220		9.67	6.8		6.87	14.1		1750		64.9	410		3.7	4.6				6670		8335	
4/27/2005	1801	125486		9.72	6.97	278391	6.93	18.8	38	2200		68.9	490		5.5	4.63	145704		75	7870		8335	
4/28/2005	1645	128210		8.67	6.94	287819	6.95	16.8	60	2490		68.2	490		4.3	4.67	152025		115	8650			
4/29/2005	1120	130446		8.56	6.89	295523	6.96	16.7	50	2190		67.2	480		4.6	4.61	157203		90	7910		8342	
4/29/2005	15.55	130963		9.45	6.97	297347	6.97	17		1980		69	480		4.9	4.68	158414			7560		8450	
5/4/2005	1500	131634		8.21	6.8	299462	6.98	22.3	38	2160		68	547		5.1	3.87	159840		68	8130		8640	
5/4/2005	1620	131770		8.13	6.7	299944	3.5	23.2		2110		68	466		4.8	4.71	160111			7960		8640	
5/4/2005	1730	131899		9.12	6.63		3.3	24.1		2110		68	448		5	4.71				7820		8640	
5/6/2005	1500	136310		8.45	6.71	318702	7.4	33.2		2280		66.2	600		7.5	4.5	172559			8131		9060	
8/1/2005	1100	170970		9.45		465563	7.1	22.4	17	1480							266522		23	7650		11790	
8/1/2005	1310	170970		9.46	6.22		7	22.7				76.1	295			1							
12/13/2005		173020		6.87	7.9	469798	6.5	17.6		2100		68	492		4.83	3.21	269136			11300		11990	
12/14/2005		173580		6.87	7.9	471164		15.7	28	1960		65	482		2.9	4.9	269996		54	11700		121050	1
12/15/2005		176600		7.49	7.9	478888		21.7	42	2110		65	546			4.8	274787		85	11900			
12/15/2005	1400	177530		7.9	7.84		7.7	23	43	2130		65	593			4.5			86	12200			1
12/15/2005	1600			7.81	7.9		7.7	24		2150		66	541		4.6	4.9				12200			
12/15/2005	710	178070		7.77	7.89		7.7	23.8		2210		66	545			5				12200			
1/26/2006	1330	182720			7.88	495747		16		2300			496			5.09	285305			13100			
4/11/2006	745	208080		9.63	7.14			15.1		2600			291			4.5	348233			11380		13110	1
4/12/2006	430	208220		9.34	7.13	582173		13.7	600/35	1940			423			4.6			600/47	13100			
4/13/2006	1230	209720		9.33	6.99	586639		24	8/600	1.466		67.9	592	670		4.93	351300			11380			
4/13/2006	200	210320		9.72	7.13	588868		24.4		1.55		70.1		420	5.09	6.17	352958			11380			
4/28/2006	FINAL	228870		9.76	0			9.5		514					13.6					15000		13120	

PANOCHE REVERSE OSMOSIS DATA SHEET

PCI Pilot Test Run #: 1

PAGE

Comments:

Membrane Type: Spiral RO

Membrane Surface Area:

CONFIG.

		FEED PARAMETERS					PRESSURES			PERMEATE					REJEC
DATE	TIME	Feed Tank Level	Feed Flow GPM	Feed pH	Feed EC		4"Feed PSI	2" IN PSI	2"OUT PSI	Stage 1 Permeate	Stage 2 Permeate	Permeate Meter Flow	Permeate Totailized	Permeate EC	Reject Tank LVL.
4/26/2005	9PM		5.5/5.7			66.50F	110	110		1.75	2.15	4.15	694588	990	
4/26/2005	22.15		5.5/5.7				110	110		1.85	2	4.08	694721		
4/27/2005	1745		5.5/5.6	6.94	5.5	70.5	110	110		1.85	1.9	4.02	696601		
4/28/2005	1700		5.5/	6.95	4.4	62.2	100	100		1.7	2	4	698963	1015	
4/29/2005	1620		5.5/5.6	6.94	5	71.6	100	100		1.8	2	4.02	701288	1800	
5/4/2005	1625		5.6	2.9	4.8	72	110	109		1.9	1.9	4.03	701907	1239	
5/4/2005	730		5.7	3.2	5	733	100	100		1.7	2.2	4.07	702009	960	
5/6/2005	1500		5.8	7.4	7.5	72.4	140	140		2	1.5	3.71	706377	543	
8/1/2005	1400		6		26.6	85.4	275	275		1.5	1.1		733815	1543	
12/14/2005	1845		6.3		3.4	65.5	150	160		2.7	1.7	4.79	735271	158	
12/15/2005	1400		5.7	7.1	4.3	68.3	155	170		2.8	1.5	4.65	737557	388	
12/15/2005	1700		5.6	7.26	4.6	68.6	155	170		2.8	1.6	4.66	738017	351	
1/26/2006	1330		5.12	7.24			150	170		2.6	1.9	4.75	742996	208	0.8
4/13/2006	615PM		5.5	7.2	5.11		240			2.5	1.5	4.25	747786	1298	6.01
4/28/2006	ALARMS-shut down											FINAL	761224		

CIP CYCLE	Time Begin	Time End		INLET PSI	OUTLET PSI	TEMP F	Water Flux
Caustic							
Acid							
Caustic							

Sample Collection History

DATE		TIME	FEED (x)	REJECT(x)

Appendix D

Reverse Osmosis Analyses Reports

Evaluation of Reuse Equilibrium Chemistry (feedwater to RO treatment plant)

Contents

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Evaluation of Reuse Equilibrium Chemistry

The equilibrium chemistry of drainage reuse was simulated using the equilibrium chemistry codes WATEQ (Ball and Nordstrom, 1991) and MINTEQ (Allison *et al*., 1991). The purpose of the study is to estimate chemical changes that may occur as water from drains in the south San Joaquin Valley is further concentrated during the irrigation of halophytes. The procedure that was followed is outlined on Figure 1. The water that is concentrated during irrigation will be collected for treatment by reverse osmosis (RO) prior to discharge. The simulations are being conducted to project the quality of water entering the RO unit.

The input data for the models (Table 1) are unpublished data developed from ground water quality data from areas that contribute to drains in the Westlands District and several irrigation districts to its north (the Northerly Area). The Westlands drains were divided into a North, Central, and South area. For modeling purposes, the halophyte irrigation is designed to have a leaching fraction of 30 percent, which would concentrate the applied drain water by a factor of about 3.3. Water concentrated by that amount is the focus of this study. A related study that evaluated the input to the RO unit used leaching fractions of 25 and 40 percent to bracket a range of possibilities. The leaching fractions result in concentration factors of 4 and 2.5, respectively, and bracket the halophyte irrigation design concentration factor of 3.3 used in this study. The other concentration factors were evaluated in WATEQ simulations, but not in the MINTEQ simulations.

The reason for using two equilibrium models concerns the detail of the output and ease of use. WATEQ is very easy to prepare and run simulations. However, the output consists of the distribution of species at equilibrium and a set of saturation indices for common minerals. In reality, not all of the oversaturated minerals would precipitate. MINTEQ was used to evaluate the mineral precipitates in somewhat more detail. In MINTEQ, simulations are conducted in sequence. As one mineral precipitates, a new equilibrium calculation is undertaken to evaluate conditions with the loss of the earlier precipitated mineral or minerals. The new solution remains in contact with the previously precipitated minerals, which may subsequently redissolve. The end result is a solution that is not only in equilibrium internally, but also with its mineral precipitates.

A main concern in the area is selenium, which generally increases in concentration in the ground water from south to north. A major problem with selenium simulations is that selenium is extremely sensitive to the reduction-oxidation potential (redox potential or Eh) of the solution. There are no Eh data

in the data base used for the simulation. Both WATEQ and MINTEQ can estimate the Eh from redox pairs. The only redox pair for which there are data in the data base that was used consists of the nitrogen species, ammonium, and nitrate. These were used to estimate the Eh of the drain water. However, there is only an ammonium concentration available from the Northerly Area. For the initial simulations in WATEQ, the ammonium concentration from the Northerly Area, 1 mg/L, was used for all inputs. The resulting Eh values ranged from 0.44 volts in the Northerly Area to 0.484 in the north and central areas of Westlands. The differences in Eh were entirely due to the differences in the nitrate concentration in the various areas, because the ammonium concentration was held constant. The same strategy was used for the initial MINTEQ simulations as well, but the Eh was allowed to fluctuate and final values tended to be much lower; *i.e.,* between 0.3 and 0.4 volts.

WATEQ Simulations

The list of oversaturated solids from the simulation of the Northerly Areas drainage is shown in Table 2. By far the greatest saturation index is for goethite, an iron oxide mineral, specifically an iron oxyhydroxide (FeOOH). Third on the list is ferrihydrite. Goethite can form hematite (Fe_2O_3) by dehydration; *i.e.,* $2FeOOH \rightarrow Fe_2O_3 + H_2O$. Note the similarity of the products of this reaction to the chemical composition of ferrihydrite in Table 2, which in the unconcentrated drain water ranks second behind goethite based on its saturation index. The preceding is an example of the above referenced problem of defining mineral precipitates based on saturation indices. Because the actual precipitates are not completely known, they cannot be removed from the solution to estimate the amount of total precipitate or the remaining dissolved solids. In the case of goethite and ferrihydrite, there may be all of one or the other or some of each. Regardless, the ultimate mineral is likely to be hematite if dehydration is complete. Furthermore, because the initial concentration of iron is small relative to the TDS, the effect of the loss of either of the iron minerals would have little effect on the resulting TDS.

The ferrihydrite is preceded and followed by several forms of dolomite (Table 2). From a chemical perspective, the mineral form of the dolomite is of no consequence because their chemical composition is the same (Table 2). The difference is in mineral faces only. The same can be said of calcite and aragonite, gypsum and anhydrite, and the three forms of silica: quartz, cristobalite, and chalcedony. While it may not be readily determinable from the WATEQ output, which is the real precipitate of the similar mineral forms shown, the most likely would be the one with the greatest saturation index.

