DEMONSTATION TESTING OF ZENOGEM AND REVERSE OSMOSIS FOR INDIRECT POTABLE REUSE

FINAL TECHNICAL REPORT

City of McAllen, TX

Cooperative Assistance Agreement No. 98-FC-81-0073

Desalination Research and Development Program Report No. 51

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This study involved demonstration-scale testing of an integrated membrane bioreactor (MBR)/reverse osmosis (RO) treatment train to reclaim the City of McAllen's municipal wastewater to a quality suitable for use as a new drinking water supply. The demonstration testing objectives include: (1) demonstration that RO product water meets all federal primary and State secondary drinking water regulations, (2) demonstrate reliable operation of the MBR on screened, degritted sewage, particularly with respect to control of membrane fouling through automatic cleaning, (3) demonstrate the MBR filtrate (RO feedwater) can be efficiently processed by composite RO membranes with minimal fouling, and (4) develop estimates of capital and operating costs for a MBR/RO system. The results showed that (1) the ZenoGem process is capable of producing a filtrate suitable for RO treatment while meeting the City's current wastewater effluent discharge requirements, and (2) the RO system is capable of producing a filtrate that meets all drinking water/reuse standards with minimal fouling and effective membrane cleanings.

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by

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Acronyms and Abbreviations

ACOE	Army Corps of Engineers
ALK	alkalinity
ASL	Applied Sciences Laboratory
bio-P	biological phosphorus
BOD	biochemical oxygen demand
BOR	Bureau of Reclamation
C	celsius
$CBOD_5$	carbonaceous biochemical oxygen demand
cfm	cubic feet per minute
CFU	colony forming units
CIP	clean in place
COD	chemical oxygen demand
CST	capillary suction time
CSWS	Central and Southwest Services
DO	dissolved oxygen
DSVI	diluted sludge volume index
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ft^2	square feet
g/L	grams per liter
GAC	granular activated carbon
gfd	gallons per square foot per day
gpd	gallons per day
gpm	gallons per minute
HAA	haloacetic acid
HPC	heterotrophic plate count
HRT	hyraulic residence time
I&C	instrumentation and controls
in Hg	inches of mercury
IPR	indirect potable reuse
KLT	King Lee Technologies
MBR	membrane bioreactor
MCL	maximum contaminant level
MF	microfiltration
mg/L	milligrams per liter
mgd	million gallons per day
mL	milliliters
ML	million liters
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter
N	nitrogen

NH_3-N	ammonia nitrogen
NPF	normalized product flow
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OUR	oxygen uptake rate
P	phosphorus
pCi/L	picoCuries per liter
PDC	pressure drop coefficient
PLC	programmable logic controller
ppm	parts per million
psi	pounds per square inch
psig	pounds per square inch gauge
RO	reverse osmosis
scfm	standard cubic feet per minute
SDI	silt density index
SDS	screened degritted sewage
SDWA	Safe Drinking Water Act
SI	solubility index
SRT	solids retention time
TDS	total dissolved solids
THM	trihalomethane
TKN	total Kjeldahl nitrogen
TMP	transmembrane pressure
TN	total nitrogen
TNRCC	Texas Natural Resources Conservation Committee
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
TWDB	Texas Water Development Board
UF	ultrafiltration
UOSA	Upper Occoquan Sewage Authority
UV	ultraviolet
µg/L	micrograms per liter
µm	microns
µS/cm	microSiemens per centimeter
WWTP	wastewater treatment plant

SI Metric Conversions

English Unit	Multiply By	SI Metric Unit
ft^2	0.0929	m^2
gal	3.785	L
gal	0.003785	m^3
gpm	0.06309	L/s
gpd/ft^2	1.698	$L/m^2/hour$
in	2.54	cm
lb	454	g
psi	0.0703	kg/cm^2

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SECTION 1

Introduction and Background

This report documents wastewater reclamation demonstration testing performed at the McAllen, Texas, wastewater treatment plant (WWTP) No. 2. The study was conducted under Task D: Water Recycling and Reuse of the U.S. Bureau of Reclamation's (BOR) Desalination Research and Development Program. The Program sponsors this research in an effort to lower the cost of treatment technologies. Testing was conducted from February 1999 to October 1999.

The results of previous pilot testing conducted for the City of McAllen (*Water Treatment Technology Program Report No. 26*) concluded that treating the City's wastewater with a membrane bioreactor (MBR) system (ZenoGem) followed by reverse osmosis (RO) and final disinfection (chlorination or ultraviolet [UV] light) may provide for a simpler, potentially less costly, treatment process for the reclamation of a portion of the City's wastewater to supplement current water supplies obtained from the Rio Grande River. The reclaimed water produced by the MBR/RO/disinfection process would in most respects contain significantly lower concentrations of most substances currently regulated under the Safe Drinking Water Act (SDWA), and as such, could improve the inorganic quality of the Rio Grande River water. However, unlike microfiltration (MF), which has been used extensively for RO pretreatment of secondary effluent, no testing has been reported on the use of the ZenoGem process to convert wastewater directly to RO feedwater for the purpose of producing a high quality effluent suitable for indirect potable reuse.

The purpose of this study was threefold: 1) to demonstrate the long-term operability and reliability of the ZenoGem system, 2) demonstrate the feasibility of RO treatment of ZenoGem permeate for the production of reclaimed water, and 3) determine if the MBR/RO process has operational, cost, and water quality benefits compared to the conventional WWTP/MF/RO in the context of indirect potable reuse (IPR).

This section addresses the following information:

- Defines indirect potable reuse.
- Explains the City of McAllen's motivations for considering implementation of indirect potable reuse to help solve their water supply problems.
- Describes the regulatory issues associated with implementation, and explains the reasons membrane processes, in particular MF/ultrafiltration (UF) and RO, are integral to its implementation.
- Presents conclusions and recommendations from this study.

1.1 Indirect Potable Reuse—Definition and History

Indirect potable reuse is the recovery of water from wastewater for the purposeful re-introduction into either a surface water or groundwater body that ultimately serves as a drinking water supply. Unplanned IPR has been occurring since humans first began disposing of wastewater into watersheds that are hydrologically connected to raw water supplies. Planned IPR began in the U.S. in the 1960s. A summary of some of the major milestones in the development of potable reuse as a viable component of a water resource management plan is presented below.

The Whittier Narrows Groundwater Replenishment Project, California. In 1962, the County Sanitation Districts of Los Angeles began spreading disinfected secondary effluent from a 10-million-gallon-per-day (mgd) (37.9 million liters [ML]/day) water reclamation plant to an underground potable water supply. The reclaimed water accounts for an annual average of 16 percent of the total inflow to the groundwater basin. The local population is estimated to be exposed to from 0 to 23 percent reclaimed water. An independent scientific advisory panel to the State of California conducted an extensive review of the project data and concluded that the Whittier Narrows Groundwater Replenishment Project was as safe as commonly used surface water supplies.

Orange County, California, Water District. Since 1976, the Orange County, California, Water District's Water Factory 21 has been reclaiming unchlorinated secondary effluent to drinking water quality and recharging it into a heavily used groundwater source to prevent salt water intrusion. The water recovery treatment facility is a 15-mgd (56.8 ML/day) facility that includes lime clarification, air stripping, recarbonation, filtration, carbon adsorption, slip-stream RO, and disinfection. It is estimated that less than 5 percent of the domestic water supply is comprised of the recovered water. The Orange County Water District has not identified any significant risk to users of the groundwater from the indirect potable reuse practice.

Upper Occoquan Sewage Authority Water Reclamation Plant, Virginia. In 1978, the 15-mgd Upper Occoquan Sewage Authority (UOSA) Water Reclamation Plant in northern Virginia began reclaiming wastewater for subsequent discharge to the Occoquan Reservoir. This reservoir is a critical source of drinking water for approximately 1 million people. The reclaimed water has accounted for as much as 90 percent of the flow into the reservoir. Treatment includes primary treatment, secondary treatment, biological nitrification, lime clarification and recarbonation, filtration, activated carbon adsorption, and disinfection. The plant has been expanded to 26 mgd (98.4 ML/day) and will be further expanded to 54 mgd (204 ML/day) by the year 2000. No negative health effects have been attributed to the plant or effluent discharges.

Potomac Estuary Experimental Water Treatment Plant, Washington, D.C. From 1981 to 1983, the 1-mgd (3.8 ML/day) Potomac Estuary Experimental Water Treatment Plant was operated with an influent blend of Potomac Estuary water and nitrified secondary effluent. The blend was designed to simulate influent water quality expected during drought conditions when up to 50 percent of the estuary flow may comprise treated wastewater. Treatment included aeration, coagulation, clarification, pre-disinfection, filtration, carbon adsorption, and post-disinfection. An independent panel reviewed the extensive testing performed by the U.S. Army Corps of Engineers (ACOE) and concluded that the advanced treatment could recover water from a highly contaminated source similar in quality to three major water supplies for the Washington, D.C., metropolitan area.

San Diego Total Resource Recovery Project, California. In 1983, a 1-mgd potable water recovery demonstration facility was commissioned as part of a total resource recovery program established in San Diego, California. The purpose of the treatment system was to reclaim raw water from raw wastewater. The system included primary treatment, a water hyacinth aquaculture system, coagulation, clarification, filtration, UV disinfection, RO, aeration, carbon adsorption, and disinfection. An extensive chronic toxicity risk analysis showed that the risk associated with use of the recovered water as a raw water supply was less than or equal to the use of the existing raw water entering the City's Miramar Water Treatment Plant. The City is now planning to reclaim up to 20 mgd (75.7 ML/day) of secondary effluent for augmentation of their 90,000 acrefoot San Vicente Reservoir for eventual distribution to water customers.

El Paso, Texas, Fred Hervey Water Reclamation Plant. The 10-mgd (37.9 ML/day) Fred Hervey Water Reclamation Plant began operation in El Paso, Texas, in 1985. The recovered water is recharged to the Hueco Bolson drinking water aquifer where, over a 2-year period, the water travels to one of El Paso's potable water wellfields to become part of the potable water supply. The treatment system includes primary treatment, activated sludge/powdered activated carbon treatment, lime treatment, recarbonation, filtration, ozonation, and granular activated carbon (GAC) adsorption. Although no negative health effects have been correlated with the reuse practice, an increase in the total dissolved solids (TDS) content of the aquifer has occurred because the increased pumping has lowered the aquifer level to the higher salinity water source. Slip-stream demineralization will be included in future plant expansions to address the TDS issue.

Tampa Water Resource Recovery Project, Florida. The City of Tampa's Water Resource Recovery Pilot Plant began operation in 1986 with the purpose of evaluating the feasibility of reclaiming denitrified secondary effluent to a quality suitable for blending with existing surface water and groundwater sources for indirect potable reuse. Several treatments were evaluated, and one was selected for health effects testing. This treatment system consisted of aeration, high pH lime clarification, recarbonation, filtration, GAC adsorption, and ozonation. The results of the health effects testing coupled with the microbiological and chemical analyses performed during the evaluation indicated that the quality of the reuse water was equivalent to or exceeded the quality of the local raw water supply. The City of Tampa intends to develop a 20- to 50-mgd (189 ML/day) water resource recovery plant in the near future.

West Basin Water Recycling Program, California. From 1990 through 1995, the West Basin Municipal Water District conceived, designed, constructed, and began operation of the West Basin Water Recycling Program. This program includes reclaiming 5 mgd (18.9 ML/day) (expandable to 20 mgd, or 75.7 ML/day) of secondary effluent from the City of Los Angeles' Hyperion Treatment Plant for injection into the West Coast Basin Barrier Project. The West Coast Basin Barrier Project has historically received an average of 20 mgd of potable water for injection into the coastal reaches of local South Bay aquifers for mitigation of saltwater intrusion. Substituting reclaimed water for the potable water provides substantially greater water use efficiency in the area. Reclamation treatment includes predecarbonation, lime clarification, recarbonation, filtration, RO, postdecarbonation, and final disinfection. Based on hydrogeologic investigation and modeling of the West Coast Basin, it is anticipated that the reclaimed water will improve groundwater quality along the Barrier because of the high quality of the reclaimed water relative to the imported water and the native groundwater.

Reedy Creek Improvement District, Advanced Water Reclamation Program, Florida. In 1992, the Reedy Creek Improvement District began a pilot program to reduce phosphorus (P) and nitrogen (N) in the effluent from their WWTP to very low levels. Although the goal of treatment was not IPR, this was the first project to evaluate the feasibility of using MF and UF as a replacement to lime clarification, recarbonation, and gravity filtration for RO pretreatment. This approach was shown to be so effective that MF and UF have displaced lime treatment as the preferred means of RO pretreatment on subsequent IPR projects.

City of Scottsdale, Arizona, Water Campus Project. In 1994, the City of Scottsdale began pilot testing MF and RO for the purpose of reclaiming wastewater for groundwater recharge. The testing program, which has culminated in a 6.8-mgd (25.7 ML/day) IPR project currently under construction at the City's Water Campus site, represents the first planned IPR project in Arizona. During periods when demand for non-potable reclaimed water is low, product water from the MF/RO system will be blended with filtered surface water and injected into a potable aquifer using dry wells. The 6.8-mgd facility represents the first phase of a multi-year project designed to have an ultimate capacity of 25 mgd (94.6 ML/day).

City of San Diego, California, Water Repurification Project. As an outgrowth of their Total Resource Recovery Project, the City of San Diego began the Repurification Project to reclaim up to 20 mgd of wastewater for indirect potable use. The program is currently evaluating the feasibility of using the following advanced water treatment processes to re-purify tertiary effluent from the City's new North City Water Reclamation Plant to a quality suitable for direct discharge to the San Vicente Reservoir, one of the City's main raw water reservoirs: MF/UF, RO, ion exchange, and ozonation. The project represents the first surface supply augmentation IPR project in California and must satisfy stringent California Department of Health Services requirements regarding virus removal and real-time monitoring of individual processes for pathogen removal. If successful, the project will result in the construction of the largest IPR plant in the U.S.

1.2 The Need for Indirect Potable Reuse for the City of McAllen

The City of McAllen, Texas, is located in the Lower Rio Grande Valley near the United States-Mexico border, approximately 40 miles upstream from the mouth of the Rio Grande River. The City presently derives its water supply from water rights in the Rio Grande River that it shares with multiple parties, including other cities, water supply corporations, irrigation districts, and Mexico. The Lower Rio Grande Valley is a growing area with an existing water shortage problem. The Texas Water Development Board (TWDB) reports that all surface water resources in the area are 100 percent appropriated. Additionally, this semi-arid area often experiences drought conditions. Projected growth in population and water use indicates that the demand for potable water will exceed the City's authorized water rights by the year 2003. Consequently, alternative water supply strategies are necessary to ensure a safe, reliable source of potable water.

The two most feasible alternative sources are groundwater and re-purified wastewater. Many of the groundwater supplies in the Lower Rio Grande Valley have an elevated dissolved solids concentration and require demineralization by RO or electrodialysis to make them suitable for potable use. Consequently, wastewater reclamation is considered by the City to be a desirable means of augmenting its water supply.

1.3 Water Quality Considerations and Proposed Treatment Strategy

In general, reclaimed water should be treated to a level where its quality exceeds that of the historical water supply. In Texas, public heath issues related to the use of reclaimed water fall under the purview of the Texas Natural Resources Conservation Commission (TNRCC). The preliminary requirements of the TNRCC with respect to IPR for the City are: 1) reclaimed water must be of equal or better quality than that of the City's current water supply, and 2) RO must be used to treat all of the reclaimed water prior to its reuse. Based on these requirements and in view of the City's desire to reduce the dissolved solids of its finished water to improve consumer acceptability, the following IPR treatment sequence was proposed for the City in 1997 and subsequently demonstrated via testing conducted in that year and reported in *Water Treatment Technology Program Report No. 26*:

- Primary and secondary treatment
- Chlorine disinfection
- MF/UF
- RO
- UV disinfection

This sequence not only satisfies the TNRCC's preliminary requirements, it also provides multiple treatment barriers to the passage of microbial, inorganic, and organic contaminants in the wastewater. The concept of "multiple barriers" has been adopted by the water supply industry to achieve the appropriate level of safety and reliability by providing redundant treatment steps for the removal of wastewater contaminants, primarily pathogens.

1.4 Membrane Technologies in Indirect Potable Reuse

A primary focus of one task of BOR's Desalination Research and Development Program is research on membrane processes for wastewater reclamation. In this context, three membrane processes (MF, UF, and RO) represent key treatment processes in the proposed treatment sequence for IPR at McAllen. RO has been applied for wastewater reclamation for more than two decades and is considered a proven treatment process. RO serves as the "workhorse" for the IPR process because it is efficient in removing nearly all contaminants of public health concern. Cost-effective RO operation on municipal wastewater requires a high degree of preliminary treatment to control membrane fouling. Such treatment is provided through the use of MF/UF to polish secondary effluent.

During the last 5 years, MF has been shown at demonstration- and full-scale to be a reliable process in the context of IPR. Production MF facilities are currently in operation in California and Arizona with additional facilities planned for Pennsylvania, Virginia, and Georgia. UF technologies have also been demonstrated for the same purpose; however, to date none have been implemented full-scale. All of the MF/UF products at these sites have employed pressure modules.

During the 1997 pilot study at McAllen, pressurized MF was demonstrated for the treatment of effluent from the City's south WWTP using Memcor MF technology. At that time, a novel, immersed MF product (ZeeWeed) was tested and found to provide performance competitive with or somewhat superior to the pressurized MF approach. In addition, ZeeWeed was also evaluated in the context of a membrane bioreactor process (ZenoGem) and found to be feasible for direct treatment of the City's screened, de-gritted wastewater. Preliminary results indicated that the ZenoGem filtrate was of equivalent quality to both Memcor and ZeeWeed filtrate with respect to general water quality (TDS, total organic carbon [TOC], coliforms, and turbidity) but had significantly higher RO feedwater colloidal fouling potential (as measured by silt density index [SDI]). Longer term testing of ZenoGem coupled with a follow-on RO system was recommended at that time and is the subject of this research.

1.5 Conclusions

Conclusions drawn from the results of this study are presented below.

1.5.1 ZenoGem System

- The ZenoGem membrane bioreactor process successfully treated screened, degritted sewage (SDS) to a quality suitable for RO processing.

- The ZenoGem process produced a permeate (see Tables 5.8 through 5.10) that exceeded the City's effluent discharge requirements for carbonaceous biochemical oxygen demand ($CBOD_5$<10 milligrams per liter [mg/L]), total suspended solids (TSS <15 mg/L)), and ammonia nitrogen (NH_3-N <3 mg/L). This result was attained at all mixed liquor suspended solids (MLSS) concentrations and with both membrane types.

- The ZeeWeed OKC MF (0.4-micrometer [µm] pore size) membrane exhibited higher sustained permeability than OCP UF (0.035-µm pore size) membrane at high MLSS levels (13 grams per liter [g/L]).

- Permeability of the MF membrane was sensitive to MLSS level. Permeability was stable at 10 g/L but declined at 13 g/L because of increased membrane fouling not adequately controlled by frequent permeate backpulsing or maintenance cleans.
- At an MLSS concentration of 13 g/L, simultaneous nitrification/denitrification and biological phosphorus (bio-P) removal occurred most likely because of the inability to completely transfer oxygen from the bulk liquid to the interior of the bioflocs at the hydraulic residence time (HRT) selected for this study (5.7 hours). The oxygen transfer limitations inhibited complete nitrification but promoted nitrogen removal.

- At an MLSS concentration of 10 g/L, the rate of oxygen transfer was sufficient to maintain complete nitrification and suppress denitrification and bio-P uptake.

- Flow peaking tests (i.e., permeate flowrate increased for a specific duration of time) were conducted over a 24-hour period to simulate the types of peak loading conditions that typically occur in a conventional WWTP. However, peaking significantly increased the rate of permeability decline and accelerated the fouling rate (fouling not reversed by backpulsing or maintenance cleans as defined in Section 3.2.1). As a result, normal diurnal variations in wastewater flow, in which peak hourly flows can equal 300 percent of average daily flow, must be dampened through flow equalization so that the ZenoGem process can operate at more or less a constant hydraulic loading (flux) rate.

- Intermittent aeration (i.e., air cycled at 15 minutes on/15 minutes off) to the aeration tank (at 6 g/L MLSS concentration) produced the greatest degree of total nitrogen removal (optimum simultaneous nitrification and denitrification).

- With respect to RO feedwater quality, ZenoGem permeate quality consistently exceeded goals for turbidity and SDI, and generally exceeded goals for bacterial concentrations.

- Per Table 5.16, compared to the City's existing raw water source, the ZenoGem permeate was of lesser quality with respect to TOC and many inorganic contaminants while the RO permeate was of better quality in nearly all respects.

- Coliform removal by the both membranes was less than 100 percent. MF membrane permeate contained significantly greater coliform concentrations at 13 g/L MLSS concentration than the UF membrane. Furthermore, coliform removal appeared to be a function of MLSS loading for the MF membrane. However, the RO system consistently removed any remaining coliform regardless of the MF or UF pretreatment.

- Cycled aeration to the membrane tank appeared to significantly increase the rate of membrane fouling (permeability decline) compared with continuous aeration. However, it is difficult to draw firm conclusions regarding aeration given the brief operating time with cycled aeration and its use in combination with other operating modifications (flow peaking, cycled aeration to the aeration tank).

- Footprint for ZenoGem facilities represents about 32 percent of the total area required for a conventional activated sludge plant providing comparable biological treatment and flow equalization.

1.5.2 RO System

- Membrane fouling by particulates and soluble organics in the screened, degritted wastewater was well controlled by the ZenoGem process as illustrated by stable first stage flux and salt rejection. Continuous disinfection, in the predominant form of monochloramine, with a low concentration of combined chlorine (approximately 1 mg/L) was effective in preventing biological fouling of the RO membranes as measured by stability of first stage feed/concentrate differential pressure (see Tables 5.12 through 5.14).

- Elevated concentrations of calcium and phosphate in the City's wastewater (and ZenoGem permeate) most likely caused precipitation of the calcium phosphate salt, hydroxyapatite, in the RO system second stage at feedwater pH levels designed to control calcium carbonate scaling. This precipitation caused rapid increases in RO feed pressures, rapid declines in normalized product flow, and marked increases in salt passage. The precipitate was readily dissolved using citric acid cleaning, and performance declines were consistently reversed by such cleanings. Further acidification of the RO feedwater to pH 5.0 (concentrate pH to 5.6) prevented such precipitation except at design (80 percent) recovery. A better control method may be to precipitate the majority of the soluble phosphorus in the wastewater during MBR treatment using a ferric or aluminum coagulant.

- RO permeate at design (80 percent) recovery was very high quality: TDS <75 mg/L, TOC <0.5 mg/L, and turbidity <0.1 nephelometric turbidity units (NTU). Levels of these and other contaminants monitored in the RO permeate were significantly less than the maximum concentrations permitted under federal drinking water regulations or indirect potable reuse guidelines established in certain states (e.g., California and Virginia). The exception being coliforms, which were consistently detected at low levels. From this standpoint, the RO permeate is of satisfactory quality for IPR use *subject to additional disinfection (chlorination or UV).* TNRCC has not established guidelines or regulations for IPR use at McAllen, however, their preliminary position is that RO treatment would be required. On the other hand, TNRCC may consider establishing quality requirements for IPR that use the quality of the existing raw water supply as the benchmark for treatment. In this case, it may be possible that an acceptable quality of reclaimed water can be produced through a bled or ZenoGem and RO permeate with post-disinfection.

1.6 Recommendations for Further Research

The following recommendations are provided with respect to further research involving MBRs and RO in the context of indirect potable reuse.

1.6.1 Membrane Bioreactors

1.6.1.1 MLSS Levels and Membrane Flux

This research illustrated that membrane fouling and permeability is sensitive to MLSS level. Further research is needed to define the optimum combination of these two parameters (MLSS level/membrane flux) as they contribute to both capital and operating cost. Increased MLSS levels permit higher solids retention times (SRTs), reducing sludge yield, however their use may result in higher capital costs and operating costs associated with additional membrane area (reduced flux).

1.6.1.2 Cycled Aeration to Promote Nitrification/Denitrification

Optimize conditions of cycled aeration for the purpose of promoting simultaneous nitrification/denitrification. Testing in this study was conducted at only one on/off cycle (15 minutes on, 15 minutes off) to the aeration tank. No water quality parameters were measured at other cycles to determine if control at other cycles may be more efficient at achieving improved or complete nitrogen removal. Control methods need to be developed in conjunction with such testing.

1.6.1.3 Cycled Aeration to Reduce Membrane Air Scour Requirements

Aeration for control of membrane fouling represents a significant operating (power) cost. Cycling of air to the coarse bubble aerator integral to the membrane module (membrane tank) represents one way to reduce operating cost; however, aeration reductions must not come at the detriment of membrane permeability. Testing is needed to determine optimum airflow rates and cycle times to achieve the optimum balance of these two needs.

1.6.1.4 Alternative MBR Designs

This research tested one MBR product, Zenon Environmental System's ZenoGem using a MF membrane module, the ZenoGem UF system should be retested at 10 g/L and 6 g/L for comparison to the MF system at these concentrations. Other MBR products are available and have been installed for municipal wastewater reclamation both in Europe and Japan. Testing of these products is needed to assess their performance relative to ZenoGem and to determine if such products represent competitive technologies for application in the U.S. IPR and wastewater treatment market.

The BOR is currently funding research by Montgomery Watson and the City of San Diego to compare the performance of ZenoGem and Mitsubishi systems.

1.6.2 Reverse Osmosis

1.6.2.1 Scale Control

For wastewaters containing elevated concentrations of calcium and phosphate, additional research is needed to determine the most cost-effective and operationally reliable means to control calcium phosphate scaling. Acidification has the advantages of low cost and typically being required for calcium carbonate scale control; however, its use to reduce pH to levels considered effective in this study (see Section 5.0) resulted in an aggressive RO permeate that was supersaturated with carbon dioxide (most likely requiring stripping). Ferric or aluminum coagulant addition to the MBR (or conventional plant) will reduce phosphorus levels in both the RO feedwater and concentrate. However, the doses required in the City's case (approximately 50 mg/L ferric chloride and 91 mg/L alum) produce additional solids in the MBR, potentially increasing membrane fouling and requiring acid maintenance cleans and reducing SRT for a given operating MLSS level.

1.6.2.2 Membrane Flux

RO testing in this study was performed at relatively low flux (10 to 11 gallons per square foot per day [gfd]). Given the low turbidity and SDI of the ZenoGem permeate, higher flux operation (reduced membrane capital cost) may be feasible if scale control can be resolved as discussed herein.

SECTION 2

Testing Objectives

The research to be conducted under this program has the following objectives:

1. Demonstrate feasibility and benefits of the ZenoGem process:

    - Produce a high quality RO feedwater (i.e., turbidity <0.2 NTU, SDI <3, heterotrophic plate count [HPC] <500 colony forming units [CFU]/milliliter [mL]).
    - Meet the City's effluent discharge permit requirements (i.e., TSS <15 mg/L, $CBOD_5$ <10 mg/L, NH_3-N <3 mg/L).
    - Operate reliably (i.e., sustained production).

2. Demonstrate successful RO treatment on ZenoGem permeate:

    - Reliable operation with minimal fouling and effective membrane cleanings.
    - Meet all drinking water/reuse standards.

3. Define design and operation and maintenance (O&M) requirements to develop full-scale ZenoGem and RO plant design criteria.

4. Develop cost estimates for current and proposed IPR advanced treatment processes for the City of McAllen.

5. Characterize ZenoGem and RO permeates relative to the City's existing raw water supply (i.e., Rio Grande River) based on:

    - Regulated drinking water contaminants.
    - State of Texas secondary drinking water requirement of TDS for 1,000 mg/L.

6. Determine impacts of IPR on waste discharges to the City's current discharge location (i.e., Arroyo Colorado/Laguna Madre).

SECTION 3

Demonstration Plant Facilities

The demonstration plant facilities consisted of ZenoGem (MBR) and RO treatment systems. The plant also contained ancillary equipment, including a raw water supply pump, chemical feed systems, transfer pump, and associated piping, valves, and fittings for delivery of raw water (i.e., ZenoGem feed), transfer of processed water (i.e., ZenoGem permeate/RO feed), and disposal of discharge flowstreams (i.e., ZenoGem sludge, RO concentrate, and RO permeate) and membrane cleaning solutions to the WWTP. A description of the other components of the demonstration plant facilities is presented in the following sections.

3.1 Raw Water Supply, Abstraction, Pumping, and Screening

The raw water source (feedwater) to the demonstration plant was SDS from the City's South WWTP No. 2. SDS was abstracted from the influent splitter box (located upstream of Aeration Basin No. 1) and transferred to the ZenoGem system via a submersible pump located in the splitter box. The abstraction point relative to the WWTP processes is shown in figure 3.1.

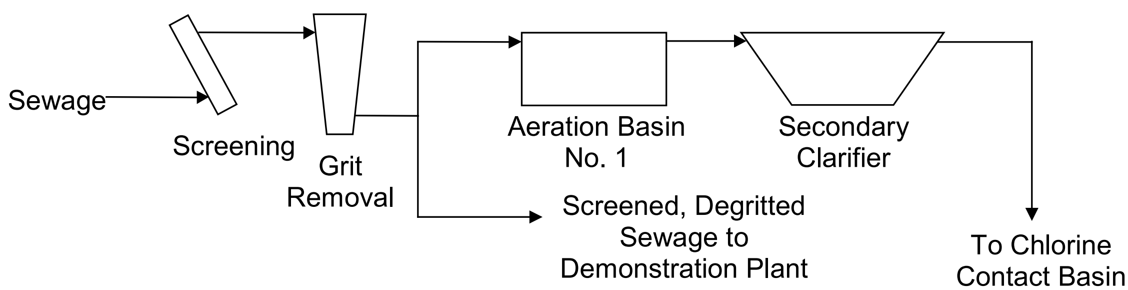

Figure 3.1.—Demonstration Plant Feedwater Abstraction Point From WWTP No. 2

Raw water to the ZenoGem system was screened using a basket strainer and a 3-millimeter (mm) screen. Screening was necessary to prevent clogging of the inlet distributors of the membrane modules.

3.2 ZenoGem Treatment System

The ZenoGem treatment system is comprised of the following components: ZeeWeed Model MSTD ZW-4 unit, a 3,000-gallon aeration tank, auxiliary aeration blower, solids recirculation pump, and sludge wasting system (submersible pump located in aeration tank and 200-gallon calibrated sludge wasting/holding tank). The ZeeWeed unit consists of the following: 185-gallon tank containing the membrane module (membrane tank); one ZW-500 module containing 500 square feet (ft^2) of hollow-fiber MF membrane with a nominal pore size of 0.4 microns (OKC membrane); permeate pump; membrane aeration blower; and backpulse/clean-in-place (CIP) tank[1]. The ZeeWeed ZW-500 membrane module consists of loose fibers connected to a manifold rack system at either end, with the rack/fiber assembly suspended in the membrane tank and submerged in the mixed liquor. Treatment occurs when a vacuum of 1.5 to 9.0 pounds per square inch gage (psig) is applied to the filtrate side of the fibers using the process (vacuum) pump. The vacuum causes the water in the mixed liquor to flow from the feed side to filtrate side of the membrane in a direct filtration mode under a positive transmembrane pressure. A process flow diagram for the ZenoGem treatment system is shown in figure 3.2. Photographs of the ZenoGem system are presented in appendix A.

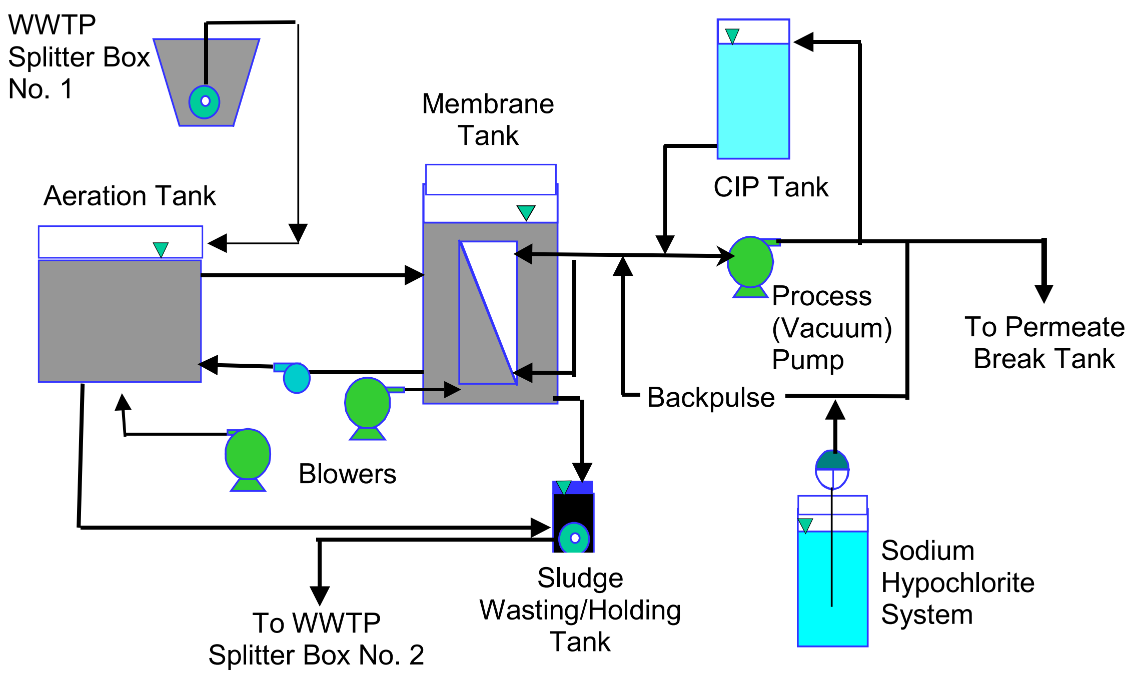

Figure 3.2.—ZenoGem Treatment System Process Flow Diagram

[1]During the commissioning stage of the testing (Stage A), a 0.035-micron UF (OCP) membrane module was installed in the membrane tank. This module was replaced with the 0.4-micron MF (OKC) membrane module to increase flow and reduce fouling.

During ZenoGem operation, biodegradable matter in the sewage (biochemical oxygen demand [BOD] and ammonia) is oxidized by the biomass maintained at high mixed liquor concentrations in the membrane and aeration tanks with air input to these tanks using coarse and fine bubble diffusers, respectively. MLSS levels and SRTs are maintained in the tanks through the frequency and volume of sludge wasted to a calibrated sludge wasting/holding tank. Waste sludge is returned to Splitter Box No. 2 using a submersible pump. The desired HRT is maintained by controlling the rate of permeate flow. Consistency of MLSS concentrations between membrane and aeration tanks is maintained by recirculating MLSS between the tanks using a submersible grinder pump located in the aeration tank.

3.2.1 Methods to Control ZeeWeed Membrane Fouling

Control of solids buildup on the outside surface of the membrane fibers and related increases in permeate side vacuum are achieved in three ways. First, a blower is used to provide continuous air input (in the form of coarse bubbles) at 25 to 30 standard cubic feet per minute (scfm) into the bottom of the membrane tank directly below the membrane fibers. The air bubbles flow upward between the vertically oriented fibers, causing the fibers to agitate against one another. This results in mechanical cleaning through air scour.

Secondly, filtration is interrupted every 10 minutes and the membrane fibers are backpulsed repeatedly for 15 seconds with permeate from the backpulse/CIP tank. The system remains on-line during backpulsing and is in a backpulse mode for a total of 36 minutes per day. Typically, a low concentration of chlorine (<5 parts per million [ppm]) is maintained in the backflush water to inactivate and remove microbes (primarily bacteria) that colonize the outer membrane surface. Hydraulic cleaning via backflushing is accomplished using discharge head from the process pump, and backwash water is retained in the membrane tank.

Thirdly, three times per week, a 100-ppm sodium hypochlorite solution is added to the backpulse/CIP tank, and the membrane module is backpulsed repeatedly for 45 minutes in a procedure called a “maintenance clean.” After the 45-minute in situ cleaning, the system is flushed with permeate for 15 minutes. An additional permeate flush-to-drain is performed for 10 to 15 minutes to purge the system of free chlorine once permeation (i.e., vacuum applied to filtrate side of membrane module) is re-initiated. The total system downtime during a maintenance clean is about 75 minutes.

The combination of air scour, backpulsing, and maintenance cleaning may not be completely effective in controlling membrane fouling, and with time, the pressure differential across the membrane (transmembrane pressure [TMP]) may increase to a maximum value of approximately 17 inches of mercury. When this condition occurs, which is anticipated to be (>3 months) infrequently at full-scale application, the membrane module is chemically cleaned with a 1,500 to 2,000-ppm sodium hypochlorite solution in a procedure called a “recovery clean.” Recovery cleaning requires in situ full tank soaking and clean water flux testing. The chemical cleaning dissolves and removes the refractory solids, and reduces TMP to “clean membrane” initial levels (i.e., levels at startup prior to any evidence of fouling).

3.2.2 Permeate Storage, Disinfection, and Pumping

The ZenoGem permeate flows from the ZeeWeed unit to a permeate break tank that serves to balance the intermittent flow of ZenoGem permeate (resulting from backpulsing and maintenance cleans) with the continuous feed flow requirement of the RO system. After the break tank and prior to entering the RO treatment system, the permeate is dosed with combined chlorine (in the predominant form of monochloramine) using a solution tank and metering pump. Combined chlorine is batched using sodium hypochlorite and aqueous ammonia. The dosage is based on maintaining at least 1 to 2 mg/L of total chlorine residual and zero free chlorine residual. The thin film composite RO membrane material is intolerant to free chlorine, and any exposure will reduce the membrane life. Combined chlorine serves to prevent the low levels of bacteria that can be present in the ZenoGem permeate (primarily through contamination) from growing in the RO feed piping and on the membrane elements (biofouling). The addition of combined chlorine is not intended to serve as disinfection to eliminate pathogens. The "disinfected" ZenoGem permeate is pumped from the break tank to the RO system using a transfer pump. Excess ZenoGem permeate overflows the break tank through drain piping.

3.2.3 ZenoGem Operation

The ZenoGem system is designed to operate at a constant flux with the TMP varying over time to maintain the design flux. The rate of filtrate discharge to the break tank is controlled to achieve the desired HRT in the membrane tank (bioreactor). Proper HRT control is required to achieve the desired degree of $CBOD_5$ and ammonia removal by the biomass maintained in the bioreactor. Solids buildup in the bioreactor is controlled through daily manual wasting to achieve the desired SRT (concentration of MLSS) in the bioreactor. Unlike a conventional WWTP that operates at MLSS levels of 2,000 to 3,000 mg/L, the ZenoGem process is designed to operate at MLSS levels of 10,000 to 15,000 mg/L. This allows for a higher organic loading of wastewater in the ZenoGem treatment system.

Three modes of operation were employed during the study:

- **Normal Flow:** Permeate flowrate maintained at 6.5 gallons per minute (gpm).

- **Peak Flow:** Permeate flowrate increased to 9.5 gpm for 6 hours over a 24-hour period.

- **Cycled Aeration:** Air cycled to membrane tank at 10 seconds on/10 seconds off with or without air cycled to aeration tank at 15 minutes on/15 minutes off.

As detailed in Table 5.1, these operating modes are presented as specific operating events during ZenoGem operation.

3.3 RO Treatment System

The RO treatment system is comprised of the following components: a treatment skid and a cleaning skid. The treatment and cleaning skids are provided courtesy of the Bureau of Reclamation's Water Treatment Engineering and Research Group.

The RO treatment skid consists of the following equipment: chemical feed systems for the addition of acid and scale inhibitor, 5 micron cartridge filter, feed (high pressure) pump, two-stage pressure vessel array, programmable logic controller (PLC) and associated instruments and controls, piping, gauges, and valves. The cartridge filter serves as backup in the event of MF pretreatment failure. The RO elements, model LFC1-2540, are manufactured by Hydranautics and contain low fouling composite polyamide membranes. Stage 1 contains four pressure vessels each containing three 2.5-inch-diameter by 40-inch-long spiral wound elements in a "2:2" configuration. Stage 2 contains two pressure vessels of identical design plumbed in a "1:1" configuration. The two-stage array permits operation up to 80 percent recovery and simulates design of a full-scale RO plant using a "2:1" array with six-element vessels. A process flow diagram for the RO treatment skid and associated pretreatment equipment is shown in figure 3.3. Photographs of the RO treatment system are presented in Appendix A.

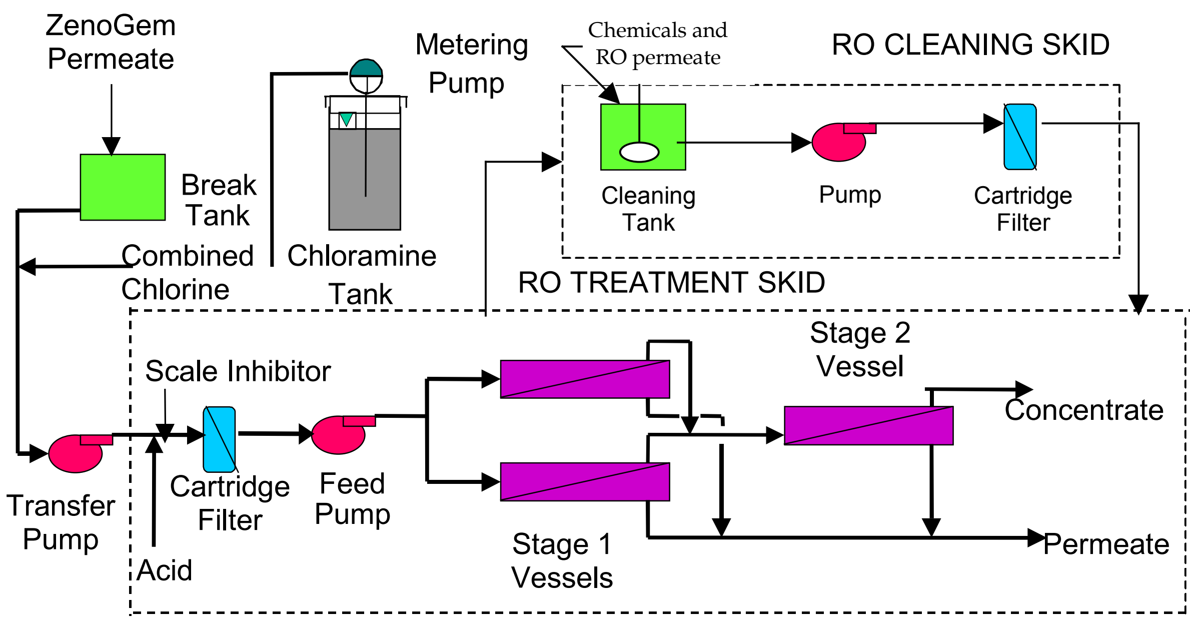

Figure 3.3.—RO Treatment System Process Flow Diagram

3.3.1 RO Feedwater Characterization

Three separate samples of unchlorinated secondary effluent (from the City's WWTP) were collected prior to the start of testing to estimate the inorganic quality of the RO feedwater. (The inorganic quality of the WWTP effluent was considered to be a good simulation of that produced by the ZenoGem system given that both were designed to operate on the same feedwater and provided the same degree of biological treatment and nitrification.) The results are shown in Table 3.1.

Table 3.1.—Results of RO Feedwater Characterization

Parameter	Units	Sampling Date			Average
		12/14/98	12/16/98	12/18/98	
Alkalinity	mg/L as $CaCO_3$	153	161	164	159
Bicarbonate	mg/L	187	196	200	194
Chloride	mg/L	388	359	378	375
Reactive Silica	mg/L	13.90	14.70	14.60	14.40
Sulfate	mg/L	327	305	332	321
Anion Sum	mg/L	1,069	1,036	1,089	1,064
Barium	µg/L	78.30	77.60	87.80	81.23
Calcium	µg/L	112,000	127,000	103,000	114,000
Magnesium	µg/L	29,100	29,700	26,800	28,533
Potassium	µg/L	17,100	18,900	19,400	18,467
Sodium	µg/L	236,000	271,000	233,000	246,667
Strontium	µg/L	1,260	1,310	1,380	1,317
Cation Sum	µg/L	395,538	447,988	383,668	409,065
TDS (Sum of Ions)	**mg/L**	**1,465**	**1,484**	**1,473**	**1,473**

The mean values were then used with two software programs, King Lee Technologies (KLT) WaterWizard and Hydranautics' RODesign, to develop feedwater chemical conditioning requirements and establish product water recovery of the RO system based on the presence and concentration of sparingly soluble salts. The program outputs, shown in Appendix B, indicated the following design condition:

- RO feedwater acidification to pH 6.8 (with sulfuric acid)
- RO feedwater dosing with scale inhibitor at 2 ppm (KLT PreTreat 0100)
- Product water recovery of 80 percent based on 53 times saturation of barium sulfate in the RO concentrate

This condition served as the basis for target operating criteria for the RO system.

3.3.2 RO Feedwater Pretreatment to Control Membrane Fouling

During extended operation, RO membrane elements are subject to fouling caused by both suspended and dissolved matter. Suspended matter includes organic and inorganic colloids and microorganisms. Sparingly soluble salts, such as carbonates, sulfates, and silica, can precipitate from solution because they are concentrated by the RO process. Suspended particles accumulate on the membrane surface causing biofouling and colloidal fouling, and can block feed channels thereby increasing the pressure drop across the system. These phenomenon reduce water permeability through the RO membranes causing flux decline and increased salt passage. The nature and rapidity of fouling depends on the condition of the feedwater. Fouling is progressive, and, if not controlled early, can impair the RO system performance in a relatively short time. For these reasons, fouling must be controlled.

Particulate fouling was addressed through the use of the ZeeWeed MF membrane. Scaling was controlled using acidification and scale inhibitor addition. Chloramines were batched and dosed into the RO feedwater to prevent biological growth (biofouling) on the membranes as discussed in Section 3.2.

The RO feedwater from the transfer pump enters the treatment skid where it is dosed with a scale inhibitor and sulfuric acid prior to entering the cartridge filter. The addition of scale inhibitor prohibits the precipitation of sulfate and carbonate scalants (specifically calcium carbonate and barium sulfate). KLT PreTreat 0100 was used for mineral precipitate control. Acidification further reduces the potential for calcium and carbonate to precipitate from solution. Sulfuric acid was used for feedwater pH control.

Chemically conditioned with King Lee PreTreat 0100 scale inhibitor and sulfuric acid, the filtered water is pumped to the RO vessels at a pressure needed to produce the design permeate flow. Target feedwater recovery is attained by adjustment of the concentrate flow control valve. The system operates in a constant permeate flow/constant recovery mode with feed pressure increasing to compensate for decreases in water mass transfer rate.

The combination of filtration, chloramination, scale inhibition, and acidification may not be completely effective in controlling membrane fouling, and with time, the pressure drop across the stages may increase with simultaneous decreases in permeate flowrate and feedwater recovery. Recirculating a citric acid solution (low pH cleaning) or an alkaline solution (high pH cleaning) containing a mixture of surfactant, detergent, and chelating agent from the cleaning skid through the RO vessels serves to chemically clean the RO system when fouling is apparent. Recirculation is coupled with soak periods to remove the membrane foulants and restore lost performance.

Cleaning was performed five times on the system throughout the study. Low pH cleanings using citric acid, and sodium hydroxide for pH adjustment, were performed to remove inorganic fouling such as calcium precipitates (e.g., calcium carbonates and phosphates) and hydroxide precipitates (e.g., metal oxides such as ferric hydroxide). High pH cleanings using a caustic solution, and sulfuric acid for pH adjustment, were performed to remove calcium sulfates and organics.

3.4 Criteria for Treatment System Operation

Tables 3.2 and 3.3 present criteria that were established for operation and biological performance, respectively, of the ZenoGem system. Table 3.4 presents the initial operating criteria for the RO system based on RO feedwater analyses and projection results. These criteria reflect the individual manufacturer's experience with the systems. Some of the criteria were modified during the study to improve operability (i.e., reduce potential for membrane fouling) and biological treatment stability and performance. Detailed descriptions of the operating stages for each treatment system are presented in Section 5.1.

Table 3.2.—Operating Criteria for the ZenoGem System

Parameter	Units	Target
Aeration Tank Air	scfm	45
Backpulse Duration	sec	15
Backpulse Frequency	min	10
Biomass Recirculation Rate	gpm	36
Flux	gfd	18.7/27.3[a]
Membrane Tank Air	scfm	25/30[b]
Permeability	gfd/psi	5[c]
Permeate Flowrate before Backpulse	gpm	6.5/9.5[a]
TMP	psi	2.5 - 8.5
Vacuum before Backpulse	in Hg	5.1 - 17.3

[a]Target value during flow peaking.
[b]Applied rate increased to 30 scfm during intermittent aeration.
[c]Expected value based on control variables.

Table 3.3.—Biological Treatment Performance Criteria for the ZenoGem System

Parameter	Units	Target			
		Stage A	Stage B	Stage C	Stage D
DO	mg/L	> 1.5	> 1.5	> 1.5	> 1.5
OUR	mg O_2/L-min	1.0 - 1.5	1.0 - 1.5	1.0 - 1.5	1.0 - 1.5
MLSS	mg/L	13,000	13,000	10,000	6,000
Sludge Wasted Daily	gals	90[a]	90[a]	110[a]	150[a]
HRT	hrs	6.2	6.2	6.2	6.2
SRT	days	25[a]	25[a]	20[a]	15[a]

[a]Expected value based on control variables.

Table 3.4.—Operating Criteria for the RO System

Parameter	Units	Target			
		Stage A	Stage B	Stage C	Stage D
Acidified Feedwater pH		6.8	6.8	6.8	5.6[a]
Feedwater Flowrate	gpm	5	5	3	3 - 5
Feedwater Recovery	%	80	80	50	50 - 80
Permeate Flowrate	gpm	4	4	1.5	1.5 - 4.0
Scale Inhibitor Dose	ppm	2	2	2	2

[a]Set target to concentrate pH during this stage (feedwater pH = 5.0).

SECTION 4

Testing Approach

The demonstration testing program was divided into two phases:

- Phase I: Operation of ZenoGem treatment system for 1 month to establish stable biological treatment performance and permeate water quality.
- Phase II: Operation of ZenoGem and RO treatment systems for 5 months to demonstrate project goals and objectives.

The demonstration plant operated 24 hours per day, 7 days per week except for chemical cleanings or planned and unplanned maintenance. Equipment was supervised on an 8-hour per day, 5-day per week basis and as required on weekends to ensure proper operation and data collection. Operating data were recorded at the beginning and end of the each shift. Water quality samples were collected at the beginning of the shift. The results of Phase I and Phase II testing are discussed in Section 5.0.

4.1 ZenoGem Treatment System Tasks

The ZenoGem treatment system tasks under Phases I and II were to:

1. Operate ZenoGem system to produce a permeate whose quality complies with the City's discharge permit (TSS <15 mg/L; BOD <10 mg/L; NH_3-N <3 mg/L).
2. Characterize ZenoGem permeate relative to goals for RO feedwater quality, defined as follows:
   - Turbidity: < 0.2 NTU
   - SDI: < 3
   - Fecal coliforms: < 1 CFU/100 milliliters (mL)
3. Characterize ZenoGem permeate relative to IPR water quality requirements and for development of RO feedwater design composition.
4. Measure O&M requirements for ZenoGem system (plant efficiency factor, labor hours required, energy consumption, and chemical and other consumable consumption); demonstrate reliable, long-term performance of the ZenoGem process; and develop criteria for design of full-scale ZenoGem system.
5. Develop information necessary for design of a full-scale ZenoGem plant. Design criteria to be developed as part of this task include the following:
   - HRT (at average and peak loading)
   - SRT
   - Aeration requirements, separately for maintenance of membrane flux (air scour) and for carbonaceous and nitrogenous removal

- Membrane flux rate
- Duration of operation between chemical cleanings
- Frequency and duration of backpulse
- Backpulse volume
- Chemical type and concentration (if any) needed in backpulse water
- Chemical cleaning regime, including chemical type(s) and concentration(s) and contact time to ensure maintenance of membrane
- Sludge production rate and characteristics to define and assess proper sludge handling, drying, and disposal

6. Evaluate the effect of flow peak testing (hydraulic peaking) on the ZenoGem process. The approach is to initially operate the ZenoGem process at a target SRT of 25 days and a HRT of approximately 6 hours to establish baseline performance. After a pre-determined period of operation, the HRT will be decreased to about 4 hours. Following this change, system operation (membrane performance) will be monitored at the new HRT by tracking changes in TMP and permeability.
7. Evaluate the effect of intermittent aeration on operational (blower) costs and the ability to concurrently nitrify and denitrify in the ZenoGem process. This task includes cycled aeration to the membrane tank and aeration tank to determine the impacts on operational (blower) costs and biological nitrogen removal, respectively.

4.2 RO Treatment System Tasks

The RO treatment system tasks under Phases II were to:

1. Characterize RO permeate quality relative to IPR quality requirements.
2. Monitor RO system operating performance as measured by the following:
   - Feed and permeate conductivity
   - Feedwater recovery
   - Feed pressure
3. Assess changes in RO membrane performance caused by fouling of RO membrane and elements and by chemical oxidation of RO membrane surface by monitoring the following parameters:
   - Normalized permeate flow
   - Normalized conductivity passage
   - Normalized vessel differential pressure
4. Perform chemical cleanings as required when normalized performance parameters change by a pre-determined amount. Assess the efficiency of one or more chemical cleaning formulations/regimes to restore RO performance losses.

5. Confirm RO membrane manufacturer's projections of attainable feedwater recovery and document RO feedwater chemical conditioning requirements to control mineral precipitation.
6. Confirm effectiveness of RO feedwater chloramination as a means to control biological fouling of RO membranes.
7. Develop information necessary for design of a full-scale RO plant. Design criteria to be developed as part of this task include the following:
   - Feedwater chemical conditioning
   - Feedwater biological monitoring requirements
   - Feedwater disinfection (chloramination)
   - Feedwater pressure
   - Membrane flux
   - Feedwater recovery
   - Membrane composition
   - Cleaning frequency and regime
   - Post-disinfection requirements

4.3 Additional Testing Activities

Prior to and during the operation of the demonstration plant, several additional activities were required and performed, including RO feedwater characterization, IPR characterization of the ZenoGem permeate and RO permeate, RO concentrate/WWTP effluent characterization, and RO integrity testing. These activities are described below.

4.3.1 RO Feedwater Characterization

Prior to testing, three sets of samples of unchlorinated secondary effluent from the South WWTP were collected to characterize the inorganic quality of the feedwater to the RO system. These analyses were required to estimate RO system operating conditions with respect to acid and scale inhibitor dosage and feedwater recovery. The samples were collected on December 14, 16, and 18, 1998, by the plant operating staff and analyzed by the CH2M HILL's Applied Sciences Laboratory (ASL). Results of these analyses were presented and discussed in Section 3.0.

4.3.2 IPR Characterization

The overall goal of IPR is to produce reclaimed water of suitable quality for supplementing McAllen's current raw water supply. Thus, it was desirable to characterize the quality of the raw water supply as part of this study to compare it with quality of reclaimed water produced by MF treatment (ZenoGem permeate) and by RO treatment (RO permeate).

Raw water characterization of McAllen's current raw water supply was conducted during the previous pilot testing. With respect to the demonstration plant, samples of ZenoGem permeate and RO permeate were collected on August 18 and September 14, 1999, respectively, by the plant operating staff and analyzed by ASL. Results of these analyses are presented and discussed in Section 5.0.

4.3.3 RO Concentrate and WWTP Effluent Characterization

RO will produce a waste stream (concentrate) containing elevated levels of most constituents present in the ZenoGem permeate, most notably TDS, TOC, and nutrients. Based on an assumed rejection of 90 percent for these constituents by RO and a feedwater recovery of 80 percent, the concentrate will contain TDS, TOC, and nutrients at four to five times their concentration in the ZenoGem permeate. It is anticipated that the RO concentrate will be disposed of by blending it with that portion of the South WWTP secondary effluent that is not reclaimed for IPR. This secondary effluent/concentrate blend would be discharged to the current WWTP effluent discharge point, the Arroyo Colorado, which flows into the Laguna Madre, a marine lagoon. Low freshwater inflows and variable salinity characterize the Arroyo Colorado-Laguna Madre system, which has TDS ranging from 3,000 to 10,000 mg/L. It is anticipated that TDS levels of the concentrate/effluent blend (which will be between 1,200 and 7,500 mg/L) will not adversely impact the ecology of the Arroyo Colorado-Laguna Madre system; however, there is concern that elevated nutrient concentrations in the blend could promote eutrophication and could adversely affect marine ecology.

Samples of WWTP effluent and RO concentrate were collected on August 18 and September 14, 1999, by the plant operating staff and analyzed by ASL and the South WWTP laboratory. The concentrations of the following constituents were measured to: 1) determine the suitability of discharge of the WWTP effluent/RO concentrate blend, and 2) develop requirements for treatment of the RO concentrate to ameliorate any constraints on discharge that are identified:

- TDS (gravimetric)
- TOC
- pH
- Total phosphorus
- Total Kjeldahl nitrogen (TKN)
- Nitrite/nitrate nitrogen

Results of these analyses are presented and discussed in Section 5.0.

4.3.4 RO Integrity Testing

The BOR performed an evaluation of RO element integrity test methods. This evaluation was outside of the scope of CH2M HILL's activities under their agreement with the City; however, activities conducted as part of the BOR's evaluation were closely coordinated with those conducted under this study and were, in large part, conducted by the City's operations staff. Furthermore, the results of the integrity method evaluation should provide useful information for future implementation of indirect potable reuse at McAllen and other locations where RO is used. Development of a field-applied integrity test method for RO elements will provide greater assurance that RO treatment is providing contaminant removal to the degree necessary to protect public health in this reuse context. Results of these analyses are presented in a separate BOR Desalting and Water Purification Program Research Report No. 55, and dated April 2000.

4.4 Treatment System Monitoring

During the demonstration testing, various performance parameters were monitored to evaluate operation of the treatment systems and the quality of the water fed to and produced by the systems. The parameters that were monitored are presented in the following sections.

4.4.1 Operator Training

The City provided two dedicated operators to supervise, operate, and maintain the demonstration plant during the course of the study. The operators were responsible for, but not limited to, equipment maintenance and operation, including manually recording operational data, saving RO system PLC data, batching chemicals, adjusting chemical addition rates, performing chemical cleanings, collecting routine water quality samples, and recording all demonstration plant activities.

Operating parameters for the systems were monitored daily to evaluate treatment system performance. ZenoGem system operating data were collected from equipment instruments and recorded manually on operations log sheets at least twice daily. RO system operating data were collected by two methods: 1) electronically via a PLC for a specified interval and duration (typically every hour over a 12-hour period), and 2) manually at the end of each operating shift from equipment instruments and panel readouts and recorded on operations log sheets. Method 1 was used for primary data collection; method 2 served as a backup source in the event of difficulties with PLC data downloading. Logbooks for each system were maintained to record all O&M events that occurred during the testing period including, but not limited to, date and time of chemical cleanings; type and amount of chemicals used during cleaning, cleaning temperature, and pH; downtimes; alarms or failures; and changes in any operating conditions.

The operating criteria (targets) were presented in Section 3.0. The actual average operating conditions, along with targets, are presented and discussed in Section 5.0.

4.4.2 Sampling and Analysis

The operators collected water quality samples from each treatment system on a routine basis. The South WWTP laboratory was responsible for performing selected physical/chemical and biological analyses. The WWTP laboratory was also responsible for collecting samples for TOC, chemical oxygen demand (COD), TKN, nitrate/nitrate nitrogen, and total phosphorous, and shipment of these samples to ASL for analyses. The central water laboratory, located at McAllen's Water Treatment Plant No. 1, was responsible for performing microbiological analyses.

Sampling activities commenced on February 8, 1999, for the ZenoGem system and on April 16, 1999, for the RO system. At these times, the operators began routine recording of system operating data and collection of water quality samples for each system. In addition, the water and wastewater treatment plants and ASL began routine sampling analyses. The biological treatment and water quality parameters, sampling location and frequency, and responsible analytical party for each treatment system are presented in Tables 4.1 and 4.2.

Table 4.1.—Biological Treatment and Water Quality Sampling Schedule for the ZenoGem System

	Location and Frequency						
Parameter	ZenoGem Feed	Membrane Tank	Aeration Tank	ZenoGem Permeate	Aeration Tank Waste Sludge	Sample Day(s)	Responsible Party
Physical/Chemical							
pH	2/W	2/W	2/W	2/W	NONE	M & W	WWTP
Temperature[a]	1/D	1/D	1/D	1/D	NONE	M - F	OPERATOR
Conductivity	1/D	NONE	NONE	1/D	NONE	M - F	WWTP
Turbidity	NONE	NONE	NONE	1/D	NONE	M - F	WWTP
COD[b]	2/M	NONE	NONE	2/M	1/W	M	CH2M
Total Chlorine	NONE	NONE	NONE	1/D	NONE	M - F	WWTP
Free Chlorine	NONE	NONE	NONE	1/D	NONE	M - F	WWTP
ALK	1/W	NONE	NONE	1/W	NONE	M	WTP
Biological							
DO[a]	1/D	1/D	1/D	NONE	NONE	M - F	OPERATOR
OUR	NONE	2/W	2/W	NONE	NONE	M & W	WWTP
MLSS[b]	NONE	3/W	3/W	NONE	3/W	M,W,F	WWTP
MLVSS[b]	NONE	3/W	3/W	NONE	1/W	M or M,W,F	WWTP
DSVI	NONE	3/W	NONE	NONE	NONE	M,W,F	WWTP
$CBOD_5$[b]	3/W	3/W	3/W	3/W	NONE	M,W,F	WWTP
TSS[b]	3/W	NONE	NONE	3/W	NONE	M,W,F	WWTP

Table 4.1.—Biological Treatment and Water Quality Sampling Schedule for the ZenoGem System

	Location and Frequency						
Parameter	**ZenoGem Feed**	**Membrane Tank**	**Aeration Tank**	**ZenoGem Permeate**	**Aeration Tank Waste Sludge**	**Sample Day(s)**	**Responsible Party**
NH_3-N[b]	3/W	NONE	NONE	3/W	NONE	M,W,F	WWTP
TKN[b]	1/W	NONE	NONE	1/W	1/W	M	CH2M
NO_2/NO_3-N[b]	1/W	NONE	NONE	1/W	NONE	M	CH2M
T Phosphorus	1/W	NONE	NONE	1/W	1/W	M	CH2M
Microbial							
Total Coliform	2/W	NONE	NONE	2/W	NONE	M & W	WTP
Fecal Coliform	2/W	NONE	NONE	2/W	NONE	M & W	WTP
HPC	NONE	NONE	NONE	2/W	NONE	M & W	WTP

[a]These samples are to be taken at the same time.
[b]Operator to analyze at sample location.
1/D=once per day
1/W=once per week
2/W=twice per week
3/W=three times per week
2/M=2 times per month
ALK=alkalinity
CH2M HILL=CH2M HILL's Applied Sciences Laboratory (ASL)
DO=dissolved oxygen
DSVI=diluted sludge volume index
MLVSS=mixed liquor volatile suspended solids
OUR=oxygen uptake rate
WTP=McAllen's Central Water Treatment Plant Laboratory
WWTP=McAllen's South Wastewater Treatment Plant Laboratory

Table 4.2.—Water Quality Sampling Schedule for the RO System

Parameter	Location and Frequency			Sample Day(s)	Responsible Party
	RO Feed	RO Permeate	RO Concentrate		
Physical/Chemical					
pH	1/W	1/W	1/W	M	WWTP
Conductivity	1/W	1/W	1/W	M	WWTP
Turbidity	1/D	1/D	1/D	M - F	WWTP
SDI[a]	1/D	1/D	NONE	M - F	OPERATOR
TOC[b]	1/D	1/D	NONE	M - F	OPERATOR
TOC	2/M	2/M	NONE	M	CH2M
Total Chlorine	1/D	1/D	NONE	M - F	WWTP
Free Chlorine	1/D	1/D	NONE	M - F	WWTP
TDS	1/W	1/W	1/W	M	WWTP
Microbial					
Total Coliform	NONE	2/W	NONE	M & W	WTP
Fecal Coliform	NONE	2/W	NONE	M & W	WTP
HPC	2/W	2/W	NONE	M & W	WTP

[a]Operator to analyze at sample location using auto analyzer.
[b]Operator to analyze at sample location using monitor.
1/D=once per day
1/W=once per week
2/W=twice per week
2/M=twice per month
CH2M=CH2M HILL's Applied Sciences Laboratory (ASL)
WWTP=McAllen's South Wastewater Treatment Plant Laboratory
WTP=McAllen's Central Water Treatment Plant Laboratory

4.5 Data Evaluation

Several of the operating parameters and water quality parameters presented previously were compiled, reduced, and analyzed to evaluate operational, biological, and membrane performance of the treatment systems. Evaluating the flux, TMP, and permeability characterized ZenoGem membrane performance. The primary water quality parameters used to evaluate the effectiveness of the ZenoGem treatment process in producing a high quality RO feedwater were turbidity and SDI. Evaluating the feedwater recovery, normalized product flow (NPF), and the pressure drop across the vessels characterized RO membrane performance.

4.5.1 Filtrate Flow and Membrane Flux

Membrane flux is directly proportional to the permeate (filtrate) flow rate as shown in the following equation:

Flux [gfd] = Permeate Flow rate[gpm] x 1440 / Membrane Area [ft^2]

where [gfd] = gallons per day per ft^2

As the filtrate flow rate increases, the membrane flux increases proportionately.

4.5.2 Transmembrane Pressure and Permeability

TMP represents the resistance to flow of water of 1) the membrane, and 2) the materials in the feedwater (foulants) that accumulate at the membrane surface or within the membrane pores. TMP at the start of testing (with a clean membrane) represents only the resistance of the membrane. As foulants accumulate and cannot be effectively removed by backwashing/backpulsing with disinfectant, TMP increases because of the resistance of flow exerted by the foulants. Thus, the rate at which TMP increases is directly proportional to the rate of membrane fouling.

Membrane permeability is inversely proportional to the TMP as shown in the following equation:

*Permeability [gfd/psi] = Flux [gfd]*1.024$^{(25-T)}$/TMP [pounds per square inch (psi)]*

where T = feedwater temperature, ^{o}C

Permeability is a direct measure of the water flow through the membrane fiber and any foulants that have accumulated on the surface or within the membrane pores. The permeability equation includes a temperature correction factor to remove or "normalize for" the effects of changing temperature on membrane permeability. Increases in temperature increase water flow through the membrane because of decreasing viscosity. This effect must be removed to accurately assess changes in permeability with run time.

4.5.3 Turbidity and SDI

Traditionally, the RO membrane manufacturers have established the following as criteria for efficient RO operation:

Turbidity: $\leq$0.2 NTU

SDI: $\leq$3 (based on 15-min test interval)

SECTION 5
Demonstration Testing Results

This section presents the results of demonstration plant testing. All data collected during the study are presented in Appendix C as follows:

Operating data for ZenoGem System	Table C-1
Water quality data for ZenoGem System	Table C-2
Operating data for RO System	Table C-3
Water quality data for RO System	Table C-4

Results for water quality parameters routinely analyzed by the McAllen water and wastewater laboratories were communicated to CH2M HILL by facsimile on daily or weekly sampling logs. These data, along with CH2M HILL laboratory data, were tabulated and incorporated into Tables C-1 through C-4 in Appendix C.

5.1 Operations

A summary of ZenoGem and RO system operating stages and events is presented in Tables 5.1 and 5.2. Additional details regarding the specific operating stages are discussed below.

Table 5.1.—Operating Stages and Events for the Zenogem System

Stage	Event	Date(s)	Run Time (hours)	Duration (hours)	Description
A		2/6/99	0.00		Start of Testing (MLSS concentration at 13 g/L and OCP Membrane)
B		3/20/99	677.58		OKC Membrane
	1	3/31/99 - 4/1/99	915.58 - 941.00	25.42	Peak Flow Testing (9.5 gpm for 6 hours over 24-hour period)
C		5/6/99	1783.00		Decrease MLSS Concentration to 10 g/L
	2	6/1/99	2406.08	2.42	Bubble Point Test
	3	8/12/99 - 8/13/99	4129.58 - 4158.33	28.75	Peak Flow Testing (9.5 gpm for 6 hours over 24-hour period)
	4	8/16/99 - 8/20/99	4225.08 - 4326.25	101.17	Peak Flow Testing (9.5 gpm for 6 hours over 24-hour period)

Table 5.1.—Operating Stages and Events for the ZenoGem System – continued

Stage	Event	Date(s)	Run Time (hours)	Duration (hours)	Description
	5	8/30/99 – 9/1/99	4561.08	51.50	Recovery (Full Tank) Clean
	6	9/14/99 – 9/16/99	4875.91	50.25	Raise Membranes
	7	9/17/99 – 9/27/99	4894.16 - 5136.25	242.09	Cycled Aeration to the Membrane Tank (10 sec on/off)
	8	9/27/99 - 9/29/99	5136.25 - 5186.91	50.66	Peak Flow Testing without Cycled Aeration
D		10/4/99	5303.41		Decrease MLSS Concentration to 6 g/L
	9	10/7/99 - 10/8/99	5328.75 - 5352.50	23.75	Cycled Aeration to the Membrane Tank (10 sec on/off)
	10	10/8/99 - 10/13/99	5352.50 - 5476.00	123.50	Peak Flow Testing with Cycled Aeration to Membrane Tank
	11	10/14/99 - 10/19/99	5476.00 - 5615.66	139.66	Normal Flow with Cycled Aeration to Membrane Tank
	12	10/19/99 - 11/2/99	5615.66 - 5948.25	332.59	Normal Flow with Cycled Aeration to Both Tanks (Aeration Tank at 15 min on/off)
	13	11/2/99	5948.25		End of Testing

Table 5.2.—Operating Stages and Events for the RO System

Stage	Event	Date(s)	Run Time (hours)	Duration (hours)	Description
A		4/21/99	0.00		Startup
B		5/19/99	0.00		Start of Testing (Target Feed pH = 6.8)
	1	5/24/99 - 5/25/99	114.89 - 147.69	32.80	1st Cleaning (Citric Acid:Stages 1 and 2)
	2	5/30/99	256.41		Decrease Recovery to 50%
	3	6/1/99 - 6/2/99	305.9 - 328.42	22.52	2nd Cleaning (Citric Acid:Stages 1 and 2)
	4	6/8/99 - 6/10/99	475.88 - 526.38	50.50	3rd Cleaning (Citric Acid:Stages 1 and 2 followed by Caustic:Stage 1)
C		6/11/99	544.50		Decrease Recovery to 50% (Stage 2 Removed from Service)
D		7/7/99	1176.51		Stage 2 Returned to Service (50% Recovery)

Table 5.2.—Operating Stages and Events for the RO System - continued

Stage	Event	Date(s)	Run Time (hours)	Duration (hours)	Description
	5	7/8/99	1196.78		Increase Recovery to 60%; Decrease Feed pH to 6.5
	6	7/9/99	1208.73		Increase Recovery to 70%; Decrease Feed pH to 6.0
	7	7/22/99	1532.92		Set Target pH to Concentrate pH = 5.6 (Feedwater pH = 5.0)
	8	7/24/99 - 7/27/99	1578.67 - 1650.27	71.60	4th Cleaning (Citric Acid:Stages 1 and 2)
	9	8/10/99	1985.17		Increase Recovery to 75%
	10	8/30/99 - 9/1/99	2464.77- 2519.55	54.78	Unit Down due to ZenoGem System Recovery (Full Tank) Clean
	11	9/2/99 - 9/8/99	2543.79 - 2687.50	143.71	5th Cleaning (Citric Acid:Stages 1 and 2); Acid Pump Failure
	12	9/14/99 - 9/16/99	2830.65 - 2880.25	49.60	Unit Down due to Raising ZenoGem System Membranes
	13	9/23/99	3041.97		Increase Recovery to 80%
	14	10/4/99 - 10/6/99	3308.51 - 3359.81	51.30	Unit Down due to Decreasing ZenoGem System MLSS
	15	10/8/99	3399.11		End of Routine Testing
	16	10/21/99	3715.41		End of Special Testing

5.1.1 Startup Activities

ZenoGem Equipment Commissioning.

ZENON field service technicians arrived at the plant site on January 11, 1999, and performed commissioning of the ZenoGem system through February 6, 1999. ZenoGem system commissioning included equipment installation; membrane bubble point and clean water flux testing; introduction and concentration of mixed liquor in the bioreactor tank; and operation on SDS to establish steady-state biological treatment (carbonaceous and nitrogenous oxidation) and membrane treatment. Operational activities included establishing target MLSS concentrations in both the membrane (process) and aeration tanks; air flow rates and dissolved oxygen (DO) levels in both tanks; solids recirculation rate between tanks; and membrane permeate flow (flux) rate. The ZenoGem system achieved steady-state operation on March 22, 1999.

RO Equipment Commissioning. BOR project managers performed commissioning of the RO system during two site visits on February 2 through February 12, 1999, and on March 15 through March 19, 1999. During the first visit, RO system commissioning included installation of plumbing and electrical connections; delivery and storage of chemicals; modifications to the computer recording system; PLC programming; and installation of temporary membranes. During the second visit, additional RO system commissioning included instrument calibration; SDI auto analyzer installation; system cleaning and disinfection; installation of permanent membranes and integrity tests. At that time, the RO system was scheduled for startup on March 22, 1999, coincident with steady-state operation of ZenoGem system. However, due to ZenoGem system special testing, replacement of defective chloramine metering pump parts, difficulties in attaining stable and effective chloramine stock solutions and residuals, combined with minor RO equipment problems, RO system start of testing was delayed until April 21, 1999.

5.1.2 Operating Stages

ZenoGem System.

The ZenoGem operating period has been divided into four separate operating stages as shown in exhibit 5.1. The ZenoGem operating stages were as follows:

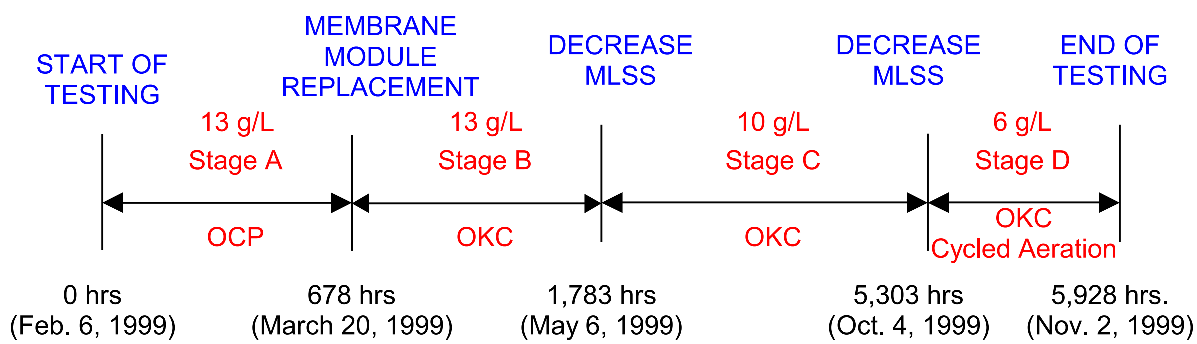

Exhibit 5.1.—ZenoGem Operating Stages

Stage A represents the start of testing using the OCP UF membrane and a target MLSS concentration of 13 g/L. During this stage, the aeration and membrane tanks were seeded with activated sludge from the WWTP and MLSS levels increased step-wise to the target level. The system accumulated 321 operating hours out of a possible 678 available hours, for an online factor of 0.47 (47 percent). This online factor includes two separate periods when the system was offline due to failure and subsequent replacement of the recirculation pump impeller, feedwater inlet level sensor replacement, and membrane module replacement.

The originally supplied membrane module, which used the OCP membrane, has recently been classified by ZENON as their drinking water membrane and is marketed primarily as an UF membrane for the treatment of natural raw water supplies to produce potable water. This membrane, which has a nominal pore size of 0.035 microns, has been found to have flux limitations when operated on high MLSS wastewaters and consequently is being phased out by ZENON in favor of the OKC MF membrane for wastewater treatment. The OKC membrane is more porous, with a nominal pore size of 0.4 microns. Initial in-house testing by ZENON showed the OKC membrane to operate at higher permeability and to benefit from a lower rate of fouling on wastewater, particularly when operating at peak loading conditions. Consequently, it was decided jointly by ZENON and CH2M HILL that the OKC membrane would be better suited for the McAllen IPR application. After the OCP module was replaced with a new OKC module, the permeate flow rate was slowly increased to the target 6.5 gpm.

Stage B represents the period of operation using the OKC module and a target MLSS concentration of 13 g/L. During this stage, the system accumulated 1,077 operating hours out of a possible 1,105 available hours, for an online factor of 0.97 (97 percent). This online factor includes a short period of time when the system was offline due to replacement of a valve in the aeration tank. A single-day peak flow test was conducted during the latter part of this stage.

Stage C represents the period of operation at a target MLSS concentration of 10 g/L. During this stage, the system accumulated 3,416 operating hours out of a possible 3,520 available hours, for an online factor of 0.97 (97 percent). This online factor includes three separate periods when the system was offline due to bubble point testing, clean water flux testing/full tank soaking, and to raise the module height (in the membrane tank). During this stage, peak flow testing continued and cycled aeration (to the membrane tank only) was initiated.

The target MLSS concentration was decreased from an initial target of 13 g/L to 10 g/L after 1,783 total available hours of operation following detailed discussions with ZENON technical personnel. Based on ZENON experience, lowering the MLSS concentration to 10 g/L provides for improved operability (lower membrane fouling) and more stable biological treatment. As discussed later in this section, MLSS reduction also improved oxygen transfer from the bulk fluid to the biomass, thereby improving nitrification efficiency and decreasing the degree of denitrification. Consequently, it was decided jointly by ZENON and CH2M HILL that the decrease in MLSS concentration would be preferred for the McAllen indirect potable reuse application.

Stage D represents the period of operation at a target MLSS concentration of 6 g/L. During this stage, the system accumulated 596 operating hours out of a possible 645 available hours, for an online factor of 0.92 (92 percent). This online factor includes a short period of time when the system was offline to decrease the MLSS concentration (i.e., wasting half the aeration tank volume) and subsequent aeration-only operation to reestablish proper biomass condition. Peak flow testing continued and cyclic aeration to the membrane and aeration tanks was also initiated during this stage.

The MLSS concentration was decreased from 10 g/L to 6 g/L after 5,303 total available hours of operation following detailed discussions with ZENON technical personnel. ZENON indicated that maintenance of stable membrane permeability during flow peaking would most likely depend on sludge filterability characteristics as indicated by the sludge capillary suction time (CST). Sludges with high CSTs are viscous and difficult to filter. The sludge generated in the ZenoGem process had a high CST (exceeding 100 seconds). ZENON indicated that for such sludge, reducing the MLSS concentration reduces the resistance to filtration and would maximize permeability during flow peak peaking. Consequently, it was decided jointly by ZENON and CH2M HILL to perform peak flow tests at a lower MLSS concentration in order to demonstrate maximum performance.

RO System. The RO operating period has been divided into four separate operating stages, as shown in Exhibit 5.2. Since the hour meter on the system was not functional, the online factor for each stage of operation was approximated by system downtimes recorded by the operators. The first two RO operating stages were as follows:

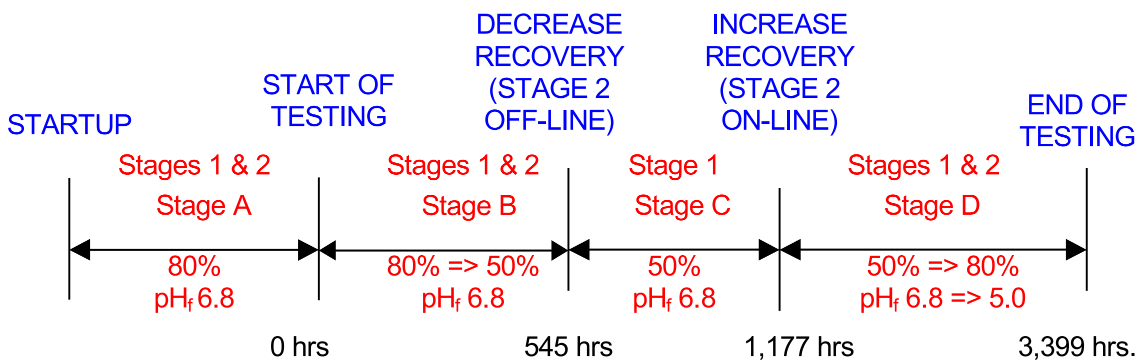

Exhibit 5.2.—RO Operating Stages

Stage A represents the period of operation from startup to the actual start of steady state testing (commissioning phase). During this stage, the system was off line approximately 70 percent of the time due to numerous downtimes associated with PLC reprogramming and tuning to optimize control of feedwater flow and pH; failure and subsequent replacement of the scale inhibitor feed pump; de-commissioning of automatic sampling valves; and troubleshooting acid feed pump loss of prime. Data collected during this phase was considered representative of continued startup activities and system troubleshooting. By May 19, the system was successfully online, and the actual start of steady state testing was achieved.

Stage B represents the period of operation at a target recovery of 80 percent. During this 545-hour stage, the system was off line approximately 19 percent of the time due to three RO membrane cleanings and maintaining target pH.

RO Feedwater Pretreatment to Control Membrane Fouling. RO membrane elements are subject to fouling during extended operation caused by both suspended and sparingly soluble salts. Suspended matter includes organic and inorganic colloids and microorganisms. Sparingly soluble salts, such as carbonates, sulfates, and silica, can precipitate from solution as the RO process concentrates them. Suspended particles accumulate on the membrane surface causing biofouling and colloidal fouling, and they can block feed channels thereby increasing the pressure drop across the system. These phenomenon reduce water permeability through the RO membranes causing flux decline and increased salt passage. The nature and rapidity of fouling depends on the condition of the feedwater. Fouling is progressive, and, if not controlled early, can impair the RO system performance in a relatively short time. For these reasons, fouling must be controlled.

Particulate fouling is addressed through the use of the ZeeWeed MF membrane. Chloramines were batched and dosed into the RO feedwater at a target dose of 1 to 2 mg/L to prevent biological growth (biofouling) of the RO elements. As described in an earlier section, mineral precipitation is controlled through a combination of acidification and scale inhibitor addition. The last two RO operating stages are described below.

Stage C represents the period of operation at a target recovery of 50 percent (operating first stage vessels only) to demonstrate that performance losses observed in Stage B resulted from mineral precipitation (as opposed to particulate or colloidal fouling). During this 632-hour stage, the system was online 100 percent of the time.

Stage D represents the period of operation at recovery of 50 to 80 percent (operating first and second stage vessels) and acidification of the concentrate stream to a reduced feedwater pH of 5.0 (concentrate target pH of 5.6) to control calcium phosphate and calcium carbonate precipitation. During this 2,222-hour stage, the system was off line approximately 10 percent of the time due to two RO membrane cleanings. It excludes three downtimes associated with ZenoGem full tank soaking, raising module height, and decreasing the MLSS concentration.

5.2 ZenoGem Testing Results

5.2.1 ZenoGem Operating Conditions

Table 5.3 presents the target and average operating conditions for the ZenoGem system during Stage A operation. The system operated at a target MLSS concentration of 13 g/L using the OCP UF membrane. After 678 hours of startup activities, the membrane was replaced with the OKC MF membrane.

Table 5.3.—Stage A Average Operating Conditions for the ZenoGem System

Parameter	Target[a]	Normal Flow
Aeration Tank Air (scfm)	> 45	48
Backpulse Duration (sec)	15	15
Backpulse Frequency (min)	10	10
Biomass Recirculation Rate (gpm)	> 36	26.2
Flux (gfd)	18.7	17.3
Membrane Tank Air (scfm)	25	25
Normalized Permeability (gfd/psi)	5	20.8
Permeate Flowrate before Backpulse (gpm)	6.5	6.0
Permeate Flowrate after Backpulse (gpm)		6.0
Temperature (degrees C)		26.2
TMP (psi)	2.5 - 8.5	1.34
Vacuum before Backpulse (in Hg)	5.1 - 17.3	2.73
Vacuum after Backpulse (in Hg)		2.57

[a]Where target left blank, no target was established.
[b]Values calculated when permeate flowrate reached 6 gpm.

Table 5.4 presents the target and average operating conditions for the ZenoGem system during Stage B operation. The system continued to operate at a target MLSS concentration of 13 g/L during this stage. After 916 hours of operation (Event 1), the permeate flowrate was increased for 25 hours to determine the short-term impact of higher membrane loading on permeability and TMP.

Table 5.4.—Stage B Average Operating Conditions for the ZenoGem System

Parameter	Target[a]	Normal Flow	Peak Flow (Event 1)
Aeration Tank Air (scfm)	> 45	43	42
Backpulse Duration (sec)	15	15	15
Backpulse Frequency (min)	10	10	10
Biomass Recirculation Rate (gpm)	> 36	38.3	39.5
Flux (gfd)	18.7/27.3[b]	18.5	27.3
Membrane Tank Air (scfm)	25	25	25
Normalized Permeability (gfd/psi)	5	17.82	13.19
Permeate Flowrate before Backpulse (gpm)	6.5/9.5[b]	6.40	9.50
Permeate Flowrate after Backpulse (gpm)		6.40	9.50
Temperature (degrees C)		28	25.8
TMP (psi)	2.5 - 8.5	1.2	2.1
Vacuum before Backpulse (in Hg)	5.1 - 17.3	2.66	4.17
Vacuum after Backpulse (in Hg)		2.59	4.12

[a]Where target left blank, no target was established.
[b]Target value during flow peaking.

Table 5.5 presents the target and average operating conditions for the ZenoGem system during Stage C operation. At the beginning of this stage (after 1,783 hours of operation), the MLSS concentration was decreased to 10 g/L. From 4,130 to 4,158 hours (Event 3) and from 4,225 and 4,326 hours (Event 4) of operation, the permeate flow rate was increased by 46 percent (6.5 to 9.5 gpm) for a period of 6 hours (flow peaking) over a 24-hour period to simulate the types of hydraulic peak loading that typically occur in a conventional WWTP. This was done to determine if the MBR system could be operational in the same manner or if additional means would be required to ensure slower changes in loading to the system. After 4,876 hours of operation, the membrane module height was raised (Event 6) to minimize sludge accumulation on the module aerators during non-aeration periods. From 4,894 to 5,136 hours (Event 7) of operation, air was cycled to the membrane tank at an applied rate of 30 scfm for 10 seconds on and 10 seconds off to evaluate the effect of intermittent aeration on operations and membrane performance. From 5,136 to 5,187 hours (Event 8) of operation, flux peaking was conducted without intermittent aeration to the membrane tank.

Tble 5.5.—Stage C Average Operating Conditions for the ZenoGem System

Parameter	Target[a]	Normal Flow	Peak Flow (Events 3,4,8)	Normal Flow with Cycled Aeration to Membrane Tank Only (Event 7)
Aeration Tank Air (scfm)	> 45	59	61	63
Backpulse Duration (sec)	15	15	15	15
Backpulse Frequency (min)	10	10	10	10
Biomass Recirculation Rate (gpm)	> 36	48.2	47.5	44.6
Flux (gfd)	18.7/27.3[b]	18.7	26.6	18.7
Membrane Tank Air (scfm)	25/30[c]	25	25	31
Normalized Permeability (gfd/psi)	5	6.61	3.05	8.67
Permeate Flowrate before Backpulse (gpm)	6.5/9.5[b]	6.50	9.20	6.50
Permeate Flowrate after Backpulse (gpm)		6.70	11.10	7.10
Temperature (degrees C)		31.2	31.9	30.3
TMP (psi)	2.5 - 8.5	2.8	7.5	2.4
Vacuum before Backpulse (in Hg)	5.1 - 17.3	5.70	15.30	4.90
Vacuum after Backpulse (in Hg)		5.10	15.90	4.10

[a]Where target left blank, no target was established.
[b]Target value during flow peaking.
[c]Applied rate increased to 30 cubic feet per minute (cfm) during intermittent aeration.

Per discussions with ZENON, cycled aeration operation to the membrane tank was planned at 10 seconds on and 10 seconds off. However, a cycle time of 15 seconds on and 15 seconds off was implemented at the site due to communication and programming error between ZENON and the demonstration plant operators. ZENON Corporate Technology tested a number of different air cycle times at other pilot locations and concluded that 10 seconds off is the maximum allowable period before a decline in permeability is observed. Longer air OFF periods allow the mixed liquor solids to accumulate in the fiber bundle and are not subsequently removed by the air pulse during the ON cycle. Thus, the error in cycle time implemented is significant enough to cause the permeability decline observed during cycled aeration events as discussed in Section 5.2.2.

Table 5.6 presents the target and average operating conditions for the ZenoGem system during Stage D operation. At the beginning of this stage (after 5,303 hours of operation), the MLSS concentration was decreased to 6 g/L. From 5,329 to 5,353 hours (Event 9) of operation, air was again cycled to the membrane tank. From 5,353 to 5,476 hours (Event 10) of operation, flux peaking was conducted; however this time with intermittent aeration to the membrane tank. From 5,476 to 5,616 hours (Event 11) of operation, the flowrate was reduced to normal conditions and air continued to cycle to the membrane tank. From 5,616 hours to the end of testing (Event 12), air was cycled to the aeration tank at an applied rate of 45 scfm for 15 minutes on and 15 minutes off to evaluate the effect of intermittent aeration on biological treatment performance (i.e., to concurrently nitrify and denitrify).

Table 5.6.—Stage D (Alternative Operating Mode) Average Operating Conditions for the ZenoGem System

Parameter	Target[a]	Normal Flow	Normal Flow with Cycled Aeration to Membrane Tank Only (Event 9)	Peak Flow with Cycled Aeration to Membrane Tank Only (Event 10)	Normal Flow with Cycled Aeration to Membrane Tank Only (Event 11)	Normal Flow with Cycled Aeration to Membrane and Aeration Tanks (Event 12)
Aeration Tank Air (scfm)	> 45	65	66	64	66	65
Backpulse Duration (sec)	15	15	15	15	15	15
Backpulse Frequency (min)	10	10	10	10	10	10
Biomass Recirculation Rate (gpm)	> 36	47.3	48.0	47.0	46.2	43.1
Flux (gfd)	18.7/27.3[b]	18.7	18.7	27.3	18.7	18.7
Membrane Tank Air (scfm)	25/30[c]	25	32	32	32	32
Normalized Permeability (gfd/psi)	5	7.27	7.52	3.25	3.86	3.42
Permeate Flowrate before Backpulse (gpm)	6.5/9.5[b]	6.50	6.50	9.5	6.50	6.50
Permeate Flowrate after Backpulse (gpm)		6.90	6.70	11.50	6.90	6.90
Temperature (degrees C)		30.3	30.0	31.6	29.0	26.4
TMP (psi)	2.5 - 8.5	2.39	2.2	7.37	4.5	5.7
Vacuum before Backpulse (in Hg)	5.1 - 17.3	4.90	4.50	15.0	9.10	11.50
Vacuum after Backpulse (in Hg)		4.30	4.60	16.30	8.20	10.50

[a]Where target left blank, no target was established.
[b]Target value during flow peaking.
[c]Applied rate increased to 30 cfm during intermittent aeration.

5.2.2 ZeeWeed Membrane Performance

Permeate Flow and Membrane Flux. Figure 5.1 illustrates changes in ZenoGem permeate flow and flux as a function of operating time. During Stage A (prior to membrane replacement), flow and flux were increased in step-wise increments to "condition" the membrane fibers to the mixed liquor. This was done to prevent the fibers from becoming fouled. Permeate flow was held constant during Stages B through D except for five events:

- Event 1: Flow increased for 25 hours to determine the short-term impact of higher membrane loading on permeability and TMP; and
- Events 3, 4, 8 and 10: Flow increased by 46 percent (6.5 to 9.5 gpm) for a period of 6 hours (flow peaking) over a 24-hour period to simulate WWTP peak hydraulic loading.

The increases caused a corresponding increase in TMP and decrease in permeability; however both changes were reversed once the flow was decreased to the target level. Thus, the temporary flux increase caused only reversible membrane fouling and flow peaking for short (one-day) periods of time can occur in response to actual WWTP loading without causing a permanent increase in fouling.

Transmembrane Pressure. Figure 5.2 illustrates changes in ZenoGem TMP as a function of operating time (permeate flow is also shown for reference).

Stage A. TMP increased gradually as permeate flow was increased to the target value. The sharp decline in TMP that occurred at 653 hours was caused by continuous aeration of the module during the 12-day period when the ZenoGem system was offline due to recirculation pump failure and replacement. Continuous aeration in the absence of permeation was very effective in reducing membrane fouling.

Stage B. During the latter part of Stage B, TMP steadily increased even when permeate flowrate (and membrane flux) were held constant. This increase in TMP clearly indicates that membrane fouling was occurring at the higher MLSS concentration. The short-term flow peaking during Stage B (Event 1) caused a temporary increase in TMP that was reversed once flux was reduced.

Stage C. During operation at intermediate (10 g/L) MLSS concentration, TMP first decreased and then increased very gradually over a 1,000-hour period, indicating: 1) a very low rate of fouling, and 2) maintenance cleans were more effective in controlling fouling at the lower MLSS concentration. The step increase in TMP at ~2,700 hours was caused by a temporary loss of air scour in the membrane tank. Flow peaking during Stage C (Events 3 and 4) resulted in a more rapid rate of TMP increase, demonstrating that flow peaking of the membrane on a daily basis over an extended operating period caused a significant increase in fouling rate at the lower MLSS concentration. TMP increased to the maximum value (8 psi) which required a recovery (full tank) clean (Event 5) to reduce TMP to clean membrane levels (0.8 psi). At the end of Stage C, TMP rapidly increased when air was cycled to the membrane tank (Event 7) and again during flow peaking without cycled aeration (Event 8).

Stage D. During this stage, the impact of both flow peaking and cycled (intermittent) aeration was evaluated at low (6 g/L) MLSS concentration. The data in Figure 5.2 shows TMP increases were rapid when flow peaking and cycled aeration was practiced, consistent with flow peaking effect observed in Stage C. The impact of cycled aeration alone (no flow peaking) is more difficult to ascertain. TMP rise rate following Event 11 and the first part of Event 12 was low, but increased rapidly near the end of testing. The latter effect may be the result of operation at high TMP levels (significant fouling present) rather than from intermittent aeration. Future testing using intermittent aeration should be conducted with a clean membrane to more clearly determine its impact on membrane fouling. It should be noted that during flow peaking events, the vacuum after backpulsing was slightly higher than before backpulsing. This indicates that backpulsing had little effect in reducing the TMP (or increasing permeability) during flow peaking. During normal flow operation, post-backpulse TMP was always less than pre-backpulse values.

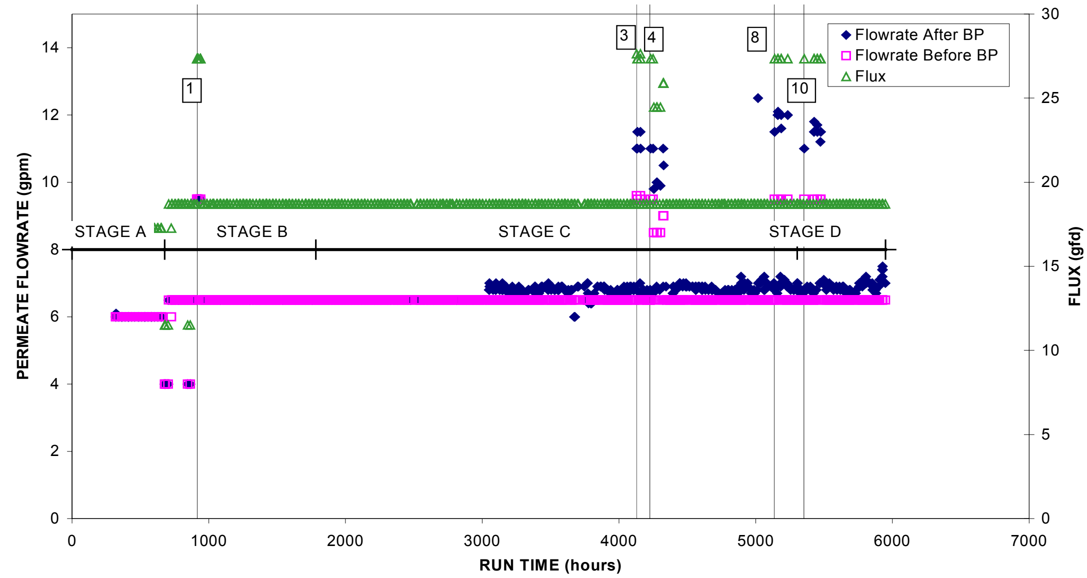

FIGURE 5.1
PERMEATE FLOWRATE AND MEMBRANE FLUX VS. RUN TIME

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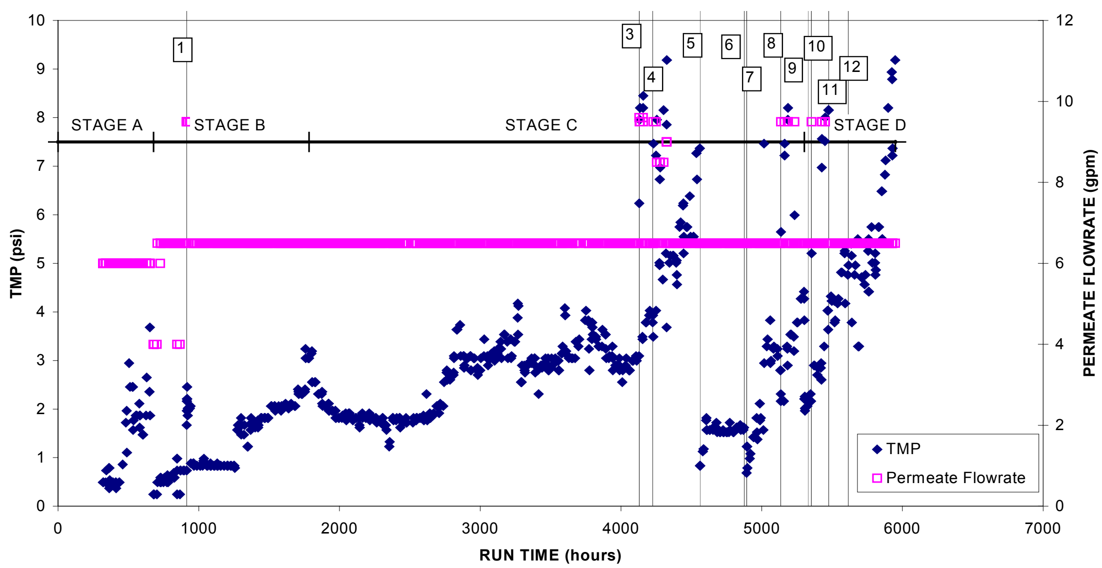

FIGURE 5.2
TRANSMEMBRANE PRESSURE AND PERMEATE FLOWRATE VS. RUN TIME

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Permeability.

Stages A – C. Figure 5.3 illustrates changes in ZenoGem permeability as a function of operating time (TMP is also shown for reference). During Stage B, permeability (normalized to 20°C) steadily decreased as TMP increased, indicating membrane fouling at the higher MLSS concentration of 13 g/L. In contrast, at the lower MLSS concentration in Stage C, permeability increased and remained relatively constant as TMP very gradually increased. However during the flow peaking test periods (Events 3, 4 and 8), permeability sharply decreased as TMP increased. This showed that the MBR system must be provided with a means of ensuring slow changes in peak loading. The peak loading cannot be raised as quickly over a 24-hour period as in a conventional WWTP. These results also confirm that ZenoGem operation at 10 g/L MLSS concentration and constant flux provides for very stable system operation.

Following raising of the membrane module and subsequent aeration of the membrane tank without operation of the permeate pump (no permeation), permeability decreased (Event 7). Subsequent operation with cycled aeration to the membrane tank produced a rapid and significant decrease in permeability.

Stage D. Operation under conditions of cycled aeration and/or flow peaking generally caused more rapid declines in permeability than operation at normal (steady) flow and continuous aeration, consistent with results under similar conditions during Stage C. This performance indicates that cycled aeration is less effective than continuous aeration in controlling foulant accumulation.

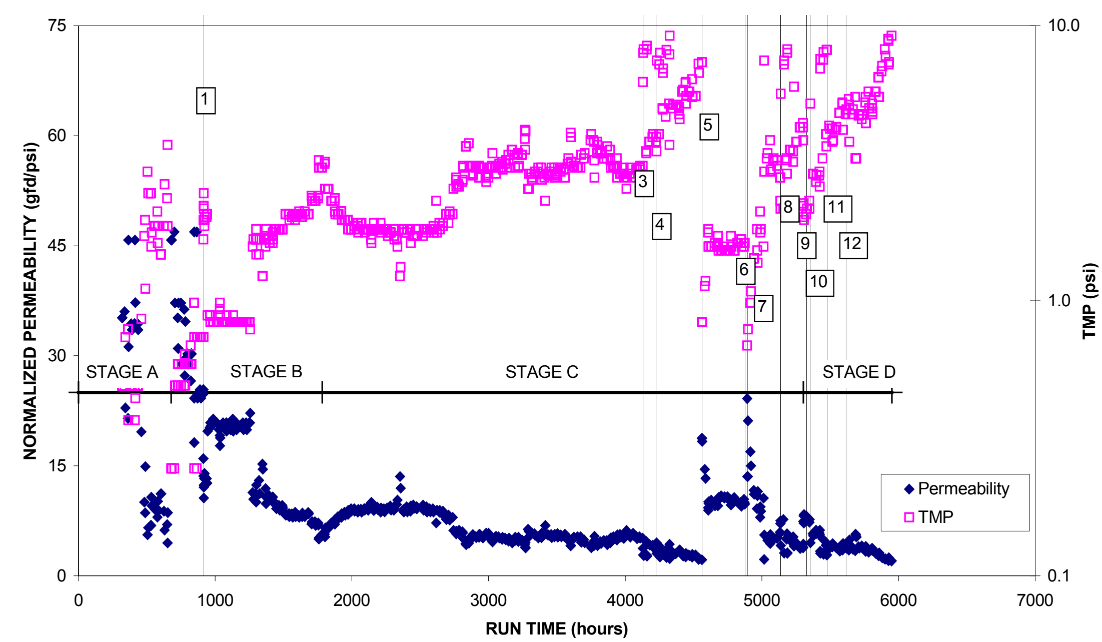

FIGURE 5.3
NORMALIZED MEMBRANE PERMEABILITY AND TRANSMEMBRANE PRESSURE VS. RUN TIME

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5.2.3 ZenoGem Biological Treatment Performance

Table 5.7 presents the average conditions within the ZenoGem bioreactor (volume weighted composite of the aeration and membrane tanks) during each stage of operation.

Table 5.7.—sults of Biological Treatment Performance Analyses for the ZenoGem System

Parameter	Target[a]	Stage A	Stage B	Stage C	Stage D
DO (mg/L)	> 1.5	2.78	1.53	2.00	3.19
OUR (mg O_2/L-min)	1.0 - 1.5			0.87	1.34
MLSS (mg/L)	13,000 (Stage A & B) 10,000 (Stage C) 6,000 (Stage D)	11,454	14,070	10,634	6,661
MLVSS (mg/L)		8,339	10,243	7,655	4,873
Sludge Wasted Daily (gals)	90 (Stage A & B) 110 (Stage C) 150 (Stage D)	96	131	114	182
Sludge Yield		1.27	1.50	1.14	2.03
HRT (hours)	5.7/3.9[b]	6.2	5.8/3.9[b]	5.7/4.0[b]	5.7/3.9[b]
System SRT (days)	25 (Stage A & B)[c] 20 (Stage C)[c] 15 (Stage D)[c]	21.29	16.79	19.25	14.04

[a]Where target left blank, no target was established.
[b]Value during flow peaking.
[c]Expected value based on control variables.

Hydraulic Residence Time. Figure 5.4 presents the HRT for the ZenoGem bioreactor. The average HRT for Stage A was slightly higher than the target range due to the step-wise increase in permeate flow to the target value of 6.5 gpm. HRT was held constant and near the target range during subsequent stages, except during flow peaking (Events 1, 3, 4, 8 and 10) when the HRT dropped by 32 percent (from 5.7 hours at 6.5 gpm down to 3.9 hours at 9.5 gpm). A 6.5-hour HRT was selected to ensure sufficient retention time to achieve complete nitrification based on prior testing at McAllen and other locations. This compares with a HRT of 30 hours for the McAllen WWTP (3 to 4 g/L MLSS) and reflects the greater biochemical oxidation efficiency at the higher MLSS levels.

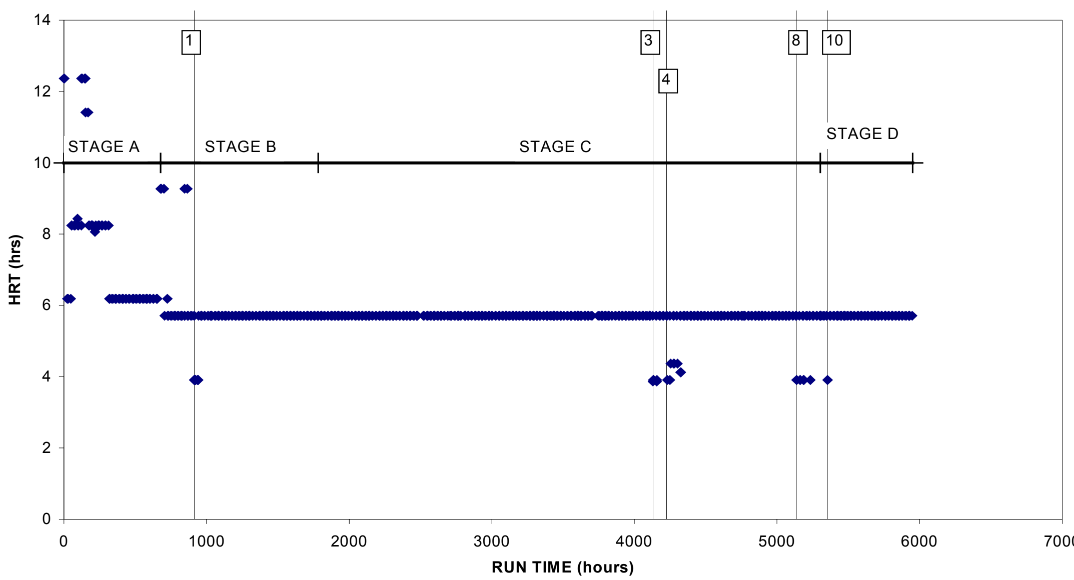

FIGURE 5.4
HYDRAULIC RESIDENCE TIME VS. RUN TIME

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Solids Retention Time. Figure 5.5 presents the SRT for the ZenoGem bioreactor. The average SRTs were near expected values during each stage, except for Stage B. A higher SRT would be expected for Stage B (versus Stage C) given that the MLSS concentration in the bioreactor was higher and loadings were similar. A lower SRT during Stage B resulted from excess sludge wasting (average 150 gpd compared to the target 110 gpd) in an effort to maintain the target MLSS concentration of 13 g/L. The ZenoGem process has the capability to be operated at a longer SRT (15 to 25 days) than the McAllen WWTP (15 days) because it is not limited by sludge settleability that limits the maximum MLSS concentration that can be accumulated in the system when using clarifiers rather than membranes for biomass retention.

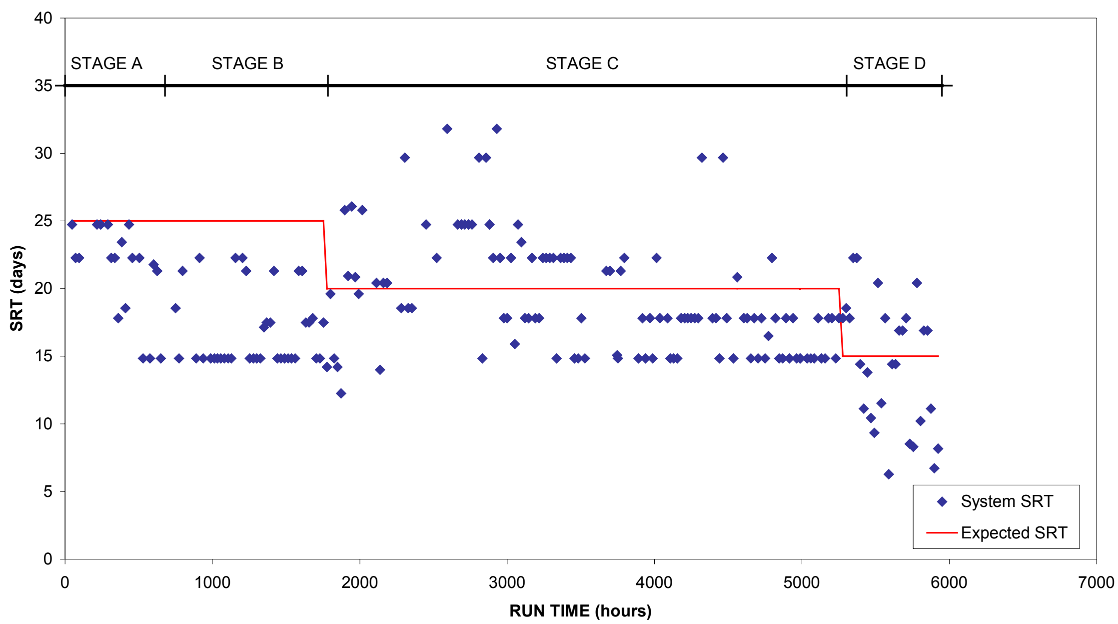

FIGURE 5.5
SOLIDS RETENTION TIME VS. RUN TIME

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Mixed Liquor Suspended and Volatile Suspended Solids. The McAllen WWTP and the ZenoGem system both use the suspended growth process (activated sludge) to achieve biological treatment. Removal of carbonaceous organic matter in a suspended growth process is directly dependent on the concentration of biomass present in the mixed liquor (activated sludge). Biomass levels can be roughly estimated by measuring the concentration of either the MLVSS or MLSS in the treatment reactor. The latter is more practical for maintaining proper bacterial levels because it is an easier and more rapid method. MLVSS is a more accurate measure of bacterial content because it excludes some of the inert fraction of the suspended solids, however it requires an additional drying and weighing step, which adds time and effort.

MLSS and MLVSS levels measured in the ZenoGem membrane (bioreactor) and aeration tanks are shown in Figures 5.6 and 5.7. The concentration of both parameters should be the same in both tanks under ideal conditions (infinite sludge recirculation rate and exact sludge wasting rates). The average MLSS concentrations in the tanks were at or near target values during each stage. Lower MLSS concentrations in Stage A are representative of startup operations (seeding and MLSS concentration increase to steady-state conditions). Higher than planned MLSS concentrations in Stage B resulted in greater sludge wasting volumes and higher sludge yields. The most common range of MLVSS values for conventional air activated sludge systems is 2,000 to 2,500 mg/L (WEF, 1991). Although air based conventional systems can operate at somewhat higher MLVSS level (up to 3,000 mg/L in practice), sludge settleability decreases as MLSS levels decrease. Settleability is not an issue for the ZenoGem process because separation is not dependent on gravity settling but rather on membrane filtration. However, sludge dewatering characteristics are important as they directly impact observed membrane permeability.

The significance of the greater MLVSS levels is that the ability to remove $CBOD_5$ is directly proportional to bacterial density in the activated sludge tank (or bioreactor). By maintaining higher MLVSS concentrations, the ZenoGem process can attain comparable reduction in $CBOD_5$ at a much lower hydraulic retention time. This is clearly illustrated in Table 5.7, where the average HRT for ZenoGem is about 6 hours versus 30 hours for the WWTP. In fact, as discussed in the following section, $CBOD_5$ removal efficiency was slightly better for the ZenoGem system. In other words, the same, or even greater, degree of treatment can be accomplished in roughly one-fifth of the time or volume used by the extended aeration process used at McAllen. Assuming similar depths for an aeration basin and ZenoGem bioreactor, the tankage area of the ZenoGem process would require only 20 percent of the land area required for the extended aeration basins. It should be noted, however, that it is possible that acceptable treatment could have been achieved in the full-scale McAllen WWTP if another activated sludge process was used.

The average ratio of MLVSS to MLSS for the ZenoGem process was 0.73. This is at the lower end of the typical range (0.7 to 0.9) and reflects the absence of a primary sedimentation step ahead of the ZenoGem process to settle and reduce inerts.

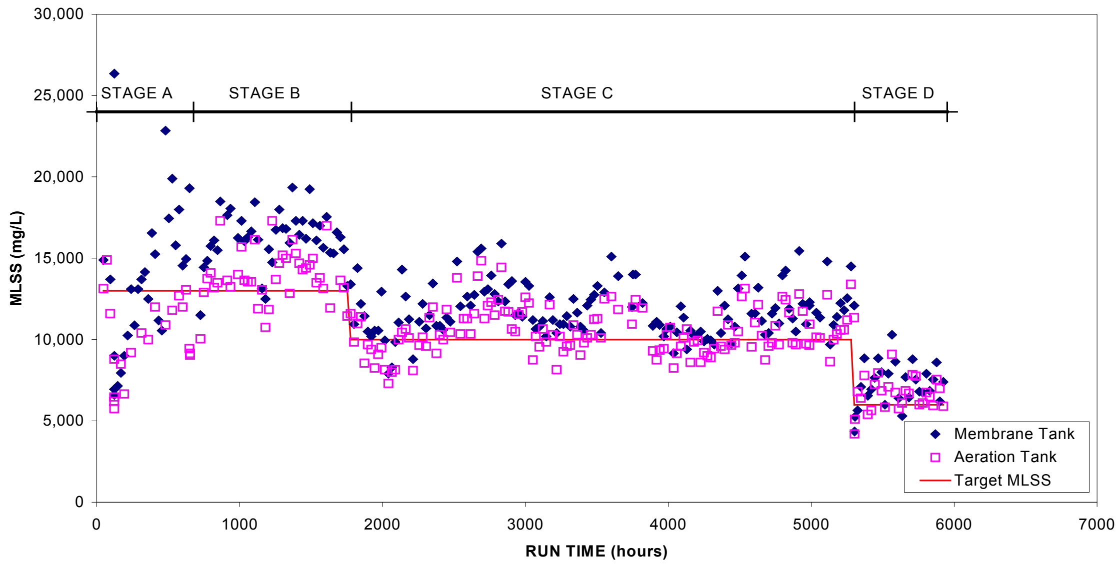

FIGURE 5.6
MIXED LIQUOR SUSPENDED SOLIDS VS. RUN TIME

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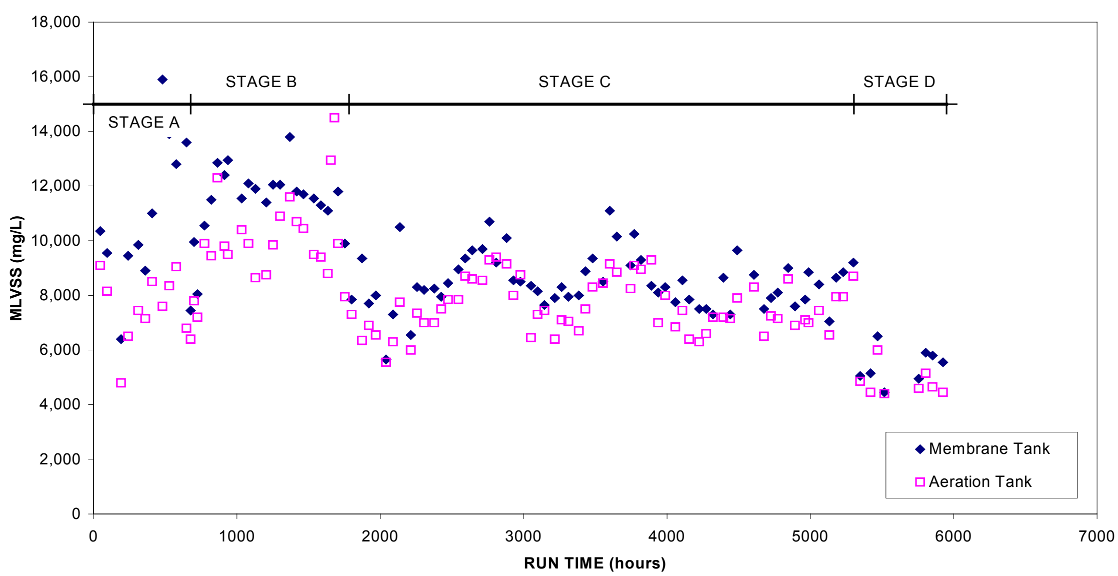

FIGURE 5.7
MIXED LIQUOR VOLATILE SUSPENDED SOLIDS VS. RUN TIME

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Dissolved Oxygen. Proper DO levels must be maintained in the activated sludge process to enable efficient degradation of both carbonaceous organic matter and organic nitrogen. Generally, DO levels in the activated sludge process should be maintained around 2.0 mg/L or greater to ensure that sufficient oxygen is present to achieve effective BOD_5 removal and nitrification (WEF, 1990). Lower levels will impede nitrification. DO levels of 1.5 mg/L or greater were targeted for the ZenoGem system.

DO levels in the membrane and aeration tanks are presented in Figure 5.8. DO levels were considerably higher than planned during Stage A as the air flowrate was optimized. Lower DO levels in the aeration tank than the membrane tank (38 to 58 percent lower throughout the study) resulted from inadequate air supply. Low DO levels in both tanks during Stage B resulted from high oxygen demand due to high BOD and TSS loading in the feedwater and to the higher MLSS concentration. Periodic increases in the ammonia content of the feedwater resulted in low DO levels during the other stages due to the increased oxygen demand required for nitrification.

Oxygen Uptake Rate. OURs in the membrane and aeration tanks are presented in Figure 5.9. OUR values were less than target from startup to the middle of Stage C due to error in the analytical method used. Samples were held for several hours prior to analysis (rather than being performed immediately), thereby decreasing oxygen uptake potential. After 3,216 hours of operation, OUR analysis was performed correctly and OUR values increased significantly.

Sludge Yield. Sludge yield coefficient, Y, is a measure of the amount of biological solids produced by a wastewater treatment process relative to the amount of organic matter removed. Ideally, the sludge yield should be as low as possible to minimize the need to dispose of sludge. For the extended aeration process used at the WWTP, Y is typically low because the microorganisms in the activated sludge operate in the endogenous phase based on the long mean SRT for this type of system (15 days). Y values for the ZenoGem system should be somewhat lower than the WWTP because the ZenoGem system operated at slightly higher SRTs; however this was not the case. The average sludge yield for the ZenoGem process ranged from 1.14 to 2.03 grams of sludge produced per gram of $CBOD_5$ removed. Based on the data available from the McAllen WWTP control logs, sludge yield for the McAllen WWTP was 0.73.

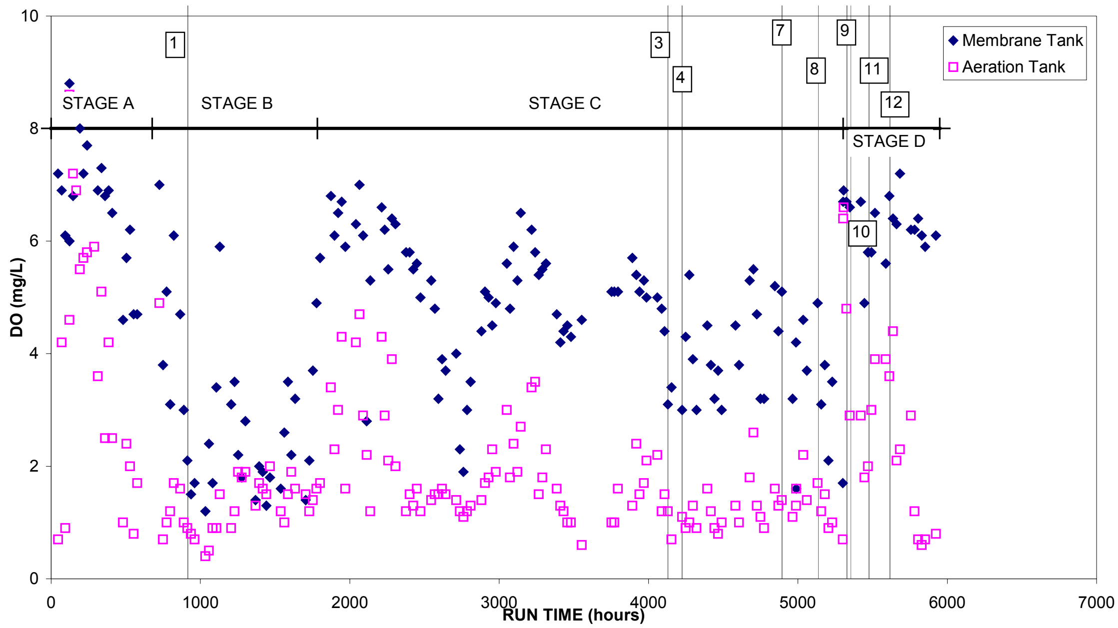

FIGURE 5.8
DISSOLVED OXYGEN VS. RUN TIME

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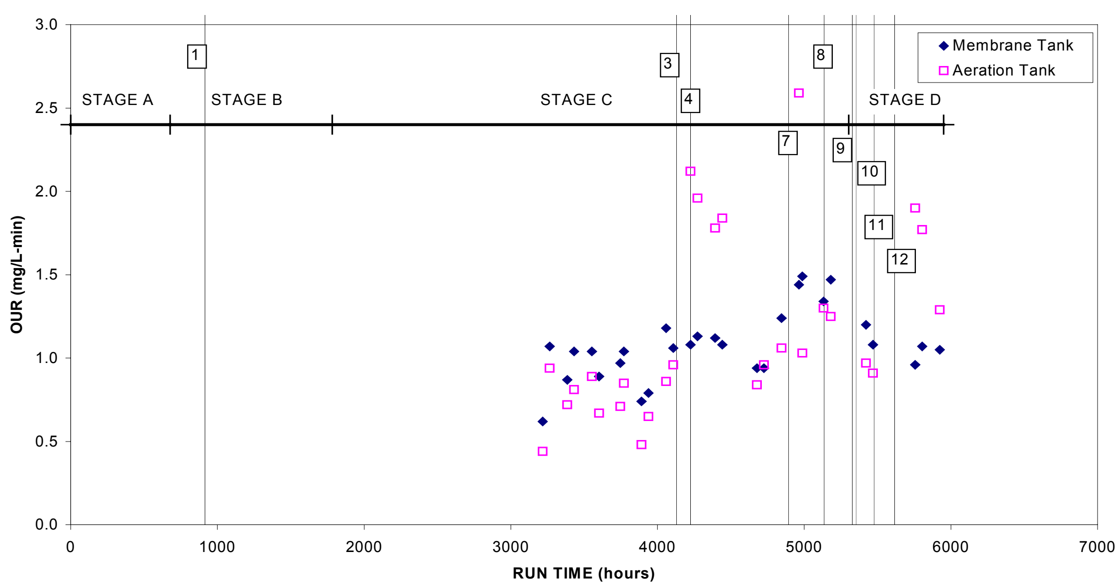

FIGURE 5.9
OXYGEN UPTAKE RATE VS. RUN TIME

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5.2.4 ZenoGem Water Quality Impacts

Several water quality parameters were measured to monitor the effectiveness of ZenoGem biological treatment and membrane filtration in improving wastewater quality. Table 5.8 presents the results of water quality analyses of the ZenoGem feed (SDS) and permeate during Stages A and B. The system operated at constant flow/flux during both stages, except for a brief 25-hour flow peaking period at the end of Stage B.

Table 5.8.—Results of Stages A and B Water Quality Analyses for the ZenoGem System

Parameter		Stage A		Stage B			
				Normal Flow		Peak Flow (Event 1)	
Physical/Chemical	**Permeate Target[a]**	**Feed**	**Permeate**	**Feed**	**Permeate**	**Feed**	**Permeate**
pH		7.23	7.33	7.22	7.59	7.12	7.58
Temperature (degrees C)		25.6	26.3	27.1	28.2	26.0	26.5
Turbidity (NTU)	< 0.2		0.17		0.24		0.34
Conductivity (µS/cm)		1,986	1,714	2,138	1,716	1,975	1,765
COD (mg/L)		300	5.0	620	15.0		
CaH (mg/L as $CaCO_3$)					331		360
ALK		391	154	422	203		230
Biological							
$CBOD_5$ (mg/L)	< 2	228	1.77	230	0.85	276	1.98
TSS (mg/L)	< 1	238	0.30	183	0.27	152	0.40
T-Phosphorus (mg/L as P)		20.65	0.96	14.00	0.18		
NH_3-N (mg/L as N)	< 0.5	26.93	0.16	25.36	5.68	26.50	6.58
TKN (mg/L as N)		111	3.31	75	9.73		
NO_2/NO_3-N (mg/L as N)		0.03	19	0.17	5.83		
Total Nitrogen (mg/L as N)		111	22	75	16		
Microbial							
Total Coliforms (CFU/100mL)	< 2.2		3.0		109.4		84.0
Fecal Coliforms (CFU/100 mL)	0		4.5		41.9		175.0
HPC (CFU/mL)	< 500		1,619		3,276		

[a]Where target left blank, no target was established.

µS/cm=microSiemens per centimeter.

Table 5.9 presents the results of water quality analyses of the ZenoGem feed and permeate during Stage C. The system operated at constant flow/flux during this stage, except during three flow peaking events and a 242-hour period when air was cycled to the membrane tank.

Table 5.9.—Results of Stage C Water Quality Analyses for the ZenoGem System

Parameter		Normal Flow		Peak Flow (Events 3,4,8)		Normal Flow with Cycled Aeration to Membrane Tank Only (Event 7)	
Physical/Chemical	**Permeate Target[a]**	**Feed**	**Permeate**	**Feed**	**Permeate**	**Feed**	**Permeate**
pH		7.16	7.42	7.20	7.37	7.20	7.35
Temperature (degrees C)		29.6	30.8	30.6	31.5	28.7	29.9
Turbidity (NTU)	< 0.2		0.15		0.10		0.15
Conductivity (µS/cm)		1,904	1,612	1,669	1,469	1,958	1,678
COD (mg/L)		383.3	15.6	380	13.0		
CaH (mg/L as $CaCO_3$)			345		312		322
ALK		352	128	336	158	334	176
Biological							
$CBOD_5$ (mg/L)	< 2	164	0.57	161	0.08	156	0.54
TSS (mg/L)	< 1	130	0.28	122	0.20	107	0.24
T-Phosphorus (mg/L as P)		9.55	3.34	5.23	3.15		1.97
NH_3-N (mg/L as N)	< 0.5	23.17	0.56	23.16	0.24	23.18	0.91
TKN (mg/L as N)		47	2.94	37	2.20	38	8.50
NO_2/NO_3-N (mg/L as N)		0.38	15.47	0.03	6.51	0.04	1.46
Total Nitrogen (mg/L as N)		47	18	37	9	38	10
Microbial							
Total Coliforms (CFU/100mL)	< 2.2		15.1		17.3		82.2
Fecal Coliforms (CFU/100 mL)	0		8.9		8.8		26.1
HPC (CFU/mL)	< 500		1,383		2,891		3,237

[a]Where target left blank, no target was established.

Table 5.10 presents the results of water quality analyses of the ZenoGem feed and permeate during Stage D. The system operated in an alternative operating mode with a reduced MLSS concentration (6 g/L) and peak flow and/or cycled aeration to one or both tanks.

Table 5.10.—Results of Stage D (Alternative Operating Mode) Water Quality Analyses for the ZenoGem System

Parameter		Normal Flow with Cycled Aeration to Membrane Tank (Event 9)		Peak Flow with Cycled Aeration to Membrane Tank Only (Event 10)		Normal Flow with Cycled Aeration to Membrane Tank Only (Event 11)		Normal Flow with Cycled Aeration to Membrane and Aeration Tanks (Event 12)	
Physical/Chemical	**Permeate Target[a]**	**Feed**	**Permeate**	**Feed**	**Permeate**	**Feed**	**Permeate**	**Feed**	**Permeate**
pH				7.06	7.13			7.13	7.33
Temperature (degrees C)		29.3	29.8	29.4	30.3	29.1	31.0	28.1	26.6
Turbidity (NTU)	< 0.2		0.12		0.10		0.13		0.14
Conductivity (µS/cm)		1,796	1,533	1,695	1,487	1,595	1,448	1,575	1,338
COD (mg/L)				448	15.0			292	14.0
CaH (mg/L as $CaCO_3$)					280		300		316
ALK				360	110	320	124	380	180
Biological									
$CBOD_5$ (mg/L)	< 2	146	0.03	157	0.15	154	0.17	154	0.37
TSS (mg/L)	< 1	104		184	0.20	140	0.20	220	0.27
T-Phosphorus (mg/L as P)		6.07	3.19	5.45	1.44	3.87	2.73	4.94	1.44
NH_3-N (mg/L as N)	< 0.5	21.30	0.05	24.85	0.15	17.20	0.14	24.28	0.31
TKN (mg/L as N)		42	2.0	43	2.0	39	2.0	47	2.85
NO_2/NO_3-N (mg/L as N)		0.01	18.30	0.02	13.5	0.01	20.10	0.01	3.96
Total Nitrogen (mg/L as N)		42	20	43	16	39	22	47	7
Microbial									
Total Coliforms (CFU/100mL)	< 2.2				8.5		9.0		6.4
Fecal Coliforms (CFU/100 mL)	0				2.0				
HPC (CFU/mL)	< 500				2,102		1,600		2,458

[a]Where target left blank, no target was established.

Particle Removal. The ZenoGem system achieved greater than 99 percent removal of TSS and CBOD during all stages of operation and was effective in reducing TSS and $CBOD_5$ in the wastewater to below target levels as shown in Figures 5.10 and 5.11. TSS measurement is not sufficiently sensitive to detect potential differences in TSS removal as a function of MLSS concentration. Figure 5.12 illustrates that COD was consistently reduced to less than 20 mg/L in the ZenoGem permeate. COD removal efficiency was not impacted by MLSS concentration.

As shown in Figure 5.13 and Table 5.8, the average permeate turbidity was slightly higher in Stage B as compared to Stage A and to the target level of 0.2 NTU established for feedwater to the downstream RO system. This suggests greater particle passage through the OKC MF versus the OCP UF membrane at the higher MLSS concentration. Permeate turbidities were higher during Stage B than Stage C (see Table 5.9), suggesting that particle passage through the OKC membrane is greater at high solids loading (high MLSS concentration).

Microbial Removal. Trends observed for turbidity removal were also seen with microbial removal. As shown in Figure 5.14, the average total and fecal coliform levels were higher in Stage B as compared to Stage A. This suggests greater bacteria passage through the MF versus the UF membrane at equal MLSS loadings. The increase coliform levels observed in Stage B compared to Stage C suggest bacteria passage through the MF membrane is a function of MLSS concentration. The high HPC levels may reflect bacterial regrowth in the ZenoGem permeate piping in the absence of a continuous disinfectant. In general, total and fecal coliform levels exceeded the informally adopted goal of State of California "Title 22" regulations pertaining to unrestricted access (2.2 CFU/100 mL for total coliforms and 0 CFU/100 mL, respectively).

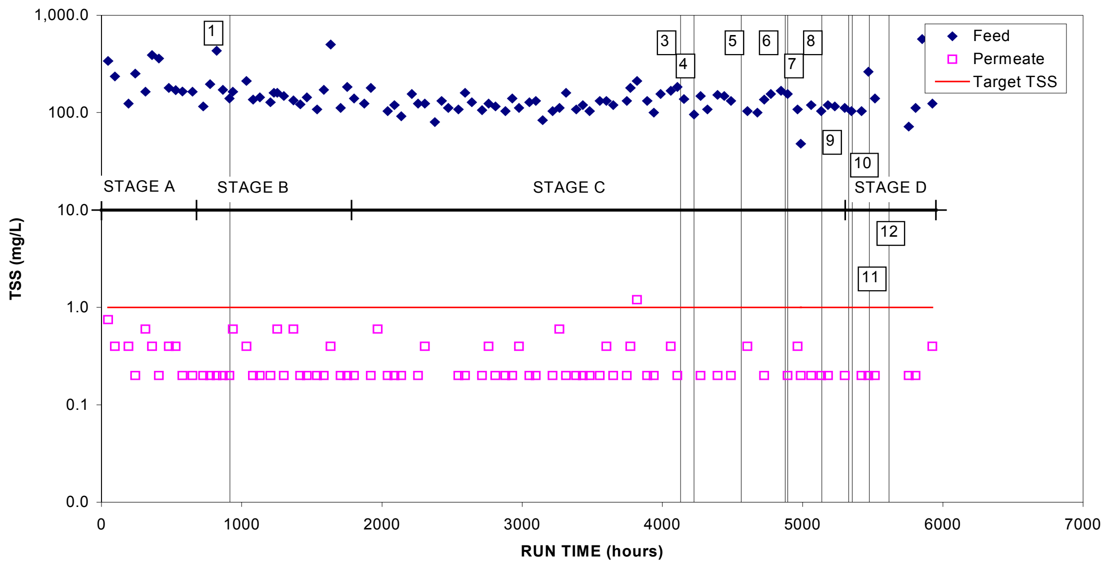

FIGURE 5.10
TOTAL SUSPENDED SOLIDS VS. RUN TIME

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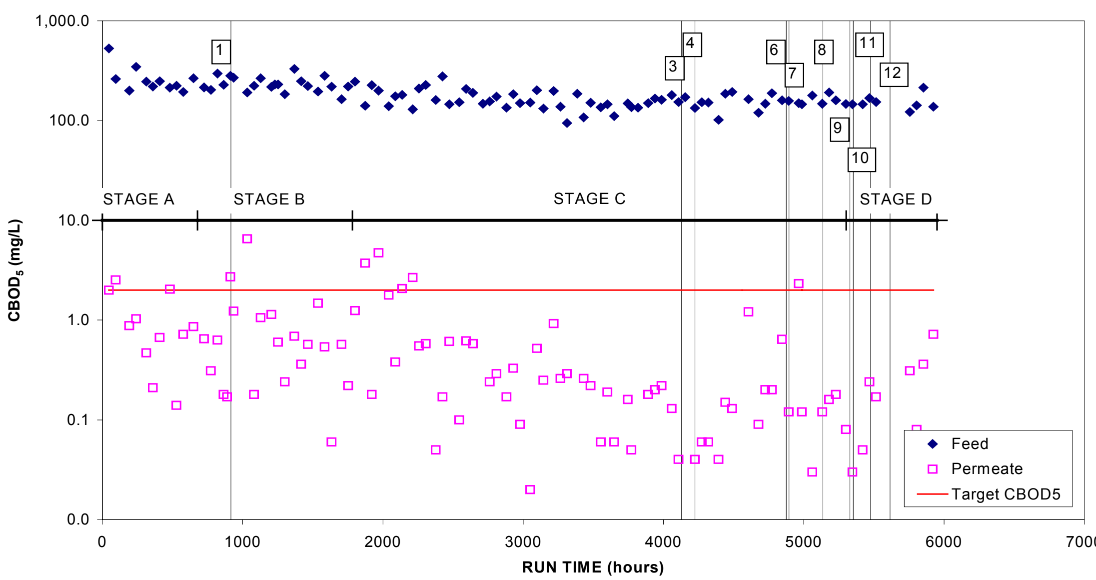

FIGURE 5.11
5-DAY CARBONACEOUS BIOCHEMICAL OXYGEN DEMAND VS. RUN TIME

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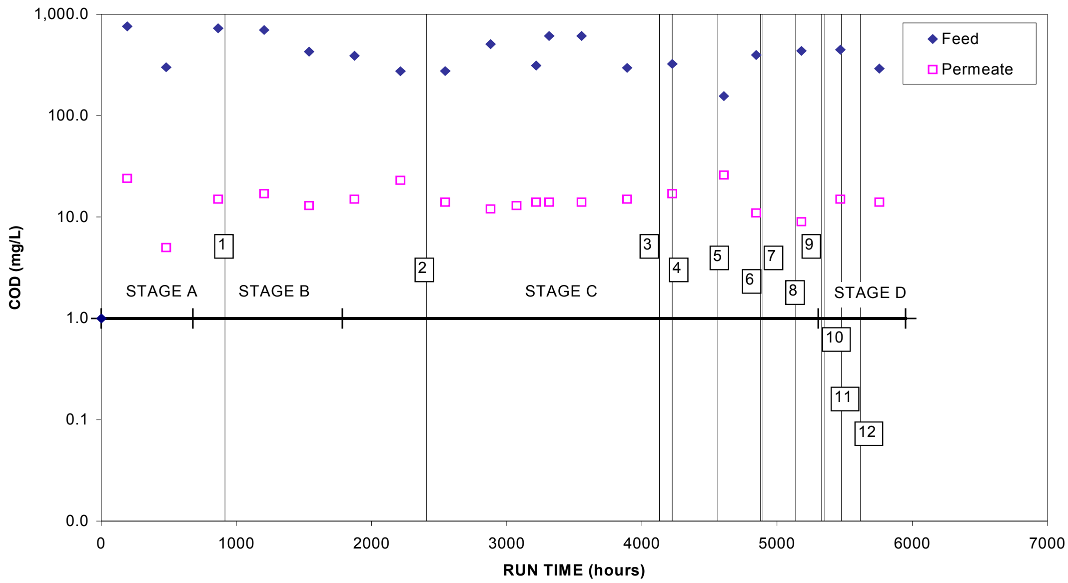

FIGURE 5.12
CHEMICAL OXYGEN DEMAND VS. RUN TIME

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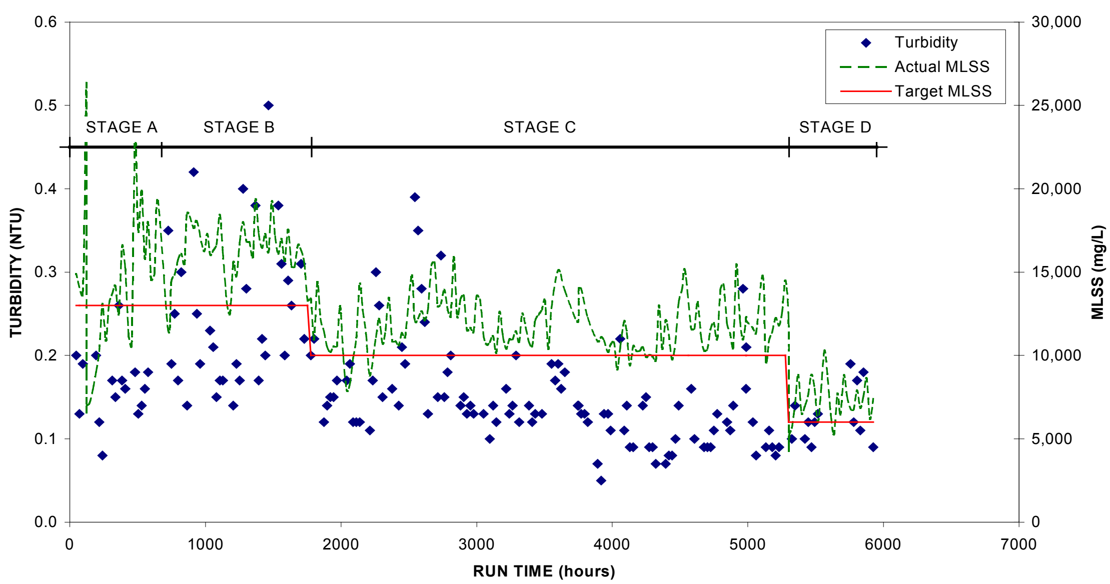

FIGURE 5.13
PERMEATE TURBIDITY VS. RUN TIME

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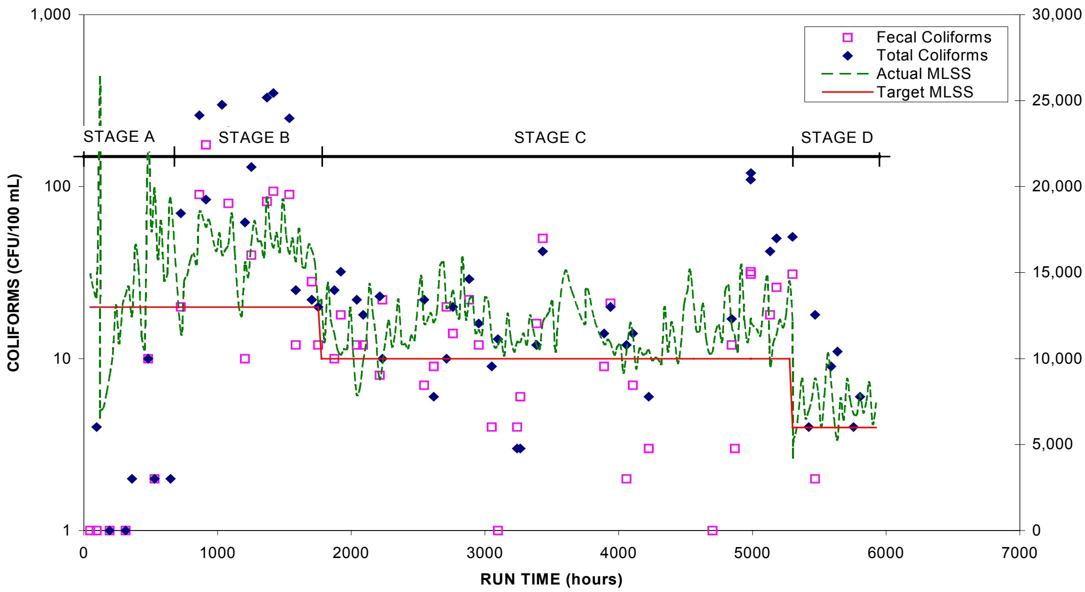

FIGURE 5.14
PERMEATE TOTAL AND FECAL COLIFORMS VS. RUN TIME

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Nutrient Removal.

Nitrogen Transformation. At the long SRTs used in this study and the high wastewater temperatures, the activated sludge portion of the ZenoGem process should be able to achieve complete nitrification, i.e., the conversion of ammonia-nitrogen to nitrate-nitrogen. A potential constraint is the ability to supply sufficient oxygen to the process, given the relatively short HRT and the high volumetric organic loading rate. Assuming sufficient DO levels and a well mixed biomass, denitrification should be minimized. These were the expectations at the start of the study.

Ammonia Removal. Ammonia nitrogen feed and permeate levels and percent removal by ZenoGem as a function of operating time are shown in Figures 5.15 and 5.16. Feed levels were relatively constant, ranging from 15 to 30 mg/L. Permeate concentrations were less than the target of 0.5 mg/L at normal flow conditions, except during Stage B. Removals were essentially complete during all stages, except Stage B. Reduced removals (partial/incomplete nitrification) during Stage B most likely reflect impaired efficiency of oxygen transfer to the nitrifiers within the dense flocs present at the higher MLSS concentration (~13 g/L) and high wastewater temperatures. Although dissolved oxygen levels in the bulk liquid were within acceptable range to achieve nitrification (under conventional wastewater MLSS levels), transfer of this oxygen from bulk liquid to bacteria contained within the flocs was not sufficient to achieve complete nitrification at the provided HRT. The reduced nitrification efficiency at higher MLSS levels suggests that MBR operation at such levels may be constrained by oxygen transfer efficiency unless such a constraint can be overcome by increase air input or better gas-to-liquid transfer efficiency than attained in this study.

When comparing normal flow versus flow peaking in Stages B and C, nitrification (ammonia removal) was incomplete during peaking due to the decrease in HRT from 5.7 hours to 3.9 hours. Cycled aeration to the membrane tank had no real effect on nitrification efficiency in Stage C. Ammonia removal was reduced from 98 to 97 percent only. This result is not surprising as most of the oxygen for biological oxidation is provided in the aeration tank. During Stage D, flow peaking with cycled aeration to both tanks during showed no significant decrease in nitrification when compared to normal flow and full aeration operation.

During all stages, the rate of nitrification was calculated at 0.48 mg/L NH_3-N per mg/L MLVSS per day regardless of MLSS concentration or permeate flowrate. However, during cycled aeration to both tanks in Stage D, the nitrification rate increased to 0.72 mg/L NH_3-N per mg/L MLVSS per day.

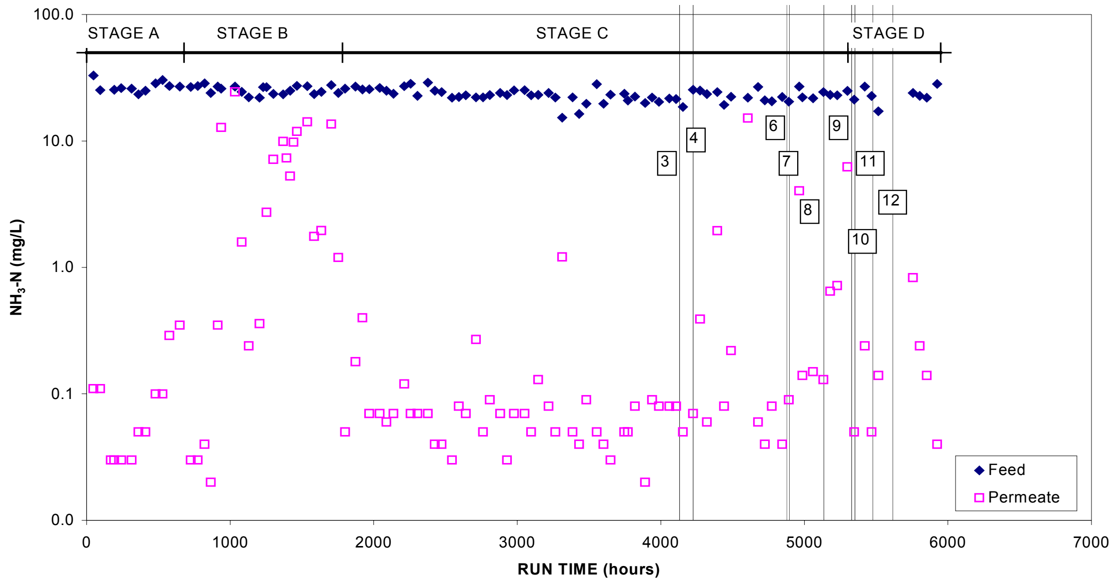

FIGURE 5.15
AMMONIA NITROGEN VS. RUN TIME

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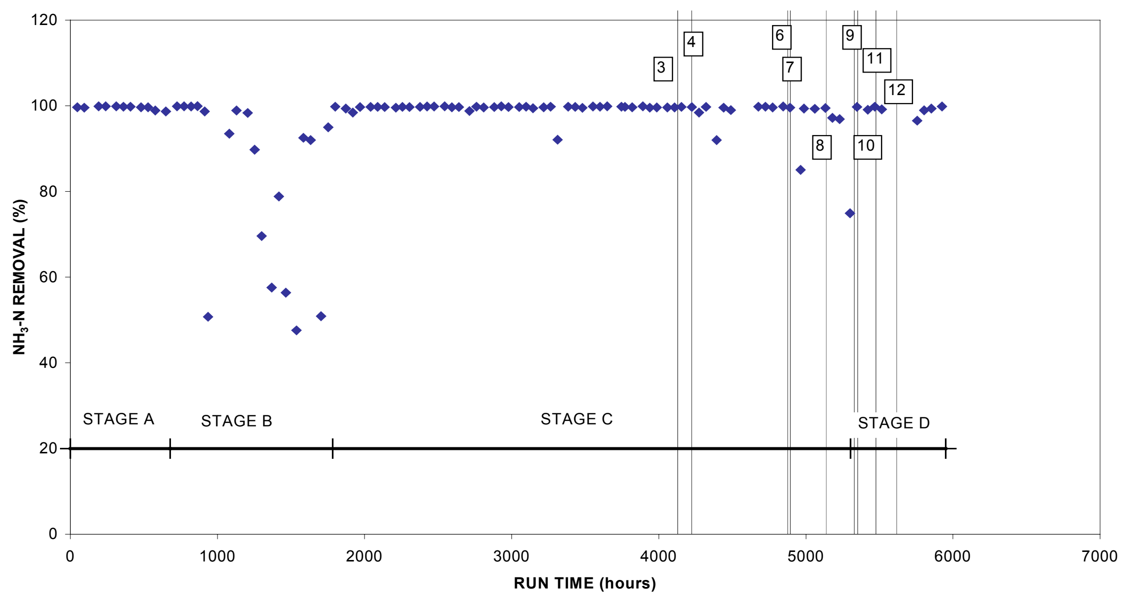

FIGURE 5.16
PERCENT AMMONIA NITROGEN REMOVAL VS. RUN TIME

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Nitrite/Nitrate Removal. Feed and permeate nitrite/nitrate nitrogen levels for the ZenoGem system as a function of operating time is shown in Figure 5.17. Feed levels were < 0.4 mg/L in all cases, as anticipated. Permeate levels ranged from 15 to 19 mg/L in Stages A and C. During Stage B and the end of Stage D, permeate levels were significantly less. Permeate levels are a function of the amount of ammonia and organic nitrogen converted to nitrite/nitrate (nitrification) and the extent to which this "converted" nitrogen is reduced to nitrogen gas by denitrifiers. In an aerated system, denitrification (nitrite/nitrate conversion to nitrogen gas) is not anticipated as the bacteria responsible for this reduction operate under anoxic conditions. During Stages A and C, denitrification was minimal yielding higher permeate nitrite/nitrate levels. However during Stage B and the end of Stage D, a significant fraction of the nitrite/nitrate generated from nitrification was converted to nitrogen gas, resulting in a condition of "simultaneous nitrification/denitrification" thus yielding lower permeate nitrite/nitrate levels. This result is consistent with the hypothesis offered under the *Ammonia Removal* discussion where reduced oxygen transfer creates micro anoxic zones within the mixed liquor, providing conditions conducive to the growth of denitrifiers. At the end of Stage D, conditions to produce this effect were put into place through cycled aeration in both treatment tanks. Such conditions were very effective for achieving a high level of both nitrification and denitrification, as illustrated by the data in Table 5.10 (Event 12) where permeate ammonia and nitrite/nitrate nitrogen concentrations were 0.31 and 3.96 mg/L, respectively.

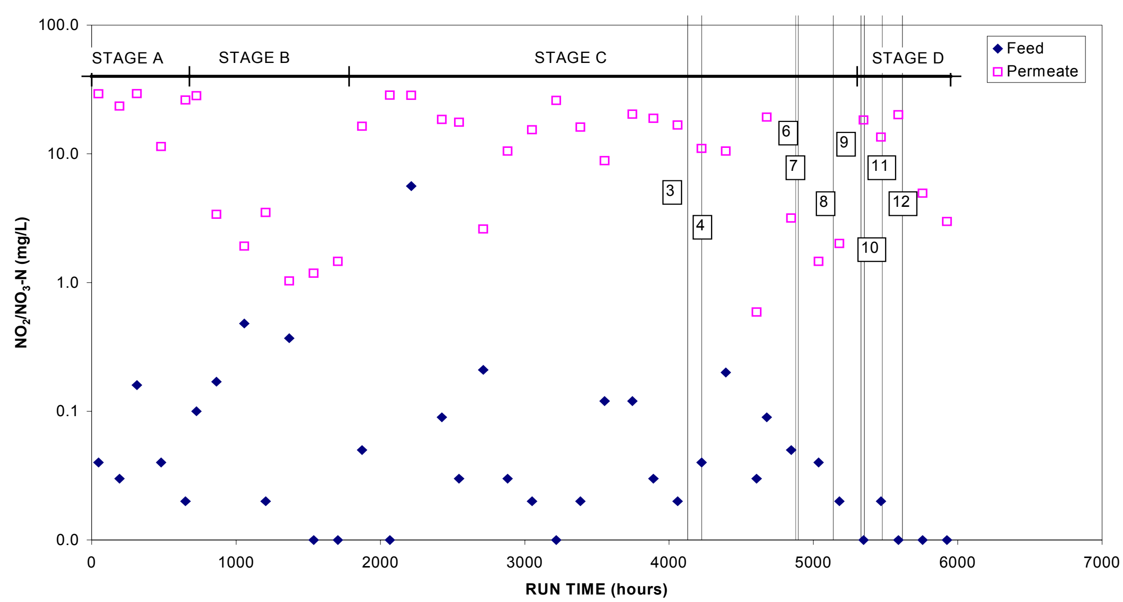

FIGURE 5.17
NITRITE/NITRATE NITROGEN VS. RUN TIME

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Total Nitrogen Removal. Feed and permeate total nitrogen (TN) levels and percent removal by the ZenoGem system as a function of operating time are shown in Figures 5.18 and 5.19. Feed TN levels were exceptionally high during Stages A and B, decreasing to the 38 to 47 mg/L range during the remainder of testing. As shown in Tables 5.8 through 5.10, highest permeate TN levels were observed at normal flow rates and at low to medium MLSS levels. Cycled aeration to the membrane tank had only minor impact on TN levels. TN removal was higher in Stage B as compared to Stage C due to nearly complete denitrification, in spite of the fact that partial nitrification (higher permeate ammonia and lower permeate nitrite/nitrate levels) was observed. TN removal decreased as a result of complete nitrification (lower permeate ammonia and higher permeate nitrite/nitrate levels) and reduced denitrification when the MLSS concentration was decreased in Stage C. The greatest degree of TN removal was observed at the end of Stage D (Event 12) during cycled aeration to both tanks. As previously discussed, such aeration is effective at maximizing simultaneous nitrification/denitrification. With a 15-minute on/off aeration cycle, the ZenoGem system was capable of reducing TN levels to 7 mg/L.

Alkalinity Consumption. During nitrification, alkalinity is consumed. During denitrification alkalinity is created. Assessing alkalinity reductions during the various stages of operation provides a means of "proofing" observed ammonia removals as well as providing a semi-quantitative measure of biological oxidation of non-ammonia organic nitrogen compounds. . Theoretically, 7.1 parts of alkalinity are consumed for each part of ammonia oxidized. As shown in Figure 5.20 during Stage B, alkalinity levels were reduced from an average of 422 mg/L as $CaCO_3$ in the feed to 203 mg/L as $CaCO_3$ in the permeate, yielding an alkalinity consumption of 219 mg/L as $CaCO_3$. In Stage C, levels were reduced from an average of 352 mg/L as $CaCO_3$ in the feed to 128 mg/L as $CaCO_3$ in the permeate, yielding an alkalinity consumption of 224 mg/L as $CaCO_3$.Based on an average ammonia nitrogen removal of 20 mg/L in Stage B and 23 mg/L in Stage C, 142 mg/L and 163 mg/L of alkalinity (as $CaCO_3$) should have been consumed in Stages B and C, respectively. The additional alkalinity consumption (77 mg/L as $CaCO_3$ in Stage B and 61 mg/L in Stage C) would have resulted from the biological oxidation of (non-ammonia) nitrogen compounds present in the wastewater. Ammonia nitrogen accounted for only 34 percent of the 75 mg/L of organic nitrogen (TKN) in Stage B and only 49 percent of the 47 mg/L of TKN in Stage C. These levels of TKN are unusually high for a domestic wastewater and indicate that nitrogen-rich discharges are present in the McAllen wastewater.

From previous discussions, nitrification was reduced and denitrification was significant during Stage B. Alkalinity changes between ZenoGem feed and permeate should reflect these differences; alkalinity removals during Stage B should be less than during Stage C as less alkalinity is consumed (from nitrification) and more is created (from denitrification). As shown in Figure 5.21, average alkalinity removal was 50 percent for Stage B and 64 percent for Stage C. Another way of comparing alkalinity consumption and nitrogen transformation is to correlate alkalinity consumption with total nitrogen removal. Lesser alkalinity consumption should occur with greater nitrogen removal as the ratio of nitrogen transformed from nitrate to nitrogen gas increases relative to the amount of organic nitrogen oxidized to nitrite/nitrate. Total nitrogen removal was 76 percent for Stage B and 58 percent for Stage C.

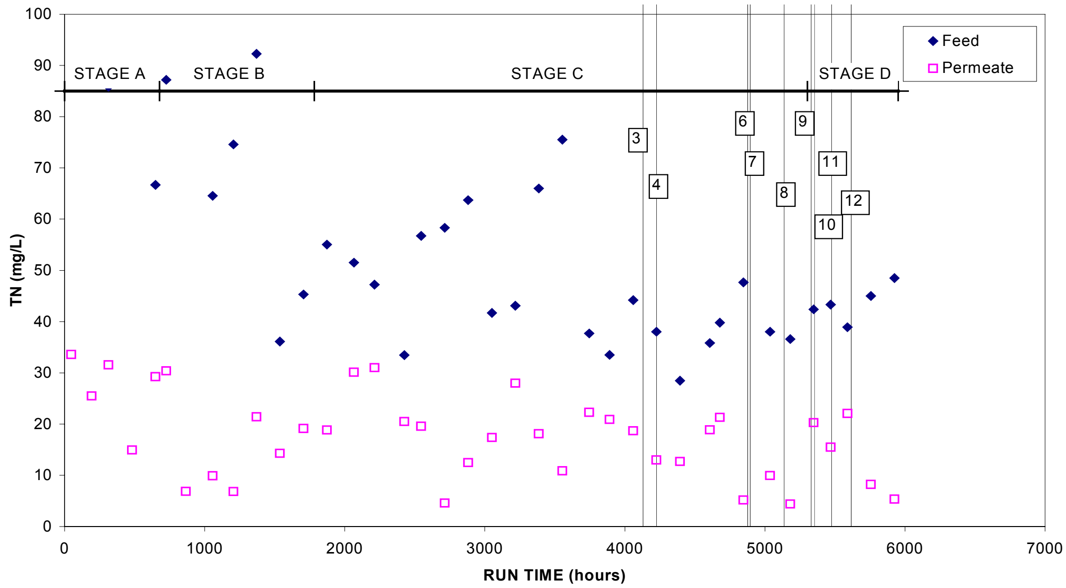

FIGURE 5.18
TOTAL NITROGEN VS. RUN TIME

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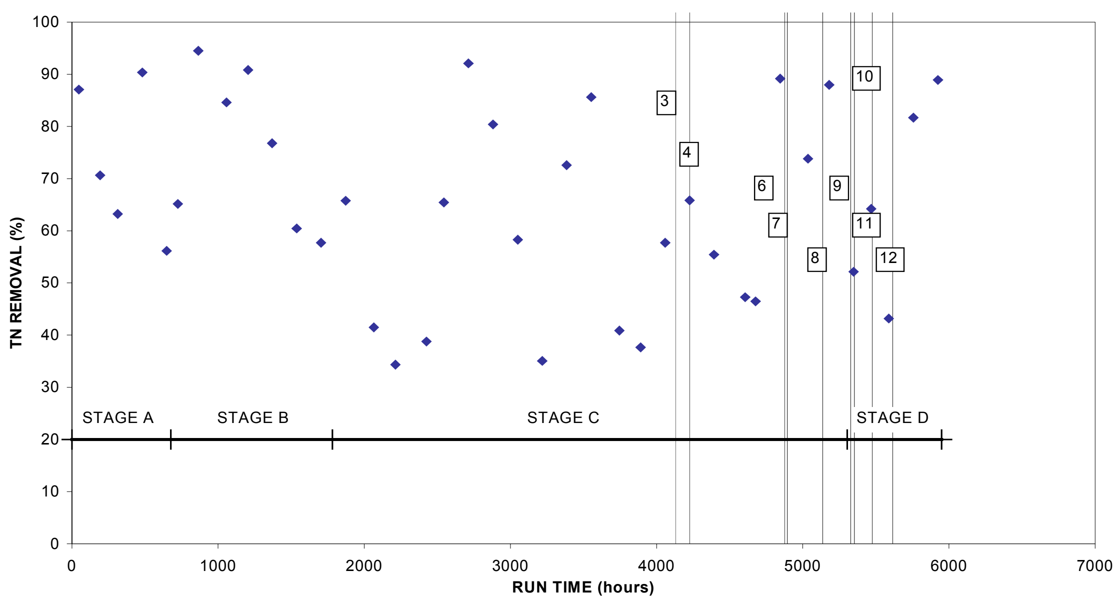

FIGURE 5.19
PERCENT TOTAL NITROGEN REMOVAL VS. RUN TIME

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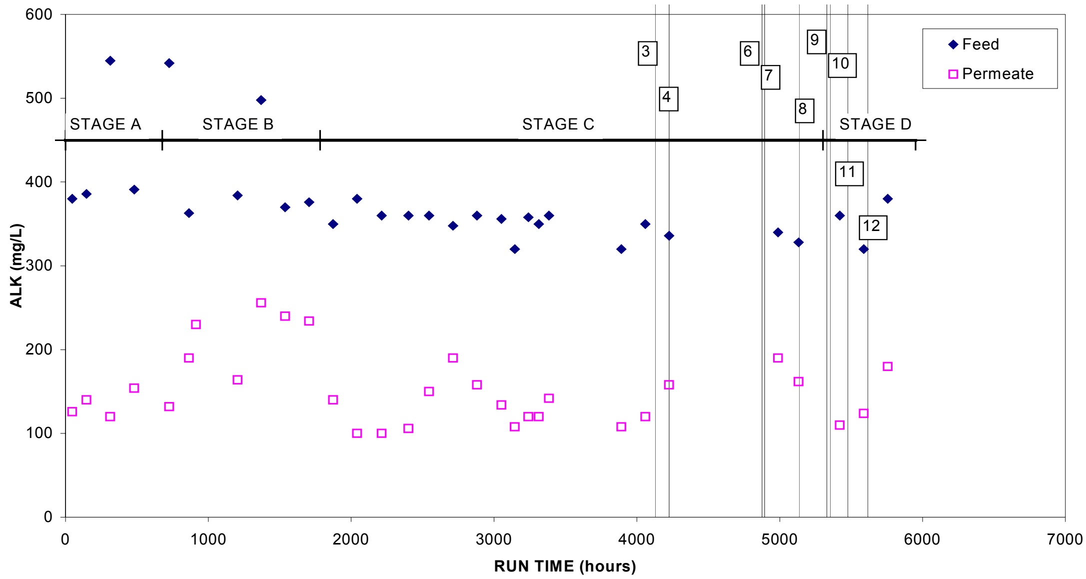

FIGURE 5.20
ALKALINITY VS. RUN TIME

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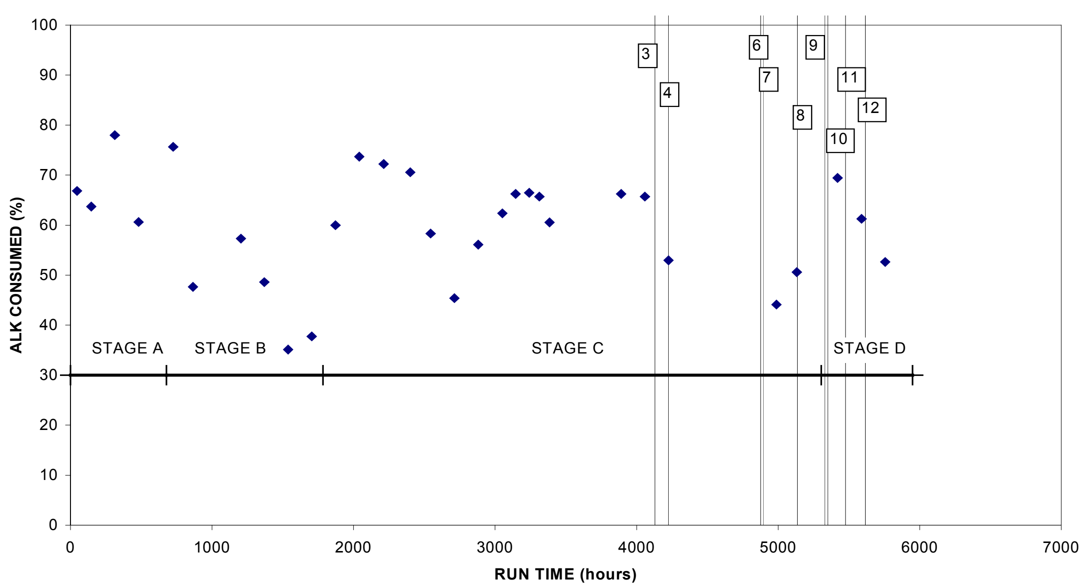

FIGURE 5.21
PERCENT ALKALINITY CONSUMED VS. RUN TIME

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Phosphorus Reduction. Feed and permeate total phosphorus (TP) levels and percent removal by the ZenoGem system as a function of operating time are shown in Figures 5.22 and 5.23. Phosphorus reduction by the ZenoGem process was significantly greater in Stage B than in Stage C at 98 percent and 58 percent, respectively. At the higher MLSS concentration, oxygen transfer to certain zones of the aeration tank was most likely poor, resulting in anaerobic conditions within segments of the biomass producing favorable conditions for biological phosphorus uptake. When the MLSS level was reduced at the beginning of Stage C, these anaerobic zones were eliminated (or greatly reduced) and the phosphorus bound in these organisms was subsequently released, causing phosphorus removal to temporarily increase as shown in Figure 5.23. During the latter part of Stage C, the phosphorus levels in the permeate were in the 2 to 5 mg/L range, which is typical for the conventional wastewater treatment process using secondary treatment and nitrification. Phosphorus removal variability in Figure 5.23 reflects variability in the measured phosphorus levels in the ZenoGem feedwater. Also during Stage C, the phosphorus reduction decreased from 58 percent at normal flow/flux to 40 percent during flow peaking due to the decrease in HRT (insufficient time for phosphorus removal).

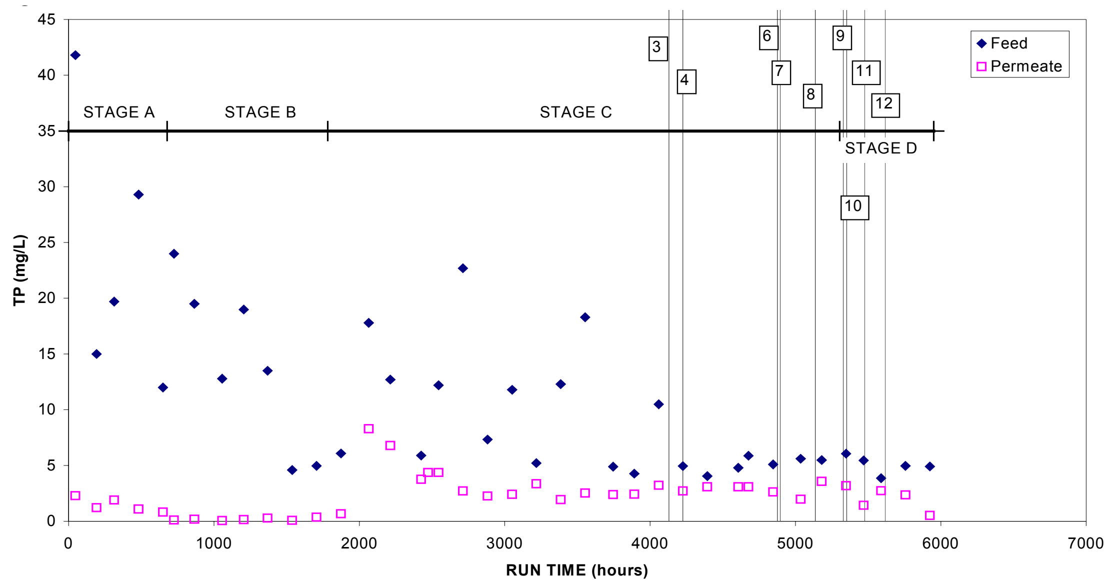

FIGURE 5.22
TOTAL PHOSPHORUS VS. RUN TIME

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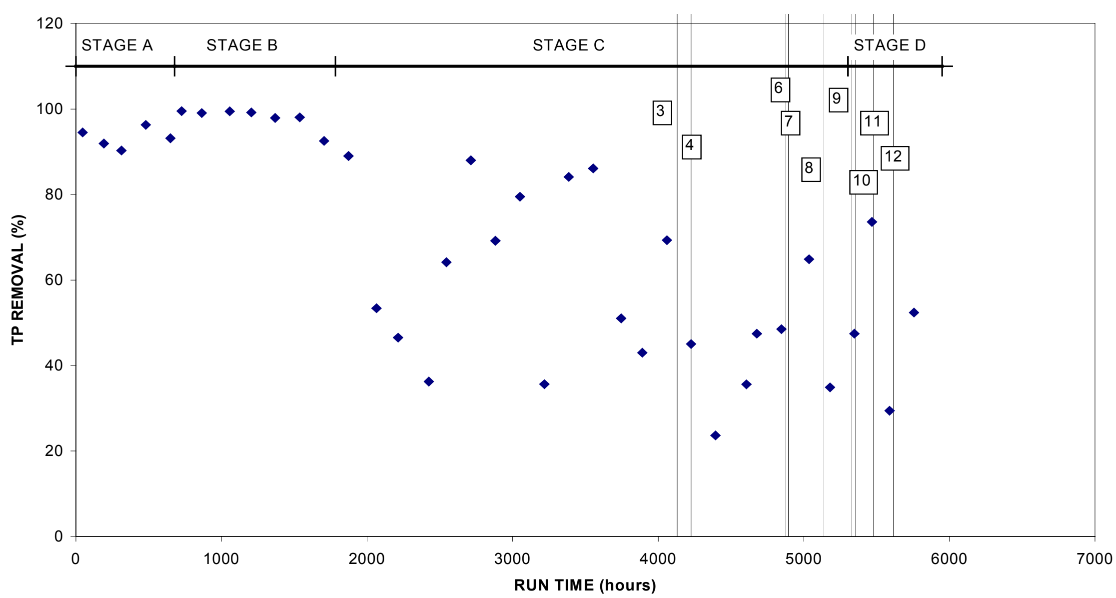

FIGURE 5.23
PERCENT TOTAL PHOSPHORUS REMOVAL VS. RUN TIME

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5.3 RO Testing Results

5.3.1 RO Feedwater Quality

Particulate Fouling Potential. Table 5.11 presents the average values for the RO feedwater quality parameters that reflect particulate and colloidal fouling potential (turbidity, SDI and heterotrophic bacteria). For all stages of testing, turbidity and SDI values were less than corresponding target levels, reflecting the low particle water produced by the ZeeWeed membrane. (Turbidity and SDI targets are those established by the spiral wound RO industry based on minimizing RO element fouling and cleaning. With a few exceptions, RO feedwater turbidity averaged less than the 0.2 NTU target (Figure 5.24). As shown in Figure 5.25, the ZenoGem system consistently produced a permeate with a SDI less than the target value of 3. The target of 500 CFU/mL for HPCs is an informal goal that is related to the acceptable level of HPCs in drinking water. There is not established correlation between HPC level in RO feedwater and degree of biological fouling, however, the greater the level the greater the potential to establish biofilms. Actual propensity to form biofilms depends on a number of interrelated factors, including organism type, level of nutrients, water chemistry, membrane material and flow hydraulics through the element. HPC levels were consistently above the target, however, as discussed in a later section of the report, there was no evidence of biological fouling. Taken together, the data in Table 5.11 indicate that the permeate from the ZenoGem permeate should cause little if any particulate fouling of downstream RO membranes.