The minerals shown in Table 2 are the result of the simulations of the drain water and the increases after applying the three concentration factors. The listing is arranged in descending order of the saturation indices of the 3.3 concentration

factor. Table 2 indicates that the number of oversaturated solids increases as the concentration of the components increase. The greatest increase in oversaturated minerals occurs at the application of the initial concentration factor. However, the increase in concentration of the dissolved constituents between the drain water and the 2.5 concentration factor also creates the largest change among the number of oversaturated solids; *i.e.,* from 12 to 17. The subsequent increases in the concentration factors are only on the order of 0.7 and 0.8 from the 2.5 concentration factor and the number of additional oversaturated solids only increases by one over what is shown by the 2.5 concentration factor.

Of the oversaturated solids shown in Table 2, only the iron salts (minerals) are redox sensitive. All of the oversaturated iron minerals include ferric (oxidized) iron. The solubility of the other minerals shown in Table 2 is controlled by equilibrium processes independent of oxidation state. Aside from iron, all of the cations included in the minerals in Table 2 exhibit only one oxidation state. Only silicon and sulfur may undergo reduction/oxidation reactions. Each of those is included in an oxyanion in the minerals in Table 2 and is at its highest oxidation state. The estimated Eh of the solution is 0.441 V. Consequently, all of the minerals in Table 2 are oxidized.

The results of the Westlands areas WATEQ simulations are shown in tables 3 through 5. The oversaturated solids in tables 3 through 5 also appear in Table 2. Of the oversaturated minerals in Table 2 (Northerly Area results), only chrysotile does not appear in any of the areas in the Westlands District. Chrysotile appears chemically similar to sepiolite, which occurs in all of the tables for Westlands and the Northerly Area. All are fibrous sheet silicates, although sepiolite sheets are more like ribbons (Deer *et al.*, 1992).

The number of oversaturated minerals in the Westlands North and South are the same, 17 (compare tables 3 and 5). There are only 15 oversaturated solids in the Westlands Central. Table 4 does not include otavite nor strontianite, each of which is a member of the anhydrite carbonate type of minerals (Staples, 1972). However, otavite is a member of the calcite group of anhydrous carbonates, while strontianite is a member of the aragonite group (*ibid.*). Both calcite and aragonite appear in all of the lists of oversaturated solids in the Westlands District, as well as in the Northerly Area (tables 2 through 5).

As was noted above in the discussion of the Northerly Area in relation to Table 2, the number of oversaturated minerals increases as the concentration factor is increased. Within the Westlands District, this is also true (tables 3 and 5). In each of the areas in the Westlands District, there are 10 oversaturated solids in the drain water samples. This increases to 14 in the Westlands Central area and to 15 in the other two areas of the Westlands District at a concentration factor of 2.5. Application of a concentration factor of 3.3 increased the number of oversaturated solids to 16 in the Westlands North and to 15 in the Westlands Central, but the total remains at 15 in the Westlands South.

In terms of the TDS of the drain water before concentration factors are applied, the Westlands Central is lower than either of the other areas, while the Westlands South is only slightly lower in TDS than the North (Table 1). The number of oversaturated solids that are present as the drain water is concentrated appears to show a somewhat complex relationship to the initial TDS of the drain water, based on the results in tables 3 and 5. This would mean that the number of precipitates would increase as the TDS increased. The problem is that the effect on reducing TDS due to the loss of mineral precipitates (salts) is not related to the number of types, but to the concentration of salts lost.

MINTEQ Simulations

The MINTEQ simulations were conducted only on input data based on the concentration factor of 3.3, following the procedure outlined on Figure 2. In the MINTEQ simulations, both the pH and the Eh were allowed to fluctuate during the equilibrium calculations. In MINTEQ, equilibrium is attained when there is convergence between the concentration of the solutes and their respective solubility product constants. These are the components of the saturation index in WATEQ. MINTEQ output also includes a saturation index in the output at the final equilibrium. However, in the final equilibrium in MINTEQ, the maximum saturation is 0, which is given for all of the precipitated solids. All other solids have a negative (undersaturated) saturation index. The output was used to calculate the TDS as the sum of constituents as described in Hem (1985).

Northerly Area and Westlands

The simulations for the Northerly Area and the three Westlands areas differed considerably and different approaches had to be used in modeling them. For that reason, the results will be presented separately. The analysis of the data from the Northerly Area was conducted in somewhat greater detail, because the data were more amenable to modeling with MINTEQ. The MINTEQ simulation of the Northerly Area data set equilibrated with few constraints, while none of the Westlands area data sets could be made to equilibrate without imposing considerable constraints on the simulation.

The simulations would represent conditions below the root zone in the reuse area. For the salt concentration to have occurred, the evapotranspiration (ET) will have had to be complete. However, it is possible for salts to deposit above this zone as concentration occurs, rather than after it is completed, as it is assumed in the MINTEQ simulations.

Northerly Area

The Northerly area simulations represent the quality of water after each of four irrigations. Each simulation is based on the same concentration of dissolved

solids as shown in Table 1. The differences in the results of the subsequent simulations represent the interaction with precipitated salts.

The simulations involve both an equilibrium and a reduction/oxidation problem. For these to occur as simulated, the water would have to remain relatively quiescent. To some extent this is somewhat unrealistic. However, all ground water simulations involve some set of assumptions that simplify conditions. The same is true here. For the reactions to proceed to an equilibrium, conditions need to be stable. For the water to remain in contact with its mineral precipitates, it would have to remain in place. As will be seen later, in some cases, minerals redissolve after other precipitates have formed. This could only happen if the water remains in place or in a long-term condition in which uniform mineralization has occurred in a broad zone of contact. Despite these shortcomings, the results can provide some insight into possible chemical reactions during the drainwater reuse. The above is true of conditions within the simulation of an individual drainwater application. The contact between the previously precipitated minerals and subsequent applications of drainwater is much more realistic.

The precipitated solids from the MINTEQ simulation of the concentrated drain water in the Northerly Area during each of four irrigations are shown in Table 6. Four applications of drainwater are projected to occur annually during operation of the reuse area. The minerals in Table 6 are shown in their order of formation in MINTEQ. The results in Table 6 include several things of note relative to the WATEQ results.

First, neither goethite nor ferrihydrite is shown, although both are included in the MINTEQ minerals data base. However, like the WATEQ results, MINTEQ shows iron, although in the form of hematite, as its first precipitate. The relationship between goethite, ferrihydrite, and hematite was discussed above, and should also be considered here. If conditions remain moist, ferrihydrite would probably be the most likely iron oxide mineral, but if drying occurs, expect hematite.

The second noteworthy result in Table 6 is the amount of gypsum that is projected to precipitate. In terms of its concentration, nearly 10 times as much gypsum is projected to precipitate as the next most common mineral formed; *i.e.,* dolomite. However, the mix of minerals does change later in the process. Initially, only the gypsum would be significant in terms of the TDS of the water in the first several drainwater applications. Later, calcite also becomes important.

Among the precipitates in Table 6 is tremolite, which did not appear among the oversaturated solids in the WATEQ output. Tremolite (and its chemical relative, ferro-actinolite) are essentially metamorphic minerals (Deer *et al.*, 1992) that are unlikely to form in the geochemical environment of the reuse area. It seems much

more likely that one or more of the silicate minerals shown in the WATEQ output would form, rather than one like tremolite shown in the MINTEQ output.

Table 6 shows the projected list of minerals formed at the conclusion of each of the MINTEQ simulations. As was noted above, precipitated solids remain in contact with the solution in MINTEQ during the simulation of an individual drainwater application. The water and the minerals can then undergo further changes as the simulation progresses. This is illustrated by the results for the first simulation, which are shown in Table 7. These results show the sequence of precipitates formed. Table 7 also shows that on two occasions, previously precipitated solids redissolved. The initial silica precipitate was quartz, which subsequently dissolved when the tremolite precipitated. Later, the quartz once again precipitated. However, Table 6 also shows that after the fourth application of drainwater, the tremolite would be replaced by chrysotile, a sheet silicate and one form of serpentine. Historically, serpentine has been the most important commercial source of asbestos (Deer *et al.*, 1992). In reality, chrysotile is no more likely to form than tremolite. Chrysotile is formed hydrothermally; *i.e.,* at temperatures of 700-800°C (*ibid.*). Suffice it to say, the projected formation of either tremolite or chrysotile in MINTEQ would indicate that some form of silicate mineral is likely to form. It would be expected that clay minerals would be the most likely. However, the clay minerals are most commonly aluminosilicates. Because there are no aluminum data from the source analysis (Table 1), aluminum is not included in the inputs, and aluminosilicate minerals cannot form in the MINTEQ simulations.

The other mineral that showed activity after it was initially formed was calcite. The sequence shown in Table 7 indicates that the earlier formed calcite would redissolve after the dolomite formed. In nature, dolomite may form from calcite as some of the calcium in calcite is displaced by magnesium. The result shown in Table 6 that shows dolomite, but no calcite, may be correct, although the dolomite may form by a different process than indicated in the MINTEQ results. However, the dolomite that replaced the calcite during the initial application of drainwater is projected to once again be replaced by calcite after subsequent applications.

The loss of salts to mineralization would reduce the dissolved solids in the water. Table 8 shows the dissolved solids in the initial and final solutions in the MINTEQ simulations. The change in TDS is also shown in Table 8. It should be noted that the TDS shown in Table 8 is calculated as the sum of the individual constituents above it in the table. In Table 1, the TDS was shown as 4,000 mg/L; applying a concentration factor of 3.3 to a TDS of 4,000 mg/L gives a TDS of 13,200 mg/L, which is obviously much larger than that shown in Table 8. The source of the 4,000 mg/L TDS of Table 1 is unknown, but it was included with the source data. However, because the TDS of the MINTEQ results must be calculated in the manner shown in Table 8 for the initial data, the calculated TDS must be used to compare the results with the MINTEQ result.