Table 5.11.—Average RO Feedwater Quality Parameters

Parameter	Target	Stage B	Stage C	Stage D
Turbidity (NTU)	< 0.2	0.18	0.16	0.11
SDI	< 3	1.46	1.83	1.53
HPC (CFU/mL)	< 500	3,274	865	1,444

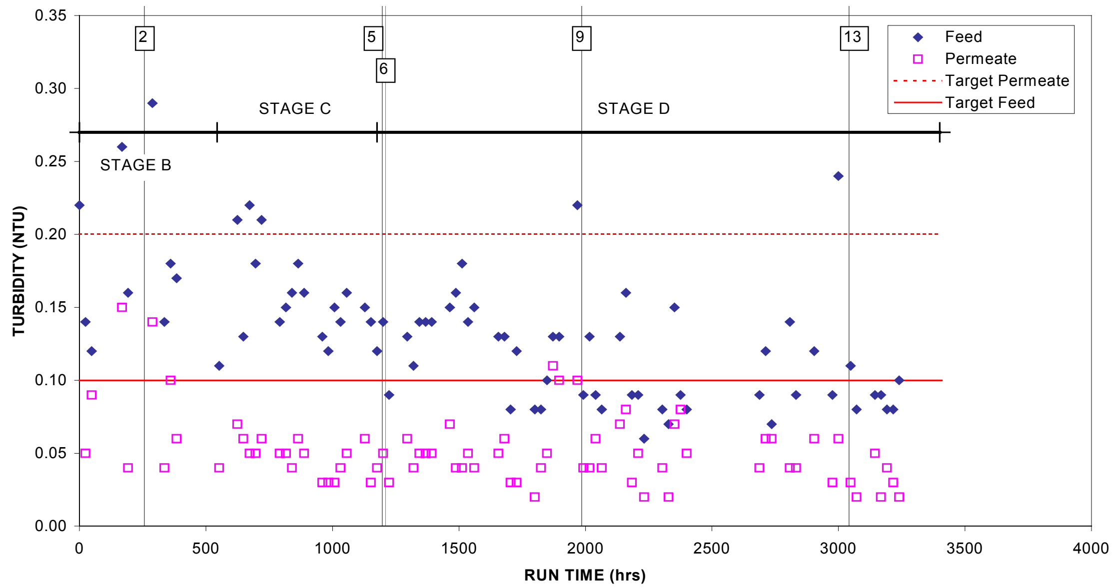

FIGURE 5.24
TURBIDITY VS. RUN TIME

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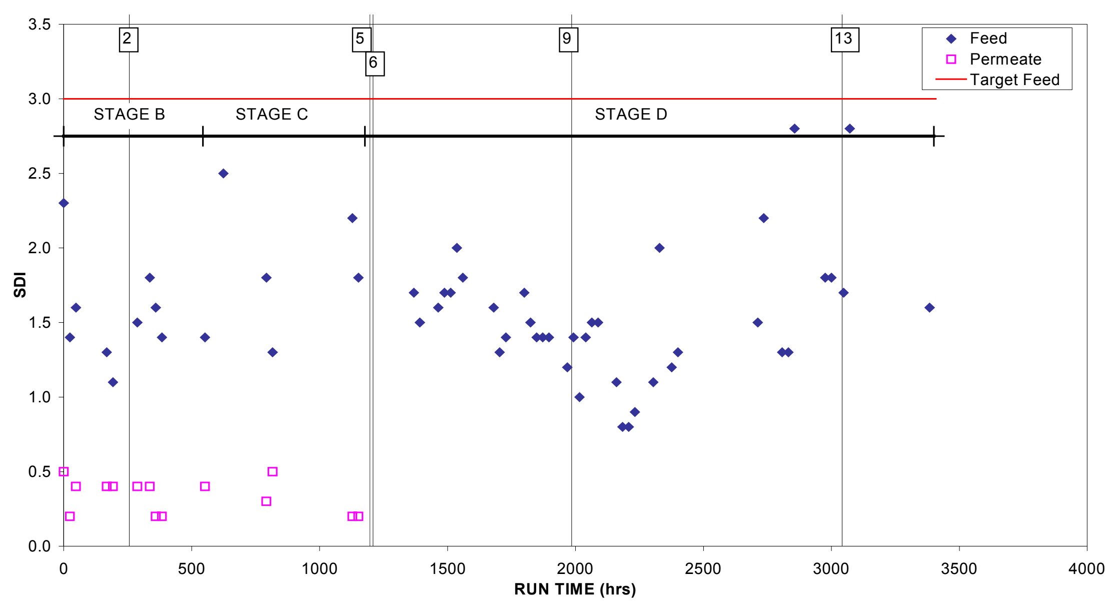

FIGURE 5.25
SILT DENSITY INDEX VS. RUN TIME

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Mineral Precipitation Potential. Section 3 discussed the need for chemical conditioning of the RO feedwater to prevent the precipitation of calcium carbonate and barium sulfate, based on their levels in the WWTP secondary effluent and the degree to which their co-ions would be concentrated during RO treatment at target recovery. The mineral saturation calculations provided in the RODesign program (and also by the scale inhibitor suppliers contacted at the beginning of the project) estimate percent saturation for only the following sparingly soluble salts: calcium carbonate, calcium fluoride, barium sulfate, calcium sulfate, strontium sulfate and silica. Consequently, other sparingly soluble salts present in the effluent, including calcium phosphate salts, were not identified as being supersaturated as a result of RO treatment of the ZenoGem permeate. As discussed in Section 5.3.2 of this report, precipitation of calcium phosphate salts occurred during testing and required additional feedwater acidification to control. Analysis of spent cleaning solutions and materials removed from the membrane surface from element autopsies, showed that calcium carbonate and barium sulfate scaling was effectively controlled and that calcium phosphate was the major mineral precipitate.

5.3.2 RO Operating Conditions/Membrane Performance

Operating Conditions. Table 5.12 presents the average RO system operating conditions for the following parameters: (recovery, flux, flow, pressure, and conductivity). With the exception of periods during Stage B, the RO system operated at or near target flowrates. Average feed pressure and permeate conductivity was significantly greater during Stage B operation at high recovery because of the increase resistance to flow caused by scaling in the second stage elements during this period. Feed pressure variations as a function of operating time is shown in Figure 5.26. This plot clearly illustrates the high feed pressure periods associated with scaling of the second stage membrane elements during Stage B. These effects were reversed by citric acid cleanings (Events 1, 3 and 4).

Table 12.—Average Operating Conditions for the RO System

Stage	Stages in Operation	Target Recovery (%)	Actual Recovery (%)	Flux gfd	Flow (gpm)			Pressure (psi)			Conductivity (µS/cm)			
					Feed	Conc	Permeate	Feed	Interstage	Conc	Feed	Interstage	Conc	Permeate
B	1&2	80	70.4	10.37	3.98	0.94	2.85	231	220	213	1,608	4,408	3,729	182
B[a]	1&2	50	59.0	10.63	5.04	2.29	2.92	132	111	91	1,701	3,544	4,024	150
C	1	50	47.9	9.83	4.11	2.31	2.01	80	NA	65	1,636	3,167	3,330	71
D	1&2	50	48.9	7.71	5.45	2.67	2.95	125	100	63	1,798	2,958	3,520	104
D	1&2	62	63.8	10.03	4.33	2.76	1.45	90	76	63	1,814	3,510	5,017	148
D	1&2	70	68.1	10.50	4.24	2.89	1.41	101	86	74	1,741	3,408	4,998	118
D	1&2	74	72.6	10.62	4.02	2.92	1.12	110	97	87	1,549	3,187	4,970	95
D	1&2	80	79.3	11.89	4.12	3.27	0.86	128	115	107	1,731	3,841	7,210	105

[a]Target feedwater recovery decreased from 80 to 50 percent after 256 hours of operation (Event 2).
NA=Not Applicable

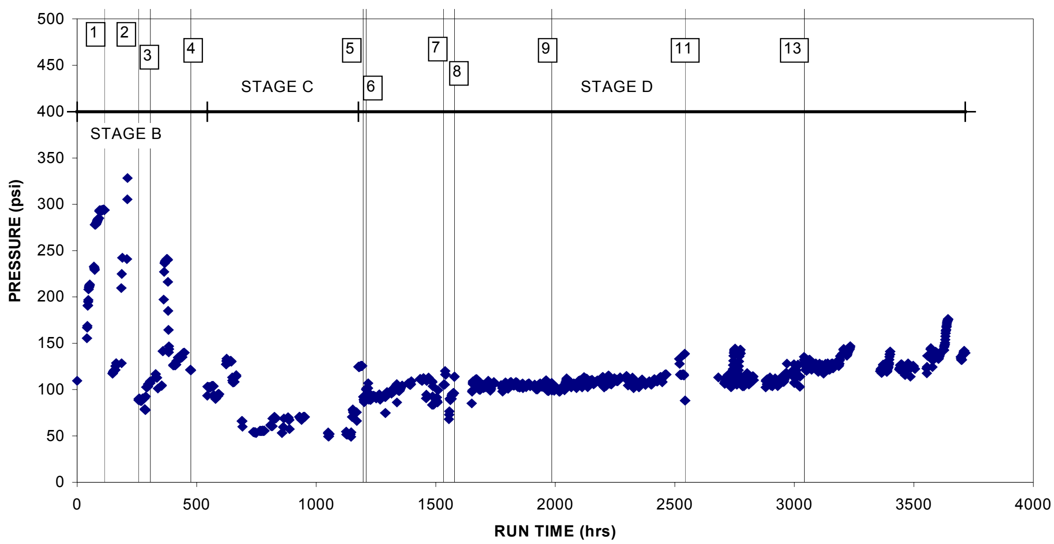

FIGURE 5.26
FEED PRESSURE VS. RUN TIME

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Performance Parameters. Table 5.13 presents RO system target and average actual membrane performance parameters (NPF, salt passage and salt rejection) as a function of operating time. Figure 5.27 illustrates changes in flux as a function of operating time. Membrane flux varied considerably during Stage B, decreasing in proportion to the decline in system productivity. Although testing called for operation at constant flux, the rapid and severe increases in feed pressure make it difficult for the plant operators to provide such control. The step decrease in flux during Stage C was intentional and reflects an attempt to reduce RO fouling potential. Flux was steady during Stage D as mineral precipitation and feed pressure was more effectively controlled.

Table 5.13.—Average Membrane Performance Parameters for the RO System

Stage	Stages in Operation	Target Recovery (%)	Normalized Product Flow (gpm)	Salt Rejection (%)	Salt Passage (%)
B	1&2	80	1.88	89.26	10.74
B[a]	1&2	50	3.47	91.65	8.30
C	1	50	2.38	95.90	4.10
D	1&2	50	2.92	94.57	5.43
D	1&2	62	4.71	92.27	7.73
D	1&2	70	4.02	93.63	6.37
D	1&2	74	3.36	94.18	5.82
D	1&2	80	3.39	94.24	5.76

[a]Target feedwater recovery decreased from 80 to 50 percent after 256 hours of operation (Event 2).

Similarly, NPF showed severe and rapid declines during Stage B. As shown in Figure 5.28, these declines were readily reversible by citric acid cleanings, however operation at high recovery and feed pH (6.8) was not sustainable on a long-term basis. At lower recovery (Stage C), NPF was quite stable confirming that performance declines were recovery and scaling related. With return to two-stage operation and recovery of 70-75 percent (Stage D), NPF again declined but a lesser rate, reflecting the partial effectiveness of reduced pH (6.0 – 6.5) operation. However, stable performance could not be achieved until feedwater pH was reduced to 5.0, corresponding to a concentrate pH of 5.6. As recovery was further increased to 80, inability to effectively control concentrate pH at 5.6 again resulted in rapid NPF decline.

Normalized salt passage was less impacted by scaling than NPF, with the exception of Stage B operation when scaling was worst (Figure 5.28). Normalized salt passage was comparable at the very beginning of Stage B (6 percent at 4 hours) and at the end of routine testing (5 percent at 3,400 hours). This indicates no loss in salt rejecting capability by the RO membranes over the course of this testing despite repeated membrane scaling and citric acid cleaning.

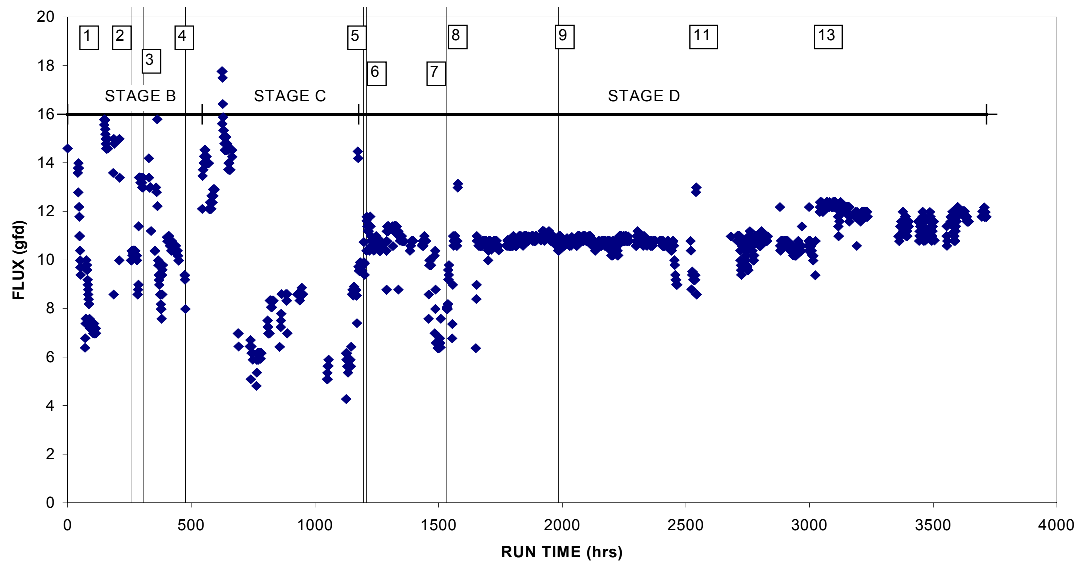

FIGURE 5.27
MEMBRANE FLUX VS. RUN TIME

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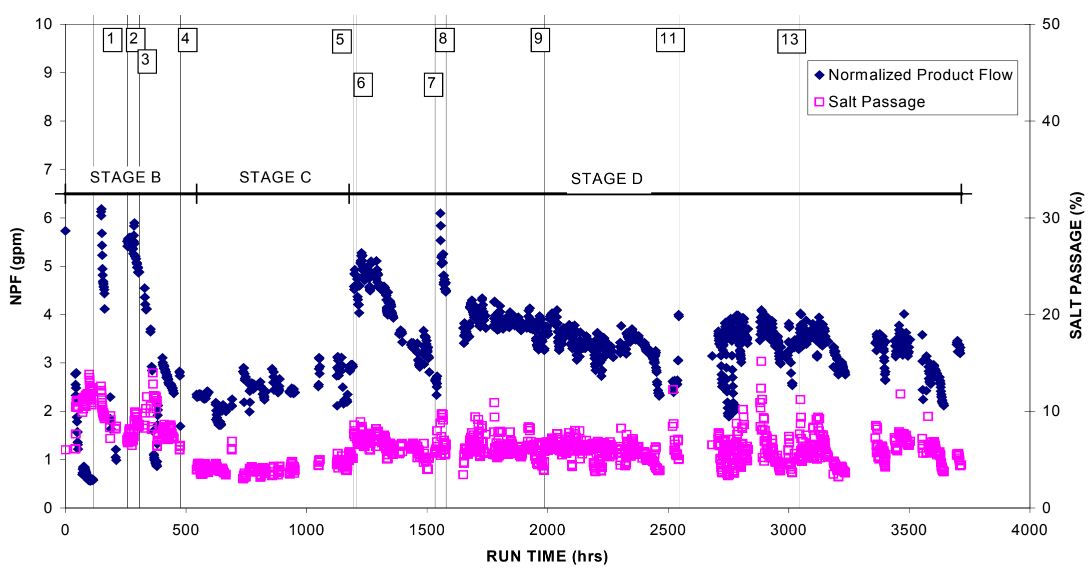

FIGURE 5.28
NORMALIZED PRODUCT FLOW AND SALT PASSAGE VS. RUN TIME

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Figures 5.29 and 5.30 present vessel differential pressure (pressure drop) for each RO system stage during the testing as well as pressure drop coefficient for Stage 1 only as a function of operating time. In RO systems operating on MF-treated wastewater effluent or MBR permeate, pressure drop is monitored primarily to indicate the occurrence biological fouling, which causes a characteristic rise in Stage 1 pressure drop. Pressure drop reflects the resistance of water flow through the RO element feed spacer. As material accumulates within the spacer or on the membrane surface, pressure drop increases. Pressure drop coefficient[1] accounts for changes in flow through the pressure and allows for a better comparison of systems operating at different recoveries. In general, the data in the figures indicate the absence of biological fouling. Stage 1 PDC was relatively unchanged, except during the beginning of Stage B. During the period considered most representative of a properly operated RO system (Stage D, 1,500 to 3,000 hours), both pressure drop and PDC were extremely stable. The very gradual decline in pressure drop during Stage C was associated with the decrease in recovery (lower feedwater flow through the feed channels).

[1]Pressure drop coefficient (PDC) is defined as follows: PDC = pressure drop /(feed flowrate)$^{1.5}$

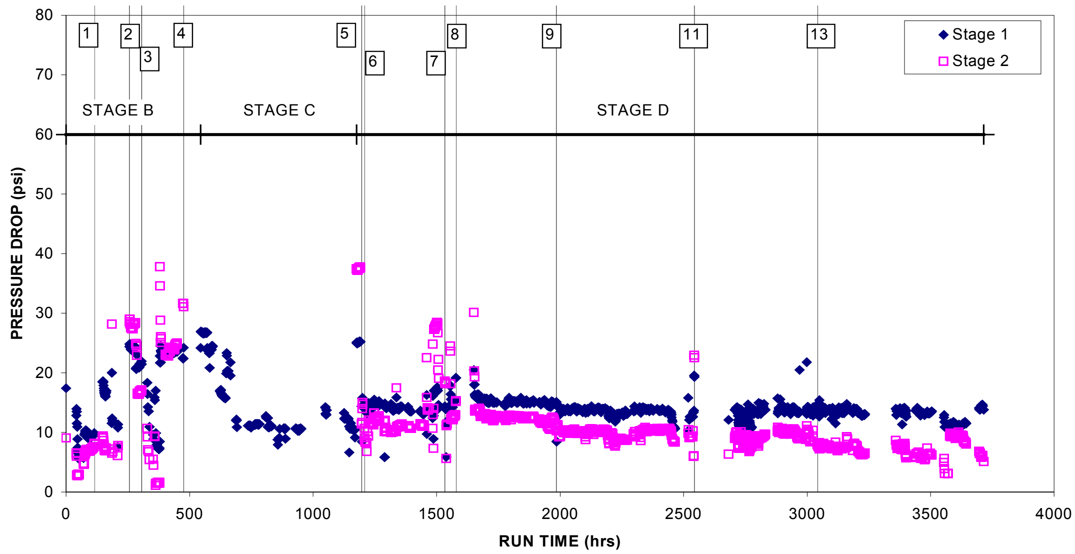

FIGURE 5.29
PRESSURE DROP VS. RUN TIME

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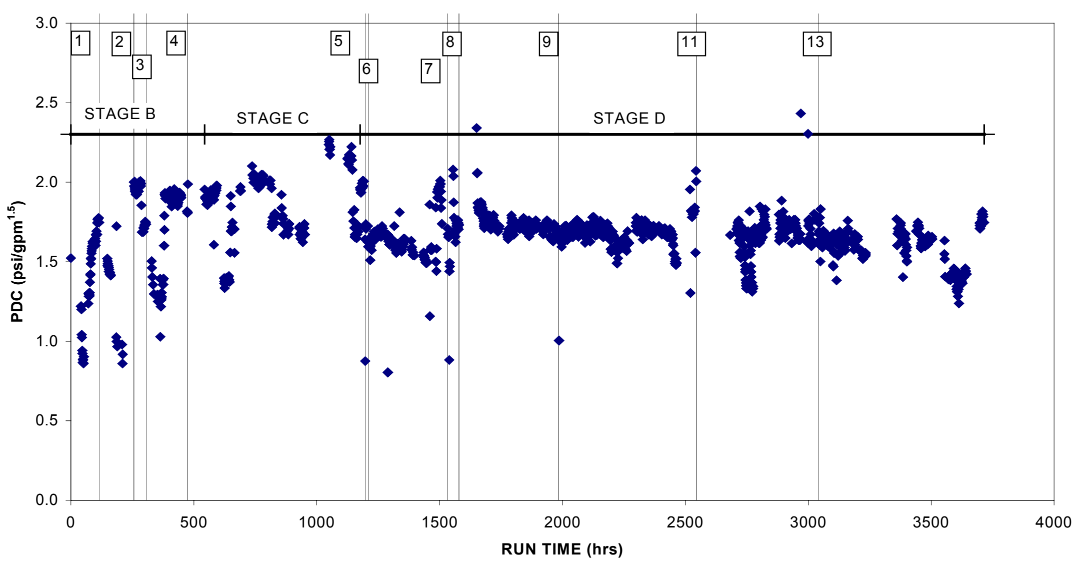

FIGURE 5.30
STAGE 1 PRESSURE DROP COEFFICIENT VS. RUN TIME

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Calcium Phosphate Scaling and Its Impacts on RO System Feed Pressure and Productivity. During Stage B, NPF declined rapidly (see Figure 5.28). Cleanings with citric acid were effective in restoring performance losses (Event 1) but with subsequent operation, NPF again rapidly declined. At this time, mineral precipitation was considered the likely cause for loss of RO performance. Biofouling was unlikely based on stable pressure drop readings. A second citric acid cleaning was then conducted (Event 2) and a portion of the second stage spent cleaning solution was analyzed to better determine the nature of the mineral precipitant. Calcium, aluminum and phosphorus were present in elevated concentrations relative to the other metals. Calcium and aluminum phosphate salts were considered the primary scaling concern, as calcium carbonate precipitation was controlled by feedwater acidification. Appendix E presents results of the cleaning solution analysis.

To determine the exact type of scale, the ZenoGem permeate, which becomes RO feedwater after chloramination, was analyzed twice a week during the period June 9 through June 23, 1999 for ions that can form precipitable salts, including phosphorus and sulfate, and metals, including barium, aluminum, and iron. (Calcium hardness, alkalinity and phosphorus levels in the ZenoGem permeate were routinely analyzed as part of ZenoGem peformance monitoring protocol.) The analysis showed less than detectable levels of the oxidizable metals aluminum and iron (<0.1 mg/L). Barium and sulfate were present at concentrations less than their solubility (as barium sulfate salt) for operation at 80 recovery (0.06 mg/L and 226 mg/L, respectively). Phosphorus levels were significant relative to natural water supplies (14 mg/L). Given the high concentration of calcium hardness in the wastewater (356 mg/L), calcium phosphate scaling was indirectly suspected. Appendix F presents results of ZenoGem permeate ion analyses.

To further confirm that scaling and not fouling caused performance losses, the second stage was removed from service after 546 hours of operation and the first stage was operated at 50 percent recovery (Stage C). At the lower percent recovery and operating only the first stage vessels, the feed pressure and NPF decreased and remained relatively low and constant during Stage C. Performance stabilized at the lower recovery confirming that performance declines were a result of ion concentration and mineral precipitation. Calcium phosphate scaling is not commonly encountered in municipal RO operations because phosphate levels in most natural raw water supplies are not elevated. Furthermore, based on discussions between CH2M HILL and several scale inhibitor manufacturers (i.e., FMC, KLT, Permacare), calcium phosphate precipitation is not effectively prevented by commercially available RO scale inhibitors. Consequently, three scaling mitigation methods were considered to control the precipitation tendency in lieu of a specific inhibitor:

1. **Decrease RO feedwater pH.** The calcium phosphate solubility index[2] was used to calculate the pH of the RO concentrate at which calcium phosphate concentration in the RO concentrate would be less than solubility ($SI = pH-pH_c$, where SI is <0). By trial and error iteration, the resulting pH was used to calculate corresponding feed

[2] The calcium phosphate solubility index (SI) is defined as follows: $SI = pH – pH_c$, where pH_c = 11.755 – (log calcium ions + log of phosphate ions = 2*log temperature)/0.65 (Green and Holmes, 1947).

pH using Hydranautics RODesign and the design conditions discussed in Section 3.3.1. Although this approach would require significant acid dose (~100 mg/L), it has the added benefit of increasing the solubility of both aluminum phosphate and calcium carbonate. This approach was considered the easiest to implement for this study.

2. **Chemically precipitate excess phosphorus from the screened, degritted wastewater during ZenoGem treatment.** Addition of an aluminum or iron salt to the wastewater would produce highly insoluble aluminum or ferric phosphates easily filterable by the ZeeWeed MF membrane. It was calculated that a dose of 45 mg/L of ferric chloride would be required to reduce the phosphate concentration in the ZenoGem permeate to 0.5 mg/L. a level that would reduce the calcium phosphate solubility index to < 0 at 80 percent recovery. This level of coagulant addition would generate more sludge, increase MLSS concentrations, require a reduction in SRT to maintain the 10 g/L target MLSS concentration and potentially increase the fouling rate of the ZeeWeed membrane.

3. **Biologically remove phosphorus by creating an anaerobic zone in the membrane bioreactor.** This was done in an uncontrolled manner during ZenoGem Stage B operation but would require extensive testing to develop the necessary operating strategy relative to oxygen input. Such testing was beyond the scope of this project.

The second stage was returned to service after 1,177 hours of operation (Stage D) and the system continued to operate at 50 percent recovery. After 1,533 hours of operation and step-wise increase in recovery to 70 percent, a target pH of 5.6 was established for the RO concentrate (corresponding to feed pH of 5.0) to maintain calcium phosphate solubility (Scaling Mitigation Method 1). However, difficulties with both the acid feed pump and PLC pH control loop caused difficulty in consistently maintaining the pH during the remainder of testing. After 1,579 hours of operation, the fourth acid cleaning was performed. Feed pressure and NPF was reduced by the cleaning and remained relatively constant until feedwater was increased to 75 percent after 1,985 hours of operation. Thereafter, feed pressure increased and NPF decreased until another cleaning was performed at 2,544 hours of operation to restore performance. Increasing the recovery to 80 percent after 3,042 hours of operation resulted in a rapid increase in feed pressure and decrease in NPF. These results indicate that the decrease in RO feedwater pH effectively stabilized system performance and reduced fouling potential when operating at a feedwater recovery up to 70 percent. Stable system performance could not be maintained at the higher recoveries (75 to 80 percent), even with the decrease in RO feedwater pH.

Autopsy of the trailing element(s) from Stage 2 confirmed calcium phosphate as the primary precipitate (see Appendix G).

5.3.3 RO Water Quality Impacts

Control of Major Contaminant Categories. Table 5.14 presents the results of water quality analyses of the RO system feed, permeate, and concentrate during each stage of operation. These data are presented to illustrate the ability of RO treatment to reduce the concentration of particulate, microbial, inorganic and organic contaminants in the ZenoGem permeate (i.e., wastewater effluent). Per the objectives of the study, the following surrogate parameters were monitored through the study to demonstrate such removal capability: turbidity (representing particles), coliforms and HPCs (representing pathogenic bacteria), conductivity and TDS (representing inorganic) and TOC (representing organic).

Table 5.14.—Average Water Quality Results for the RO System

Parameter		Stage B			Stage C			Stage D		
Physical/Chemical	**Permeate Target**[a]	**Feed**	**Permeate**	**Conc**	**Feed**	**Permeate**	**Conc**	**Feed**	**Permeate**	**Conc**
pH		7.13	6.00	7.32	7.30	6.07	7.44	6.22	5.66	6.06
Conductivity (uS/cm)		1,651	86	3,420	1,560	63	3,718	1,668	110	5,367
Turbidity (NTU)	< 0.1	0.18	0.08	0.54	0.16	0.05	0.32	0.11	0.05	0.36
SDI		1.46	0.33		1.83	0.32		1.53		1.57
TOC (mg/L)	< 1	6.18	< 0.5		6.77	< 0.5		6.62	< 0.5	
TDS (mg/L)	< 500	999	51	2,341	943	44	1,702	899	73	3,503
Microbial										
Total Coliform (CFU/100 mL)		2.0	7.0		5.7	2.9		6.0	1.0	
Fecal Coliform (CFU/100 mL)	0				2.0	2.0		3.0	2.0	
HPC (CFU/mL)		3,274	110		865	65		1,444	276	

[a]Where target left blank, no target was established.

Particulate. As described in earlier in this section, turbidity levels in the RO feedwater were well controlled by ZeeWeed membrane (average of 0.15 NTU). Consequently, only minor improvements in turbidity were possible by the RO system. RO permeate turbidity was consistently measured at to 0.05 NTU. This compares with the target level of 0.1 NTU and the current Environmental Protection Agency (EPA) regulatory level of 0.3 NTU for conventional water treatment plants (95 percent of readings).

Microbial. The target level of coliforms was established at 0 CFU/mL. Coliforms were routinely measured in the RO permeate, typically at levels of 2 CFU/mL based on similar levels in the feed. This is surprising given the presence of a low level of monochloramines in the RO feed and permeate. HPCs were reduced by more than an order of magnitude by RO treatment, with permeate levels less than the drinking water trigger level of 500 CFU/100mL.

Inorganic. At the target 80 percent recovery (beginning of Stage B and end of Stage D), RO treatment produced an effluent (permeate) having an average TDS of 66 mg/L (in the absence of mineral scaling effects), significantly below both federal and State of Texas secondary drinking water standard for TDS (500 and 1,000 mg/L, respectively). The average RO permeate TDS compares very favorably with the 700 to 800 mg/L TDS level that is typical for the City's existing raw water supply (Lozier, 1998). As shown in Figure 5.31, permeate TDS was consistently < 75 mg/L (greater than 92 percent removal) throughout the study, despite periods of severe membrane scaling.

Organic. As shown in Figure 5.32, TOC levels in the RO permeate grab samples were consistently less than detectable (0.5 mg/L) based on a feedwater TOC range of 6 to 8 mg/L. This represents greater than 92 to 94 percent TOC removals. By comparison, TOC levels in the City's existing raw water supply average 3.8 mg/L (Lozier, 1998) and the California Dept. of Health Services TOC limit for direct injection of reclaimed water is 1 mg/L.

In association with RO membrane integrity studies conducted by the BOR and coincident with this research, permeate TOC levels were measured on-line using two low detection limit (20 ppb) analyzers provided by Sievers and Anatel on a short-term trial basis. Results of these tests found TOC to be less than 100 mg/L in the RO permeate. Readers are referred to in a separate BOR Desalting and Water Purification Program Research Report No. 55, dated April 2000 for related membrane integrity results. Other sites using the Sievers instrument have shown RO systems treating microfiltered secondary effluent contain less than 100 µg/L TOC.

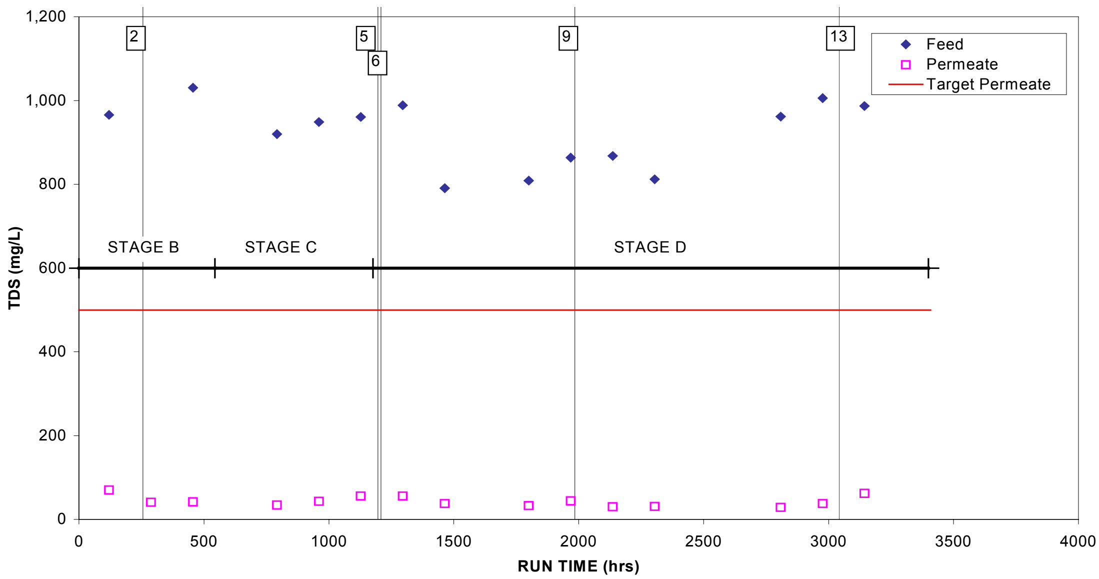

FIGURE 5.31
TOTAL DISSOLVED SOLIDS VS. RUN TIME

CH2MHILL

RO System
McAllen Demonstration Study

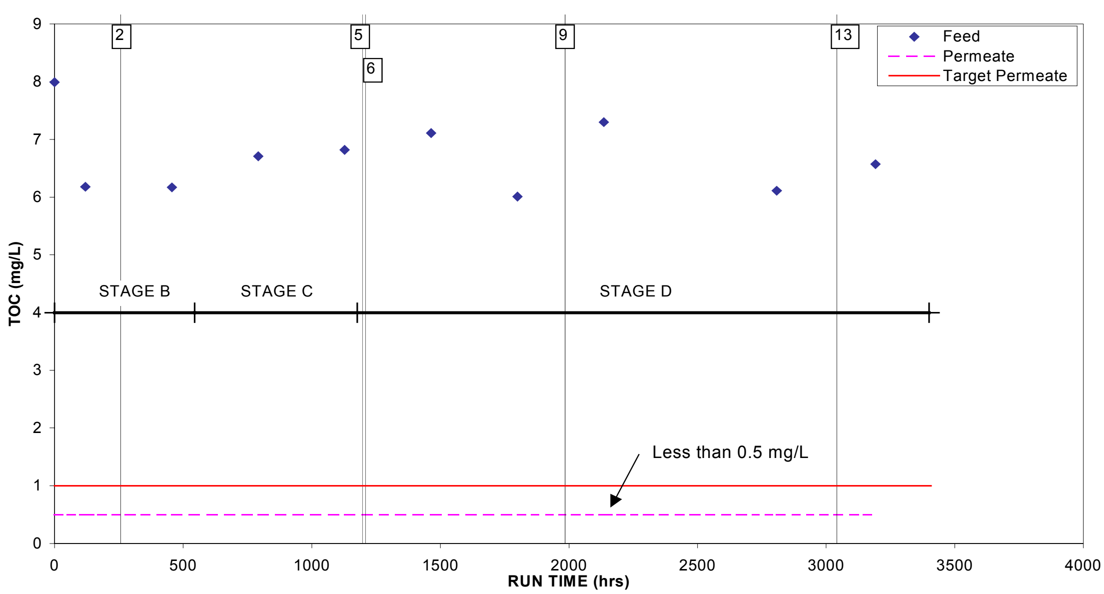

FIGURE 5.32
TOTAL ORGANIC CARBON VS. RUN TIME

CH2MHILL

RO System
McAllen Demonstration Study

5.4 Impacts of IPR on Waste Discharges

One of the objectives of this testing was to characterize the quality of the ZenoGem permeate and RO concentrate for water quality parameters important to the ecosystems of the Arroyo Colorado and Laguna Madre. The former is a non-perennial waterway to which the City currently discharges the effluent from the South WWTP. Flows into the Arroyo Colorado eventually empty into the Laguna Madre, an estuary that is connected to the Gulf of Mexico. Currently, the City's discharge is regulated with respect to three parameters: $CBOD_5$, TSS, and ammonia nitrogen. The limits for discharge are as follows:

- $CBOD_5$: 10 mg/L
- TSS: 15 mg/L
- NH_3-N: 3 mg/L

As part of a reuse feasibility study previously conducted for the City, TNRCC expressed concern regarding the presence and concentration of nutrient and TDS in the waste stream(s) from a future IPR treatment system, as it would pertain to discharges to these water bodies. The IPR treatment system evaluated in this research would generate one waste stream, the RO concentrate. Sludge from the ZenoGem system would be dewatered and dried using existing WWTP facilities. For the purpose of this evaluation, it is assumed that 8.5 mgd of wastewater from the WWTP would be diverted to ZenoGem/RO treatment system or, alternatively, 8.5 mgd of WWTP effluent (from the secondary clarifiers) would be diverted for ZeeWeed/RO treatment system. With either alternative, 1.5 mgd (average flow) of undiverted secondary effluent would be disinfected and discharged to the Arroyo Colorado as is currently done. As shown in Exhibit 5.3, these assumed treatment scenarios would result in the following discharges:

- 1.5 mgd of effluent from the South WWTP
- 1.7 mgd of RO concentrate (20% of 8.5 mgd RO feedwater flow)

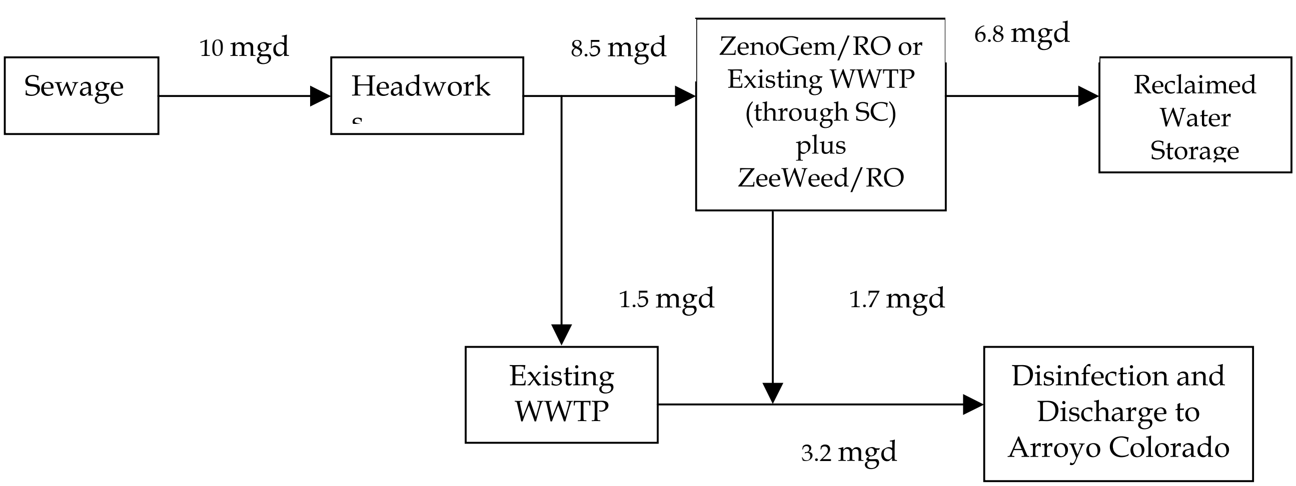

Exhibit 5.3.—Wastewater Discharge Characterization

In both alternatives, the 8.5 mgd of secondary effluent would be processed by RO to produce 6.8 mgd of final efffluent and 1.7 mgd of RO concentrate (waste). This waste concentrate would then be blended with the remaining 1.5 mgd of WWTP effluent (flow which bypasses IPR treatment), disinfected, and discharged to the current location. As shown in Table 5.15, concentrations of TDS, nutrients and TOC were then calculated for the 47:53 blend of WWTP effluent/RO concentrate using the data collected in Appendix D.

Table 5.15.—Comparative Loading of Critical Contaminants to Arroyo Colorado/Laguna Madre

Parameter	(A) RO Concentrate (mg/L)[a]	(B) WWTP Effluent (mg/L)[a]	Composite Stream (Blend) Loading (lbs/day)[b]	Existing WWTP Effluent Discharge Loading (lbs/day)[c]
NO_2/NO_3-N	29.9	3.45	467	288
T-Phosphorus	10.20	2.38	174	199
TKN	3.16	2	70	167
TDS	3,780	930	65,227	77,562
TOC	28.15	7.25	490	605

[a]Based on average results of two sampling events.
[b]Calculated as: 8.34*(1.7*A + 1.5*B) where 1.7=RO concentrate flow (mgd) and 1.5=WWTP effluent flow (mgd).
[c]Calculated as: 8.34*10*B where 10=existing average WWTP effluent flow (mgd).

The comparison shows that for each parameter, the concentration is much higher in the RO concentrate than the WWTP effluent. This reflects the concentration of each parameter by RO treatment and in the case of nitrate, a higher level in the "RO Concentrate" than the WWTP effluent. In some cases, agencies regulate contaminant discharges based on mass loading (pounds of contaminant per day) rather than concentration. Table 5.15 also shows the predicted mass loading for the RO concentrate/WWTP effluent composite stream (blend) verses the current WWTP effluent discharge. In contrast to the concentration comparison, mass loadings for the blend are higher only for nitrate. Consequently, it would be in the City's best interest to work toward establishing mass loading-based discharge regulations versus the current concentration-based regulations if they wish to discharge RO concentrate to the Arroyo Colorado/Laguna Madre ecosystem. If successful, the City could incorporate biological denitrification into the design of the ZenoGem system to control nitrate loadings at the current levels.

5.5 Comparing Reclaimed and Existing Raw Water Quality

No federal regulations exist regarding the quality requirements for reclaimed water to be used in the context of indirect potable reuse. Currently, such requirements are established on a state-by-state basis. To date, the City has had preliminary meetings with TNRCC regarding such requirements. However TNRCC has not yet proposed regulations for McAllen, but have only referenced potential treatment techniques (e.g., treat all the reclaimed water with RO). To provide a basis for development of IPR regulations for this project, all primary and secondary contaminants currently regulated under the SDWA were analyzed in both the ZenoGem and RO permeates. Results of these analyses are presented in Appendix D. The results were then compared with data from similar characterization of the City's existing raw water supply (Rio Grande River) as sampled in 1997 during the *Wastewater Reclamation Pilot Study, City of McAllen, Texas* (1998).

Comparing the quality of the ZenoGem permeate to the City's existing raw water supply and to federal and state drinking water regulations as shown in Table 5.16, the following conclusions are drawn:

- The ZenoGem permeate contains greater levels (i.e., lower quality) of most inorganic contaminants than the City's raw water supply. The degradation reflects: 1) the inability of the City's water treatment plant and the ZenoGem process to remove such compounds, and 2) increases in these contaminants from the domestic water use/wastewater generation process. Consequently, the ZenoGem permeate, on at least one sampling event, exceeded the maximum contaminant level (MCLs) for chloride, color (APHA) apparent, and TDS.

- The ZenoGem permeate contains lower concentrations of certain metals (i.e., iron, manganese, aluminum, barium, and strontium) than the City's raw water supply and the MCLs as a result of their removal by oxidation or precipitation in both the WWTP and the ZenoGem processes.

- The concentration of dissolved organic matter (as measured by TOC) is significantly greater in the ZenoGem permeate than the City's raw water supply. Although there is not a current MCL for TOC, the greater the TOC level, the greater the potential for formation of trihalomethanes (THMs) and haloacetic acids (HAAs). These chlorinated byproducts have been shown to be carcinogenic and are regulated at very low levels (μg/L levels). This greater potential is illustrated by the significantly higher levels of HAAs in the ZenoGem permeate relative to the raw water supply. Further, the chronic health risks associated with identified organic compounds in wastewater are not well understood. For this reason, respected authorities in the field of IPR recommend that TOC levels be reduced. In the State of California, a TOC guideline of 1 mg/L has been established for reclaimed water used for surface water supplementation IPR projects.

- Particle levels in the ZenoGem permeate are significantly lower than the City's raw water supply based on turbidity measurements. This reflects the very small pore size of the MF and UF membranes used with ZenoGem, which serves as a effective barrier to the passage of most particles.

Comparing the quality of the RO permeate to the City's existing raw water supply and to federal and state drinking water regulations as shown in Table 5.16, the following conclusions are drawn:

- The RO permeate meets all established drinking water regulations as well as the TOC guideline of 1 mg/L.

- To produce reclaimed water meeting state and federal drinking water regulations and the State of California TOC guideline, both ZenoGem and RO treatment of the City's wastewater is required. Assuming an RO permeate TOC of 0.5 mg/L, greater than 90 percent of the wastewater would require RO treatment. If the TOC guideline were not considered, RO treatment would still be required, however, the percent of treatment would be reduced depending on the controlling contaminant (e.g., HAAs, nitrate or TDS). Assuming nitrate would be more cost effectively removed through biological denitrification, approximately 80 percent of the wastewater would require RO treatment to control HAA formation.

- Beyond simply meeting the drinking water regulations, experts involved in setting IPR policy strongly recommend the concept of multiple treatment barriers to ensure that the proposed treatment scheme adequately protect public health, particularly with respect to acute health risk from microbes. In this regard, the combination of ZenoGem and RO treatment provides two robust barriers to the passage of viral, bacterial and protozoan pathogens as opposed to relying on only a single barrier (i.e., ZenoGem only). An additional barrier or chlorine/UV disinfection may also be desirable while only marginally increasing costs.

- If TNRCC were to approach IPR guidelines for this project from the viewpoint that the reclaimed water must equal or exceed the quality of the existing raw water supply, a lower percentage of the ZenoGem permeate would require RO treatment. Based on the data shown in Table 5.16, it is estimated that about 50 percent of the wastewater would require RO treatment to have a reclaimed water match the TOC concentration of the raw water.

Table 5.16.—Results of ZenoGem and RO Permeate Sampling for IPR Characterization

	Primary MCL	Existing Raw Water Supply[a]		ZenoGem Permeate		RO Permeate	
Parameter		**3/11/97**	**6/2/97**	**8/17/99**	**9/14/99**	**8/17/99**	**9/14/99**
General Chemistry							
Alkalinity (mg/L as $CaCO_3$)		130	106	121	153	14	16
Bromide (mg/L)		0.100	0.54	0.132	0.32	0.02[b]	0.02[b]
Chloride (mg/L)	250	155	207	160	281	9.73	15.20
Color Apparent	15	17	10	22	17	5[b]	5[b]
Fluoride (mg/L)		0.59	0.99	1.07	1.14	0.32	0.45
NH_3-N (mg/L as N)					0.1[b]		0.1[b]
NO_2-N (mg/L as N)				9.55	7.90	1.11	1.08
TKN (mg/L as N)				2[b]	2[b]	2[b]	2[b]
Reactive Silica (mg/L)		6.0	13.5	15.1	16.1	0.65	0.90
Sulfate (mg/L)	250	247	262	150	247	4	5.31
TDS (mg/L)	500 - 1,000	720	772	774	1,950	33	72
TOC (mg/L)	1[g]	3.70	3.90	7.48	5.90	0.63	0.52
T-Phos (mg/L)		0.05	0.05[b]	2.48	2.89	0.10	0.1[b]
UV-254 (cm^{-1})		0.112	0.092	0.129	0.126		
Metals							
Aluminum (mg/L)	0.05 - 0.2	1.22	0.248	0.111	1[b]	0.046[b]	0.1[b]
Arsenic (mg/L)				0.004*	0.01[b]	0.004[b]	0.01[b]
Barium (mg/L)		0.127	0.124	0.056	0.062	0.0008[b]	0.025*
Cadmium (mg/L)				.003	0.005[b]	0.0004[b]	0.005[b]
Calcium (mg/L)		77	77.7	72.1	86.9	0.714	833
Chromium (mg/L)				0.007[b]	0.010[b]	0.008[b]	0.01[b]
Iron (mg/L)	0.3[e]	0.77	0.171	0.032	0.1[b]	0.01	0.1
Lead (mg/L)				0.028	0.003[b]	0.002[b]	0.003[b]
Magnesium (mg/L)		22.1	27.9	20.4	25.6	0.197	0.5[b]
Manganese (mg/L)	0.05[e]	0.025	0.018	0.015	0.017	0.001 [b]	0.01[b]
Mercury (mg/L)				0.0003[b]	0.0003[b]	0.0003 [b]	0.0003[b]
Potassium (mg/L)		9	9.58	17.8	29.9	1.36	2*
Selenium (mg/L)				0.007[b]	0.007[b]	0.007	0.007[b]
Silver (mg/L)				0.008[b]	0.010[b]	0.008[b]	0.01[b]
Sodium (mg/L)		102	140	157	253	13	16.2
Strontium (mg/L)		2.05	2.40	1.87	2	0.029 [b]	0.1[b]
Zinc (mg/L)				0.463	0.054	0.007	0.02[b]
Purgeable Volatiles							
Vinyl Chloride				1[b]	1[b]	1[b]	1[b]
tran-1,2-Dichloroethene				1[b]	1[b]	1[b]	1[b]
cis-1,2-Dichloroethene				1[b]	1[b]	1[b]	1[b]
1,1,1-Trichloroethane				1[b]	1[b]	1[b]	1[b]
Carbon Tetrachloride				1[b]	1[b]	1[b]	1[b]
Trichloroethene				1[b]	1[b]	1[b]	1[b]

Table 5.16.—Results of ZenoGem and RO Permeate Sampling for IPR Characterization

	Primary MCL	Existing Raw Water Supply[a]		ZenoGem Permeate		RO Permeate	
Parameter		**3/11/97**	**6/2/97**	**8/17/99**	**9/14/99**	**8/17/99**	**9/14/99**
1,4-Dichlorobenzene				1[b]	1[b]	1[b]	0.60
Disinfection Byproducts							
Trihalomethanes (SDS THMs)[c] (µg/L)	80	236.00	215.00	198.00	244.00	5.40	8.30
Haloacetic Acids (SDS HAA5)[d] (µg/L)	60	58.00	72.00	119.00	90.60	1.10	1.10
Semi-volatile Organics							
Lindane (µg/L)				0.024	0.011	0.02[b]	0.02[b]
Endrin (µg/L)				0.02[b]	0.01	0.02[b]	0.02[b]
Methoxychlor (µg/L)				0.04[b]	0.04[b]	0.04[b]	0.04[b]
Toxaphene (µg/L)				0.5[b]	0.5[b]	0.5[b]	0.5[b]
Radiochemicals							
Radium-226 (pCi/L)				0.2[b]	0.2[b]	0.2[b]	0.2[b]
Radium-228 (pCi/L)				1[b]	1[b]	1[b]	1[b]
Gross Alpha (pCi/L)				1[b]	1[b]	1[b]	1[b]
Chlorinated Herbicides							
2,4-D (µg/L)				ND	ND	ND	ND
Silvex (2,4,5-TP) (µg/L)				ND	ND	ND	ND

[a]Source: Table 5.2 of Water Treatment Technology Program Report No. 26
[b]Not Detected at specified reporting limits.
[c]SDS THM - Simulated Distribution System Trihalomethanes (4 species)
[d]SDS HAA5 - Simulated Distribution System Haloacetic Acids (5 species)
[e]Secondary MCL
[f]Secondary MCL: Federal = 500 mg/L; State = 1,000 mg/L
[g]Guildeline set by the State of California
ND =No Detection
pCi/L=picoCuries per liter

SECTION 6

Cost Estimates Using ZenoGem, ZeeWeed, and RO Facilities

This section presents the cost estimates for two advanced treatment systems to produce 6.8 mgd of reclaimed water that would supplement the City of McAllen's drinking water supply by providing a new source of raw water to the City's water treatment plant. The advanced treatment system would be located at the site of the City's south WWTP. The effluent from the advanced treatment system would be of a quality suitable for discharge to a new reclaimed water storage reservoir to be located in the vicinity of the City's existing water treatment plant. It is anticipated that the effluent from the advanced treatment system would receive additional disinfection depending on TNRCC requirements.

UV light disinfection or chlorination are two candidate disinfection methods. The most appropriate may depend on whether the effluent consists of 100 percent RO permeate or a blend of RO permeate and ZenoGem/ZeeWeed permeate[1]. In the latter case, UV disinfection may be required because of the increased chlorine disinfection byproduct formation potential of the UF permeate. For the purposes of this exercise, costs for final disinfection have not been included because the method of disinfection has yet to be determined. Costs for disinfection of the UF permeate with chloramines (prior to RO treatment) have been included.

Estimates were developed for two alternatives:

- Treatment Alternative 1: ZenoGem MBR, UF permeate storage/disinfection and RO facilities treating screened, de-gritted wastewater
- Treatment Alternative 2: Extended aeration and clarification (existing), ZeeWeed system, UF permeate storage/disinfection and RO facilities treating secondary effluent from the existing south WWTP

For Alternative 1, a new ZenoGem MBR system would be installed to treat the screened, de-gritted wastewater and produce 8.5 mgd of reclaimed effluent. The UF permeate would be disinfected with monochloramines, stored, and then treated by the RO system (which includes acidification and antiscalant addition to the RO feedwater) to produce 6.8 mgd of RO permeate.

For Alternative 2, 9.4 mgd of effluent from the existing secondary clarifiers would be treated by the ZeeWeed UF system to produce 8.5 mgd of permeate. The UF permeate would then be disinfected, stored, and treated by RO as described for Alternative 1. For either alternative, wastewater flows in excess of those necessary to produce 6.8 mgd of RO permeate and would be processed by the existing WWTP facilities. Concentrate

[1] For purposes of the estimates, the ZenoGem/ZeeWeed permeate is referred to as UF permeate, as both processes use the same UF membranes.

from the ZeeWeed UF system would be recycled back to the aeration basins, while sludge from the ZenoGem system would be digested and dried using existing facilities at the WWTP. Both alternatives use existing headworks facilities for wastewater screening and de-gritting.

Figure 6.1 displays a schematic of the existing WWTP. Figures 6.2 and 6.3 are schematics of the two alternatives including existing facilities.

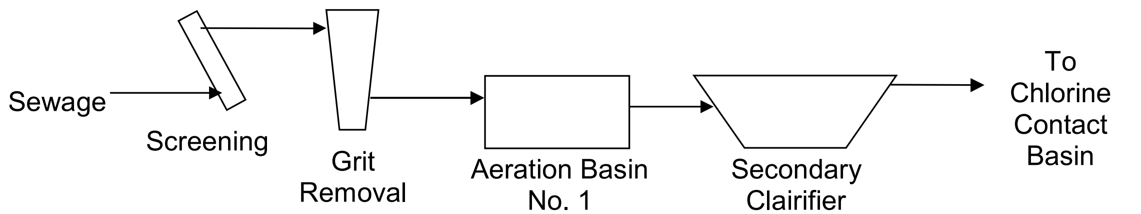

Figure 6.1.—Existing WWTP Schematic

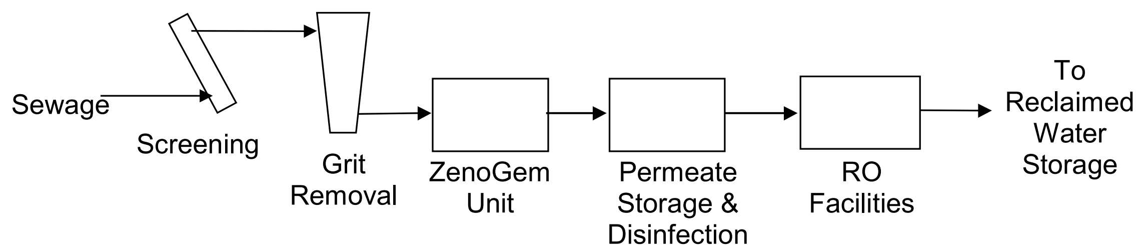

FIGURE 6.2.—ZENOGEM MBR AND RO FACILITIES

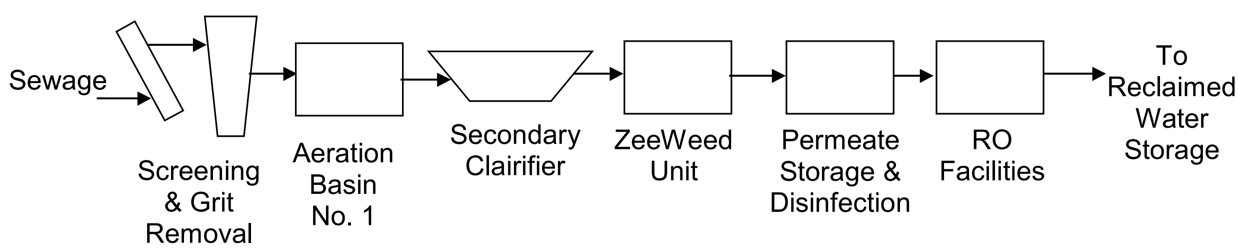

Figure 6.3.—Conventional WWTP with Zeeweed and RO Facilities

6.1 Cost Assumptions

The estimates were prepared at an order-of-magnitude level to provide a relative and preliminary cost comparison between the two treatment alternatives and are based on information presently available. Order-of-magnitude cost estimates are defined by the American Association of Cost Engineers as an approximate estimate made without detailed engineering data. Final costs for each alternative will depend on such variables as actual labor and material costs, market conditions, project scope, implementation schedule, and will differ from the estimates presented. The costs are in present day dollars, and annual unit costs are based on ZenoGem/ZeeWeed permeate capacity of 8.5 mgd and RO permeate capacity of 6.8 mgd. ZENON budget proposals used in estimating ZenoGem/ZeeWeed and RO equipment costs are presented in Appendix H.

The estimates do not include costs for sewage screening and de-gritting (these facilities are currently being upgraded at the south WWTP) for either alternative. Alternative 2 does not include capital costs for extended aeration or secondary clarification, as these are existing. The costs related to ZenoGem, ZeeWeed, and RO equipment and required ancillaries are included. The ZenoGem system is sized to account for downtime associated with backpulsing and maintenance cleanings while the ZeeWeed system is sized to account for downtimes associated with backpulsing only. At the assumed RO feedwater recovery of 80 percent, 20 percent of the RO feedwater flow (1.7 mgd) becomes waste concentrate requiring appropriate disposal. For purposes of this estimate, RO concentrate is assumed to be discharged to the Arroyo Colorado using the City's existing outfall. Consequently, costs are not included for concentrate disposal.

6.2 Cost Estimates

Estimates were prepared for the following cost categories:

- Installed equipment, total construction, total capital, total unit capital, and amortized capital
- Total O&M and total unit O&M
- Total annual and total unit annual

Tables 6.1 and 6.2 present the estimates for the Alternatives 1 and 2, respectively. The tables include the assumptions and references used in developing component capital costs and operating and maintenance costs. Table 6.3 presents design criteria assumptions used in developing the cost estimates for each major process. In addition, a line-item comparison of capital and O&M costs for the ZenoGem and ZeeWeed technologies is presented in Appendix I.

Table 6.1.—Order of Magnitude Cost Estimate for ZenoGem® and RO Alternative
Capital and O&M Cost Opinion

Item	Cost	Assumption	Cost Reference
Fine Screening	$ 20,000	3–mm screen	CH2M HILL estimator [b]
ZenoGem® System[a]	$ 8,620,000		Zenon Budget Proposal
Bioreactor/Equalization Tanks	$ 1,307,808	6 tanks @ 170 ft x 21 ft x 23 ft (1.29 MG for equalization)	CH2M HILL estimator [b]
Permeate Storage	$ 70,000	180,000 gallons	CH2M HILL estimator [b]
Transfer Pump to RO System	$ 52,500	(2) 2,950 gpm @ 70 ft TDH pumps plus one stand-by	CH2M HILL estimator [b]
Chloramine Feed System			
Chlorinator	$ 30,000	50 lb/day duplex system	CH2M HILL estimator [b]
Ammoniator	$ 30,000	100 gal/day duplex system	CH2M HILL estimator [b]
RO System[a]	$ 2,300,000		Zenon Budget Proposal
Installation	$ 2,730,000	25% of installed equipment costs	
Installed Costs Subtotal	**$ 15,160,308**		
ZenoGem Equipment Building	$ 288,000	4,800 SF	CH2M HILL estimator [b]
RO Building	$ 390,000	6,500 SF	CH2M HILL estimator [b]
Installed Costs and Building Cost Subtotal	**$ 15,838,308**		
Unit Process Noncomponent Costs			
Yard Piping Allowance (10%)	$ 1,583,831		
Site Electrical Allowance (8%)	$ 1,267,065		
Site I&C Allowance (5%)	$ 791,915		
Site Civil Allowance (5%)	$ 791,915		
Unit Process Subtotal	**$ 20,273,034**		
Contingency (10%)	$ 2,027,303		
Contractor Overhead & Mark-up (10%)	$ 2,027,303		
Total Construction Cost	**$ 24,327,641**		
Engineering & Administration (15%)	$ 3,649,146		
Total Capital Cost	**$ 27,976,787**		
Total Capital Unit Cost ($/1,000 gallon)	**$ 11.87**		
Amortized Capital Cost (20yr @ 6.5%)	**$ 2,539,072**		
Operation & Maintenance Costs			
Major Chemical Costs			
Disinfection: Chlorine	$ 21,350	$610/ton	Hill Brothers Chemical Co.
Disinfection: Ammonia	$ 9,620	$370/ton	Hill Brothers Chemical Co.
Backpulse Chemicals: Sodium Hypochlorite	$ 8,232	$0.31/Liter	Zenon Budget Proposal
CIP Chemical #1: MC-1	$ 220	$1.67/Liter	Zenon Budget Proposal
CIP Chemical #2: Sodium Hypochlorite (250 mg/L)	$ 304	$0.31/Liter	Zenon Budget Proposal
RO - Sulfuric Acid	$ 5,745	$0.04/lb	Zenon Budget Proposal
RO - Sodium Bisulfite	$ 2,594	$0.25/lb	Zenon Budget Proposal
RO – Antiscalant	$ 122,359	$3.27/Liter	Zenon Budget Proposal
RO - Organic Acid: MC-1	$ 8,658	$2.29/kg	Zenon Budget Proposal

Table 6.1.—Order of Magnitude Cost Estimate for ZenoGem® and RO Alternative
Capital and O&M Cost Opinion

Item		Cost	Assumption	Cost Reference
RO – Alkali Surfactant: MC-4	$	1,738	$3.06/kg	Zenon Budget Proposal
RO - Sanitizer: MP-1	$	4,748	$5.01/Liter	Zenon Budget Proposal
Major Power Costs			$0.075/kW-hr	
Screening	$	-	Existing	
Permeate Pumps	$	37,392		Zenon Budget Proposal
Recirculation Pumps	$	59,068		Zenon Budget Proposal
Sludge Wasting Pumps	$	890		Zenon Budget Proposal
Membrane Air Scour Blowers	$	237,213		Zenon Budget Proposal
Process Air Blowers	$	119,501		Zenon Budget Proposal
Anoxic Zone Mixers	$	-		Zenon Budget Proposal
Air Separation System Vacuum Pumps	$	2,520		Zenon Budget Proposal
Backpulse Sodium Hypochlorite – Metering	$	3		Zenon Budget Proposal
Chemical Feed #1 – Metering	$	245		Zenon Budget Proposal
Air Compressors	$	2,515		Zenon Budget Proposal
Air Driers	$	-		Zenon Budget Proposal
Controls & Instrumentation	$	657		Zenon Budget Proposal
Miscellaneous	$	657		Zenon Budget Proposal
RO - Pretreatment Chemical Mixers, Process Pump, CIP Pump	$	501,591		Zenon Budget Proposal
Membrane/Cartridge Filter Replacement Costs				
ZenoGem	$	329,311	1-yr warranty; 8-yr replacement frequency	Zenon Budget Proposal
RO	$	226,286	5-yr replacement frequency	Zenon Budget Proposal
Cartridge Filter	$	24,637	Annual replacement	Zenon Budget Proposal
Other Costs				
Maintenance	$	63,750		Prorated South WWTP Costs
Permit Fees	$	39,100		Prorated South WWTP Costs
Land Maintenance	$	12,750	Replacement of sand in drying beds	Prorated South WWTP Costs
Supplies	$	61,200	Includes land application of sludge ($31.50/dry ton)	Prorated South WWTP Costs
Labor	$	436,800	14 O&M personnel @ $15.00/hr (9 ZenoGem; 5 for RO)	CH2M HILL estimate
Laboratory	$	141,100	Includes 4 lab techs, analysis, O&M, etc.	Prorated South WWTP Costs
Total Annual Operation & Maintenance Cost	**$**	**2,482,754**		
Total Annual O&M Unit Cost ($/1,000 gallon)	**$**	**1.05**		
Total Annual Cost	**$**	**5,021,826**		
Total Unit Cost ($/1,000 gallon)	**$**	**2.13**	Based on 6.8 MGD product water flow; plant availability factor = 95%	

[a] Detailed listing of components comprising ZenoGem and RO systems are presented in Appendix H.

[b] ENR CCI reference number 6126.79

Table 6.2.—Order of Magnitude Cost Estimate for ZeeWeed® and RO Alternative Capital and O&M Cost Opinion

Item	Cost	Assumption	Cost Reference
Fine Screening	$ 20,000	3-mm screen	CH2M HILL estimator [b]
ZeeWeed® Tertiary Treatment System[a]	$ 5,075,000		Zenon Budget Proposal
ZeeWeed Tanks	$ 162,468	4 tanks @ 70 ft x 10 ft x 10 ft	CH2M HILL estimator [b]
Permeate Storage	$ 70,000	180,000 gallons	CH2M HILL estimator [b]
Transfer Pump to RO System	$ 52,500	(2) 2950 gpm @ 70 ft TDH pumps plus one stand-by	CH2M HILL estimator [b]
Chloramine Feed System			
Chlorinator	$ 30,000	50 lb/day duplex system	CH2M HILL estimator [b]
Ammoniator	$ 30,000	100 gal/day duplex system	CH2M HILL estimator [b]
RO System[a]	$ 2,300,000		Zenon Budget Proposal
Installation	$ 1,843,750	25% of installed equipment costs	
Installed Costs Subtotal	**$ 9,583,718**		
ZeeWeed Equipment Building	$ 84,000	1,400 SF	CH2M HILL estimator [b]
RO Building	$ 390,000	6,500 SF	CH2M HILL estimator [b]
Installed Costs and Building Cost Subtotal	**$ 10,057,718**		
Unit Process Noncomponent Costs			
Yard Piping Allowance (10%)	$ 1,005,772		
Site Electrical Allowance (8%)	$ 804,617		
Site I&C Allowance (5%)	$ 502,886		
Site Civil Allowance (5%)	$ 502,886		
Unit Process Subtotal	**$ 12,873,879**		
Contingency (10%)	$ 1,287,388		
Contractor Overhead & Mark-up (10%)	$ 1,287,388		
Total Construction Cost	**$ 15,448,655**		
Engineering & Administration (15%)	$ 2,317,298		
Total Capital Cost	**$ 17,765,953**		
Total Capital Unit Cost ($/1,000 gallon)	**$ 7.53**		
Amortized Capital Cost (20yr @ 6.5%)	**$ 1,612,374**		
Operation & Maintenance Costs			
Major Chemical Costs			
Disinfection: Chlorine	$ 21,350	$610/ton	Hill Brothers Chemical Co.
Disinfection: Ammonia	$ 9,620	$370/ton	Hill Brothers Chemical Co.
Backpulse Chemicals: Sodium Hypochlorite	$ 8,232	$0.31/Liter	Zenon Budget Proposal
CIP Chemical #1: MC-1	$ 3,211	$1.67/Liter	Zenon Budget Proposal
CIP Chemical #2: Sodium Hypochlorite (250 mg/L)	$ 4,435	$0.31/Liter	Zenon Budget Proposal
CIP Neutralization Chemical #1: Sodium Hydroxide	$ 175	$0.36/Liter	Zenon Budget Proposal
CIP Neutralization Chemical #2: Sodium Bisulfite	$ 117	$0.06/Liter	Zenon Budget Proposal
RO - Sulfuric Acid	$ 5,745	$0.04/lb	Zenon Budget Proposal

Table 6.2.—Order of Magnitude Cost Estimate for ZeeWeed® and RO Alternative Capital and O&M Cost Opinion

Item	Cost		Assumption	Cost Reference
RO - Sodium Bisulfite	$	2,594	$0.25/lb	Zenon Budget Proposal
RO - Antiscalant	$	122,359	$3.27/Liter	Zenon Budget Proposal
RO - Organic Acid: MC-1	$	8,658	$2.29/kg	Zenon Budget Proposal
RO - Alkali Surfactant: MC-4	$	1,738	$3.06/kg	Zenon Budget Proposal
RO - Sanitizer: MP-1	$	4,748	$5.01/Liter	Zenon Budget Proposal
Major Power Costs			$0.075/kW-hr	
Screening	$	-	Existing	
Aeration Basins	$	419,000	18 motors @ 50 HP; 24 hrs/day	South WWTP info
Recirculation Pumps	$	74,500	4 pumps @ 40 HP; 24 hrs/day	South WWTP info
Permeate Pumps	$	36,901		Zenon Budget Proposal
Membrane Air Scour Blowers	$	114,440		Zenon Budget Proposal
Air Separation System Vacuum Pumps	$	2,520		Zenon Budget Proposal
Backpulse Sodium Hypochlorite – Metering	$	7		Zenon Budget Proposal
Air Compressors	$	2,515		Zenon Budget Proposal
Air Driers	$	-		Zenon Budget Proposal
I&C	$	657		Zenon Budget Proposal
Miscellaneous	$	657		Zenon Budget Proposal
RO – Pretreatment Chemical Mixers, Process Pump, CIP Pump	$	357,495		Zenon Budget Proposal
Membrane/Cartridge Filter Replacement Costs				
ZeeWeed	$	190,905	1-yr warranty; 8-yr replacement frequency	Zenon Budget Proposal
RO	$	190,179	5-yr replacement frequency	Zenon Budget Proposal
Cartridge Filter	$	24,637	annual replacement	Zenon Budget Proposal
Other Costs				
Maintenance	$	63,750		Prorated South WWTP Costs
Permit Fees	$	39,100		Prorated South WWTP Costs
Land Maintenance	$	12,750	replacement of sand in drying beds	Prorated South WWTP Costs
Supplies	$	61,200	includes land application of sludge ($31.50/dry ton)	Prorated South WWTP Costs
Labor	$	655,200	21 O&M personnel @ $15.00/hr (16 exst. plant w/Zeeweed; 5 for RO)	CH2M HILL estimate
Laboratory	$	141,100	includes 4 lab techs, analysis, O&M, etc.	Prorated South WWTP Costs
Total Annual Operation & Maintenance Cost	**$**	**2,760,698**		
Total Annual O&M Unit Cost ($/1,000 gallon)	**$**	**1.17**		
Total Annual Cost	**$**	**4,373,072**		
Total Unit Cost ($/1,000 gallon)	**$**	**1.85**	Based on 6.8 MGD product water flow; plant availability factor = 95%	

[a] Detailed listing of components comprising ZeeWeed and RO systems are presented in Appendix H.

[b] ENR CCI reference number 6126.79

Table 6.3.—Design Criteria Assumptions for ZenoGem, ZeeWeed, and RO Systems

Criterion	Value
ZenoGem System	
Design Permeate Flow, mgd	8.5
Hydraulic Residence Time, hours	6
Solids Retention Time, days	17
Mixed Liquor Suspended Solids Level, g/L	10
Aeration Rate, fine bubble, scfm/mgd	647
Aeration Rate, membrane air scour, scfm/mgd	2,586
Aeration mode (both systems)	Cyclic
Membrane flux, gfd	15.4
No. of membrane trains	6
No. of reactor tanks	6
Backpulse interval, minutes	15
Backpulse duration, seconds	30
Backpulse pressure, psi	8
Maintenance clean interval, hours	168
Maintenance clean duration, minutes	60
ZeeWeed System	
Design Permeate Flow, mgd	8.5
Hydraulic Residence Time, hours	0.56
Feedwater Recovery, percent	95
Aeration Rate, membrane air scour, scfm/mgd	1,207
Aeration Mode	Continuous
Membrane flux, gfd	20.4
Backpulse interval, minutes	15
Backpulse duration, seconds	30
Backpulse pressure, psi	8
RO System	
Design Permeate Flow, mgd	6.8
Feedwater pH, units	5
Antiscalant dose, mg/L	Manufacturer dependent; 3 max
Feedwater recovery, percent	80
Membrane flux, gfd	12
Membrane type	low fouling, aromatic composite
Vessel array	three stage, concentrate taper

Estimated total capital cost for the ZenoGem/RO approach (Alternative 1) is significantly higher than for the ZeeWeed/RO approach (Alternative 2), $28.0MM versus $17.8MM, a difference of nearly $10MM. The difference reflects the higher cost of treatment for ZenoGem relative to ZeeWeed. Compared to the requirements for ZeeWeed, ZenoGem requires more membrane modules because a lower flux rate must be used to treat the significantly higher solids concentration of the mixed liquor (relative to the secondary effluent from the existing WWTP); larger tankage to provide wastewater flow equalization and the necessary hydraulic retention time to complete nitrification; and increased blower capacity to achieve carbonaceous and nitrogenous oxidation of the wastewater.

Estimated annual operating and maintenance costs for the ZenoGem-based alternative were slightly lower than for the ZeeWeed alternative ($2.48MM/year versus $2.76MM/year). This reflects lower energy and labor costs associated with operating the ZenoGem system versus those for operating costs for the extended aeration basins, secondary clarifiers and ZeeWeed system.

The significantly higher capital cost for Alternative 1 outweighs the slightly lower O&M costs. Consequently, total unit cost for Alternative 1 is higher ($2.13/1000 gals versus $1.85/1000 gals). Based on these estimates, it would be more cost-effective for McAllen to implement Alternative 2 (using ZeeWeed and RO to treat existing plant secondary effluent) to achieve their indirect potable reuse treatment goals. This reflects the cost savings of associated with the use of their existing flow equalization and secondary treatment facilities that are a sunk cost.

The disparity in capital cost between the ZenoGem and ZeeWeed alternatives could be reduced somewhat in the instance where a municipality's existing WWTP utilized concrete basins for aeration, rather than the earthen basins used a McAllen. Cost savings in the instance would result from avoiding the costs associated with constructing new concrete basins and instead retrofitting the membrane modules into the existing tankage. For the flow rate assumed in this cost comparison (8.5-mgd), the avoided cost would be $1.3MM or 5.5 percent of the total capital cost for the ZenoGem alternative. Actual savings would be somewhat less due to the costs associated with basin retrofit. The $1.3MM savings would reduce the difference in capital costs between the two alternatives, however, the ZeeWeed alternative would still be significantly less expensive (by $8.9 MM). Additional capitol cost savings would be realized if the blowers used for aeration in the conventional, concrete basin plant could be adapted and used where membrane modules are retrofitted into existing basins.

It was beyond the scope of this study to perform an order-of-magnitude level cost estimate for conventional treatment facilities (primary clarification, secondary [activated sludge] treatment and secondary clarification) followed by ZeeWeed in the case where no conventional wastewater treatment existed. However, based on design and costing of conventional treatment facilities that CH2M HILL has performed over the past 20 years, rule-of-thumb costs for 8.5-mgd of conventional treatment would be in the $16MM - $20MM range. Adding ZeeWeed costs of $12MM results in a cost estimate of $28–32MM. This compares with ZenoGem cost of $22MM as estimated in this report. Based on these estimates, constructing a 8.5-mgd ZenoGem treatment plant to treat screened, de-gritted sewage would save $6-10MM compared with the conventional treatment/ZeeWeed approach using the combination of rule-of-thumb and order-of-magnitude cost estimates. This represents a significant savings potential and indicates that for municipalities considering indirect potable reuse and who would be starting with raw sewage, it should be considerably less expensive to construct a treatment facility using ZenoGem/RO versus conventional wastewater plant (through secondary treatment)/ZeeWeed/RO.

SECTION 7

References

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Water Environment Federation. 1990. Operation of Municipal Wastewater Treatment Plants. Manual of Practice 11, Volume II.

Water Environment Federation and American Society of Civil Engineers. 1991. Design of Municipal Wastewater Treatment Plants, Volume I. WEF Manual of Practice No. 8. ASCE Manual and Report on Engineering Practice No. 76.

Appendix A. Photographs of Demonstration Plant Facilities and Associated Equipment

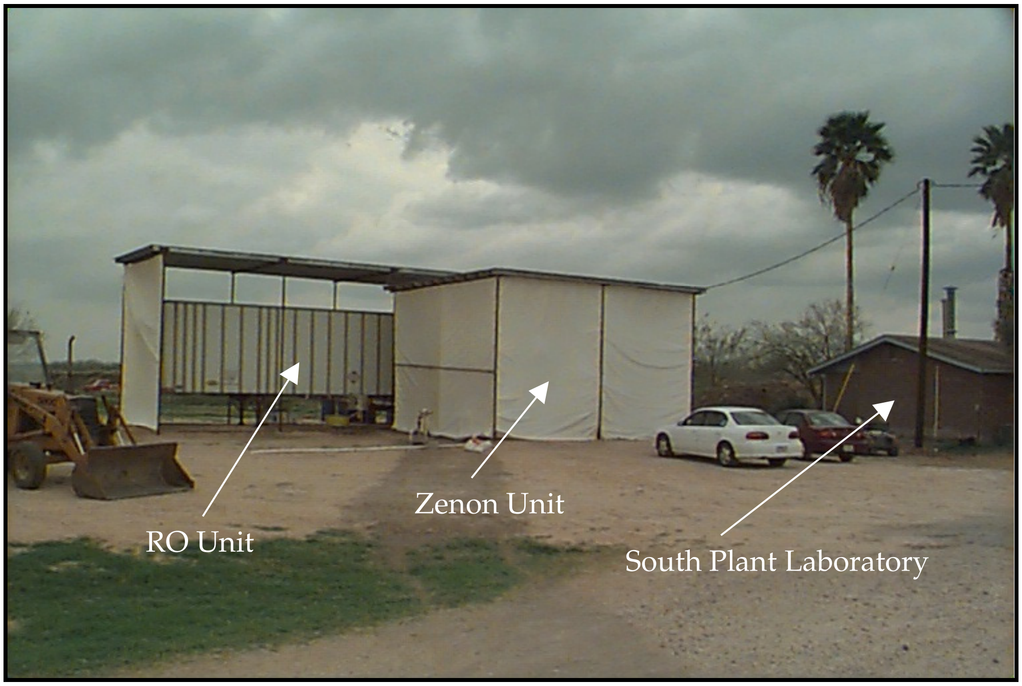

Exhibit A-1. Demonstration plant location (located to the west of the South WWTP laboratory).

Exhibit A-2. ZenoGem® and RO treatment systems (looking west).

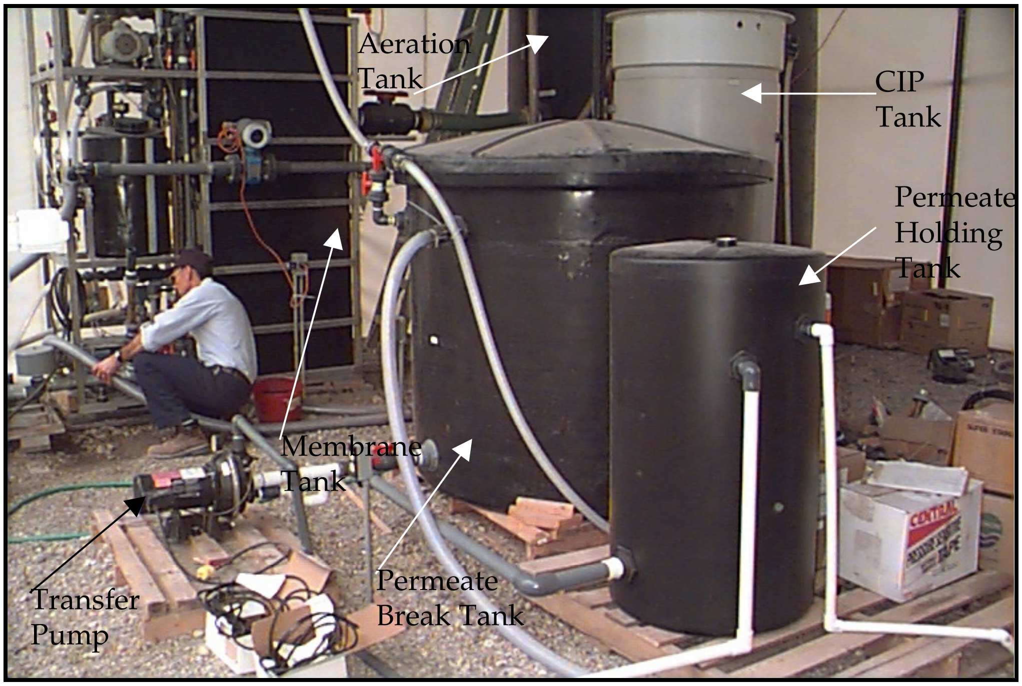

Exhibit A-3. Process tanks for ZenoGem system (operator Henry Perez in background).

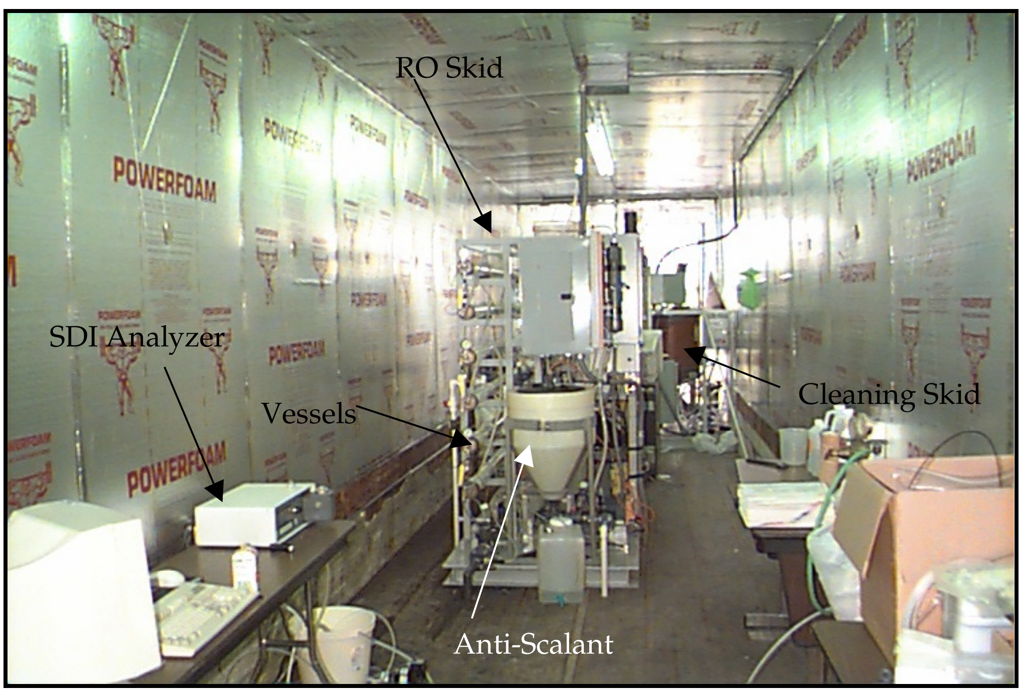

Exhibit A-4. RO system equipment (looking east inside trailer).

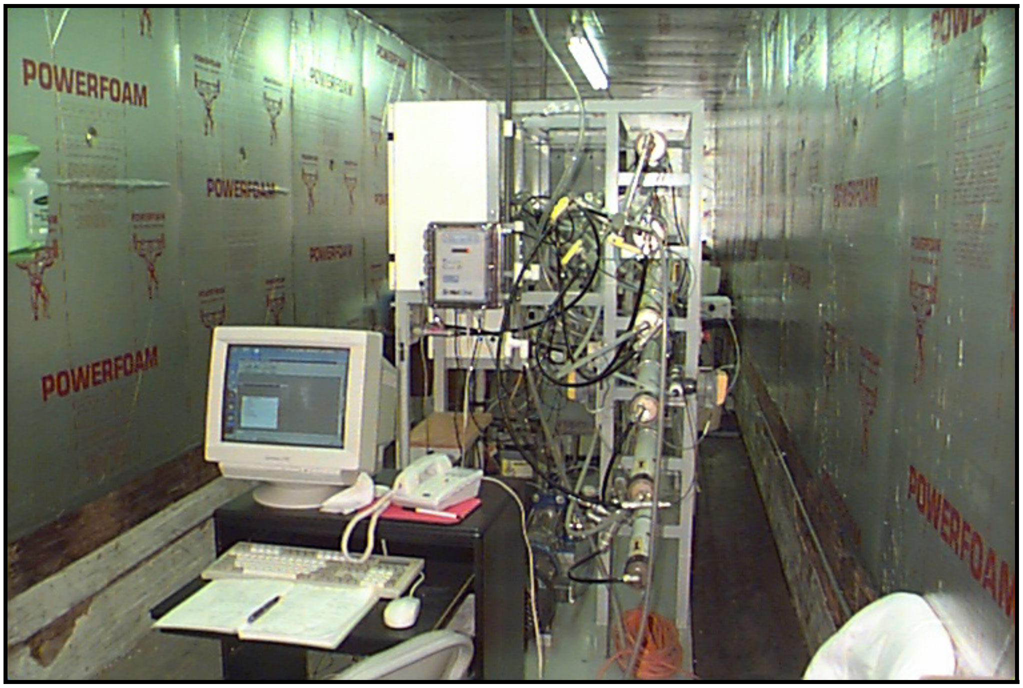

Exhibit A-5. RO data acquisition equipment (looking west inside trailer).

Appendix B.   RO Projections

HYDRANAUTICS RO SYSTEM DESIGN SOFTWARE, VERSION 6.4 (c) 1998 12/12/1999

BASIC DESIGN

RO program licensed to:
Calculation created by: J. Lozier (CH2M HILL)

Project name: McAllen Phase II		Permeate flow:	7.2 gpm
HP Pump flow:	14.4 gpm	Raw water flow:	14.4 gpm
Recommended pump press.:	100.5 psi		
Feed pressure:	91.1 psi	Permeate recovery ratio:	50.0 %
Feedwater Temperature:	31.0 C(88F)		
Raw water pH:	7.80	Element age:	0.0 years
Acid dosage, ppm (100%):	56.9 H2SO4	Flux decline % per year:	7.0
Acidified feed CO2:	57.9	Salt passage increase, %/yr:	10.0
Average flux rate:	10.2 gfd	Feed type:	Wastewater

Stage	Perm. Flow gpm	Flow per Vessel Feed gpm	Flow per Vessel Conc gpm	Flux gfd	Beta	Conc. Press. psi	Element Type	Elem. No.	Array
1-1	4.1	7.2	5.2	11.5	1.11	81.9	LFC1-4040	6	2x3
1-2	3.1	5.2	3.6	8.8	1.12	73.2	LFC1-4040	6	2x3

Ion	Raw water mg/l	Raw water CaCO3	Feed water mg/l	Feed water CaCO3	Permeate mg/l	Permeate CaCO3	Concentrate mg/l	Concentrate CaCO3
Ca	140.0	349.1	140.0	349.1	1.6	4.0	278.4	694.3
Mg	29.1	119.8	29.1	119.8	0.3	1.4	57.9	238.1
Na	332.0	721.7	332.0	721.7	18.0	39.1	646.0	1404.4
K	17.1	21.9	17.1	21.9	1.2	1.5	33.0	42.4
NH4	1.0	2.8	1.0	2.8	0.1	0.2	1.9	5.4
Ba	0.1	0.1	0.1	0.1	0.0	0.0	0.2	0.1
Sr	1.3	1.4	1.3	1.4	0.0	0.0	2.5	2.9
CO3	0.3	0.5	0.1	0.1	0.0	0.0	0.1	0.2
HCO3	293.0	240.2	224.0	183.6	18.3	15.0	429.6	352.2
SO4	327.0	340.6	382.8	398.7	4.4	4.6	761.1	792.8
Cl	388.0	547.2	388.0	547.2	17.8	25.1	758.2	1069.4
F	1.0	2.6	1.0	2.6	0.1	0.2	1.9	5.0
NO3	1.5	1.2	1.5	1.2	0.3	0.3	2.7	2.1
SiO2	13.9		13.9		0.3		27.5	
TDS	1545.2		1531.8		62.4		3001.1	
pH	7.8		6.8		5.7		7.1	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	8%	10%	23%
SrSO4 / Ksp * 100:	5%	6%	13%
BaSO4 / Ksp * 100:	371%	428%	990%
SiO2 saturation:	9%	9%	18%
Langelier Saturation Index	0.92	-0.19	0.65
Stiff & Davis Saturation Index	0.95	-0.17	0.56
Ionic strength	0.03	0.03	0.06
Osmotic pressure	13.3 psi	13.1 psi	25.7 psi

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

Hydranautics (USA) Ph: (619) 901-2500 Fax: (619) 901-2578
Hydranautics (Europe) Ph: 31 5465 49335 Fax: 31 5465 49337

HYDRANAUTICS RO SYSTEM DESIGN SOFTWARE, VERSION 6.4 (c) 1998 12/12/1999

BASIC DESIGN

RO program licensed to:
Calculation created by: J. Lozier (CH2M HILL)

Project name: McAllen Phase II		Permeate flow:	7.2 gpm
HP Pump flow:	14.4 gpm	Raw water flow:	14.4 gpm
Recommended pump press.:	100.5 psi		
Feed pressure:	91.1 psi	Permeate recovery ratio:	50.0 %
Feedwater Temperature:	31.0 C(88F)		
Raw water pH:	7.80	Element age:	0.0 years
Acid dosage, ppm (100%):	56.9 H2SO4	Flux decline % per year:	7.0
Acidified feed CO2:	57.9	Salt passage increase, %/yr:	10.0
Average flux rate:	10.2 gfd	Feed type:	Wastewater

Stage	Perm. Flow gpm	Flow per Vessel Feed gpm	Flow per Vessel Conc gpm	Flux gfd	Beta	Conc. Press. psi	Element Type	Elem. No.	Array
1-1	4.1	7.2	5.2	11.5	1.11	81.9	LFC1-4040	6	2x3
1-2	3.1	5.2	3.6	8.8	1.12	73.2	LFC1-4040	6	2x3

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Concentrate saturation level CaSO4	SrSO4	BaSO4	SiO2	Lang.
1-1	1	91.1	3.5	0.7	12.2	1.10	39.0	14.6	11	6	486	10	-0.1
1-1	2	87.5	3.0	0.7	11.4	1.10	42.4	16.2	13	7	555	11	0.1
1-1	3	84.5	2.6	0.6	10.7	1.11	46.2	18.1	15	9	638	13	0.2
1-2	1	78.9	2.2	0.6	9.5	1.11	51.2	20.5	17	10	733	14	0.4
1-2	2	76.7	1.9	0.5	8.8	1.11	56.8	22.7	20	11	848	16	0.5
1-2	3	74.8	1.6	0.5	8.1	1.12	62.7	25.9	23	13	985	18	0.7

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

Hydranautics (USA) Ph: (619) 901-2500 Fax: (619) 901-2578
Hydranautics (Europe) Ph: 31 5465 49335 Fax: 31 5465 49337

HYDRANAUTICS RO SYSTEM DESIGN SOFTWARE, VERSION 6.4 (c) 1998 12/12/1999

BASIC DESIGN

RO program licensed to:
Calculation created by: J. Lozier (CH2M HILL)

Project name: McAllen Phase II		Permeate flow:	12.7 gpm
HP Pump flow:	25.4 gpm	Raw water flow:	25.4 gpm
Recommended pump press.:	140.9 psi		
Feed pressure:	131.5 psi	Permeate recovery ratio:	50.0 %
Feedwater Temperature:	31.0 C(88F)		
Raw water pH:	7.80	Element age:	0.0 years
Acid dosage, ppm (100%):	56.9 H2SO4	Flux decline % per year:	7.0
Acidified feed CO2:	57.9	Salt passage increase, %/yr:	10.0
Average flux rate:	12.0 gfd	Feed type:	Wastewater

Stage	Perm. Flow gpm	Flow per Vessel Feed gpm	Flow per Vessel Conc gpm	Flux gfd	Beta	Conc. Press. psi	Element Type	Elem. No.	Array
1-1	6.0	12.7	9.7	17.0	1.09	110.5	LFC1-4040	6	2x3
1-2	4.6	9.7	7.4	13.0	1.09	93.2	LFC1-4040	6	2x3
1-3	1.5	14.8	13.3	8.4	1.03	61.3	LFC1-4040	3	1x3
1-4	0.6	13.3	12.7	3.3	1.01	32.4	LFC1-4040	3	1x3

	Raw water		Feed water		Permeate		Concentrate	
Ion	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3
Ca	140.0	349.1	140.0	349.1	1.4	3.6	278.6	694.7
Mg	29.1	119.8	29.1	119.8	0.3	1.2	57.9	238.3
Na	332.0	721.7	332.0	721.7	16.2	35.1	647.8	1408.4
K	17.1	21.9	17.1	21.9	1.0	1.3	33.2	42.5
NH4	1.0	2.8	1.0	2.8	0.1	0.2	1.9	5.4
Ba	0.1	0.1	0.1	0.1	0.0	0.0	0.2	0.1
Sr	1.3	1.4	1.3	1.4	0.0	0.0	2.5	2.9
CO3	0.3	0.5	0.1	0.1	0.0	0.0	0.1	0.2
HCO3	293.0	240.2	224.0	183.6	16.7	13.7	431.3	353.5
SO4	327.0	340.6	382.8	398.7	4.0	4.2	761.5	793.2
Cl	388.0	547.2	388.0	547.2	16.2	22.8	759.8	1071.7
F	1.0	2.6	1.0	2.6	0.1	0.2	1.9	5.0
NO3	1.5	1.2	1.5	1.2	0.3	0.3	2.7	2.2
SiO2	13.9		13.9		0.3		27.5	
TDS	1545.2		1531.8		56.5		3007.0	
pH	7.8		6.8		5.7		7.1	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	8%	10%	23%
SrSO4 / Ksp * 100:	5%	6%	13%
BaSO4 / Ksp * 100:	371%	428%	990%
SiO2 saturation:	9%	9%	18%
Langelier Saturation Index	0.92	-0.19	0.65
Stiff & Davis Saturation Index	0.95	-0.17	0.56
Ionic strength	0.03	0.03	0.06
Osmotic pressure	13.3 psi	13.1 psi	25.8 psi

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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Calculation created by: J. Lozier (CH2M HILL)

Project name: McAllen Phase II		Permeate flow:	12.7 gpm
HP Pump flow:	25.4 gpm	Raw water flow:	25.4 gpm
Recommended pump press.:	140.9 psi		
Feed pressure:	131.5 psi	Permeate recovery ratio:	50.0 %
Feedwater Temperature:	31.0 C(88F)		

Raw water pH:	7.80	Element age:	0.0 years
Acid dosage, ppm (100%):	56.9 H2SO4	Flux decline % per year:	7.0
Acidified feed CO2:	57.9	Salt passage increase, %/yr:	10.0
Average flux rate:	12.0 gfd	Feed type:	Wastewater

Stage	Perm. Flow gpm	Flow per Vessel Feed gpm	Conc gpm	Flux gfd	Beta	Conc. Press. psi	Element Type	Elem. No.	Array
1-1	6.0	12.7	9.7	17.0	1.09	110.5	LFC1-4040	6	2x3
1-2	4.6	9.7	7.4	13.0	1.09	93.2	LFC1-4040	6	2x3
1-3	1.5	14.8	13.3	8.4	1.03	61.3	LFC1-4040	3	1x3
1-4	0.6	13.3	12.7	3.3	1.01	32.4	LFC1-4040	3	1x3

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Concentrate CaSO4	SrSO4	saturation BaSO4	SiO2	level Lang.
1-1	1	131.5	7.9	1.1	18.3	1.08	25.6	14.3	11	6	477	10	-0.1
1-1	2	123.6	7.0	1.0	17.0	1.08	27.9	15.7	12	7	532	11	0.0
1-1	3	116.6	6.1	0.9	15.7	1.09	30.3	17.1	14	8	594	12	0.1
1-2	1	107.5	5.4	0.8	14.0	1.08	33.3	18.8	15	9	661	13	0.3
1-2	2	102.1	4.8	0.8	12.9	1.08	36.4	20.4	17	10	738	14	0.4
1-2	3	97.3	4.2	0.7	11.9	1.09	39.7	22.4	19	11	823	16	0.5
1-3	1	90.1	10.1	0.6	10.1	1.04	41.8	23.5	20	12	865	16	0.5
1-3	2	80.0	9.6	0.5	8.3	1.03	44.2	24.0	21	12	903	17	0.6
1-3	3	70.4	9.2	0.4	6.7	1.03	46.8	25.0	22	13	935	17	0.6
1-4	1	58.2	8.9	0.3	4.7	1.02	49.9	25.6	23	13	959	18	0.7
1-4	2	49.4	8.6	0.2	3.2	1.01	53.3	25.6	23	13	977	18	0.6
1-4	3	40.7	8.5	0.1	1.9	1.01	56.9	26.2	23	13	987	18	0.7

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Project name:	McAllen Phase II	Permeate flow:	12.7 gpm
HP Pump flow:	15.9 gpm	Raw water flow:	15.9 gpm
Recommended pump press.:	132.2 psi		
Feed pressure:	121.4 psi	Permeate recovery ratio:	80.0 %
Feedwater Temperature:	31.0 C(88F)		
Raw water pH:	7.80	Element age:	0.0 years
Acid dosage, ppm (100%):	56.9 H2SO4	Flux decline % per year:	7.0
Acidified feed CO2:	57.9	Salt passage increase, %/yr:	10.0
Average flux rate:	12.0 gfd	Feed type:	Wastewater

Stage	Perm. Flow gpm	Flow per Vessel Feed gpm	Flow per Vessel Conc gpm	Flux gfd	Beta	Conc. Press. psi	Element Type	Elem. No.	Array
1-1	5.7	7.9	5.1	16.2	1.16	111.5	LFC1-4040	6	2x3
1-2	4.5	5.1	2.8	12.7	1.21	103.6	LFC1-4040	6	2x3
1-3	1.6	5.7	4.1	8.8	1.10	94.1	LFC1-4040	3	1x3
1-4	0.9	4.1	3.2	5.3	1.07	86.7	LFC1-4040	3	1x3

Ion	Raw water mg/l	Raw water CaCO3	Feed water mg/l	Feed water CaCO3	Permeate mg/l	Permeate CaCO3	Concentrate mg/l	Concentrate CaCO3
Ca	140.0	349.1	140.0	349.1	2.3	5.7	690.9	1723.0
Mg	29.1	119.8	29.1	119.8	0.5	1.9	143.6	591.0
Na	332.0	721.7	332.0	721.7	25.2	54.8	1559.2	3389.5
K	17.1	21.9	17.1	21.9	1.6	2.1	79.1	101.4
NH4	1.0	2.8	1.0	2.8	0.1	0.3	4.6	12.8
Ba	0.1	0.1	0.1	0.1	0.0	0.0	0.4	0.3
Sr	1.3	1.4	1.3	1.4	0.0	0.0	6.2	7.1
CO3	0.3	0.5	0.1	0.1	0.0	0.0	0.3	0.6
HCO3	293.0	240.2	224.0	183.6	25.5	20.9	1017.8	834.3
SO4	327.0	340.6	382.8	398.7	6.3	6.6	1888.6	1967.3
Cl	388.0	547.2	388.0	547.2	25.0	35.3	1839.8	2594.9
F	1.0	2.6	1.0	2.6	0.1	0.3	4.5	11.8
NO3	1.5	1.2	1.5	1.2	0.5	0.4	5.7	4.6
SiO2	13.9		13.9		0.5		67.7	
TDS	1545.2		1531.8		87.6		7308.5	
pH	7.8		6.8		5.9		7.4	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	8%	10%	73%
SrSO4 / Ksp * 100:	5%	6%	42%
BaSO4 / Ksp * 100:	371%	428%	2994%
SiO2 saturation:	9%	9%	45%
Langelier Saturation Index	0.92	-0.19	1.73
Stiff & Davis Saturation Index	0.95	-0.17	1.35
Ionic strength	0.03	0.03	0.16
Osmotic pressure	13.3 psi	13.1 psi	62.8 psi

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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Project name:	McAllen Phase II	Permeate flow:	12.7 gpm
HP Pump flow:	15.9 gpm	Raw water flow:	15.9 gpm
Recommended pump press.:	132.2 psi		
Feed pressure:	121.4 psi	Permeate recovery ratio:	80.0 %
Feedwater Temperature:	31.0 C(88F)		

Raw water pH:	7.80	Element age:	0.0 years
Acid dosage, ppm (100%):	56.9 H2SO4	Flux decline % per year:	7.0
Acidified feed CO2:	57.9	Salt passage increase, %/yr:	10.0
Average flux rate:	12.0 gfd	Feed type:	Wastewater

Stage	Perm. Flow gpm	Flow per Vessel Feed gpm	Flow per Vessel Conc gpm	Flux gfd	Beta	Conc. Press. psi	Element Type	Elem. No.	Array
1-1	5.7	7.9	5.1	16.2	1.16	111.5	LFC1-4040	6	2x3
1-2	4.5	5.1	2.8	12.7	1.21	103.6	LFC1-4040	6	2x3
1-3	1.6	5.7	4.1	8.8	1.10	94.1	LFC1-4040	3	1x3
1-4	0.9	4.1	3.2	5.3	1.07	86.7	LFC1-4040	3	1x3

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Concentrate CaSO4	SrSO4	saturation BaSO4	SiO2	level Lang.
1-1	1	121.4	4.0	1.0	17.0	1.13	28.4	15.0	12	7	504	10	0.0
1-1	2	117.4	3.3	0.9	16.1	1.14	31.2	17.3	14	8	602	12	0.2
1-1	3	114.2	2.6	0.9	15.2	1.16	34.7	20.3	17	10	733	14	0.4
1-2	1	108.5	2.1	0.8	13.7	1.17	39.3	24.3	21	12	903	17	0.6
1-2	2	106.4	1.6	0.7	12.7	1.19	44.8	29.1	27	16	1140	20	0.8
1-2	3	104.8	1.2	0.7	11.5	1.21	51.5	36.2	35	20	1476	25	1.1
1-3	1	100.6	2.6	0.6	9.8	1.10	55.9	40.7	40	23	1679	28	1.2
1-3	2	98.1	2.2	0.5	8.6	1.10	61.1	44.0	46	26	1907	31	1.3
1-3	3	95.9	1.9	0.5	7.8	1.10	66.6	49.9	52	30	2161	34	1.5
1-4	1	91.0	1.7	0.4	6.1	1.08	73.4	55.0	58	33	2410	37	1.6
1-4	2	89.3	1.5	0.3	5.0	1.08	81.0	57.3	65	37	2665	41	1.6
1-4	3	87.8	1.3	0.3	4.5	1.07	88.6	63.9	71	41	2925	44	1.8

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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Appendix C. ZenoGem and RO Operating and Water Quality Data

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
A	Sat 2/6/99	02/06/1999 8:00	8:00 AM	0.00	5563.2	424632.7		27.0	25.0	3.5	24.0	3.0		3.0	13.0	3.0		15.00	10	START OF TESTING				12.37	8.6
	Sat 2/6/99	02/06/1999 11:30	11:30 AM	3.50	5566.7	425188.9		28.0	25.0	3.5	32.0	3.0		3.0	13.0	3.0		15.00	10					12.37	8.6
	Sun 2/7/99	02/07/1999 8:30	8:30 AM	24.50	5582.2	428701.3		28.0	25.0	3.5	33.0	6.0	0.50	2.8	13.0	6.0	0.5	15.00	10	increased flow rate to 6.0				6.18	17.3
	Sun 2/7/99	02/07/1999 13:13	1:13 PM	29.22	5586.0	429858.3		28.0	25.0	3.5	26.0	6.0	0.50	2.8	13.0	6.0	0.5	15.00	10					6.18	17.3
	Mon 2/8/99	02/08/1999 7:15	7:15 AM	47.25	5604.9	435718.9		27.0	25.0	3.5	28.0	6.0	0.75	3.0	14.0	6.0	0.8	15.00	10		0.37	46.88	44.71	6.18	17.3
	Mon 2/8/99	02/08/1999 13:00	1:00 PM	53.00	5610.7	437333.4		27.0	25.0	3.5	21.0	4.5	0.50	3.0	14.0	4.5	0.3	15.10	10	maint cleaning	0.25	52.74	50.30	8.24	13.0
	Mon 2/8/99	02/08/1999 14:45	2:45 PM	54.75	5611.7	437538.0		28.0	25.0	3.5	20.0	4.5	0.50	3.0	14.0	4.5	0.5	15.00	10	start sampling	0.25	52.74	49.12	8.24	13.0
	Tue 2/9/99	02/09/1999 7:30	7:30 AM	71.50	5628.4	441298.4		27.0	25.0	3.5	15.0	4.5	0.50	3.0	14.0	4.5	0.5	15.00	10		0.25	52.74	50.30	8.24	13.0
	Tue 2/9/99	02/09/1999 13:00	1:00 PM	77.00	5633.5	443078.9		28.0	25.0	3.5	31.0	4.5	0.75	3.1	13.0	4.5	0.8	15.00	10		0.37	35.16	32.75	8.24	13.0
	Wed 2/10/99	02/10/1999 7:15	7:15 AM	95.25	5651.7	446930.0		27.0	25.0	3.5	30.0	4.4	0.75	3.0	13.0	4.5	0.5	15.00	10	maint cleaning	0.37	34.38	32.79	8.43	13.0
	Wed 2/10/99	02/10/1999 9:30	9:30 AM	97.50	5653.3	447298.0		27.0	25.0	3.5	31.0	4.5	0.50	3.3	13.0	4.6	0.5	15.00	10		0.25	52.74	50.30	8.24	13.2
	Wed 2/10/99	02/10/1999 13:00	1:00 PM	101.00	5656.8	448200.0		28.0	25.0	3.5	32.0	4.5	0.50	3.0	13.0	4.5	0.3	15.00	10		0.25	52.74	49.12	8.24	13.0
	Thu 2/11/99	02/11/1999 10:35	10:35 AM	122.58	5676.1	452864.7		27.0	25.0	3.5		4.5	3.25	3.3	13.0	4.5	0.5	15.00	10	unit down due to recirculation pump impeller	1.60	8.11	7.74	8.24	13.0
	Sun 2/14/99	02/14/1999 9:00	9:00 AM	122.58	5677.6	455015.0		18.0	25.0	3.4	27.0	3.0	0.25	3.3	13.0	3.0	0.2	15.00	10	restart unit	0.12	70.32	83.02	12.37	8.6
	Sun 2/14/99	02/14/1999 14:00	2:00 PM	127.58	5682.8	455088.1		21.0	25.0	3.4	25.0	3.0		3.3	13.0	3.0	0.2	15.00	10					12.37	8.6
	Mon 2/15/99	02/15/1999 9:00	9:00 AM	146.58	5701.6	458874.1		22.0	25.0	3.5	28.0	3.0	0.20	3.2	13.0	3.0		15.00	10		0.10	87.90	94.39	12.37	8.6
	Mon 2/15/99	02/15/1999 10:35	10:35 AM	148.17	5703.2	459143.0		22.0	25.0	3.5	28.0	3.0	0.20	3.0	13.0	3.0	0.1	15.00	10	maint cleaning	0.10	87.90	94.39	12.37	8.6
	Mon 2/15/99	02/15/1999 11:55	11:55 AM	149.50	5703.9	459209.8		23.0	25.0	3.5	26.0	3.0		3.3	13.0	3.3	0.1	15.00	10					12.37	9.4
	Mon 2/15/99	02/15/1999 13:17	1:17 PM	150.87	5705.2	459440.0		24.0	25.0	3.5	25.0	3.3	0.10	3.2	13.0	3.0		15.00	10		0.05	190.46	195.03	11.42	8.6
	Tue 2/16/99	02/16/1999 7:30	7:30 AM	169.08	5723.4	462327.5		19.0	25.0	3.5	26.0	3.3		3.3	13.0	3.0		15.00	10					11.42	8.6
	Tue 2/16/99	02/16/1999 14:00	2:00 PM	175.58	5729.9	463441.7		25.0	25.0	3.5	30.0	4.5	0.35	3.0	13.0	4.5	0.4	15.00	10	increased flow rate to 4.5	0.17	75.35	75.35	8.24	13.0
	Tue 2/16/99	02/16/1999 15:30	3:30 PM	177.08	5731.4	463812.7		26.0	25.0	3.5	31.0	4.5	0.25	3.2	13.0	4.5	0.3	15.00	10		0.12	105.48	103.01	8.24	13.0
	Wed 2/17/99	02/17/1999 7:15	7:15 AM	192.83	5747.6	467639.8		25.0	25.0	3.5	30.0	4.5	0.40	3.1	13.0	4.5	0.4	15.00	10		0.20	65.93	65.93	8.24	13.0
	Wed 2/17/99	02/17/1999 10:00	10:00 AM	195.58	5749.8	468201.1		25.0	25.0	3.5	31.0	4.5	0.40	3.0	13.0	4.5	0.4	15.10	10	maint cleaning	0.20	65.93	65.93	8.24	13.0
	Wed 2/17/99	02/17/1999 11:10	11:10 AM	196.75	5750.4	468278.8		25.0	25.0	3.5	31.0	4.5	0.25	3.3	13.0	4.5	0.4	15.10	10		0.12	105.48	105.48	8.24	13.0
	Wed 2/17/99	02/17/1999 15:00	3:00 PM	200.58	5754.2	468205.6		26.0	25.0	3.5	32.0	4.5	0.40	3.2	13.0	4.5	0.3	15.10	10		0.20	65.93	64.38	8.24	13.0
	Thu 2/18/99	02/18/1999 7:30	7:30 AM	217.08	5770.7	473188.4		24.0	25.0	3.5	32.0	4.6	0.40	3.1	13.0	4.5	0.4	15.00	10		0.20	67.39	69.01	8.07	13.0
	Thu 2/18/99	02/18/1999 13:30	1:30 PM	223.08	5776.7	474806.0		26.0	25.0	3.5	31.0	4.5	0.25	3.0	13.0	4.5	0.1	15.00	10	maint cleaning	0.12	105.48	103.01	8.24	13.0
	Fri 2/19/99	02/19/1999 7:30	7:30 AM	241.08	5794.7	479290.0		26.0	25.0	3.5	30.0	4.5	0.25	3.0	13.0	4.5	0.3	15.00	10		0.12	105.48	103.01	8.24	13.0
	Fri 2/19/99	02/19/1999 9:30	9:30 AM	243.08	5796.7	479641.8		26.0	25.0	3.5	29.0	4.5	0.50	3.0	13.0	4.5	0.5	15.00	10	maint cleaning	0.25	52.74	51.51	8.24	13.0
	Fri 2/19/99	02/19/1999 11:00	11:00 AM	244.58	5797.5	479721.1		26.5	25.0	3.5	30.0	4.5	0.25	3.1	13.0	4.5	0.4	15.00	10		0.12	105.48	101.80	8.24	13.0
	Fri 2/19/99	02/19/1999 13:30	1:30 PM	247.08	5799.9	480351.7		27.0	25.0	3.5	30.0	4.5	0.25	3.1	13.0	4.5	0.3	15.00	10		0.12	105.48	100.60	8.24	13.0
	Sat 2/20/99	02/20/1999 7:30	7:30 AM	265.08	5817.8	484651.8		24.0	25.0	3.5	26.0	4.5	0.10	3.1	13.0	4.5		15.00	10		0.05	263.71	270.04	8.24	13.0
	Sat 2/20/99	02/20/1999 12:00	12:00 PM	269.58	5822.4	485110.5		26.0	25.0	3.5	28.0	4.5		3.2	13.0	4.5		15.00	10					8.24	13.0
	Sun 2/21/99	02/21/1999 8:00	8:00 AM	289.58	5842.5	490222.6		24.0	25.0	3.5	30.0	4.5	0.50	3.1	13.0	4.5	0.5	15.00	10		0.25	52.74	54.01	8.24	13.0
	Sun 2/21/99	02/21/1999 11:30	11:30 AM	293.08	5845.9	491046.4		24.0	25.0	3.5	29.0	4.5	0.30	3.2	13.0	4.5	0.3	15.00	10		0.15	87.90	90.01	8.24	13.0
	Mon 2/22/99	02/22/1999 7:30	7:30 AM	313.08	5865.9	496091.5		22.0	25.0	3.5	29.0	4.5	0.40	3.2	13.0	4.5	0.3	15.00	10		0.20	65.93	70.79	8.24	13.0
	Mon 2/22/99	02/22/1999 13:30	1:30 PM	319.08	5871.8	497771.4		25.0	25.0	3.5	29.0	6.0	1.00	3.2	13.0	6.0	0.5	15.00	10	increase flow to 6 gpm as per Doreen G.	0.49	35.16	35.16	6.18	17.3
	Mon 2/22/99	02/22/1999 14:15	2:15 PM	319.83	5872.7	498040.0		25.0	25.0	3.5	29.0	6.0	1.00	3.2	13.0	6.0	0.6	15.00	10	maint cleaning	0.49	35.16	35.16	6.18	17.3
	Mon 2/22/99	02/22/1999 15:30	3:30 PM	321.08	5873.2	498114.6		25.0	25.0	3.5	28.0	6.0	1.00	3.2	13.0	6.1	0.5	15.00	10		0.49	35.16	35.16	6.18	17.6
	Tue 2/23/99	02/23/1999 7:30	7:30 AM	337.08	5888.2	503172.8		24.0	25.0	3.5	21.0	6.0	1.00	3.2	13.0	6.0	1.0	15.00	10		0.49	35.16	36.01	6.18	17.3
	Tue 2/23/99	02/23/1999 13:30	1:30 PM	343.08	5895.1	504924.0		26.0	25.0	3.5	23.0	6.0	1.50	3.2	13.0	6.0	1.0	15.00	10		0.74	23.44	22.89	6.18	17.3
	Wed 2/24/99	02/24/1999 7:30	7:30 AM	361.08	5912.0	508427.1		26.0	25.0	3.5	26.0	6.0	1.60	3.3	13.0	6.0	1.5	15.00	10		0.79	21.98	21.46	6.18	17.3
	Wed 2/24/99	02/24/1999 9:30	9:30 AM	363.08	5914.0	509101.1		26.0	25.0	3.5	27.0	6.0	1.60	3.3	13.0	6.0	1.5	15.00	10	maint cleaning	0.79	21.98	21.46	6.18	17.3
	Wed 2/24/99	02/24/1999 10:35	10:35 AM	364.17	5914.4	509155.6		26.0	25.0	3.5	28.0	6.0	0.75	3.3	13.0	6.0	0.8	15.00	10		0.37	46.88	45.78	6.18	17.3
	Wed 2/24/99	02/24/1999 13:00	1:00 PM	366.58	5917.2	510071.4		26.0	25.0	3.5	27.0	6.0	1.10	3.3	13.0	6.0	0.8	15.00	10		0.54	31.96	31.22	6.18	17.3
	Thu 2/25/99	02/25/1999 8:00	8:00 AM	385.58	5935.8	515533.1		26.0	25.0	3.5	31.0	6.0	1.00	3.3	13.0	6.0	0.8	15.00	10		0.49	35.16	34.34	6.18	17.3
	Thu 2/25/99	02/25/1999 13:30	1:30 PM	391.08	5938.4	516334.0		27.0	25.0	3.5	31.0	6.0	1.00	3.3	13.0	6.0	1.0	15.00	10		0.49	35.16	33.53	6.18	17.3
	Fri 2/26/99	02/26/1999 7:30	7:30 AM	409.08	5956.4	520718.4		26.0	25.0	3.5	31.0	6.0	1.00	3.3	13.0	6.0	0.8	15.00	10		0.49	35.16	34.34	6.18	17.3
	Fri 2/26/99	02/26/1999 9:30	9:30 AM	411.08	5958.4	521406.8		26.0	25.0	3.5	28.0	6.0	1.00	3.3	13.0	6.0	1.0	15.00	10	maint cleaning	0.49	35.16	34.34	6.18	17.3
	Fri 2/26/99	02/26/1999 10:35	10:35 AM	412.17	5858.9	521488.4		26.0	25.0	3.5	28.0	6.0	0.75	3.5	13.0	6.0	0.6	15.00	10		0.37	46.88	45.78	6.18	17.3
	Fri 2/26/99	02/26/1999 13:30	1:30 PM	415.08	5961.8	522490.0		27.0	25.0	3.5	31.0	6.0	0.90	3.2	13.0	6.0	0.8	15.00	10		0.44	39.07	37.26	6.18	17.3
	Sat 2/27/99	02/27/1999 8:10	8:10 AM	433.75	5980.4	527005.4		26.0	25.0	3.5	31.0	6.0	1.00	3.2	13.0	6.0	0.5	15.00	10		0.49	35.16	34.34	6.18	17.3
	Sat 2/27/99	02/27/1999 11:15	11:15 AM	436.83	5983.5	528009.1		27.0	25.0	3.5	31.0	6.0	1.00	3.2	13.0	6.0	0.8	15.00	10		0.49	35.16	33.53	6.18	17.3
	Sun 2/28/99	02/28/1999 7:00	7:00 AM	456.58	6003.9	534360.5		25.0	25.0	3.5	25.0	6.0	0.50	3.2	13.0	6.0	0.5	15.00	10					6.18	17.3
	Sun 2/28/99	02/28/1999 10:00	10:00 AM	459.58	6006.3	535149.7		26.0	25.0	3.5	26.0	6.0	1.75	3.2	13.0	6.0	1.5	15.00	10		0.86	20.09	19.62	6.18	17.3
	Mon 3/1/99	03/01/1999 7:30	7:30 AM	481.08	6027.5	541741.8		25.0	25.0	3.5	26.0	6.0	3.50	3.3	13.0	6.0	3.0	15.00	10		1.72	10.05	10.05	6.18	17.3
	Mon 3/1/99	03/01/1999 13:30	1:30 PM	487.08	6033.7	543777.2		26.0	25.0	3.5	26.0	6.0	4.00	3.3	13.0	6.0	3.8	15.00	10	maint cleaning	1.96	8.79	8.58	6.18	17.3
	Mon 3/1/99	03/01/1999 14:40	2:40 PM	488.25	6034.3	543890.1		27.0	25.0	3.5	31.0	6.0	2.25	3.3	13.0	6.0	1.8	15.00	10	changed gauges with the blower as of today	1.11	15.63	14.90	6.18	17.3
	Tue 3/2/99	03/02/1999 7:30	7:30 AM	505.08	6043.7	546997.0		27.0	25.0	3.5	30.0	6.0	6.00	3.2	13.0	6.0	5.0	15.00	10		2.95	5.86	5.59	6.18	17.3

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Tue 3/2/99	03/02/1999 13:30	1:30 PM	511.08	6049.7	548918.4		28.0	25.0	3.5	29.0	6.0	5.00	3.2	13.0	6.0	5.0	15.00	10		2.46	7.03	6.55	6.18	17.3
	Wed 3/3/99	03/03/1999 7:30	7:30 AM	529.08	6067.7	554831.9		26.0	25.0	3.5	29.0	6.0	5.00	3.2	13.0	6.0	4.9	15.00	10		2.46	7.03	6.87	6.18	17.3
	Wed 3/3/99	03/03/1999 10:00	10:00 AM	531.58	6070.1	555653.6		26.0	25.0	3.5	28.0	6.0	5.00	3.2	13.0	6.0	5.0	15.00	10	maint cleaning	2.46	7.03	6.87	6.18	17.3
	Wed 3/3/99	03/03/1999 11:00	11:00 AM	532.58	6070.5	555696.0		26.0	25.0	3.5	27.0	6.0	3.20	3.6	13.0	6.0	3.0	15.00	10		1.57	10.99	10.73	6.18	17.3
	Wed 3/3/99	03/03/1999 13:30	1:30 PM	535.08	6072.9	556539.1		26.0	25.0	3.5	28.0	6.0	3.60	3.2	13.0	6.0	3.6	15.00	10		1.77	9.77	9.54	6.18	17.3
	Thu 3/4/99	03/04/1999 7:30	7:30 AM	553.08	6091.0	562382.0		25.0	25.0	3.5	24.0	6.0	3.80	3.2	13.0	6.0	3.8	15.00	10		1.87	9.25	9.25	6.18	17.3
	Thu 3/4/99	03/04/1999 13:30	1:30 PM	559.08		564212.0		26.0	25.0	3.4	28.0	6.0	3.80	3.2	13.0	6.0	3.8	15.00	10		1.87	9.25	9.04	6.18	17.3
	Fri 3/5/99	03/05/1999 7:30	7:30 AM	577.08	6115.0	570183.1		26.0	25.0	3.4	18.0	6.0	4.30	3.2	13.0	6.0	4.0	15.00	10		2.11	8.18	7.99	6.18	17.3
	Fri 3/5/99	03/05/1999 9:30	9:30 AM	579.08	6117.0	570867.5		26.0	25.0	3.4	18.0	6.0	3.80	3.2	13.0	6.0	4.0	15.00	10	maint cleaning	1.87	9.25	9.04	6.18	17.3
	Fri 3/5/99	03/05/1999 10:35	10:35 AM	580.17	6117.4	570916.6		27.0	25.0	3.4	19.0	6.0	3.30	3.6	13.0	6.0	3.8	15.00	10		1.62	10.65	10.16	6.18	17.3
	Fri 3/5/99	03/05/1999 13:30	1:30 PM	583.08	6120.3	571917.6		27.0	25.0	3.5	22.0	6.0	3.80	3.2	13.0	6.0	3.8	15.00	10		1.87	9.25	8.82	6.18	17.3
	Sat 3/6/99	03/06/1999 7:30	7:30 AM	601.08	6138.3	577996.5		27.0	25.0	3.5	21.0	6.0	3.00	3.4	13.0	6.0	3.3	15.00	10		1.47	11.72	11.18	6.18	17.3
	Sat 3/6/99	03/06/1999 10:30	10:30 AM	604.08	6141.2	578991.8		27.0	25.0	3.5	17.0	6.0	3.00	3.2	13.0	6.0	3.3	15.00	10	maint flush	1.47	11.72	11.18	6.18	17.3
	Sun 3/7/99	03/07/1999 7:30	7:30 AM	625.08	6162.3	586120.1		27.0	25.0	3.5	14.0	6.0	3.80	3.2	13.0	6.0	3.9	15.00	10		1.87	9.25	8.82	6.18	17.3
	Sun 3/7/99	03/07/1999 11:30	11:30 AM	629.08	6166.2	587409.0		27.0	25.0	3.5	28.0	6.0	5.40	3.2	13.0	6.0	5.4	15.00	10		2.65	6.51	6.21	6.18	17.3
	Mon 3/8/99	03/08/1999 7:30	7:30 AM	649.08	6173.8	590263.4		27.0	25.0	3.5		6.0	4.80	3.2	13.0	6.0	4.6	15.00	10		2.36	7.33	6.99	6.18	17.3
	Mon 3/8/99	03/08/1999 10:30	10:30 AM	652.08	6176.3	591103.0		27.0	25.0	3.5		6.0	7.50	3.2	13.0	6.0	6.8	15.00	10		3.68	4.69	4.47	6.18	17.3
	Mon 3/8/99	03/08/1999 11:30	11:30 AM	653.08	6177.1	591283.1		28.0	25.0	3.5		6.0	3.80	3.4	13.0	6.0	3.6	15.00	10	unit down due to recirculation pump failure	1.87	9.25	8.62	6.18	17.3
	Tue 3/9/99	03/09/1999 0:00	12:00 AM	653.08																					
	Wed 3/10/99	03/10/1999 0:00	12:00 AM	653.08																					
	Thu 3/11/99	03/11/1999 0:00	12:00 AM	653.08																					
	Fri 3/12/99	03/12/1999 0:00	12:00 AM	653.08																					
	Sat 3/13/99	03/13/1999 0:00	12:00 AM	653.08																					
	Sun 3/14/99	03/14/1999 0:00	12:00 AM	653.08																					
	Mon 3/15/99	03/15/1999 0:00	12:00 AM	653.08																					
	Tue 3/16/99	03/16/1999 0:00	12:00 AM	653.08																					
	Wed 3/17/99	03/17/1999 0:00	12:00 AM	653.08																					
	Thu 3/18/99	03/18/1999 0:00	12:00 AM	653.08																					
	Fri 3/19/99	03/19/1999 7:00	7:00 AM	653.08																					
B	Sat 3/20/99	03/20/1999 7:30	7:30 AM	677.58	6211.0	598140.0		26.0	25.0	37.0	27.0	4.0	0.50	2.6	13.0	4.0	0.5	15.00	10		0.25	46.88	45.78	9.28	11.5
	Sat 3/20/99	03/20/1999 11:30	11:30 AM	681.58	6215.0	599023.0		26.0	25.0	35.0	38.0	4.0	0.50	2.8	16.0	4.0	0.5	15.00	10		0.25	46.88	45.78	9.28	11.5
	Sun 3/21/99	03/21/1999 7:30	7:30 AM	701.58	6235.4	603455.6		25.0	25.0	26.0	31.0	4.0	0.50	2.4	16.0	4.0	0.5	15.00	10		0.25	46.88	46.88	9.28	11.5
	Sun 3/21/99	03/21/1999 12:00	12:00 PM	706.08	6238.9	604443.2		26.0	25.0	20.0	38.0	6.5	1.00	2.2	16.0	6.5	1.0	15.00	10	membrane changeout	0.49	38.09	37.20	5.71	18.7
	Mon 3/22/99	03/22/1999 7:30	7:30 AM	725.58	6258.4	611286.0		25.0	25.0	39.0	37.0	6.0	1.00	2.8	16.0	6.5	1.0	15.00	10		0.49	35.16	35.16	6.18	18.7
	Mon 3/22/99	03/22/1999 10:05	10:05 AM	728.17	6260.9	612183.8		26.0	25.0	36.0	37.0	6.5	1.20	2.8	16.0	6.5	1.2	15.00	10	maint cleaning	0.59	31.74	31.00	5.71	18.7
	Mon 3/22/99	03/22/1999 11:40	11:40 AM	729.75	6261.9	612446.1		26.0	25.0	35.0	37.0	6.5	1.20	2.8	16.0	6.5	1.2	15.00	10	after cleaning	0.59	31.74	31.00	5.71	18.7
	Mon 3/22/99	03/22/1999 13:30	1:30 PM	731.58	6263.8	613120.0		26.0	25.0	35.0	36.0	6.5	1.00	2.7	13.0	6.5	1.0	15.00	10		0.49	38.09	37.20	5.71	18.7
	Tue 3/23/99	03/23/1999 7:30	7:30 AM	749.58	6281.7	619419.8		26.0	25.0	35.0	37.0	6.5	1.00	2.6	13.0	6.5	1.2	15.00	10		0.49	38.09	37.20	5.71	18.7
	Tue 3/23/99	03/23/1999 13:30	1:30 PM	755.58	6287.5	621489.2		29.0	25.0	35.0	36.0	6.5	1.20	2.6	13.0	6.5	1.0	15.00	10		0.59	31.74	28.87	5.71	18.7
	Wed 3/24/99	03/24/1999 7:30	7:30 AM	773.58	6305.4	627910.5		27.0	25.0	39.0	37.0	6.5	1.00	2.6	13.0	6.5	1.2	15.00	10		0.49	38.09	36.33	5.71	18.7
	Wed 3/24/99	03/24/1999 10:45	10:45 AM	776.83	6307.0	628730.2	26.0	28.0	25.0	38.0	36.0	6.5	1.30	2.6	13.0	6.5	1.2	15.00	10	maint cleaning	0.64	29.30	27.29	5.71	18.7
	Wed 3/24/99	03/24/1999 12:00	12:00 PM	778.08	6309.2	629162.0	24.0	28.0	25.0	35.0	36.0	6.5	1.20	2.6	13.0	6.5	1.2	15.00	10	after cleaning	0.59	31.74	29.56	5.71	18.7
	Wed 3/24/99	03/24/1999 15:00	3:00 PM	781.08	6312.2	630189.9	10.0	29.0	25.0	39.0	37.0	6.5	1.00	2.6	13.0	6.5	1.2	15.00	10		0.49	38.09	34.64	5.71	18.7
	Thu 3/25/99	03/25/1999 7:30	7:30 AM	797.58	6328.7	635991.2	28.0	27.0	25.0	34.0	36.0	6.5	1.20	2.6	13.0	6.5	1.0	15.00	10		0.59	31.74	30.27	5.71	18.7
	Thu 3/25/99	03/25/1999 14:00	2:00 PM	804.08	6335.1	638268.0	28.0	29.0	25.0	33.0	42.0	6.5	1.20	2.6	13.0	6.5	1.1	15.00	10		0.59	31.74	28.87	5.71	18.7
	Fri 3/26/99	03/26/1999 7:15	7:15 AM	821.33	6352.5	644297.0	24.0	26.0	25.0	36.0	35.0	6.5	1.40	2.6	13.0	6.5	1.4	15.00	10		0.69	27.21	26.57	5.71	18.7
	Fri 3/26/99	03/26/1999 9:30	9:30 AM	823.58	6354.7	645090.0	30.0	27.0	25.0	35.0	37.0	6.5	1.20	2.6	13.0	6.5	1.4	15.00	10	maint cleaning	0.59	31.74	30.27	5.71	18.7
	Fri 3/26/99	03/26/1999 10:45	10:45 AM	824.83	6355.3	645237.9	30.0	27.0	25.0	35.0	37.0	6.5	1.20	2.6	13.0	6.5	1.4	15.00	10	after cleaning	0.59	31.74	30.27	5.71	18.7
	Fri 3/26/99	03/26/1999 13:30	1:30 PM	827.58	6358.1	646227.2	18.0	27.0	25.0	35.0	36.0	6.5	1.20	2.6	13.0	6.5	1.3	15.00	10		0.59	31.74	30.27	5.71	18.7
	Sat 3/27/99	03/27/1999 7:30	7:30 AM	845.58	6376.1	652761.9		27.0	25.0	34.0	36.0	6.5	1.50	2.6	13.0	6.5	1.0	15.10	10		0.74	25.39	24.22	5.71	18.7
	Sat 3/27/99	03/27/1999 10:00	10:00 AM	845.58	6378.6	653689.5	22.0	27.0	25.0	33.0	36.0	6.5	2.00	2.5	13.0	6.5	1.5	15.10	10	before maint flush	0.98	19.05	18.16	5.71	18.7
	Sat 3/27/99	03/27/1999 10:15	10:15 AM	845.58	6378.7	653725.9		27.0	25.0	34.0	36.0	6.5	2.00	2.6	13.0	6.5	0.2	15.10	10	after maint flush	0.98	19.05	18.16	5.71	18.7
	Sun 3/28/99	03/28/1999 12:00	12:00 PM	845.58	6390.0	659336.8	30.0	25.0	25.0	34.0	38.0	4.0	0.50	2.8	13.0	4.0	0.5	15.00	10		0.25	46.88	46.88	9.28	11.5
	Mon 3/29/99	03/29/1999 7:30	7:30 AM	865.08	6409.6	661267.0	26.0	25.0	25.0	35.0	36.0	4.0	0.50	2.8	13.0	4.0	0.5	15.00	10		0.25	46.88	46.88	9.28	11.5
	Mon 3/29/99	03/29/1999 10:00	10:00 AM	867.58	6412.1	661868.2	23.0	26.0	25.0	34.0	36.0	6.5	1.50	2.8	13.0	6.5	1.5	15.00	10	maint cleaning	0.74	25.39	24.80	5.71	18.7
	Mon 3/29/99	03/29/1999 11:30	11:30 AM	869.08	6413.0	662118.9	27.0	26.0	25.0	43.0	36.0	6.5	1.50	2.8	13.0	6.5	1.5	15.00	10	after maint cleaning	0.74	25.39	24.80	5.71	18.7
	Mon 3/29/99	03/29/1999 14:00	2:00 PM	871.58	6415.4	662952.1	21.0	27.0	25.0	40.0	39.0	6.5	1.50	2.8	13.0	6.5	1.5	15.00	10		0.74	25.39	24.22	5.71	18.7
	Tue 3/30/99	03/30/1999 7:30	7:30 AM	889.08	6432.8	668053.5	26.0	25.0	25.0	42.0	38.0	6.5	1.50	2.7	14.0	6.5	1.5	15.00	10		0.74	25.39	25.39	5.71	18.7
	Tue 3/30/99	03/30/1999 14:30	2:30 PM	896.08	6439.8	671511.8	21.0	27.0	25.0	41.0	38.0	6.5	1.50	2.7	14.0	6.5	1.5	15.00	10		0.74	25.39	24.22	5.71	18.7
	Wed 3/31/99	03/31/1999 7:30	7:30 AM	913.08	6456.8	677430.0	28.0	25.0	25.0	41.0	36.0	6.5	1.50	2.8	13.0	6.5	1.5	15.00	10		0.74	25.39	25.39	5.71	18.7

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Wed 3/31/99	03/31/1999 7:35	7:35 AM	913.16	6459.4	678315.5	22.0	26.0	25.0	41.0	40.0	6.5	1.50	2.8	13.0	6.5	1.5	15.00	10		0.74	25.39	24.80	5.71	18.7
1	Wed 3/31/99	03/31/1999 7:40	7:40 AM	913.25	6459.4	678343.7	22.0	26.0	25.0	41.0	40.0	9.5	3.40	2.8	12.0	9.5	3.5	15.00	10		1.67	16.37	15.99	3.91	27.3
1	Wed 3/31/99	03/31/1999 10:00	10:00 AM	915.58	5459.8	678543.5	22.0	26.0	25.0	41.0	39.0	9.5	4.00	2.8	12.0	9.5	4.0	15.00	10	start peak flow testing @ 9.5 gpm for 6 hrs/day	1.96	13.92	13.59	3.91	27.3
1	Wed 3/31/99	03/31/1999 10:05	10:05 AM	915.66	6460.1	678727.5	21.0	26.0	25.0	41.0	43.0	9.5	4.40	2.8	13.0	9.5	4.2	15.00	10		2.16	12.65	12.36	3.91	27.3
1	Wed 3/31/99	03/31/1999 10:25	10:25 AM	916.00	6460.4	678911.5	21.0	21.0	25.0	41.0	39.0	9.5	4.50	2.8	13.0	9.5	4.4	15.00	10		2.21	12.37	13.60	3.91	27.3
1	Wed 3/31/99	03/31/1999 10:45	10:45 AM	916.33	6460.8	678091.0	20.0	26.0	25.0	40.0	39.0	9.5	4.50	2.8	13.0	9.5	4.4	15.00	10		2.21	12.37	12.08	3.91	27.3
1	Wed 3/31/99	03/31/1999 11:05	11:05 AM	916.66	6462.8	680123.0	24.0	27.0	25.0	42.0	42.0	9.5	5.00	2.8	13.0	9.5	4.8	15.00	10	maint cleaning	2.46	11.13	10.62	3.91	27.3
1	Wed 3/31/99	03/31/1999 14:45	2:45 PM	920.33	6463.4	680364.1	29.0	27.0	25.0	40.0	38.0	9.5	4.00	2.9	13.0	9.5	3.8	15.00	10	after maint cleaning	1.96	13.92	13.27	3.91	27.3
1	Wed 3/31/99	03/31/1999 15:30	3:30 PM	921.08	6464.1	680792.1	27.0	27.0	25.0	40.0	39.0	9.5	3.80	3.4	13.0	9.5	3.8	15.00	10		1.87	14.65	13.97	3.91	27.3
1	Wed 3/31/99	03/31/1999 15:45	3:45 PM	921.33	6470.9	684380.1	29.0	25.0	25.0	41.0	37.0	9.5	4.00	3.2	13.0	9.5	4.1	15.00	10		1.96	13.92	13.92	3.91	27.3
1	Wed 3/31/99	03/31/1999 16:00	4:00 PM	921.58	6471.6	684902.0	28.0	25.0	25.0	47.0	47.0	9.5	4.10	3.3	13.0	9.5	4.1	15.00	10		2.01	13.58	13.58	3.91	27.3
1	Thu 4/1/99	04/01/1999 7:00	7:00 AM	936.58	6479.7	689400.1	29.0	26.0	25.0	45.0	37.0	9.5	4.10	3.3	13.0	9.5	4.1	15.00	10		2.01	13.58	13.26	3.91	27.3
1	Thu 4/1/99	04/01/1999 10:00	10:00 AM	939.58	6482.6	691067.2	29.0	27.0	25.0	43.0	36.0	9.5	4.20	3.2	13.0	9.5	4.2	15.00	10		2.06	13.26	12.64	3.91	27.3
1	Thu 4/1/99	04/01/1999 11:25	11:25 AM	941.00	6484.0	691842.9	29.0	27.0	25.0	43.0	37.0	9.5	4.20	3.2	13.0	9.5	4.2	15.00	10	end peak flow testing	2.06	13.26	12.64	3.91	27.3
	Thu 4/1/99	04/01/1999 14:00	2:00 PM	943.58	6486.6	692729.0	24.0	28.0	25.0	41.0	36.0	6.5	1.80	3.2	13.0	6.5	1.9	15.00	10		0.88	21.16	19.71	5.71	18.7
	Fri 4/2/99	04/02/1999 7:30	7:30 AM	961.08	6504.1	699074.0	21.0	27.0	25.0	42.0	40.0	6.5	1.80	3.3	13.0	6.5	1.8	15.00	10		0.88	21.16	20.18	5.71	18.7
	Fri 4/2/99	04/02/1999 10:00	10:00 AM	963.58	6506.7	700015.4	26.0	27.0	25.0	42.0	38.0	6.5	1.80	3.2	13.0	6.5	1.8	15.00	10	maint cleaning	0.88	21.16	20.18	5.71	18.7
	Fri 4/2/99	04/02/1999 11:30	11:30 AM	965.08	6507.4	700190.4	29.0	28.0	25.0	41.0	39.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10	after maint cleaning	0.83	22.41	20.87	5.71	18.7
	Fri 4/2/99	04/02/1999 13:00	1:00 PM	966.58	6508.9	700678.2	29.0	29.0	25.0	45.0	38.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.38	5.71	18.7
	Sat 4/3/99	04/03/1999 7:00	7:00 AM	984.58	6526.9	706969.8	29.0	27.0	25.0	44.0	43.0	6.5	1.70	3.1	13.0	6.5	1.6	15.00	10		0.83	22.41	21.37	5.71	18.7
	Sat 4/3/99	04/03/1999 10:30	10:30 AM	988.08	6530.4	708255.5	26.0	28.0	25.0	43.0	37.0	6.5	1.70	3.1	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Sun 4/4/99	04/04/1999 8:00	8:00 AM	1009.58	6551.1	715887.5	4.0	28.0	25.0	45.0	32.0	6.5	1.70	3.1	13.0	6.5	1.5	15.00	10	strainer needs cleaning	0.83	22.41	20.87	5.71	18.7
	Sun 4/4/99	04/04/1999 10:00	10:00 AM	1011.58	6552.9	716559.5	29.0	28.0	25.0	43.0	31.0	6.5	1.70	3.1	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Mon 4/5/99	04/05/1999 8:05	8:05 AM	1033.66	6573.5	723846.2	29.0	27.0	25.0	46.0	39.0	6.5	1.90	3.2	13.0	6.5	1.7	15.00	10		0.93	20.05	19.12	5.71	18.7
	Mon 4/5/99	04/05/1999 10:00	10:00 AM	1035.58	6575.4	724534.0	28.0	28.0	25.0	44.0	40.0	6.5	2.00	3.1	13.0	6.5	2.0	15.00	10	maint cleaning	0.98	19.05	17.74	5.71	18.7
	Mon 4/5/99	04/05/1999 11:25	11:25 AM	1037.00	6576.1	724653.4	28.0	30.0	25.0	42.0	35.0	6.5	1.80	3.3	13.0	6.5	1.9	15.00	10		0.88	21.16	18.80	5.71	18.7
	Mon 4/5/99	04/05/1999 1:30	1:30 AM	1027.08	6578.2	725391.2	28.0	30.0	25.0	41.0	39.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	19.90	5.71	18.7
	Tue 4/6/99	04/06/1999 7:30	7:30 AM	1057.08	6596.7	731784.9	22.0	28.0	25.0	43.0	49.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Tue 4/6/99	04/06/1999 13:30	1:30 PM	1063.08	6602.1	733926.0	28.0	29.0	25.0	40.0	37.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	20.38	5.71	18.7
	Wed 4/7/99	04/07/1999 7:30	7:30 AM	1081.08	6620.1	740265.6	29.0	28.0	25.0	42.0	37.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Wed 4/7/99	04/07/1999 9:30	9:30 AM	1083.08	6622.1	740989.6	17.0	28.0	25.0	40.0	37.0	6.5	1.80	3.2	13.0	6.5	1.7	15.00	10	maint cleaning	0.88	21.16	19.71	5.71	18.7
	Wed 4/7/99	04/07/1999 11:15	11:15 AM	1084.83	6623.2	741287.5	29.0	29.0	25.0	40.0	38.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.38	5.71	18.7
	Wed 4/7/99	04/07/1999 14:00	2:00 PM	1087.58	6626.0	742277.7	29.0	30.0	25.0	40.0	36.0	6.5	1.70	3.0	13.0	6.5	1.7	15.00	10		0.83	22.41	19.90	5.71	18.7
	Thu 4/8/99	04/08/1999 8:45	8:45 AM	1106.33	6644.7	748857.8	29.0	28.0	25.0	43.0	42.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Thu 4/8/99	04/08/1999 14:30	2:30 PM	1112.08	6650.5	750915.1	17.0	30.0	25.0	41.0	37.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	19.90	5.71	18.7
	Fri 4/9/99	04/09/1999 7:30	7:30 AM	1129.08	6667.4	756881.8	29.0	27.0	25.0	42.0	46.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	21.37	5.71	18.7
	Fri 4/9/99	04/09/1999 9:30	9:30 AM	1131.08	6669.4	757577.8	28.0	28.0	25.0	44.0	42.0	6.5	1.80	3.2	13.0	6.5	1.7	15.00	10		0.88	21.16	19.71	5.71	18.7
	Fri 4/9/99	04/09/1999 11:45	11:45 AM	1133.33	6671.0	758067.5	27.0	29.0	25.0	42.0	36.0	6.5	1.70	3.3	13.0	6.5	1.6	15.00	10		0.83	22.41	20.38	5.71	18.7
	Fri 4/9/99	04/09/1999 14:30	2:30 PM	1136.08	6673.7	759039.6	25.0	30.0	25.0	44.0	40.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	19.90	5.71	18.7
	Sat 4/10/99	04/10/1999 8:00	8:00 AM	1153.58	6691.4	765389.9	28.0	28.0	25.0	42.0	38.0	6.5	1.70	3.1	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Sat 4/10/99	04/10/1999 11:30	11:30 AM	1157.08	6694.8	766616.2	20.0	30.0	25.0	40.0	37.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	19.90	5.71	18.7
	Sun 4/11/99	04/11/1999 8:00	8:00 AM	1177.58	6715.2	773931.5	16.0	29.0	25.0	42.0	48.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.38	5.71	18.7
	Sun 4/11/99	04/11/1999 11:45	11:45 AM	1181.33	6719.0	775279.9	28.0	29.0	25.0	42.0	37.0	6.5	1.70	3.2	14.0	6.5	1.7	15.00	10		0.83	22.41	20.38	5.71	18.7
	Mon 4/12/99	04/12/1999 7:30	7:30 AM	1201.08	6738.8	782396.1	26.0	28.0	25.0	42.0	39.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Mon 4/12/99	04/12/1999 10:30	10:30 AM	1204.08	6741.7	783472.0	22.0	29.0	25.0	42.0	38.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10	maint cleaning	0.83	22.41	20.38	5.71	18.7
	Mon 4/12/99	04/12/1999 11:55	11:55 AM	1205.50	6742.5	783667.8	28.0	29.0	25.0	41.0	36.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	20.38	5.71	18.7
	Mon 4/12/99	04/12/1999 13:30	1:30 PM	1207.08	6744.1	784229.9	28.0	30.0	25.0	40.0	42.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	19.90	5.71	18.7
	Tue 4/13/99	04/13/1999 7:30	7:30 AM	1225.08	6768.1	790514.2	27.0	28.0	25.0	44.0	37.0	6.5	1.70	3.2	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Tue 4/13/99	04/13/1999 13:30	1:30 PM	1231.08	6768.1	792718.5	25.0	30.0	25.0	44.0	37.0	6.5	1.70	3.2	13.0	6.5	1.6	15.00	10		0.83	22.41	19.90	5.71	18.7
	Wed 4/14/99	04/14/1999 7:30	7:30 AM	1249.08	6786.1	799093.8	28.0	28.0	25.0	40.0	44.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Wed 4/14/99	04/14/1999 9:30	9:30 AM	1251.08	6788.1	799815.6	28.0	28.0	25.0	40.0	39.0	6.5	1.70	3.1	13.0	6.5	1.7	15.00	10	maint cleaning	0.83	22.41	20.87	5.71	18.7
	Wed 4/14/99	04/14/1999 11:00	11:00 AM	1252.58	6788.9	800028.4	27.0	28.0	25.0	40.0	39.0	6.5	1.70	3.3	13.0	6.5	1.7	15.00	10		0.83	22.41	20.87	5.71	18.7
	Wed 4/14/99	04/14/1999 14:30	2:30 PM	1256.08	6792.4	801262.8	18.0	28.0	25.0	40.0	37.0	6.5	1.60	3.2	13.0	6.5	1.7	15.00	10		0.79	23.81	22.17	5.71	18.7
	Thu 4/15/99	04/15/1999 7:30	7:30 AM	1273.08	6808.6	807004.5	29.0	27.0	25.0	44.0	40.0	6.5	3.20	3.3	13.0	6.5	3.2	15.00	10		1.57	11.90	11.35	5.71	18.7
	Thu 4/15/99	04/15/1999 13:30	1:30 PM	1279.08	6814.5	809091.8	25.0	28.0	25.0	41.0	36.0	6.5	3.40	3.3	13.0	6.5	3.2	15.00	10		1.67	11.20	10.43	5.71	18.7
	Fri 4/16/99	04/16/1999 7:15	7:15 AM	1296.83	6832.3	815402.4	28.0	25.0	25.0	43.0	47.0	6.5	3.40	3.5	13.0	6.5	3.5	15.00	10		1.67	11.20	11.20	5.71	18.7
	Fri 4/16/99	04/16/1999 10:00	10:00 AM	1299.58	6835.1	816412.2	26.0	26.0	25.0	42.0	41.0	6.5	3.70	3.5	13.0	6.5	3.7	15.00	10		1.82	10.29	10.05	5.71	18.7
	Fri 4/16/99	04/16/1999 11:30	11:30 AM	1301.08	6835.9	816588.4	29.0	26.0	25.0	42.0	41.0	6.5	3.00	3.7	13.0	6.5	2.8	15.00	10		1.47	12.70	12.40	5.71	18.7
	Fri 4/16/99	04/16/1999 13:15	1:15 PM	1302.83	6839.7	817218.5	28.0	26.0	25.0	41.0	38.0	6.5	3.40	3.5	13.0	6.5	2.9	15.00	10		1.67	11.20	10.94	5.71	18.7
	Sat 4/17/99	04/17/1999 7:15	7:15 AM	1320.83	6855.7	823447.8	28.0	24.0	25.0	45.0	35.0	6.5	3.00	3.5	13.0	6.5	2.9	15.00	10		1.47	12.70	13.00	5.71	18.7

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Sat 4/17/99	04/17/1999 10:45	10:45 AM	1324.33	6859.2	824680.0	21.0	25.0	25.0	43.0	39.0	6.5	3.40	3.4	13.0	6.5	3.2	15.00	10		1.67	11.20	11.20	5.71	18.7
	Sun 4/18/99	04/18/1999 8:00	8:00 AM	1345.58	6880.7	832190.5	29.0	25.0	25.0	42.0	35.0	6.5	2.50	3.4	13.0	6.5	2.5	15.00	10		1.23	15.24	15.24	5.71	18.7
	Sun 4/18/99	04/18/1999 11:00	11:00 AM	1348.58	6883.5	833188.5	24.0	27.0	25.0	40.0	37.0	6.5	2.50	3.4	13.0	6.5	2.5	15.00	10		1.23	15.24	14.53	5.71	18.7
	Mon 4/19/99	04/19/1999 7:30	7:30 AM	1369.08	6903.8	840240.4	29.0	25.0	25.0	41.0	48.0	6.5	3.20	3.5	13.0	6.5	3.2	15.00	10		1.57	11.90	11.90	5.71	18.7
	Mon 4/19/99	04/19/1999 9:50	9:50 AM	1371.41	6906.2	841079.0	28.0	27.0	25.0	40.0	39.0	6.5	3.70	3.5	13.0	6.5	3.4	15.00	10	maint cleaning	1.82	10.29	9.82	5.71	18.7
	Mon 4/19/99	04/19/1999 11:15	11:15 AM	1372.83	6909.9	841239.0	26.0	27.0	25.0	40.0	37.0	6.5	3.40	3.6	13.0	6.5	3.3	15.00	10		1.67	11.20	10.68	5.71	18.7
	Mon 4/19/99	04/19/1999 13:30	1:30 PM	1375.08	6909.2	842062.4	24.0	29.0	25.0	46.0	3.6	6.5	3.50	3.5	13.0	6.5	3.4	15.00	10		1.72	10.88	9.90	5.71	18.7
	Tue 4/20/99	04/20/1999 7:30	7:30 AM	1393.08	6927.0	848418.5	28.0	26.0	25.0	45.0	4.0	6.5	3.40	3.5	13.0	6.5	3.3	15.00	10		1.67	11.20	10.94	5.71	18.7
	Tue 4/20/99	04/20/1999 13:30	1:30 PM	1399.08	6933.3	850615.4	27.0	29.0	25.0	50.0	43.0	6.5	3.30	3.5	13.0	6.5	3.3	15.00	10		1.62	11.54	10.50	5.71	18.7
	Wed 4/21/99	04/21/1999 7:30	7:30 AM	1417.08	6951.2	857057.8	22.0	26.0	25.0	50.0	40.0	6.5	3.50	3.5	13.0	6.5	3.5	15.00	10		1.72	10.88	10.63	5.71	18.7
	Wed 4/21/99	04/21/1999 9:45	9:45 AM	1419.33	6953.5	857864.7	16.0	27.0	25.0	49.0	39.0	6.5	3.60	3.5	13.0	6.5	3.7	15.00	10	maint cleaning	1.77	10.58	10.09	5.71	18.7
	Wed 4/21/99	04/21/1999 11:45	11:45 AM	1421.33	6954.8	858270.1	28.0	28.0	25.0	50.0	39.0	6.5	3.30	3.6	13.0	6.5	3.3	15.00	10		1.62	11.54	10.75	5.71	18.7
	Wed 4/21/99	04/21/1999 14:20	2:20 PM	1423.91	6953.7	859188.0	28.0	29.0	25.0	50.0	37.0	6.5	3.40	3.6	13.0	6.5	3.5	15.00	10		1.67	11.20	10.19	5.71	18.7
	Thu 4/22/99	04/22/1999 7:30	7:30 AM	1441.08	6974.5	865398.5	28.0	27.0	25.0	50.0	42.0	6.5	3.70	3.5	13.0	6.5	3.6	15.00	10		1.82	10.29	9.82	5.71	18.7
	Thu 4/22/99	04/22/1999 13:30	1:30 PM	1447.08	6980.5	867549.9	27.0	30.0	25.0	49.0	36.0	6.5	3.70	3.5	13.0	6.5	3.6	15.00	10		1.82	10.29	9.14	5.71	18.7
	Fri 4/23/99	04/23/1999 7:30	7:30 AM	1465.08	6998.5	873952.0	28.0	28.0	25.0	49.0	41.0	6.5	3.70	3.6	13.0	6.5	3.5	15.00	10		1.82	10.29	9.59	5.71	18.7
	Fri 4/23/99	04/23/1999 10:00	10:00 AM	1467.58	7000.9	874807.8	19.0	29.0	25.0	48.0	37.0	6.5	3.70	3.5	13.0	6.5	3.3	15.00	10	maint cleaning	1.82	10.29	9.36	5.71	18.7
	Fri 4/23/99	04/24/1999 11:00	11:00 AM	1492.58	7001.3	874888.5	28.0	29.0	25.0	49.0	37.0	6.5	3.70	3.6	13.0	6.5	3.4	15.00	10		1.82	10.29	9.36	5.71	18.7
	Fri 4/23/99	04/23/1999 14:30	2:30 PM	1472.08	7004.8	876132.9	24.0	31.0	25.0	50.0	47.0	6.5	3.70	3.5	13.0	6.5	3.4	15.00	10		1.82	10.29	8.93	5.71	18.7
	Sat 4/24/99	04/24/1999 8:00	8:00 AM	1489.58	7022.3	882359.6	28.0	28.0	25.0	49.0	46.0	6.5	3.70	3.7	13.0	6.5	3.5	15.00	10		1.82	10.29	9.59	5.71	18.7
	Sat 4/24/99	04/24/1999 11:30	11:30 AM	1493.08	7025.9	880658.3	29.0	30.0	25.0	49.0	36.0	6.5	3.70	3.6	13.0	6.5	3.3	15.00	10		1.82	10.29	9.14	5.71	18.7
	Sun 4/25/99	04/25/1999 7:30	7:30 AM	1513.08	7045.8	890792.0	28.0	28.0	25.0	50.0	43.0	6.5	4.20	3.6	13.0	6.5	4.2	15.00	10		2.06	9.07	8.45	5.71	18.7
	Sun 4/25/99	04/25/1999 11:30	11:30 AM	1517.08	7049.8	892162.0	26.0	29.0	25.0	49.0	39.0	6.5	4.20	3.6	13.0	6.5	4.2	15.00	10		2.06	9.07	8.25	5.71	18.7
	Mon 4/26/99	04/26/1999 7:45	7:45 AM	1537.33	7070.0	899423.4	21.0	28.0	25.0	49.0	50.0	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10		2.06	9.07	8.45	5.71	18.7
	Mon 4/26/99	04/26/1999 10:00	10:00 AM	1539.58	7072.3	900248.6	28.0	29.0	25.0	47.0	37.0	6.5	4.20	3.7	13.0	6.5	4.0	15.00	10	maint cleaning	2.06	9.07	8.25	5.71	18.7
	Mon 4/26/99	04/26/1999 11:30	11:30 AM	1541.08	7073.2	900427.5	28.0	30.0	25.0	48.0	36.0	6.5	4.20	3.7	13.0	6.5	4.0	15.00	10		2.06	9.07	8.06	5.71	18.7
	Mon 4/26/99	04/26/1999 13:30	1:30 PM	1543.08	7075.1	901135.8	26.0	30.0	25.0	47.0	43.0	6.5	4.00	3.7	13.0	6.5	4.0	15.00	10		1.96	9.52	8.46	5.71	18.7
	Tue 4/27/99	04/27/1999 7:30	7:30 AM	1561.08	7093.1	907610.4	28.0	29.0	25.0	48.0	42.0	6.5	4.10	3.6	13.0	6.5	4.1	15.00	10		2.01	9.29	8.45	5.71	18.7
	Tue 4/27/99	04/27/1999 14:00	2:00 PM	1567.58	7099.6	909973.5	20.0	30.5	25.0	45.0	40.0	6.5	4.20	3.6	13.0	6.5	4.2	15.00	10		2.06	9.07	7.96	5.71	18.7
	Wed 4/28/99	04/28/1999 7:30	7:30 AM	1585.08	7117.1	916233.4	27.0	29.0	25.0	48.0	35.0	6.5	4.00	3.6	13.0	6.5	3.6	15.00	10		1.96	9.52	8.66	5.71	18.7
	Wed 4/28/99	04/28/1999 9:30	9:30 AM	1587.08	7118.1	916947.5	24.0	29.0	24.0	50.0	34.0	6.5	4.20	3.6	13.0	6.5	3.6	15.00	10	maint cleaning	2.06	9.07	8.25	5.71	18.7
	Wed 4/28/99	04/28/1999 11:00	11:00 AM	1588.58	7119.9	917156.4	28.0	30.0	25.0	49.0	40.0	6.5	4.20	3.7	13.0	6.5	4.1	15.00	10		2.06	9.07	8.06	5.71	18.7
	Wed 4/28/99	04/28/1999 13:45	1:45 PM	1591.33	7122.7	918137.0	22.0	30.5	25.0	48.0	38.0	6.5	4.10	3.7	13.0	6.5	4.1	15.00	10		2.01	9.29	8.15	5.71	18.7
	Thu 4/29/99	04/29/1999 7:30	7:30 AM	1609.08	7140.4	924484.2	28.0	29	25	49.0	42	6.5	4.20	3.7	13.0	6.5	4.1	15.00	10		2.06	9.07	8.25	5.71	18.7
	Thu 4/29/99	04/29/1999 13:30	1:30 PM	1615.08	7146.4	926648.0	26.0	29.5	25	45.0	39	6.5	4.30	3.6	13.0	6.5	4.3	15.00	10		2.11	8.86	7.96	5.71	18.7
	Fri 4/30/99	04/30/1999 8:30	8:30 AM	1634.08	7164.0	932965.0	28.0	29	25	49.0	43	6.5	4.20	3.2	13.0	6.5	4.2	15.00	10		2.06	9.07	8.25	5.71	18.7
	Fri 4/30/99	04/30/1999 9:30	9:30 AM	1635.08	7166.4	933526.8	27.0	30	25	50.0	40	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10	maint cleaning	2.06	9.07	8.06	5.71	18.7
	Fri 4/30/99	04/30/1999 11:00	11:00 AM	1636.58	7167.2	933727	27.0	30	25	50.0	39	6.5	4.10	3.8	13.0	6.5	4.1	15.00	10		2.01	9.29	8.25	5.71	18.7
	Fri 4/30/99	04/30/1999 13:00	1:00 PM	1638.58	7169.2	934460	25.0	28.5	25	51.0	40	6.5	4.10	3.7	13.0	6.5	4.0	15.00	10		2.01	9.29	8.55	5.71	18.7
	Sat 5/1/99	05/01/1999 6:30	6:30 AM	1656.08	7186.7	941021.0	20.0	29	25	49.0	37	6.5	4.30	3.7	16.0	6.5	4.3	15.00	10		2.11	8.86	8.06	5.71	18.7
	Sat 5/1/99	05/01/1999 10:45	10:45 AM	1660.33	7190.9	942528.0	28.0	29	25	50.0	40	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10		2.06	9.07	8.25	5.71	18.7
	Sun 5/2/99	05/02/1999 7:30	7:30 AM	1681.08	7211.7	949971.5	16.0	27	25	50.0	35	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10		2.06	9.07	8.65	5.71	18.7
	Sun 5/2/99	05/02/1999 11:30	11:30 AM	1685.08	7215.6	951347.9	21.0	28	25	50.0	39	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10		2.06	9.07	8.45	5.71	18.7
	Mon 5/3/99	05/03/1999 7:30	7:30 AM	1705.08	7235.7	958517.0	28.0	29	25	49.0	40	6.5	4.90	3.8	13.0	6.5	4.8	15.00	10		2.41	7.77	7.07	5.71	18.7
	Mon 5/3/99	05/03/1999 10:00	10:00 AM	1707.58	7238.0	959316.0	29.0	29	25	48.0	38	6.5	4.80	3.8	13.0	6.5	4.8	15.00	10	maint cleaning	2.36	7.94	7.22	5.71	18.7
	Mon 5/3/99	05/03/1999 11:30	11:30 AM	1709.08	7238.7	959510.0	28.0	29	25	48.0	39	6.5	4.70	3.9	13.0	6.5	4.6	15.00	10		2.31	8.10	7.37	5.71	18.7
	Mon 5/3/99	05/03/1999 13:30	1:30 PM	1711.08	7240.6	960215.0	26.0	30	25	50.0	48	6.5	4.70	3.8	13.0	6.5	4.7	15.00	10		2.31	8.10	7.20	5.71	18.7
	Tue 5/4/99	05/04/1999 7:30	7:30 AM	1729.08	7258.7	966592.9	28.0	29	25	50.0	44	6.5	4.70	3.8	13.0	6.5	4.7	15.00	10		2.31	8.10	7.37	5.71	18.7
	Tue 5/4/99	05/04/1999 13:45	1:45 PM	1735.33	7265.0	968897.2	26.0	32	25	45.0	39	6.5	4.70	3.8	13.0	6.5	4.6	15.00	10		2.31	8.10	6.86	5.71	18.7
	Wed 5/5/99	05/05/1999 7:30	7:30 AM	1753.08	7282.7	975451.6	28.0	29	25	50.0	44	6.5	4.80	3.8	13.0	6.5	4.7	15.00	10		2.36	7.94	7.22	5.71	18.7
	Wed 5/5/99	05/05/1999 9:45	9:45 AM	1755.33	7284.9	976241.2	27.0	30	25	48.0	39	6.5	4.90	3.7	13.0	6.5	5.0	15.00	10	maint cleaning	2.41	7.77	6.90	5.71	18.7
	Wed 5/5/99	05/05/1999 11:45	11:45 AM	1757.33	7285.7	976409.0	27.0	31	25	50.0	47	6.5	6.60	3.8	13.0	6.5	5.8	15.00	10	vacuum high at 6.2	3.24	5.77	5.01	5.71	18.7
	Wed 5/5/99	05/05/1999 13:30	1:30 PM	1759.08	7287.9	977170.0	25.0	32	25	46.0	42	6.5	6.20	3.8	13.0	6.5	6.2	15.00	10		3.05	6.14	5.20	5.71	18.7
	Thu 5/6/99	05/06/1999 7:30	7:30 AM	1777.08	7305.9	983510.8	28.0	29	25	48.0	46	6.5	6.20	3.8	13.0	6.5	6.1	15.00	10		3.05	6.14	5.59	5.71	18.7
C	Thu 5/6/99	05/06/1999 13:30	1:30 PM	1783.08	7312.0	985656.0	24.0	30	25	48.0	44	6.5	6.20	3.8	13.0	6.5	6.1	15.00	10	dec target MLSS to 10,000 mg/L	3.05	6.14	5.46	5.71	18.7
	Fri 5/7/99	05/07/1999 7:30	7:30 AM	1801.08	7329.9	992173.7	26.0	27	25	50.0	46	6.5	6.40	3.9	13.0	6.5	6.4	15.00	10		3.14	5.95	5.68	5.71	18.7
	Fri 5/7/99	05/07/1999 10:00	10:00 AM	1803.58	7332.4	993068.4	24.0	29	25	48.0	40	6.5	6.50	3.8	13.0	6.5	6.3	15.00	10	maint cleaning	3.19	5.86	5.33	5.71	18.7
	Fri 5/7/99	05/07/1999 11:30	11:30 AM	1805.08	7333.2	993286.9	28.0	30	25	50.0	40	6.5	5.20	4.0	13.0	6.5	5.1	15.00	10		2.55	7.33	6.51	5.71	18.7
	Fri 5/7/99	05/07/1999 13:00	1:00 PM	1806.58	7334.7	993843.6	24.0	30	25	50.0	40	6.5	5.20	3.8	13.0	6.5	5.1	15.00	10		2.55	7.33	6.51	5.71	18.7
	Sat 5/8/99	05/08/1999 7:30	7:30 AM	1825.08	7353.2	1000397.5	26.0	29	25	53.0	35	6.5	5.20	3.8	13.0	6.5	3.6	15.00	10		2.55	7.33	6.66	5.71	18.7

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Sat 5/8/99	05/08/1999 11:30	11:30 AM	1829.08	7357.2	1001845.5	18.0	30	25	49.0	39	6.5	5.20	4.0	13.0	6.5	3.6	15.00	10		2.55	7.33	6.51	5.71	18.7
	Sun 5/9/99	05/09/1999 7:00	7:00 AM	1848.58	7376.7	1008765.4	22.0	30	25	50.0	37	6.5	4.70	3.7	13.0	6.5	4.7	15.00	10		2.31	8.10	7.20	5.71	18.7
	Sun 5/9/99	05/09/1999 12:00	12:00 PM	1853.58	7381.7	1010555.1	16.0	31	25	49.0	44	6.5	4.70	3.7	13.0	6.5	4.7	15.00	10		2.31	8.10	7.03	5.71	18.7
	Mon 5/10/99	05/10/1999 7:30	7:30 AM	1873.08	7401.2	1017644.0	21.0	29	25	49.0	38	6.5	4.70	3.8	13.0	6.5	4.7	15.00	10		2.31	8.10	7.37	5.71	18.7
	Mon 5/10/99	05/10/1999 9:45	9:45 AM	1875.33	7403.4	1018466.0	17.0	30	25	48.0	40	6.5	4.80	3.8	13.0	6.5	4.7	15.00	10	maint cleaning	2.36	7.94	7.05	5.71	18.7
	Mon 5/10/99	05/10/1999 11:15	11:15 AM	1876.83	7404.2	1018658.9	28.0	31	25	49.0	52	6.5	4.30	3.8	13.0	6.5	4.2	15.00	10		2.11	8.86	7.68	5.71	18.7
	Mon 5/10/99	05/10/1999 13:45	1:45 PM	1879.33	7406.8	1019563.8	24.0	32	25	49.0	52	6.5	4.20	3.7	13.0	6.5	4.1	15.00	10		2.06	9.07	7.68	5.71	18.7
	Tue 5/11/99	05/11/1999 7:30	7:30 AM	1897.08	7424.5	1026038.5	28.0	30	25	49.0	53	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10		2.06	9.07	8.06	5.71	18.7
	Tue 5/11/99	05/11/1999 13:30	1:30 PM	1903.08	7430.4	1028200.0	22.0	31	25	51.0	50	6.5	4.20	3.7	13.0	6.5	4.2	15.00	10		2.06	9.07	7.87	5.71	18.7
	Wed 5/12/99	05/12/1999 7:30	7:30 AM	1921.08	7448.0	103460.0	21.0	29.5	25	51.0	51	6.5	4.30	3.7	13.0	6.5	4.2	15.00	10		2.11	8.86	7.96	5.71	18.7
	Wed 5/12/99	05/12/1999 9:30	9:30 AM	1923.08	7450.0	1035320.0	28.0	29.5	25	51.0	51	6.5	4.30	3.7	13.0	6.5	4.2	15.00	10	maint cleaning	2.11	8.86	7.96	5.71	18.7
	Wed 5/12/99	05/12/1999 11:05	11:05 AM	1924.66	7450.9	1035581.0	27.0	30	25	54.0	51	6.5	4.00	3.8	13.0	6.5	3.9	15.00	10		1.96	9.52	8.46	5.71	18.7
	Wed 5/12/99	05/12/1999 13:30	1:30 PM	1927.08	7453.4	1036456.0	26.0	30	25	52.0	50	6.5	4.00	3.7	13.0	6.5	3.9	15.00	10		1.96	9.52	8.46	5.71	18.7
	Thu 5/13/99	05/13/1999 7:30	7:30 AM	1945.08	7471.3	1042810.0	20.0	29	25	55.0	50	6.5	4.00	3.6	13.0	6.5	4.0	15.00	10		1.96	9.52	8.66	5.71	18.7
	Thu 5/13/99	05/13/1999 13:30	1:30 PM	1951.08	7477.3	1044966.0	26.0	31	25	51.0	50	6.5	4.00	3.6	13.0	6.5	3.9	15.00	10		1.96	9.52	8.26	5.71	18.7
	Fri 5/14/99	05/14/1999 7:45	7:45 AM	1969.33	7495.6	1051646.4	28.0	30	25	52.0	52	6.5	4.00	3.7	13.0	6.5	4.0	15.00	10		1.96	9.52	8.46	5.71	18.7
	Fri 5/14/99	05/14/1999 9:45	9:45 AM	1971.33	7497.6	1052370.0	28.0	30.5	25	52.0	51	6.5	4.00	3.7	13.0	6.5	4.0	15.00	10	maint cleaning	1.96	9.52	8.36	5.71	18.7
	Fri 5/14/99	05/14/1999 11:00	11:00 AM	1972.58	7498.1	1052503.9	27.0	31	25	51.0	51	6.5	3.70	3.7	13.0	6.5	3.7	15.00	10		1.82	10.29	8.93	5.71	18.7
	Fri 5/14/99	05/14/1999 13:30	1:30 PM	1975.08	7500.6	1053396.4	24.0	32	25	50.0	51	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	8.72	5.71	18.7
	Sat 5/15/99	05/15/1999 7:30	7:30 AM	1993.08	7518.6	1059804.6	27.0	30	25	51.0	52	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.14	5.71	18.7
	Sat 5/15/99	05/15/1999 11:30	11:30 AM	1997.08	7522.7	1061282.1	26.0	31.5	25	50.0	52	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	8.82	5.71	18.7
	Sun 5/16/99	05/16/1999 7:00	7:00 AM	2016.58	7542.1	1068343.6	28.0	30	25	52.0	51	6.5	3.70	3.6	13.0	6.5	3.8	15.00	10		1.82	10.29	9.14	5.71	18.7
	Sun 5/16/99	05/16/1999 11:00	11:00 AM	2020.58	7546.1	1069765.5	27.0	30.5	25	50.0	51	6.5	3.80	3.6	13.0	6.5	3.8	15.00	10		1.87	10.02	8.80	5.71	18.7
	Mon 5/17/99	05/17/1999 7:30	7:30 AM	2041.08	7566.6	1077017.6	28.0	30	25	51.0	50	6.5	3.80	3.6	13.0	6.5	3.7	15.00	10		1.87	10.02	8.90	5.71	18.7
	Mon 5/17/99	05/17/1999 9:50	9:50 AM	2043.41	7568.9	1077844.2	26.0	30	25	50.0	50	6.5	3.90	3.6	13.0	6.5	3.9	15.00	10	maint cleaning	1.92	9.77	8.67	5.71	18.7
	Mon 5/17/99	05/17/1999 11:30	11:30 AM	2045.08	7569.9	1078111.6	28.0	31	25	51.0	51	6.5	3.70	3.7	13.0	6.5	3.6	15.00	10		1.82	10.29	8.93	5.71	18.7
	Mon 5/17/99	05/17/1999 13:30	1:30 PM	2047.08	7571.9	1078836.8	26.0	31.5	25	50.0	50	6.5	3.60	3.6	13.0	6.5	3.6	15.00	10		1.77	10.58	9.07	5.71	18.7
	Tue 5/18/99	05/18/1999 7:45	7:45 AM	2065.33	7590.1	1085542.4	20.0	28	25	56.0	48	6.5	3.90	3.7	13.0	6.5	3.8	15.00	10		1.92	9.77	9.10	5.71	18.7
	Tue 5/18/99	05/18/1999 13:30	1:30 PM	2071.08	7595.9	1087612.6	13.0	30	25	55.0	49	6.5	3.90	3.7	13.0	6.5	3.9	15.00	10		1.92	9.77	8.67	5.71	18.7
	Wed 5/19/99	05/19/1999 7:30	7:30 AM	2089.08	7613.9	1093956.8	27.0	30	25	55.0	49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.14	5.71	18.7
	Wed 5/19/99	05/19/1999 10:00	10:00 AM	2091.58	7616.4	1094855.6	28.0	30	25	52.0	49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10	maint cleaning	1.82	10.29	9.14	5.71	18.7
	Wed 5/19/99	05/19/1999 11:30	11:30 AM	2093.08	7617.2	1095090.9	28.0	31	25	52.0	49	6.5	3.70	3.6	13.0	6.5	3.6	15.00	10		1.82	10.29	8.93	5.71	18.7
	Wed 5/19/99	05/19/1999 13:30	1:30 PM	2095.08	7619.2	1095806.5	26.0	31.5	25	52.0	49	6.5	3.60	3.5	13.0	6.5	3.5	15.00	10		1.77	10.58	9.07	5.71	18.7
	Thu 5/20/99	05/20/1999 7:30	7:30 AM	2113.08	7637.2	1102065.2	26.0	29	25	53.0	49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.36	5.71	18.7
	Thu 5/20/99	05/20/1999 13:30	1:30 PM	2119.08	7643.2	1104291.3	13.0	31	25	53.0	49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	8.93	5.71	18.7
	Fri 5/21/99	05/21/1999 7:30	7:30 AM	2137.08	7661.2	1110626.8	20.0	29	25	53.0	48	6.5	3.70	3.7	13.0	6.5	3.7	15.00	10		1.82	10.29	9.36	5.71	18.7
	Fri 5/21/99	05/21/1999 10:00	10:00 AM	2139.58	7663.7	1111550.0	26.0	29.5	25	50.0	48	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10	maint cleaning	1.82	10.29	9.25	5.71	18.7
	Fri 5/21/99	05/21/1999 11:30	11:30 AM	2141.08	7664.5	1111761.0	27.0	30	25	50.0	48	6.5	3.40	3.8	13.0	6.5	3.1	15.00	10		1.67	11.20	9.95	5.71	18.7
	Fri 5/21/99	05/21/1999 13:00	1:00 PM	2142.58	7666.1	1112330.0	26.0	31	25	50.0	48	6.5	3.30	3.6	13.0	6.5	3.4	15.00	10		1.62	11.54	10.01	5.71	18.7
	Sat 5/22/99	05/22/1999 7:30	7:30 AM	2161.08	7684.4	1118906.0	28.0	29	25		47	6.5	3.90	3.6	13.0	6.5	3.9	15.00	10	air flow meter broken	1.92	9.77	8.88	5.71	18.7
	Sat 5/22/99	05/22/1999 11:00	11:00 AM	2164.58	7687.8	1120106.5	28.0	30.5	25		47	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.04	5.71	18.7
	Sun 5/23/99	05/23/1999 7:30	7:30 AM	2185.08	7708.3	1127156.0	28.0	29	25		48	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.36	5.71	18.7
	Sun 5/23/99	05/23/1999 11:30	11:30 AM	2189.08	7712.3	1128608.5	26.0	30.5	25		49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.04	5.71	18.7
	Mon 5/24/99	05/24/1999 11:30	11:30 AM	2213.08	7732.3	1135621.6	28.0	29.5	25		48	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.25	5.71	18.7
	Mon 5/24/99	05/24/1999 9:30	9:30 AM	2211.08	7734.3	1136371.2	26.0	30	25		49	6.5	3.90	3.6	13.0	6.5	3.7	15.00	10	maint cleaning	1.92	9.77	8.67	5.71	18.7
	Mon 5/24/99	05/24/1999 11:00	11:00 AM	2212.58	7735.2	1136600.0	28.0	31	25		49	6.5	3.70	3.7	13.0	6.5	3.6	15.00	10		1.82	10.29	8.93	5.71	18.7
	Mon 5/24/99	05/24/1999 13:30	1:30 PM	2215.08	7737.6	1137497.2	26.0	31.5	25		48	6.5	3.60	3.6	13.0	6.5	3.5	15.00	10		1.77	10.58	9.07	5.71	18.7
	Tue 5/25/99	05/25/1999 7:30	7:30 AM	2233.08	7755.7	1144156.5	26.0	30	25		48	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.14	5.71	18.7
	Tue 5/25/99	05/25/1999 13:30	1:30 PM	2239.08	7761.6	1146290.0	24.0	32	25		49	6.5	3.70	3.6	16.0	6.5	3.7	15.00	10		1.82	10.29	8.72	5.71	18.7
	Wed 5/26/99	05/26/1999 7:30	7:30 AM	2257.08	7719.6	1152637.1	26.0	29.5	25		48	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.25	5.71	18.7
	Wed 5/26/99	05/26/1999 9:30	9:30 AM	2259.08	7781.7	1153419.8	22.0	30	25		49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10	maint cleaning	1.82	10.29	9.14	5.71	18.7
	Wed 5/26/99	05/26/1999 11:30	11:30 AM	2261.08	7783.0	1153813.6	28.0	31	25		49	6.5	3.60	3.7	13.0	6.5	3.6	15.00	10		1.77	10.58	9.18	5.71	18.7
	Wed 5/26/99	05/26/1999 14:00	2:00 PM	2263.58	7785.4	1154670.9	24.0	32	25		48	6.5	3.50	3.6	13.0	6.5	3.4	15.00	10		1.72	10.88	9.22	5.71	18.7
	Thu 5/27/99	05/27/1999 7:30	7:30 AM	2281.08	7802.9	1161080.5	28.0	29.5	25		48	6.5	3.60	3.6	13.0	6.5	3.6	15.00	10		1.77	10.58	9.51	5.71	18.7
	Thu 5/27/99	05/27/1999 13:30	1:30 PM	2287.08	7809.0	1163223.0	25.0	32	25		49	6.5	3.60	3.6	13.0	6.5	3.6	15.00	10		1.77	10.58	8.96	5.71	18.7
	Fri 5/28/99	05/28/1999 7:30	7:30 AM	2305.08	7826.9	1169741.9	27.0	30	25	56.0	49	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10		1.82	10.29	9.14	5.71	18.7
	Fri 5/28/99	05/28/1999 9:30	9:30 AM	2307.08	7829.0	1170505.9	24.0	31	25	56.0	47	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10	maint cleaning	1.82	10.29	8.93	5.71	18.7
	Fri 5/28/99	05/28/1999 11:00	11:00 AM	2308.58	7829.8	1170698.0	20.0	31.5	25	56.0	48	6.5	3.50	3.6	13.0	6.5	3.3	15.00	10		1.72	10.88	9.33	5.71	18.7
	Fri 5/28/99	05/28/1999 13:30	1:30 PM	2311.08	7832.9	1171594.9	26.0	32	25	55.0	49	6.5	3.40	3.6	13.0	6.5	3.3	15.00	10		1.67	11.20	9.49	5.71	18.7
	Sat 5/29/99	05/29/1999 7:00	7:00 AM	2328.58	7849.8	1178006.9	27.0	31	25	58.0	49	6.5	3.40	3.6	13.0	6.5	3.2	15.00	10		1.67	11.20	9.72	5.71	18.7