The precipitated solids in Table 8 consist of calcium, magnesium, sulfate, silica, selenium, and iron. The calcium was precipitated mainly as gypsum, but would also be contained in the dolomite. The magnesium would be mostly lost as dolomite, but there would also be some lost to the tremolite. All of the carbonate would also be lost as dolomite. Although iron is shown in both hematite and tremolite, all of the iron lost was as hematite. Similarly, all of the strontium was lost as celestite, which accounts for only a small fraction of the sulfate loss. The vast majority of the sulfate loss was as gypsum.

With each subsequent application of water, the amount of gypsum in the soil increased in the MINTEQ results (Table 6). As indicated by the amount of sulfate lost in the applied water in each of the applications in Table 8, the amount of sulfate deposited was greater than the preceding. In other words, gypsum was forming at an increasing rate below the root zone. However, the percentages in Table 6 show a decrease. The reason the percentages decreased is because the base on which they were calculated increased and the amount of gypsum deposited decreased somewhat. For example, after each of the first and second applications of drainwater, there were about 2,500 mg/L deposited, but after the third application, about 2,000 mg/L was formed, and it was closer to 1,860 mg/L after the fourth application. There were some difficulties in getting the MINTEQ simulation to run to completion in the third application analysis. After the deposition of calcite, talc was being precipitated. However, the silica concentration fell to 0. To get the simulation completed, additional water had to be added and talc had to be excluded from the analysis. The decrease in the amount of gypsum formation could have been affected by the added water, which would dilute the solution; *i.e.,* it would also lower the actual concentration factor from what was originally applied. Alternatively, the formation of celestite, which is chemically somewhat similar to gypsum (strontium and calcium are both alkaline-earth elements, *i.e.* members of Group IIA on the Periodic Table of the elements), continued to form about 50 mg/L of mineral throughout (Table 6).

Table 6 shows that tremolite may consist of hydroxide or fluoride. There are no fluoride data in Table 1. The fluoride concentration entered into the MINTEQ simulation is 0.3 mg/L, which is median for the Mendota Pool and represents the source water for irrigation in the area. The fluoride was entered as part of the evaluation of boron. Boron is a significant concern in the use of the drainwater for irrigation because of its potential toxicity to plants. For example, in the classic early water quality criteria document, (McKee and Wolf, 1963), it is noted that a boron concentration in excess of 3.75 mg/L is unsuitable for irrigation of even boron tolerant crops. Boron in the concentrated drainwater is nearly 10 times that criterion (Table 8).

Boron is generally present in the form of boric acid (H_3BO_3), which is an extremely weak acid and does not dissociate to any great extent. In alkaline solutions, boric acid can be designated as $B(OH)_3$ (Hem, 1985). In the latter form, fluoride can substitute for OH^-. However, there was no great amount of

substitution indicated in the MINTEQ distribution of dissolved solids (Table 9). For example, the first substitution [$BF(OH)_2^-$] has a projected concentration at equilibrium of < 1 µg/L as B, while the concentration of H_3BO_3 and its first dissociation, $H_2BO_3^-$, are over 30 mg/L as B. The second through fourth fluoride substitutions have extremely low concentrations (Table 9). Because of the low concentrations of the fluoride substitutions in the $B(OH)_3$ series, they can be ignored in evaluating boron solubility (or speciation). Any boron loss during reuse will be due to biological activity; *i.e.,* plant uptake, and is beyond the scope of this analysis. In all of the MINTEQ analyses, boron is simply concentrated by evapotranspiration and remains in solution (Table 8).

The application of the drainwater for irrigation would obviously occur during the growing season. The non-growing season is also the rainy season in the San Joaquin Valley. The rainfall during that season would provide ground water recharge to the reuse area. The rainwater would also be considerably more dilute than the concentrated drainwater and may serve to dissolve some of the previously deposited minerals in the reuse area. The possibility of the leaching of the deposited minerals was also evaluated with MINTEQ.

Rain has few dissolved constituents. For example, the specific conductivity of rain is in the range of 2 to 100 µS/cm (McCutcheon *et al.*, 1993). The dissolved solids in rain water result from the ionization of gasses that are dissolved from the atmosphere. The principal dissolved solid is bicarbonate, which ranges in concentration from about 0.6 to 3 mg/L (*ibid.*). However, to reach the bottom of the root zone, which is the area that the MINTEQ simulations are representing, the rainwater will mix with soil water. To represent dilute recharge, a sample of soil water was diluted by a factor of 10 and used as input to the winter recharge simulation. However, MINTEQ could not calculate an equilibrium based on that diluted solution. After trying several modifications, the original soil water solution was entered into MINTEQ. However, the data showed a large cation/anion imbalance. There were twice as many cations as anions in the laboratory result. The bicarbonate concentration was only 2 mg/L. To bring the data into balance, the difference was made up by adding enough bicarbonate to equal the cations. The resulting MINTEQ simulation showed a chemical precipitation of calcite and dolomite. The results of that simulation were then multiplied by 0.1 to represent chemical dilution by rainfall. The resulting dissolved solids concentrations in the recharge water are shown in Table 10.

A sequence of mineral formation and dissolution similar to the one shown previously for the first application of drainwater is shown in Table 11. As was the case in that simulation, tremolite is once again precipitated, while quartz and chrysotile are dissolved. However, quartz is again precipitated later. In the end, what happens with the silicate minerals has little bearing on either the TDS of the water or the total mineral formation in the soil. The concentrations are too low to make much difference.

When reporting mineral activity, only the formation or disappearance of a mineral is flagged. Changes in concentration are not. As shown in Table 11, there were large increases in the concentration of both calcium and sulfate. At the same time, there was also a decrease in gypsum (Table 12). The decrease amounted to a little less than 20 percent of the original gypsum content of the soil. These changes represent the dissolution (leaching) of gypsum by the recharge. As a consequence, the TDS of the recharge increased from about 100 mg/L to well over 1,300 mg/L. Nevertheless, there was a rather significant net deposit of gypsum in the soil profile during the year.

The final results also indicate a significant accumulation of calcite in the soil profile over the course of the year. The accumulated calcite and gypsum can fill pore spaces in the soil and inhibit the movement of water. To further evaluate this, the deposition of calcite and gypsum relative to the available pore space in the soil could be compared to estimate the expected life of the reuse area. The amount of mineral deposition could be estimated by converting the minerals from weights to volumes based on their respective densities. The specific gravity of calcite is 2.7 and that of gypsum is 2.3 g/cm^3 (Pough, 1996). The conversion would be made by dividing the mass of calcite and gypsum in Table 12, which represents the year-end total, by their respective specific gravities to get the volume of mineral in cm^3.

Water Quality for Reverse-Osmosis Treatment

The previous section of this report dealt primarily with the mineral precipitates. This section of the report will deal with the dissolved solids that remain in solution and will provide an estimate of the solids content and composition of the water that will be delivered to the reverse osmosis (RO) plants. For this analysis, data from Table 1 were concentrated by a factor of 3.3 for input into MINTEQ. The procedure that was followed is outlined on Figure 3. However, unlike the preceding analysis, the Eh was not simulated, but it was not specified either. The Eh was calculated in the MINTEQ simulation. No redox couples were added; so changes in Eh did not affect the concentration of dissolved solids. Since all of the iron was entered as ferric iron, virtually all of it precipitated during the simulation.

The San Luis Drain Feature Re-evaluation Environmental Impact Statement (Reclamation, 2006) also presented an estimate of the quality of the drainage from the reuse areas. That drain water in the EIS was then mixed with ground water to estimate the quality of the inflow to the RO plants. The EIS treated all of the TDS constituents conservatively. The mixed water composition from Table 2.8 of Appendix C of Reclamation (2006) was entered into MINTEQ. The same procedure as shown on Figure 3 was also followed with the exception that the Eh calculated in WATEQ from the NO_3/NH_4 redox couple was entered and held constant. As was noted above, in the absence of redox couples entered into

MINTEQ, the constant Eh makes no difference in the results from allowing the Eh to fluctuate.

Selenium was entered as both selenite and selenate in the same proportions as in the previous simulations, but these would then remain constant throughout the simulation. In all cases, the final selenium concentration is the same as the initial concentration. There was no loss of selenium in any of the simulations due to mineral precipitation.

The main reason that selenium was not simulated in more detail in the simulation relates to its behavior and the capabilities in the 1991 version of MINTEQ that was used in the simulations. The primary factor that affects the solubility of selenium is adsorption. The selenite form of selenium is strongly adsorbed onto iron oxides. Selenium is highly redox sensitive and selenite could predominate in a slightly less oxidizing environment than has been observed in drain water in the study area. The 1991 version of MINTEQ is capable of simulating adsorption, but the preferred method does not include selenium in the adsorption database. An updated version of MINTEQ (*i.e.* 2000 release) does include selenium in that database (HydroGeoLogic, 1999). However, the executable was compiled under Windows 95® and would not run under Windows XP®. For several reasons, but most importantly the speciation of selenium in WATEQ, which was over-whelmingly selenate, the adsorption simulation was not pursued further. In the 2000 MINTEQ database for selenium adsorption, the adsorption coefficients for selenate are essentially the same as those for sulfate, are five orders of magnitude less than for selenite, and would, therefore, have little effect on the final selenium concentration in the reuse water.

The MINTEQ output would show the composition of the water at equilibrium and after the loss of minerals. As was described above, the minerals would be expected to be precipitated in either the soil profile or in drains that would convey the water to an RO unit. The resulting water quality of the drain water should be considered a rough estimate, in that natural water rarely reaches chemical equilibrium. As water moves, conditions are constantly changing. As conditions change, any tendency toward equilibrium is affected. As a result, natural water may tend toward an equilibrium, but will generally be in a disequilibrium condition.