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Sat 5/29/99	05/29/1999 11:30	11:30 AM	2333.08	7854.2	1179617.9	21.0	31	25	56.0	47	6.5	3.20	3.6	13.0	6.5	3.2	15.00	10		1.57	11.90	10.32	5.71	18.7
	Sun 5/30/99	05/30/1999 7:00	7:00 AM	2352.58	7874.0	1186840.5	21.0	30	25	56.0	50	6.5	2.50	3.6	13.0	6.5	3.1	15.00	10		1.23	15.24	13.53	5.71	18.7
	Sun 5/30/99	05/30/1999 11:00	11:00 AM	2356.58	7877.6	1188146.5	24.0	32	25	56.0	49	6.5	2.70	3.6	13.0	6.5	3.2	15.00	10		1.33	14.11	11.95	5.71	18.7
	Mon 5/31/99	05/31/1999 7:30	7:30 AM	2377.08	7898.2	1195643.8	28.0	30.5	25	57.0	49	6.5	3.70	3.6	13.0	6.5	3.6	15.00	10		1.82	10.29	9.04	5.71	18.7
	Mon 5/31/99	05/31/1999 9:30	9:30 AM	2379.08	7899.6	1196215.6	26.0	32	25	57.0	48	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10	maint cleaning	1.82	10.29	8.72	5.71	18.7
	Mon 5/31/99	05/31/1999 11:15	11:15 AM	2380.83	7801.3	1196747.0	28.0	32	25	54.0	48	6.5	3.70	3.7	13.0	6.5	3.7	15.00	10		1.82	10.29	8.72	5.71	18.7
	Mon 5/31/99	05/31/1999 13:30	1:30 PM	2383.08	7803.5	1197569.8	26.0	33	25	54.0	48	6.5	3.60	3.6	13.0	6.5	3.6	15.00	10		1.77	10.58	8.75	5.71	18.7
	Tue 6/1/99	06/01/1999 7:30	7:30 AM	2401.08	7921.5	1203879.6	28.0	30	25	56.0	48	6.5	3.60	3.6	13.0	6.5	3.7	15.00	10		1.77	10.58	9.40	5.71	18.7
	Tue 6/1/99	06/01/1999 12:30	12:30 PM	2406.08	7926.5	1205701.9	27.0	32	25	54.0	47	6.5	3.70	3.6	13.0	6.5	3.7	15.00	10	bubble point test	1.82	10.29	8.72	5.71	18.7
	Wed 6/2/99	06/02/1999 7:30	7:30 AM	2425.08	7942.7	1211639.6	28.0	30	25	56.0	49	6.5	3.70	3.6	13.0	6.5	3.6	15.00	10		1.82	10.29	9.14	5.71	18.7
	Wed 6/2/99	06/02/1999 9:30	9:30 AM	2427.08	7944.8	1212398.0	24.0	31	25	56.0	48	6.5	3.70	3.6	13.0	6.5	3.6	15.00	10	maint cleaning	1.82	10.29	8.93	5.71	18.7
	Wed 6/2/99	06/02/1999 11:20	11:20 AM	2428.91	7946.0	1212749.5	28.0	31.5	25	56.0	48	6.5	3.70	3.7	13.0	6.5	3.5	15.00	10		1.82	10.29	8.82	5.71	18.7
	Wed 6/2/99	06/02/1999 13:30	1:30 PM	2431.08	7948.2	1213542.6	27.0	33	25	56.0	49	6.5	3.30	3.6	13.0	6.5	3.5	15.00	10		1.62	11.54	9.55	5.71	18.7
	Thu 6/3/99	06/03/1999 7:30	7:30 AM	2449.08	7866.3	1219992.5	28.0	30	25	58.0	49	6.5	3.50	3.6	13.0	6.5	3.2	15.00	10		1.72	10.88	9.67	5.71	18.7
	Thu 6/3/99	06/03/1999 13:30	1:30 PM	2455.08	7972.1	1222183.4	26.0	32	25	56.0	50	6.5	3.50	3.6	13.0	6.5	3.4	15.00	10		1.72	10.88	9.22	5.71	18.7
	Fri 6/4/99	06/04/1999 7:30	7:30 AM	2473.08	7990.5	1228631.0	28.0	30	25	57.0	49	6.5	3.70	3.6	13.0	6.5	3.6	15.00	10	maint cleaning	1.82	10.29	9.14	5.71	18.7
	Fri 6/4/99	06/04/1999 8:45	8:45 AM	2474.33	7990.7	1228781.3	27.0	31	25	57.0	49	6.5	3.50	3.7	13.0	6.5	3.2	15.00	10		1.72	10.88	9.44	5.71	18.7
	Fri 6/4/99	06/04/1999 13:00	1:00 PM	2478.58	7994.9	1230260.0	26.0	32	25	55.0	48	6.5	3.50	3.6	13.0	6.5	3.4	15.00	10		1.72	10.88	9.22	5.71	18.7
	Sun 6/6/99	06/06/1999 7:30	7:30 AM	2521.08	8036.8	1245297.8	28.0	30	25	56.0	48	6.5	3.50	3.6	13.0	6.5	3.4	15.00	10		1.72	10.88	9.67	5.71	18.7
	Sun 6/6/99	06/06/1999 11:30	11:30 AM	2525.08	8040.9	1246736.0	26.0	31	25	56.0	48	6.5	3.70	3.6	13.0	6.5	3.5	15.00	10		1.82	10.29	8.93	5.71	18.7
	Mon 6/7/99	06/07/1999 7:30	7:30 AM	2545.08	8060.8	1253870.0	27.0	30	25	56.0	48	6.5	3.60	3.7	13.0	6.5	3.7	15.00	10		1.77	10.58	9.40	5.71	18.7
	Mon 6/7/99	06/07/1999 9:30	9:30 AM	2547.08	8062.8	1254589.1	26.0	31	25	56.0	48	6.5	3.70	3.7	13.0	6.5	3.7	15.00	10	maint cleaning	1.82	10.29	8.93	5.71	18.7
	Mon 6/7/99	06/07/1999 11:30	11:30 AM	2549.08	8064.1	1254992.6	28.0	32	25	54.0	47	6.5	3.70	3.7	13.0	6.5	3.6	15.00	10		1.82	10.29	8.72	5.71	18.7
	Mon 6/7/99	06/07/1999 13:30	1:30 PM	2551.08	8066.0	1255706.4	27.0	32	25	54.0	48	6.5	3.70	3.6	13.0	6.5	3.2	15.00	10		1.82	10.29	8.72	5.71	18.7
	Tue 6/8/99	06/08/1999 7:30	7:30 AM	2569.08	8084.1	1262249.9	28.0	30	25	56.0	49	6.5	3.70	3.6	13.0	6.5	3.2	15.00	10		1.82	10.29	9.14	5.71	18.7
	Tue 6/8/99	06/08/1999 13:00	1:00 PM	2574.58	8088.6	1264280.0	26.0	32	25	55.0	48	6.5	3.70	3.6	13.0	6.5	3.3	15.00	10		1.82	10.29	8.72	5.71	18.7
	Wed 6/9/99	06/09/1999 7:30	7:30 AM	2593.08	8108.0	1270977.5	27.0	30	25	56.0	48	6.5	3.70	3.6	13.0	6.5	3.1	15.00	10		1.82	10.29	9.14	5.71	18.7
	Wed 6/9/99	06/09/1999 10:40	10:40 AM	2596.25	8111.4	1272151.6	26.0	31	25	55.0	49	6.5	3.80	3.6	13.0	6.5	3.3	15.00	10	maint cleaning	1.87	10.02	8.69	5.71	18.7
	Wed 6/9/99	06/09/1999 11:45	11:45 AM	2597.33	8111.7	1272231.5	24.0	32	25	55.0	49	6.5	3.70	3.6	13.0	6.5	3.2	15.00	10		1.82	10.29	8.72	5.71	18.7
	Wed 6/9/99	06/09/1999 13:30	1:30 PM	2599.08	8113.4	1272880.1	28.0	32.5	25	54.0	48	6.5	3.60	3.6	13.0	6.5	3.3	15.00	10		1.77	10.58	8.86	5.71	18.7
	Thu 6/10/99	06/10/1999 7:30	7:30 AM	2617.08	8131.1	1279316.8	28.0	30	25	56.0	48	6.5	4.70	3.7	13.0	6.5	4.7	15.00	10		2.31	8.10	7.20	5.71	18.7
	Thu 6/10/99	06/10/1999 13:15	1:15 PM	2622.83	8136.2	1281034.9	27.0	32	25	57.0	47	6.5	3.60	3.6	13.0	6.5	3.3	15.00	10		1.77	10.58	8.96	5.71	18.7
	Fri 6/11/99	06/11/1999 7:30	7:30 AM	2641.08	8154.4	1287364.9	28.0	30	25	56.0	48	6.5	3.90	3.6	13.0	6.5	3.4	15.00	10	maint cleaning	1.92	9.77	8.67	5.71	18.7
	Fri 6/11/99	06/11/1999 8:45	8:45 AM	2642.33	8155.0	1287507.4	26.0	31	25	56.0	48	6.5	3.70	3.7	13.0	6.5	3.8	15.00	10		1.82	10.29	8.93	5.71	18.7
	Fri 6/11/99	06/11/1999 12:35	12:35 PM	2646.16	8158.8	1288947.2	27.0	32	25	56.0	48	6.5	3.70	3.6	13.0	6.5	3.4	15.00	10		1.82	10.29	8.72	5.71	18.7
	Sat 6/12/99	06/12/1999 7:30	7:30 AM	2665.08	8177.8	1295761.6	26.0	30.5	25	58.0	49	6.5	3.80	3.6	13.0	6.5	3.4	15.00	10		1.87	10.02	8.80	5.71	18.7
	Sat 6/12/99	06/12/1999 10:30	10:30 AM	2668.08	8180.7	1296858.4	27.0	32	25	57.0	49	6.5	3.90	3.6	13.0	6.5	3.5	15.00	10		1.92	9.77	8.27	5.71	18.7
	Sun 6/13/99	06/13/1999 8:30	8:30 AM	2690.08	8202.8	1304758.8	23.0	32	25	58.0	49	6.5	4.20	3.4	13.0	6.5	3.4	15.00	10		2.06	9.07	7.68	5.71	18.7
	Sun 6/13/99	06/13/1999 11:00	11:00 AM	2692.58	8205.4	1305739.3	16.0	32	25	58.0	49	6.5	4.20	3.4	13.0	6.5	3.4	15.00	10		2.06	9.07	7.68	5.71	18.7
	Mon 6/14/99	06/14/1999 7:30	7:30 AM	2713.08	8225.8	1313048.6	26.0	31	25	57.0	48	6.5	4.20	3.6	13.0	6.5	3.7	15.00	10		2.06	9.07	7.87	5.71	18.7
	Mon 6/14/99	06/14/1999 9:30	9:30 AM	2715.08	8227.8	1313788.4	24.0	31.5	25	56.0	48	6.5	4.30	3.7	13.0	6.5	3.8	15.00	10	maint cleaning	2.11	8.86	7.59	5.71	18.7
	Mon 6/14/99	06/14/1999 11:00	11:00 AM	2716.58	8228.6	1313972.9	28.0	32	25	58.0	49	6.5	4.20	3.8	13.0	6.5	3.8	15.00	10		2.06	9.07	7.68	5.71	18.7
	Mon 6/14/99	06/14/1999 1:15	1:15 AM	2706.83	8230.8	1314798.1	27.0	32	25	58.0	48	6.5	3.90	3.7	13.0	6.5	3.3	15.00	10		1.92	9.77	8.27	5.71	18.7
	Tue 6/15/99	06/15/1999 7:15	7:15 AM	2736.83	8248.8	1321086.8	28.0	30.5	25	58.0	49	6.5	4.20	3.7	13.0	6.5	3.3	15.00	10		2.06	9.07	7.96	5.71	18.7
	Tue 6/15/99	06/15/1999 13:30	1:30 PM	2743.08	8254.0	1322954.2	26.0	32	25	58.0	52	6.5	5.20	3.7	13.0	6.5	3.3	15.00	10		2.55	7.33	6.20	5.71	18.7
	Wed 6/16/99	06/16/1999 7:30	7:30 AM	2761.08	8272.0	1329341.0	28.0	30	25	60.0	49	6.5	5.60	3.8	13.0	6.5	4.2	15.00	10		2.75	6.80	6.04	5.71	18.7
	Wed 6/16/99	06/16/1999 9:30	9:30 AM	2763.08	8274.0	1330078.0	27.0	31.5	25	60.0	50	6.5	5.70	3.7	13.0	6.5	4.3	15.00	10	maint cleaning	2.80	6.68	5.73	5.71	18.7
	Wed 6/16/99	06/16/1999 11:00	11:00 AM	2764.58	8274.8	1330280.0	28.0	32	25	58.0	50	6.5	5.30	3.8	13.0	6.5	4.2	15.00	10		2.60	7.19	6.09	5.71	18.7
	Wed 6/16/99	06/16/1999 13:15	1:15 PM	2766.83	8277.1	1331098.6	26.0	32.5	25	58.0	50	6.5	5.30	3.7	13.0	6.5	3.7	15.00	10		2.60	7.19	6.02	5.71	18.7
	Thu 6/17/99	06/17/1999 7:15	7:15 AM	2784.83	8295.1	1337484.3	28.0	31	25	61.0	49	6.5	5.30	3.6	13.0	6.5	4.3	15.00	10		2.60	7.19	6.23	5.71	18.7
	Thu 6/17/99	06/17/1999 1:15	1:15 AM	2778.83	8301.1	1339640.6	25.0	32	25	60.0	49	6.5	5.40	3.7	13.0	6.5	4.3	15.00	10		2.65	7.05	5.97	5.71	18.7
	Fri 6/18/99	06/18/1999 7:30	7:30 AM	2809.08	8317.7	1345407.5	28.0	31	25	60.0	52	6.5	5.50	3.8	13.0	6.5	4.4	15.00	10		2.70	6.93	6.01	5.71	18.7
	Fri 6/18/99	06/18/1999 9:30	9:30 AM	2811.08	8319.7	1346114.8	28.0	31.5	25	60.0	52	6.5	5.60	3.8	13.0	6.5	4.5	15.00	10	maint cleaning	2.75	6.80	5.83	5.71	18.7
	Fri 6/18/99	06/18/1999 11:45	11:45 AM	2813.33	8320.2	1346234.8	27.0	32	25	59.0	51	6.5	6.30	3.7	13.0	6.5	3.7	15.00	10		3.09	6.05	5.12	5.71	18.7
	Fri 6/18/99	06/18/1999 12:45	12:45 PM	2814.33	8322.3	1346945.6	25.0	32.5	25	60.0	51	6.5	6.20	3.7	13.0	6.5	4.2	15.00	10		3.05	6.14	5.14	5.71	18.7
	Sat 6/19/99	06/19/1999 7:00	7:00 AM	2832.58	8340.9	1352461.2	24.0	32	25	60.0	51	6.5	7.40	3.4	13.0	6.5	6.4	15.00	10		3.63	5.15	4.36	5.71	18.7
	Sat 6/19/99	06/19/1999 10:30	10:30 AM	2836.08	8344.0	1354639.7	18.0	33	25	60.0	51	6.5	7.40	3.4	13.0	6.5	6.4	15.00	10		3.63	5.15	4.26	5.71	18.7
	Sun 6/20/99	06/20/1999 7:00	7:00 AM	2856.58	8386.3	1366212.9	28.0	30	25	60.0	51	6.5	7.60	3.8	13.0	6.5	6.3	15.00	10		3.73	5.01	4.45	5.71	18.7
	Sun 6/20/99	06/20/1999 11:05	11:05 AM	2860.66	8356.0	1358625.1	26.0	32	25	60.0	52	6.5	6.30	3.8	13.0	6.5	5.2	15.00	10		3.09	6.05	5.12	5.71	18.7
	Mon 6/21/99	06/21/1999 7:30	7:30 AM	2881.08	8376.4	1365984.4	27.0	30	25	61.0	51	6.5	6.30	3.9	13.0	6.5	5.4	15.00	10		3.09	6.05	5.37	5.71	18.7

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Mon 6/21/99	06/21/1999 9:30	9:30 AM	2883.08	8378.4	1366691.7	24.0	31	25	61.0	51	6.5	6.30	3.9	13.0	6.5	4.9	15.00	10	maint cleaning	3.09	6.05	5.24	5.71	18.7
	Mon 6/21/99	06/21/1999 11:00	11:00 AM	2884.58	8379.3	1366906.0	28.0	31.5	25	62.0	51	6.5	5.80	3.9	13.0	6.5	4.2	15.00	10		2.85	6.57	5.63	5.71	18.7
	Mon 6/21/99	06/21/1999 13:15	1:15 PM	2886.83	8381.6	1367727.1	27.0	32	25	60.0	51	6.5	5.90	3.8	13.0	6.5	4.2	15.00	10		2.90	6.46	5.47	5.71	18.7
	Tue 6/22/99	06/22/1999 7:15	7:15 AM	2904.83	8399.5	1374218.0	28.0	31	25	62.0	52	6.5	6.20	3.9	13.0	6.5	4.7	15.00	10		3.05	6.14	5.33	5.71	18.7
	Tue 6/22/99	06/22/1999 13:00	1:00 PM	2910.58	8405.3	1376285.2	26.0	32	25	60.0	52	6.5	6.20	3.8	13.0	6.5	4.7	15.00	10		3.05	6.14	5.20	5.71	18.7
	Wed 6/23/99	06/23/1999 7:30	7:30 AM	2929.08	8423.7	1382922.4	27.0	30.5	25	62.0	52	6.5	6.30	3.9	13.0	6.5	4.7	15.00	10		3.09	6.05	5.31	5.71	18.7
	Wed 6/23/99	06/23/1999 9:30	9:30 AM	2931.08	8425.8	1383661.0	28.0	31	25	61.0	52	6.5	6.30	3.8	13.0	6.5	4.8	15.00	10		3.09	6.05	5.24	5.71	18.7
	Wed 6/23/99	06/23/1999 10:45	10:45 AM	2932.33	8426.3	1383784.2	28.0	32	25	60.0	51	6.5	5.70	3.8	13.0	6.5	4.2	15.00	10	maint cleaning	2.80	6.68	5.66	5.71	18.7
	Wed 6/23/99	06/23/1999 13:00	1:00 PM	2934.58	8428.6	1384606.0	27.0	32	25	60.0	52	6.5	5.70	3.8	13.0	6.5	4.1	15.00	10		2.80	6.68	5.66	5.71	18.7
	Thu 6/24/99	06/24/1999 7:15	7:15 AM	2952.83	8446.8	1391160.0	28.0	31	25	62.0	51	6.5	6.20	3.8	13.0	6.5	4.7	15.00	10		3.05	6.14	5.33	5.71	18.7
	Thu 6/24/99	06/24/1999 13:00	1:00 PM	2958.58	8452.6	1393226.4	27.0	32.5	25	60.0	52	6.5	6.20	7.0	17.0	6.5	4.7	15.00	10	increase back pulse pressure to 6.9 and 7.0	3.05	6.14	5.14	5.71	18.7
	Fri 6/25/99	06/25/1999 8:00	8:00 AM	2977.58	8471.6	1398418.4	26.0	31.5	25	60.0	52	6.5	5.70	6.9	19.0	6.5	3.2	15.00	10		2.80	6.68	5.73	5.71	18.7
	Fri 6/25/99	06/25/1999 9:30	9:30 AM	2979.08	8473.1	1398954.9	28.0	32	25	60.0	52	6.5	5.70	7.0	19.0	6.5	4.7	15.00	10		2.80	6.68	5.66	5.71	18.7
	Fri 6/25/99	06/25/1999 10:45	10:45 AM	2980.33	8473.7	1399104.0	27.0	32	25	60.0	52	6.5	5.80	7.0	18.0	6.5	4.8	15.00	10		2.85	6.57	5.56	5.71	18.7
	Fri 6/25/99	06/25/1999 13:00	1:00 PM	2982.58	8475.9	1399868.0	26.0	32.5	25	60.0	53	6.5	5.50	6.9	19.0	6.5	4.1	15.00	10		2.70	6.93	5.80	5.71	18.7
	Sat 6/26/99	06/26/1999 6:15	6:15 AM	2999.83	8473.2	1405722.4	24.0	31	25	61.0	52	6.5	5.70	6.9	18.0	6.5	4.2	15.00	10		2.80	6.68	5.80	5.71	18.7
	Sat 6/26/99	06/26/1999 10:00	10:00 AM	3003.58	8496.9	1406998.9	28.0	32	25	60.0	50	6.5	6.20	6.9	18.0	6.5	4.2	15.00	10		3.05	6.14	5.20	5.71	18.7
	Sun 6/27/99	06/27/1999 8:00	8:00 AM	3025.58	8518.8	1414759.9	26.0	32	25	61.0	49	6.5	6.30	6.9	18.0	6.5	5.2	15.00	10		3.09	6.05	5.12	5.71	18.7
	Sun 6/27/99	06/27/1999 10:30	10:30 AM	3028.08	8521.6	1415740.6	26.0	32	25	61.0	50	6.5	7.00	6.9	18.0	6.5	5.2	15.00	10		3.44	5.44	4.61	5.71	18.7
	Mon 6/28/99	06/28/1999 7:30	7:30 AM	3049.08	8542.4	1423055.7	27.0	31	25	61.0	49	6.5	6.20	7.1	18.0	6.8	4.9	15.00	10		3.05	6.14	5.33	5.71	19.6
	Mon 6/28/99	06/28/1999 9:30	9:30 AM	3051.08	8544.4	1423755.1	28.0	32	25	60.0	49	6.5	6.30	7.1	18.0	6.8	4.7	15.00	10	maint cleaning	3.09	6.05	5.12	5.71	19.6
	Mon 6/28/99	06/28/1999 11:00	11:00 AM	3052.58	8545.2	1423986.0	27.0	32	25	60.0	49	6.5	6.20	7.1	18.0	7.0	4.3	15.00	10		3.05	6.14	5.20	5.71	20.1
	Mon 6/28/99	06/28/1999 13:00	1:00 PM	3054.58	8547.2	1424682.1	26.0	32.5	25	60.0	49	6.5	5.90	7.0	18.0	6.9	4.7	15.00	10		2.90	6.46	5.40	5.71	19.9
	Tue 6/29/99	06/29/1999 7:30	7:30 AM	3073.08	8565.7	1431335.5	27.0	31	25	61.0	49	6.5	6.20	7.0	18.0	6.9	4.7	15.00	10		3.05	6.14	5.33	5.71	19.9
	Tue 6/29/99	06/29/1999 13:30	1:30 PM	3079.08	8576.2	1439725.2	29.0	31	25	61.0	51	6.5	6.40	7.1	18.0	6.8	4.8	15.00	10		3.14	5.95	5.16	5.71	19.6
	Wed 6/30/99	06/30/1999 7:30	7:30 AM	3097.08	8589.7	1439725.2	29.0	31	25	61.0	51	6.5	6.40	7:1	18.0	6.8	4.8	15.00	10		3.14	5.95	5.16	5.71	19.6
	Wed 6/30/99	06/30/1999 9:30	9:30 AM	3099.08	8591.7	1440476.1	28.0	32	25	60.0	50	6.5	6.50	7.0	18.0	6.8	4.8	15.00	10	maint cleaning	3.19	5.86	4.96	5.71	19.6
	Wed 6/30/99	06/30/1999 11:00	11:00 AM	3100.58	8592.5	1440701.4	27.0	32	25	60.0	60	6.5	6.20	7.1	18.0	7.0	4.3	15.00	10		3.05	6.14	5.20	5.71	20.1
	Wed 6/30/99	06/30/1999 13:00	1:00 PM	3102.58	8594.5	1441455.4	26.0	32.5	25	60.0	50	6.5	6.10	7.0	18.0	6.9	4.6	15.00	10		3.00	6.24	5.23	5.71	19.9
	Thu 7/1/99	07/01/1999 8:00	8:00 AM	3121.58	8613.5	1448171.2	27.0	31	25	61.0	50	6.5	6.40	7.1	18.0	6.9	4.8	15.00	10		3.14	5.95	5.16	5.71	19.9
	Thu 7/1/99	07/01/1999 13:00	1:00 PM	3126.58	8618.5	1448848.7	24.0	32	25	60.0	50	6.5	6.60	7.1	18.0	6.8	4.8	15.00	10		3.24	5.77	4.89	5.71	19.6
	Fri 7/2/99	07/02/1999 7:30	7:30 AM	3145.08	8637.0	1456527.4	28.0	31.5	25	62.0	50	6.5	6.90	7.2	18.0	6.8	5.2	15.00	10	maint cleaning	3.39	5.52	4.73	5.71	19.6
	Fri 7/2/99	07/02/1999 9:50	9:50 AM	3147.41	8637.7	1456713.9	27.0	32	25	60.0	50	6.5	6.60	7.2	18.0	7.0	4.7	15.00	10		3.24	5.77	4.89	5.71	20.1
	Fri 7/2/99	07/02/1999 13:00	1:00 PM	3150.58	8641.8	1458141.2	26.0	32.5	25	59.0	51	6.5	6.20	7.1	18.0	6.8	4.7	15.00	10		3.05	6.14	5.14	5.71	19.6
	Sat 7/3/99	07/03/1999 7:00	7:00 AM	3168.58	8660.0	1464487.8	20.0	30	25	62.0	50	6.5	7.20	7.0	18.0	6.9	6.0	15.00	10		3.54	5.29	4.70	5.71	19.9
	Sat 7/3/99	07/03/1999 11:30	11:30 AM	3173.08	8684.1	1465934.7	13.0	32	25	62.0	50	6.5	7.20	7.0	18.0	6.9	6.0	15.00	10		3.54	5.29	4.48	5.71	19.9
	Sun 7/4/99	07/04/1999 6:30	6:30 AM	3192.08	8683.3	1472592.1	28.0	31	25	61.0	50	6.5	6.90	7.2	18.0	6.7	5.8	15.00	10		3.39	5.52	4.79	5.71	19.3
	Sun 7/4/99	07/04/1999 10:00	10:00 AM	3195.58	8686.1	1473504.9	28.0	31.5	25	62.0	50	6.5	6.20	7.2	18.0	6.8	4.7	15.00	10		3.05	6.14	5.27	5.71	19.6
	Mon 7/5/99	07/05/1999 6:15	6:15 AM	3215.83	8706.4	1480569.1	21.0	31	25	62.0	50	6.5	7.00	7.2	18.0	6.8	5.4	15.00	10	change OUR procedure (prior data incorrect)	3.44	5.44	4.72	5.71	19.6
	Mon 7/5/99	07/05/1999 7:55	7:55 AM	3217.50	8708.0	1481155.6	28.0	31.5	25	61.0	50	6.5	7.00	7.1	18.0	6.8	5.4	15.00	10	maint cleaning	3.44	5.44	4.66	5.71	19.6
	Mon 7/5/99	07/05/1999 9:00	9:00 AM	3218.58	8708.5	1481225.9	28.0	31.5	25	61.0	49	6.5	6.20	7.1	18.0	6.9	4.7	15.00	10		3.05	6.14	5.27	5.71	19.9
	Mon 7/5/99	07/05/1999 13:00	1:00 PM	3222.58	8712.4	1482618.6	27.0	32	25	61.0	50	6.5	6.30	7.1	18.0	6.8	4.9	15.00	10		3.09	6.05	5.12	5.71	19.6
	Tue 7/6/99	07/06/1999 7:30	7:30 AM	3241.08	8731.0	1488994.6	26.0	30.5	25	63.0	49	6.5	6.90	7.3	18.0	6.7	5.2	15.00	10		3.39	5.52	4.85	5.71	19.3
	Tue 7/6/99	07/06/1999 13:00	1:00 PM	3246.58	8736.5	1490878.2	26.0	30.5	25	62.0	49	6.5	6.90	7.3	18.0	6.7	5.2	15.00	10		3.39	5.52	4.85	5.71	19.3
	Wed 7/7/99	07/07/1999 7:30	7:30 AM	3265.08	8755.0	1497189.0	25.0	30.5	25	62.0	49	6.5	7.90	7.3	18.0	6.8	6.8	15.00	10		3.88	4.82	4.23	5.71	19.6
	Wed 7/7/99	07/07/1999 9:45	9:45 AM	3267.33	8757.2	1497995.2	22.0	31	25	61.0	49	6.5	8.50	7.3	18.0	6.9	6.2	15.00	10	maint cleaning	4.17	4.48	3.89	5.71	19.9
	Wed 7/7/99	07/07/1999 11:00	11:00 AM	3268.58	8758.3	1498312.1	28.0	31.5	25	60.0	50	6.5	7.20	7.3	18.0	6.8	4.9	15.00	10		3.54	5.29	4.53	5.71	19.6
	Wed 7/7/99	07/07/1999 13:30	1:30 PM	3271.08	8762.3	1499684.2	24.0	32.5	25	60.0	49	6.5	8.40	7.3	18.0	6.7	5.0	15.00	10		4.13	4.53	3.80	5.71	19.3
	Thu 7/8/99	07/08/1999 7:30	7:30 AM	3289.08	8778.3	1505219.6	23.0	31	25	62.0	50	6.5	5.20	7.4	18.0	6.8	4.2	15.00	10		2.55	7.33	6.35	5.71	19.6
	Thu 7/8/99	07/08/1999 11:00	11:00 AM	3292.58	8779.7	1505657.1	28.0	31.5	25	61.0	50	6.5	5.20	7.4	18.0	6.8	4.2	15.00	10		2.55	7.33	6.28	5.71	19.6
	Thu 7/8/99	07/08/1999 12:50	12:50 PM	3294.41	8781.5	1506289.0	26.0	33	25	60.0	50	6.5	5.20	7.2	18.0	6.7	4.2	15.00	10		2.55	7.33	6.06	5.71	19.3
	Thu 7/8/99	07/08/1999 15:00	3:00 PM	3296.58	8783.7	1507037.2	23.0	33	25	63.0	49	6.5	5.90	7.3	18.0	6.7	4.2	15.00	10		2.90	6.46	5.34	5.71	19.3
	Fri 7/9/99	07/09/1999 7:30	7:30 AM	3313.08	8797.4	1511719.9	24.0	30	25	63.0	49	6.5	5.90	7.3	18.0	6.7	4.7	15.00	10		2.90	6.46	5.73	5.71	19.3
	Fri 7/9/99	07/09/1999 9:15	9:15 AM	3314.83	8798.4	1512031.5	28.0	30.5	25	62.0	50	6.5	5.70	7.3	18.0	6.7	4.2	15.00	10	maint cleaning	2.80	6.68	5.87	5.71	19.3
	Fri 7/9/99	07/09/1999 13:00	1:00 PM	3318.58	8802.2	1513231.5	26.0	31.5	25	61.0	50	6.5	5.60	7.2	18.0	6.5	4.2	15.00	10		2.75	6.80	5.83	5.71	18.7
	Sat 7/10/99	07/10/1999 6:15	6:15 AM	3335.83	8819.4	1519228.4	28.0	30	25	62.0	49	6.5	5.90	7.9	18.0	6.8	5.1	15.00	10		2.90	6.46	5.73	5.71	19.6
	Sat 7/10/99	07/10/1999 10:45	10:45 AM	3340.33	8823.9	1520826.0	28.0	31	25	62.0	49	6.5	6.00	7.2	18.0	6.8	5.2	15.00	10		2.95	6.35	5.51	5.71	19.6
	Sun 7/11/99	07/11/1999 8:30	8:30 AM	3362.08	8845.6	1528498.9	18.0	32	25	62.0	49	6.5	6.00	7.2	18.0	6.8	6.0	15.00	10		2.95	6.35	5.38	5.71	19.6
	Sun 7/11/99	07/11/1999 11:00	11:00 AM	3364.58	8948.3	1529432.7	10.0	32.5	25	60.0	49	6.5	6.20	6.9	18.0	6.8	6.0	15.00	10		3.05	6.14	5.14	5.71	19.6
	Mon 7/12/99	07/12/1999 7:30	7:30 AM	3385.08	8868.6	1536596.4	28.0	30	25	61.0	47	6.5	6.20	7.3	18.0	6.9	5.4	15.00	10		3.05	6.14	5.46	5.71	19.9

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Mon 7/12/99	07/12/1999 9:30	9:30 AM	3387.08	8870.7	1537327.5	26.0	32	25	61.0	49	6.5	6.20	7.3	18.0	6.9	5.4	15.00	10	maint cleaning	3.05	6.14	5.20	5.71	19.9
	Mon 7/12/99	07/12/1999 11:00	11:00 AM	3388.58	8871.4	1537511.6	24.0	32	25	61.0	49	6.5	5.90	7.2	18.0	6.7	4.7	15.00	10		2.90	6.46	5.47	5.71	19.3
	Mon 7/12/99	07/12/1999 13:00	1:00 PM	3390.58	8873.5	1538249.6	28.0	31.5	25	62.0	49	6.5	5.60	7.3	18.0	6.8	4.2	15.00	10		2.75	6.80	5.83	5.71	19.6
	Tue 7/13/99	07/13/1999 7:30	7:30 AM	3409.08	8891.9	1544671.8	26.0	30.5	25	63.0	49	6.5	5.70	7.3	18.0	6.8	4.9	15.00	10		2.80	6.68	5.87	5.71	19.6
	Tue 7/13/99	07/13/1999 13:00	1:00 PM	3414.58	8897.4	1546583.0	27.0	32	25	61.0	49	6.5	4.70	7.2	18.0	6.7	5.1	15.00	10		2.31	8.10	6.86	5.71	19.3
	Wed 7/14/99	07/14/1999 6:00	6:00 AM	3431.58	8914.4	1552520.1	24.0	31	25	62.0	49	6.5	5.90	7.3	18.0	6.8	5.2	15.00	10	maint cleaning	2.90	6.46	5.60	5.71	19.6
	Wed 7/14/99	07/14/1999 7:30	7:30 AM	3433.08	8915.2	1552716.8	28.0	31	25	62.0	49	6.5	5.90	7.2	18.0	6.9	4.8	15.00	10		2.90	6.46	5.60	5.71	19.9
	Wed 7/14/99	07/14/1999 13:25	1:25 PM	3439.00	8921.1	1554867.6	25.0	32	25	61.0	49	6.5	5.80	7.2	18.0	6.9	5.2	15.00	10		2.85	6.57	5.56	5.71	19.9
	Thu 7/15/99	07/15/1999 7:30	7:30 AM	3457.08	8939.2	1561313.4	27.0	30	25	62.0	49	6.5	6.00	7.3	18.0	6.9	5.3	15.00	10		2.95	6.35	5.64	5.71	19.9
	Thu 7/15/99	07/15/1999 13:00	1:00 PM	3462.58	8944.5	1563276.5	26.0	32	25	61.0	49	6.5	6.20	7.3	18.0	6.9	5.5	15.00	10		3.05	6.14	5.20	5.71	19.9
	Fri 7/16/99	07/16/1999 7:30	7:30 AM	3481.08	8963.2	1569880.0	28.0	31	25	61.0	41	6.5	6.20	7.3	18.0	6.8	5.5	15.00	10		3.05	6.14	5.33	5.71	19.6
	Fri 7/16/99	07/16/1999 9:30	9:30 AM	3483.08	8965.2	1570602.1	28.0	32	25	61.0	48	6.5	5.90	7.3	18.0	6.8	5.4	15.00	10	maint cleaning	2.90	6.46	5.47	5.71	19.6
	Fri 7/16/99	07/16/1999 11:00	11:00 AM	3484.58	8966.1	1570812.5	27.0	32	25	60.0	48	6.5	5.70	7.2	18.0	7.0	5.2	15.00	10		2.80	6.68	5.66	5.71	20.1
	Fri 7/16/99	07/16/1999 13:00	1:00 PM	3486.58	8968.0	1571505.6	24.0	32.5	25	60.0	48	6.5	5.70	7.2	18.0	6.9	5.0	15.00	10		2.80	6.68	5.59	5.71	19.9
	Sat 7/17/99	07/17/1999 6:15	6:15 AM	3503.83	8985.3	1577621.4	26.0	30.5	25	62.0	49	6.5	5.80	7.3	18.0	6.8	5.2	15.00	10		2.85	6.57	5.76	5.71	19.6
	Sat 7/17/99	07/17/1999 9:30	9:30 AM	3507.08	8988.5	1578773.2	28.0	31.5	25	61.0	48	6.5	6.20	7.2	18.0	6.9	5.3	15.00	10		3.05	6.14	5.27	5.71	19.9
	Sun 7/18/99	07/18/1999 6:30	6:30 AM	3528.08	9007.8	1585567.2	24.0	30.5	25	62.0	48	6.5	6.00	7.3	18.0	6.8	5.3	15.00	10		2.95	6.35	5.57	5.71	19.6
	Sun 7/18/99	07/18/1999 10:30	10:30 AM	3532.08	9011.7	1586965.2	27.0	31	25	61.0	48	6.5	6.20	7.3	18.0	6.8	5.7	15.00	10		3.05	6.14	5.33	5.71	19.6
	Mon 7/19/99	07/19/1999 7:30	7:30 AM	3553.08	9032.7	1594350.8	27.0	31	25	62.0	48	6.5	6.10	7.4	18.0	6.8	5.5	15.00	10		3.00	6.24	5.42	5.71	19.6
	Mon 7/19/99	07/19/1999 9:30	9:30 AM	3555.08	9034.7	1595068.2	26.0	31.5	25	61.0	48	6.5	6.10	7.2	18.0	6.8	5.5	15.00	10	maint cleaning	3.00	6.24	5.35	5.71	19.6
	Mon 7/19/99	07/19/1999 11:00	11:00 AM	3556.58	9035.5	1595276.1	28.0	32	25	61.0	49	6.5	5.70	7.3	18.0	6.9	5.2	15.00	10		2.80	6.68	5.66	5.71	19.9
	Mon 7/19/99	07/19/1999 14:00	2:00 PM	3559.58	9038.6	1596350.9	26.0	32	25	61.0	49	6.5	5.70	7.0	18.0	6.8	5.1	15.00	10		2.80	6.68	5.66	5.71	19.6
	Tue 7/20/99	07/20/1999 10:00	10:00 AM	3579.58	9058.5	1603405.7	20.0	32	25	61.0	48	6.5	6.40	7.0	18.0	6.9	6.2	15.00	10		3.14	5.95	5.04	5.71	19.9
	Tue 7/20/99	07/20/1999 15:20	3:20 PM	3584.91	9062.9	1605323.5	3.5	32	25	60.0	46	6.5	6.70	7.0	18.0	6.9	6.2	15.00	10		3.29	5.69	4.82	5.71	19.9
	Wed 7/21/99	07/21/1999 7:30	7:30 AM	3601.08	9080.2	1611035.5	25.0	30	25	62.0	45	6.5	8.30	7.1	18.0	6.8	7.8	15.00	10	maint cleaning	4.08	4.59	4.08	5.71	19.6
	Wed 7/21/99	07/21/1999 9:30	9:30 AM	3603.08	9081.5	1611421.3	25.0	31	25	61.0	46	6.5	8.00	7.1	18.0	6.8	7.8	15.00	10		3.93	4.76	4.13	5.71	19.6
	Wed 7/21/99	07/21/1999 11:30	11:30 AM	3605.08	9083.3	1612103.9	26.0	32	25	60.0	47	6.5	6.50	7.0	18.0	6.8	7.8	15.00	10		3.19	5.86	4.96	5.71	19.6
	Wed 7/21/99	07/21/1999 15:20	3:20 PM	3608.91	9086.8	1613365.5	14.0	33	25	60.0	46	6.5	6.50	7.0	18.0	6.8	7.8	15.00	10		3.19	5.86	4.85	5.71	19.6
	Thu 7/22/99	07/22/1999 6:15	6:15 AM	3623.83	9102.1	1618777.6	21.0	30.5	25	62.0	47	6.5	6.30	7.3	18.0	6.7	5.7	15.00	10		3.09	6.05	5.31	5.71	19.3
	Thu 7/22/99	07/22/1999 11:40	11:40 AM	3629.25	9106.6	1620395.9	22.0	32	25	60.0	49	6.5	6.20	7.2	18.0	6.8	5.7	15.00	10		3.05	6.14	5.20	5.71	19.6
	Fri 7/23/99	07/23/1999 8:00	8:00 AM	3649.58	9126.8	1627629.5	25.0	31	25	61.0	38	6.5	6.20	7.2	18.0	6.8	5.7	15.00	10		3.05	6.14	5.33	5.71	19.6
	Fri 7/23/99	07/23/1999 14:30	2:30 PM	3656.08	9133.5	1630029.7	12.0	32	25	60.0	36	6.5	6.20	7.2	18.0	6.8	5.7	15.00	10		3.05	6.14	5.20	5.71	19.6
	Sat 7/24/99	07/24/1999 7:30	7:30 AM	3673.08	9150.4	1636086.5	25.0	31	25	61.0	47	6.5	6.20	7.0	18.0	6.0	7.0	15.00	10		3.05	6.14	5.33	5.71	17.3
	Sat 7/24/99	07/24/1999 13:00	1:00 PM	3678.58	9155.5	1637924.3	15.0	33	25	60.0	45	6.5	6.90	7.2	18.0	6.0	5.7	15.00	10		3.39	5.52	4.57	5.71	17.3
	Sun 7/25/99	07/25/1999 7:30	7:30 AM	3697.08	9174.6	1644783.2	18.0	31	25	61.0	46	6.5	6.70	7.2	18.0	6.9	5.7	15.00	10		3.29	5.69	4.93	5.71	19.9
	Sun 7/25/99	07/25/1999 13:30	1:30 PM	3703.08	9180.6	1646928.3	11.0	33	25	60.0	47	6.5	7.00	7.3	18.0	6.9	5.7	15.00	10		3.44	5.44	4.50	5.71	19.9
	Mon 7/26/99	07/26/1999 7:30	7:30 AM	3721.08																					
	Tue 7/27/99	07/27/1999 8:00	8:00 AM	3745.58	9221.1	1661504.7	24.0	32	25	60.0	32	6.5	7.80	7.2	18.0	6.9	6.9	15.00	10		3.83	4.88	4.14	5.71	19.9
	Tue 7/27/99	07/27/1999 14:30	2:30 PM	3752.08	9228.3	1663987.5	13.0	33	25	60.0	32	6.5	8.20	7.2	18.0	6.5	6.4	15.00	10		4.03	4.65	3.84	5.71	18.7
	Wed 7/28/99	07/28/1999 7:00	7:00 AM	3768.58	9244.7	1669808.8	26.0	32	25	61.0	34	6.5	7.80	7.2	18.0	7.0	6.8	15.00	10		3.83	4.88	4.14	5.71	20.1
	Wed 7/28/99	07/28/1999 9:30	9:30 AM	3771.08	9247.3	1670716.5	25.0	33	25	61.0	34	6.5	7.70	7.2	18.0	7.0	6.7	15.00	10		3.78	4.95	4.09	5.71	20.1
	Wed 7/28/99	07/28/1999 11:30	11:30 AM	3773.08	9248.4	1670992.9	24.0	33	25	60.0	49	6.5	6.60	7.2	18.0	6.7	6.1	15.00	10	maint cleaning	3.24	5.77	4.77	5.71	19.3
	Wed 7/28/99	07/28/1999 14:20	2:20 PM	3775.91	9251.1	1671948.5	20.0	34	25	60.0	49	6.5	5.70	7.2	18.0	6.4	6.4	15.00	10		2.80	6.68	5.40	5.71	18.4
	Thu 7/29/99	07/29/1999 7:30	7:30 AM	3793.08	9268.3	1678035.0	26.0	32	25	61.0	50	6.5	7.00	7.2	18.0	6.4	6.8	15.00	10		3.44	5.44	4.61	5.71	18.4
	Thu 7/29/99	07/29/1999 9:30	9:30 AM	3795.08	9270.7	1678902.9	25.0	30	25	61.0	50	6.5	7.70	7.0	18.0	6.4	6.8	15.00	10		3.78	4.95	4.39	5.71	18.4
	Thu 7/29/99	07/29/1999 11:30	11:30 AM	3797.08	9272.3	1679481.0	22.0	34	25	61.0	50	6.5	7.50	7.0	18.0	6.5	7.0	15.00	10		3.68	5.08	4.10	5.71	18.7
	Thu 7/29/99	07/29/1999 14:00	2:00 PM	3799.58	9274.7	1680269.1	18.0	34	25	61.0	49	6.5	7.20	7.1	18.0	6.4	6.8	15.00	10		3.54	5.29	4.27	5.71	18.4
	Fri 7/30/99	07/30/1999 7:30	7:30 AM	3817.08	9292.2	1686521.3	26.0	31	25	70.0	48	6.5	7.10	7.1	18.0	6.5	7.2	15.00	10		3.49	5.36	4.65	5.71	18.7
	Fri 7/30/99	07/30/1999 9:30	9:30 AM	3819.08	9294.3	1687232.4	22.0	32	25	60.0	49	6.5	7.00	7.1	18.0	6.7	6.8	15.00	10	maint cleaning	3.44	5.44	4.61	5.71	19.3
	Fri 7/30/99	07/30/1999 11:00	11:00 AM	3820.58	9295.2	1687457.4	21.0	32	25	60.0	48	6.5	7.10	7.1	18.0	6.5	6.8	15.00	10		3.49	5.36	4.54	5.71	18.7
	Fri 7/30/99	07/30/1999 13:30	1:30 PM	3823.08	9297.2	1688210.8	17.0	34	25	61.0	39	6.5	7.00	7.0	18.0	6.6	6.8	15.00	10		3.44	5.44	4.40	5.71	18.9
	Sat 7/31/99	07/31/1999 8:00	8:00 AM	3841.58	9316.2	1695078.7	10.0	32	25	61.0	36	6.5	6.70	7.3	18.0	6.9	6.8	15.00	10		3.29	5.69	4.82	5.71	19.9
	Sat 7/31/99	07/31/1999 10:30	10:30 AM	3844.08	9318.8	1693069.9	10.0	32	25	61.0	48	6.5	6.70	7.3	18.0	6.9	6.8	15.00	10		3.29	5.69	4.82	5.71	19.9
	Sun 8/1/99	08/01/1999 7:00	7:00 AM	3864.58	9339.3	1703887.9	26.0	32	25	61.0	49	6.5	6.70	7.3	18.0	6.9	6.5	15.00	10		3.29	5.69	4.82	5.71	19.9
	Sun 8/1/99	08/01/1999 11:00	11:00 AM	3868.58	9343.1	1705274.6	23.0	33	25	60.0	48	6.5	7.40	7.3	18.0	6.9	6.7	15.00	10		3.63	5.15	4.26	5.71	19.9
	Mon 8/2/99	08/02/1999 8:00	8:00 AM	3889.58	9364.1	1712828.4	27.0	30.5	25	61.0	47	6.5	7.20	7.4	18.0	6.9	6.6	15.00	10		3.54	5.29	4.64	5.71	19.9
	Mon 8/2/99	08/02/1999 9:30	9:30 AM	3891.08	9395.6	1713396.7	26.0	31.9	25	61.0	48	6.5	7.20	7.5	18.0	6.9	6.7	15.00	10	maint cleaning	3.54	5.29	4.49	5.71	19.9
	Mon 8/2/99	08/02/1999 10:45	10:45 AM	3892.33	9366.7	1713501.5	28.0	32	25	61.0	48	6.5	6.60	7.4	18.0	6.9	5.7	15.00	10		3.24	5.77	4.89	5.71	19.9
	Mon 8/2/99	08/02/1999 13:00	1:00 PM	3894.58	9368.4	1714355.6	27.0	32	25	60.0	48	6.5	6.20	7.4	18.0	6.8	5.6	15.00	10		3.05	6.14	5.20	5.71	19.6
	Tue 8/3/99	08/03/1999 7:15	7:15 AM	3912.83	9386.7	1720635.4	28.0	31	25	62.0	48	6.5	6.20	7.4	18.0	6.8	5.7	15.00	10		3.05	6.14	5.33	5.71	19.6

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Mon 8/23/99	08/23/1999 11:00	11:00 AM	4396.58	9856.3	189.564.6	28.0	30	25	62.0	49	6.5	9.70	4.9	13.0	6.9	8.7	15.00	10		4.76	3.93	3.49	5.71	19.9
	Mon 8/23/99	08/23/1999 13:00	1:00 PM	4398.58	9858.3	1894269.6	26.0	31	25	61.0	48	6.5	9.30	4.9	13.0	6.9	8.2	15.00	10		4.57	4.10	3.55	5.71	19.9
	Tue 8/24/99	08/24/1999 7:30	7:30 AM	4417.08	9876.8	1900823.1	27.0	30	25	62.0	49	6.5	11.70	4.9	13.0	6.8	8.2	15.00	10		5.75	3.26	2.89	5.71	19.6
	Tue 8/24/99	08/24/1999 13:30	1:30 PM	4423.08	9882.8	1902928.2	26.0	32	25	62.0	49	6.5	11.90	4.9	13.0	6.9	9.7	15.00	10		5.84	3.20	2.71	5.71	19.9
	Wed 8/25/99	08/25/1999 7:30	7:30 AM	4441.08	9900.8	1909432.1	27.0	30.5	25	63.0	48	6.5	12.60	4.9	13.0	6.9	10.7	15.00	10		6.19	3.02	2.65	5.71	19.9
	Wed 8/25/99	08/25/1999 9:30	9:30 AM	4443.08	9902.8	1910149.8	26.0	31	25	62.0	47	6.5	12.70	5.0	13.0	7.0	12.7	15.00	10	maint cleaning	6.24	3.00	2.60	5.71	20.1
	Wed 8/25/99	08/25/1999 11:00	11:00 AM	4444.58	9903.6	1910365.0	28.0	31.5	25	62.0	48	6.5	10.60	5.1	13.0	7.0	11.7	15.00	10		5.21	3.59	3.08	5.71	20.1
	Wed 8/25/99	08/25/1999 13:00	1:00 PM	4446.58	9905.8	1911113.8	28.0	32	25	62.0	48	6.5	11.30	4.9	13.0	7.0	9.7	15.00	10		5.55	3.37	2.86	5.71	20.1
	Thu 8/26/99	08/26/1999 7:15	7:15 AM	4464.83	9923.8	1917843.6	26.0	30.5	25	63.0	47	6.5	11.70	4.9	13.0	6.9	9.2	15.00	10		5.75	3.26	2.86	5.71	19.9
	Thu 8/26/99	08/26/1999 13:00	1:00 PM	4470.58	9929.6	1919945.1	28.0	32	25	61.0	48	6.5	11.70	4.9	13.0	7.0	10.7	15.00	10		5.75	3.26	2.76	5.71	20.1
	Fri 8/27/99	08/27/1999 7:30	7:30 AM	4489.08	9948.1	1926642.4	27.0	31	25	63.0	47	6.5	13.00	4.9	13.0	6.9	12.7	15.00	10	maint cleaning	6.39	2.93	2.54	5.71	19.9
	Fri 8/27/99	08/27/1999 8:45	8:45 AM	4490.33	9948.7	1926768.9	26.0	31.5	25	62.0	47	6.5	11.20	5.1	13.0	7.0	12.2	15.00	10		5.50	3.40	2.92	5.71	20.1
	Fri 8/27/99	08/27/1999 13:00	1:00 PM	4494.58	9952.9	1928342.4	27.0	32.5	25	61.0	48	6.5	11.30	4.9	13.0	6.9	10.7	15.00	10		5.55	3.37	2.82	5.71	19.9
	Sat 8/28/99	08/28/1999 8:30	8:30 AM	4514.08	9972.6	1935462.3	26.0	32	25	62.0	47	6.5	11.30	4.9	13.0	6.9	10.7	15.00	10		5.55	3.37	2.86	5.71	19.9
	Sat 8/28/99	08/28/1999 11:00	11:00 AM	4516.58	9975.1	1936345.9	26.0	33	25	62.0	48	6.5	11.30	4.9	13.0	6.9	10.7	15.00	10		5.55	3.37	2.79	5.71	19.9
	Sun 8/29/99	08/29/1999 6:30	6:30 AM	4536.08	9994.4	1943127.1	28.0	31	25	63.0	48	6.5	14.80	5.1	13.0	6.9	14.2	15.00	10		7.27	2.57	2.23	5.71	19.9
	Sun 8/29/99	08/29/1999 10:30	10:30 AM	4540.08	9997.8	1944220.1	28.0	32	25	61.0	48	6.5	13.70	5.0	13.0	6.9	13.8	15.00	10		6.73	2.78	2.36	5.71	19.9
	Mon 8/30/99	08/30/1999 7:00	7:00 AM	4560.58	10018.4	1951462.4	27.0	31	25	63.0	47	6.5	15.00	5.1	13.0	6.9	13.7	15.00	10	just prior to full tank soak and flux test	7.37	2.54	2.20	5.71	19.9
	Mon 8/30/99	08/30/1999 7:30	7:30 AM	4561.08																begin full tank soak and flux test					
	Tue 8/31/99	08/31/1999 7:30	7:30 AM	4561.08																end full tank soak and flux test					
	Wed 9/1/99	09/01/1999 11:00	11:00 AM	4561.08	10022.3	1951634.8	28.0	32.5	25	62.0	48	6.5	1.70	4.0	13.0	6.8	1.7	15.00	10		0.83	22.41	18.76	5.71	19.6
	Wed 9/1/99	09/01/1999 11:30	11:30 AM	4561.58	10022.8	1951832.9	28.0	32.5	25	61.0	48	6.5	1.70	3.8	13.0	6.9	2.0	15.00	10		0.83	22.41	18.76	5.71	19.9
	Wed 9/1/99	09/01/1999 13:00	1:00 PM	4563.08	10024.3	1952341.5	27.0	33.5	25	61.0	48	6.5	1.70	3.8	13.0	6.8	1.7	15.00	10		0.83	22.41	18.32	5.71	19.6
	Thu 9/2/99	09/02/1999 7:30	7:30 AM	4581.58	10042.8	1958915.0	27.0	30.5	25	64.0	49	6.5	2.30	3.9	13.0	6.9	2.2	15.00	10		1.13	16.56	14.54	5.71	19.9
	Thu 9/2/99	09/02/1999 13:00	1:00 PM	4587.08	10048.3	1960899.6	26.0	32.5	25	61.0	48	6.5	2.40	3.9	13.0	6.9	2.3	15.00	10		1.18	15.87	13.29	5.71	19.9
	Fri 9/3/99	09/03/1999 8:00	8:00 AM	4606.08	10067.3	1967593.8	24.0	30.5	25	65.0	48	6.5	3.60	4.1	13.0	6.8	2.2	15.00	10		1.77	10.58	9.29	5.71	19.6
	Fri 9/3/99	09/03/1999 9:30	9:30 AM	4607.58	10068.8	1968134.5	28.0	31	25	62.0	48	6.5	3.70	3.9	13.0	6.9	3.2	15.00	10		1.82	10.29	8.93	5.71	19.9
	Fri 9/3/99	09/03/1999 11:00	11:00 AM	4609.08	10009.7	1963363.5	28.0	32	25	62.0	49	6.5	3.20	4.2	13.0	6.9	3.1	15.00	10		1.57	11.90	10.08	5.71	19.9
	Fri 9/3/99	09/03/1999 12:45	12:45 PM	4610.83	10071.4	1968939.8	27.0	33	25	62.0	48	6.5	3.20	4.1	13.0	6.8	3.1	15.00	10		1.57	11.90	9.85	5.71	19.6
	Sat 9/4/99	09/04/1999 7:00	7:00 AM	4629.08	10089.9	1975351.4	28.0	31	25	62.0	48	6.5	3.20	4.1	13.0	6.9	3.1	15.00	10		1.57	11.90	10.32	5.71	19.9
	Sat 9/4/99	09/04/1999 10:00	10:00 AM	4632.08	10092.7	1976455.1	27.0	32	25	61.0	49	6.5	3.20	4.1	13.0	6.8	3.2	15.00	10		1.57	11.90	10.08	5.71	19.6
	Sun 9/5/99	09/05/1999 8:00	8:00 AM	4654.08	10114.8	1984508.3	28.0	32	25	61.0	49	6.5	3.20	4.1	13.0	6.8	3.2	15.00	10		1.57	11.90	10.08	5.71	19.6
	Sun 9/5/99	09/05/1999 10:00	10:00 AM	4656.08	10118.0	1985667.9	28.0	33	25	61.0	49	6.5	3.30	4.1	13.0	6.8	3.2	15.00	10		1.62	11.54	9.55	5.71	19.6
	Mon 9/6/99	09/06/1999 7:00	7:00 AM	4677.08	10137.7	1992816.7	27.0	30	25	62.0	48	6.5	3.30	4.3	13.0	6.9	3.3	15.00	10		1.62	11.54	10.25	5.71	19.9
	Mon 9/6/99	09/06/1999 8:30	8:30 AM	4678.58	10139.1	1993319.4	27.0	30.5	25	63.0	49	6.5	3.50	4.3	13.0	6.8	3.4	15.00	10	maint cleaning	1.72	10.88	9.55	5.71	19.6
	Mon 9/6/99	09/06/1999 10:00	10:00 AM	4680.08	10140.0	1993550.9	28.0	30.5	25	63.0	49	6.5	3.20	4.2	13.0	6.8	3.2	15.00	10		1.57	11.90	10.45	5.71	19.6
	Mon 9/6/99	09/06/1999 13:00	1:00 PM	4683.08	10143.5	1994788.4	26.0	31	25	62.0	48	6.5	3.10	4.2	13.0	6.8	3.2	15.00	10		1.52	12.29	10.66	5.71	19.6
	Tue 9/7/99	09/07/1999 7:40	7:40 AM	4701.75	10161.7	2001219.6	28.0	30	25	63.0	48	6.5	3.10	4.2	13.0	6.8	3.2	15.00	10		1.52	12.29	10.91	5.71	19.6
	Tue 9/7/99	09/07/1999 13:00	1:00 PM	4707.08	10167.0	2003091.2	26.0	30.5	25	62.0	48	6.5	3.10	4.2	13.0	6.8	3.2	15.00	10		1.52	12.29	10.78	5.71	19.6
	Wed 9/8/99	09/08/1999 7:15	7:15 AM	4725.33	10185.2	2009521.5	27.0	30	25	63.0	48	6.5	3.20	4.1	13.0	6.7	3.2	15.00	10	maint cleaning	1.57	11.90	10.57	5.71	19.3
	Wed 9/8/99	09/08/1999 8:45	8:45 AM	4726.83	10186.1	2004749.8	28.0	30.5	25	63.0	48	6.5	3.10	4.2	13.0	6.7	3.1	15.00	10		1.52	12.29	10.78	5.71	19.3
	Wed 9/8/99	09/08/1999 12:45	12:45 PM	4730.83	10190.1	2011168.9	27.0	31	25	62.0	49	6.5	3.10	4.1	13.0	6.7	3.1	15.00	10		1.52	12.29	10.66	5.71	19.3
	Thu 9/9/99	09/09/1999 7:15	7:15 AM	4749.33	10208.6	2017678.5	28.0	30.5	25	63.0	48	6.5	3.10	4.1	13.0	6.7	3.2	15.00	10		1.52	12.29	10.78	5.71	19.3
	Thu 9/9/99	09/09/1999 12:45	12:45 PM	4754.83	10214.1	2019633.4	26.0	32	25	60.0	49	6.5	3.10	4.1	13.0	6.7	3.2	15.00	10		1.52	12.29	10.41	5.71	19.3
	Fri 9/10/99	09/10/1999 7:15	7:15 AM	4773.33	10232.6	20264150.9	27.0	30	25	62.0	49	6.5	3.50	4.1	13.0	6.7	3.2	15.00	10	maint cleaning	1.72	10.88	9.67	5.71	19.3
	Fri 9/10/99	09/10/1999 8:35	8:35 AM	4774.66	10233.2	20263523.8	28.0	31	25	62.0	46	6.5	3.20	4.2	13.0	6.8	3.2	15.00	10		1.57	11.90	10.32	5.71	19.6
	Fri 9/10/99	09/10/1999 1:00	1:00 AM	4767.08	10237.7	2027889.9	27.0	32	25	60.0	48	6.5	3.10	4.2	13.0	6.7	3.2	15.00	10		1.52	12.29	10.41	5.71	19.3
	Sat 9/11/99	09/11/1999 7:00	7:00 AM	4797.08	10255.8	2034283.9	28.0	31	25	62.0	49	6.5	3.10	4.2	13.0	6.8	3.2	15.00	10		1.52	12.29	10.66	5.71	19.6
	Sat 9/11/99	09/11/1999 11:30	11:30 AM	4801.58	10260.3	2039865.3	26.0	33	25	60.0	48	6.5	3.10	4.1	13.0	6.8	3.1	15.00	10		1.52	12.29	10.16	5.71	19.6
	Sun 9/12/99	09/12/1999 6:30	6:30 AM	4820.58	10279.2	2042503.8	28.0	30.5	25	62.0	48	6.5	3.30	4.1	13.0	6.7	3.3	15.00	10		1.62	11.54	10.13	5.71	19.3
	Sun 9/12/99	09/12/1999 11:00	11:00 AM	4825.08	10283.7	2044097.5	27.0	31	25	62.0	48	6.5	3.30	4.2	13.0	6.8	3.3	15.00	10		1.62	11.54	10.01	5.71	19.6
	Mon 9/13/99	09/13/1999 7:40	7:40 AM	4845.75	10304.3	2051362.1	27.0	31	25	62.0	49	6.5	3.30	4.2	13.0	6.7	3.4	15.00	10		1.62	11.54	10.01	5.71	19.3
	Mon 9/13/99	09/13/1999 9:30	9:30 AM	4847.58	10306.2	2052016.4	26.0	31	25	61.0	49	6.5	3.40	4.2	13.0	6.8	3.6	15.00	10	maint cleaning	1.67	11.20	9.72	5.71	
	Mon 9/13/99	09/13/1999 11:00	11:00 AM	4849.08	10307.0	2052243.9	28.0	32	25	61.0	49	6.5	3.40	4.2	13.0	6.7	3.3	15.00	10		1.67	11.20	9.49	5.71	19.3
	Mon 9/13/99	09/13/1999 12:45	12:45 PM	4850.83	10308.5	2052275.5	27.0	32.5	25	60.0	49	6.5	3.20	4.2	13.0	6.8	3.2	15.00	10		1.57	11.90		5.71	19.6
	Tue 9/14/99	09/14/1999 7:15	7:15 AM	4869.33	10327.3	2059388.7	24.0	30.5	25	62.0	49	6.5	3.20	4.2	13.0	6.7	3.3	15.00	10		1.57	11.90	10.45	5.71	19.3
	Tue 9/14/99	09/14/1999 9:30	9:30 AM	4871.58	10329.5	2060184.1	28.0	31	25	62.0	50	6.5	3.30	4.2	13.0	6.8	3.4	15.00	10	reading before C.S.T. test	1.62	11.54	10.01	5.71	19.6
	Tue 9/14/99	09/14/1999 11:05	11:05 AM	4873.16	10336.1	2060739.1	27.0	31.5	25	61.0	50	6.5	3.30	4.2	13.0	6.8	3.5	15.00	10	reading before C.S.T. test	1.62	11.54	9.89	5.71	19.6
	Tue 9/14/99	09/14/1999 12:45	12:45 PM	4874.83	10332.8	2061319.9	26.0	32	25	60.0	50	6.5	3.30	4.2	13.0	6.8	3.5	15.00	10	reading before C.S.T. test	1.62	11.54	9.78	5.71	19.6
	Tue 9/14/99	09/14/1999 13:50	1:50 PM	4875.91																					

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
	Wed 9/15/99	09/15/1999 7:00	7:00 AM	4875.91																unit off line at 1:50 PM to raise membranes					
	Thu 9/16/99	09/16/1999 15:00	3:00 PM	4875.91	100335.7	2062252.0	28.0	32.5	30	63.0	50	6.5	0.70	4.0	13.0	6.9	1.0	15.00	10	unit on line at 2 PM					
	Fri 9/17/99																								
	Fri 9/17/99	09/17/1999 7:15	7:15 AM	4892.16	10351.9	2068378.0	26.0	30	30	64.0	44	6.5	1.40	4.1	13.0	7.2	1.7	15.00	10		0.69	27.21	24.17	5.71	20.7
7	Fri 9/17/99	09/17/1999 9:15	9:15 AM	4894.16	10353.7	2069052.0	26.0	30	30	64.0	47	6.5	2.50	4.0	13.0	7.0	2.0	15.00	10	start cycled air to membrane tank 10 sec ON/OFF	1.23	15.24	13.53	5.71	20.1
7	Fri 9/17/99	09/17/1999 11:15	11:15 AM	4896.16	10357.4	2069787.4	26.0	30	30	64.0	47	6.5	2.50	4.0	13.0	6.8	2.0	15.00	10		1.23	15.24	13.53	5.71	19.6
7	Fri 9/17/99	09/17/1999 13:00	1:00 PM	4897.91	10374.5	2070420.1	24.0	30	32	62.0	49	6.5	1.60	4.2	13.0	7.0	1.7	15.00	10		0.79	23.81	21.15	5.71	20.1
7	Sat 9/18/99	09/18/1999 6:00	6:00 AM	4914.91	10374.5	2076656.4	26.0	30	32	64.0	48	6.5	2.00	4.2	13.0	6.8	2.3	15.00	10		0.98	19.05	16.92	5.71	19.6
7	Sat 9/18/99	09/18/1999 10:45	10:45 AM	4919.66	10379.2	2078370.1	28.0	31	30	63.0	45	6.5	2.20	4.2	13.0	7.0	2.3	15.00	10		1.08	17.31	15.02	5.71	20.1
7	Sun 9/19/99	09/19/1999 7:30	7:30 AM	4940.41	10349.9	2085955.1	25.0	30	30	64.0	38	6.5	2.90	4.2	13.0	7.0	2.3	15.00	10		1.42	13.13	11.67	5.71	20.1
7	Sun 9/19/99	09/19/1999 11:00	11:00 AM	4943.91	10403.5	2087250.7	24.0	32	30	61.0	49	6.5	2.90	4.2	13.0	6.9	2.8	15.00	10		1.42	13.13	11.13	5.71	19.9
7	Mon 9/20/99	09/20/1999 7:15	7:15 AM	4964.16	10423.7	2094520.1	27.0	30	32	63.0	49	6.5	3.70	4.4	13.0	6.8	3.3	15.00	10	maint cleaning	1.82	10.29	9.14	5.71	19.6
7	Mon 9/20/99	09/20/1999 9:50	9:50 AM	4966.75	10424.6	2094796.1	28.0	30	32	63.0	42	6.5	3.10	4.4	13.0	6.7	2.8	15.00	10		1.52	12.29	10.91	5.71	19.3
7	Mon 9/20/99	09/20/1999 13:00	1:00 PM	4969.91	10428.7	2096268.6	26.0	32	32	61.0	41	6.5	2.80	4.3	13.0	6.8	2.6	15.00	10		1.38	13.60	11.52	5.71	19.6
7	Tue 9/21/99	09/21/1999 7:15	7:15 AM	4988.16	10447.0	2102551.2	27.0	30	32	63.0	48	6.5	3.60	4.3	13.0	6.7	3.0	15.00	10		1.77	10.58	9.40	5.71	19.3
7	Tue 9/21/99	09/21/1999 12:45	12:45 PM	4993.66	10457.5	2104470.1	26.0	31.5	32	60.0	40	6.5	3.70	4.3	13.0	6.7	3.2	15.00	10		1.82	10.29	8.82	5.71	19.3
7	Wed 9/22/99	09/21/1999 6:00	6:00 AM	4986.91	10469.7	2110390.0	27.0	29.5	32	64.0	36	6.5	4.30	4.5	13.0	6.8	3.7	15.00	10	maint cleaning	2.11	8.86	7.96	5.71	19.6
7	Wed 9/22/99	09/22/1999 7:30	7:30 AM	5012.41	10470.6	2110606.4	27.0	30	32	64.0	47	6.5	3.20	4.5	13.0	6.8	3.6	15.00	10		1.57	11.90	10.57	5.71	19.6
7	Wed 9/22/99	09/22/1999 11:10	11:10 AM	5016.08	10474.2	2111991.5	28.0	30	32	63.0	43	6.5	15.20	4.3	13.0	12.5	13.2	15.00	10	high vacuum alarm	7.47	2.51	2.23	5.71	36.0
7	Wed 9/22/99	09/22/1999 13:00	1:00 PM	5017.91	10475.9	21122649.9	27.0	30.5	32	63.0	41	6.5	6.00	4.6	13.0	7.0	4.2	15.00	10		2.95	6.35	5.57	5.71	20.1
7	Thu 9/23/99	09/23/1999 7:00	7:00 AM	5035.91	10484.4	2119296.8	26.0	28.5	32	66.0	48	6.5	6.70	4.6	13.0	7.0	4.7	15.00	10		3.29	5.69	5.23	5.71	20.1
7	Thu 9/23/99	09/23/1999 12:45	12:45 PM	5041.66	10499.9	2121182.0	26.0	30	32	63.0	48	6.5	7.00	4.6	13.0	7.1	5.0	15.00	10		3.44	5.44	4.83	5.71	20.4
7	Fri 9/24/99	09/24/1999 7:15	7:15 AM	5060.16	10518.2	2127757.6	28.0	29.5	32	64.0	47	6.5	7.80	4.7	13.0	6.8	5.4	15.00	10	maint cleaning	3.83	4.88	4.39	5.71	19.6
7	Fri 9/24/99	09/24/1999 9:30	9:30 AM	5062.41	10519.8	2128271.5	27.0	30	32	63.0	47	6.5	6.00	4.6	13.0	7.2	5.0	15.00	10		2.95	6.35	5.64	5.71	20.7
7	Fri 9/24/99	09/24/1999 13:00	1:00 PM	5065.91	10523.6	2129524.6	26.0	31	32	62.0	48	6.5	6.10	4.5	13.0	6.8	5.1	15.00	10		3.00	6.24	5.42	5.71	19.6
7	Sat 9/25/99	09/25/1999 6:00	6:00 AM	5082.91	10540.7	2135554.1	27.0	29.5	32	64.0	40	6.5	6.60	4.6	13.0	7.0	5.2	15.00	10		3.24	5.77	5.19	5.71	20.1
7	Sat 9/25/99	09/25/1999 10:30	10:30 AM	5087.41	10544.8	2137127.6	28.0	30.5	32	64.0	48	6.5	6.70	4.6	13.0	6.9	5.2	15.00	10		3.29	5.69	4.99	5.71	19.9
7	Sun 9/26/99	09/26/1999 10:00	10:00 AM	5110.91	10560.2	2142593.5	25.0	30	32	64.0	36	6.5	6.60	4.6	13.0	6.9	5.2	15.00	10		3.24	5.77	5.13	5.71	19.9
7	Sun 9/26/99	09/26/1999 11:30	11:30 AM	5112.41	10563.0	2143613.5	26.0	31	32	64.0	44	6.5	6.30	4.6	13.0	6.9	5.3	15.00	10		3.09	6.05	5.24	5.71	19.9
7	Mon 9/27/99	09/27/1999 7:15	7:15 AM	5132.16	10582.6	2150616.7	28.0	30	32	64.0	36	6.5	5.70	4.6	13.0	7.0	4.7	15.00	10		2.80	6.68	5.94	5.71	20.1
7	Mon 9/27/99	09/27/1999 9:30	9:30 AM	5134.41	10584.8	2151436.8	28.0	30.5	32	63.0	45	6.5	5.70	4.6	13.0	7.0	4.9	15.00	10	maint cleaning	2.80	6.68	5.87	5.71	20.1
7	Mon 9/27/99	09/27/1999 10:45	10:45 AM	5135.66	10585.5	2151593.0	27.0	30.5	32	62.0	48	6.5	4.70	4.5	13.0	6.9	4.6	15.00	10		2.31	8.10	7.11	5.71	19.9
7	Mon 9/27/99	09/27/1999 11:20	11:20 AM	5136.25	10586.0	2151806.0	27.0	31	25	62.0	48	6.5	4.40	4.5	13.0	6.8	4.2	15.00	10	start peak flow at 9.5 gpm w/o intermittent aeration	2.16	8.66	7.51	5.71	19.6
8	Mon 9/27/99	09/27/1999 12:45	12:45 PM	5137.66	10587.5	2152592.3	26.0	31.5	25	62.0	48	9.5	11.50	4.5	13.0	11.5	12.2	15.00	10		5.65	4.84	4.15	3.91	33.1
	Tue 9/28/99	09/28/1999 7:30	7:30 AM	5156.41	10606.2	2159394.9	27.0	30	25	64.0	48	6.5	4.40	4.6	13.0	6.7	4.2	15.00	10		2.16	8.66	7.69	5.71	19.3
8	Tue 9/28/99	09/28/1999 13:00	1:00 PM	5161.91	10611.7	2162311.5	28.0	33.2	25	62.0	49	9.5	14.70	4.5	13.0	12.0	15.2	15.00	10		7.22	3.79		3.91	34.5
8	Tue 9/28/99	09/28/1999 14:00	2:00 PM	5162.91	10612.7	2162858.4	26.0	32	25	62.0	47	9.5	15.20	4.5	13.0	12.1	15.7	15.00	10	end of peak flow testing at 2 PM	7.47	3.66	3.10	3.91	34.8
	Wed 9/29/99	09/29/1999 7:15	7:15 AM	5180.16	10629.9	2169229.4	25.0	30.5	25	63.0	48	6.5	6.70	4.6	13.0	7.2	5.8	15.00	10		3.29	5.69	4.99	5.71	20.7
	Wed 9/29/99	09/29/1999 9:30	9:30 AM	5182.41	10632.3	2170090.1	28.0	30	25	64.0	45	6.5	6.60	4.6	13.0	7.0	5.7	15.00	10	maint cleaning	3.24	5.77	5.13	5.71	20.1
	Wed 9/29/99	09/29/1999 10:45	10:45 AM	5183.66	10632.8	2170122.5	28.0	30	25	64.0	47	6.5	5.90	4.8	13.0	6.9	5.3	15.00	10	start peak flow testing at 10:45 AM	2.90	6.46	5.73	5.71	19.9
8	Wed 9/29/99	09/29/1999 13:00	1:00 PM	5185.91	10635.0	2171429.5	27.0	28.5	25	64.0	42	9.5	16.20	4.6	13.0	12.0	16.2	15.00	10		7.96	3.44	3.16	3.91	34.5
8	Wed 9/29/99	09/29/1999 14:00	2:00 PM	5186.91	10636.0	2171960.4	27.0	28.5	25	64.0	46	9.5	16.70	4.6	13.0	11.6	17.2	15.00	10	end peak flow testing at 2 PM	8.20	3.33	3.07	3.91	33.4
	Thu 9/30/99	09/30/1999 7:30	7:30 AM	5204.41	10653.5	2178399.8	26.0	28.5	25	63.0	48	6.5	7.20	4.7	13.0	7.0	6.2	15.00	10		3.54	5.29	4.87	5.71	20.1
	Thu 9/30/99	09/30/1999 13:00	1:00 PM	5209.91	10659.0	2180398.0	28.0	29.5	25	62.0	46	6.5	7.20	4.7	13.0	7.1	6.2	15.00	10		3.54	5.29	4.75	5.71	20.4
	Fri 10/1/99	10/01/1999 7:15	7:15 AM	5228.16	10677.2	2186993.5	27.0	28.5	25	64.0	39	6.5	7.10	4.7	13.0	7.0	6.3	15.00	10		3.49	5.36	4.94	5.71	20.1
	Fri 10/1/99	10/01/1999 8:30	8:30 AM	5229.41	10677.9	2187157.0	28.0	29	25	63.0	48	6.5	6.50	4.7	13.0	6.9	6.2	15.00	10	reading before Peak Flow	3.19	5.86	5.33	5.71	19.9
8	Fri 10/1/99	10/01/1999 13:00	1:00 PM	5233.91	10682.4	2189252.5	26.0	30	25	61.0	45	9.5	12.20	4.6	13.0	12.0	17.2	15.00	10		5.99	4.56	4.05	3.91	34.5
	Sat 10/2/99	10/02/1999 6:15	6:15 AM	5251.16	10699.4	2195522.0	24.0	29	25	63.0	43	6.5	7.70	4.7	13.0	6.9	7.7	15.00	10		3.78	4.95	4.50	5.71	19.9
	Sat 10/2/99	10/02/1999 10:25	10:25 AM	5255.33	10703.7	2197090.4	27.0	30	25	62.0	41	6.5	7.70	4.8	13.0	6.8	7.2	15.00	10		3.78	4.95	4.39	5.71	19.6
	Sun 10/3/99	10/03/1999 8:30	8:30 AM	5277.41	10723.6	2204921.5	20.0	30	25	63.0	38	6.5	8.70	4.7	13.0	6.8	7.4	15.00	10		4.27	4.38	3.89	5.71	19.6
	Sun 10/3/99	10/03/1999 11:30	11:30 AM	5280.41	10728.7	2206035.2	26.0	32	25	63.0	48	6.5	8.70	4.7	13.0	6.8	7.4	15.00	10		4.27	4.38	3.71	5.71	19.6
	Mon 10/4/99	10/04/1999 7:15	7:15 AM	5300.16	10748.4	2213000.5	28.0	29.5	25	62.0	47	6.5	9.00	4.7	13.0	6.9	8.7	15.00	10		4.42	4.23	3.80	5.71	19.9
	Mon 10/4/99	10/04/1999 9:15	9:15 AM	5302.16	10750.4	2213713.8	26.0	30	25	64.0	40	6.5	8.70	4.7	13.0	6.9	8.7	15.00	10	maint cleaning	4.27	4.38	3.89	5.71	19.9
D	Mon 10/4/99	10/04/1999 10:30	10:30 AM	5303.41	10750.9	2213845.6	28.0	30	25	64.0	43	6.5	7.80	4.8	13.0	7.0	6.7	15.00	10	waste from aeration tank MLSS to 6000 mg/L	3.83	4.88	4.34	5.71	20.1
	Tue 10/5/99	10/05/1999 12:45	12:45 PM	5303.41	10752.5	2214426.9	28.0	30.5	25	64.0	48	6.5	4.50	4.6	13.0	6.9	4.1	15.00	10	unit ran from 12:45 to 3:30 PM only	2.21	8.46	7.43	5.71	19.9
	Tue 10/5/99	10/05/1999 15:00	3:00 PM	5305.66	10754.8	2215255.0	27.0	31	25	64.0	48	6.5	4.60	4.6	13.0	7.0	4.2	15.00	10		2.26	8.28	7.18	5.71	20.1
	Wed 10/6/99	10/06/1999 12:40	12:40 PM	5305.66																					
	Wed 10/6/99	10/06/1999 14:00	2:00 PM	5307.00	10757.3	2215938.4	28.0	30.5	25	65.0	48	6.5	4.10	4.6	13.0	6.9	3.3	15.00	10	started unit at 12:40 PM	2.01	9.29	8.15	5.71	19.9
	Wed 10/6/99	10/06/1999 15:00	3:00 PM	5308.00	10758.3	2216304.0	27.0	30.5	25	65.0	48	6.5	4.00	4.6	13.0	6.8	3.5	15.00	10	normal flow and full aeration	1.96	9.52	8.36	5.71	19.6
	Thu 10/7/99	10/07/1999 7:15	7:15 AM	5324.25	10774.6	2222081.5	26.0	29.5	25	67.0	49	6.5	4.20	4.7	13.0	6.7	4.2	15.00	10		2.06	9.07	8.15	5.71	19.3

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeate Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
9	Thu 10/7/99	10/07/1999 11:45	11:45 AM	5328.75																start cycled aeration to MT at 11:45 AM					
9	Thu 10/7/99	10/07/1999 13:00	1:00 PM	5330.00	10780.3	2224120.9	27.0	30.5	32	64.0	49	6.5	4.40	4.7	13.0	6.7	4.6	15.00	10		2.16	8.66	7.60	5.71	19.3
9	Fri 10/8/99	10/08/1999 6:45	6:45 AM	5347.75	10798.1	2230322.0	25.0	29.5	32	67.0	47	6.5	4.70	4.8	13.0	6.7	4.8	15.00	10	maint cleaning	2.31	8.10	7.28	5.71	19.3
9	Fri 10/8/99	10/08/1999 8:30	8:30 AM	5349.50	10799.2	2230644.8	28.0	30	32	68.0	48	6.5	4.40	4.8	13.0	6.8	4.5	15.00	10		2.16	8.66	7.69	5.71	19.6
9	Fri 10/8/99	10/08/1999 11:30	11:30 AM	5352.50																start peak flux testing from 11:45 to 2:00 PM					
10	Fri 10/8/99	10/08/1999 13:30	1:30 PM	5354.50	10804.2	2232975.4	24.0	31.5	32	64.0	48	9.5	10.60	4.6	13.0	11.0	10.7	15.00	10		5.21	5.25	4.50	3.91	31.7
	Sat 10/9/99	10/09/1999 7:00	7:00 AM	5372.00	10821.7	2239326.1	26.0	30	32	64.0	47	6.5	5.90	4.8	13.0	6.8	4.8	15.00	10		2.90	6.46	5.73	5.71	19.6
	Sat 10/9/99	10/09/1999 11:00	11:00 AM	5376.00	10825.6	2240756.9	26.0	32	30	66.0	48	6.5	5.90	5.8	13.0	6.9	4.8	15.00	10		2.90	6.46	5.47	5.71	19.9
	Sun 10/10/99	10/10/1999 6:15	6:15 AM	5395.25	10899.9	2247624.0	28.0	29.5	32	67.0	49	6.5	5.50	4.9	13.0	6.8	5.7	15.00	10		2.70	6.93	6.22	5.71	19.6
	Sun 10/10/99	10/10/1999 11:30	11:30 AM	5400.50	10850.2	2249510.4	27.0	30.5	32	65.0	48	6.5	5.80	4.7	13.0	6.9	5.8	15.00	10		2.85	6.57	5.76	5.71	19.9
	Mon 10/11/99	10/11/1999 7:30	7:30 AM	5420.50	10870.2	2256639.4	28.0	30	32	66.0	46	6.5	5.80	4.8	13.0	6.7	6.2	15.00	10		2.85	6.57	5.83	5.71	19.3
	Mon 10/11/99	10/11/1999 9:30	9:30 AM	5422.50	10872.1	2257309.8	27.0	30	32	66.0	45	6.5	6.00	4.7	13.0	6.8	6.0	15.00	10	maint cleaning	2.95	6.35	5.64	5.71	19.6
	Mon 10/11/99	10/11/1999 10:45	10:45 AM	5423.75	10872.3	2257459.6	28.0	31	32	66.0	47	6.5	5.30	4.7	13.0	6.7	5.3	15.00	10	started peak flow from 10:50 AM to 3:00 PM	2.60	7.19	6.23	5.71	19.3
10	Mon 10/11/99	10/11/1999 13:15	1:15 PM	5426.25	10873.3	2258851.1	26.0	31.5	32	65.0	46	9.5	14.20	4.6	13.0	11.5	15.3	15.00	10		6.97	3.92	3.36	3.91	33.1
10	Mon 10/11/99	10/11/1999 15:00	3:00 PM	5428.00	10894.0	2259790.5	28.0	32	32	64.0	46	9.5	15.40	4.6	13.0	11.8	16.5	15.00	10	started peak flow from 8 AM to 2 PM	7.56	3.62	3.06	3.91	34.0
	Tue 10/12/99	10/12/1999 7:30	7:30 AM	5444.50	10890.5	2265748.0	28.0	30	32	66.0	46	6.5	6.70	4.8	13.0	6.8	6.7	15.00	10		3.29	5.69	5.05	5.71	19.6
10	Tue 10/12/99	10/12/1999 12:45	12:45 PM	5449.75	10895.8	2268540.5	26.0	31	32	65.0	47	9.5	15.30	4.6	13.0	11.7	17.7	15.00	10		7.51	3.64	3.16	3.91	33.7
10	Tue 10/12/99	10/12/1999 14:00	2:00 PM	5451.00	10899.0	2269172.9	28.0	31.5	32	65.0	48	9.5	16.30	4.7	13.0	11.5	18.3	16.00	10		8.01	3.42	2.93	3.91	33.1
	Wed 10/13/99	10/13/1999 7:30	7:30 AM	5468.50	10914.5	2275644.2	24.0	29.5	32	67.0	47	6.5	8.20	4.9	13.0	7.0	8.2	15.00	10		4.03	4.65	4.18	5.71	20.1
	Wed 10/13/99	10/13/1999 9:30	9:30 AM	5470.50	10916.4	2276374.0	28.0	30	32	65.0	48	6.5	8.20	4.9	13.0	7.0	8.2	15.00	10	maint cleaning	4.03	4.65	4.13	5.71	20.1
	Wed 10/13/99	10/13/1999 10:45	10:45 AM	5471.75	10917.0	2276529.9	28.0	30.5	32	66.0	48	6.5	7.40	4.8	13.0	7.0	7.8	15.00	10	started peak flow from 11 AM to 3 PM	3.63	5.15	4.52	5.71	20.1
10	Wed 10/13/99	10/13/1999 12:45	12:45 PM	5473.75	10919.0	2277547.2	26.0	31.5	32	64.0	47	9.5	16.60	4.6	13.0	11.2	16.2	15.00	10		8.15	3.35	2.87	3.91	32.2
10	Wed 10/13/99	10/13/1999 15:00	3:00 PM	5476.00	10921.1	2278686.5	28.0	32	32	64.0	47	9.5	16.60	4.6	13.0	11.5	19.2	15.00	10	end peak flow testing to MT; continue intermittent air	8.15	3.35	2.84	3.91	33.1
11	Thu 10/14/99	10/14/1999 7:15	7:15 AM	5492.25	10937.4	2284666.1	26.0	30	32	66.0	43	6.5	8.80	4.7	13.0	7.0	8.6	15.00	10		4.32	4.33	3.84	5.71	20.1
11	Thu 10/14/99	10/14/1999 12:45	12:45 PM	5497.75	10942.9	2286691.0	28.0	31.5	32	64.0	49	6.5	8.60	4.7	13.0	7.1	8.2	15.00	10		4.22	4.43	3.80	5.71	20.4
11	Fri 10/15/99	10/15/1999 6:45	6:45 AM	5515.75	10951.7	2293193.9	28.0	30	32	67.0	49	6.5	8.60	4.8	13.0	6.9	8.2	15.00	10	maint cleaning	4.22	4.43	3.93	5.71	19.9
11	Fri 10/15/99	10/15/1999 8:20	8:20 AM	5517.33	10952.6	2293193.9	27.0	30	32	67.0	49	6.5	7.70	4.9	13.0	6.8	7.4	15.00	10		3.78	4.95	4.39	5.71	19.6
11	Fri 10/15/99	10/15/1999 13:00	1:00 PM	5522.00	10957.3	2295180.1	26.0	31.5	32	64.0	47	6.5	7.80	4.7	13.0	6.9	7.7	15.00	10		3.83	4.88	4.19	5.71	19.9
11	Sat 10/16/99	10/16/1999 6:15	6:15 AM	5539.25	10974.5	2301417.2	28.0	30	32	67.0	45	6.5	8.50	4.9	13.0	7.0	8.2	15.00	10		4.17	4.48	3.98	5.71	20.1
11	Sat 10/16/99	10/16/1999 11:30	11:30 AM	5544.50	10979.0	2303295.8	27.0	31	32	65.0	49	6.5	8.70	4.7	13.0	6.9	8.6	15.00	10		4.27	4.38	3.80	5.71	19.9
11	Sun 10/17/99	10/17/1999 8:00	8:00 AM	5565.00	11006.6	2310776.8	27.0	30	32	65.0	37	6.5	9.80	4.7	13.0	6.9	8.8	15.00	10		4.81	3.89	3.45	5.71	19.9
11	Sun 10/17/99	10/17/1999 13:15	1:15 PM	5570.25	11004.0	2312002.9	27.0	31	32	65.0	49	6.5	9.80	4.7	13.0	6.8	3.6	15.00	10		4.81	3.89	3.37	5.71	19.6
11	Mon 10/18/99	10/18/1999 7:45	7:45 AM	5588.75	11024.0	2319042.0	28.0	26	32	68.0	45	6.5	10.60	4.8	13.0	6.9	10.2	15.00	10		5.21	3.59	3.51	5.71	19.9
11	Mon 10/18/99	10/18/1999 9:30	9:30 AM	5590.50	11025.6	2319192.9	27.0	25.5	32	69.0	47	6.5	10.70	4.8	13.0	6.9	10.3	15.00	10	maint cleaning	5.26	3.56	3.52	5.71	19.9
11	Mon 10/18/99	10/18/1999 12:45	12:45 PM	5593.75	11026.9	2320568.9	28.0	25.5	32	67.0	48	6.5	8.50	4.9	13.0	6.8	7.2	15.00	10		4.17	4.48	4.43	5.71	19.6
11	Tue 10/19/99	10/19/1999 7:15	7:15 AM	5612.25	11045.4	2327160.1	27.0	25	32	69.0	44	6.5	9.70	4.8	13.0	6.9	9.0	15.00	10		4.76	3.93	3.93	5.71	19.9
11	Tue 10/19/99	10/19/1999 10:40	10:40 AM	5615.66																start intermittent aeration on both tanks					
12	Tue 10/19/99	10/19/1999 13:00	1:00 PM	5618.00	11051.1	2329176.5	26.0	25	32	68.0	44	6.5	10.10	4.8	13.0	6.8	9.2	15.00	10		4.96	3.77	3.77	5.71	19.6
12	Wed 10/20/99	10/20/1999 6:45	6:45 AM	5635.75	11068.9	2335400.1	27.0	24.8	32	68.0	48	6.5	11.00	4.9	13.0	6.9	9.7	15.00	10		5.40	3.46	3.48	5.71	19.9
12	Wed 10/20/99	10/20/1999 9:30	9:30 AM	5638.50	11071.6	2336337.5	28.0	25	32	68.0	48	6.5	10.50	4.9	13.0	6.8	9.7	15.00	10	maint cleaning	5.16	3.63	3.63	5.71	19.6
12	Wed 10/20/99	10/20/1999 11:45	11:45 AM	5640.75	11073.0	2336717.5	28.0	25.5	32	66.0	46	6.5	7.70	5.0	13.0	6.9	7.2	15.00	10		3.78	4.95	4.89	5.71	19.9
12	Thu 10/21/99	10/21/1999 7:15	7:15 AM	5660.25	11092.5	2353391.5	28.0	25	32	70.0	44	6.5	9.70	4.9	13.0	6.7	8.7	15.00	10		4.76	3.93	3.93	5.71	19.3
12	Thu 10/21/99	10/21/1999 12:45	12:45 PM	5665.75	11098.0	2345270.1	26.0	27	32	66.0	46	6.5	10.10	4.9	13.0	6.8	9.2	15.00	10		4.96	3.77	3.60	5.71	19.6
12	Fri 10/22/99	10/22/1999 6:00	6:00 AM	5683.00	11115.3	2351125.4	28.0	25	32	68.0	39	6.5	11.20	4.9	13.0	6.7	10.4	15.00	10		5.50	3.40	3.40	5.71	19.3
12	Fri 10/22/99	10/22/1999 8:00	8:00 AM	5685.00	11116.6	2351225.0	27.0	25	32	68.0	46	6.5	6.70	4.9	13.0	6.8	5.2	15.00	10	maint cleaning	3.29	5.69	5.69	5.71	19.6
12	Fri 10/22/99	10/22/1999 10:40	10:40 AM	5687.66	11119.3	2352147.0	28.0	26	32	66.0	38	6.5	6.70	4.7	13.0	6.7	6.2	15.00	10		3.29	5.69	5.55	5.71	19.3
12	Fri 10/22/99	10/22/1999 14:30	2:30 PM	5691.50	11123.1	2353438.0	27.0	28	32	65.0	45	6.5	6.70	4.7	13.0	6.8	6.4	15.00	10		3.29	5.69	5.29	5.71	19.6
12	Sat 10/23/99	10/23/1999 7:00	7:00 AM	5708.00	11139.7	2359253.5	26.0	25	32	66.0	41	6.5	9.60	4.7	13.0	6.7	7.3	15.00	10		4.72	3.97	3.97	5.71	19.3
12	Sat 10/23/99	10/23/1999 12:00	12:00 PM	5713.00	11144.3	2360848.3	22.0	27	32	66.0	48	6.5	9.60	4.7	13.0	6.7	7.3	15.00	10		4.72	3.97	3.78	5.71	19.3
12	Sun 10/24/99	10/24/1999 6:30	6:30 AM	5731.50	11163.1	2367382.0	27.0	25	32	68.0	45	6.5	9.30	4.8	13.0	6.7	8.6	15.00	10		4.57	4.10	4.10	5.71	19.3
12	Sun 10/24/99	10/24/1999 11:30	11:30 AM	5736.50	11168.6	2369264.2	28.0	27	32	64.0	47	6.5	9.70	4.8	13.0	6.8	8.7	15.00	10		4.76	3.93	3.75	5.71	19.6
12	Mon 10/25/99	10/25/1999 7:30	7:30 AM	5756.50	11188.1	2375959.5	28.0	25	32	66.0	47	6.5	10.70	4.9	13.0	6.9	10.2	15.00	10		5.26	3.56	3.56	5.71	19.9
12	Mon 10/25/99	10/25/1999 9:45	9:45 AM	5758.75	11190.4	2376759.0	28.0	26	32	66.0	45	6.5	11.20	4.9	13.0	7.0	10.2	15.00	10	maint cleaning	5.50	3.40	3.32	5.71	20.1
12	Mon 10/25/99	10/25/1999 11:00	11:00 AM	5760.00	11190.9	2376904.1	28.0	27	32	65.0	47	6.5	9.00	4.8	13.0	6.9	8.2	15.00	10		4.42	4.23	4.04	5.71	19.9
12	Mon 10/25/99	10/25/1999 13:00	1:00 PM	5762.00	11192.9	2377619.2	26.0	28	32	64.0	46	6.5	9.00	4.8	13.0	7.0	8.2	15.00	10		4.42	4.23	3.94	5.71	20.1
12	Tue 10/26/99	10/26/1999 7:30	7:30 AM	5780.50	11211.3	2384174.6	27.0	25.5	32	66.0	43	6.5	11.70	4.9	13.0	6.9	10.0	15.00	10		5.75	3.26	3.22	5.71	19.9
12	Tue 10/26/99	10/26/1999 12:45	12:45 PM	5785.75	11215.3	2385708.1	28.0	27.5	32	64.0	48	6.5	10.20	4.7	13.0	7.1	9.6	15.00	10		5.01	3.73	3.52	5.71	20.4
12	Wed 10/27/99	10/27/1999 7:30	7:30 AM	5804.50	11234.1	2392524.8	28.0	25	32	66.0	38	6.5	10.20	4.7	13.0	7.1	9.7	15.00	10		5.01	3.73	3.73	5.71	20.4
12	Wed 10/27/99	10/27/1999 9:45	9:45 AM	5806.75	11236.3	2393340.5	28.0	26.5	32	65.0	40	6.5	10.60	4.8	13.0	7.2	9.7	15.00	10	maint cleaning	5.21	3.59	3.47	5.71	20.7
12	Wed 10/27/99	10/27/1999 11:00	11:00 AM	5808.00	11236.8	2399488.5	27.0	27	32	63.0	44	6.5	9.70	4.8	13.0	7.0	9.2	15.00	10		4.76	3.93	3.75	5.71	20.1

Table C-1
ZenoGem Operating Data

Stage/Event	Date	Date	Time (hr:min)	Cumulative Operating Time (hrs)	Hour Meter Reading	Permeate Totalizer Reading (gal)	Feed Flowrate (gpm)	Temp ZW (degrees C)	Air ZW (cfm)	Supplemental Air (cfm)	Biomass Recirculation Rate (gpm)	Permeate Rate before BP (gpm)	Vacuum before BP (in Hg)	BP Pressure (psi)	BP loss in CIP Tank (Liters)	Permeat Rate after BP (gpm)	Vacuum after BP (in Hg)	BP Duration (sec)	BP Frequency (min)	Comments	TMP (psi)	Permeability (gfd/psi)	Permeability Corrected for Temperature Effects (gfd/psi)	HRT (hrs)	Flux (gfd) (After BP)
12	Wed 10/27/99	10/27/1999 13:00	1:00 PM	5810.00	11238.7	2394194.8	26.0	27.5	32	63.0	41	6.5	9.90	4.7	13.0	7.0	9.2	15.00	10		4.86	3.85	3.63	5.71	20.1
12	Thu 10/28/99	10/28/1999 7:30	7:30 AM	5828.50	11257.2	2400763.5	27.0	26.5	32	66.0	45	6.5	11.70	4.7	13.0	7.0	10.7	15.00	10		5.75	3.26	3.14	5.71	20.1
12	Thu 10/28/99	10/28/1999 12:45	12:45 PM	5833.75	11262.5	2402606.5	28.0	28	32	64.0	41	6.5	11.70	4.7	13.0	7.0	10.7	15.00	10		5.75	3.26	3.03	5.71	20.1
12	Fri 10/29/99	10/29/1999 7:30	7:30 AM	5852.50	11281.2	2409099.4	26.0	27	32	65.0	38	6.5	13.20	4.7	13.0	7.0	11.7	15.00	10		6.48	2.89	2.75	5.71	20.1
12	Fri 10/29/99	10/29/1999 9:45	9:45 AM	5854.75	11283.5	2409862.8	28.0	27	32	64.0	41	6.5	13.20	4.7	13.0	6.8	12.2	15.00	10	maint cleaning	6.48	2.89	2.75	5.71	19.6
12	Fri 10/29/99	10/29/1999 11:00	11:00 AM	5856.00	11283.8	2410006.0	28.0	29.5	32	62.0	44	6.5	11.20	4.9	13.0	6.9	10.2	15.00	10		5.50	3.40	3.06	5.71	19.9
12	Fri 10/29/99	10/29/1999 13:00	1:00 PM	5858.00	11285.7	2410698.6	26.0	28.5	32	62.0	39	6.5	11.20	4.7	13.0	6.8	10.7	15.00	10		5.50	3.40	3.13	5.71	19.6
12	Sat 10/30/99	10/30/1999 7:00	7:00 AM	5876.00	11303.7	2416855.9	25.0	27	32	64.0	37	6.5	13.90	4.8	13.0	6.8	11.7	15.00	10		6.83	2.74	2.61	5.71	19.6
12	Sat 10/30/99	10/30/1999 11:00	11:00 AM	5880.00	11307.9	2418312.3	15.0	28	32	62.0	43	6.5	14.50	4.7	13.0	6.7	11.7	15.00	10		7.12	2.63	2.45	5.71	19.3
12	Sun 10/31/99	10/31/1999 6:15	6:15 AM	5899.25	11326.9	2424672.0	24.0	25	32	66.0	38	6.5	16.70	4.8	13.0	6.9	15.2	15.00	10		8.20	2.28	2.28	5.71	19.9
12	Sun 10/31/99	10/31/1999 12:30	12:30 PM	5905.50	11332.4	2426487.8	28.0	27	32	64.0	41	6.5	15.80	4.9	13.0	7.1	14.7	15.00	10		7.76	2.41	2.30	5.71	20.4
12	Mon 11/1/99	11/01/1999 7:30	7:30 AM	5924.50	11352.2	2433077.4	26.0	24.5	32	66.0	49	6.5	18.20	4.9	13.0	7.4	17.7	15.00	10		8.94	2.09	2.12	5.71	21.3
12	Mon 11/1/99	11/01/1999 9:45	9:45 AM	5926.75	11354.7	2433859.8	28.0	26	32	64.0	42	6.5	17.90	4.7	13.0	7.2	17.7	15.00	10	maint cleaning	8.79	2.13	2.08	5.71	20.7
12	Mon 11/1/99	11/01/1999 11:00	11:00 AM	5928.00	11355.2	2433985.0	28.0	27	32	64.0	40	6.5	14.70	4.9	13.0	7.5	13.7	15.00	10		7.22	2.59	2.47	5.71	21.6
12	Mon 11/1/99	· 11/01/1999 13:00	1:00 PM	5930.00	11357.2	2434664.9	27.0	28	32	62.0	42	6.5	15.00	4.7	13.0	7.4	14.2	15.00	10		7.37	2.54	2.37	5.71	21.3
12	Tue 11/2/99	11/02/1999 7:15	7:15 AM	5948.25	11375.4	2440592.2	26.0	25.5	32	65.0	38	6.5	18.70	4.9	13.0	7.0	17.7	15.00	10	END OF TESTING	9.18	2.04	2.01	5.71	20.1
A(AT 6 GPM)	MEAN							26.2	25.0	3.5	26.2	6.0	2.73	3.3	13.0	6.0	2.57	15.00	10.0		1.37	20.06	19.57	6.18	17.28
	MIN							24.0	25.0	3.4	14.0	6.0	0.5	3.2	13.0	6.0	0.50	15.00	10.0		0.37	4.69	4.47	6.18	17.27
	MAX							28.0	25.0	3.5	31.0	6.0	7.50	3.6	13.0	6.1	6.80	15.00	10.0		3.68	46.88	45.78	6.18	17.56
B	MEAN						25.5	27.8	25.0	42.8	38.4	6.7	2.79	3.2	13.2	6.7	2.72	15.0	10.0		1.37	18.48	17.44	5.67	19.23
	MIN						4.0	21.0	24.0	20.0	3.6	4.0	0.50	2.2	12.0	4.0	0.20	15.0	10.0		0.25	5.77	5.01	3.91	11.51
	MAX						30.0	32.0	25.0	51.0	50.0	9.5	6.60	3.9	16.0	9.5	6.20	15.1	10.0		3.24	46.88	46.88	9.28	27.34
C	MEAN						25.5	31.2	25.5	59.6	47.9	6.6	6.07	5.1	14.7	6.9	5.53	15.0	10.0		2.99	7.72	6.68	5.63	19.89
	MIN						3.5	27.0	25.0	48.0	32.0	6.5	0.70	3.4	12.0	6.0	1.00	15.0	10.0		0.69	2.51	2.20	3.86	17.27
	MAX						29.0	34.0	32.0	70.0	60.0	9.6	18.70	7.9	19.0	12.5	18.00	15.0	10.0		9.18	27.21	24.17	5.71	35.98
D	MEAN						26.9	28.3	31.4	65.5	45.1	6.8	9.93	4.8	13.0	7.3	9.34	15.0	10.0		4.88	4.57	4.19	5.55	21.03
	MIN						15.0	24.5	25.0	62.0	37.0	6.5	4.0	4.6	13.0	6.7	3.30	15.0	10.0		1.96	2.04	2.01	3.91	19.28
	MAX						28.0	32.0	32.0	70.0	49.0	9.5	18.70	5.8	13.0	11.8	19.20	15.0	10.0		9.18	9.52	8.36	5.71	33.96
A(AT 6 GPM)								26.2	25.0	3.5	26.2	6.0	2.73	3.3	13.0	6.0	2.57	15.0	10.0		1.37	20.06	19.57	6.18	17.28
B(NORMAL MIN)							4.0	24.0	24.0	20.0	3.6	4.0	0.50	2.2	13.0	4.0	0.20	15.0	10.0		0.25	5.77	5.01	3.91	11.51
B(NORMAL MAX)							30.0	32.0	25.0	51.0	50.0	9.5	6.60	3.9	16.0	9.5	6.20	15.1	10.0		3.24	46.88	46.88	9.28	27.34
B(NORMAL MEAN)							25.6	28.0	25.0	42.9	38.3	6.4	2.66	3.3	13.2	6.4	2.59	15.0	10.0		1.31	18.93	17.82	5.83	18.50
B(PEAK-EVENT 1)							25.4	25.8	25.0	41.9	39.5	9.5	4.17	3.0	12.8	9.5	4.12	15.0	10.0		2.05	13.46	13.19	3.91	27.34
C (NORMAL)							25.4	31.2	25.0	59.2	48.2	6.5	5.7	5.2	14.9	6.7	5.1	15.0	10.0		2.80	7.76	6.69	5.70	19.27
C(PEAK-EVENTS 3,4,8)							26.7	31.9	25.0	61.4	47.5	9.2	15.3	5.1	13.8	11.1	15.9	15.0	10.0		7.53	3.59	3.05	4.02	31.87
C(NORMAL WITH CYCLED AIR TO MT-EVENT 7)							26.6	30.3	31.4	63.1	44.6	6.5	4.9	4.4	13.0	7.1	4.1	15.0	10.0		2.41	9.85	8.67	5.71	20.41
D(NORMAL)							27.3	30.3	25.0	64.8	47.3	6.5	4.9	4.7	13.0	6.9	4.3	15.0	10.0		2.39	8.25	7.27	5.71	19.81
D(NORMAL AND CYCLED AIR TO MT-EVENT 9)							26.7	30.0	32.0	66.3	48.0	6.5	4.5	4.8	13.0	6.7	4.6	15.0	10.0		2.21	8.47	7.52	5.71	19.38
D(PEAK WITH CYCLED AIR TO MT-EVENT 10)							26.6	31.6	32.0	64.4	47.0	9.5	15.0	4.6	13.0	11.5	16.3	15.0	10.0		7.37	3.79	3.25	3.91	32.98
D(NORMAL AND CYCLED AIR TO MT-EVENT 11)							27.2	29.0	32.0	66.4	46.2	6.5	9.1	4.8	13.0	6.9	8.2	15.0	10.0		4.45	4.25	3.86	5.71	19.88
D(NORMAL AND CYCLED AIR TO MT AND AT-EVENT 12)							26.7	26.4	32.0	65.3	43.1	6.5	11.5	4.8	13.0	6.9	10.5	15.0	10.0		5.65	3.54	3.42	5.71	19.96

Table C-2
ZenoGem Water Quality Data

																		FEED														MEMBRANE TANK					
STAGE/EVENT	Date	Run Time (hr)	Permeate Flowrate (gpm)	WWTP Influent NH3-N (mg/L)	WWTP Influent CBOD (mg/L)	WWTP Influent TSS (mg/L)	Sludge Wasted from Aeration Tank (gpd)	Sludge Wasted from Membrane Tank (gpd)	Total Mass Produced (lb/day)	Total Mass BOD5 Applied (lb/day)	Sludge Yield	System SRT (days)	Waste Sludge COD (mg/L)	Waste Sludge TKN (mg/L)	Waste Sludge TP (mg/L)	Waste Sludge MLSS (mg/L)	Waste Sludge MLVSS (mg/L)	pH	Temperature (degrees C)	Conductivity (uS/cm)	COD (mg/L)	ALK (mg/L)	DO (mg/L)	Feed CBOD5 (mg/L)	Feed TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)
A	Mon 2/8/99	47.25	6.00	28.00	196.00	184.00	90			38		24.73						7.29	26.00			380.00	0.30	530.00	340.00	33.00		0.04			41.80	6.96	26.20	7.20	0.56	14,900.00	10,350.00
	Tue 2/9/99	71.50	4.50	28.10			100					22.26							26.00				1.30										27.00	6.90			
	Wed 2/10/99	95.25	4.40		218.00	196.00	100			14		22.26						7.13	26.00	1,930.00			1.10	262.00	236.00	25.30						7.07	27.00	6.10	0.50	13,700.00	9,550.00
	Thu 2/11/99	122.58	4.50																26.40				0.40										27.00	6.00		26,350.00	
	Fri 2/12/99	122.58																																8.80		9,000.00	
	Sat 2/13/99	122.58																																		6,600.00	
	Sun 2/14/99	122.58	3.00																																	6,950.00	
	Mon 2/15/99	146.58	3.00	31.10																		386.00												6.80		7,150.00	
	Tue 2/16/99	169.08	3.25	30.10															24.50				0.40										24.50	8.50		7,950.00	
	Wed 2/17/99	192.83	4.50		220.00	152.00				11								7.10	25.00	190.00	760.00		0.40	200.00	124.00	25.40		0.03	86.80	86.83	15.00	7.42	25.00	8.00	0.44	9,000.00	6,400.00
	Thu 2/18/99	217.08	4.60					90	8			24.73							25.00	1,780.00			0.70										25.00	7.20		10,250.00	
	Fri 2/19/99	241.08	4.50		335.00	196.00		90	10	19	0.52	24.73							25.00	1,740.00			0.70	347.00	252.00	26.20							26.00	7.70		13,100.00	9,450.00
	Sat 2/20/99	265.08	4.50																																	10,875.00	
	Sun 2/21/99	289.58	4.50					90	10			24.73																								13,100.00	
	Mon 2/22/99	313.08	4.50	33.30	183.00	120.00		100	11	13	0.86	22.26						6.81	25.00	1,060.00		545.00	1.10	246.00	164.00	26.00		0.16	85.70	85.86	19.70	7.05	25.00	6.90		13,700.00	9,850.00
	Tue 2/23/99	337.08	6.00	28.20			100	100	12			22.26							25.00	1,770.00			2.10										25.00	7.30		14,150.00	
	Wed 2/24/99	361.08	6.00		246.00	192.00		125	13	16	0.82	17.81						7.18	25.00	1,830.00			3.00	220.00	390.00	23.40						7.22	26.00	6.80	0.74	12,500.00	8,900.00
	Thu 2/25/99	385.58	6.00					95	13			23.43							25.00	1,770.00			1.80										26.50	6.90		16,550.00	
	Fri 2/26/99	409.08	6.00		288.00	168.00		120	15	18	0.85	18.55							26.00	1,990.00			2.40	248.00	360.00	25.00							26.00	6.50		15,250.00	11,000.00
	Sat 2/27/99	433.75	6.00				90					24.73																								11,175.00	
	Sun 2/28/99	456.58	6.00				100					22.26																								10,550.00	
	Mon 3/1/99	481.08	6.00	32.40	232.00	192.00	50	100	24	15	1.53							7.20	26.00	1,850.00	300.00	391.00	0.60	214.00	180.00	26.60		0.04	155.00	155.04	29.30	7.09	26.00	4.60	0.68	22,850.00	15,900.00
	Tue 3/2/99	505.08	6.00	32.10				100	15			22.26							26.00	1,860.00			1.80										27.00	5.70		17,450.00	
	Wed 3/3/99	529.08	6.00		270.00	216.00		150	25	16	1.54	14.84						7.32	25.50	2,030.00			1.30	224.00	170.00	30.40						7.40	26.00	6.20	0.68	19,900.00	13,900.00
	Thu 3/4/99	553.08	6.00				50	125	16										25.50	2,630.00			0.60										25.50	4.70		15,800.00	
	Fri 3/5/99	577.08	6.00		265.00	208.00	150	150	38	14	2.75	14.84							26.00	2,140.00			1.80	194.00	165.00	27.20							27.00	4.70		18,000.00	12,800.00
	Sat 3/6/99	601.08	6.00				100	125	25			21.77																								14,550.00	
	Sun 3/7/99	625.08	6.00				100	150	30			21.30																								14,950.00	
	Mon 3/8/99	649.08	6.00	32.00	278.00	188.00		150	24	19	1.26	14.84												266.00	164.00	27.00		0.02	66.70	66.72	12.00					19,300.00	13,600.00
	Tue 3/9/99	653.08		30.00																																	
	Wed 3/10/99	653.08																																			
	Thu 3/11/99	653.08																																			
	Fri 3/12/99	653.08																																			
	Sat 3/13/99	653.08																																			
	Mon 3/15/99	653.08		32.30																																	
	Wed 3/17/99	653.08		33.70																																	
	Fri 3/19/99	653.08																																			
B	Sat 3/20/99	677.58	4.00																																		7,450.00
	Sun 3/21/99	701.58	4.00																																		9,950.00
	Mon 3/22/99	725.58	6.00	33.00	222.00	184.00				15								7.31	26.00	2,370.00		542.00	0.90	215.00	116.00	26.80		0.10	87.10	87.20	24.00	7.18	25.00	7.00	0.66	11,500.00	8,050.00
	Tue 3/23/99	749.58	6.50	33.10				120	14			18.55							26.00	1,980.00			1.00										27.00	3.80		14,450.00	
	Wed 3/24/99	773.58	6.50		268.00	192.00		150	19	16	1.17	14.84						7.27	26.00	2,000.00			0.60	204.00	196.00	27.20						7.30	27.80	5.10	0.87	14,850.00	10,550.00
	Thu 3/25/99	797.58	6.50				100	150	31			21.30							26.00	2,640.00			0.70										27.30	3.10		15,750.00	
	Fri 3/26/99	821.33	6.50		264.00	212.00				23									26.00	2,002.00			2.40	296.00	432.00	28.60							27.00	6.10		16,100.00	11,500.00
	Sat 3/27/99	845.58	6.50																																	15,500.00	
	Sun 3/28/99	845.58	4.00																																		
	Mon 3/29/99	865.08	4.00	25.00	220.00	240.00				11								7.33	26.00	2,060.00	730.00	363.00	0.90	229.00	172.00	24.00		0.17	125.00	125.17	19.50	7.25	26.00	4.70	0.80	18,500.00	12,850.00
	Tue 3/30/99	889.08	4.00	26.40				150				14.84							26.00	2,170.00			0.70										26.40	3.00			
1	Wed 3/31/99	913.08	6.50		276.00	180.00		100	15	22	0.67	22.26						7.12	26.00	1,860.00			0.80	282.00	140.00	27.00						7.39	26.00	2.10	0.80	17,650.00	12,400.00
1	Thu 4/1/99	936.58	9.50		372.00	296.00		150	23	31	0.73	14.84							26.00	2,090.00			0.50	270.00	164.00	26.00							27.00	1.50		18,050.00	12,950.00
	Fri 4/2/99	961.08	6.50																26.50	1,920.00			0.90										28.00	1.70			
	Sat 4/3/99	988.58	6.50					150	20			14.84																								16,250.00	
	Sun 4/4/99	1013.58	6.50					150	22			14.84																								17,300.00	
	Mon 4/5/99	1033.66	6.50	28.20	193.00	156.00		150	20	15	1.34	14.84						7.27	27.00	1,960.00			0.60	192.00	212.00	27.00						7.47	28.00	1.20		16,050.00	11,550.00
	Tue 4/6/99	1057.08	6.50	26.40				150	20			14.84							26.40	1,890.00			0.30					0.48	64.10	64.58	12.80		28.20	2.40		16,300.00	
	Wed 4/7/99	1081.08	6.50		316.00	200.00		150	21	17	1.19	14.84						7.12	27.00	2,040.00			0.30	224.00	136.00	24.50						6.84	29.00	1.70	0.69	16,650.00	12,100.00
	Thu 4/8/99	1106.33	6.50					150	23			14.84							27.50	2,300.00			0.40										28.50	3.40		18,450.00	
	Fri 4/9/99	1129.08	6.50		265.00	164.00		150	20	21	0.97	14.84							27.50	2,140.00			0.30	266.00	144.00	22.20							29.80	5.90		16,150.00	11,900.00
	Sat 4/10/99	1157.58	6.50					100	11			22.26																								13,150.00	
	Sun 4/11/99	1181.58	6.50																																	12,500.00	
	Mon 4/12/99	1205.08	6.50	26.00	201.00	120.00		100	13	17	0.76	22.26						7.18	27.00	2,150.00	700.00	384.00	0.40	218.00	128.00	22.00		0.02	74.60	74.62	19.00	7.12	29.80	3.10	0.74	15,550.00	11,400.00
	Tue 4/13/99	1229.08	6.50	31.00	210.00	228.00	100	150	33	18	1.82	21.30							27.00	2,050.00			0.70	231.00	180.00	26.70							29.00	3.50		14,750.00	

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT	Date	Run Time (hr)	Permeate Flowrate (gpm)	WWTP Influent NH3-N (mg/L)	WWTP Influent CBOD (mg/L)	WWTP Influent TSS (mg/L)	Sludge Wasted from Aeration Tank (gpd)	Sludge Wasted from Membrane Tank (gpd)	Total Mass Produced (lb/day)	Total Mass BOD Applied (lb/day)	Sludge Yield	System SRT (days)	Waste Sludge COD (mg/L)	Waste Sludge TKN (mg/L)	Waste Sludge TP (mg/L)	Waste Sludge MLSS (mg/L)	Waste Sludge MLVSS (mg/L)
	Wed 4/14/99	1253.08	6.50		276.00	164.00		150	21	18	1.16	14.84					
	Thu 4/15/99	1277.08	6.50					150	23			14.84					
	Fri 4/16/99	1300.83	6.50		264.00	164.00		150	21	14	1.47	14.84					
	Sat 4/17/99	1324.83	6.50					150	21			14.84					
	Sun 4/18/99	1349.58	6.50		193.00	208.00		130	17			17.12					
	Mon 4/19/99	1369.08	6.50	31.50	239.00	120.00	125	150	41	26	1.59	17.49					
	Tue 4/20/99	1393.08	6.50	30.00	264.00	148.00	125	150	38			17.49					
	Wed 4/21/99	1417.08	6.50		368.00	212.00	100	150	33	19	1.70	21.30				17,700.00	
	Thu 4/22/99	1441.08	6.50		268.00	204.00	150	150	40			14.84					
	Fri 4/23/99	1465.08	6.50		296.00	172.00	150	150	38	17	2.21	14.84				16,500.00	
	Sat 4/24/99	1489.58	6.50		260.00	200.00	150	150	42			14.84					
	Sun 4/25/99	1513.08	6.50		222.00	188.00	150	150	40			14.84					
	Mon 4/26/99	1537.33	6.50	25.60	146.00	116.00	150	150	37	15	2.42	14.84				19,150.00	
	Tue 4/27/99	1561.08	6.50	27.50	368.00	168.00	150	150	39			14.84					
	Wed 4/28/99	1585.08	6.50		407.00	192.00	100	150	31	22	1.39	21.30				15,800.00	
	Thu 4/29/99	1609.08	6.50		240.00	176.00	100	150	36			21.30					
	Fri 4/30/99	1634.08	6.50		293.00	180.00	125	150	32	17	1.85	17.49				15,300.00	
	Sat 5/1/99	1656.08	6.50		256.00	176.00	125	150	19			17.49					
	Sun 5/2/99	1681.08	6.50		193.00	160.00	125	125	17			17.81					
	Mon 5/3/99	1705.08	6.50	31.40	155.00	48.00	150	150	37	13	2.93	14.84				16,900.00	
	Tue 5/4/99	1729.08	6.50	30.70	285.00	180.00	150	150	36			14.84					
	Wed 5/5/99	1753.08	6.50		238.00	180.00	125	150	29	17	1.66	17.49				13,250.00	
	Thu 5/6/99	1777.08	6.50		230.00	172.00	150	225	40			14.20					
C	Fri 5/7/99	1801.08	6.50		236.00	168.00	100	250	31	19	1.62	19.60				11,000.00	
	Sat 5/8/99	1825.08	6.50		252.00	180.00	150	150	32			14.84					
	Sun 5/9/99	1848.58	6.50		225.00	176.00	150	225	37			14.20					
	Mon 5/10/99	1873.08	6.50	27.20	136.00	120.00	175	250	36	11	3.30	12.25				11,400.00	
	Tue 5/11/99	1897.08	6.50	28.00	192.00	172.00	75	200	24			25.80					
	Wed 5/12/99	1921.08	6.50		251.00	172.00	100	170	22	18	1.26	20.94				10,150.00	
	Thu 5/13/99	1945.08	6.50		216.00	160.00	75	190	22			26.07					
	Fri 5/14/99	1969.33	6.50		150.00	160.00	100	175	23	16	1.47	20.85				12,950.00	
	Sat 5/15/99	1993.08	6.50		212.00	180.00	100	250	35			19.60					
	Sun 5/16/99	2016.58	6.50		256.00	212.00	75	200	22			25.80					
	Mon 5/17/99	2041.08	6.50	28.00	145.00	116.00				11							
	Tue 5/18/99	2065.33	6.50	27.80	212.00	172.00											
	Wed 5/19/99	2089.08	6.50		230.00	240.00				14							
	Thu 5/20/99	2113.08	6.50		216.00	168.00	100	200	27			20.42					
	Fri 5/21/99	2137.08	6.50		192.00	144.00	150	250	43	14	3.04	14.00					
	Sat 5/22/99	2161.08	6.50		202.00	144.00	100	200	30			20.42					
	Sun 5/23/99	2185.08	6.50		202.00	124.00	100	200	27			20.42					
	Mon 5/24/99	2213.08	6.50	30.10	151.00	100.00				10							
	Tue 5/25/99	2233.08	6.50	26.20	154.00	128.00											
	Wed 5/26/99	2257.08	6.50		206.00	152.00				16							
	Thu 5/27/99	2281.08	6.50		164.00	168.00		120	12			18.55					
	Fri 5/28/99	2305.08	6.50		242.00	172.00		75	7	18	0.38	29.68				12,000.00	
	Sat 5/29/99	2328.58	6.50		238.00	172.00		120	12			18.55					
	Sun 5/30/99	2352.58	6.50		162.00	140.00		120	13			18.55					
	Mon 5/31/99	2377.08	6.50	30.00	180.00	116.00				13						10,750.00	
	Tue 6/1/99	2401.08	6.50	29.50	148.00	112.00											
	Wed 6/2/99	2425.08	6.50		359.00	164.00				22							
	Thu 6/3/99	2449.08	6.50		179.00	144.00		90	9			24.73					
	Fri 6/4/99	2473.08	6.50		191.00	160.00				11							
	Sun 6/6/99	2521.08	6.50		208.00	148.00		100	12			22.26					
	Mon 6/7/99	2545.08	6.50	28.10	146.00	140.00				12							
	Tue 6/8/99	2569.08	6.50	24.40	180.00	132.00											
	Wed 6/9/99	2593.08	6.50		212.00	144.00		70	7	16	0.45	31.80	2880	1502	169	11,700.00	9,000.00
	Thu 6/10/99	2617.08	6.50		162.00	200.00											
	Fri 6/11/99	2641.08	6.50		204.00	164.00				15							
	Sat 6/12/99	2665.08	6.50		204.00	168.00		90	12			24.73					
	Sun 6/13/99	2690.08	6.50		190.00	136.00		90	12			24.73					
	Mon 6/14/99	2713.08	6.50	22.50	135.00	112.00		90	10	12	0.84	24.73	3140	1304	153	12,300.00	9,600.00
	Tue 6/15/99	2736.83	6.50	26.50	156.00	168.00		90	10			24.73					

Date	FEED pH	Temperature (degrees C)	Conductivity (uS/cm)	COD (mg/L)	ALK (mg/L)	DO (mg/L)	Feed CBOD5 (mg/L)	Feed TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)
Wed 4/14/99	7.22	27.50	2,050.00			0.70	231.00	160.00	26.70					
Thu 4/15/99		28.00	2,200.00			0.80								
Fri 4/16/99		25.20	2,310.00			0.70	184.00	148.00	23.60					
Sat 4/17/99														
Sun 4/18/99														
Mon 4/19/99	7.08	26.00	2,320.00		498.00	0.40	330.00	134.00	23.40		0.37	91.90	92.27	13.50
Tue 4/20/99		27.00	2,260.00			0.60								
Wed 4/21/99	7.18	27.00	2,150.00			0.90	248.00	122.00	25.00	11.30				
Thu 4/22/99		27.50	2,220.00			0.90								
Fri 4/23/99		28.00	2,050.00			0.80	222.00	144.00	27.30	27.60				
Sat 4/24/99														
Sun 4/25/99														
Mon 4/26/99	7.65	27.00	2,430.00	429.00	370.00	0.80	196.00	108.00	27.10		0.01	36.10	36.11	4.60
Tue 4/27/99		30.00	2,070.00			0.60								
Wed 4/28/99	6.78	27.00	2,030.00			0.60	282.00	172.00	23.50	26.80				
Thu 4/29/99		28.00	1,884.00			0.70								
Fri 4/30/99		27.00	1,945.00			0.60	219.00	500.00	24.50					
Sat 5/1/99														
Sun 5/2/99														
Mon 5/3/99	7.28	28.00	2,510.00		376.00	0.70	164.00	112.00	27.70		0.01	45.30	45.31	4.97
Tue 5/4/99		28.00	2,040.00			0.80								
Wed 5/5/99	7.23	29.00	2,330.00			0.60	220.00	184.00	24.00					
Thu 5/6/99		29.00	1,940.00			0.70								
Fri 5/7/99		28.00	2,040.00			0.60	246.00	140.00	26.00					
Sat 5/8/99														
Sun 5/9/99														
Mon 5/10/99	6.97	29.00	1,982.00	390.00	350.00	0.80	141.00	124.00	27.00		0.05	55.00	55.05	6.09
Tue 5/11/99		28.50	1,846.00			0.80								
Wed 5/12/99	7.06	28.00	1,911.00			0.70	227.00	180.00	25.60					
Thu 5/13/99		28.50	1,980.00			0.50								
Fri 5/14/99		29.00	1,995.00			0.80	200.00		25.70					
Sat 5/15/99														
Sun 5/16/99														
Mon 5/17/99	7.10	29.00	1,858.00		380.00	0.70	140.00	104.00	26.30					
Tue 5/18/99		28.00	1,836.00			1.00					0.01	51.50	51.51	17.80
Wed 5/19/99	7.36	29.00	1,826.00			0.80	176.00	120.00	25.00					
Thu 5/20/99		29.00	1,804.00			0.90								
Fri 5/21/99		29.00	1,667.00			0.70	181.00	92.00	23.70					
Sat 5/22/99														
Sun 5/23/99														
Mon 5/24/99	7.31	29.00	1,982.00	275.00	360.00	0.90	130.00	156.00	27.10		5.62	41.60	47.22	12.70
Tue 5/25/99		29.50	1,896.00			1.00								
Wed 5/26/99	6.83	28.50	1,993.00			0.80	210.00	124.00	28.40					
Thu 5/27/99		28.00	1,810.00			1.10								
Fri 5/28/99		28.50	1,993.00			0.80	228.00	124.00	22.80					
Sat 5/29/99														
Sun 5/30/99														
Mon 5/31/99	7.48	29.50	1,854.00			0.70	161.00	80.00	29.00					
Tue 6/1/99		30.00	1,823.00		360.00	0.90								
Wed 6/2/99	7.04	30.00	1,860.00			0.80	278.00	132.00	25.00		0.09	33.40	33.49	5.90
Thu 6/3/99		29.50	2,100.00			0.90								
Fri 6/4/99		29.00	1,870.00			0.90	146.00	112.00	24.40					
Sun 6/6/99														
Mon 6/7/99	7.31	29.50	2,110.00	276.00	360.00	0.90	153.00	108.00	22.00		0.03	56.70	56.73	12.20
Tue 6/8/99		30.00	1,980.00			0.80								
Wed 6/9/99	7.18	30.00	2,300.00				208.00	160.00	22.30					
Thu 6/10/99		29.70	2,200.00			0.80								
Fri 6/11/99		30.00	2,000.00			0.90	190.00	128.00	23.00					
Sat 6/12/99														
Sun 6/13/99														
Mon 6/14/99	7.08	29.50	1,960.00		348.00	0.80	148.00	106.00	22.20		0.21	58.10	58.31	22.70
Tue 6/15/99		30.00	1,870.00			0.90								

Date	MEMBRANE TANK pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)
Wed 4/14/99	7.09	28.10	2.20	0.76	16,750.00	12,050.00
Thu 4/15/99		28.00	1.80		18,000.00	
Fri 4/16/99		27.00	2.80		16,850.00	12,050.00
Sat 4/17/99					16,800.00	
Sun 4/18/99					15,950.00	
Mon 4/19/99	7.28	27.00	1.40	0.86	19,350.00	13,800.00
Tue 4/20/99		26.00	2.00		17,300.00	
Wed 4/21/99	7.18	27.00	1.90	0.85	16,450.00	11,800.00
Thu 4/22/99		28.00	1.30		17,300.00	
Fri 4/23/99		29.00	1.80		16,200.00	11,700.00
Sat 4/24/99					19,250.00	
Sun 4/25/99					17,150.00	
Mon 4/26/99	6.98	29.50	1.60	0.74	16,100.00	11,550.00
Tue 4/27/99		30.00	2.60		17,000.00	
Wed 4/28/99	6.80	28.00	3.50	0.70	15,650.00	11,300.00
Thu 4/29/99		28.60	2.20		17,550.00	
Fri 4/30/99		28.00	3.20		15,350.00	11,100.00
Sat 5/1/99					15,300.00	
Sun 5/2/99					16,600.00	
Mon 5/3/99	7.30	29.00	1.40	0.77	16,300.00	11,800.00
Tue 5/4/99		29.00	2.10		15,550.00	
Wed 5/5/99	6.78	29.50	3.70	0.62	13,300.00	9,900.00
Thu 5/6/99		30.00	4.90		13,400.00	
Fri 5/7/99		28.80	5.70		10,950.00	7,850.00
Sat 5/8/99					14,400.00	
Sun 5/9/99					12,200.00	
Mon 5/10/99	7.25	31.00	6.80	0.63	11,450.00	9,350.00
Tue 5/11/99		31.00	6.10		10,500.00	
Wed 5/12/99	6.94	29.90	6.50	0.53	10,200.00	7,700.00
Thu 5/13/99		29.50	6.70		10,550.00	
Fri 5/14/99		30.50	5.90		10,550.00	8,000.00
Sat 5/15/99					12,950.00	
Sun 5/16/99					9,950.00	
Mon 5/17/99	7.12	31.00	6.30	0.61	7,900.00	5,650.00
Tue 5/18/99		29.00	7.00		8,300.00	
Wed 5/19/99	7.01	31.00	6.10	0.68	9,850.00	7,300.00
Thu 5/20/99		33.50	2.80		11,050.00	
Fri 5/21/99		29.00	5.30		14,300.00	10,500.00
Sat 5/22/99					12,650.00	
Sun 5/23/99					11,250.00	
Mon 5/24/99	7.11	30.50	6.60	0.62	8,800.00	6,550.00
Tue 5/25/99		30.50	6.20			
Wed 5/26/99	7.05	30.60	5.50	0.64	11,100.00	8,300.00
Thu 5/27/99		29.00	6.40		12,200.00	
Fri 5/28/99		31.00	6.30		10,700.00	8,200.00
Sat 5/29/99					11,500.00	
Sun 5/30/99					13,450.00	
Mon 5/31/99	7.15	34.00	5.80	0.52	10,850.00	8,250.00
Tue 6/1/99		33.00	5.80		10,850.00	
Wed 6/2/99	7.25	31.50	5.50	0.63	10,600.00	7,950.00
Thu 6/3/99		30.30	5.60		11,350.00	
Fri 6/4/99		31.80	5.00		11,100.00	8,450.00
Sun 6/6/99					14,800.00	
Mon 6/7/99	7.34	32.00	5.30	0.72	12,050.00	8,950.00
Tue 6/8/99		31.00	4.80			
Wed 6/9/99	6.85	32.00	3.20	0.79	12,650.00	9,350.00
Thu 6/10/99		32.00	3.90		12,100.00	
Fri 6/11/99		32.50	3.70		12,750.00	9,650.00
Sat 6/12/99					15,400.00	
Sun 6/13/99					15,600.00	
Mon 6/14/99	7.25	32.00	4.00	0.61	12,950.00	9,700.00
Tue 6/15/99		31.80	2.30		13,100.00	

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT	Date	Run Time (hr)	Permeate Flowrate (gpm)	WWTP Influent NH3-N (mg/L)	WWTP Influent CBOD (mg/L)	WWTP Influent TSS (mg/L)	Sludge Wasted from Aeration Tank (gpd)	Sludge Wasted from Membrane Tank (gpd)	Total Mass Produced (lb/day)	Total Mass BOD5 Applied (lb/day)	Sludge Yield	System SRT (days)	Waste Sludge COD (mg/L)	Waste Sludge TKN (mg/L)	Waste Sludge TP (mg/L)	Waste Sludge MLSS (mg/L)	Waste Sludge MLVSS (mg/L)
	Wed 6/16/99	2761.08	6.50		262.00	236.00		90	10	12	0.86	24.73				13,200.00	
	Thu 6/17/99	2784.83	6.50		190.00	248.00											
	Fri 6/18/99	2809.08	6.50		190.00	160.00		75	8	14	0.57	29.68				14,450.00	
	Sat 6/19/99	2832.58	6.50		172.00	184.00		150	20			14.84					
	Sun 6/20/99	2856.58	6.50		164.00	188.00		75	8			29.68					
	Mon 6/21/99	2881.08	6.50	28.60	144.00	112.00		90	10	11	0.95	24.73	3220	1240	147	12,950.00	9,950.00
	Tue 6/22/99	2904.83	6.50	27.30	133.00	132.00		100	11			22.26					
	Wed 6/23/99	2929.08	6.50		214.00	188.00		70	7	14	0.47	31.80				12,600.00	
	Thu 6/24/99	2952.83	6.50		182.00	144.00		100	10			22.26					
	Fri 6/25/99	2977.58	6.50		166.00	96.00		125	12	12	1.01	17.81				13,450.00	
	Sat 6/26/99	2999.83	6.50		154.00	176.00		125	14			17.81					
	Sun 6/27/99	3025.58	6.50		194.00	148.00	100	100	21			22.26					
	Mon 6/28/99	3051.08	6.50	29.40	148.00	112.00		140	13	12	1.10	15.90	16300	1740	187	13,050.00	10,250.00
	Tue 6/29/99	3073.08	6.50	31.70	124.00	144.00		90	8			24.73					
	Wed 6/30/99	3097.08	6.50		98.00	164.00		95	9	16	0.54	23.43				10,500.00	
	Thu 7/1/99	3121.58	6.50		191.00	156.00		125	12			17.81					
	Fri 7/2/99	3145.08	6.50		159.00	132.00		125	11	10	1.03	17.81				10,100.00	
	Sat 7/3/99	3168.58	6.50		218.00	200.00		100	11			22.26					
	Sun 7/4/99	3192.08	6.50		210.00	148.00		125	12			17.81					
	Mon 7/5/99	3217.50	6.50	28.40	156.00	152.00		125	11	15	0.70	17.81	12900	1090	185	10,350.00	7,800.00
	Tue 7/6/99	3241.08	6.50	23.60	147.00	164.00		100	9			22.26					
	Wed 7/7/99	3265.08	6.50		142.00	196.00		100	9	11	0.85	22.26				10,500.00	
	Thu 7/8/99	3289.08	6.50		221.00	144.00		100	10			22.26					
	Fri 7/9/99	3313.08	6.50		278.00	192.00		100	9	7	1.22	22.26				11,650.00	
	Sat 7/10/99	3335.83	6.50		224.00	164.00		150	16			14.84					
	Sun 7/11/99	3362.08	6.50		173.00	132.00		100	10			22.26					
	Mon 7/12/99	3385.08	6.50	21.70	124.00	100.00		100	9	15	0.62	22.26	3280	1230	136	10,400.00	7,750.00
	Tue 7/13/99	3409.08	6.50	23.50	131.00	152.00		100	9			22.26					
	Wed 7/14/99	3431.58	6.50		126.00	212.00		100	10	8	1.20	22.26				12,700.00	
	Thu 7/15/99	3457.08	6.50		184.00	188.00		150	16			14.84					
	Fri 7/16/99	3481.08	6.50		168.00	168.00		150	16	12	1.35	14.84				13,150.00	
	Sat 7/17/99	3503.83	6.50		201.00	172.00		125	14			17.81					
	Sun 7/18/99	3528.08	6.50		196.00	244.00		150	13			14.84					
	Mon 7/19/99	3553.08	6.50	26.10	132.00	132.00				11			3020	1060	133	13,850.00	9,950.00
	Tue 7/20/99	3579.58	6.50	24.30	176.00	188.00											
	Wed 7/21/99	3601.08	6.50		160.00	176.00				11						13,300.00	
	Thu 7/22/99	3623.83	6.50		162.00	184.00											
	Fri 7/23/99	3649.58	6.50		158.00	164.00				9						15,050.00	
	Sat 7/24/99	3673.08	6.50		146.00	116.00	100	150				21.30					
	Sun 7/25/99	3697.08	6.50		160.00	132.00	100	150				21.30					
	Mon 7/26/99	3745.58	6.50	21.40	127.00	128.00	150	125	26	12	2.25	15.07	2920	972	124		
	Tue 7/27/99	3752.08	6.50		170.00	200.00		150	18			14.84					
	Wed 7/28/99	3771.08	6.50	21.00	128.00	60.00	100	150	28	11	2.61	21.30				12,100.00	8,750.00
	Thu 7/29/99	3795.08	6.50		127.00	64.00		100				22.26					
	Fri 7/30/99	3819.08	6.50		134.00	112.00				11						13,150.00	10,100.00
	Sat 7/31/99	3844.08	6.50		132.00	120.00											
	Sun 8/1/99	3868.58	6.50		126.00	128.00											
	Mon 8/2/99	3891.08	6.50	21.80	152.00	116.00		150	14	12	1.16	14.84	13700	893	159	11,050.00	8,400.00
	Tue 8/3/99	3918.08	6.50	21.00	196.00	184.00		125	12			17.81					
	Wed 8/4/99	3939.08	6.50		155.00	88.00		150	14	13	1.05	14.84				11,900.00	
	Thu 8/5/99	3968.58	6.50		126.00	36.00		125	11			17.81					
	Fri 8/6/99	3987.08	6.50		162.00	116.00		150	13	13	1.05	14.84				10,500.00	
	Sat 8/7/99	4013.08	6.50		164.00	120.00		100	9			22.26					
	Sun 8/8/99	4036.83	6.50		170.00	124.00		125	10			17.81					
	Mon 8/9/99	4059.08	6.50	24.30	166.00	116.00				14							
	Tue 8/10/99	4087.58	6.50	30.10	160.00	192.00		125	13			17.81					
	Wed 8/11/99	4107.08	6.50		140.00	136.00		150	14	12	1.18	14.84				11,450.00	8,600.00
3	Thu 8/12/99	4129.58	6.50		153.00	128.00		150	12			14.84					
3	Fri 8/13/99	4154.33	6.50		149.00	104.00		150	13	13	0.98	14.84				10,450.00	
	Sat 8/14/99	4179.83	6.50		188.00	144.00		125	11			17.81					
	Sun 8/15/99	4204.58	6.50		156.00	116.00		125	11			17.81					
4	Mon 8/16/99	4225.08	6.50	23.80	176.00	132.00		125	11	10	1.05	17.81	12400	1120	132	10,550.00	7,850.00

Date	FEED														MEMBRANE TANK					
	pH	Temperature (degrees C)	Conductivity (uS/cm)	COD (mg/L)	ALK (mg/L)	DO (mg/L)	Feed CBOD5 (mg/L)	Feed TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)
Wed 6/16/99	7.13	30.00	2,000.00			0.70	156.00	124.00	22.20						7.20	31.50	1.90	0.71	13,950.00	10,700.00
Thu 6/17/99		29.50	1,940.00			1.00										32.00	3.00		12,800.00	
Fri 6/18/99		30.00	1,980.00			1.10	174.00	116.00	23.10							31.80	3.50		12,350.00	9,200.00
Sat 6/19/99																			15,900.00	
Sun 6/20/99																			12,350.00	
Mon 6/21/99	6.76	29.50	1,845.00	508.00	360.00	0.90	135.00	104.00	24.00		0.03	63.70	63.73	7.34	7.30	31.80	4.40	0.48	13,400.00	10,100.00
Tue 6/22/99		30.00	1,729.00			0.80										31.70	5.10		13,600.00	
Wed 6/23/99	7.02	32.00	1,910.00			1.00	184.00	140.00	23.10						6.87	32.20	5.00	0.56	11,500.00	8,550.00
Thu 6/24/99		30.50	2,080.00			1.10										33.00	4.50		11,650.00	
Fri 6/25/99		29.50	2,080.00			0.90	150.00	112.00	25.20							31.00	4.90		11,400.00	8,500.00
Sat 6/26/99																			13,550.00	
Sun 6/27/99																			13,300.00	
Mon 6/28/99	7.19	31.00	1,738.00		356.00	0.90	152.00	128.00	25.30		0.02	41.70	41.72	11.80	7.22	32.80	5.60	0.55	11,200.00	8,350.00
Tue 6/29/99		30.00	1,954.00			0.70										32.00	4.80		10,650.00	
Wed 6/30/99	6.68	29.80	1,834.00			1.00	202.00	132.00	23.00						7.23	32.00	5.90	0.60	10,800.00	8,150.00
Thu 7/1/99		30.00	1,941.00			0.90										31.80	5.30		11,150.00	
Fri 7/2/99		30.00	1,920.00		320.00	0.80	132.00	84.00	23.20							32.00	6.50		10,200.00	7,650.00
Sat 7/3/99																			12,600.00	
Sun 7/4/99																			11,200.00	
Mon 7/5/99	7.24	29.00	1,776.00	312.00		1.10	198.00	104.00	24.00		0.01	43.10	43.11	5.22	6.89	31.20	6.20	0.62	10,400.00	7,900.00
Tue 7/6/99		28.50	1,757.00		358.00	1.10										32.00	5.80		10,950.00	
Wed 7/7/99	6.89	29.50	1,928.00			1.00	138.00	112.00	22.10						7.19	31.00	5.40	1.07	10,950.00	8,300.00
Thu 7/8/99		30.00	2,080.00			0.80										33.00	5.50		11,450.00	
Fri 7/9/99		29.00	2,140.00	612.00	350.00	1.10	94.80	160.00	15.30							31.00	5.60		10,800.00	7,950.00
Sat 7/10/99																			12,500.00	
Sun 7/11/99																			11,650.00	
Mon 7/12/99	6.86	30.50	2,100.00		360.00	0.80	186.00	108.00	22.20		0.02	66.00	66.02	12.30	7.15	32.00	4.70	0.87	10,800.00	8,000.00
Tue 7/13/99		31.00				0.90										31.00	4.20		10,550.00	
Wed 7/14/99	7.73	30.00	1,700.00			1.10	108.00	120.00	16.40						7.12	31.00	4.40	1.04	12,100.00	8,880.00
Thu 7/15/99		29.50	2,120.00			0.80											4.50		12,450.00	
Fri 7/16/99		30.00	1,843.00			1.20	151.00	104.00	19.70							31.40	4.30		12,750.00	9,350.00
Sat 7/17/99																			13,300.00	
Sun 7/18/99																			10,400.00	
Mon 7/19/99	7.20	30.00	2,100.00	612.00		0.90	136.00	132.00	28.20		0.12	75.40	75.52	18.30	7.11	31.60	4.60	1.04	12,900.00	8,500.00
Tue 7/20/99			2,450.00																	
Wed 7/21/99	7.23		1,852.00				146.00	132.00	19.70						7.10			0.89	15,100.00	11,100.00
Thu 7/22/99			2,100.00																	
Fri 7/23/99			1,888.00				111.00	120.00	23.30										13,900.00	10,150.00
Sat 7/24/99																				
Sun 7/25/99																				
Mon 7/26/99	7.13		2,130.00				149.00	132.00	23.70		0.12	37.60	37.72	4.90	7.08			0.97	12,000.00	9,100.00
Tue 7/27/99			1,900.00														5.10		14,000.00	
Wed 7/28/99	7.46	30.00	2,330.00			1.20	137.00	180.00	20.90						7.70	32.00	5.10	1.04	14,000.00	10,250.00
Thu 7/29/99		29.00	2,070.00			1.00										28.00	5.10			
Fri 7/30/99			2,180.00				135.00	212.00	22.50										12,250.00	9,300.00
Sat 7/31/99																				
Sun 8/1/99																				
Mon 8/2/99	7.33	30.00	2,080.00	296.00	320.00	1.10	150.00	132.00	20.00		0.03	33.50	33.53	4.28	7.20	31.90	5.70	0.74	10,850.00	8,350.00
Tue 8/3/99		31.00	2,110.00			0.60										32.10	5.40		11,100.00	
Wed 8/4/99	7.15	30.40	2,114.00			0.80	167.00	100.00	22.10						7.29	31.30	5.10	0.79	10,900.00	8,100.00
Thu 8/5/99		30.00	1,739.00			0.80										31.50	5.30		10,200.00	
Fri 8/6/99		30.40				1.00	162.00	156.00	20.40							31.20	5.00		10,650.00	8,300.00
Sat 8/7/99																			10,800.00	
Sun 8/8/99																			9,150.00	
Mon 8/9/99	7.07	30.60	1,944.00		350.00	0.90	180.00	168.00	21.70		0.02	44.20	44.22	10.50	7.17	32.40	5.00	1.18	10,450.00	7,750.00
Tue 8/10/99		30.40	1,600.00			0.90										30.00	4.80		12,050.00	
Wed 8/11/99	7.04	29.80	1,879.00			1.10	154.00	184.00	21.50						6.99	32.00	4.40	1.06	11,350.00	8,550.00
Thu 8/12/99		30.20	1,643.00			0.80										32.00	3.10		9,400.00	
Fri 8/13/99		29.60	1,626.00			1.20	172.00	138.00	18.60							32.00	3.40		10,550.00	7,850.00
Sat 8/14/99																			10,250.00	
Sun 8/15/99																			10,300.00	
Mon 8/16/99	7.29	30.40	1,601.00	324.00	336.00	1.20	134.00	96.00	25.40		0.04	38.00	38.04	4.95	7.23	34.00	3.00	1.08	10,500.00	7,500.00

STAGE/EVENT																	
	Date	Run Time (hr)	Permeate Flowrate (gpm)	WWTP Influent NH3-N (mg/L)	WWTP Influent CBOD (mg/L)	WWTP Influent TSS (mg/L)	Sludge Wasted from Aeration Tank (gpd)	Sludge Wasted from Membrane Tank (gpd)	Total Mass Produced (lb/day)	Total Mass BOD_5 Applied (lb/day)	Sludge Yield	System SRT (days)	Waste Sludge COD (mg/L)	Waste Sludge TKN (mg/L)	Waste Sludge TP (mg/L)	Waste Sludge MLSS (mg/L)	Waste Sludge MLVSS (mg/L)
4	Tue 8/17/99	4248.58	6.50	25.40	201.00	160.00		125	10			17.81	12400	1120	132		
4	Wed 8/18/99	4272.83	6.50		137.00	132.00		125	10	12	0.88	17.81				10,950.00	
4	Thu 8/19/99	4296.83	6.50		164.00	160.00		125	10			17.81					
4	Fri 8/20/99	4320.58	6.50		178.00	192.00		75	6	12	0.51	29.68				10,750.00	
	Sat 8/21/99	4344.08	6.50		180.00	168.00											
	Sun 8/22/99	4368.58	6.50		204.00	156.00											
	Mon 8/23/99	4393.08	6.50	26.40	142.00	160.00		125	13	8	1.58	17.81	18000	917	136	11,500.00	8,550.00
	Tue 8/24/99	4417.08	6.50	26.80	130.00	188.00		125	12			17.81					
	Wed 8/25/99	4441.08	6.50		143.00	140.00		150	12	15	0.84	14.84				11,850.00	
	Thu 8/26/99	4464.83	6.50		150.00	140.00		75	7			29.68					
	Fri 8/27/99	4489.08	6.50		198.00	164.00		125	14	15	0.91	17.81				12,800.00	
	Sat 8/28/99	4514.08	6.50		228.00	112.00											
	Sun 8/29/99	4536.08	6.50		178.00	124.00		150	19			14.84					
	Mon 8/30/99	4560.58	6.50	32.50	142.00	96.00											
	Tue 8/31/99	4561.08	10.00	24.80	208.00	136.00											
	Wed 9/1/99	4561.08	10.00		209.00	144.00	100	175			–	20.85					
	Thu 9/2/99	4581.58	10.00		160.00	160.00											
	Fri 9/3/99	4606.08	6.50		160.00	156.00		125	12	13	0.95	17.81	13900	1230	130	12,750.00	9,400.00
	Sat 9/4/99	4629.08	6.50		181.00	168.00		125	14			17.81					
	Sun 9/5/99	4654.08	6.50		194.00	136.00		150	14			14.84					
	Mon 9/6/99	4677.08	6.50		117.00	120.00		125	11	9	1.15	17.81	12300	1070	166	10,450.00	7,800.00
	Tue 9/7/99	4701.75	6.50		148.00	136.00		150	13			14.84					
	Wed 9/8/99	4725.33	6.50		144.00	148.00		125	12	12	1.05	17.81				13,050.00	
	Thu 9/9/99	4749.33	6.50		180.00	192.00		150	15			14.84					
	Fri 9/10/99	4773.33	6.50		178.00	144.00		135	12	15	0.84	16.49				12,700.00	
	Sat 9/11/99	4797.08	6.50		324.00	192.00	100	100	22			22.26					
	Sun 9/12/99	4820.58	6.50		176.00	168.00		125	15			17.81					
	Mon 9/13/99	4845.75	6.50		184.00	144.00		150	15	12	1.19	14.84	11300	1280	198	13,750.00	10,500.00
	Tue 9/14/99	4869.33	6.50		194.00	180.00		150	14			14.84					
	Wed 9/15/99	4875.91	6.50		174.00	204.00											
	Thu 9/16/99	4875.91	6.50		156.00	172.00											
7	Fri 9/17/99	4892.16	6.50		166.00	92.00		125	11			17.81				11,950.00	
7	Sat 9/18/99	4914.91	6.50		126.00	156.00		150	19			14.84					
7	Sun 9/19/99	4940.41	6.50		195.00	148.00	125	125	25			17.81					
7	Mon 9/20/99	4964.16	6.50	32.60	189.00	152.00		150	14	12	1.17	14.84				13,200.00	9,650.00
7	Tue 9/21/99	4988.16	6.50	26.00	186.00	168.00		150	15			14.84					
7	Wed 9/22/99	4986.91	6.50		180.00	200.00		150	15	11	1.33	14.84				11,750.00	
7	Thu 9/23/99	5035.91	6.50		150.00	152.00		150	15			14.84	17100	1260	215		
7	Fri 9/24/99	5060.16	6.50		178.00	148.00		150	14	14	1.02	14.84				14,150.00	
7	Sat 9/25/99	5082.91	6.50		224.00	180.00		150				14.84					
7	Sun 9/26/99	5110.91	6.50		174.00	148.00	125	125	29			17.81					
7	Mon 9/27/99	5132.16	6.50	24.00	154.00	144.00		150	12	12	1.05	14.84				12,300.00	9,200.00
8	Tue 9/28/99	5156.41	6.50	26.20	194.00	152.00		150	14			14.84					
8	Wed 9/29/99	5180.16	6.50		192.00	160.00		125	12	15	0.79	17.81	17100	1230	191	12,050.00	
	Thu 9/30/99	5204.41	6.50		151.00	168.00		125	13			17.81					
	Fri 10/1/99	5229.41	6.50		176.00	164.00		150	15	12	1.18	14.84				14,050.00	
	Sat 10/2/99	5251.16	6.50		159.00	148.00	125	125	25			17.81					
	Sun 10/3/99	5277.41	6.50		217.00	148.00	125	125	29			17.81					
	Mon 10/4/99	5300.16	6.50	28.60	140.00	176.00		120	12	11	1.06	18.55				13,650.00	
D	Tue 10/5/99	5303.41	6.50	25.30	221.00	156.00											
	Wed 10/6/99	5305.66	6.50		280.00	140.00											
9	Thu 10/7/99	5324.25	6.50		182.00	264.00		125	6			17.81					
9	Fri 10/8/99	5347.75	6.50		179.00	160.00	100	100	11	11	0.99	22.26	10600	842	127	7,600.00	5,600.00
10	Sat 10/9/99	5372.00	6.50		200.00	164.00	100	100	14			22.26					
10	Sun 10/10/99	5395.25	6.50		166.00	124.00	150	200	18			14.41					
10	Mon 10/11/99	5420.50	6.50	28.10	162.00	180.00		200	12	11	1.02	11.13				7,650.00	
10	Tue 10/12/99	5444.50	6.50	25.10	152.00	172.00	150	275	27			13.80					
10	Wed 10/13/99	5468.50	6.50		189.00	260.00	200	350	39	13	2.98	10.42	13400	879	108	9,650.00	7,450.00
11	Thu 10/14/99	5492.25	6.50		164.00	140.00	225	375	38			9.33					
11	Fri 10/15/99	5515.75	6.50		192.00	180.00	100	200	15	12	1.24	20.42				7,650.00	
11	Sat 10/16/99	5539.25	6.50		243.00	176.00	200	125	20			11.52					
11	Sun 10/17/99	5565.00	6.50		150.00	148.00	125	125	20			17.81					

	FEED														MEMBRANE TANK					
Date	pH	Temperature (degrees C)	Conductivity (uS/cm)	COD (mg/L)	ALK (mg/L)	DO (mg/L)	Feed CBOD5 (mg/L)	Feed TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)
Tue 8/17/99		32.90	1,654.00			0.80										33.00	4.30		9,900.00	
Wed 8/18/99	7.24	31.20	1,603.00			0.90	153.00	148.00	25.10						7.23	33.00	5.40	1.13	10,050.00	7,500.00
Thu 8/19/99		32.10	1,550.00			1.10										32.40	3.90		9,950.00	
Fri 8/20/99		32.20	1,489.00			1.00	152.00	108.00	23.50							32.20	3.00		9,700.00	7,300.00
Sat 8/21/99																			13,000.00	
Sun 8/22/99						1.00													10,400.00	
Mon 8/23/99	7.29	29.00	1,255.00			1.00	102.00	152.00	24.40		0.20	28.30	28.50	4.06	7.16	29.90	4.50	1.12	12,100.00	8,650.00
Tue 8/24/99		30.20	1,493.00			0.80										31.60	3.80		11,250.00	
Wed 8/25/99	7.17	30.00	1,537.00			0.90	186.00	148.00	19.30						7.22	32.00	3.20	1.08	9,750.00	7,300.00
Thu 8/26/99		30.00	1,470.00			1.10										32.00	3.70		10,800.00	
Fri 8/27/99			1,544.00			0.80	194.00	132.00	22.40								3.00		13,150.00	9,650.00
Sat 8/28/99																			13,950.00	
Sun 8/29/99																			15,100.00	
Mon 8/30/99																				
Tue 8/31/99																				
Wed 9/1/99																				
Thu 9/2/99		30.50	1,582.00			0.90										31.00	4.50		11,600.00	
Fri 9/3/99		30.90	1,621.00	156.00		1.00	164.00	104.00	22.00		0.03	35.80	35.83	4.80		31.40	3.80		11,605.00	8,750.00
Sat 9/4/99																			13,200.00	
Sun 9/5/99																			11,150.00	
Mon 9/6/99	7.41	29.60	1,564.00			1.10	120.00	100.00	26.80		0.09	39.70	39.79	5.88	7.19	31.00	5.30	0.94	10,300.00	7,500.00
Tue 9/7/99		28.00	1,397.00			1.70										28.20	5.50		10,400.00	
Wed 9/8/99	7.20	30.40	1,899.00			1.20	148.00	136.00	21.00						7.25	31.50	4.70	0.94	11,600.00	7,900.00
Thu 9/9/99		30.60	1,621.00			0.90										31.60	3.20		11,950.00	
Fri 9/10/99		30.90	1,814.00			1.10	188.00	156.00	20.60							31.90	3.20		11,000.00	8,100.00
Sat 9/11/99																			13,950.00	
Sun 9/12/99																			14,250.00	
Mon 9/13/99	7.25	30.40	1,958.00	396.00		0.70	160.00	168.00	22.30		0.05	47.60	47.65	5.11	7.39	31.80	5.20	1.24	11,900.00	9,000.00
Tue 9/14/99		30.00	1,923.00			0.90										32.00	4.40		11,300.00	
Wed 9/15/99																				
Thu 9/16/99																				
Fri 9/17/99		29.00	1,853.00			1.10	158.00	156.00	20.50							31.00	5.10		10,500.00	7,600.00
Sat 9/18/99																			15,450.00	
Sun 9/19/99																			12,200.00	
Mon 9/20/99	7.20	29.20	2,020.00			1.00	150.00	108.00	27.00						7.02	31.00	3.20	1.44	10,950.00	7,850.00
Tue 9/21/99		29.00	2,150.00		340.00	0.80										31.00	1.60		12,300.00	
Wed 9/22/99	7.27	29.00	1,923.00			1.10	146.00	48.00	22.20						6.96	29.80	4.20	1.49	12,100.00	8,850.00
Thu 9/23/99		28.50	1,875.00			1.20					0.04	38.00	38.04	5.61		29.00	4.60		11,650.00	
Fri 9/24/99		28.10	1,894.00			1.20	179.00	120.00	21.80							29.50	3.70		11,350.00	8,400.00
Sat 9/25/99																				
Sun 9/26/99																			14,800.00	
Mon 9/27/99	7.13	28.20	1,993.00		328.00	0.80	148.00	104.00	24.40						7.18	29.00	4.90	1.34	9,700.00	7,050.00
Tue 9/28/99		28.90	1,924.00			1.00										31.00	3.10		10,900.00	
Wed 9/29/99	7.07	28.00	1,930.00	436.00		1.20	192.00	120.00	23.20		0.02	36.60	36.62	5.50	7.23	31.00	3.80	1.47	11,400.00	8,650.00
Thu 9/30/99		28.00	2,140.00			1.30										29.00	2.10		12,250.00	
Fri 10/1/99		27.00	2,010.00			1.20	160.00	116.00	23.00							27.70	3.50		11,800.00	8,850.00
Sat 10/2/99																			12,550.00	
Sun 10/3/99																			14,500.00	
Mon 10/4/99		29.40				1.00	147.00	112.00	24.90	6.24					7.09	30.70	1.70		12,100.00	9,200.00
Tue 10/5/99																30.00	6.70		4,350.00	
Wed 10/6/99																31.00	6.90		5,250.00	
Thu 10/7/99		29.50	1,960.00			0.50										29.50	6.70		5,650.00	
Fri 10/8/99		29.00	1,631.00			0.80	146.00	104.00	21.30		0.01	42.40	42.41	6.07		29.90	6.60		7,100.00	5,050.00
Sat 10/9/99																			8,850.00	
Sun 10/10/99																			6,550.00	
Mon 10/11/99	6.95	29.20	1,742.00		360.00	0.90	146.00	104.00	27.00						6.97	31.00	6.70	1.20	6,950.00	5,150.00
Tue 10/12/99		29.40	1,671.00			0.90										31.00	4.90		7,650.00	
Wed 10/13/99	7.16	29.60	1,671.00	448.00		1.00	168.00	264.00	22.70		0.02	43.30	43.32	5.45	7.08	31.00	5.80	1.08	8,850.00	6,500.00
Thu 10/14/99		29.00	1,612.00			0.70										30.80	5.80		8,000.00	
Fri 10/15/99		29.10	1,578.00			1.20	154.00	140.00	17.20							30.90	6.50		6,000.00	4,450.00
Sat 10/16/99																			7,900.00	
Sun 10/17/99																			10,300.00	

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT	Date	Run Time (hr)	Permeate Flowrate (gpm)	WWTP Influent NH3-N (mg/L)	WWTP Influent CBOD (mg/L)	WWTP Influent TSS (mg/L)	Sludge Wasted from Aeration Tank (gpd)	Sludge Wasted from Membrane Tank (gpd)	Total Mass Produced (lb/day)	Total Mass BOD5 Applied (lb/day)	Sludge Yield	System SRT (days)	Waste Sludge COD (mg/L)	Waste Sludge TKN (mg/L)	Waste Sludge TP (mg/L)	Waste Sludge MLSS (mg/L)	Waste Sludge MLVSS (mg/L)
11	Mon 10/18/99	5588.75	6.50	26.80	152.00	160.00	350	400	49			6.28	14400	1004	155		
11	Tue 10/19/99	5612.25	6.50	31.30	190.00	144.00	150	200	18			14.41					
12	Wed 10/20/99	5635.75	6.50		178.00	156.00	150	200	16			14.41					
12	Thu 10/21/99	5660.25	6.50		171.00	160.00	125	200	20			16.89					
12	Fri 10/22/99	5683.00	6.50		144.00	128.00	125	200	18			16.89					
12	Sat 10/23/99	5708.00	6.50		163.00	140.00	125	125	17			17.81					
12	Sun 10/24/99	5731.50	6.50		142.00	128.00	250	375	40			8.52					
12	Mon 10/25/99	5756.50	6.50	28.00	144.00	128.00	260	350	33	10	3.45	8.30	10600	971	163	7,350.00	
12	Tue 10/26/99	5780.50	6.50	24.00	170.00	176.00	100	200	16			20.42					
12	Wed 10/27/99	5804.50	6.50		188.00	152.00	200	400	38	11	3.39	10.21				8,950.00	6,900.00
12	Thu 10/28/99	5828.50	6.50		147.00	136.00	125	200	18			16.89					
12	Fri 10/29/99	5852.50	6.50		214.00	148.00	125	200	19	17	1.13	16.89				7,700.00	
12	Sat 10/30/99	5876.00	6.50		188.00	188.00	200	200	27			11.13					
12	Sun 10/31/99	5899.25	6.50		161.00	148.00	325	400	40			6.71					
12	Mon 11/1/99	5924.50	6.50	31.00	187.00	160.00	260	400	37			8.16	8100	754	124	9,400.00	7,200.00
	MEAN		5.18		248.27	182.91	93.64	116.25	16.04	17.57	1.27	21.29					
A	MIN		3.00		183.00	120.00	50.00	90.00		10.80	0.52	14.84					
	MAX		6.00		335.00	216.00	150.00	150.00	38.39	38.18	2.75	24.73					
	MEAN		6.29		258.38	178.13	130.00	146.15	27.15	18.37	1.50	16.79				16,371.43	
B	MIN		4.00		146.00	48.00	100.00	100.00	10.96	11.00	0.67	14.20				13,250.00	
	MAX		9.50		407.00	296.00	150.00	225.00	42.33	30.79	2.93	22.26				19,150.00	
	MEAN		6.57	26.40	176.96	152.32	112.00	133.01	14.62	12.72	1.14	19.25	10,344.71	1,191.65	158.41	12,123.53	9,061.11
C	MIN		6.50	21.00	98.00	36.00	75.00	70.00		7.40	0.38	12.25	2,880.00	893.00	124.00	10,100.00	7,750.00
	MAX		10.00	32.60	359.00	248.06	175.00	250.00	42.87	21.69	3.30	31.80	18,000.00	1,740.00	215.00	15,050.00	10,500.00
	MEAN		6.50	27.45	179.25	161.29	175.83	239.42	24.02	12.17	2.03	14.04	11,420.00	890.00	135.40	8,243.75	6,787.50
D	MIN		6.50	24.00	142.00	124.00	100.00	100.00	5.89	9.52	0.99	6.28	8,100.00	754.00	108.00	7,350.00	5,600.00
	MAX		6.50	31.30	280.00	264.00	350.00	400.00	48.54	16.70	3.45	22.26	14,400.00	1,004.00	163.00	9,650.00	7,450.00
A(AT 6 GPM)			6.00	31.53	263.17	194.00	92.50	124.17	17.85	16.40	1.46	19.91					
B(NORMAL)			6.22	28.99	254.00	174.13	130.00	147.30	27.62	17.52	1.60	16.70				16,371.43	
B(PEAK)			8.00		324.00	238.00		125.00	18.64	26.40	0.70	18.55					
C(NORMAL)			6.58	26.41	177.52	152.62	110.87	132.35	14.73	12.79	1.18	19.75	8,989.23	1,194.46	155.62	12,200.00	9,093.33
C(PEAK-EVENTS 3,4,8)			6.50	25.13	171.56	146.67		127.78	10.96	12.53	0.84	18.14	13,966.67	1,156.67	151.67	10,950.00	7,850.00
C(NORMAL WITH CYCLED AIR TO MT-EVENT 7)			6.50	27.53	174.73	153.45	125.00	143.18	16.90	12.15	1.14	15.65	17100.00	1260.00	215.00	12670.00	9425.00
D(NORMAL WITH CYCLED AIR TO MT-EVENT9)			6.50		180.50	212.00	100.00	112.50	8.57	11.39	0.99	20.03	10600.00	842.00	127.00	7600.00	5600.00
D(PEAK WITH CYCLED AIR TO MT-EVENT 10)			6.50	26.60	173.80	180.00	150.00	225.00	21.77	12.25	2.00	14.40	13400.00	879.00	108.00	8650.00	7450.00
D(NORMAL WITH CYCLED AIR TO MT-EVENT 11)			6.50	29.05	181.83	158.00	191.67	237.50	26.57	12.02	1.24	13.29	14400.00	1004.00	155.00	7650.00	
D(NORMAL WITH CYCLED AIR TO MT AND AT-EVENT 12)			6.50	27.67	169.00	149.85	182.31	265.38	26.08	12.43	2.66	13.33	9350.00	862.50	143.50	8350.00	7050.00

		FEED														MEMBRANE TANK					
STAGE/EVENT	Date	pH	Temperature (degrees C)	Conductivity (uS/cm)	COD (mg/L)	ALK (mg/L)	DO (mg/L)	Feed CBOD5 (mg/L)	Feed TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)
11	Mon 10/18/99					320.00	1.20					0.01	38.90	38.91	3.87			5.60		8,650.00	
11	Tue 10/19/99						0.50											6.80		6,400.00	
12	Wed 10/20/99						0.60											6.40		5,300.00	
12	Thu 10/21/99						0.90											6.30		7,700.00	
12	Fri 10/22/99						0.60											7.20		6,450.00	
12	Sat 10/23/99																			8,800.00	
12	Sun 10/24/99																			7,550.00	
12	Mon 10/25/99	6.96	28.20	1,590.00	292.00	380.00	0.60	122.00	72.00	24.00		0.01	45.00	45.01	4.96	7.16	28.00	6.20	0.96	6,800.00	4,950.00
12	Tue 10/26/99		28.40	1,570.00			0.70										27.80	6.20		6,750.00	
12	Wed 10/27/99	7.24	27.90	1,471.00			0.50	142.00	112.00	22.80						7.22	26.40	6.40	1.07	7,900.00	5,900.00
12	Thu 10/28/99		28.20	1,563.00			0.80										27.40	6.10		6,850.00	
12	Fri 10/29/99		28.00	1,539.00			0.80	214.00	570.00	22.00							27.00	5.90		7,550.00	5,800.00
12	Sat 10/30/99																			8,600.00	
12	Sun 10/31/99																			6,200.00	
12	Mon 11/1/99	7.20	28.10	1,716.00			0.90	138.00	124.00	28.30		0.01	48.50	48.51	4.92	7.27	27.00	6.10	1.05	7,400.00	5,550.00
	MEAN	7.15	25.49	1,756.43	530.00	425.50	1.21	268.27	231.36	27.05		0.06	98.55	98.61	23.56	7.17	25.98	6.68	0.60	13,771.43	11,063.64
A	MIN	6.81	24.50	190.00	300.00	380.00	0.30	194.00	124.00	23.40		0.02	66.70	66.72	12.00	6.96	24.50	4.60	0.44	6,600.00	6,400.00
	MAX	7.32	26.40	2,630.00	760.00	545.00	3.00	530.00	390.00	33.00		0.16	155.00	155.04	41.80	7.42	27.00	8.80	0.74	26,350.00	15,900.00
	MEAN	7.22	27.03	2,128.26	619.67	422.17	0.71	234.43	180.19	25.47	21.90	0.17	74.87	75.04	14.05	7.14	27.99	2.93	0.76	16,160.47	11,350.00
B	MIN	6.78	25.20	1,860.00	429.00	363.00	0.30	164.00	108.00	22.00	11.30	0.01	36.10	36.11	4.60	6.78	25.00	1.20	0.62	11,500.00	7,450.00
	MAX	7.65	30.00	2,640.00	730.00	542.00	2.40	330.00	500.00	28.60	27.60	0.48	125.00	125.17	24.00	7.47	30.00	7.00	0.87	19,350.00	13,800.00
	MEAN	7.16	29.65	1,886.49	382.75	349.18	0.94	162.96	127.15	23.17	6.24	0.33	45.98	46.30	8.95	7.16	31.26	4.67	0.88	11,777.44	8,486.77
C	MIN	6.68	27.00	1,255.00	156.00	320.00	0.50	94.80	48.00	15.30	6.24	0.01	28.30	28.50	4.06	6.85	27.70	1.60	0.48	7,900.00	5,650.00
	MAX	7.73	32.90	2,450.00	612.00	380.00	1.70	278.00	212.00	29.00	6.24	5.62	75.40	75.52	22.70	7.70	34.00	7.00	1.49	15,900.00	11,100.00
	MEAN	7.10	28.74	1,639.54	370.00	353.33	0.78	153.75	186.25	23.16		0.01	43.62	43.63	5.05	7.14	29.25	6.29	1.07	7,225.00	5,418.75
D	MIN	6.95	27.90	1,471.00	292.00	320.00	0.50	122.00	72.00	17.20		0.01	38.90	38.91	3.87	6.97	26.40	4.90	0.96	4,350.00	4,450.00
	MAX	7.24	29.60	1,960.00	448.00	380.00	1.20	214.00	570.00	28.30		0.02	48.50	48.51	6.07	7.27	31.00	7.20	1.20	10,300.00	6,500.00
A(AT 6 GPM)		7.23	25.56	1,985.56	300.00	391.00	1.71	227.67	238.17	26.93		0.03	110.85	110.88	20.65	7.24	26.11	5.93	0.70	15,926.79	12,683.33
B(NORMAL)		7.22	27.10	2,137.84	619.67	422.17	0.72	230.05	183.16	25.36	21.90	0.17	74.87	75.04	14.05	7.12	28.08	3.00	0.76	16,078.05	11,217.50
B(PEAK)		7.12	26.00	1,975.00			0.65	276.00	152.00	26.50						7.39	26.50	1.80	0.80	17,850.00	12,675.00
C(NORMAL)		7.16	29.62	1,904.04	383.30	352.29	0.92	163.84	129.61	23.17	6.24	0.38	47.38	47.76	9.55	7.16	31.25	4.85	0.80	11,867.28	8,608.27
C(PEAK-EVENTS 3,4,8)		7.20	30.61	1,668.89	380.00	336.00	1.02	160.60	122.00	23.16		0.03	37.30	37.33	5.23	7.23	32.29	3.67	1.23	10,261.11	7,760.00
C(NORMAL WITH CYCLED AIR TO MT-EVENT 7)		7.20	28.71	1958.29		334.00	1.03	156.20	107.20	23.18		0.04	38.00	38.04	5.61	7.05	30.04	3.90	1.42	12100.00	7950.00
D(NORMAL WITH CYCLED AIR TO MT-EVENT9)			29.25	1795.50			0.65	146.00	104.00	21.30		0.01	42.40	42.41	6.07		29.70	6.65		6375.00	5050.00
D(PEAK WITH CYCLED AIR TO MT-EVENT 10)		7.06	29.40	1694.67	448.00	360.00	0.93	157.00	184.00	24.85		0.02	43.30	43.32	5.45	7.03	31.00	5.80	1.14	7770.00	5825.00
D(NORMAL WITH CYCLED AIR TO MT-EVENT 11)			29.05	1595.00		320.00	0.90	154.00	140.00	17.20		0.01	38.90	38.91	3.87		30.85	6.18		7875.00	4450.00
D(NORMAL WITH CYCLED AIR TO MT AND AT-EVENT 12)		7.13	28.13	1574.83	292.00	380.00	0.71	154.00	219.50	24.28		0.01	46.75	46.76	4.94	7.22	27.27	6.31	1.03	7219.23	5550.00