Simulation of the 3.3 Concentrate

Table 13 summarizes the MINTEQ output for the equilibrium simulation of the drain water from the Northerly Area. The column labeled “initial” represents the concentrated drain water. The column labeled “final” is the concentrated drain water after the removal of salts that would be expected to be lost to the soil profile. As was done in the MINTEQ simulations described earlier, fluoride was added at three times the Mendota Pool median concentration, although this

addition has no real effect on the results. These results would better represent the end of pipe drainage that would be sent to the RO unit.

The MINTEQ output shows a slight increase in some of the conservative elements between the initial and final solutions (chemical, not mathematical). For example, chloride increased from 1,815 mg/L to 1,837 mg/L. This is not due to any further analysis of evaporation. That was entirely accounted for by the factor of 3.3. Instead, the results reflect rounding during transformations among the various expressions of chemical concentrations. MINTEQ carries out its calculations on the basis of molality (moles/Kg)*. The actual inputs are in mg/L, which the MINTEQ preprocessor converts to molarity (moles/L), which is used to approximate molality. In part, the differences reflect the effect of conversions back and forth between molarity, molality, and mass per unit volume (mg/L). Another potential source of change is numerical dispersion during the mathematical solution of the simultaneous exponential equations that MINTEQ uses to calculate equilibrium. To avoid showing these minor changes in the results, the final concentrations are calculated from the dissolved percentages that are also shown in the tables.

Table 1 is the basis for this set of MINTEQ simulations for the estimated quality of the RO feed water. However, not all of the data that appear in Table 1 were used. Most of the trace elements shown in Table 1 were not included in the analysis, mainly because they would not be an important component of the total dissolved solids. In addition, the Eh was set to the value shown in Table 1 and was held constant throughout the simulation. In other words, no chemical oxidation or reduction was allowed. This is not particularly unreasonable in that the data in Table 1 represent drain water and thus have been through 1 irrigation sequence. Putting the water through another irrigation cycle should not drastically change the Eh.

The one odd result in Table 13 concerns the bicarbonate (HCO_3^{-1}) concentration. Its final concentration is 120 mg/L, which is only about ⅔ of the bicarbonate concentration before the concentration factor of 3.3 was applied to develop the 561 mg/L initial concentration. An expected concentration would be near the 170 mg/L concentration in Table 1, at least on the basis of the assumption described above for the constant Eh. The simulation summarized in Table 13 used many MINTEQ defaults. No CO_2 was included in the input data set. Consequently, CO_2 would have been at atmospheric pressure or about 330 ppm. To compensate, an initial CO_2 concentration was defined based on the WATEQ results. The result was an even lower bicarbonate concentration. After reviewing Reclamation drainage data, a value of 0.0035 atmosphere (3500 ppm) was selected, based on a large database for drains in the Grand Valley in Colorado. The Grand Valley CO_2 value is approximately 10 times atmospheric. The results of this simulation are shown in Table 14. The HCO_3^{-1} concentration in the final solution is 309 mg/L, which is greater than the 170 mg/L measured concentration

* mole – gram-molecular weight

in drain water in the Northerly Area. Because an increase in all dissolved solids was expected, 0.0035 atmosphere is used for the partial pressure of CO_2 in the simulations of the leachate from each of the reuse areas in the Westlands District. In addition, like the Northerly Area, each of the drain waters from the Westlands reuse areas are concentrated by a factor of 3.3 to simulate evapotranspiration during reuse.

The initial TDS of the leachate from the reuse area is estimated to be more than 10,000 mg/L, based on the concentration factor of 3.3. The final equilibrium TDS, as simulated in MINTEQ, is about 8,000 mg/L. The difference in TDS is due to the loss of calcite and gypsum in either the subsoil or in the drains (or both).

In Table 13, the pH decreased from 8.2 to 7.9 from the initial to final simulated result. In Table 14, the final pH is 7.5, a somewhat lower value than in Table 13. The reason for the greater decrease is the added CO_2, which when dissolved, forms carbonic acid (H_2CO_3), which will weakly ionize to $H^+ + HCO_3^{-1}$. The latter will augment the bicarbonate in the solution, but at the same time, the former ion will reduce the pH; *i.e.,* it will make the solution more acidic.

Table 15 shows the results of the MINTEQ simulation of drainage from the Westlands District North reuse area. The Westlands North area has a much higher TDS than the Northerly Area drain water. Like the Northerly Area drainage, the Westlands North drain water is predominantly a sodium sulfate-type. Also like the Northerly Area, large amounts of calcite and gypsum are projected to precipitate either in the soil profile or in the drains or both. The final HCO_3^{-1} concentration is projected to be around 260 mg/L, compared to an initial concentration of 230 mg/L before being subjected to further concentration by evapotranspiration in the reuse area. The loss of calcite, gypsum, and minor amounts of silicate minerals and celestite, would reduce the concentrated TDS from more than 24,000 mg/L to near 19,400 mg/L. In other words, the TDS is projected to decrease by about 20 percent from what would be expected strictly from evapotranspirative concentration in the reuse area.

Table 16 shows the results of the MINTEQ simulation of the concentrated drain water from the Westlands Central reuse area. The Westlands Central reuse area is intermediate in TDS between the Northerly Area and the Westlands North reuse area. Like the Westlands North reuse area, the MINTEQ simulation indicates about a 20 percent decrease in TDS in the soil profile or the drains or both.

Prior to concentrating the drain water from the Westlands Central reuse area, the bicarbonate concentration was 169 mg/L. The final bicarbonate concentration in the MINTEQ output is 228 mg/L in Table 16, which is somewhat greater than the initial concentration. Despite the increase in bicarbonate, the pH decreased from 7.7 to 7.6.

Table 17 shows the results of the MINTEQ simulation of the concentrated drainage from the last of the reuse areas, the Westlands South area. The TDS of the Westlands South area has a concentrated TDS of 22,700 mg/L. The MINTEQ simulation indicates that this would be reduced to about 18,400 mg/L. Once again, the TDS reduction is about 20 percent. As was true of the other reuse areas in the Westlands District, the reduction is due primarily to the loss of calcite and gypsum, with minor reductions due to the precipitation of silicates and celestite.

The initial bicarbonate concentration in the Westlands South area before the application of the concentration factor of 3.3 was 210 mg/L. The MINTEQ simulation shows a final bicarbonate concentration of 255 mg/L (Table 17). Once again, despite the increase over what the bicarbonate concentration had been before applying the concentration factor, there was still a decrease in the pH from 7.7 to 7.5.

In summary, there is a reduction in the simulated TDS of about 20 percent between the concentrating effect of ET and the delivery of the drain water as feed water to an RO unit. The 20 percent reduction occurred in the simulation of the Northerly Area and all three of the reuse areas in the Westlands District due to the precipitation of calcite and gypsum. Although there is a great deal of difference in the TDS of the various waters, their geochemical response is rather consistent in the MINTEQ simulations.

Another factor that appears consistent across all of the simulations is a slight decrease in pH. In all of the simulations of drain water from reuse in the Westlands District, there was a slight decrease in pH. Alternatively, the initial pH in the Northerly Area was higher than in the Westlands District reuse areas, but the final results on the MINTEQ simulations show a pH between 7.4 and 7.6 for all of the areas, including the Northerly Area.

San Luis Drain Feature Re-evaluation Final EIS Reuse Data

The Final EIS on the San Luis Drain Feature Re-evaluation (SLDFR) estimated the TDS of the reuse area ground water quality for delivery to the RO units based on a statistical analysis of historic ground water data and evapoconcentration of the applied water. In that analysis, the reuse water that went to deep percolation was mixed with other ground water flowing laterally under the reuse area. The TDS of the deep percolation was estimated based on 27 percent of the applied water going to deep percolation. This gives a concentration factor of 3.7 to the reuse water. The laterally flowing ground water is shown as being lower in TDS than the deep percolation from the reuse areas. As a consequence, the deep percolation TDS is reduced through dilution. Both the laterally flowing ground water and the deep percolation are treated conservatively in the FEIS analysis. In other words, there is no loss or gain of dissolved solids through chemical changes.

The preceding analysis in this report looks at chemical changes, but assumes no interaction with other ground water. This section of this report presents the results of MINTEQ simulations of FEIS estimates and may be considered the more complete analysis of the potential RO inflow chemical composition.

Table 18 presents a reproduction of the data presented in Table C2-8 of the FEIS in Appendix C. A comparison between the TDS of the four reuse areas from the FEIS with those from tables 14 through 17 indicates that the FEIS values are similar to those of the concentrated TDS of this study in all three of the Westlands Reuse areas, but the TDS of the FEIS data for the Northerly area is much higher than the estimate from this study. As was noted above, the TDS is projected to decrease by about 20 percent in transit through the soil and drains under the reuse areas. For this reason, the projected TDS of the RO plants feed water is about 20 percent lower in the three Westlands areas. The concentrated TDS of the reuse water in the Northerly Area from this study is projected to be about two-thirds of the FEIS projection, while the feed water to the RO unit is projected to be 40 percent lower than that.

The data in Table 18 had to be supplemented to perform the MINTEQ simulations. Iron and strontium data from Northerly Area samples collected in November 2005 were used to supplement the data in the table: iron = 0.43 mg/L and strontium = 20 mg/L. As was done for the other MINTEQ simulations, the Eh was taken from WATEQ simulations based on the NO_3/NH_4 concentrations in Table 18: Westlands (all) = .351 V and Northerly Area = 0.295 V. Although the NO_3 and NH_4 concentrations vary among the three Westlands areas, they remain proportionally the same and the Eh does not differ. This result appears to reflect the way in which the EIS data were developed [see Appendix C of Reclamation (2006) for details].