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT				AERATION TANK							PERMEATE																				REMOVALS						
	Date	Run Time (hr)	CBOD5 (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)	CBOD5 (mg/L)	pH	Temperature (degrees C)	Conductivity (uS/cm)	Turbidity (NTU)	COD (mg/L)	ALK (mg/L)	Calcium Hardness (mg/L)	CBOD5 (mg/L)	TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	HPC (CFU/mL)	% TSS Removal	% COD Removal	% CBOD5 Removal	% Ammonia Removal	% ALK Consumed	% Total Nitrogen Removal	% Phosphorous Removal
A	Mon 2/8/99	47.25	1,020.00	6.84	27.00	0.70	0.50	13,133.00	9,100.00	1,100.00	7.10	26.10	1,620.00	0.20		126.00		2.00	0.75	0.11				29.30	4.28	33.58	2.29		1.00	6,000.00	99.78		99.62	99.67	66.84		94.52
	Tue 2/9/99	71.50			27.00	4.20		14,900.00				27.00	1,620.00	0.13																							
	Wed 2/10/99	95.25	2,820.00	7.00	27.50	0.90	0.41	11,600.00	8,150.00	3,050.00	7.47	27.50	1,660.00	0.19				2.52	0.40	0.11								4.00	1.00	3,110.00	99.83		99.04	99.57			
	Thu 2/11/99	122.58			27.50	4.60		8,800.00				27.00																									
	Fri 2/12/99	122.58				8.60		6,200.00																													
	Sat 2/13/99	122.58						5,750.00																													
	Sun 2/14/99	122.58						6,475.00																													
	Mon 2/15/99	146.58				7.20										140.00																			63.73		
	Tue 2/16/99	169.08			24.50	6.90		8,500.00				24.00								0.03																	
	Wed 2/17/99	192.83	725.00	7.20	25.00	5.50	0.34	6,650.00	4,800.00	508.00	7.63	26.00	1,650.00	0.20	24.00			0.88	0.40	0.03		0.04	0.04	23.50	2.00	25.50	1.21	1.00	1.00	7.00	99.68	96.84	99.56	99.88		70.63	91.93
	Thu 2/18/99	217.08			25.00	5.70						25.50	1,640.00	0.12								0.03	0.03														
	Fri 2/19/99	241.08	1,300.00		26.40	5.80		9,200.00	6,500.00	842.00		26.50	1,640.00	0.08				1.03	0.20	0.03		0.22	0.10								99.92		99.70	99.89			
	Sat 2/20/99	265.08																																			
	Sun 2/21/99	289.58				5.90																															
	Mon 2/22/99	313.08	980.00	7.01	25.00	3.60	0.47	10,400.00	7,450.00	780.00	7.59	25.00	1,550.00	0.17		120.00		0.47	0.60	0.03		0.03	0.03	29.40	2.17	31.57	1.91	1.00	1.00	931.00	99.63		99.81	99.88	77.98	63.23	90.30
	Tue 2/23/99	337.08			25.00	5.10				—		26.00	1,880.00	0.15								0.03	0.03														
	Wed 2/24/99	361.08	1,080.00	7.26	26.40	2.50	0.51	10,000.00	7,150.00	855.00	7.30	26.50	1,760.00	0.26				0.21	0.40	0.05		0.03	0.03					2.00		462.00	99.90		99.90	99.79			
	Thu 2/25/99	385.58			26.50	4.20						27.00	1,660.00	0.17								0.02	0.03														
	Fri 2/26/99	409.08	1,490.00		26.50	2.50		12,000.00	8,500.00	1,170.00		26.00	1,710.00	0.16				0.67	0.20	0.05		0.03	0.03								99.94		99.73	99.80			
	Sat 2/27/99	433.75																																			
	Sun 2/28/99	456.58																																			
	Mon 3/1/99	481.08	1,580.00	7.05	26.50	1.00	0.56	10,900.00	7,600.00	900.00	7.29	27.00	1,610.00	0.18	5.00	154.00		2.04	0.40	0.10		0.05	0.05	11.40	3.56	14.96	1.09	10.00	10.00	3,300.00	99.78	98.33	99.05	99.65	60.61	90.35	96.28
	Tue 3/2/99	505.08			26.50	2.40						28.00	1,610.00	0.13								0.03	0.03														
	Wed 3/3/99	529.08	1,660.00	7.62	26.00	2.00	0.48	11,800.00	8,350.00	1,150.00	7.40	24.00	1,750.00	0.14				0.14	0.40	0.10		0.04	0.04					2.00	2.00	1,365.00	99.76		99.94	99.67			
	Thu 3/4/99	553.08			25.50	0.80						25.50	1,720.00	0.16								0.03	0.03														
	Fri 3/5/99	577.08	1,560.00		26.50	1.70		12,700.00	9,050.00	1,190.00		26.80	1,730.00	0.18				0.72	0.20	0.29		0.03	0.03								99.88		99.63	98.93			
	Sat 3/6/99	601.08						12,000.00																													
	Sun 3/7/99	625.08						13,050.00																													
	Mon 3/8/99	649.08	1,850.00					9,450.00	6,800.00	1,040.00								0.86	0.20	0.35				26.20	3.06	29.26	0.82	2.00		3,300.00	99.88		99.68	98.70		56.15	93.17
	Tue 3/9/99	653.08						9,150.00																													
	Wed 3/10/99	653.08						9,050.00																													
	Thu 3/11/99	653.08																																			
	Fri 3/12/99	653.08																																			
	Sat 3/13/99	653.08																																			
	Mon 3/15/99	653.08																																			
	Wed 3/17/99	653.08																																			
	Fri 3/19/99	653.08																																			
B	Sat 3/20/99	677.58							6,400.00																												
	Sun 3/21/99	701.58							7,800.00																												
	Mon 3/22/99	725.58	930.00	7.12	26.00	4.90	0.56	10,050.00	7,200.00	1,070.00	7.42	26.00	1,590.00	0.35		132.00		0.65	0.20	0.03		0.12	0.03	28.30	2.08	30.38	0.12	70.00	20.00	6,920.00	99.83		99.70	99.89	75.65	65.16	99.50
	Tue 3/23/99	749.58			27.00	0.70		12,900.00				27.50	1,800.00	0.19								0.04	0.04														
	Wed 3/24/99	773.58	1,400.00	7.33	27.50	1.00	0.65	13,750.00	9,900.00	1,120.00	7.53	27.80	1,680.00	0.25				0.31	0.20	0.03		0.04	0.04							4,300.00	99.90		99.85	99.89			
	Thu 3/25/99	797.58			27.00	1.20		14,100.00				27.50	1,710.00	0.17								0.04	0.04														
	Fri 3/26/99	821.33	1,570.00		26.50	1.70		13,200.00	9,450.00	1,360.00		26.50	1,690.00	0.30				0.63	0.20	0.04		0.05	0.05								99.95		99.79	99.86			
	Sat 3/27/99	845.58						13,500.00																													
	Sun 3/28/99	845.58																																			
	Mon 3/29/99	865.08	1,070.00	7.23	26.00	1.60	0.60	17,300.00	12,300.00	1,080.00	7.68	26.00	1,640.00	0.14	15.00	190.00	344.00	0.18	0.20	0.02		0.05	0.05	3.39	3.50	6.89	0.18	260.00	90.00	4,000.00	99.88	97.95	99.92	99.92	47.66	94.50	99.08
	Tue 3/30/99	889.08			26.00	1.00						26.40	1,700.00					0.17				0.06	0.06														
1	Wed 3/31/99	913.08	1,530.00	7.37	26.00	0.90	0.62	13,650.00	9,800.00	1,300.00	7.58	26.00	1,660.00	0.42		230.00	360.00	2.72	0.20	0.35		0.05	0.05					84.00	175.00		99.86		99.04	98.70			
1	Thu 4/1/99	936.58	2,100.00		27.00	0.80		13,250.00	9,500.00	1,740.00		27.00	1,870.00	0.25				1.23	0.60	12.80		0.03	0.02								99.63		99.54	50.77			
	Fri 4/2/99	961.08			27.80	0.70						27.60	1,690.00	0.19								0.03	0.03														
	Sat 4/3/99	988.58						14,000.00																													
	Sun 4/4/99	1013.58						15,700.00																													
	Mon 4/5/99	1033.66	1,760.00	7.47	28.00	0.40		13,650.00	10,400.00	1,550.00	7.68	27.00	1,710.00	0.23			332.00	6.54	0.40	24.50		0.04	0.04					300.00	180.00	4,500.00	99.81		96.59				
	Tue 4/6/99	1057.08			28.00	0.50		13,550.00				28.00	1,740.00	0.21								0.03	0.03	1.92	8.01	9.93	0.07									84.62	99.45
	Wed 4/7/99	1081.08	1,460.00	6.81	28.60	0.90	0.59	13,550.00	9,900.00	1,300.00	7.58	28.00	1,710.00	0.15			340.00	0.18	0.20	1.59		0.03	0.03					210.00	80.00	5,300.00	99.85		99.92	93.51			
	Thu 4/8/99	1106.33			28.60	0.90		16,150.00				28.40	1,650.00	0.17								0.04	0.04														
	Fri 4/9/99	1129.08	1,420.00		29.50	1.50		11,900.00	8,650.00	1,280.00		29.80	1,750.00	0.17				1.06	0.20	0.24		0.04	0.04								99.86		99.60	98.92			
	Sat 4/10/99	1157.58						13,050.00																													
	Sun 4/11/99	1181.58						10,750.00																													
	Mon 4/12/99	1205.08	1,300.00	7.11	29.60	0.90	0.56	11,850.00	8,750.00	920.00	7.44	29.00	1,780.00	0.14	17.00	164.00	324.00	1.14	0.20	0.36		0.04	0.04	3.51	3.34	6.85	0.15	62.00	10.00	3,200.00	99.84	97.57	99.48	98.36	57.29	90.82	99.21
	Tue 4/13/99	1229.08			28.80	1.20		17,300.00				29.00	1,680.00	0.19								0.05	0.05														

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT	Date	Run Time (hr)	CBOD5 (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)	CBOD5 (mg/L)	pH	Temperature (degrees C)	Conductivity (uS/cm)	Turbidity (NTU)	COD (mg/L)	ALK (mg/L)	Calcium Hardness (mg/L)	CBOD5 (mg/L)	TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	HPC (CFU/mL)	% TSS Removal	% COD Removal	% CBOD5 Removal	% Ammonia Removal	% ALK Consumed	% Total Nitrogen Removal	% Phosphorous Removal
				AERATION TANK							PERMEATE																				REMOVALS						
	Wed 4/14/99	1253.08	1,320.00	7.09	28.60	1.90	0.59	13,700.00	9,850.00	1,060.00	7.40	28.50	1,700.00	0.17				0.60	0.60	2.73		0.02	0.02					130.00	40.00	2,500.00	99.63		99.74	89.78			
	Thu 4/15/99	1277.08			28.90	1.80		14,700.00				28.00	1,770.00	0.40								0.04	0.04														
	Fri 4/16/99	1300.83	1,560.00		26.00	1.90		15,200.00	10,900.00	1,140.00		24.00	1,820.00	0.28				0.24	0.20	7.18		0.02	0.02								99.86		99.87	69.58			
	Sat 4/17/99	1324.83						15,000.00																													
	Sun 4/18/99	1349.58						12,850.00																													
	Mon 4/19/99	1369.08	1,860.00	7.32	27.00	1.30	0.71	16,150.00	11,600.00	1,370.00	7.63	27.00	1,950.00	0.38		256.00	352.00	0.69	0.60	9.93				1.03	20.40	21.43	0.28	330.00	82.00	3,000.00	99.55		99.79	57.56	48.59	76.77	97.93
	Tue 4/20/99	1393.08			27.50	1.70		15,300.00				27.40	1,880.00	0.17						7.35		0.01	0.01														
	Wed 4/21/99	1417.08	1,320.00	7.21	27.00	1.60	0.64	14,700.00	10,700.00	1,140.00	7.63	28.00	1,820.00	0.22				0.36	0.20	5.29	5.74	0.02	0.02					350.00	94.00	3,400.00	99.84		99.85	78.84			
	Thu 4/22/99	1441.08			28.00	1.50		14,300.00				28.00	1,920.00	0.20						9.78		0.04	0.04														
	Fri 4/23/99	1465.08	1,720.00		29.00	2.00		14,400.00	10,450.00	1,580.00		31.00	1,620.00	0.50				0.57	0.20	11.90	11.40	0.03	0.03								99.86		99.74	56.41			
	Sat 4/24/99	1489.58						14,600.00																													
	Sun 4/25/99	1513.08						15,000.00																													
	Mon 4/26/99	1537.33	1,580.00	6.94	29.00	1.20	0.69	13,500.00	9,500.00	1,180.00	7.82	29.00	1,674.00	0.38	13.00	240.00	328.00	1.48	0.20	14.20		0.04	0.04	1.18	13.10	14.28	0.09	250.00	90.00	3,200.00	99.81	96.97	99.24	47.60	35.14	60.45	98.04
	Tue 4/27/99	1561.08			30.00	1.00		13,800.00				29.50	1,651.00	0.31								0.04	0.04														
	Wed 4/28/99	1585.08	1,620.00	6.83	29.00	1.50	0.61	13,150.00	9,400.00	1,260.00	7.54	29.40	1,624.00	0.20				0.54	0.20	1.76	1.43	0.03	0.03					25.00	12.00	3,000.00	99.88		99.81	92.51			
	Thu 4/29/99	1609.08			29.00	1.90		17,000.00				29.00	1,672.00	0.29								0.03	0.03														
	Fri 4/30/99	1634.08	2,630.00		28.70	1.60		11,950.00	8,800.00	1,370.00		29.00	1,630.00	0.26				0.06	0.40	1.96		0.03	0.03								99.92		99.97	92.00			
	Sat 5/1/99	1656.08							12,950.00																												
	Sun 5/2/99	1681.08							14,500.00																												
	Mon 5/3/99	1705.08	1,100.00	7.33	28.70	1.50	0.73	13,650.00	9,900.00	960.00	7.78	31.00	1,632.00	0.31		234.00	300.00	0.57	0.20	13.60		0.03	0.03	1.46	17.70	19.16	0.37	22.00	28.00	1,500.00	99.82		99.65	50.90	37.77	57.71	92.56
	Tue 5/4/99	1729.08			29.00	1.20		13,200.00				28.20	1,654.00	0.22								0.03	0.03														
	Wed 5/5/99	1753.08	1,110.00	6.83	30.00	1.40	0.49	11,450.00	7,950.00	955.00	7.51	30.00	1,662.00					0.22	0.20	1.20		0.03	0.03					20.00	12.00	1,500.00	99.89		99.90	95.00			
	Thu 5/6/99	1777.08			29.50	1.60		11,600.00				29.60	1,725.00	0.20								0.03	0.03														
C	Fri 5/7/99	1801.08	1,050.00		28.70	1.70		9,850.00	7,300.00	920.00		28.00	1,840.00	0.22				1.24	0.20	0.05		0.03	0.03								99.86		99.50	99.81			
	Sat 5/8/99	1825.08						11,000.00																													
	Sun 5/9/99	1848.58						11,400.00																													
	Mon 5/10/99	1873.08	730.00	7.17	30.90	3.40	0.51	8,550.00	6,350.00	600.00	7.61	31.00	1,445.00	0.12	15.00	140.00	348.00	3.73		0.18		0.03	0.03	16.40	2.45	18.85	0.67	25.00	10.00	1,600.00		96.15	97.35	99.33	60.00	65.76	89.00
	Tue 5/11/99	1897.08			30.50	2.30		9,700.00				30.00	1,584.00	0.14								0.02	0.02														
	Wed 5/12/99	1921.08	742.00	6.96	29.80	3.00	0.40	9,400.00	6,900.00	640.00	7.60	29.80	1,938.00	0.15				0.18	0.20	0.40		0.05	0.04					32.00	18.00	2,200.00	99.89		99.92	98.44			
	Thu 5/13/99	1945.08			29.80	4.30		8,250.00				29.20	1,855.00	0.15								0.02	0.02														
	Fri 5/14/99	1969.33	860.00		30.00	1.60		9,100.00	6,550.00	680.00		30.50	1,718.00	0.17				4.72	0.60	0.07		0.04	0.03										97.64	99.73			
	Sat 5/15/99	1993.08						9,500.00																													
	Sun 5/16/99	2016.58						8,150.00																													
	Mon 5/17/99	2041.08	700.00	7.08	30.70	4.20	0.45	7,300.00	5,550.00	620.00	7.25	30.50	1,596.00	0.17		100.00	356.00	1.78	0.20	0.07		0.03	0.03					22.00	12.00	4,000.00	99.81		98.73	99.73	73.68		
	Tue 5/18/99	2065.33			29.00	4.70		8,000.00				28.60	1,564.00	0.19								0.04	0.03	28.60	1.54	30.14	8.29									41.49	53.43
	Wed 5/19/99	2089.08	1,070.00	7.03	31.00	2.90	0.56	8,150.00	6,300.00	1,020.00	7.34	28.00	1,522.00	0.12				0.38	0.20	0.06		0.07	0.04					18.00	12.00	4,200.00	99.83		99.78	99.76			
	Thu 5/20/99	2113.08			33.00	2.20		10,000.00				32.00	1,436.00	0.12								0.04	0.03														
	Fri 5/21/99	2137.08	1,240.00		30.00	1.20		10,450.00	7,750.00	1,100.00		29.50	1,542.00	0.12				2.07	0.20	0.07		0.04	0.30								99.78		98.86	99.70			
	Sat 5/22/99	2161.08						10,650.00																													
	Sun 5/23/99	2185.08						10,100.00																													
	Mon 5/24/99	2213.08	900.00	7.04	30.50	4.30	0.48	8,100.00	6,000.00	830.00	7.34	30.00	1,623.00	0.11	23.00	100.00	340.00	2.67		0.12		0.03	0.03	28.50	2.50	31.00	6.79	23.00	8.00	1,400.00		91.64	97.95	99.56	72.22	34.35	46.54
	Tue 5/25/99	2233.08			30.50	2.90						30.00	1,647.00	0.17								0.03	0.03					10.00	22.00	1,500.00							
	Wed 5/26/99	2257.08	1,090.00	7.05	30.50	2.10	0.57	9,650.00	7,350.00	1,080.00	7.15	29.00	1,730.00	0.30				0.55	0.20	0.07		0.03	0.03								99.84		99.74	99.75			
	Thu 5/27/99	2281.08			30.10	3.90		10,150.00				30.00	1,633.00	0.26								0.07	0.03														
	Fri 5/28/99	2305.08	1,350.00		31.00	2.00		9,600.00	7,000.00	1,300.00		30.00	1,689.00	0.15				0.58	0.40	0.07		0.07	0.04								99.68		99.75	99.69			
	Sat 5/29/99	2328.58						11,350.00																													
	Sun 5/30/99	2352.58						12,000.00																													
	Mon 5/31/99	2377.08	1,090.00	7.07	32.00	1.20	0.46	9,150.00	7,000.00	1,010.00	7.39	32.80	1,650.00	0.16				0.05		0.07		0.04	0.03										99.97	99.76			
	Tue 6/1/99	2401.08				1.50		10,300.00								106.00	328.00													1,600.00					70.56		
	Wed 6/2/99	2425.08	1,460.00	7.21	31.00	1.30	0.53	10,000.00	7,500.00	1,160.00	7.26	30.50	1,642.00	0.14				0.17		0.04		0.04	0.04	18.50	2.00	20.50	3.76						99.94	99.84		38.79	36.27
	Thu 6/3/99	2449.08			31.40	1.60		11,850.00				30.50	1,756.00	0.21								0.15	0.04							2,000.00							
	Fri 6/4/99	2473.08	880.00		31.00	1.20		10,450.00	7,850.00	760.00		31.00	1,733.00	0.19				0.61		0.04		0.15	0.05				4.37						99.58	99.84			
	Sun 6/6/99	2521.08						13,800.00																													
	Mon 6/7/99	2545.08	900.00	7.36	32.00	1.40	0.59	10,350.00	7,850.00	770.00	7.66	31.00	1,840.00	0.39	14.00	150.00	360.00	0.10	0.20	0.03		0.04	0.03	17.60	2.00	19.60	4.37	22.00	7.00	1,800.00	99.81	94.93	99.93	99.86	58.33	65.45	64.18
	Tue 6/8/99	2569.08			31.40	1.50		11,300.00				31.30	1,630.00	0.35																							
	Wed 6/9/99	2593.08	1,100.00	6.85	32.00	1.50	0.60	11,300.00	8,700.00	915.00	7.40	32.00	1,860.00	0.28				0.62	0.20	0.08		0.07	0.04								99.88		99.70	99.64			
	Thu 6/10/99	2617.08			31.60	1.60		10,350.00				31.00	1,860.00	0.24								0.04	0.04					6.00	9.00	191.00							
	Fri 6/11/99	2641.08	1,090.00		32.00	1.50		11,600.00	8,600.00	965.00		32.00	1,820.00	0.13				0.58		0.07		0.04	0.04										99.69	99.70			
	Sat 6/12/99	2665.08						13,900.00																													
	Sun 6/13/99	2690.08						14,850.00																													
	Mon 6/14/99	2713.08	745.00	7.25	31.80	1.40	0.56	11,300.00	8,550.00	652.00	7.40	31.00	1,580.00	0.15		190.00	348.00		0.20	0.27		0.04	0.03	2.61	2.00	4.61	2.72	10.00	20.00		99.81			98.78	45.40	92.09	88.02
	Tue 6/15/99	2736.83			31.50	1.20		12,100.00				31.00	1,510.00	0.32								0.04	0.04														

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT				AERATION TANK							PERMEATE																				REMOVALS						
	Date	Run Time (hr)	CBOD5 (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)	CBOD5 (mg/L)	pH	Temperature (degrees C)	Conductivity (uS/cm)	Turbidity (NTU)	COD (mg/L)	ALK (mg/L)	Calcium Hardness (mg/L)	CBOD5 (mg/L)	TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	HPC (CFU/mL)	% TSS Removal	% COD Removal	% CBOD5 Removal	% Ammonia Removal	% ALK Consumed	% Total Nitrogen Removal	% Phosphorous Removal
	Wed 6/16/99	2761.08	1,150.00	7.20	31.50	1.10	0.60	12,300.00	9,300.00	1,020.00	7.45	31.50	1,610.00	0.15				0.24	0.40	0.05		0.03	0.03					20.00	14.00	6,000.00	99.68		99.85	99.77			
	Thu 6/17/99	2784.83			31.90	1.20		11,500.00				31.60	1,340.00	0.18								0.03	0.03														
	Fri 6/18/99	2809.08	1,130.00		31.50	1.30		12,450.00	9,400.00	1,000.00		31.80	1,480.00	0.20				0.29	0.20	0.09		0.03	0.03								99.83		99.83	99.61			
	Sat 6/19/99	2832.58						14,450.00																													
	Sun 6/20/99	2856.58						11,750.00																													
	Mon 6/21/99	2881.08	620.00	7.21	31.20	1.40	0.46	11,700.00	9,150.00	640.00	7.40	31.00	1,558.00	0.14	12.00	158.00	360.00	0.17	0.20	0.07		0.04	0.03	10.50	2.00	12.50	2.26	29.00	22.00	2,500.00	99.81	97.64	99.87	99.71	56.11	80.39	69.21
	Tue 6/22/99	2904.83			31.80	1.70		10,650.00				31.70	1,535.00	0.15								0.05	0.04														
	Wed 6/23/99	2929.08	1,060.00	6.87	32.00	1.80	0.54	10,500.00	8,000.00	865.00	7.51	32.00	1,551.00	0.13				0.33	0.20	0.03		0.04	0.03								99.86		99.82	99.87			
	Thu 6/24/99	2952.83			32.20	2.30		11,550.00				30.00	1,600.00	0.14								0.04	0.03					16.00	12.00								
	Fri 6/25/99	2977.58	902.00		31.00	1.90		11,700.00	8,750.00	735.00		29.50	1,128.00	0.13				0.09	0.40	0.07		0.05	0.04								99.64		99.94	99.72			
	Sat 6/26/99	2999.83						12,600.00																													
	Sun 6/27/99	3025.58						12,250.00																													
	Mon 6/28/99	3051.08	755.00	7.19	32.50	3.00	0.49	8,750.00	6,450.00	720.00	7.37	32.10	1,564.00	0.13		134.00	328.00	0.02	0.20	0.07		0.05	0.04	15.40	2.00	17.40	2.42	9.00	4.00	700.00	99.84		99.99	99.72	62.36	58.29	79.49
	Tue 6/29/99	3073.08			32.00	1.80		10,200.00				31.50	1,582.00		13.00							0.08	0.05														
	Wed 6/30/99	3097.08	1,100.00	7.18	32.90	2.40	0.53	9,550.00	7,300.00	865.00	7.34	31.60	1,597.00	0.10				0.52	0.20	0.05		0.04	0.03					13.00	1.00	200.00	99.85		99.74	99.78			
	Thu 7/1/99	3121.58			31.90	1.90		10,650.00				32.00	1,643.00	0.14								0.04	0.03														
	Fri 7/2/99	3145.08	852.00		32.00	2.70		9,850.00	7,450.00	940.00		32.20	1,600.00	0.12		108.00	380.00	0.25		0.13		0.05	0.04										99.81	99.44	66.25		
	Sat 7/3/99	3168.58						12,150.00																													
	Sun 7/4/99	3192.08						10,300.00																													
	Mon 7/5/99	3217.50	1,270.00	6.89	31.50	3.40	0.44	8,150.00	6,400.00	1,100.00	7.19	31.00	1,500.00	0.16	14.00			0.92	0.20	0.08		0.05	0.04	26.00	2.00	28.00	3.36				99.81	95.51	99.54	99.67		35.05	35.63
	Tue 7/6/99	3241.08			32.90	3.50		10,200.00				32.00	1,663.00	0.13		120.00	348.00					0.11	0.04					3.00	4.00	800.00					66.48		
	Wed 7/7/99	3265.08	915.00	7.20	30.50	1.50	0.94	9,250.00	7,100.00	810.00	7.41	31.50	1,710.00	0.14				0.26	0.60	0.05		0.04	0.04					3.00	6.00	1,000.00	99.46		99.81	99.77			
	Thu 7/8/99	3289.08			32.60	1.80		9,600.00				33.00	1,877.00	0.20								0.04	0.03														
	Fri 7/9/99	3313.08	765.00		30.00	2.30		9,650.00	7,050.00	680.00		30.30	1,574.00	0.12	14.00	120.00	304.00	0.29	0.20	1.21		0.05	0.04								99.88	97.71	99.69	92.09	65.71		
	Sat 7/10/99	3335.83						10,900.00																													
	Sun 7/11/99	3362.08						10,300.00																													
	Mon 7/12/99	3385.08	695.00	7.24	32.00	1.60	0.72	9,050.00	6,700.00	642.00	7.45	32.00	1,634.00	0.14		142.00	340.00		0.20	0.05	0.05	0.03	0.03	16.10	2.00	18.10	1.95	12.00	16.00	1,000.00	99.81			99.77	60.56	72.58	84.15
	Tue 7/13/99	3409.08			31.00	1.30		9,800.00				30.70	1,626.00	0.12								0.03	0.03														
	Wed 7/14/99	3431.58	742.00	7.18	31.40	1.20	0.81	10,100.00	7,500.00	775.00	7.35	31.00	1,670.00	0.13				0.26	0.20	0.04	0.04	0.04	0.04					42.00	50.00	40.00	99.83		99.76	99.76			
	Thu 7/15/99	3457.08				1.00		10,300.00																													
	Fri 7/16/99	3481.08	1,120.00		31.40	1.00		11,250.00	8,300.00	888.00		31.00	1,631.00	0.13				0.22	0.20	0.09		0.04	0.04								99.81		99.85	99.54			
	Sat 7/17/99	3503.83						11,300.00																													
	Sun 7/18/99	3528.08						10,100.00																													
	Mon 7/19/99	3553.08	908.00	7.12	31.40	0.60	0.89	12,500.00	8,450.00	758.00	7.55	31.00	1,806.00	0.19	14.00			0.06	0.20	0.05		0.04	0.04	8.86	2.00	10.86	2.54				99.85	97.71	99.96	99.82		85.62	86.12
	Tue 7/20/99	3579.58											1,656.00	0.17								0.03	0.03														
	Wed 7/21/99	3601.08	1,140.00	7.10			0.67	12,650.00	9,150.00	1,040.00	7.53		1,568.00	0.19				0.19	0.40	0.04		0.04	0.02								99.70		99.87	99.80			
	Thu 7/22/99	3623.83											1,584.00	0.16								0.04	0.03														
	Fri 7/23/99	3649.58	878.00					11,850.00	8,850.00	810.00			1,609.00	0.18				0.06	0.20	0.03		0.04	0.04								99.83		99.95	99.87			
	Sat 7/24/99	3673.08																																			
	Sun 7/25/99	3697.08																																			
	Mon 7/26/99	3745.58	790.00	7.08			0.71	10,950.00	8,250.00	680.00	7.60		1,721.00	0.14				0.16	0.20	0.05		0.04	0.04	20.30	2.00	22.30	2.40				99.85		99.89	99.79		40.88	51.02
	Tue 7/27/99	3752.08				1.00		12,000.00					1,723.00	0.14								0.07	0.05														
	Wed 7/28/99	3771.08	910.00	7.18	30.00	1.00	0.85	12,450.00	9,100.00	768.00	7.66	27.00	1,839.00	0.13				0.05	0.40	0.05		0.08	0.06								99.78		99.96	99.76			
	Thu 7/29/99	3795.08			28.00	1.60						25.00	1,783.00	0.13								0.07	0.05														
	Fri 7/30/99	3819.08	848.00					11,950.00	8,950.00	745.00			1,982.00	0.12					1.20	0.08		0.06	0.04								99.43			99.64			
	Sat 7/31/99	3844.08																																			
	Sun 8/1/99	3868.58																																			
	Mon 8/2/99	3891.08	822.00	7.21	31.80	1.30	0.48	9,300.00	9,300.00	615.00	7.56	32.00	1,871.00	0.07	15.00	108.00	380.00	0.18	0.20	0.02		0.06	0.04	18.90	2.00	20.90	2.44	14.00	9.00	2,000.00	99.85	94.93	99.88	99.90	66.25	37.67	42.99
	Tue 8/3/99	3918.08			32.10	2.40		8,750.00				32.00	1,790.00	0.05								0.04	0.04														
	Wed 8/4/99	3939.08	882.00	7.29	31.90	1.50	0.65	9,350.00	7,000.00	750.00	7.32	32.00	1,779.00	0.13				0.20	0.20	0.09		0.04	0.04					20.00	21.00	1,000.00	99.80		99.88	99.59			
	Thu 8/5/99	3968.58			31.40	1.70		9,450.00				31.80	1,690.00	0.13								0.04	0.03														
	Fri 8/6/99	3987.08	832.00		31.40	2.10		10,300.00	8,000.00	770.00		32.00	1,710.00	0.11				0.22		0.08		0.03	0.03										99.86	99.61			
	Sat 8/7/99	4013.08						10,750.00																													
	Sun 8/8/99	4036.83						8,250.00																													
	Mon 8/9/99	4059.08	820.00	7.14	32.30	2.20	0.86	9,150.00	6,850.00	805.00	7.00	32.10	1,742.00	0.22		120.00	304.00	0.13	0.40	0.08		0.04	0.03	16.70	2.00	18.70	3.22	12.00	2.00	1,400.00	99.76		99.93	99.63	65.71	57.71	69.33
	Tue 8/10/99	4087.58			32.00	1.20		9,600.00				32.40	1,408.00	0.11								0.03	0.03														
	Wed 8/11/99	4107.08	725.00	7.00	31.10	1.50	0.96	10,100.00	7,450.00	620.00	7.46	32.50	1,608.00	0.14				0.04	0.20	0.08		0.04	0.04					14.00	7.00	4,200.00	99.89		99.97	99.63			
3	Thu 8/12/99	4129.58			32.00	1.20		10,650.00				32.00	1,488.00	0.09								0.03	0.03														
3	Fri 8/13/99	4154.33	837.00		32.00	0.70		8,600.00	6,400.00	755.00		31.40	1,437.00	0.09						0.05		0.03	0.03											99.73			
	Sat 8/14/99	4179.83						9,850.00																													
	Sun 8/15/99	4204.58						9,950.00																													
4	Mon 8/16/99	4225.08	732.00	7.13	32.50	1.10	2.12	8,600.00	6,300.00	620.00	7.39	32.40	1,405.00	0.14	17.00	158.00	312.00	0.04		0.07		0.02	0.03	11.00	2.00	13.00	2.72	6.00	3.00	1,900.00		94.75	99.97	99.72	52.98	65.83	45.05

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT				AERATION TANK							PERMEATE																				REMOVALS						
	Date	Run Time (hr)	CBOD5 (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)	CBOD5 (mg/L)	pH	Temperature (degrees C)	Conductivity (uS/cm)	Turbidity (NTU)	COD (mg/L)	ALK (mg/L)	Calcium Hardness (mg/L)	CBOD5 (mg/L)	TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	HPC (CFU/mL)	% TSS Removal	% COD Removal	% CBOD5 Removal	% Ammonia Removal	% ALK Consumed	% Total Nitrogen Removal	% Phosphorous Removal
4	Tue 8/17/99	4248.58			32.90	0.90		9,200.00				31.90	1,409.00	0.15								0.03	0.03														
4	Wed 8/18/99	4272.83	1,010.00	7.20	32.40	1.00	1.96	9,000.00	6,600.00	800.00	7.30	31.40	1,405.00	0.09				0.06	0.20	0.39		0.03	0.03								99.86		99.96	98.45			
4	Thu 8/19/99	4296.83			32.80	1.30		8,900.00				33.00	1,365.00	0.09								0.03	0.03														
4	Fri 8/20/99	4320.58	790.00		32.40	0.90		9,450.00	7,200.00	800.00		32.50	1,370.00	0.07				0.06		0.06		0.03	0.03										99.96	99.74			
	Sat 8/21/99	4344.08						11,750.00																													
	Sun 8/22/99	4368.58						9,600.00																													
	Mon 8/23/99	4393.08	812.00	7.18	29.80	1.60	1.78	9,400.00	7,200.00	705.00	7.18	28.90	1,143.00	0.07				0.04	0.20	1.95		0.03	0.03	10.50	2.20	12.70	3.10				99.87		99.96	92.01		55.44	23.65
	Tue 8/24/99	4417.08			31.60	1.20		10,900.00				30.00	1,210.00	0.08								0.03	0.03														
	Wed 8/25/99	4441.08	862.00	7.18	31.50	0.90	1.84	9,650.00	7,150.00	702.00	7.62	31.80	1,310.00	0.08				0.15		0.08		0.02	0.02										99.92	99.59			
	Thu 8/26/99	4464.83			31.00	0.80		9,800.00				31.40	1,356.00	0.10								0.03	0.03														
	Fri 8/27/99	4489.08	1,058.00			1.00		10,500.00	7,900.00	950.00			1,294.00	0.14				0.13	0.20	0.22		0.03	0.03								99.85		99.93	99.02			
	Sat 8/28/99	4514.08						12,650.00																													
	Sun 8/29/99	4536.08						13,150.00																													
	Mon 8/30/99	4560.58																																			
	Tue 8/31/99	4561.08																																			
	Wed 9/1/99	4561.08								–																											
	Thu 9/2/99	4581.58			31.50	1.30		9,550.00				31.00	1,378.00	0.16								0.04	0.03														
	Fri 9/3/99	4606.08	902.00		31.80	1.00		11,050.00	8,300.00	820.00		31.50	1,389.00	0.10	26.00			1.21	0.40			0.03	0.03	0.59	18.30	18.89	3.09				99.62	83.33	99.26			47.28	35.63
	Sat 9/4/99	4629.08						12,150.00																													
	Sun 9/5/99	4654.08						10,250.00																													
	Mon 9/6/99	4677.08	702.00	7.19	31.00	1.80	0.84	8,750.00	6,500.00	618.00	7.34	30.40	1,463.00	0.09				0.09		0.06		0.04	0.04	19.30	2.00	21.30	3.09						99.93	99.78		46.47	47.45
	Tue 9/7/99	4701.75			30.40	2.60		9,600.00				30.20	1,219.00	0.09								0.04	0.03						1.00								
	Wed 9/8/99	4725.33	980.00	7.22	31.50	1.30	0.96	9,800.00	7,250.00	715.00	7.64	31.40	1,379.00	0.09				0.20	0.20	0.04		0.05	0.04								99.85		99.86	99.81			
	Thu 9/9/99	4749.33			31.70	1.10		10,850.00				31.60	1,348.00	0.11								0.08	0.05														
	Fri 9/10/99	4773.33	950.00		31.60	0.90		9,700.00	7,150.00	815.00		32.00	1,515.00	0.13				0.20		0.08		0.97	0.27										99.89	99.61			
	Sat 9/11/99	4797.08						12,650.00																													
	Sun 9/12/99	4820.58						12,450.00																													
	Mon 9/13/99	4845.75	1,090.00	7.36	31.90	1.60	1.06	11,650.00	8,600.00	820.00	7.60	31.80	1,696.00	0.12	11.00			0.64		0.04		0.08	0.04	3.17	2.00	5.17	2.63	17.00	12.00	5,700.00		97.22	99.60	99.82		89.15	48.53
	Tue 9/14/99	4869.33			32.00	1.30		9,800.00				32.70	1,651.00	0.11								0.05	0.04						3.00								
	Wed 9/15/99	4875.91																																			
	Thu 9/16/99	4875.91																																			
7	Fri 9/17/99	4892.16	802.00		29.90	1.40		9,700.00	6,900.00	690.00		30.00	1,705.00	0.14				0.12	0.20	0.09		0.04	0.04								99.87		99.92	99.56			
7	Sat 9/18/99	4914.91						12,800.00																													
7	Sun 9/19/99	4940.41						11,750.00																													
7	Mon 9/20/99	4964.16	890.00	7.00	31.00	1.10	2.59	9,750.00	7,100.00	720.00	7.30	31.00	1,728.00	0.28				2.33	0.40	4.04		0.03	0.02								99.63		98.45	85.04			
7	Tue 9/21/99	4988.16			30.90	1.60		10,950.00				31.00	1,631.00	0.21		190.00	328.00					0.04	0.04					120.00	31.00	9,100.00					44.12		
7	Wed 9/22/99	4986.91	878.00	6.94	29.50	1.30	1.03	9,650.00	7,000.00	792.00	7.36	29.70	1,660.00	0.16				0.12	0.20	0.14		0.07	0.05					110.00	32.00	810.00	99.58		99.92	99.37			
7	Thu 9/23/99	5035.91			29.10	2.20		10,150.00				29.00	1,618.00	0.12								0.05	0.05	1.46	8.50	9.96	1.97									73.82	64.88
7	Fri 9/24/99	5060.16	940.00		28.00	1.40		10,100.00	7,450.00	750.00		28.00	1,682.00	0.08				0.03	0.20	0.15		0.04	0.04								99.83		99.98	99.31			
7	Sat 9/25/99	5082.91																																			
7	Sun 9/26/99	5110.91						12,750.00																													
7	Mon 9/27/99	5132.16	800.00	7.20	30.20	1.70	1.30	8,650.00	6,550.00	660.00	7.40	30.40	1,724.00	0.09		162.00	316.00	0.12	0.20	0.13		0.03	0.01					42.00	18.00	4,600.00	99.81		99.92	99.47	50.61		
8	Tue 9/28/99	5156.41			31.30	1.20		10,000.00				29.00	1,652.00	0.11								0.06	0.05														
8	Wed 9/29/99	5180.16	985.00	7.24	28.90	1.50	1.25	10,350.00	7,950.00	858.00	7.42	29.50	1,692.00	0.09	9.00			0.16	0.20	0.65		0.05	0.04	2.01	2.40	4.41	3.58	50.00	26.00	4,400.00	99.83	97.94	99.92	97.20		87.96	34.91
	Thu 9/30/99	5204.41			29.00	0.90		10,600.00				28.80	1,893.00	0.08								0.06	0.05														
	Fri 10/1/99	5229.41	1,060.00		27.50	1.00		10,600.00	7,950.00	900.00		28.80	1,784.00	0.09				0.18		0.72		0.03	0.03										99.89	96.87			
	Sat 10/2/99	5251.16						11,200.00																													
	Sun 10/3/99	5277.41						13,400.00																													
	Mon 10/4/99	5300.16	1,085.00	7.12	30.50	0.70		11,350.00	8,700.00	1,000.00		30.80						0.08	0.20	6.24								51.00	31.00	3,900.00	99.82		99.95	74.94			
D	Tue 10/5/99	5303.41			30.00	6.40		4,200.00																													
	Wed 10/6/99	5305.66			31.00	6.60		5,100.00																													
9	Thu 10/7/99	5324.25			29.30	4.80		6,800.00				29.40	1,586.00	0.10								0.04	0.04														
9	Fri 10/8/99	5347.75	490.00		29.80	2.90		6,400.00	4,850.00	360.00		30.20	1,480.00	0.14				0.03		0.05		0.09	0.03	18.30	2.00	20.30	3.19						99.98	99.77		52.13	47.45
10	Sat 10/9/99	5372.00						7,800.00																													
10	Sun 10/10/99	5395.25						5,400.00																													
10	Mon 10/11/99	5420.50	680.00	6.97	30.80	2.90	0.97	5,650.00	4,450.00	560.00	7.14	29.60	1,502.00	0.10		110.00	280.00	0.05	0.20	0.24		0.03	0.02					4.00		3,400.00	99.81		99.97	99.11	69.44		
10	Tue 10/12/99	5444.50			30.70	1.80		7,250.00				30.90	1,517.00	0.12								0.05	0.02														
10	Wed 10/13/99	5468.50	1,016.00	7.07	30.80	2.00	0.91	7,950.00	6,000.00	832.00	7.11	30.50	1,442.00	0.09	15.00			0.24	0.20	0.05		0.03	0.02	13.50	2.00	15.50	1.44	18.00	2.00	1,300.00	99.92	96.65	99.86	99.78		64.22	73.58
11	Thu 10/14/99	5492.25			30.60	3.00		6,850.00				31.00	1,479.00	0.12								0.02	0.01														
11	Fri 10/15/99	5515.75	580.00		30.60	3.90		5,850.00	4,400.00	545.00		31.00	1,416.00	0.13				0.17	0.20	0.14		0.01	0.01								99.86		99.89	99.19			
11	Sat 10/16/99	5539.25						7,100.00																													
11	Sun 10/17/99	5565.00						9,100.00																													

Table C-2
ZenoGem Water Quality Data

STAGE/EVENT				AERATION TANK							PERMEATE																				REMOVALS						
	Date	Run Time (hr)	CBOD5 (mg/L)	pH	Temperature (degrees C)	DO (mg/L)	OUR (mg O2/L/min)	MLSS (mg/L)	MLVSS (mg/L)	CBOD5 (mg/L)	pH	Temperature (degrees C)	Conductivity (uS/cm)	Turbidity (NTU)	COD (mg/L)	ALK (mg/L)	Calcium Hardness (mg/L)	CBOD5 (mg/L)	TSS (mg/L)	NH3-N (mg/L)	NH3-N (mg/L) (ASL Check)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	NO2/NO3-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	HPC (CFU/mL)	% TSS Removal	% COD Removal	% CBOD5 Removal	% Ammonia Removal	% ALK Consumed	% Total Nitrogen Removal	% Phosphorous Removal
11	Mon 10/18/99	5588.75				3.90		6,750.00								124.00	300.00							20.10	2.00	22.10	2.73	9.00		1,600.00					61.25	43.20	29.46
11	Tue 10/19/99	5612.25				3.60		5,750.00																													
12	Wed 10/20/99	5635.75				4.40		6,100.00																				11.00		1,800.00							
12	Thu 10/21/99	5660.25				2.10		6,850.00																													
12	Fri 10/22/99	5683.00				2.30		6,700.00																													
12	Sat 10/23/99	5708.00						7,850.00																													
12	Sun 10/24/99	5731.50						7,750.00																													
12	Mon 10/25/99	5756.50	632.00	7.16	25.40	2.90	1.90	6,000.00	4,600.00	612.00	7.33	25.00	1,414.00	0.19	14.00	180.00	316.00	0.31	0.20	0.83		0.04	0.03	4.94	3.30	8.24	2.36	4.00		3,300.00	99.72	95.21	99.75	96.54	52.63	81.69	52.42
12	Tue 10/26/99	5780.50			27.50	1.20		6,100.00				27.90	1,515.00	0.12								0.04	0.03														
12	Wed 10/27/99	5804.50	984.00	7.21	26.10	0.70	1.77	6,750.00	5,150.00	882.00	7.32	26.00	918.00	0.17				0.08	0.20	0.24		0.03	0.02					6.00		2,500.00	99.82		99.94	98.95			
12	Thu 10/28/99	5828.50			27.40	0.60		6,500.00				27.00	1,316.00	0.11								0.05	0.03														
12	Fri 10/29/99	5852.50	930.00		27.00	0.70		5,950.00	4,650.00	897.00		27.10	1,328.00	0.18				0.36		0.14		0.09	0.04										99.83	99.36			
12	Sat 10/30/99	5876.00						7,550.00																													
12	Sun 10/31/99	5899.25						7,000.00																													
12	Mon 11/1/99	5924.50	780.00	7.28	27.20	0.80	1.29	5,900.00	4,450.00	665.00	7.35	26.40	1,536.00	0.09				0.72	0.40	0.04		0.07	0.04	2.98	2.40	5.38	0.52				99.68		99.48	99.86		88.91	
A	MEAN		1,460.45	7.14	26.13	3.90	0.47	10,081.33	7,586.36	1,144.09	7.40	26.19	1,675.63	0.16	14.50	135.00		1.05	0.38	0.11		0.05	0.04	23.96	3.01	26.97	1.46	2.28	1.65	977.73	99.82	97.59	99.61	99.58	67.29	70.09	93.24
	MIN		725.00	6.84	24.50	0.70	0.34	5,750.00	4,800.00	508.00	7.10	24.00	1,550.00	0.08	5.00	120.00		0.14	0.20	0.03		0.02	0.03	11.40	2.00	14.96	0.82	1.00	1.00	7.00	99.63	96.84	99.04	98.70	60.61	56.15	90.30
	MAX		2,820.00	7.62	27.50	8.60	0.56	14,900.00	9,100.00	3,050.00	7.63	28.00	1,880.00	0.26	24.00	154.00		2.52	0.75	0.35		0.22	0.10	29.40	4.28	33.58	2.29	10.00	10.00	6,000.00	99.94	98.33	99.94	99.89	77.98	90.35	96.28
B	MEAN		1,518.00	7.14	28.02	1.39	0.62	13,862.20	9,856.25	1,236.75	7.59	28.06	1,719.24	0.25	15.00	206.57	335.00	0.96	0.28	5.77	6.19	0.04	0.03	5.83	9.73	15.56	0.18	107.19	46.74	3,275.88	99.82	97.50	99.55	82.63	50.35	75.72	97.97
	MIN		930.00	6.81	26.00	0.40	0.49	10,050.00	6,400.00	920.00	7.40	24.00	1,590.00	0.14	13.00	132.00	300.00	0.06	0.20	0.02	1.43	0.01	0.01	1.03	2.08	6.85	0.07	20.00	10.00	1,500.00	99.55	96.97	96.59	47.60	35.14	57.71	92.56
	MAX		2,630.00	7.47	30.00	4.90	0.73	17,300.00	14,500.00	1,740.00	7.82	31.00	1,950.00	0.50	17.00	256.00	360.00	6.54	0.60	24.50	11.40	0.12	0.06	28.30	20.40	30.38	0.37	350.00	180.00	6,920.00	99.95	97.95	99.97	99.92	75.65	94.50	99.50
C	MEAN		932.15	7.13	31.14	1.73	0.87	10,520.22	7,571.77	815.37	7.41	30.83	1,603.88	0.15	15.15	135.65	340.00	0.54	0.27	0.32	0.05	0.05	0.04	13.95	3.14	17.09	3.26	18.15	9.87	1,589.02	99.79	94.96	99.67	98.64	61.02	60.57	56.93
	MIN		620.00	6.85	27.50	0.60	0.40	7,300.00	5,550.00	600.00	7.00	25.00	1,128.00	0.05	9.00	100.00	304.00	0.02	0.20	0.02	0.04	0.02	0.01	0.59	1.54	4.41	0.67	3.00	1.00	40.00	99.43	83.33	97.35	74.94	44.12	34.35	23.65
	MAX		1,460.00	7.36	33.00	4.70	2.59	14,850.00	9,400.00	1,300.00	7.66	33.00	1,982.00	0.39	26.00	190.00	380.00	4.72	1.20	6.24	0.05	0.97	0.30	28.60	18.30	31.00	8.29	120.00	50.00	9,100.00	99.89	97.94	99.99	99.90	73.68	92.09	89.00
D	MEAN		761.50	7.14	28.95	2.88	1.37	6,605.36	4,818.75	669.13	7.25	28.62	1,419.15	0.13	14.50	138.00	298.67	0.25	0.23	0.22		0.05	0.03	11.96	2.34	14.30	2.05	7.45	2.00	2,172.09	99.80	95.93	99.84	99.07	61.11	66.03	50.73
	MIN		490.00	6.97	25.40	0.60	0.91	4,200.00	4,400.00	360.00	7.11	25.00	918.00	0.09	14.00	110.00	280.00	0.03	0.20	0.04		0.01	0.01	2.98	2.00	5.38	0.52	4.00	2.00	1,300.00	99.68	95.21	99.48	96.54	52.63	43.20	29.46
	MAX		1,016.00	7.28	31.00	6.60	1.90	9,100.00	6,000.00	897.00	7.35	31.00	1,586.00	0.19	15.00	180.00	316.00	0.72	0.40	0.83		0.09	0.04	20.10	3.30	22.10	3.19	18.00	2.00	3,400.00	99.92	96.65	99.98	99.86	69.44	88.91	73.58
A(AT 6 GPM)			1,536.67	7.31	26.16	2.47	0.52	11,010.00	7,908.33	1,050.83	7.33	26.31	1,714.44	0.17	5.00	154.00		0.77	0.30	0.16		0.03	0.03	18.80	3.31	22.11	0.96	2.99	4.47	1,618.83	99.86	98.33	99.65	99.42	60.61	73.25	94.72
B(NORMAL)			1,485.00	7.12	28.12	1.43	0.62	13,883.33	9,875.00	1,205.28	7.59	28.16	1,716.38	0.24	15.00	202.67	331.43	0.85	0.27	5.68	6.19	0.04	0.03	5.83	9.73	15.56	0.18	109.39	41.87	3,275.88	99.83	97.50	99.58	83.56	50.35	75.72	97.97
B(PEAK)			1,815.00	7.37	26.50	0.85	0.62	13,450.00	9,650.00	1,520.00	7.58	26.50	1,765.00	0.34		230.00	360.00	1.98	0.40	6.58		0.04	0.04					84.00	175.00		99.75		99.29	74.74			
C(NORMAL)			944.79	7.14	31.17	1.82	0.72	10,596.15	7,692.31	829.00	7.42	30.84	1,612.20	0.15	15.55	128.29	344.57	0.57	0.28	0.27	0.05	0.06	0.04	15.47	2.94	18.42	3.34	15.09	8.90	1,383.07	99.79	94.68	99.65	98.82	63.55	58.03	58.37
C(PEAK-EVENTS 3,4,8)			870.80	7.19	31.91	1.09	1.78	9,416.67	6,890.00	766.60	7.37	31.46	1,469.22	0.10	13.00	158.00	312.00	0.08	0.20	0.24		0.03	0.03	6.51	2.20	8.71	3.15	17.32	8.83	2,891.37	99.85	96.34	99.95	98.97	52.98	76.89	39.98
C(NORMAL WITH CYCLED AIR TO MT-EVENT 7)			862.00	7.05	29.80	1.53	1.64	10625.00	7000.00	722.40	7.35	29.87	1678.29	0.15		176.00	322.00	0.54	0.24	0.91		0.04	0.04	1.46	8.50	9.96	1.97	82.15	26.14	3236.64	99.75		99.64	96.55	47.36	73.82	64.88
D(NORMAL WITH CYCLED AIR TO MT-EVENT9)			490.00		29.55	3.85		6600.00	4850.00	360.00		29.80	1533.00	0.12				0.03		0.05		0.07	0.04	18.30	2.00	20.30	3.19						99.98	99.77		52.13	47.45
D(PEAK WITH CYCLED AIR TO MT-EVENT 10)			848.00	7.02	30.77	2.23	0.94	6810.00	5225.00	696.00	7.13	30.33	1487.00	0.10	15.00	110.00	280.00	0.15	0.20	0.15		0.04	0.02	13.50	2.00	15.50	1.44	8.49	2.00	2102.38	99.87	96.65	99.91	99.45	69.44	64.22	73.58
D(NORMAL WITH CYCLED AIR TO MT-EVENT 11)			580.00		30.60	3.60		6900.00	4400.00	545.00		31.00	1447.50	0.13		124.00	300.00	0.17	0.20	0.14		0.02	0.01	20.10	2.00	22.10	2.73	9.00		1600.00	99.86		99.89	99.19	61.25	43.20	29.46
D(NORMAL WITH CYCLED AIR TO MT AND AT-EVENT 12)			831.50	7.22	26.77	1.74	1.65	6692.31	4712.50	764.00	7.33	26.57	1337.83	0.14	14.00	180.00	316.00	0.37	0.27	0.31		0.05	0.03	3.96	2.85	6.81	1.44	6.42		2457.96	99.74	95.21	99.75	98.68	52.63	85.30	52.42

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm[illegible]) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
A	STARTUP		4/21/99 11:37 PM	1728	3582	5238	48	68	6.5	7.0	4.7	19.2	15.2	4.2	1035	902	840	19	9	1.69	29.0	28.1	1.2	105	15	
			04/22/1999 7:47	1668	3370	4958	45	29	6.5	7.0	4.7	19.2	14.6	4.6	1042	907	848	20	8	1.72	28.2	27.3	2.0	107	14	
			04/22/1999 9:47	1654	3413	5012	47	32	6.6	7.1	4.8	19.2	14.8	4.6	1033	902	839	19	9	1.65	28.8	28.0	1.9	105	14	
			04/22/1999 12:47	1676	3752	5579	54	35	6.6	7.1	4.8	19.2	14.8	3.8	1049	920	870	19	7	1.63	29.8	28.9	1.5	104	14	
			04/22/1999 14:47	1699	3903	4952	58	38	6.6	7.1	4.9	19.3	14.6	3.8	1044	917	866	18	7	1.60	30.6	29.7	2.0	104	14	
			04/22/1999 17:47	1720	4128	5106	65	42	6.6	7.1	4.9	18.6	14.2	3.4	1052	939	893	16	7	1.50	31.5	30.5	1.9	104	14	
			04/23/1999 18:22	1661	4644	5805	98	51	6.7	7.3	5.4	14.8	12.3	1.9	1251	1173	1150	11	3	1.46	31.7	30.7	2.0	104	12	
			05/09/1999 7:01	1514	4604	5896	62	8	6.6	7.3	4.7	20.7	15.6	4.8	1040	916	859	18	8	1.41	30.5	29.6	0.2		15	
			05/09/1999 8:01	1518	4617	5908	63	8	6.6	7.3	4.8	20.7	15.4	4.8	1039	916	861	18	8	1.40	30.4	29.6	0.2		15	
			05/09/1999 9:01	1512	4614	5890	65	8	6.6	7.3	5.3	20.7	15.6	4.8	1040	917	862	18	8	1.40	30.5	29.7	0.2		15	
			05/11/1999 15:00	1648	5723	5748	183		6.9	7.0	5.2	19.7	15.4	3.8	2261	2196	2155	9	6	0.79	30.0	29.0			15	
			05/17/1999 0:00	1605	3921	3450	197		6.5			19.2	15.5	3.8	757	634	572	18	9	1.56	30.0	29.0			15	
			05/18/1999 13:57	1469	2502	3434	102	26	6.3	6.3	5.3	22.8	12.5	11.5	688	484	260	29	32	2.00	29.3	28.5	0.1	143	12	
			05/19/1999 0:57	1581	2741	3634	102	23	6.5	6.4	4.9	22.8	12.5	11.5	686	486	262	29	32	1.98	30.4	29.6	0.1	148	12	
			05/19/1999 13:48	1584	3845	6527	102	22	6.6	6.4	4.4	19.0	15.4	3.8	739	620	558	17	9	1.54	31.4	30.7	0.1		15	
B	START OF TESTING	0.00	05/19/1999 14:48	1601	3915	6768	102	26	6.6	6.4	4.8	19.2	15.2	3.8	756	636	574	17	9	1.52	31.6	30.8	0.1		15	
		41.01	05/21/1999 7:49	1580	5550	3722	102	27	6.9	6.9	5.1	18.2	14.1	4.4	1072	983	939	13	6	1.22	30.1	29.2	0.1		14	
		42.01	05/21/1999 8:49	1571	5643	3811	102	27	6.9	6.9	4.8	19.2	14.4	4.6	1151	1054	1009	14	7	1.22	30.3	29.4	0.1		14	
		43.01	05/21/1999 9:49	1566	5842	3487	126	25	6.9	6.9	4.8	19.0	13.3	4.2	1163	1070	1029	14	6	1.20	30.6	29.6	0.1		13	
		44.01	05/21/1999 10:49	1565	8345	3472	172	490	6.9	6.9	4.9	18.8	14.6	2.1	1313	1234	1214	12	3	1.04	30.7	29.6	0.1		14	
		45.01	05/21/1999 11:49	1574	8308	3320	172	164	6.8	6.9	4.9	18.4	14.3	1.5	1318	1243	1223	11	3	1.02	31.0	30.0	0.1		14	
		46.01	05/21/1999 12:49	1585	7657	2969	183	228	6.8	6.9	4.9	16.9	12.7	1.5	1343	1282	1262	9	3	0.94	31.5	30.4	0.1		12	
		47.01	05/21/1999 13:49	1602	7003	2876	186	165	6.8	6.8	4.9	15.2	11.4	1.5	1357	1306	1287	7	3	0.92	31.7	30.6	0.1		11	
		48.01	05/21/1999 14:49	1612	6590	2233	189	149	6.9	6.8	5.0	15.0	12.3	1.6	1436	1389	1369	7	3	0.87	32.0	30.8	0.1		12	
		49.01	05/21/1999 15:49	1613	6194	1772	187	153	6.9	6.8	5.0	14.2	11.4	1.7	1448	1404	1384	6	3	0.89	32.3	31.0	0.1		11	
		50.01	05/21/1999 16:49	1616	5943	1582	186	166	6.9	6.8	5.0	13.6	10.8	1.3	1456	1415	1394	6	3	0.88	32.5	31.2	0.1		10	
		51.01	05/21/1999 17:49	1616	5754	1360	188	170	7.0	6.8	5.0	13.4	10.4	1.7	1462	1422	1403	6	3	0.86	32.6	31.3	0.1		10	
		51.51	05/21/1999 18:19	1615	5669	1681	176	169	7.0	6.8	5.0	13.2	10.1	1.7	1464	1426	1405	6	3	0.86	32.7	31.3	0.1		10	
		52.51	05/21/1999 19:19	1618	5505	1511	176	184	7.0	6.8	5.1	12.8	9.8	1.9	1472	1433	1414	6	3	0.90	32.6	31.3	0.1		9	
		70.52	05/22/1999 13:19	1591	4134	815	165	51	7.2	6.9	5.3	10.5	6.6	2.5	1606	1566	1533	6	5	1.24	32.6	31.0	0.1		6	
		71.52	05/22/1999 14:19	1602	4417	1015	185	38	7.2	6.9	5.3	10.9	7.1	3.0	1596	1552	1519	6	5	1.30	32.9	31.3	0.1		7	
		72.52	05/22/1999 15:19	1611	4600	1047	190	35	7.2	6.9	5.3	11.5	7.7	3.0	1588	1540	1508	7	5	1.30	33.1	31.6	0.1		7	
		73.52	05/22/1999 16:19	1615	4702	1124	174	30	7.2	6.9	5.3	11.9	7.9	3.0	1580	1530	1497	7	5	1.28	33.3	31.8	0.1		8	
		74.52	05/22/1999 17:19	1616	4813	2132	190	34	7.2	6.9	5.3	14.4	10.2	3.6	1917	1851	1808	10	6	1.29	33.6	31.8	0.1		10	
		75.52	05/22/1999 18:19	1617	4742	2312	194	31	7.2	6.9	5.3	14.6	10.4	3.8	1918	1851	1807	10	6	1.29	33.6	31.9	0.1		10	
		76.52	05/22/1999 19:19	1613	4617	2539	192	30	7.2	6.8	5.3	14.6	10.2	3.4	1917	1849	1804	10	6	1.31	33.6	31.8	0.1		10	
		77.52	05/22/1999 20:19	1606	4466	2809	186	29	7.2	6.9	5.4	14.4	10.2	3.4	1919	1849	1804	10	6	1.37	33.3	31.5	0.1		10	
		78.52	05/22/1999 21:19	1605	4315	3019	180	28	7.2	6.8	5.4	14.2	10.0	3.6	1922	1851	1805	10	7	1.42	33.0	31.2	0.1		10	
		79.52	05/22/1999 22:19	1612	4169	3209	194	27	7.2	6.8	5.4	14.2	10.0	3.8	1925	1854	1807	10	7	1.42	32.7	30.9	0.1		10	
		80.52	05/22/1999 23:19	1610	4040	3323	191	27	7.1	6.8	5.4	13.8	9.6	3.6	1930	1859	1811	10	7	1.49	32.4	30.6	0.1		9	
		81.52	05/23/1999 0:19	1606	3928	3523	185	27	7.1	6.8	5.4	13.6	9.4	3.4	1934	1863	1814	10	7	1.52	32.2	30.4	0.1		9	
		82.52	05/23/1999 1:19	1604	3840	3629	182	27	7.1	6.9	5.4	13.4	9.1	3.4	1938	1869	1819	10	7	1.52	32.1	30.2	0.1		9	
		83.52	05/23/1999 2:19	1596	3760	3601	178	28	7.1	6.9	5.4	13.2	8.9	3.8	1943	1874	1825	10	7	1.55	31.9	30.1	0.1		9	
		84.52	05/23/1999 3:19	1588	3684	3775	175	28	7.1	6.8	5.4	13.0	8.7	3.6	1948	1880	1830	10	7	1.57	31.8	30.0	0.1		8	
		85.52	05/23/1999 4:19	1580	3613	3745	192	27	7.1	6.8	5.4	12.8	8.5	3.4	1952	1885	1836	10	7	1.58	31.8	29.9	0.1		8	
		86.52	05/23/1999 5:19	1572	3556	3656	192	28	7.1	6.8	5.4	12.5	8.5	3.4	1956	1890	1841	10	7	1.60	31.7	29.8	0.1		8	
		88.39	05/23/1999 7:11	1574	3476	3472	193	28	7.1	6.8	5.4	12.1	7.9	3.4	1962	1898	1850	9	7	1.63	31.6	29.6	0.1		8	
		89.39	05/23/1999 8:11	1574	3454	3560	192	29	7.1	6.8	5.4	11.9	7.9	3.6	1964	1902	1853	9	7	1.62	31.7	29.7	0.1		8	
		90.39	05/23/1999 9:11	1565	3443	3494	193	29	7.1	6.8	5.4	11.9	7.5	3.8	1964	1902	1854	9	7	1.62	31.9	30.0	0.1		7	
		91.39	05/23/1999 10:11	1558	3423	3424	192	28	7.1	6.8	5.4	11.9	7.5	3.6	1965	1902	1855	9	7	1.62	32.1	30.1	0.1		7	
		92.39	05/23/1999 11:11	1549	3433	3507	192	31	7.0	6.7	5.4	12.1	7.5	3.4	2018	1955	1906	9	7	1.60	32.4	30.4	0.1		7	
		93.39	05/23/1999 12:11	1562	3454	3412	194	33	7.0	6.8	5.4	12.1	7.7	3.6	2024	1960	1912	9	7	1.61	32.6	30.6	0.1		7	
		94.39	05/23/1999 13:11	1583	3494	3515	196	33	7.1	6.7	5.4	11.9	7.5	3.8	2023	1960	1912	9	7	1.62	32.9	30.8	0.1		7	
		95.39	05/23/1999 14:11	1596	3529	3670	196	33	7.1	6.7	5.4	11.9	7.5	3.4	2023	1961	1913	9	7	1.61	33.2	31.1	0.1		7	
		96.39	05/23/1999 15:11	1608	3561	3458	195	33	7.1	6.7	5.4	11.9	7.5	3.4	2023	1960	1912	9	7	1.64	33.5	31.4	0.1		7	
		97.39	05/23/1999 16:11	1613	3587	3790	198	34	7.0	6.6	5.4	11.9	7.5	3.4	2022	1960	1911	9	7	1.62	33.7	31.7	0.1		7	
		98.39	05/23/1999 17:11	1612	3597	3799	233	34	7.0	6.6	5.3	11.9	7.5	3.5	2022	1959	1910	9	7	1.64	33.9	31.9	0.1		7	
		99.39	05/23/1999 18:11	1613	3596	3720	227	36	7.0	6.6	5.3	12.1	7.5	3.6	2021	1958	1909	9	7	1.60	34.0	32.0	0.1		7	
		100.39	05/23/1999 19:11	1613	3574	3968	223	36	7.0	6.6	5.3	12.1	7.7	3.4	2023	1960	1910	9	7	1.60	34.0	31.9	0.1		7	
		101.39	05/23/1999 20:11	1613	3536	3999	219	37	7.0	6.5	5.2	12.1	7.5	3.6	2023	1959	1909	9	7	1.63	33.8	31.7	0.1		7	
		102.39	05/23/1999 21:11	1608	3485	3879	211	37	7.0	6.5	5.2	11.9	7.5	3.4	2024	1960	1910	9	7	1.67	33.5	31.5	0.1		7	
		103.39	05/23/1999 22:11	1599	3436	3990	205	37	7.0	6.6	5.2	11.9	7.3	3.6	2024	1960	1910	9	7	1.66	33.3	31.2	0.1		7	
		104.39	05/23/1999 23:11	1593	3383	4009	198	38	7.0	6.6	5.2	11.9	7.5	3.4	2026	1961	1911	9	7	1.69	33.0	30.9	0.1		7	
		105.39	05/24/1999 0:11	1588	3343	4028	193	37	7.0	6.6	5.2	11.9	7.5	3.6	2025	1960	1910	9	7	1.67	32.8	30.7	0.1		7	
		106.39	05/24/1999 1:11	1580	3298	4132	187	38	7.0	6.6	5.3	11.9	7.7	3.6	2026	1961	1910	9	7	1.67	32.5	30.5	0.1		7	
		107.39	05/24/1999 2:11	1572	3259	3901	184	37	7.0	6.6	5.3	11.7	7.5	3.4	2027	1961	1911	9	7	1.74	32.4	30.3	0.1		7	
		108.39	05/24/1999 3:11	1567	3214	4043	179	38	7.0	6.6	5.3	11.7	7.3	3.4	2029	1964	1912	9	8	1.74	32.3	30.2	0.1		7	
		109.39	05/24/1999 4:11	1559	3178	4054	175	38	7.0	6.6	5.3	11.7	7.3	3.6	2030	1964	1912	10	7	1.77	32.2	30.1	0.1		7	
		110.39	05/24/1999 5:11	1552	3143	4072	202	37	7.0	6.6	5.3	11.7	7.3	3.6	2029	1963	1911	10	7	1.77	32.1	30.0	0.1		7	
		111.39	05/24/1999 6:11	1545	3112	4051	201	36	7.0	6.6	5.3	11.7	7.5	3.6	2030	1964	1912	10	8	1.75	32.0	29.9	0.1		7	
		112.89	05/24/1999 7:42	1556	3095	4049	199	37	7.0	6.6	5.2	11.7	7.3	3.4	2028	1961	1909	10	8	1.77	32.0	29.9	0.1		7	
		113.89	05/24/1999 8:42	1566	3059	4308	198	37	7.0	6.6	5.2	11.9	7.5	3.8	2026	1958	1901	10	8	1.78	32.1	30.0	0.1		7	
		114.89	05/24/1999 9:42	1574	3076	4236	201	37	7.0	6.6	5.2	11.9	7.3	3.8	2026	1959	1903	10	8	1.75	32.4	30.3	0.1		7	
1	After 1st Cleaning with Citric Acid (Stages 1 and 2)	147.69	05/25/1999 18:29	1794	4502	5938	238	9	6.4	6.6	4.8	20.0	16.2	3.3	808	681	617	18	9	1.52	32.5	31.9	0.1	107	16	
		148.69	05/25/1999 19:29	1790	4498	6280	229	9	6.7	6.8	4.9	20.5	16.4	3.6	810	682	617	19	9	1.48	32.4	31.7	0.1	108	16	
		149.69	05/25/1999 20:29	1782	4445	6609	224	9	6.8	6.8	4.9	20.3	16.4	3.3	814	686	621	19	9	1.50	32.2	31.4	0.1	107	16	
		150.69	05/25/1999 21:29	1767	4432	6322	212	9	6.9	6.8	4.8	20.3	16.4	3.8	820	693	630	18	9	1.49	31.9	31.2	0.1	106	16	
		151.69	05/25/1999 22:29	1748	4431	6022	201	9	6.9	6.8	4.9	20.0	16.0	3.8	823	700	640	18	9	1.47	31.7	30.9	0.1	106	15	
		152.69	05/25/1999 23:29	1726	4453	6159	190	9	7.0	6.8	4.8	19.6	15.8	3.8	826	706	650	17	8	1.48	31.5	30.7	0.1	106	15	
		153.69	05/26/1999 0:29	1705	4481	5520	184	9	7.0	6.8	4.8	19.4	15.6	4.0	829	712	659	17	8	1.46	31.3	30.6	0.1	105	15	
		154.69	05/26/1999 1:29	1687	4494	5650	178	9	7.0	6.8	5.0	19.4	15.4	4.0	832	717	666	17	7	1.44	31.2	30.4	0.1	106	15	
		155.69	05/26/1999 2:29	1670	4489	4881	174	8	7.0	6.8	4.8	19.2	15.2	4.0	834	720	671	17	7	1.45	31.1	30.3	0.1	108	15	
		156.69	05/26/1999 3:29	1653	4467	5306	171	9	6.9	6.8	4.9	19.2	15.2	4.0	836	723	674	16	7	1.43	31.0	30.2	0.1	106	15	
		157.69	05/26/1999 4:29	1632	4427	4808	168	9	6.9	6.8	4.8	19.2	15.2	4.0	836	724	676	16	7	1.42	30.9	30.1	0.1	106	15	
		158.69	05/26/1999 5:29	1611	4378	5355	164	9	6.9	6.8	4.9	19.0	15.2	4.0	837	726	678	16	7	1.43	30.8	30.1	0.1	106	15	
		159.69	05/26/1999 6:29	1594	4338	4635	161	9	6.9	6.8	4.8	19.0	15.2	4.0	837	727	679	16	7	1.42	30.7	30.0	0.1	107	15	
		160.69	05/26/1999 7:29	1591	4365	4720	158	8	6.9	6.7	4.8	19.6	15.6	4.0	865	750	701	17	7	1.42	30.7	29.9	0.1	106	15	
		161.69	05/26/1999 8:29	1588	4374	4269	155	18	6.9	6.8	4.8	19.6	15.6	4.2	865	750	699	17	7	1.41	30.8	30.0	0.4	111	15	
		162.69	05/26/1999 9:29	1584	4401	4596	154	20	6.9	6.8	5.4	19.8	15.2	4.2	887	770	720	17	7	1.42	31.1	30.3	0.3	108	15	
		184.58	05/27/1999 7:23	1598	5425	3789	140	43	6.8	6.8	4.9	19.0	14.1	5.0	1445	1366	1316	12	7	1.03	30.6	29.5	0.3	109	14	6.8
		185.58	05/27/1999 8:23	1594	2766	2415	121	415	6.9	6.7	5.0	19.4	8.9	11.9	886	748	554	20	28	1.72	30.3	29.5	2.0	105	9	
		186.58	05/27/1999 9:23	1587	5861	4585	159	205	6.8	6.8	4.8	20.3	15.6	4.6	1551	1465	1421	12	7	1.00	30.8	29.6	0.3	105	15	
		188.57	05/27/1999 11:22	1589	5852	4221	152	121	6.8	6.8	5.4	20.3	15.4	4.6	1671	1588	1541	12	7	0.97	31.3	30.0	0.3	105	15	
		208.48	05/28/1999 7:17	1573	4746	3282	135	34	6.9	6.8	5.2	14.8	10.4	4.2	1661	1608	1566	8	6	0.98	32.0	30.5	0.3	107	10	6.8
		209.48	05/28/1999 8:17	1573	5492	3591	136	34	6.9	6.9	5.3	20.5	15.6	5.2	2106	2031	1980	11	8	0.86	32.0	30.4	0.3	105	15	6.8
		210.48	05/28/1999 9:17	1570	5408	3679	140	28	6.9	6.9	5.1	20.3	13.9	5.2	2265	2186	2132	11	8	0.92	32.3	30.5	0.4	108	13	6.8
		233.77	05/29/1999 8:34																							
2	Dec to 50%	256.41	05/30/1999 7:13	1568	2625	3400	117	25	7.0	6.6	4.6	20.0	10.4	10.9	612	444	247	24	29	2.00	31.0	30.3	0.1	108	10	6.8
		257.41	05/30/1999 8:13	1590	2673	3471	119	25	7.0	6.6	4.6	20.5	10.4	10.9	622	450	251	25	29	1.98	31.1	30.4	0.1	106	10	6.8
		258.41	05/30/1999 9:13	1602	2699	3503	115	25	7.0	6.6	4.6	20.3	10.4	10.9	621	450	249	25	29	2.00	31.3	30.6	0.1	107	10	6.8
		259.41	05/30/1999 10:13	1612	2753	3568	115	27	7.0	6.6	4.6	20.5	10.8	10.7	623	452	258	25	28	1.96	31.5	30.8	0.1	108	10	6.8
		260.41	05/30/1999 11:13	1620	2784	3595	124	28	7.0	6.6	4.7	20.5	10.8	10.7	622	452	258	25	28	1.95	31.7	31.0	0.1	106	10	6.8
		261.41	05/30/1999 12:13	1632	2828	3630	127	27	7.0	6.6	4.7	20.5	10.8	10.7	623	454	260	24	28	1.94	32.0	31.2	0.1	109	10	6.8
		262.41	05/30/1999 13:13	1645	2860	3643	119	28	7.0	6.6	4.7	20.1	10.6	10.5	611	445	255	24	28	1.96	32.2	31.5	0.1	106	10	6.8