The TDS shown in Table 18 is higher than the equivalent initial TDS concentrations shown in tables 19 through 22 for each of the areas. The TDS concentrations shown as inputs to MINTEQ in tables 19 through 22 are calculated from the sum of the major ions (calcium, magnesium, sodium, potassium, sulfate, chloride, and bicarbonate, which is converted to an equivalent amount of carbonate to account for carbon dioxide loss as a sample is dried), as recommended in Hem (1985). The TDS concentrations in Table 18 are derived from ground water model output, as described in Reclamation (2006), and the concentrations of the various constituents are derived from TDS data. The specific values for the Reclamation (2006) constituents do not sum to the TDS shown in the table.

The inputs and results of the MINTEQ simulation of the water quality constituents in the Northerly Area reuse water are summarized in Table 19. The initial composition of the FEIS data set for the Northerly Area generally has higher concentrations of the various dissolved constituents than the straight irrigation water concentrated 3.3 times (compare tables 14 and 19). This is

illustrated best by the TDS concentration that is 1,200 mg/L higher in the FEIS data set (Table 19). The decreases in salts as simulated in MINTEQ are the same in the two data sets and consist of dolomite, gypsum, celestite, quartz, and hematite, but the amounts formed differ in the two data sets. In all cases, there is a greater amount of precipitate of each of the minerals in the FEIS data set, reflecting the higher concentration of ions that form the minerals in the original water.

The inputs and results of the MINTEQ simulation of the water quality constituents in the Westlands North reuse water are summarized in Table 20. In this case, the 3.3 concentrate has the higher initial TDS concentration by over 5,000 mg/L (compare tables 15 and 20). With the exception of iron and silica, the concentrations of the individual dissolved solids are higher in the initial 3.3 concentrate. The results also show a higher concentration of TDS in the 3.3 concentrate, but the difference is closer to 3,000 mg/L. The concentrations of most of the individual ions remain higher in the 3.3 concentrate, although calcium and strontium are slightly higher in the final solutions of the FEIS data. The precipitated minerals are the same in both waters and include the same ones as listed above for the Northerly Area.

The inputs and results of the MINTEQ simulation of the water quality constituents in the Westlands Central reuse water are summarized in Table 21. Although the TDS of the Westlands Central reuse area is much lower than that of the Westlands North area, the difference in the TDS of the 3.3 concentrate and the FEIS data is not that different at over 5,000 mg/L in the initial water. The only constituent of the TDS that is higher in the FEIS data set is silica. The difference in the final TDS concentrations between the 3.3 concentrate and the FEIS data set in the Westlands Central reuse area is even larger than that in the Westlands North, even though the TDS in the Westlands Central is about two-thirds of that in the Westlands North reuse area. Once again, only calcium and strontium are the only ions that have a higher concentration in the final FEIS data set. The precipitated solids consist of the same minerals as in the results of the two previous simulations.

The inputs and results of the MINTEQ simulation of the water quality constituents in the Westlands South reuse water are summarized in Table 22. The initial Westland South reuse water is second in TDS behind the Westlands North in both the 3.3 concentrate and the FEIS reuse water data sets. The initial TDS of the 3.3 concentrate is about 2,700 mg/L greater than that of the FEIS reuse data set (compare tables 17 and 22). The individual ions in the 3.3 concentrate are higher than those in the FEIS reuse data set with the exception of silica and boron. The results of the simulation show a TDS difference of about 1,500 mg/L between the 3.3 concentrate and the FEIS reuse data sets. As was the case in the other Westlands results, calcium and strontium are again higher in the FEIS data, but boron, which is treated conservatively in the MINTEQ simulations, also remains higher in the FEIS data. As it was in each of the previous data sets, the chemical

precipitation of dolomite, gypsum, celestite, quartz, and hematite is responsible for the decrease in TDS in the MINTEQ simulations.

The precipitation of minerals was discussed in a previous section of this report. Although that discussion was relatively extensive, it was confined to modeling results. There was no relationship made to actual conditions in the field. At the time sampling was undertaken to define the reuse water quality in the existing system in the Northern Area, a soil sample was collected and submitted to the Reclamation Petrology Laboratory in Denver for mineralogical analysis. The results are shown in Table 23. The soil is primarily composed of alumino-silicates. Recall that there were no aluminum analyses in any of the reuse databases that were input into the MINTEQ simulations. In the absence of aluminum, the silicon in the MINTEQ is apparently precipitated as silica. However, it is almost certain that a very large percentage of the soil minerals are derived from the deposition of particles eroded from elsewhere, rather than deposited chemically *in situ*. Even if there had been aluminum data in the inputs, it would not be enough to come near that contained in the soil sample regard;ess pf how much of it formed alumino-silicates.

In addition to the wide variety of alumino-silicate minerals in the sample, at the lower end of the measurable minerals in the soil sample were hematite, calcite, and gypsum, each of which was deposited at some point in the MINTEQ simulations. The presence of measurable concentrations of these minerals in the soil sample helps to lend credence to the MINTEQ results.

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Table 1. Input data for chemical simulations (all in mg/L unless otherwise noted)				
	Northerly Area	Westlands Drainage Areas		
		North	Central	South
Conductivity (µS/cm)	6,154	14,308	10,923	13,385
TDS (mg/L)	4,000	9,300	7,100	8,700
Chromium (total)	59	0.032	0.025	0.03
Molybdenum	0.034	0.068	0.11	0.22
Temperature (°C)	18	18	18	18
Field pH	8.2	7.7	7.7	7.7
Eh (Volts)	0.3	0.3	0.3	0.3
Calcium	290	440	340	410
Magnesium	93	200	150	190
Sodium	600	1700	1300	1600
Potassium	9.2	7	6	7
Chloride	550	1000	780	950
Sulfate	1,500	3700	2900	3500
Bicarbonate	170	230	170	210
Iron (total)	0.13	0.068	0.12	0.14
Silica	35	37	29	35
Ammonium	1	1	1	1
Boron	9.1	10	6.7	7.7
Nitrate (as N)	44	53	41	50
Strontium	6	6.4	5	6
Bromide	2.2	1.6	1.2	1.5
Manganese	0.002	0.01	0.008	0.009
Copper	0.0034	0.01	0.008	0.009
Zinc	0.24	0.01	0.008	0.009
Cadmium	0.03	0.037	0.025	0.035
Lead	0.0048	0.001	0.001	0.001
Nickel	0.0053	0.02	0.015	0.019
Silver		0.001	0.001	0.001
Selenium (total)	1.2	1.2	1.2	1.2
Selenite (Se^{IV})	0.01	0.01	0.003	0.001
Selenate (Se^{VI})	0.12	0.1	0.057	0.019

Table 2. List of WATEQ oversaturated Solids from the Northerly Areas simulation of raw drain water and increases by 3 concentrations factors

Mineral	Composition	Saturation Indices			
		Drain Water	Concentration Factor		
			2.5	3.3	4
Goethite	FeOOH	7.996	8.399	8.523	8.61
Dolomite (c)	$CaMg(CO_3)_2$	1.559	2.752	3.109	3.356
Ferrihydrite	$Fe_2O_3 \cdot 0.5H_2O$	2.360	2.762	2.886	2.972
Dolomite (d)	$CaMg(CO_3)_2$	0.980	2.173	2.529	2.777
Sepiolite (c)	$Mg_2Si_3O_6(OH)_4$	1.306	1.849	2.023	2.149
Chrysotile	$Mg_3[Si_2O_5](OH)_4$	0.885	1.674	1.922	2.099
Jarosite K	$KFe_3(SO_4)_2(OH)_6$	—	1.08	1.694	2.119
Calcite	$CaCO_3$	0.898	1.492	1.669	1.792
Aragonite	$CaCO_3$	0.749	1.343	1.52	1.643
Magnesite	$MgCO_3$	0.101	0.7	0.88	1.004
Quartz	SiO_2	0.850	0.861	0.867	0.872
Otavite	$CdCO_3$	—	0.358	0.493	0.583
Strontianite	$SrCO_3$	—	0.305	0.482	0.605
Cristobalite	SiO_2	0.448	0.459	0.465	0.47
Chalcedony	SiO_2	0.399	0.41	0.416	0.421
Celestite	$SrSO_4$	—	0.159	0.304	0.403
Gypsum	$CaSO_4 \cdot H_2O$	—	0.133	0.276	0.375
Anhydrite	$CaSO_4$	—	—	0.037	0.137

Table 3. List of WATEQ oversaturated Solids from the Westlands North Area simulation of raw drain water and increases by 3 concentrations factors

Mineral	Composition	Saturation Indices			
		Drain Water	Concentration Factor		
			2.5	3.3	4
Goethite	FeOOH	7.718	8.129	8.259	8.352
Ferrihydrite	$Fe_2O_3 \cdot 0.5H_2O$	2.081	2.491	2.62	2.711
Dolomite (c)	$CaMg(CO_3)_2$	1.034	2.245	2.619	2.882
Jarosite K	$KFe_3(SO_4)_2(OH)_6$	0.092	2.111	2.73	3.165
Dolomite (d)	$CaMg(CO_3)_2$	0.455	1.665	2.04	2.303
Calcite	$CaCO_3$	0.559	1.161	1.347	1.477
Aragonite	$CaCO_3$	0.410	1.012	1.198	1.328
Quartz	SiO_2	0.891	0.917	0.906	0.943
Magnesite	$MgCO_3$	—	0.524	0.713	0.845
Cristobalite	SiO_2	0.489	0.515	0.505	0.541
Chalcedony	SiO_2	0.439	0.465	0.455	0.491
Gypsum	$CaSO_4 \cdot H_2O$	—	0.422	0.567	0.669
Sepiolite(c)	$Mg_2Si_3O_6(OH)_4$	—	0.398	0.537	0.768
Celestite	$SrSO_4$	—	0.297	0.442	0.545
Anhydrite	$CaSO_4$	—	0.185	0.332	0.435
Strontianite	$SrCO_3$	—	—	0.003	0.132
Otavite	$CdCO_3$	—	—	—	0.077

Table 4. List of WATEQ oversaturated Solids from the Westlands Central Area simulation of raw drain water and increases by 3 concentrations factors

Mineral	Composition	Saturation Indices			
		Drain Water	Concentration Factor		
			2.5	3.3	4
Goethite	FeOOH	7.964	8.370	8.497	8.587
Jarosite K	$KFe_3(SO_4)_2(OH)_6$	0.659	2.677	3.292	3.721
Ferrihydrite	$Fe_2O_3 \cdot 0.5H_2O$	2.327	2.732	2.858	2.948
Dolomite (c)	$CaMg(CO_3)_2$	0.640	1.845	2.215	2.474
Dolomite (d)	$CaMg(CO_3)_2$	0.060	1.266	1.636	1.895
Calcite	$CaCO_3$	0.369	0.969	1.152	1.281
Aragonite	$CaCO_3$	0.220	0.820	1.004	1.132
Quartz	SiO_2	0.781	0.801	0.894	0.821
Magnesite	$MgCO_3$	—	0.317	0.503	0.633
Cristobalite	SiO_2	0.379	0.399	0.492	0.419
Chalcedony	SiO_2	0.330	0.350	0.442	0.370
Gypsum	$CaSO_4 \cdot H_2O$	—	0.294	0.438	0.538
Celestite	$SrSO_4$	—	0.173	0.317	0.418
Sepiolite (c)	$Mg_2Si_3O_6(OH)_4$	—	—	0.307	0.207
Anhydrite	$CaSO_4$	—	0.056	0.201	0.302

Table 5. List of WATEQ oversaturated Solids from the Westlands South Area simulation of raw drain water and increases by 3 concentrations factors

Mineral	Composition	Saturation Indices			
		Drain Water	Concentration Factor		
			2.5	3.3	4
Goethite	FeOOH	8.031	8.442	8.571	8.663
Jarosite K	$KFe_3(SO_4)_2(OH)_6$	1.009	3.027	3.645	4.078
Ferrihydrite	$Fe_2O_3 \cdot 0.5H_2O$	2.394	2.803	2.931	3.022
Dolomite (c)	$CaMg(CO_3)_2$	0.928	2.137	2.510	2.772
Dolomite (d)	$CaMg(CO_3)_2$	0.348	1.557	1.931	2.193
Calcite	$CaCO_3$	0.501	1.103	1.288	1.418
Aragonite	$CaCO_3$	—	0.954	1.139	1.269
Quartz	SiO_2	0.866	0.89	0.903	0.915
Magnesite	$MgCO_3$	—	0.474	0.662	0.794
Gypsum	$CaSO_4 \cdot H_2O$	—	0.388	0.532	0.634
Cristobalite	SiO_2	0.464	0.488	0.501	0.513
Sepiolite (c)	$Mg_2Si_3O_6(OH)_4$	—	0.289	0.496	0.652
Chalcedony	SiO_2	0.414	0.439	0.452	0.463
Celestite	$SrSO_4$	—	0.265	0.410	0.512
Anhydrite	$CaSO_4$	0.353	0.151	0.297	0.400
Strontianite	$SrCO_3$	—	—	—	0.077
Otavite	$CdCO_3$	—	—	—	0.034

Table 6. Summary of concentrations of precipitated solids in the reuse area after subsequent applications of drain water

Precipitated solids		Concentration (mg/L) following consecutive irrigations						
Mineral	Composition	After 1st	After 2nd	% increase	After 3rd	% increase	After 4th	% increase
Calcite	$CaCO_3$	—	—	—	693.7	—	1570	126%
Celestite	$SrSO_4$	50.3	100.7	100%	152.1	51%	202.7	33%
Dolomite	$CaMg(CO_3)_2$	227	468	106%	289	-38%	—	—
Gypsum	$CaSO_4 \cdot 2H_2O$	2515	5033	100%	6990	39%	8853	27%
Hematite	Fe_2O_3	0.2	0.4	100%	0.6	50%	0.8	33%
Quartz	SiO_2	2.6	15.8	505%	38.1	141%	89.8	136%
Tremolite	$Ca_2(Mg,Fe^{+2})_5[Si_8O_{22}](OH,F)_2$	49.7	81.9	65%	98.9	21%	—	—
Chrysotile	$Mg_3[Si_2O_5](OH)_4$	—	—	—	—	—	61.1	—

Table 7. Sequence of Activity in MINTEQ simulation of Northerly Area drain water concentrated by a factor of 3.3		
Iteration	Mineral	Result
20	Hematite	Precipitates
25	Calcite	Precipitates
68	Quartz	Precipitates
73	Gypsum	Precipitates
126	Tremolite	Precipitates
137	Quartz	Dissolves
152	Celestite	Precipitates
160	Dolomite	Precipitates
167	Calcite	Dissolves
177	Quartz	Precipitates

Table 8. Summary of concentrations of dissolved solids in the reuse water after subsequent applications of drain water from the Northerly Area						
Constituent	Units	Concentration after each application for irrigation				
		Initial	1st	2nd	3rd	4th
Calcium	mg/L	957	300	176	121	92
Magnesium	mg/L	307	256	219	254	288
Sodium	mg/L	1980	1980	1980	1980	1980
Potassium	mg/L	30	30	30	30	30
Sulfate	mg/L	4950	3549	2767	2465	2188
Chloride	mg/L	1815	1815	1815	1815	1815
Bicarbonate	mg/L	561	120	52	27	19
Silica	mg/L	58	7	3	2	1
Strontium	mg/L	20	11	7	5	4
Nitrate	mg/L	145	145	145	145	145
Boron	mg/L	30.1	30.4	30.4	30.4	30.4
Selenium	µg/L	466	341	341	341	341
Fluoride	mg/L	0.3	0.3	0.3	0.3	0.3
Iron	µg/L	130	0	0	0	0
TDS	mg/L	10,858	8,248	7,229	6,879	6,597

Table 9. Boron speciation — MINTEQ simulation of the Northerly Area	
Ion	mg/L as B
H_3BO_3 (aq.)	28.96
$H_2BO_3^{-1}$	1.43
$BF(OH)_3^-$	0.00015
$BF_2(OH)_2^-$	2.45E-09
BF_3OH^-	4.48E-16
BF_4^-	2.69E-22

Table 10. Northerly Area changes in TDS and dissolved constituents in winter recharge water before and after contact with precipitated minerals					
Constituent	Units	Recharge	Leachate	Change	% Change
Boron	mg/L	4.1	4.1	0	0.0%
Bicarbonate	mg/L	29	8.1	-21	-72.1%
Calcium	mg/L	0.2	368	368	184,040%
Chloride	mg/L	6	5.5	0	0.2%
Iron	µg/L	10	0	-10	-100.0%
Potassium	mg/L	0.1	0.1	0	0.0%
Magnesium	mg/L	0.2	0.1	0	-73.5%
Nitrate	mg/L	0.2	0.2	0	0.0%
Sodium	mg/L	24.8	24.8	0	0.0%
Sulfate	mg/L	22.3	959.3	937	4201.9%
Silica	mg/L	5.0	0.1	-5	-97.5%
Strontium	mg/L	0.02	0.01	0	-59.6%
TDS	mg/L	101	1371	1269	1250.7%

Table 11. Sequence of Activity due to exposure to winter recharge		
Iteration	Mineral	Result
24	Tremolite	Precipitates
50	Quartz	Dissolves
61	Chrysotile	Dissolves
67	Quartz	Precipitates

Table 12. Summary of concentrations of precipitated solids in the reuse area before and after exposure to winter recharge			
Precipitated solids		Concentration (mg/L)	
Mineral	Composition	Before	After
Calcite	$CaCO_3$	1570	1581
Celestite	$SrSO_4$	202.7	120.8
Gypsum	$CaSO_4 \cdot 2H_2O$	8852.8	7203.4
Hematite	Fe_2O_3	0.8	0.8
Quartz	SiO_2	89.8	62.0
Tremolite	$Ca_2(Mg,Fe^{+2})_5[Si_8O_{22}](OH,F)_2$	—	113.5
Chrysotile	$Mg_3[Si_2O_5](OH)_4$	61.1	—

Table 13. Initial simulation of the Northerly Area leachate based on 3.3 times the concentrations in Table 1						
Constituent		Final Result – equilibrated mass distribution				
	Concentration (mg/L)		Dissolved		Precipitated	
	Initial	Final	mol/kg	Percent	mol/kg	Percent
Boron	30	30	0.002812	100	0	0
HCO_3^{-1}	561	120	0.002021	21.4	0.007432	78.6
Ca^{+2}	957	300	0.007573	31.4	0.01657	68.6
Cl^{-1}	1,815	1,815	0.05175	100	0	0
F^{-1}	0.3	0.3	1.6E-05	100	0	0
Fe^{+3}	0.1	< 0.001	8.75E-18	0	0	100
K^{+1}	30.4	30.4	1.62E-15	100	0.0000024	0
Mg^{+2}	307	256	0.000785	83.3	0	16.7
NH_4^{+1}	3.3	3.3	0.01063	100	0.002133	0
NO_3^{-1}	145.2	145	0.000184	100	0	0
Na^{+1}	1,980	1,980	0.002368	100	0	0
SO_4^{-2}	4,950	3,549	0.08706	71.7	0	28.3
Selenium	0.4	0.4	0.03736	100	0.01472	0
H_4SiO_4	58	7.0	5.38E-06	12.1	0	87.9
Sr^{+2}	20	10.7	7.4E-05	53.3	0.000536	46.7
pH	8.2	7.9	0.000122		0.000107	
TDS	10,494	7,990				

Table 14. Simulation of the Northerly Area leachate based on 3.3 times the concentrations in Table 1 – CO_2 increased to 0.35 atmosphere, based on data from drains in the Grand Valley

Constituent	Concentration (mg/L)		Dissolved		Precipitated	
	Initial	Final	mol/kg	Percent	mol/kg	Percent
Boron	30	30	0.002812	100	0	0
HCO_3^{-1}	561	237	0.005073	42.2	0.003422	57.8
Ca^{+2}	957	303	0.007647	31.7	0.01649	68.3
Cl^{-1}	1815	1815	0.05175	100	0	0
F^{-1}	0.9	0.9	4.79E-05	100	0	0
Fe^{+3}	0.13	< 0.001	2.47E-15	0	0.0000024	100
K^{+1}	30.36	30.4	0.000785	100	0	0
Mg^{+2}	306.9	266	0.01105	86.6	0.001711	13.4
NH_4^{+1}	3.3	3.3	0.000185	100	0	0
NO_3^{-1}	145.2	145	0.002367	100	0	0
Na^{+1}	1980	1980	0.08706	100	0	0
SO_4^{-2}	4950	3534	0.0372	71.4	0.01488	28.6
Selenium	0.4	0.4	5.38E-06	100	0	0
H_4SiO_4	58	7.0	7.36E-05	12.1	0.000536	87.9
Sr^{+2}	19.8	10.7	0.000123	53.9	0.000105	46.1
TDS	10,494	8,045				
pH	8.2	7.5				

Table 15. Simulation of the Westlands North Reuse Area leachate based on 3.3 times the concentrations in Table 1 – CO_2 set to 0.35 atm. based on data from drains in the Grand Valley

	Concentration (mg/L)		Dissolved		Precipitated	
Name	Initial	Final	mol/kg	Percent	mol/kg	Percent
Boron	33	33	0.002812	100	0	0
HCO_3^{-1}	759	261	0.00538	34.4	0.01026	65.6
Ca^{+2}	1,452	221	0.005629	15.2	0.03149	84.8
Cl^{-1}	3,300	3,300	0.09538	100	0	0
F^{-1}	0.9	0.9	0.000049	100	0	0
Fe^{+3}	0.22	0.0	2.67E-15	0	0.0000041	100
K^{+1}	23.1	23.1	0.000605	100	0	0
Mg^{+2}	660	600	0.02529	90.9	0.002523	9.1
NH_4^{+1}	3.3	3.3	0.000188	100	0	0
NO_3^{-1}	175	175	0.00289	100	0	0
Na^{+1}	5,610	5,610	0.25	100	0	0
SO_4^{-2}	12,210	9,475	0.1011	77.6	0.02912	22.4
Selenium	0.36	0.4	0.000070	100	0	0
H_4SiO_4	62	6.5	0.000097	10.5	0.000591	89.5
Sr^{+2}	21.1	8.3	0.000097	39.4	0.00015	60.6
TDS	24,014	19,357				

pH	7.7	7.4

Table 16. Simulation of the Westlands Central Reuse Area leachate based on 3.3 times the concentrations in Table 1 – CO_2 set to 0.35 atm. based on data from drains in the Grand Valley

Constituent	Concentration (mg/L)		Dissolved		Precipitated	
	Initial	Final	mol/kg	Percent	mol/kg	Percent
Boron	22	22	0.002077	100	0	0
HCO_3^{-1}	559	228	0.002391	40.8	0.003468	59.2
Ca^{+2}	1,122	232	0.005916	20.7	0.02261	79.3
Cl^{-1}	2,574	2,574	0.07399	100	0	0
F^{-1}	0.9	0.9	0.000048	100	0	0
Fe^{+3}	0.46	< 0.001	2.16E-15	0	0.0000072	100
K^{+1}	19.8	19.8	0.000516	100	0	0
Mg^{+2}	495	453	0.01902	91.6	0.001734	8.4
NH_4^{+1}	3.3	3.3	0.000186	100	0	0
NO_3^{-1}	135	135	0.002224	100	0	0
Na^{+1}	4,290	4,290	0.1902	100	0	0
SO_4^{-2}	9,570	7,589	0.08053	79.3	0.02099	20.7
Selenium	0.2	0.2	0.000003	100	0	0
H_4SiO_4	58	6.7	0.000071	11.6	0.000544	88.4
Sr^{+2}	16.5	7.0	0.000082	42.6	0.00011	57.4
TDS	18,630	15,271				
pH	7.7	7.6				

Table 17. Simulation of the Westlands South Drainwater Area leachate based on 3.3 times the concentrations in Table 1 – CO_2 set to 0.35 atm. based on data from drains in the Grand Valley

Constituent	Concentration (mg/L)		Dissolved		Precipitated	
	Initial	Final	mol/kg	Percent	mol/kg	Percent
Boron	4.4	4.4	0.00042	100	0	0
HCO_3^{-1}	693	255	0.002629	36.8	0.004509	63.2
Ca^{+2}	1,353	222	0.005671	16.4	0.02887	83.6
Cl^{-1}	3,135	3,135	0.09047	100	0	0
F^{-1}	0.9	0.9	0.000048	100	0	0
Fe^{+3}	0.462	< 0.001	2.32E-15	0	0.0000085	100
K^{+1}	23.1	23.1	0.000604	100	0	0
Mg^{+2}	627	574	0.02413	91.5	0.002254	8.5
NH_4^{+1}	3.3	3.3	0.000187	100	0	0
NO_3^{-1}	165	165	0.002723	100	0	0
Na^{+1}	5,280	5,280	0.235	100	0	0
SO_4^{-2}	11,550	9,032	0.09625	78.2	0.02677	21.8
Selenium	0.1	0.1	0.0000008	100	0	0
H_4SiO_4	58	6.6	0.000070	11.3	0.000547	88.7
Sr^{+2}	19.8	6.5	0.000076	32.9	0.000155	67.1
TDS	22,661	18,391				
pH	7.7	7.5				

Table 18. Drainwater Quality After Reuse for the In-Valley Disposal Alternative and the Out-of-Valley Disposal Alternatives (FEIS Table C2.8)

Constituent	Unit	North Westlands	Central Westlands	South Westlands	Northerly Area
Sodium	mg/L	4,463	3,086	4,747	2,231
Potassium	mg/L	19	13	20	35
Calcium	mg/L	1,132	783	1,204	1,073
Magnesium	mg/L	522	361	555	349
Hardness	mg/L	4,975	3,440	5,291	4,550
Alkalinity	mg/L	508	352	541	638
Sulfate	mg/L	9,685	6,697	10,302	5,625
Chloride	mg/L	2,618	1,810	2,785	2,048
Nitrate (NO_3)	mg/L	609	421	648	165
Nitrate (N)	mg/L	137	95	146	37
Ammonia	mg/L	0.03	0.02	0.03	4
Silica	mg/L	96	67	103	NA
Bicarbonate	mg/L	585	404	622	649
Carbonate	mg/L	NA	NA	NA	14
Bromide	mg/L	4	3	4	8
TDS	mg/L	24,000	16,596	25,528	12,285
TSS	mg/L	26	18	28	NA
TOC	mg/L	10	7	9	10
COD	mg/L	30	23	28	NA
BOD	mg/L	8	5	8	NA
Temperature	°C	18.1	NA	NA	NA
pH	SU	7.7	7.7	7.7	8.2
Boron	µg/L	22,140	15,613	16,781	25,759
Selenium	µg/L	270	130	56	293
Strontium	µg/L	16,684	11,537	17,747	NA
Iron	µg/L	391	270	416	NA
Molybdenum	µg/L	150	335	343	85
Aluminum	µg/L	NA	NA	NA	NA
Arsenic	µg/L	8	5	8	31
Cadmium	µg/L	3	2	3	NA
Chromium	µg/L	84	58	89	22
Copper	µg/L	26	18	28	13
Lead	µg/L	3	2	3	18
Manganese	µg/L	26	18	28	8
Mercury	µg/L	0.3	0.2	0.3	0.8
Nickel	µg/L	52	36	55	20
Silver	µg/L	3	2	3	NA
Zinc	µg/L	26	18	28	9

Table 19. Summary of Northerly Area MINTEQ simulation of EIS reuse data

Constituent	Concentration (mg/L)		Percent of initial concentration	
	Input	Output	Dissolved	Precipitated
B	25.7	26.0	100	0
HCO_3	677	154	36.6	63.4
Ca	1,073	296	27	72.7
Cl	2,048	2,076	100	0
F	0.9	0.9	100	0
Fe^{III}	0.430	< 0.001	0.0	100
K	35	35.4	100	0
Mg	349	300	85	15
NH_4-N	3.11	3.14	100	0
NO_3-N	37	38	100	0
Na	2,231	2,260	100	0
SO_4	5,625	3,999	70.3	29.7
Se^{IV}	0.012	0.012	100	0
Se^{VI}	0.273	0.276	100	0
SiO_2	116.9	4.4	3.7	96.3
Sr	20	10.3	50.8	49.2
TDS	11,694	9,043		
pH	8.2	7.45		

Table 20. Summary of Westlands North MINTEQ simulation of EIS reuse data

Constituent	Concentration (mg/L)		Percent of initial concentration	
	Input	Output	Dissolved	Precipitated
B	22.2	22.6	100	0
HCO_3	586	160	42.1	57.9
Ca	1,132	234	20	79.7
Cl	2,618	2,674	100	0
F	0.9	0.9	100	0
Fe^{III}	0.391	< 0.001	0.0	100
K	19	19	100	0
Mg	522	489	92	8.2
NH_4-N	0.02	0.02	100	0
NO_3-N	138	140	100	0
Na	4,463	4,554	100	0
SO_4	9,685	7,833	79.3	20.7
Se^{IV}	0.011	0.011	100	0
Se^{VI}	0.252	0.257	100	0
SiO_2	96.3	4.3	4.3	95.7
Sr	17	9	50.5	49.5
TDS	18,727	15,881		
pH	7.7	7.4		

Table 21. Summary of Westlands Central MINTEQ simulation of EIS reuse data

Constituent	Concentration (mg/L)		Percent of initial concentration	
	Input	Output	Dissolved	Precipitated
B	15.6	15.8	100	0
HCO_3	405	141	51.1	48.9
Ca	783	259	33	67.4
Cl	1,810	1,837	100	0
F	0.9	0.9	100	0
Fe^{III}	0.270	< 0.001	0.0	100
K	13	13.2	100	0
Mg	361	339	93	7.3
NH_4-N	0.02	0.02	100	0
NO_3-N	95	96	100	0
Na	3,086	3,130	100	0
SO_4	6,697	5,606	82.6	17.4
Se^{IV}	0.005	0.005	100	0
Se^{VI}	0.121	0.123	100	0
SiO_2	66.9	4.4	6.4	93.6
Sr	12	8.3	70.9	29.1
TDS	12,949	11,254		
pH	7.7	7.6		

Table 22. Summary of Westlands South MINTEQ simulation of EIS reuse data

Constituent	Concentration (mg/L)		Percent of initial concentration	
	Input	Output	Dissolved	Precipitated
B	16.8	17.1	100	0
HCO_3	622	159	40.1	59.9
Ca	1,204	234	19	80.9
Cl	2,785	2,848	100	0
F	0.9	0.9	100	0
Fe^{III}	0.416	< 0.001	0.0	100
K	20	20.4	100	0
Mg	555	519	92	8.4
NH_4-N	0.02	0.02	100	0
NO_3-N	146	149	100	0
Na	4,747	4,851	100	0
SO_4	10,300	8,305	79	21
Se^{IV}	0.002	0.002	100	0
Se^{VI}	0.052	0.053	100	0
SiO_2	103.2	4.2	4.0	96
Sr	18	7.1	39.0	61
TDS	19,917	16,856		
pH	7.7	7.5		

Table 23. Mineral composition of a soil sample from the Northerly Area

Mineral	Formula	Concentration	
		ppm	mmoles
Montmorillonite	$(Al,Fe^{+3},Mg)_3(OH)_2[Si_4O_{10}]Na_x \cdot nH_2O$	220,000	320.37
Kaolinite	$Al_4(OH)_8[Si_4O_{10}]$	165,000	319.62
Mica	$K(Al,Mg)(AlSi_3)O_{10}(OH)_2$	110,000	251.16
Chlorite	$(Al,Fe,Mg)_3(OH)_2(Al,Si)_4O_{10}Mg_3(OH)_6$	27,500	78.39
Feldspars	$(K,Na)AlSi_3O_8$	27,500	118.40
Microcline	$KAlSi_3O_8$	22,500	80.82
Plagioclase[1]	$(Na,Ca)AlSi_3O_8$	180,000	664.75
Albite	$NaAlSi_3O_8$	45,000	171.57
Andesine	$NaAlSi_3O_8$	45,000	171.57
Oligoclase	$NaAlSi_3O_8$	45,000	171.57
Hematite	Fe_2O_3	38,500	241.1
Calcite	$CaCO_3$	13,500	135.0
Gypsum	$CaSO_4$	9,000	66.1
	K_2O	6,600	70.1

[1] Albite is the only plagioclase feldspar in the MINTEQ minerals data base. If all of the plagioclase is converted to albite, the concentration in millimoles is 1,201.

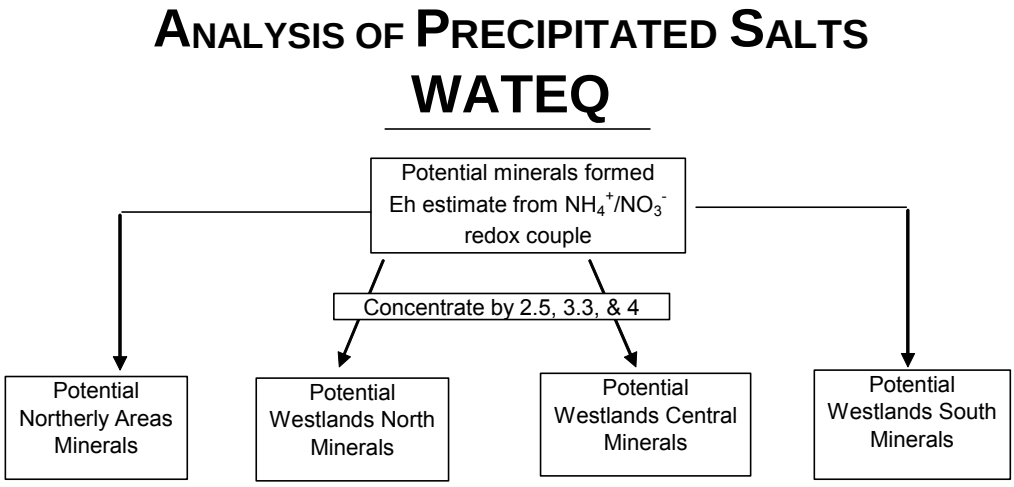

Figure 1. Overview of WATEQ simulations of irrigation water in the reuse area

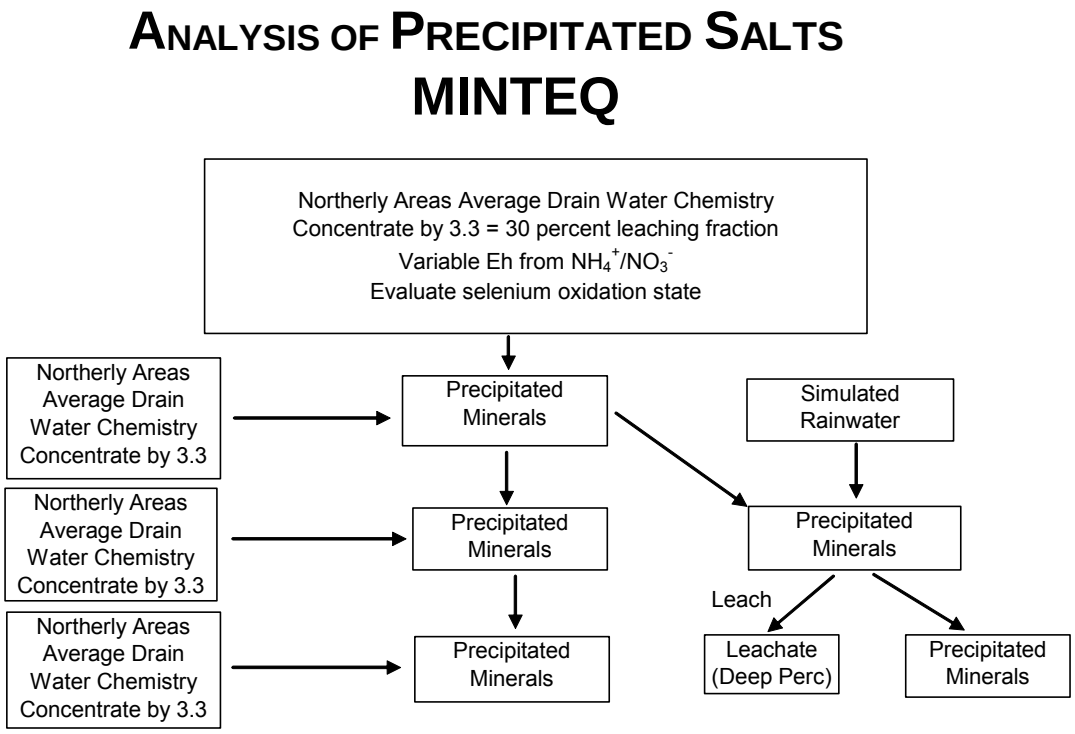

Figure 2. Outline of the procedure followed in the MINTEQ simulations of the irrigation water in the reuse areas

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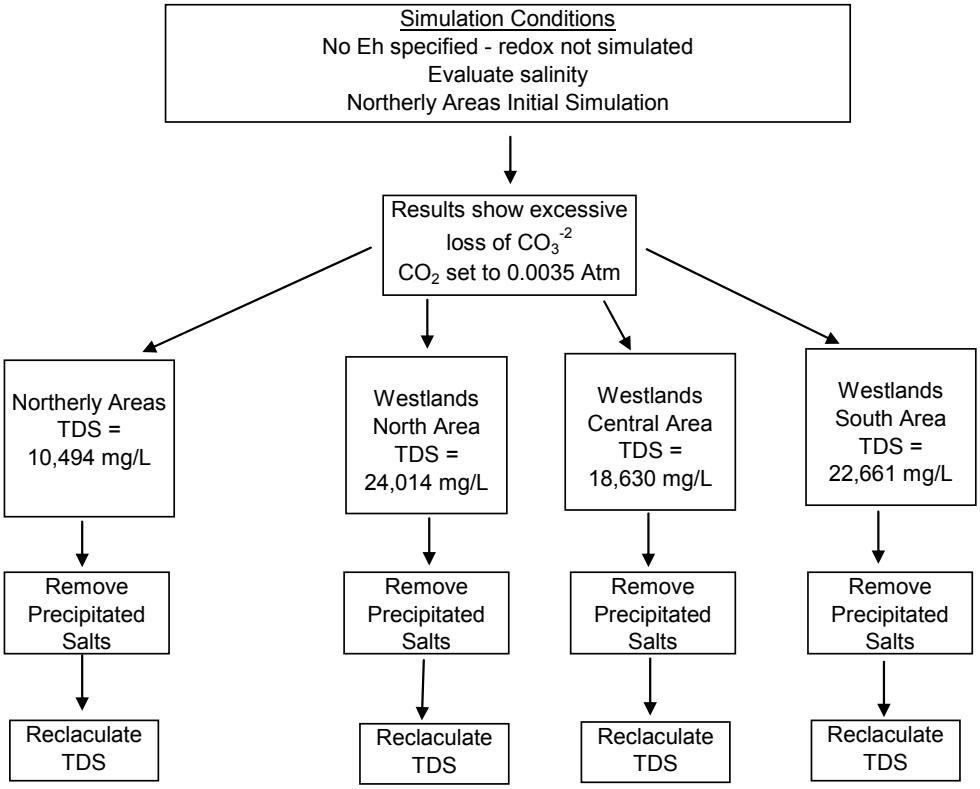

Figure 3. Outline of the procedure followed in the simulation of the inflow to the reverse osmosis plants