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Conductivity Interstage	Conductivity Conc	Conductivity Tot Perm	Conductivity Samplvalve	pH Raw Feed	pH RO Feed	pH Concentrate	Flow (Lpm) Feed	Flow Tot Perm	Flow Conc	Pressure (kPa) Feed	Pressure Interstage	Pressure Conc	Pressure Drop (psi) Stage 1	Pressure Drop Stage 2	PDC (psi/gpm^1.5) Stage 1	Temperature RO Feed	Temperature Raw	Turbidity	Particle Index	Flux	Target pH
		263.41	05/30/1999 14:13	1656	2895	3678	123	28	6.9	6.6	4.7	20.2	10.6	10.5	610	445	254	24	28	1.94	32.5	31.8	0.1	106	10	6.8
		264.41	05/30/1999 15:13	1669	2930	3713	142	28	6.9	6.6	4.7	20.3	10.7	10.5	608	444	254	24	28	1.92	32.7	32.0	0.1	117	10	6.8
		265.41	05/30/1999 16:13	1669	2953	3731	137	28	6.9	6.5	4.8	20.3	10.6	10.7	609	444	254	24	28	1.93	32.9	32.2	0.1	106	10	6.8
		266.41	05/30/1999 17:13	1668	2962	3739	140	28	6.9	6.4	4.8	20.3	10.8	10.5	608	444	253	24	28	1.92	33.1	32.3	0.1	105	10	6.8
		267.41	05/30/1999 18:13	1658	2948	3721	144	28	6.8	6.5	4.8	20.3	10.8	10.5	608	443	254	24	27	1.93	33.1	32.4	0.1	106	10	6.8
		268.41	05/30/1999 19:13	1649	2925	3713	134	27	6.8	6.4	4.9	20.3	10.8	10.5	607	443	253	24	27	1.92	33.0	32.3	0.1	106	10	6.8
		269.41	05/30/1999 20:13	1646	2885	3682	139	27	6.9	6.4	4.9	20.3	10.8	10.5	609	444	254	24	28	1.93	32.8	32.1	0.1	109	10	6.8
		270.41	05/30/1999 21:13	1633	2846	3647	134	28	6.9	6.5	4.8	20.1	10.6	10.5	608	443	254	24	27	1.97	32.6	31.9	0.1	107	10	6.8
		272.41	05/30/1999 23:13	1615	2802	3617	121	28	6.9	6.5	4.8	20.3	10.8	10.7	623	454	260	25	28	1.98	32.1	31.4	0.1	107	10	6.8
		273.41	05/31/1999 0:13	1610	2779	3582	116	29	6.9	6.5	4.7	20.3	10.8	10.7	624	454	260	25	28	1.99	31.9	31.2	0.1	172	10	6.8
		275.41	05/31/1999 2:13	1611	2752	3559	110	28	7.0	6.6	4.7	20.5	10.6	10.7	624	455	260	24	28	1.94	31.7	31.0	0.1	140	10	6.8
		276.41	05/31/1999 3:13	1608	2739	3551	121	27	7.0	6.6	4.6	20.3	10.6	10.7	626	456	262	25	28	1.98	31.6	30.9	0.1	117	10	6.8
		278.41	05/31/1999 5:13	1598	2712	3511	121	27	7.0	6.6	4.6	20.1	10.6	10.7	625	456	262	24	28	2.00	31.4	30.7	0.1	130	10	6.8
		279.41	05/31/1999 6:13	1590	2695	3494	118	28	7.0	6.6	4.6	20.1	10.6	10.7	625	456	262	24	28	2.00	31.3	30.6	0.1	130	10	6.8
		280.91	05/31/1999 7:42	1601	2704	3512	117	28	7.0	6.6	4.6	20.0	10.4	10.7	626	457	262	24	28	2.00	31.3	30.6	0.1	125	10	6.8
		282.91	05/31/1999 9:42	1611	2664	3428	126	26	7.0	6.6	4.5	18.0	8.9	10.0	546	403	231	21	25	2.01	31.5	30.9	0.4	110	9	6.8
		283.91	05/31/1999 10:42	1662	2744	3494	142	27	7.0	6.8	3.4	18.0	8.9	9.9	542	400	230	21	25	1.99	31.7	31.1	0.5	109	9	6.8
		284.91	05/31/1999 11:42	1632	2757	3516	127	28	6.9	6.6	3.5	18.2	9.1	9.8	538	395	226	21	25	1.98	32.0	31.4	1.5	115	9	6.8
		285.91	05/31/1999 12:42	1646	2824	3581	156	28	6.9	6.6	4.0	18.2	9.3	9.8	539	395	226	21	25	1.99	32.3	31.7	2.0	111	9	6.8
		286.91	05/31/1999 13:42	1653	3099	4161	152	30	6.9	6.6	4.3	20.3	11.9	9.0	639	480	322	23	23	1.86	32.6	31.9	1.9	117	11	6.8
		288.91	05/31/1999 15:42	1674	3547	5271	174	36	6.9	6.6	4.7	20.3	13.9	6.7	707	563	449	21	17	1.69	33.2	32.4	1.1	105	13	6.8
		289.91	05/31/1999 16:42	1675	3578	5302	175	36	6.9	6.5	4.7	20.3	13.9	6.7	707	563	450	21	16	1.69	33.3	32.5	1.2	105	13	6.8
		292.91	05/31/1999 19:42	1678	3565	5284	172	37	6.9	6.5	5.0	20.3	13.9	6.9	707	563	450	21	16	1.69	33.3	32.5	1.2	105	13	6.8
		294.91	05/31/1999 21:42	1664	3484	5220	165	38	6.9	6.5	5.0	20.3	13.7	6.9	711	567	454	21	16	1.69	32.8	32.0	1.0	110	13	6.8
		295.91	05/31/1999 22:42	1658	3450	5171	164	38	7.0	6.6	4.9	20.1	13.7	6.9	714	569	456	21	16	1.71	32.5	31.7	1.0	106	13	6.8
		296.91	05/31/1999 23:42	1652	3431	5166	159	37	7.0	6.6	4.9	20.5	13.9	6.9	730	581	465	22	17	1.71	32.2	31.5	1.3	106	13	6.8
		297.91	06/01/1999 0:42	1651	3396	5131	153	35	7.0	6.6	4.9	20.5	13.7	6.9	731	583	468	21	17	1.71	32.0	31.2	1.5	106	13	6.8
		298.91	06/01/1999 1:42	1647	3369	5100	153	36	7.0	6.6	4.9	20.3	13.7	6.9	731	584	468	21	17	1.72	31.8	31.0	1.7	106	13	6.8
		299.91	06/01/1999 2:42	1642	3347	5061	151	35	7.1	6.6	4.9	20.3	13.7	6.9	732	585	469	21	17	1.72	31.6	30.8	1.0	108	13	6.8
		300.91	06/01/1999 3:42	1637	3325	5044	148	34	7.1	6.6	5.0	20.3	13.7	6.9	735	587	471	21	17	1.73	31.5	30.7	1.4	118	13	6.8
		301.91	06/01/1999 4:42	1631	3303	5016	148	33	7.1	6.6	4.9	20.1	13.5	6.9	735	588	471	21	17	1.75	31.4	30.6	1.2	107	13	6.8
		302.91	06/01/1999 5:42	1625	3276	4977	144	34	7.1	6.7	4.9	20.1	13.5	7.1	736	588	472	21	17	1.75	31.2	30.5	0.9	108	13	6.8
		304.90	06/01/1999 7:42	1619	3268	5013	144	34	7.1	6.7	5.0	20.5	13.9	7.1	751	600	482	22	17	1.74	31.2	30.4	1.5		13	
	2nd Cleaning with Citric Acid (Stage 1 Only)						--																			
3		305.90	06/01/1999 8:42	1629	3281	5000	148	32	7.1	6.7	5.0	20.3	13.5	6.9	738	590	473	21	17	1.73	31.3	30.6	1.1	106	13	6.8
		328.42	06/02/1999 7:13	1656	4093	4995	144	24	7.3	7.1	5.0	20.1	14.8	5.4	806	680	606	18	11	1.50	31.4	30.6	1.0	108	14	6.8
		329.42	06/02/1999 8:13	1659	4247	4942	150	24	7.3	7.1	5.0	19.0	13.9	5.2	783	670	606	16	9	1.46	31.5	30.7	1.0	114	13	6.8
		331.42	06/02/1999 10:13	1646	4563	5369	170	693	7.3	6.8	4.8	17.8	13.5	4.4	779	681	632	14	7	1.40	31.7	31.0	0.7	110	13	6.8
		334.42	06/02/1999 13:13	1678	4955	5153	181	108	7.3	6.7	4.7	17.6	13.5	4.4	778	685	638	14	7	1.36	32.6	31.8	1.3	113	13	6.8
		337.42	06/02/1999 16:13	1698	5223	5051	206	67	7.2	6.6	4.7	15.7	11.6	3.8	698	622	585	11	5	1.30	33.4	32.6	0.8	110	11	6.8
		352.50	06/03/1999 7:18	1711	5212	4626	177	37	7.3	6.7	4.7	14.4	10.8	4.0	717	651	613	10	6	1.29	31.2	30.5	0.6	107	10	6.8
		353.50	06/03/1999 8:18	1708	5630	4948	190	36	7.3	6.7	4.8	14.0	10.8	3.4	722	661	630	9	4	1.25	31.4	30.7	0.6	107	10	6.8
		357.50	06/03/1999 12:18	1715	5372	4449	147	34	7.3	6.7	4.6	20.3	13.5	5.7	976	867	803	16	9	1.28	32.2	31.3	0.1	106	13	6.8
		359.45	06/03/1999 14:15	1743	5514	4479	155	516	7.2	6.7	4.6	20.1	13.3	5.7	977	871	806	15	9	1.27	32.6	31.7	0.1	108	13	6.8
		362.45	06/03/1999 17:15	1767	9217	10017	259	137	7.2	6.7	4.8	20.1	16.4	1.9	1360	1243	1235	17	1	1.39	33.5	32.4	0.1	109	16	6.8
		363.45	06/03/1999 18:15	1770	6976	4553	238	140	7.2	6.6	4.8	17.1	12.7	1.9	1567	1499	1488	10	1	1.03	33.8	32.5	0.1	110	12	6.8
		366.45	06/03/1999 21:15	1815	5397	3239	221	200	7.3	6.6	4.8	13.2	10.4	2.3	1631	1576	1566	8	1	1.22	33.4	31.9	0.1	111	10	6.8
		367.45	06/03/1999 22:15	1831	5265	3279	223	209	7.3	6.7	4.8	12.7	10.2	2.3	1639	1585	1575	8	1	1.26	33.1	31.7	0.1	111	10	6.8
		368.45	06/03/1999 23:15	1829	5137	3214	223	197	7.3	6.6	4.8	12.5	9.8	2.3	1643	1590	1580	8	1	1.27	32.9	31.4	0.1	111	9	6.8
		369.45	06/04/1999 0:15	1815	5000	3174	217	180	7.3	6.7	4.8	12.1	9.6	2.3	1647	1595	1585	7	1	1.31	32.8	31.2	0.1	110	9	6.8
		370.45	06/04/1999 1:15	1795	4868	3044	215	166	7.3	6.7	4.9	12.1	9.3	2.3	1652	1601	1590	7	2	1.28	32.6	31.1	0.1	111	9	6.8
		373.45	06/04/1999 4:15	1744	4599	3086	212	140	7.3	6.6	4.9	11.7	8.9	2.3	1658	1607	1596	7	2	1.36	32.4	30.8	0.1	111	9	6.8
		374.45	06/04/1999 5:15	1730	4541	2934	207	136	7.3	6.6	4.9	11.5	8.9	2.5	1661	1610	1600	7	1	1.39	32.3	30.8	0.1	111	9	6.8
		375.45	06/04/1999 6:15	1723	4515	3036	208	134	7.3	6.6	4.8	11.5	8.9	2.1	1660	1610	1599	7	2	1.36	32.3	30.7	0.1	111	9	6.8
		376.78	06/04/1999 7:34	1727	4497	2992	187	129	7.3	6.7	4.8	11.3	8.5	2.1	1662	1612	1601	7	2	1.39	32.3	30.7	0.1	111	8	6.8
		377.78	06/04/1999 8:35	1730	4411	2921	199	1172	7.3	6.7	4.8	11.5	8.3	2.1	1658	1607	1596	7	2	1.39	32.2	30.6	0.1	110	8	6.8
		378.78	06/04/1999 9:34	1725	4462	2927	201	951	7.4	6.7	4.9	11.5	8.3	2.3	1656	1597	1587	8	2	1.60	32.6	31.0	0.1	110	8	6.8
		378.78	06/04/1999 9:35	1725	4462	2927	201	951	7.4	6.7	4.9	11.5	8.3	2.3	1656	1597	1587	8	2	1.60	32.6	31.0	0.1	110	8	6.8
		379.78	06/04/1999 10:35	1717	2475	2284	117	747	7.3	6.7	4.9	20.7	7.9	14.4	1491	1334	1073	23	38	1.79	32.3	31.1	0.3	110	8	6.8
		380.78	06/04/1999 11:35	1717	2912	2930	116	610	7.3	6.6	4.9	20.7	8.9	13.4	1276	1127	888	22	35	1.70	32.3	31.3	0.1	110	9	6.8
		381.78	06/04/1999 12:35	1729	3117	3335	128	524	7.3	6.6	4.9	20.7	9.8	12.3	1135	966	767	25	29	1.92	32.4	31.5	0.2	111	9	6.8
		382.56	06/04/1999 13:22	1732	3153	3436	139	479	7.3	6.6	4.8	19.0	8.9	11.3	967	817	644	22	25	1.93	32.6	31.7	0.2	111	9	6.8
		383.56	06/04/1999 14:22	1740	3281	3634	136	368	7.2	6.6	4.9	20.3	10.0	11.5	1012	849	669	24	26	1.91	32.9	32.0	0.2	218	10	4.5
		384.56	06/04/1999 15:22	1750	3339	3709	141	274	7.2	6.5	4.9	20.3	10.2	11.5	992	830	652	24	26	1.90	33.1	32.2	0.3	128	10	4.5
		401.20	06/05/1999 8:00																							
		402.19	06/05/1999 8:59	1778	3352	4282	151	82	7.3	6.6	4.9	20.2	11.4	9.8	869	703.1	543	24	23	1.95	31.5	30.7	0.2	103	11	4.5
		403.19	06/05/1999 9:59	1748	3303	4181	141	80	7.3	6.6	5.0	20.2	11.2	9.8	874	708.1	549	24	23	1.95	31.6	30.8	0.2	104	11	4.5
		404.19	06/05/1999 10:59	1727	3285	4131	142	78	7.3	6.6	5.0	20.3	11.2	10.0	875	709.9	552	24	23	1.94	31.7	31.0	0.2	104	11	4.5
		405.19	06/05/1999 11:59	1719	3285	4111	143	77	7.3	6.6	5.0	20.3	11.2	10.0	874	709.9	552	24	23	1.93	31.9	31.1	0.2	104	11	4.5
		407.19	06/05/1999 13:59	1740	3365	4137	151	72	7.3	6.6	5.1	20.3	11.2	10.0	873	711.0	553	24	23	1.90	32.4	31.6	0.2	104	11	4.5
		408.19	06/05/1999 14:59	1754	3414	4172	153	70	7.3	6.6	5.1	20.5	11.4	10.0	874	712.0	553	24	23	1.87	32.7	31.9	0.2	105	11	4.5
		409.19	06/05/1999 15:59	1759	3450	4198	156	68	7.3	6.6	5.1	20.3	11.2	10.0	871	709.9	552	23	23	1.89	33.0	32.2	0.2	105	11	4.5
		410.19	06/05/1999 16:59	1764	3476	4211	161	69	7.3	6.6	5.1	20.5	11.4	10.0	871	711.0	552	23	23	1.85	33.2	32.3	0.2	105	11	4.5
		412.19	06/05/1999 18:59	1763	3463	4202	154	70	7.3	6.6	5.1	20.3	11.2	10.0	873	712.0	554	23	23	1.89	33.1	32.3	0.2	105	11	4.5
		413.19	06/05/1999 19:59	1762	3423	4163	155	72	7.3	6.6	5.1	20.3	11.2	10.0	878	716.0	558	24	23	1.90	32.9	32.1	0.2	105	11	4.5
		414.19	06/05/1999 20:59	1749	3365	4106	146	72	7.3	6.6	5.1	20.0	11.0	10.0	876	714.9	558	23	23	1.92	32.6	31.8	0.2	105	11	4.5
		415.19	06/05/1999 21:59	1739	3342	4105	144	70	7.3	6.6	5.1	20.5	11.2	10.1	901	735.9	574	24	23	1.91	32.3	31.5	0.2	114	11	4.5
		416.19	06/05/1999 22:59	1734	3312	4080	143	65	7.3	6.6	5.1	20.5	11.2	10.0	900	735.9	574	24	23	1.90	32.1	31.3	0.2	113	11	4.5
		419.19	06/06/1999 1:59	1727	3249	3996	137	64	7.3	6.6	5.1	20.0	10.8	10.2	905	741.9	579	24	24	1.94	31.7	30.9	0.2	112	10	4.5
		420.19	06/06/1999 2:59	1718	3223	3970	134	62	7.3	6.6	5.1	20.0	11.0	10.2	908	743.7	581	24	24	1.96	31.6	30.8	0.2	114	11	4.5
		421.19	06/06/1999 3:59	1708	3201	3938	134	63	7.3	6.7	5.1	20.3	11.0	10.2	908	744.8	583	24	24	1.91	31.5	30.7	0.2	113	11	4.5
		422.19	06/06/1999 4:59	1698	3187	3921	127	62	7.3	6.6	5.2	20.5	11.2	10.4	928	762.9	595	24	24	1.91	31.5	30.7	0.2	114	11	4.5
		423.19	06/06/1999 5:59	1686	3161	3899	126	61	7.3	6.6	5.1	20.3	11.0	10.2	929	763.9	596	24	24	1.94	31.4	30.6	0.2	114	11	4.5
		424.45	06/06/1999 7:15	1679	3143	3877	127	62	7.3	6.7	5.0	20.3	11.0	10.2	928	762.9	596	24	24	1.94	31.3	30.5	0.2	114	11	4.5
		426.45	06/06/1999 9:15	1737	3246	3979	130	61	7.4	6.7	4.9	20.3	11.0	10.4	931	766.8	599	24	24	1.93	31.5	30.7	0.2	113	11	4.5
		427.45	06/06/1999 10:15	1761	3298	4036	135	61	7.4	6.7	4.9	20.3	10.8	10.4	931	767.9	600	24	24	1.91	31.7	30.9	0.2	113	10	4.5
		428.45	06/06/1999 11:15	1762	3325	4035	141	63	7.4	6.7	4.9	20.2	10.8	10.4	930	766.8	600	24	24	1.92	31.9	31.1	0.3	112	10	4.5
		429.45	06/06/1999 12:15	1772	3361	4057	140	61	7.3	6.7	4.9	20.3	10.8	10.4	932	768.9	602	24	24	1.91	32.1	31.3	0.3	106	10	4.5
		430.45	06/06/1999 13:15	1788	3405	4076	144	60	7.4	6.7	4.9	20.3	10.8	10.4	932	770.0	603	23	24	1.90	32.3	31.5	0.2	106	10	4.5
		431.45	06/06/1999 14:15	1793	3427	4088	151	59	7.3	6.7	5.0	20.3	10.8	10.4	929	767.9	601	23	24	1.89	32.6	31.7	0.2	106	10	4.5
		432.45	06/06/1999 15:15	1792	3445	4097	155	58	7.3	6.7	5.0	20.3	11.0	10.4	927	766.8	600	23	24	1.88	32.8	32.0	0.2	105	11	4.5
		433.45	06/06/1999 16:15	1785	3449	4088	158	58	7.3	6.6	5.0	20.5	11.0	10.4	929	767.9	601	23	24	1.86	33.0	32.2	0.2	106	11	4.5
		434.45	06/06/1999 17:15	1783	3454	4083	160	58	7.3	6.6	5.0	20.5	11.0	10.4	926	765.8	599	23	24	1.85	33.1	32.3	0.2	106	11	4.5
		435.45	06/06/1999 18:15	1781	3454	4083	162	59	7.3	6.6	5.0	20.3	11.0	10.4	927	765.8	600	23	24	1.89	33.2	32.3	0.2	107	11	4.5
		436.45	06/06/1999 19:15	1779	3436	4065	157	60	7.3	6.6	5.0	20.5	11.0	10.4	930	767.9	602	24	24	1.87	33.1	32.2	0.2	105	11	4.5
		437.45	06/06/1999 20:15	1769	3388	4031	157	60	7.3	6.5	5.0	20.3	11.0	10.4	929	766.8	602	24	24	1.90	32.9	32.0	0.2	105	11	4.5
		438.45	06/06/1999 21:15	1758	3343	4014	155	61	7.3	6.6	5.0	20.3	10.8	10.4	932	770.0	604	24	24	1.90	32.6	31.7	0.2	108	10	4.5
		439.45	06/06/1999 22:15	1747	3303	3961	143	61	7.3	6.6	5.0	20.3	10.8	10.4	933	771.8	606	23	24	1.89	32.3	31.5	0.1	105	10	4.5
		441.45	06/07/1999 0:15	1730	3241	3904	140	59	7.3	6.6	5.1	20.5	10.8	10.4	954	789.9	620	24	25	1.89	31.8	31.0	0.2	114	10	4.5
		442.45	06/07/1999 1:15	1721	3214	3877	132	58	7.3	6.6	5.1	20.3	10.8	10.7	959	793.8	623	24	25	1.94	31.7	30.8	0.2	115	10	4.5
		443.45	06/07/1999 2:15	1717	3188	3851	129	58	7.3	6.6	5.0	20.3	10.8	10.7	961	796.7	626	24	25	1.93	31.5	30.7	0.2	115	10	4.5
		444.45	06/07/1999 3:15	1713	3169	3833	131	57	7.3	6.6	5.1	20.3	10.8	10.7	960	795.9	625	24	25	1.92	31.4	30.6	0.2	113	10	4.5
		445.45	06/07/1999 4:15	1705	3147	3803	133	58	7.3	6.6	5.1	20.3	10.6	10.7	962	798.8	627	24	25	1.91	31.3	30.5	0.2	114	10	4.5
		446.45	06/07/1999 5:15	1697	3130	3785	128	57	7.3	6.7	5.1	20.2	10.6	10.7	965	800.9	629	24	25	1.92	31.3	30.5	0.2	122	10	4.5
		448.39	06/07/1999 7:12	1682	3090	3737	128	58	7.4	6.6	5.1	20.3	10.4	10.7	964	800.6	629	24	25	1.91	31.2	30.4	0.2	114	10	4.5
		449.39	06/07/1999 8:12	1679	3095	3742	128	57	7.4	6.7	5.1	20.2	10.4	10.7	964	801.7	629	24	25	1.90	31.3	30.5	0.2	114	10	4.5
		472.88	06/08/1999 7:41	1723	3005	3498	110	36	7.5	6.8	4.6	20.3	9.8	11.9	837	682.1	464	22	32	1.82	31.4	30.6	0.2	111	9	4.5
		473.88	06/08/1999 8:41	1723	3001	3480	109	36	7.5	7.0	4.7	20.3	9.7	11.9	838	684.0	466	22	32	1.81	31.5	30.7	0.2	113	9	4.5

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed		Conductivity (uS/cm)					pH			Flow (Lpm)			Pressure (kPa)			Pressure Drop (psi)		PDC (psi/gpm$^{1.4}$)	Temperature			Particle		Target
		Time (hrs)	Date/Time	Feed	Interstage	Conc	Tot Perm	Samplvalve	Raw Feed	RO Feed	Concentrate	Feed	Tot Perm	Conc	Feed	Interstage	Conc	Stage 1	Stage 2	Stage 1	RO Feed	Raw	Turbidity	Index	Flux	pH
4	3rd Cleaning (Citric Acid Stage 2 on 6/8; Citric Acid Stage 1 on 6/9; Caustic Stage 1 on 6/10)	475.88	06/08/1999 10:41	1713	3011	3476	117	36	7.5	6.8	4.7	20.1	8.3	11.9	833	666.1	452	24	31	1.99	32.0	31.2	0.2	113	8	4.5
C	Operate Stage 1 Only at 50%	544.50	06/11/1999 7:18	1642	3019	3785	68	19	7.5	7.2	4.9	20.3	9.3	12.3	644		478	24		1.95	31.4	30.7	0.3	142	12	4.5
		545.50	06/11/1999 8:18	1649	3153	3934	70	20	7.4	6.8	4.7	22.1	10.4	12.9	712		527	27		1.91	31.4	30.7	0.3	132	13	4.5
		547.50	06/11/1999 10:18	1653	3206	3948	75	21	7.4	6.8	4.6	22.1	10.6	12.9	707		523	27		1.90	32.0	31.3	0.3	160	14	4.5
		548.50	06/11/1999 11:18	1642	3210	3935	77	22	7.4	6.8	4.7	22.1	10.6	12.9	709		524	27		1.90	32.2	31.5	0.3	153	14	4.5
		550.50	06/11/1999 13:18	1653	3263	3965	80	25	7.4	6.8	4.7	22.1	10.8	13.2	707		523	27		1.89	32.8	32.0	0.3	153	14	4.5
		551.50	06/11/1999 14:18	1661	3304	3978	82	26	7.4	6.8	4.8	22.3	11.0	13.0	706		523	27		1.86	33.1	32.3	0.4	130	14	4.5
		552.50	06/11/1999 15:18	1669	3344	4012	82	26	7.4	6.8	4.8	22.1	11.0	13.0	707		523	27		1.90	33.4	32.6	0.4	110	14	4.5
		553.50	06/11/1999 16:18	1671	3370	4029	81	26	7.4	6.8	4.9	22.1	11.2	13.0	707		523	27		1.89	33.7	32.9	0.3	109	15	4.5
		554.50	06/11/1999 17:18	1662	3375	4028	79	25	7.4	6.8	4.9	22.2	11.0	13.0	705		522	27		1.88	33.8	33.0	0.2	142	14	4.5
		555.50	06/11/1999 18:18	1656	3348	3999	76	26	7.4	6.8	4.9	22.4	11.2	13.0	705		522	27		1.86	33.8	33.0	0.2	107	15	4.5
		556.50	06/11/1999 19:18	1649	3313	3968	73	24	7.4	6.8	4.9	22.3	11.2	13.0	706		523	27		1.87	33.6	32.8	0.2	105	15	4.5
		557.50	06/11/1999 20:18	1644	3272	3937	71	25	7.4	6.8	4.8	22.1	11.0	13.0	707		524	27		1.88	33.3	32.6	0.2	105	14	4.5
		558.50	06/11/1999 21:18	1642	3237	3930	69	24	7.5	6.9	4.5	22.1	11.0	13.0	710		526	27		1.89	33.0	32.2	0.2	105	14	4.5
		559.50	06/11/1999 22:18	1632	3183	3881	67	23	7.4	6.8	4.4	22.1	11.0	13.2	710		527	27		1.88	32.7	31.9	0.3	105	14	4.5
		560.50	06/11/1999 23:18	1621	3143	3850	65	23	7.4	6.9	4.4	21.9	11.0	13.0	712		528	27		1.92	32.4	31.6	0.2	113	14	4.5
		561.50	06/12/1999 0:18	1619	3117	3828	60	23	7.5	7.2	4.6	21.9	11.0	13.0	716		531	27		1.92	32.2	31.4	0.3	114	14	4.5
		562.50	06/12/1999 1:18	1619	3103	3819	61	21	7.5	7.1	4.5	21.9	10.8	13.1	715		531	27		1.92	32.0	31.3	0.3	113	14	4.5
		563.50	06/12/1999 2:18	1626	3107	3832	61	20	7.5	7.1	4.5	21.9	10.8	13.0	715		531	27		1.91	31.9	31.2	0.2	114	14	4.5
		564.50	06/12/1999 3:18	1622	3098	3823	60	21	7.5	7.1	4.5	21.9	10.8	12.9	716		532	27		1.92	31.9	31.1	0.3	113	14	4.5
		565.50	06/12/1999 4:18	1622	3095	3819	60	21	7.5	7.1	4.5	21.9	10.8	13.1	716		532	27		1.92	31.8	31.1	0.3	113	14	4.5
		566.50	06/12/1999 5:18	1618	3085	3813	60	21	7.5	7.1	4.5	21.9	10.8	13.1	716		532	27		1.91	31.7	31.0	0.2	113	14	4.5
		568.43	06/12/1999 7:14	1622	3085	3832	60	21	7.5	7.2	4.6	21.7	10.8	12.9	717		533	27		1.95	31.6	30.9	0.3	114	14	4.5
		569.43	06/12/1999 8:14	1613	3068	3807	61	22	7.5	7.2	4.6	21.9	10.8	13.1	715		532	27		1.91	31.8	31.0	0.2	113	14	4.5
		570.49	06/12/1999 9:17	1603	3055	3785	62	22	7.5	7.2	4.5	21.9	10.8	12.9	715		531	27		1.92	31.9	31.1	0.2	113	14	4.5
		571.49	06/12/1999 10:17	1596	2988	3684	66	22	7.4	7.1	4.6	20.5	9.3	12.3	651		484	24		1.92	32.0	31.3	0.2	134	12	6.8
		572.98	06/12/1999 11:46	1586	2984	3658	68	27	7.5	7.1	4.7	20.1	9.3	12.3	638		474	24		1.95	32.3	31.6	0.3	119	12	6.8
		573.49	06/12/1999 12:17	1590	3001	3674	69	28	7.5	7.2	4.7	20.3	9.3	12.3	639		475	24		1.92	32.4	31.7	0.2	114	12	6.8
		574.49	06/12/1999 13:17	1601	3046	3714	72	30	7.5	7.2	4.7	20.3	9.4	12.3	638		474	24		1.93	32.7	31.9	0.3	112	12	6.8
		575.49	06/12/1999 14:17	1607	3090	3748	75	31	7.5	7.1	4.7	20.5	9.6	12.3	638		474	24		1.89	33.0	32.2	0.2	113	12	6.8
		576.49	06/12/1999 15:17	1613	3130	3761	77	28	7.4	7.1	4.7	20.3	9.4	12.3	637		472	24		1.93	33.3	32.5	0.3	114	12	6.8
		577.49	06/12/1999 16:17	1613	3143	3771	78	29	7.4	7.1	4.6	20.3	9.6	12.3	634		470	24		1.92	33.5	32.8	0.3	111	12	6.8
		578.49	06/12/1999 17:17	1615	3148	3761	79	28	7.4	7.1	4.6	20.1	9.4	12.1	621		460	23		1.91	33.7	32.9	0.2	113	12	6.8
		579.49	06/12/1999 18:17	1615	3152	3765	77	30	7.4	7.1	4.6	20.1	9.4	12.1	623		462	23		1.91	33.7	33.0	0.2	113	12	6.8
		580.49	06/12/1999 19:17	1613	3134	3756	75	29	7.4	7.1	4.6	20.1	9.4	12.1	624		463	23		1.91	33.6	32.9	0.3	114	12	6.8
		581.49	06/12/1999 20:17	1610	3105	3735	72	30	7.4	7.1	4.6	20.9	9.6	12.3	635		491	21		1.61	33.4	32.7	0.2	115	12	6.8
		582.49	06/12/1999 21:17	1607	3082	3740	70	27	7.4	7.1	4.6	20.5	9.8	12.3	638		474	24		1.89	33.1	32.4	0.3	114	13	6.8
		583.49	06/12/1999 22:17	1603	3041	3709	67	28	7.4	7.1	4.6	20.3	9.8	12.3	638		474	24		1.92	32.7	32.0	0.3	117	13	6.8
		584.49	06/12/1999 23:17	1593	3006	3679	66	27	7.4	7.1	4.5	20.3	9.6	12.3	641		476	24		1.93	32.4	31.7	0.3	114	12	6.8
		585.49	06/13/1999 0:17	1582	2966	3643	64	26	7.4	7.1	4.6	20.3	9.6	12.3	642		477	24		1.93	32.2	31.5	0.3	115	12	6.8
		586.49	06/13/1999 1:17	1580	2947	3629	63	26	7.5	7.1	4.6	20.1	9.8	12.3	642		477	24		1.96	32.0	31.3	0.2	115	13	6.8
		587.49	06/13/1999 2:17	1572	2934	3635	63	26	7.4	7.1	4.6	20.3	9.8	12.3	643		478	24		1.93	31.8	31.2	0.3	114	13	6.8
		588.49	06/13/1999 3:17	1567	2926	3626	62	24	7.4	7.1	4.5	20.5	10.0	12.5	654		486	24		1.94	31.8	31.1	0.2	116	13	6.8
		589.49	06/13/1999 4:17	1562	2898	3599	62	24	7.4	7.1	4.5	20.1	9.8	12.3	642		477	24		1.96	31.7	31.1	0.3	114	13	6.8
		590.49	06/13/1999 5:17	1561	2912	3612	61	24	7.5	7.1	4.6	20.5	10.0	12.5	658		489	24		1.95	31.7	31.0	0.2	124	13	6.8
		591.49	06/13/1999 6:17	1566	2916	3620	61	25	7.5	7.1	4.6	20.5	10.0	12.5	657		488	24		1.95	31.6	30.9	0.3	114	13	6.8
		591.97	06/13/1999 6:46	1569	2917	3621	62	25	7.5	7.2	4.6	20.3	10.0	12.5	656		488	24		1.96	31.6	30.9	0.3	115	13	6.8
		592.49	06/13/1999 7:17	1568	2917	3621	61	24	7.5	7.2	4.6	20.3	10.0	12.5	658		489	24		1.98	31.6	30.9	0.3	114	13	6.8
		593.49	06/13/1999 8:17	1560	2903	3608	61	25	7.5	7.2	4.6	20.3	10.0	12.3	657		488	24		1.98	31.6	30.9	0.2	115	13	6.8
		623.31	06/14/1999 14:06	1580	4658	4670	77	28	7.4	7.0	4.6	20.0	13.7	7.1	878		761	17		1.40	32.7	31.9	0.2	114	16	6.8
		623.63	06/14/1999 14:26	1589	4676	4679	77	27	7.4	7.1	4.6	20.3	13.7	7.1	877		761	17		1.36	32.7	32.0	0.2	113	18	6.8
		624.63	06/14/1999 15:26	1596	4645	4640	77	27	7.4	7.1	4.6	20.3	12.1	7.3	901		784	17		1.38	32.9	32.1	0.2	114	16	6.8
		625.63	06/14/1999 16:26	1598	4694	4670	76	29	7.4	7.1	4.6	20.7	13.7	7.5	919		802	17		1.33	33.2	32.3	0.2	118	18	6.8
		626.63	06/14/1999 17:26	1594	4685	4656	73	29	7.4	7.1	4.6	20.3	13.5	7.3	907		789	17		1.38	33.3	32.5	0.2	107	17	6.8
		627.63	06/14/1999 18:26	1589	4627	4594	72	27	7.4	7.1	4.6	20.1	12.7	7.3	889		775	17		1.36	33.4	32.6	0.2	107	16	6.8
		628.64	06/14/1999 19:26	1587	4569	4550	71	25	7.4	7.1	4.5	19.8	12.3	7.3	890		777	16		1.37	33.2	32.4	0.2	107	16	6.8
		629.63	06/14/1999 20:26	1577	4511	4506	69	26	7.4	7.0	4.5	19.8	11.9	7.3	892		779	16		1.37	33.0	32.3	0.2	105	15	6.8
		630.64	06/14/1999 21:26	1576	4470	4475	68	24	7.4	7.0	4.5	19.6	11.6	7.3	893		780	16		1.39	32.8	32.0	0.2	111	15	6.8
		631.64	06/14/1999 22:26	1582	4453	4475	67	25	7.4	7.1	4.5	19.6	11.9	7.3	894		783	16		1.37	32.7	31.9	0.2	105	15	6.8
		632.64	06/14/1999 23:26	1581	4431	4463	67	25	7.4	7.1	4.5	19.4	11.6	7.3	898		786	16		1.40	32.5	31.7	0.2	105	15	6.8
		633.64	06/15/1999 0:26	1579	4395	4440	66	25	7.4	7.1	4.5	19.4	11.6	7.5	897		786	16		1.39	32.4	31.6	0.2	105	15	6.8
		634.64	06/15/1999 1:26	1575	4364	4427	65	24	7.4	7.1	4.5	19.4	11.4	7.3	901		790	16		1.39	32.3	31.5	0.2	105	15	6.8
		635.64	06/15/1999 2:26	1569	4334	4405	65	24	7.5	7.1	4.5	19.4	11.2	7.3	899		789	16		1.38	32.2	31.4	0.2	105	15	6.8
		636.64	06/15/1999 3:26	1559	4293	4365	64	23	7.4	7.1	4.5	19.2	11.4	7.3	899		789	16		1.40	32.2	31.4	0.2	105	15	6.8
		637.64	06/15/1999 4:26	1553	4267	4343	63	23	7.4	7.1	4.5	19.2	11.4	7.3	899		790	16		1.39	32.1	31.3	0.2	105	15	6.8
		638.64	06/15/1999 5:26	1544	4231	4312	63	23	7.4	7.1	4.5	19.2	11.2	7.3	900		790	16		1.40	32.0	31.2	0.2	105	15	6.8
		639.64	06/15/1999 6:26	1543	4209	4295	62	23	7.4	7.1	4.5	19.2	11.2	7.5	901		792	16		1.39	31.9	31.1	0.2	106	15	6.8
		640.57	06/15/1999 7:22	1561	4222	4321	63	24	7.5	7.1	4.5	19.2	11.4	7.3	903		794	16		1.39	31.8	31.0	0.2	115	15	6.8
		641.57	06/15/1999 8:22	1569	4240	4339	63	24	7.5	7.1	4.5	19.2	11.6	7.5	903		794	16		1.39	31.8	31.0	0.2	116	15	6.8
		642.57	06/15/1999 9:22	1568	4249	4343	64	22	7.5	7.1	4.5	19.0	11.2	7.5	904		795	16		1.41	31.8	31.0	0.2	114	15	6.8
		643.57	06/15/1999 10:22	1565	4272	4348	66	23	7.4	7.1	4.5	19.2	11.4	7.3	900		792	16		1.38	32.2	31.4	0.2	113	15	6.8
		644.57	06/15/1999 11:22	1562	4296	4340	67	24	7.4	7.1	4.5	19.2	11.4	7.3	900		791	16		1.39	32.4	31.6	0.2	116	15	6.8
		645.57	06/15/1999 12:22	1571	4330	4362	68	25	7.4	7.1	4.5	19.2	11.4	7.3	899		791	16		1.37	32.6	31.8	0.2	114	15	6.8
		646.57	06/15/1999 13:22																							6.8
		648.69	06/15/1999 15:30	1617	3451	3414	68	30	7.4	7.1	4.5	20.7	11.2	11.1	780		643	20		1.56	33.3	32.5	0.2	117	15	6.8
		649.70	06/15/1999 16:30	1677	3642	3599	73	29	7.4	7.1	4.6	20.1	10.6	10.6	758		597	23		1.91	33.4	32.7	0.2	111	14	6.8
		650.69	06/15/1999 17:30	1694	3668	3621	74	30	7.4	7.1	4.6	20.3	10.8	10.7	757		600	23		1.85	33.5	32.7	0.2	112	14	6.8
		651.70	06/15/1999 18:30	1695	3587	3568	72	30	7.4	7.1	4.6	19.8	10.8	10.7	742		602	20		1.69	33.1	32.3	0.2	113	14	6.8
		652.69	06/15/1999 19:30	1684	3539	3537	70	29	7.4	7.1	4.5	19.8	10.8	10.7	745		604	20		1.69	32.8	32.1	0.2	112	14	6.8
		653.70	06/15/1999 20:30	1672	3499	3507	68	29	7.4	7.1	4.5	19.8	10.8	10.7	746		606	20		1.69	32.6	31.8	0.2	112	14	6.8
		654.69	06/15/1999 21:30	1659	3445	3471	66	29	7.4	7.1	4.5	19.6	10.6	10.7	745		605	20		1.72	32.3	31.6	0.2	112	14	6.8
		655.70	06/15/1999 22:30	1649	3410	3450	65	28	7.4	7.1	4.5	19.6	10.6	10.7	747		607	20		1.72	32.2	31.4	0.2	114	14	6.8
		656.70	06/15/1999 23:30	1642	3384	3433	64	29	7.4	7.1	4.5	19.6	10.6	10.7	748		608	20		1.72	32.0	31.3	0.2	112	14	6.8
		657.70	06/16/1999 0:30	1627	3344	3397	63	29	7.4	7.1	4.5	19.4	10.6	10.7	747		607	20		1.75	31.9	31.2	0.2	112	14	6.8
		658.70	06/16/1999 1:30																							
		659.69	06/16/1999 2:30																							
		660.70	06/16/1999 3:30																							
		661.69	06/16/1999 4:30																							
		662.70	06/16/1999 5:30																							
		663.69	06/16/1999 6:30																							
		665.70	06/16/1999 8:30	1497	3095	3156	54	30	7.4	7.1	4.4	20.5	11.0	10.9	788		654	20		1.56	31.7	30.9	0.2	200	14	6.8
		665.74	06/16/1999 8:32	1497	3090	3146	55	29	7.4	7.1	4.4	20.7	11.2	11.1	797		647	22		1.70	31.7	31.0	0.2	176	15	6.8
		688.45	06/17/1999 7:15	1538	2699	2758	100	43	7.4	6.0	4.5	12.7	5.4	8.2	455		372	12		1.94	31.7	31.2	0.1	114	7	6.2
		689.45	06/17/1999 8:15	1545	2708	2763	98	37	7.5	6.1	4.5	12.7	5.4	8.2	456		372	12		1.97	31.7	31.2	0.2	120	7	6.2
		690.45	06/17/1999 9:15	1537	2717	2760	98	38	7.5	6.0	4.5	12.7	5.4	8.2	455		372	12		1.94	32.0	31.4	0.2	117	7	6.2
		691.45	06/17/1999 10:15	1531	2660	2699	111	36	7.5	6.2	4.6	11.9	5.0	7.7	413		338	11		1.95	32.2	31.7	0.2	125	6	6.2
		736.85	06/19/1999 7:39	1621	2570	2573	52	71	7.5	6.2	5.6	11.5	5.0	7.7	374		297	11		2.10	31.7	31.2	0.2	112	6	6.8
		738.85	06/19/1999 9:39	1606	2570	2573	52	69	7.5	6.6	5.6	11.7	5.2	7.7	374		297	11		2.05	32.1	31.6	0.2	112	7	6.8
		739.85	06/19/1999 10:39	1596	2575	2578	54	68	7.5	6.8	5.6	11.7	5.2	7.7	373		296	11		2.05	32.4	31.9	0.2	112	7	6.8
		740.85	06/19/1999 11:39	1586	2546	2555	56	76	7.6	6.2	5.6	11.7	3.9	7.7	372		295	11		2.04	32.6	32.1	0.2	112	5	6.8
		741.85	06/19/1999 12:39	1594	2570	2580	57	71	7.6	6.8	5.7	11.7	5.0	7.7	371		295	11		2.04	32.7	32.2	0.2	104	6	6.8
		742.85	06/19/1999 13:39	1607	2581	2591	62	81	7.5	6.5	5.7	11.7	5.0	7.7	371		295	11		2.02	32.8	32.3	0.2	104	6	6.8
		743.85	06/19/1999 14:39	1620	2605	2599	59	78	7.5	6.2	5.7	11.9	4.8	7.7	372		295	11		2.00	33.0	32.4	0.2	104	6	6.8
		744.85	06/19/1999 15:39	1627	2606	2608	60	80	7.4	6.2	5.7	11.7	4.8	7.7	371		294	11		2.05	32.9	32.4	0.2	104	6	6.8

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Conductivity (uS/cm) Interstage	Conductivity (uS/cm) Conc	Conductivity (uS/cm) Tot Perm	Conductivity (uS/cm) Samplvalve	pH Raw Feed	pH RO Feed	pH Concentrate	Flow (Lpm) Feed	Flow (Lpm) Tot Perm	Flow (Lpm) Conc	Pressure (kPa) Feed	Pressure (kPa) Interstage	Pressure (kPa) Conc	Pressure Drop (psi) Stage 1	Pressure Drop (psi) Stage 2	PDC (psi/gpm^1.5) Stage 1	Temperature RO Feed	Temperature Raw	Turbidity	Particle Index	Flux	Target pH
		745.85	06/19/1999 16:39	1632	2615	2618	58	78	7.4	6.1	5.6	11.7	4.8	7.7	370		294	11		2.02	33.0	32.5	0.2	104	6	6.8
		746.85	06/19/1999 17:39	1632	2615	2618	56	75	7.4	6.5	5.6	11.7	4.8	7.7	371		295	11		2.04	33.0	32.5	0.2	104	6	6.8
		747.85	06/19/1999 18:39	1633	2633	2630	58	74	7.4	6.8	5.6	11.7	4.8	7.7	369		293	11		2.02	32.9	32.4	0.2	104	6	6.8
		748.85	06/19/1999 19:39	1642	2619	2630	56	77	7.5	6.3	5.6	11.5	4.6	7.7	367		292	11		2.04	32.8	32.3	0.3	103.8	6	6.8
		760.20	06/20/1999 7:00																							
		763.20	06/20/1999 10:00	1662	2646	2654	67	80	7.3	6.6	4.8	12.1	3.7	8.0	382		304	11		1.96	32.8	32.3	0.2	113	5	6.8
		764.20	06/20/1999 11:00	1654	2646	2653	71	77	7.4	6.4	4.8	12.1	4.6	7.9	383		304	11		1.99	32.9	32.4	0.2	211	6	6.8
		765.20	06/20/1999 12:00	1638	2624	2630	68	78	7.5	7.1	4.9	12.1	4.1	8.0	384		305	11		1.99	32.7	32.2	0.2	175	5	6.8
		766.20	06/20/1999 13:00	1628	2632	2639	70	78	7.4	6.5	5.0	12.1	4.6	8.0	382		304	11		1.97	32.7	32.2	0.2	198	6	6.8
		767.20	06/20/1999 14:00	1628	2612	2622	70	84	7.4	6.4	5.0	12.1	4.8	8.0	383		304	11		1.99	32.5	32.0	0.2	146	6	6.8
		768.20	06/20/1999 15:00	1630	2615	2613	69	84	7.3	6.9	5.0	12.1	4.8	8.0	383		304	11		1.99	32.3	31.8	0.1	135	6	6.8
		769.20	06/20/1999 16:00	1634	2624	2622	71	83	7.3	7.0	5.0	12.1	4.8	8.0	383		304	11		1.99	32.2	31.7	0.1	128	6	6.8
		770.20	06/20/1999 17:00	1636	2619	2618	72	90	7.3	6.7	5.0	11.9	4.6	8.0	383		304	11		2.04	32.1	31.6	0.2	159	6	6.8
		771.20	06/20/1999 18:00	1641	2619	2617	71	88	7.3	6.9	5.0	12.1	4.8	8.0	383		304	11		1.99	32.1	31.6	0.1	143	6	6.8
		772.20	06/20/1999 19:00	1638	2633	2635	74	89	7.3	6.3	5.0	12.1	4.8	8.0	383		304	11		1.99	32.0	31.5	0.1	122	6	6.8
		773.20	06/20/1999 20:00	1630	2624	2622	73	87	7.3	6.3	5.0	12.1	4.8	8.0	383		304	11		1.99	31.9	31.4	0.1	117	6	6.8
		774.20	06/20/1999 21:00	1630	2633	2634	73	84	7.5	6.7	5.0	12.1	4.8	8.0	384		305	11		1.99	31.8	31.3	0.1	137	6	6.8
		775.20	06/20/1999 22:00	1624	2593	2595	69	88	7.5	6.6	5.0	11.9	4.8	8.0	384		305	11		2.05	31.7	31.2	0.1	121	6	6.8
		776.20	06/20/1999 23:00	1616	2583	2582	66	85	7.5	6.9	5.1	12.1	4.8	8.0	384		306	11		1.99	31.7	31.2	0.2	139	6	6.8
		777.20	06/21/1999 0:00	1599	2557	2555	65	84	7.4	6.7	5.1	11.9	4.8	7.9	383		305	11		2.02	31.7	31.2	0.1	128	6	6.8
		778.20	06/21/1999 1:00	1594	2570	2573	68	82	7.4	6.5	5.1	11.9	4.8	8.0	383		304	11		2.04	31.7	31.2	0.1	123	6	6.8
		779.20	06/21/1999 2:00	1589	2544	2541	63	80	7.4	6.7	5.0	11.9	4.8	8.0	383		305	11		2.02	31.7	31.2	0.1	118	6	6.8
		780.20	06/21/1999 3:00	1582	2538	2538	65	83	7.4	6.4	5.0	12.1	4.6	8.0	383		304	11		1.99	31.7	31.2	0.2	137	6	6.8
		781.20	06/21/1999 4:00	1585	2539	2538	62	80	7.5	6.8	4.9	11.9	4.8	8.0	384		305	11		2.05	31.7	31.2	0.1	116	6	6.8
		782.20	06/21/1999 5:00	1574	2526	2524	63	82	7.6	6.4	5.0	12.1	4.8	8.0	385		306	11		1.99	31.6	31.1	0.1	117	6	6.8
		783.20	06/21/1999 6:00	1556	2522	2520	64	75	7.5	7.0	5.0	11.9	4.8	8.0	383		304	11		2.04	31.5	31.0	0.2	127	6	6.8
		808.48	06/22/1999 7:17	1582	2593	2596	53	31	7.6	7.3	4.9	13.0	5.8	8.4	426		338	13		2.01	31.6	31.0	0.1	125	8	6.8
		809.48	06/22/1999 8:17	1588	2606	2605	54	32	7.6	7.3	5.0	13.0	5.6	8.4	426		338	13		2.01	31.7	31.2	0.1	119	7	6.8
		810.48	06/22/1999 9:17	1590	2610	2613	56	31	7.6	7.3	5.0	13.0	5.6	8.4	425		338	13		1.99	31.8	31.3	0.1	126	7	6.8
		811.48	06/22/1999 10:17	1591	2598	2599	58	72	7.6	7.3	5.1	12.7	5.4	8.4	418		332	12		2.01	31.9	31.4	0.1	138	7	6.8
		816.77	06/22/1999 15:34	1677	2739	2735	74	129	7.5	6.7	5.1	13.0	5.4	8.4	418		332	12		1.96	33.0	32.4	0.1	187	7	6.8
		817.77	06/22/1999 16:34	1705	3232	3242	70	96	7.5	6.2	4.9	13.0	6.4	6.9	476		401	11		1.72	33.2	32.6	0.1	172	8	
		818.77	06/22/1999 17:34	1711	3250	3259	74	61	7.5	6.4	4.8	13.0	6.4	6.9	476		400	11		1.74	33.3	32.7	0.2	118	8	
		819.77	06/22/1999 18:34	1707	3259	3259	75	47	7.6	6.5	4.8	13.0	6.4	6.9	476		400	11		1.74	33.3	32.7	0.2	105	8	
		820.77	06/22/1999 19:34	1687	3219	3218	74	45	7.5	6.9	4.6	12.8	6.4	6.9	475		400	11		1.75	33.1	32.6	0.2	111	8	
		821.77	06/22/1999 20:34	1676	3188	3190	71	42	7.5	6.6	4.5	12.8	6.4	6.9	476		400	11		1.78	32.9	32.3	0.2	106	8	
		822.77	06/22/1999 21:34	1662	3157	3168	67	41	7.5	6.3	4.5	12.7	6.2	6.9	476		401	11		1.75	32.7	32.1	0.2	123	8	
		823.77	06/22/1999 22:34	1653	3152	3163	72	40	7.5	6.8	4.5	12.7	6.2	6.9	478		402	11		1.78	32.5	31.9	0.2	118	8	
		824.77	06/22/1999 23:34	1654	3178	3181	71	38	7.5	6.8	4.4	13.0	6.4	6.9	486		408	11		1.78	32.3	31.7	0.2	115	8	
		825.77	06/23/1999 0:34	1650	3147	3146	62	38	7.5	6.2	4.3	13.0	6.2	6.9	486		410	11		1.74	32.1	31.5	0.2	116	8	
		826.77	06/23/1999 1:34	1649	3148	3150	65	39	7.5	6.4	4.4	12.7	6.4	6.9	476		400	11		1.78	31.9	31.3	0.2	114	8	
		827.77	06/23/1999 2:34	1645	3161	3163	70	38	7.5	6.9	4.4	12.7	6.4	6.9	476		400	11		1.79	31.8	31.2	0.2	114	8	
		828.77	06/23/1999 3:34	1637	3139	3141	66	38	7.5	6.8	4.4	12.7	6.4	6.9	477		400	11		1.80	31.7	31.1	0.2	114	8	
		829.77	06/23/1999 4:34	1624	3107	3110	64	37	7.5	6.7	4.4	12.7	6.4	6.9	477		400	11		1.80	31.6	31.0	0.2	114	8	
		830.77	06/23/1999 5:34	1610	3085	3084	63	37	7.5	6.7	4.3	13.0	6.4	6.9	477		401	11		1.74	31.6	31.0	0.2	114	8	
		831.77	06/23/1999 6:34	1606	3076	3084	65	36	7.5	6.9	4.3	12.7	6.4	6.9	477		401	11		1.78	31.5	30.9	0.2	114	8	
		856.85	06/24/1999 7:39	1624	2757	2765	57	37	7.6	7.1	5.1	10.4	5.0	6.3	367		306	9		1.92	31.6	31.1	0.2	104	6	6.8
		857.29	06/24/1999 8:05	1607	2897	2906	58	38	7.5	7.0	5.1	10.0	5.0	5.7	367		312	8		1.84	31.7	31.2	0.2	104	6	6.8
		861.89	06/24/1999 12:42	1631	3104	3111	72	88	7.5	7.0	4.7	11.1	5.6	6.1	412		350	9		1.79	32.7	32.0	0.2	108	7	6.5
		862.89	06/24/1999 13:42	1647	3165	3172	66	87	7.5	7.0	4.8	11.3	5.8	5.9	411		348	9		1.77	33.1	32.3	0.2	104	8	6.5
		863.89	06/24/1999 14:42	1662	3203	3207	76	60	7.5	7.0	4.8	11.3	6.0	5.9	410		348	9		1.74	33.3	32.6	0.2	103	8	6.5
		864.89	06/24/1999 15:42	1665	3410	3413	61	31	7.5	6.9	4.8	13.0	6.6	6.5	475		402	11		1.67	33.6	32.8	0.2	103	9	6.2
		881.89	06/25/1999 8:42	1615	3268	3275	59	22	7.5	6.9	4.9	13.0	6.6	6.5	485		411	11		1.70	32.4	31.8	0.2	104	9	6.2
		882.89	06/25/1999 9:42	1605	3241	3248	68	21	7.5	6.9	4.8	12.7	6.6	6.5	476		403	11		1.71	32.5	32.0	0.2	103	9	6.2
		883.89	06/25/1999 10:42	1601	3250	3256	66	22	7.5	7.0	4.8	13.0	6.6	6.5	480		407	11		1.67	32.5	32.0	0.2	104	9	6.2
		885.33	06/25/1999 12:08	1612	3183	3203	63	87	7.5	6.9	4.8	12.7	6.4	6.5	463		390	11		1.70	32.9	32.4	0.2	105	8	6.2
		886.33	06/25/1999 13:08	1620	3237	3244	74	89	7.5	6.9	4.8	12.8	6.4	6.5	465		391	11		1.73	33.2	32.6	0.2	105	8	6.2
		886.92	06/25/1999 13:43	1628	3251	3256	65	87	7.4	6.9	4.8	12.8	6.6	6.5	464		391	11		1.71	33.3	32.6	0.2	105	9	6.2
		887.92	06/25/1999 14:43	1665	3124	3127	76	84	7.4	6.8	4.7	11.3	5.4	6.1	396		334	9		1.74	33.5	32.9	0.2	104	7	6.2
		887.92	06/25/1999 14:43	1665	3124	3127	76	84	7.4	6.8	4.7	11.3	5.4	6.1	396		334	9		1.74	33.5	32.9	0.2	104	7	6.2
		929.01	06/27/1999 7:49	1642	3304	3317	62	19	7.5	6.8	4.7	12.7	6.6	6.5	487		414	11		1.71	31.9	31.3	0.2	104	9	6.5
		930.00	06/27/1999 8:48	1641	3312	3322	64	19	7.5	6.8	4.7	12.8	6.6	6.5	488		414	11		1.72	32.0	31.4	0.2	104	9	6.5
		931.00	06/27/1999 9:48	1637	3299	3313	61	18	7.5	6.8	4.6	13.0	6.6	6.5	486		413	11		1.67	32.3	31.9	0.2	104	9	6.5
		932.00	06/27/1999 10:48	1631	3299	3309	64	19	7.5	6.8	4.6	13.0	6.6	6.5	485		412	11		1.67	32.5	32.1	0.2	104	9	6.5
		933.00	06/27/1999 11:48	1616	3285	3295	68	19	7.5	6.8	4.6	13.0	6.6	6.5	485		412	11		1.67	32.6	32.1	0.2	104	9	6.5
		934.00	06/27/1999 12:48	1608	3263	3268	73	18	7.5	6.8	4.6	12.8	6.6	6.3	476		403	11		1.71	32.8	32.4	0.2	104	9	6.5
		935.00	06/27/1999 13:48	1612	3272	3291	68	19	7.5	6.8	4.6	13.0	6.6	6.5	475		403	10		1.65	33.1	32.7	0.2	104	9	6.5
		936.00	06/27/1999 14:48	1619	3298	3303	72	19	7.5	6.8	4.6	12.8	6.6	6.5	474		402	10		1.68	33.4	32.9	0.2	104	9	6.5
		937.00	06/27/1999 15:48	1631	3326	3333	79	19	7.4	6.8	4.7	13.0	6.6	6.3	474		402	10		1.65	33.7	33.1	0.2	104	9	6.5
		938.00	06/27/1999 16:48	1632	3317	3320	83	19	7.4	6.7	4.6	12.8	6.6	6.3	465		394	10		1.66	33.8	33.2	0.2	104	9	6.5
		939.00	06/27/1999 17:48	1635	3330	3338	75	21	7.4	6.7	4.8	12.8	6.4	6.3	466		395	10		1.66	34.0	33.3	0.2	105	8	6.5
		941.00	06/27/1999 19:48	1647	3352	3355	82	21	7.3	6.7	5.0	13.0	6.7	6.3	474		401	11		1.67	33.8	33.0	0.2	104	9	6.5
		942.00	06/27/1999 20:48	1654	3343	3361	84	20	7.3	6.7	5.0	12.8	6.6	6.3	474		402	10		1.69	33.5	32.7	0.2	104	9	6.5
		943.00	06/27/1999 21:48	1662	3338	3352	73	20	7.4	6.7	5.0	12.7	6.6	6.3	476		404	10		1.69	33.1	32.4	0.2	104	9	6.5
		944.00	06/27/1999 22:48	1657	3320	3330	77	20	7.4	6.7	4.8	13.0	6.6	6.3	476		405	10		1.62	32.9	32.1	0.2	104	9	6.5
		945.00	06/27/1999 23:48	1648	3321	3331	67	20	7.4	6.7	4.8	13.0	6.6	6.5	485		412	11		1.67	32.6	31.9	0.2	104	9	6.5
		946.00	06/28/1999 0:48	1641	3312	3313	75	21	7.4	6.7	4.9	13.0	6.6	6.5	487		414	11		1.67	32.4	31.7	0.2	104	9	6.5
		947.00	06/28/1999 1:48	1632	3290	3291	68	20	7.4	6.7	4.9	13.0	6.8	6.5	486		413	11		1.67	32.3	31.6	0.2	104	9	6.5
		948.00	06/28/1999 2:48	1627	3276	3287	73	20	7.4	6.8	4.6	12.7	6.6	6.5	486		413	11		1.71	32.1	31.4	0.2	105	9	6.5
		949.00	06/28/1999 3:48	1620	3263	3273	62	18	7.4	6.8	4.6	12.7	6.6	6.5	487		414	11		1.71	32.0	31.3	0.2	104	9	6.5
		950.00	06/28/1999 4:48	1615	3249	3265	70	18	7.4	6.8	4.8	12.7	6.6	6.5	488		414	11		1.74	31.9	31.2	0.2	104	9	6.5
		951.00	06/28/1999 5:48	1608	3236	3247	67	19	7.4	6.8	4.7	13.0	6.6	6.5	487		414	11		1.67	31.9	31.2	0.2	105	9	6.5
		952.00	06/28/1999 6:48	1606	3227	3238	67	17	7.4	6.8	4.6	13.0	6.6	6.5	487		414	11		1.67	31.8	31.1	0.2	105	9	6.5
		1049.11	07/02/1999 7:54	1765	2518	2525	83	49	7.5	6.9	4.8	13.0	3.9	9.8	365		268	14		2.24	31.8	31.0	0.2	109	5	6.5
		1050.11	07/02/1999 8:54	1768	2544	2547	82	47	7.5	6.9	4.8	13.0	4.1	9.8	372		274	14		2.25	31.8	31.0	0.2	105	5	6.5
		1051.11	07/02/1999 9:54	1769	2526	2529	89	47	7.6	6.9	4.9	12.2	3.9	9.2	340		249	13		2.27	32.3	31.3	0.2	103	5	6.5
		1052.11	07/02/1999 10:54	1756	2531	2538	90	105	7.6	6.9	4.9	12.3	4.3	9.2	342		253	13		2.21	32.5	31.4	0.2	103	6	6.5
		1053.11	07/02/1999 11:54	1749	2535	2538	92	105	7.6	6.8	4.9	12.3	4.3	9.2	342		253	13		2.21	32.7	31.6	0.2	121	6	6.5
		1054.11	07/02/1999 12:54	1754	2557	2564	91	105	7.6	6.8	4.9	12.9	4.4	9.4	360		265	14		2.17	32.9	31.7	0.2	442	6	6.5
		1055.11	07/02/1999 13:54	1763	2588	2590	94	104	7.5	6.8	4.9	12.8	4.6	9.4	359		264	14		2.22	33.1	32.1	0.2	108	6	6.5
		1055.92	07/02/1999 14:43																							
		1125.34	07/05/1999 12:08	1662	2535	2540	79	58	7.3	6.6	4.8	12.7	4.8	9.0	377		286	13		2.15	32.0	31.6	0.2	105	6	6.5
		1126.34	07/05/1999 13:08	1684	2544	2547	84	59	7.4	6.6	4.8	12.1	3.3	8.6	356		271	12		2.15	32.1	31.8	0.2	105	4	6.5
		1127.34	07/05/1999 14:08	1700	2571	2574	87	121	7.4	6.6	4.8	12.1	4.6	8.6	356		271	12		2.14	32.4	32.0	0.2	211	6	6.5
		1128.34	07/05/1999 15:08	1724	2619	2622	103	121	7.3	6.6	4.9	12.1	4.8	8.6	356		271	12		2.14	31.8	31.4	0.2	103	6	6.5
		1129.34	07/05/1999 16:08	1746	2650	2652	104	120	7.3	6.5	4.9	12.3	4.8	8.6	357		271	12		2.12	31.7	31.5	0.2	103	6	6.5
		1130.34	07/05/1999 17:08	1757	2664	2667	93	120	7.3	6.5	4.9	12.3	4.3	8.6	357		271	12		2.11	31.7	31.3	0.2	103	6	6.5
		1131.34	07/05/1999 18:08	1761	2673	2675	78	120	7.3	6.5	4.9	12.1	4.6	8.6	356		270	12		2.17	31.7	31.5	0.2	103	6	6.5
		1132.34	07/05/1999 19:08	1767	2665	2670	93	120	7.3	6.5	4.8	12.1	4.3	8.6	356		270	12		2.17	31.9	31.2	0.2	103	6	6.5
		1133.34	07/05/1999 20:08	1764	2663	2666	88	121	7.3	6.6	4.8	12.1	4.1	8.6	356		271	12		2.15	31.9	31.4	0.2	103	5	6.5
		1134.34	07/05/1999 21:08	1758	2650	2653	84	121	7.4	6.6	4.8	12.1	4.3	8.6	357		271	12		2.17	31.9	31.5	0.2	103	6	6.5
		1136.34	07/05/1999 23:08	1744	2624	2627	93	121	7.4	6.6	4.8	12.1	4.3	8.6	357		273	12		2.15	31.8	31.9	0.2	103	6	6.5
		1138.34	07/06/1999 1:08	1729	2601	2604	86	120	7.5	6.7	4.8	12.1	4.3	8.6	358		273	12		2.15	31.6	32.1	0.2	103	6	6.5
		1139.34	07/06/1999 2:08	1727	2593	2599	84	116	7.5	6.7	4.8	12.1	4.3	8.6	358		273	12		2.17	31.5	32.2	0.2	104	6	6.5
		1140.34	07/06/1999 3:08	1726	2593	2595	84	111	7.5	6.7	4.8	12.1	4.4	8.6	358		273	12		2.17	31.5	32.1	0.2	103	6	6.5
		1141.34	07/06/1999 4:08	1725	2588	2590	83	104	7.5	6.7	4.8	11.9	4.3	8.6	358		273	12		2.22	31.4	32.0	0.2	103	6	6.5
		1142.34	07/06/1999 5:08	1722	2583	2586	83	97	7.5	6.7	4.8	12.1	4.3	8.6	358		274	12		2.14	31.4	31.7	0.2	103	6	6.5
		1143.34	07/06/1999 6:08	1715	2575	2582	83	90	7.4	6.7	4.7	12.1	4.6	8.6	358		274	12		2.14	31.3	31.8	0.2	103	6	6.5
		1145.34	07/06/1999 8:08	1730	2567	2570	89	76	7.5	6.7	4.7	11.5	4.3	8.4	339		263	11		2.08	31.4	31.4	0.2	104	6	6.5
		1146.34	07/06/1999 9:08	1735	3423	3436	99	82	7.5	6.7	4.7	9.0	5.0	4.6	373		327	7		1.81	31.6	32.1	0.2	103	6	6.5

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm)					pH			Flow (Lpm)			Pressure (kPa)			Pressure Drop (psi)		PDC (psi/gpm^[illegible])	Temperature		Turbidity	Particle Index	Flux	Target pH
				Feed	Interstage	Conc	Tot Perm	Samplvalve	Raw Feed	RO Feed	Concentrate	Feed	Tot Perm	Conc	Feed	Interstage	Conc	Stage 1	Stage 2	Stage 1	RO Feed	Raw				
		1149.60	07/06/1999 12:24	1728	3510	3519	79	65	7.5	6.7	4.5	12.5	6.6	6.3	487		414	11		1.75	31.4	31.6	0.2	104	9	6.5
		1150.73	07/06/1999 13:32																							
		1151.60	07/06/1999 14:24																							
		1152.60	07/06/1999 15:24	1783	3827	3848	85	54	7.5	6.8	4.5	13.0	6.8	6.5	543		463	12		1.83	31.4	31.4	0.2	123	9	6.7
		1153.60	07/06/1999 16:24	1783	3711	3729	86	56	7.4	6.7	4.4	13.0	6.6	6.5	534		459	11		1.71	31.5	31.3	0.2	112	9	6.7
		1154.60	07/06/1999 17:24	1757	3671	3686	85	51	7.4	6.7	4.5	13.2	6.8	6.5	531		457	11		1.65	31.8	31.7	0.2	112	9	6.7
		1155.60	07/06/1999 18:24	1716	3587	3602	84	48	7.4	6.7	4.5	13.0	6.6	6.5	520		447	11		1.67	32.1	32.1	0.2	118	9	6.7
		1157.60	07/06/1999 20:24	1635	3445	3444	78	46	7.3	6.7	4.5	13.0	6.9	6.5	518		445	11		1.67	32.3	32.4	0.2	110	9	6.7
		1158.60	07/06/1999 21:24	1617	3400	3418	76	44	7.4	6.7	4.5	13.0	6.8	6.5	518		445	11		1.67	32.2	32.4	0.2	108	9	6.7
		1159.60	07/06/1999 22:24	1612	3387	3404	73	45	7.4	6.7	4.5	13.0	6.8	6.5	518		445	11		1.67	32.1	32.4	0.2	108	9	6.7
		1160.60	07/06/1999 23:24	1617	3396	3413	72	42	7.4	6.7	4.5	13.0	6.8	6.5	517		444	11		1.67	32.0	32.4	0.2	110	9	6.7
		1162.60	07/07/1999 1:24	1635	3418	3435	69	39	7.4	6.8	4.5	13.0	6.8	6.5	519		447	10		1.65	31.8	32.2	0.2	122	9	6.7
		1163.60	07/07/1999 2:24	1643	3431	3448	69	40	7.5	6.8	4.5	12.8	6.8	6.5	520		447	11		1.71	31.7	32.1	0.2	115	9	6.7
		1164.60	07/07/1999 3:24	1651	3444	3461	68	39	7.5	6.8	4.5	13.0	6.8	6.5	521		448	11		1.67	31.6	32.0	0.2	113	9	6.7
		1166.60	07/07/1999 5:24	1657	3444	3462	69	37	7.5	6.8	4.5	12.8	6.8	6.5	522		449	11		1.71	31.4	31.3	0.2	111	9	6.7
		1167.60	07/07/1999 6:24	1669	3454	3471	69	39	7.5	6.8	4.5	12.8	6.6	6.5	521		449	10		1.69	31.3	31.1	0.2	112	9	6.7
		1168.60	07/07/1999 7:24	1691	3489	3509	70	38	7.6	6.8	4.6	12.7	6.6	6.5	522		450	10		1.69	31.2	31.1	0.2	115	9	6.7
		1169.60	07/07/1999 8:24	1698	3396	3400	78	39	7.6	6.8	4.6	11.5	5.7	6.1	457		394	9		1.72	31.3	31.3	0.2	104	7	6.7
		1171.80	07/07/1999 10:36																							
		1172.60	07/07/1999 11:24																							
		1173.56	07/07/1999 12:22	1726	2868	3392	91	36	7.5	6.9	4.8	22.8	11.2	12.2							32.5	32.0	0.3	116	14	6.8
		1174.95	07/07/1999 13:45	1750	2921	3476	91	34	7.5	6.9	4.7	24.4	11.0	13.1							32.8	32.1	0.3	122	14	6.8
D	Both Stages On-Line at 50% with pH (feed) = 6.8	1176.51	07/07/1999 15:19	1779	2943	3506	107	38	7.4	6.8	4.8	20.7	10.1	11.0	860	687	429	25	37	1.97	33.0	32.6	0.3	140	10	6.8
		1176.95	07/07/1999 15:45	1790	2961	3514	108	39	7.4	6.8	4.8	20.7	10.1	11.0	859	687	429	25	37	1.95	33.1	32.8	0.3	137	10	6.8
		1177.95	07/07/1999 16:45	1811	2979	3545	111	40	7.4	6.8	4.8	20.7	9.9	11.0	859	686	429	25	37	1.97	33.4	33.4	0.3	141	10	6.8
		1178.95	07/07/1999 17:45	1818	2992	3558	112	40	7.4	6.8	4.8	20.7	9.9	11.2	857	685	428	25	37	1.95	33.6	33.6	0.3	139	10	6.8
		1179.95	07/07/1999 18:45	1818	2997	3568	111	39	7.4	6.8	4.8	20.9	9.9	11.2	858	685	429	25	37	1.93	33.6	33.9	0.4	148	10	6.8
		1180.95	07/07/1999 19:45	1811	2988	3554	110	38	7.4	6.8	4.8	20.9	10.1	11.2	860	687	430	25	37	1.94	33.6	33.6	0.4	124	10	6.8
		1181.95	07/07/1999 20:45	1808	2979	3541	108	39	7.4	6.8	4.8	20.7	10.3	11.2	861	688	430	25	37	1.97	33.4	33.4	0.3	131	10	6.8
		1182.95	07/07/1999 21:45	1802	2979	3532	105	37	7.4	6.8	4.8	20.7	10.3	11.2	862	689	431	25	37	1.96	33.2	33.1	0.3	136	10	6.8
		1183.95	07/07/1999 22:45	1797	2962	3528	103	36	7.4	6.8	4.8	20.5	10.3	11.2	861	688	430	25	37	1.99	33.0	32.6	0.3	143	10	6.8
		1184.95	07/07/1999 23:45	1802	2956	3523	101	36	7.4	6.8	4.8	20.7	10.1	11.2	864	691	432	25	38	1.96	32.7	32.5	0.3	117	10	6.8
		1185.95	07/08/1999 0:45	1802	2956	3523	100	35	7.5	6.9	4.8	20.7	10.1	11.2	865	692	433	25	38	1.97	32.5	32.1	0.3	125	10	6.8
		1186.95	07/08/1999 1:45	1801	2947	3516	99	36	7.5	6.9	4.8	20.5	10.1	11.2	866	692	433	25	38	2.01	32.3	31.7	0.3	114	10	6.8
		1187.95	07/08/1999 2:45	1798	2952	3510	98	36	7.5	6.9	4.8	20.5	10.1	11.2	865	691	432	25	38	2.01	32.1	31.6	0.3	188	10	6.8
		1188.95	07/08/1999 3:45	1794	2943	3501	98	34	7.5	6.9	4.8	20.7	10.1	11.2	867	693	433	25	38	1.98	32.0	31.5	0.2	123	10	6.8
		1189.95	07/08/1999 4:45	1787	2930	3484	97	35	7.5	6.9	4.8	20.7	10.1	11.2	867	693	434	25	38	1.98	31.9	31.4	0.3	117	10	6.8
		1190.95	07/08/1999 5:45	1777	2912	3467	97	34	7.5	6.9	4.8	20.5	9.9	11.2	867	693	433	25	38	2.01	31.8	31.5	0.3	124	10	6.8
		1191.95	07/08/1999 6:45	1776	2906	3462	97	35	7.5	6.9	4.8	20.5	9.9	11.2	866	692	433	25	38	2.01	31.7	31.4	0.3	112	10	6.8
E	Inc to 60% with pH (feed) = 6.5	1196.78	07/08/1999 11:35	1783	3561	5510	145	50	7.5	6.5	5.0	16.1	10.3	5.1	637	537	459	14	11	1.64	32.3	32.6	0.2	210	10	6.5
		1197.78	07/08/1999 12:34	1785	3539	5366	162	44	7.5	6.5	4.8	17.2	11.2	5.1	636	577	497	8	12	0.87	32.5	32.8	0.2	157	11	
		1198.79	07/08/1999 13:35	1792	3410	5018	145	50	7.5	6.5	4.7	16.5	10.3	5.9	617	509	412	16	14	1.72	32.7	32.5	0.3	385	10	
		1199.88	07/08/1999 14:41	1827	3392	4789	142	41	7.5	6.5	4.6	16.5	10.3	6.3	606	497	393	16	15	1.74	33.1	33.3	0.4		10	6.5
		1200.78	07/08/1999 15:35	1845	3436	4849	156	325	7.5	6.1	4.6	16.5	9.8	6.3	596	488	387	16	15	1.71	33.3	33.5	0.4	191	9	6.0
		1207.74	07/08/1999 22:33	1851	3720	4573	140	72	7.5	6.9	5.2	15.5	10.8	4.4	632	533	460	14	11	1.72	31.9	32.5	0.3	301	10	6.0
F	Inc to 70% with pH (feed) = 6.0	1208.73	07/08/1999 23:32	1788	3889	5716	141	48	7.5	6.9	5.1	15.9	12.1	3.8	690	594	532	14	9	1.62	31.8	32.4	0.3	125	12	6.0
		1209.73	07/09/1999 0:32	1703	3791	6058	130	39	7.5	6.9	5.1	16.1	12.3	3.8	696	600	541	14	9	1.60	31.5	32.0	0.3	117	12	6.0
		1211.73	07/09/1999 2:32	1547	3507	5532	112	34	7.4	6.8	5.0	16.1	11.9	3.6	700	604	547	14	8	1.59	31.2	31.5	0.2	114	11	6.0
		1212.73	07/09/1999 3:32	1492	3393	5329	105	31	7.4	6.8	5.0	15.9	11.9	4.0	702	604	547	14	8	1.64	31.1	31.3	0.2	111	11	6.0
		1213.73	07/09/1999 4:32	1462	3334	5215	102	31	7.3	6.8	5.0	16.1	11.6	4.0	700	604	547	14	8	1.59	31.0	31.5	0.2	118	11	6.0
		1214.73	07/09/1999 5:32	1446	3303	5148	100	31	7.3	6.8	5.0	16.1	11.6	3.8	700	604	547	14	8	1.59	30.9	31.3	0.2	120	11	6.0
		1215.73	07/09/1999 6:32	1440	3285	5105	99	31	7.3	6.8	4.9	16.1	11.6	4.0	700	604	548	14	8	1.59	30.8	31.4	0.2	111	11	6.0
		1216.73	07/09/1999 7:32	1438	3281	5079	99	30	7.2	6.7	4.9	15.9	11.6	4.0	700	604	548	14	8	1.62	30.7	31.4	0.2	108	11	6.0
		1217.73	07/09/1999 8:32	1434	3538	5866	106	318	7.2	6.7	4.9	16.1	11.9	2.5	737	646	599	13	7	1.51	30.7	31.5	0.2	114	11	6.0
		1219.73	07/09/1999 10:32	1459	3027	4278	106	117	7.3	5.9	4.6	15.5	10.8	4.4	616	525	455	13	10	1.60	31.3	32.3	0.2	179	10	6.0
		1223.73	07/09/1999 14:32	1608	3481	5923	151	43	7.3	5.7	6.2	16.1	12.3	3.4	659	564	500	14	9	1.57	32.2	32.8	0.2	121	12	6.7
		1224.73	07/09/1999 15:32	1654	3298	5064	128	224	7.3	5.6	7.1	16.7	11.9	4.8	640	536	453	15	12	1.62	32.5	33.1	0.3	121	11	6.7
		1225.81	07/09/1999 16:36	1703	3423	5143	148	100	7.3	5.5	7.1	16.3	11.4	4.8	623	521	441	15	12	1.64	32.7	33.4	0.2	116	11	6.7
		1226.73	07/09/1999 17:32	1763	3489	5341	156	76	7.3	6.5	6.0	15.9	11.2	4.8	614	516	436	14	12	1.64	32.8	33.5	0.2	124	11	6.5
		1227.73	07/09/1999 18:32	1821	3645	5441	162	59	7.3	5.5	7.1	15.9	11.2	4.8	614	516	437	14	12	1.64	32.8	33.5	0.2	109	11	6.5
		1228.73	07/09/1999 19:32	1850	3662	5566	165	54	7.3	6.3	6.1	15.9	11.0	4.8	617	520	440	14	12	1.64	32.7	33.4	0.2	114	11	6.5
		1229.73	07/09/1999 20:32	1855	3675	5552	161	51	7.3	6.3	6.2	15.7	11.0	4.8	617	519	440	14	12	1.67	32.5	33.1	0.2	105	11	6.5
		1230.73	07/09/1999 21:32	1848	3680	5564	160	52	7.4	5.7	6.3	15.9	11.0	5.0	627	527	447	14	12	1.67	32.3	32.5	0.2	111	11	6.5
		1231.53	07/09/1999 22:20	1837	3658	5509	156	51	7.3	5.8	6.3	15.9	11.2	4.8	626	527	447	14	12	1.65	32	32	0.2	111	11	6.5
		1232.53	07/09/1999 23:20	1830	3627	5438	134	45	7.4	6.8	7.4	15.9	11.0	4.8	634	536	455	14	12	1.66	32	32	0.2	111	11	6.5
		1233.53	07/10/1999 0:20	1830	3626	5418	132	41	7.4	6.9	7.4	15.7	11.0	4.8	635	536	456	14	12	1.69	32	32	0.2	109	11	6.5
		1234.53	07/10/1999 1:20	1830	3627	5403	129	40	7.4	6.9	7.4	15.9	11.0	4.8	638	540	459	14	12	1.66	32	32	0.2	109	11	6.5
		1235.53	07/10/1999 2:20	1828	3631	5381	127	38	7.5	6.9	7.4	15.7	11.0	4.8	641	542	462	14	12	1.69	32	32	0.2	110	11	6.5
		1236.53	07/10/1999 3:20	1823	3617	5350	124	38	7.5	6.9	7.4	15.7	11.0	4.8	641	543	463	14	12	1.67	31	31	0.2	121	11	6.5
		1237.53	07/10/1999 4:20	1813	3606	5315	123	37	7.5	6.9	7.5	15.7	10.8	4.8	640	542	463	14	12	1.67	31	32	0.2	112	10	6.5
		1238.53	07/10/1999 5:20	1804	3596	5293	122	37	7.5	6.9	7.5	15.9	11.0	4.8	644	546	466	14	12	1.66	31	31	0.2	114	11	6.5
		1241.53	07/10/1999 8:20	1793	3591	5245	121	36	7.5	7.0	7.5	15.9	10.8	4.8	644	546	467	14	12	1.64	32	32	0.2	117	10	
		1244.69	07/10/1999 11:30	1759	3574	5228	141	37	7.5	5.9	6.6	15.9	11.2	4.8	636	537	460	14	11	1.66	32	32	0.2	349	11	
		1245.58	07/10/1999 12:23	1760	3449	4902	133	199	7.5	5.9	6.5	16.5	11.2	4.8	636	531	440	15	13	1.66	32	32	0.2	118	11	
		1247.58	07/10/1999 14:23	1782	3467	4932	141	76	7.5	5.8	6.4	16.5	11.4	5.7	638	531	440	16	13	1.70	33	32	0.2	111	11	
		1250.58	07/10/1999 17:23	1812	3538	5064	145	374	7.4	6.1	6.7	16.1	11.0	5.5	625	524	437	15	13	1.67	33	33	0.2	111	11	
		1251.58	07/10/1999 18:23	1816	3556	5121	145	81	7.4	6.0	6.5	16.1	11.0	5.2	629	527	443	15	12	1.68	33	33	0.2	108	11	
		1252.58	07/10/1999 19:23	1808	3556	5116	144	92	7.4	6.0	6.5	16.1	11.0	5.2	631	530	445	15	12	1.67	33	33	0.2	105	11	
		1253.58	07/10/1999 20:23	1801	3547	5103	142	66	7.4	6.0	6.5	16.1	11.0	5.3	631	530	445	15	12	1.67	33	32	0.2	105	11	
		1254.58	07/10/1999 21:23	1794	3529	5076	139	56	7.4	5.9	6.5	16.1	11.0	5.2	635	533	448	15	12	1.67	32	32	0.2	108	11	
		1255.58	07/10/1999 22:23	1783	3507	5046	136	51	7.4	5.9	6.5	16.1	11.0	5.2	638	536	450	15	13	1.68	32	32	0.2	108	11	
		1256.58	07/10/1999 23:23	1779	3494	5025	136	48	7.4	6.0	6.5	16.1	11.0	5.2	639	537	451	15	13	1.68	32	32	0.2	108	11	
		1257.58	07/11/1999 0:23	1767	3470	4990	133	48	7.5	5.9	6.5	16.1	11.0	5.3	640	538	452	15	13	1.67	32	32	0.2	106	11	
		1258.58	07/11/1999 1:23	1758	3450	4964	131	47	7.5	5.9	6.5	16.1	11.0	5.2	640	536	451	15	12	1.71	32	32	0.2	105	11	
		1259.58	07/11/1999 2:23	1753	3432	4946	129	46	7.5	5.9	6.5	16.3	11.0	5.5	642	540	454	15	12	1.66	32	32	0.2	105	11	
		1260.58	07/11/1999 3:23	1750	3410	4876	112	42	7.5	6.9	7.4	16.1	10.8	5.5	649	546	461	15	12	1.69	32	31	0.3	107	10	
		1261.58	07/11/1999 4:23	1742	3405	4836	111	37	7.5	6.9	7.5	16.1	10.9	5.4	650	547	462	15	12	1.69	32	31	0.3	114	11	
		1262.58	07/11/1999 5:23	1733	3391	4799	110	35	7.5	6.9	7.5	16.1	10.8	5.5	651	547	463	15	12	1.71	32	31	0.3	106	10	
		1263.58	07/11/1999 6:23	1736	3405	4791	110	35	7.5	6.9	7.5	16.3	10.8	5.4	652	549	465	15	12	1.66	32	32	0.3	105	10	
		1264.58	07/11/1999 7:23	1737	3410	4784	110	34	7.5	6.9	7.5	16.1	11.0	5.4	655	552	468	15	12	1.69	31	32	0.3	109	11	
		1265.58	07/11/1999 8:23	1739	3370	4980	123	48	7.5	6.6	7.3	16.1	10.8	5.2	631	526	439	15	13	1.72	32	32	0.2	249	10	
		1266.58	07/11/1999 9:23	1734	3378	5010	141	44	7.5	5.7	6.4	16.3	11.2	5.2	631	525	437	15	13	1.71	32	33	0.2	121	11	
		1267.58	07/11/1999 10:23	1721	3374	5035	140	48	7.5	5.9	6.4	15.9	11.0	5.0	616	515	433	15	12	1.69	32	33	0.2	116	11	
		1268.58	07/11/1999 11:23	1715	3370	5066	140	47	7.5	5.9	6.5	15.9	11.0	5.0	618	516	435	15	12	1.71	32	32	0.2	108	11	
		1288.61	07/12/1999 7:25	1723	3392	4895	116	36	7.5	6.9	7.5	15.9	10.8	5.2	635	536	454	14	12	1.67	31	32	0.2	106	10	6.7
		1289.60	07/12/1999 8:24	1725	3277	4753	150	39	7.5	6.1	6.6	14.2	9.1	4.8	516	476	406	6	10	0.80	31	32	0.2	404	9	6.7
		1290.60	07/12/1999 9:24	1718	3401	5032	135	46	7.5	5.9	6.5	16.3	11.2	5.0	638	535	453	15	12	1.66	32	32	0.2	108	11	6.7
		1291.60	07/12/1999 10:24	1711	3510	5426	138	345	7.5	5.9	6.5	16.1	11.6	4.6	656	557	482	14	11	1.64	32	33	0.2	153	11	
		1288.61	07/12/1999 7:25	1723	3392	4895	116	36	7.5	6.9	7.5	15.9	10.8	5.2	635	536	454	14	12	1.67	31	32	0.2	106	10	
		1289.60	07/12/1999 8:24	1725	3277	4753	150	39	7.5	6.1	6.6	14.2	9.1	4.8	516	476	406	6	10	0.80	31	32	0.2	404	9	
		1290.60	07/12/1999 9:24	1718	3401	5032	135	46	7.5	5.9	6.5	16.3	11.2	5.0	638	535	453	15	12	1.66	32	32	0.2	108	11	
		1291.60	07/12/1999 10:24	1711	3510	5426	138	345	7.5	5.9	6.5	16.1	11.6	4.6	656	557	482	14	11	1.64	32	33	0.2	153	11	
		1292.60	07/12/1999 11:24	1710	3529	5441	140	99	7.5	5.9	6.5	16.3	11.8	4.6	655	554	480	15	11	1.63	32	33	0.2	109	11	
		1293.60	07/12/1999 12:24	1715	3534	5431	141	82	7.5	6.6	6.5	15.9	11.6	4.6	649	551	477	14	11	1.65	33	33	0.2	110	11	
		1294.60	07/12/1999 13:24	1724	3530	5361	126	41	7.5	6.9	7.5	16.1	11.6	4.6	665	564	491	15	11	1.66	32	33	0.2	125	11	
		1295.60	07/12/1999 14:24	1737	3641	5476	129	78	7.5	6.6	7.5	16.1	11.6	4.4	672	574	504	14	10	1.61	32	33	0.2	110	11	

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Conductivity (uS/cm) Interstage	Conductivity (uS/cm) Conc	Conductivity (uS/cm) Tot Perm	Conductivity (uS/cm) Samplvalve	pH Raw Feed	pH RO Feed	pH Concentrate	Flow (Lpm) Feed	Flow (Lpm) Tot Perm	Flow (Lpm) Conc	Pressure (kPa) Feed	Pressure (kPa) Interstage	Pressure (kPa) Conc	Pressure Drop (psi) Stage 1	Pressure Drop (psi) Stage 2	PDC (psi/gpm$^{1.5}$) Stage 1	Temperature RO Feed	Temperature Raw	Turbidity	Particle Index	Flux	Target pH
		1296.60	07/12/1999 15:24	1755	3676	5652	147	383	7.5	5.9	6.5	16.1	11.9	4.6	663	565	496	14	10	1.61	32	33	0.2	110	11	
		1288.61	07/12/1999 7:25	1723	3392	4895	116	36	7.5	6.9	7.5	15.9	10.8	5.2	635	536	454	14	12	1.67	31	32	0.2	106	10	6.7
		1289.60	07/12/1999 8:24	1725	3277	4753	150	39	7.5	6.1	6.6	14.2	9.1	4.8	516	476	406	6	10	0.80	31	32	0.2	404	9	
		1290.60	07/12/1999 9:24	1718	3401	5032	135	46	7.5	5.9	6.5	16.3	11.2	5.0	638	535	453	15	12	1.66	32	32	0.2	108	11	
		1291.60	07/12/1999 10:24	1711	3510	5426	138	345	7.5	5.9	6.5	16.1	11.6	4.6	656	557	482	14	11	1.64	32	33	0.2	153	11	
		1292.60	07/12/1999 11:24	1710	3529	5441	140	99	7.5	5.9	6.5	16.3	11.8	4.6	655	554	480	15	11	1.63	32	33	0.2	109	11	
		1293.60	07/12/1999 12:24	1715	3534	5431	141	82	7.5	6.6	6.5	15.9	11.6	4.6	649	551	477	14	11	1.65	33	33	0.2	110	11	
		1294.60	07/12/1999 13:24	1724	3530	5361	126	41	7.5	6.9	7.5	16.1	11.6	4.6	665	564	491	15	11	1.66	32	33	0.2	125	11	
		1295.60	07/12/1999 14:24	1737	3641	5476	129	78	7.5	6.6	7.5	16.1	11.6	4.4	672	574	504	14	10	1.61	32	33	0.2	110	11	
		1296.60	07/12/1999 15:24	1755	3676	5652	147	383	7.5	5.9	6.5	16.1	11.9	4.6	663	565	496	14	10	1.61	32	33	0.2	110	11	
		1313.14	07/13/1999 7:57	1686	3516	5399	120	314	7.5	5.9	6.5	16.1	11.8	4.6	685	586	515	14	10	1.63	32	32	0.2	106	11	
		1314.14	07/13/1999 8:57	1683	3509	5386	121	73	7.5	5.8	6.5	16.1	11.8	4.6	684	586	515	14	10	1.62	32	32	0.2	105	11	
		1315.14	07/13/1999 9:57	1675	3496	5361	122	76	7.5	5.9	6.5	15.9	11.0	4.4	661	558	490	15	10	1.72	32	32	0.2	105	11	
		1316.14	07/13/1999 10:57	1667	3489	5349	123	67	7.5	5.9	6.5	16.1	11.8	4.6	678	579	509	14	10	1.63	32	33	0.2	107	11	
		1316.46	07/13/1999 11:15	1665	3485	5353	124	57	7.5	5.9	6.5	16.1	11.8	4.6	679	581	510	14	10	1.61	32	33	0.2	105	11	
		1317.14	07/13/1999 11:57	1668	3485	5357	125	326	7.5	5.9	6.5	16.1	11.7	4.6	679	580	509	14	10	1.63	32	33	0.2	105	11	
		1318.14	07/13/1999 12:57	1684	3520	5396	127	112	7.5	5.9	6.5	16.1	11.8	4.6	679	581	511	14	10	1.61	32	33	0.2	104	11	
		1319.14	07/13/1999 13:57	1723	3601	5498	133	66	7.5	5.9	6.5	16.1	11.6	4.6	678	581	511	14	10	1.59	33	33	0.2	105	11	
		1320.14	07/13/1999 14:57	1775	3707	5620	140	362	7.4	5.9	6.5	16.1	11.9	4.6	677	581	511	14	10	1.57	33	34	0.2	104	11	
		1320.95	07/13/1999 15:45	1794	3751	5695	142	90	7.4	5.9	6.5	16.1	11.9	4.6	679	583	513	14	10	1.58	33	34	0.2	104	11	
		1321.95	07/13/1999 16:45	1799	3770	5708	143	74	7.4	5.9	6.5	16.1	11.9	4.6	675	580	510	14	10	1.57	33	34	0.2	106	11	
		1322.95	07/13/1999 17:45	1790	3769	5708	141	62	7.4	5.9	6.5	16.1	11.6	4.6	674	578	509	14	10	1.58	33	34	0.2	105	11	
		1323.95	07/13/1999 18:45	1785	3761	5689	139	54	7.4	5.9	6.5	16.1	11.9	4.6	674	580	510	14	10	1.55	33	34	0.2	105	11	
		1324.95	07/13/1999 19:45	1777	3738	5659	137	50	7.4	5.9	6.5	16.1	11.9	4.6	678	583	512	14	10	1.57	33	34	0.2	107	11	
		1325.95	07/13/1999 20:45	1777	3721	5629	135	48	7.4	5.9	6.5	16.1	11.9	4.6	680	586	515	14	10	1.56	33	34	0.2	105	11	
		1326.95	07/13/1999 21:45	1771	3711	5594	132	45	7.5	5.9	6.5	16.1	11.9	4.6	686	590	520	14	10	1.58	33	33	0.2	105	11	
		1327.95	07/13/1999 22:45	1759	3680	5573	128	45	7.5	5.9	6.5	16.1	11.9	4.6	690	593	522	14	10	1.60	32	33	0.2	104	11	
		1328.95	07/13/1999 23:45	1749	3672	5537	124	45	7.5	5.9	6.5	16.1	11.8	4.6	693	595	525	14	10	1.61	32	33	0.2	105	11	
		1329.95	07/14/1999 0:45	1741	3649	5502	118	42	7.5	5.9	6.6	16.1	11.8	4.6	696	599	528	14	10	1.61	32	33	0.2	104	11	
		1330.95	07/14/1999 1:45	1739	3632	5476	114	41	7.6	6.0	6.6	16.1	11.8	4.4	699	601	531	14	10	1.61	32	33	0.2	104	11	
		1331.95	07/14/1999 2:45	1732	3618	5445	111	41	7.6	6.0	6.6	16.1	11.6	4.6	700	603	532	14	10	1.60	32	33	0.2	104	11	
		1332.46	07/14/1999 3:15	1730	3583	5320	94	38	7.6	7.0	7.5	16.1	11.6	4.6	712	615	543	14	10	1.61	32	33	0.2	105	11	
		1332.95	07/14/1999 3:45	1724	3583	5277	93	32	7.6	7.0	7.6	16.1	11.6	4.6	715	618	547	14	10	1.61	32	33	0.2	105	11	
		1333.46	07/14/1999 4:15	1720	3583	5241	93	30	7.6	7.0	7.6	16.1	11.6	4.6	716	619	549	14	10	1.61	32	33	0.2	106	11	
		1333.95	07/14/1999 4:45	1714	3578	5216	92	31	7.6	7.0	7.6	16.1	11.6	4.8	720	623	552	14	10	1.60	32	33	0.2	105	11	
		1334.95	07/14/1999 5:45	1709	3578	5167	92	29	7.6	7.0	7.6	16.1	11.6	4.8	721	625	554	14	10	1.59	31	32	0.2	105	11	
		1335.46	07/14/1999 6:15	1714	3591	5172	93	28	7.6	7.0	7.6	16.1	11.6	4.8	722	626	554	14	10	1.59	31	32	0.2	105	11	
		1336.76	07/14/1999 7:33	1717	3618	5225	93	28	7.6	7.0	7.6	16.1	11.6	4.6	731	634	564	14	10	1.60	31	32	0.2	105	11	6.7
		1337.46	07/14/1999 8:15	1715	3006	3754	100	32	7.6	6.0	6.6	16.1	9.1	7.3	595	486	365	16	17	1.81	31	32	0.2	116	9	6.7
		1338.76	07/14/1999 9:33	1707	3552	5136	110	40	7.5	6.0	6.6	16.1	11.4	4.8	689	592	517	14	11	1.61	32	33	0.2	114	11	
		1339.76	07/14/1999 10:33	1706	3547	5140	113	41	7.6	6.0	6.6	16.1	11.4	5.0	691	594	519	14	11	1.61	32	33	0.2	107	11	
		1340.76	07/14/1999 11:33	1713	3561	5148	115	40	7.6	6.0	6.6	16.1	11.4	5.0	690	594	520	14	11	1.59	32	33	0.2	108	11	
		1341.76	07/14/1999 12:33	1731	3592	5188	119	42	7.6	6.0	6.6	16.1	11.4	5.0	691	595	520	14	11	1.59	32	33	0.2	105	11	
		1342.76	07/14/1999 13:33	1743	3605	5175	121	43	7.5	6.0	6.6	16.1	11.4	5.0	690	592	517	14	11	1.61	32	33	0.2	107	11	
		1343.76	07/14/1999 14:33	1754	3614	5135	123	43	7.5	5.9	6.5	16.1	11.2	5.0	685	587	511	14	11	1.61	32	34	0.2	104	11	
		1344.76	07/14/1999 15:33	1764	3636	5162	125	44	7.5	5.9	6.5	16.1	11.4	5.0	681	584	509	14	11	1.59	33	34	0.2	106	11	
		1345.76	07/14/1999 16:33	1768	3654	5187	125	45	7.5	5.9	6.5	16.2	11.4	5.0	680	584	508	14	11	1.56	33	34	0.2	104	11	
		1346.76	07/14/1999 17:33	1768	3640	5183	126	46	7.5	5.9	6.5	16.1	11.4	5.0	680	584	508	14	11	1.58	33	34	0.2	105	11	
		1347.76	07/14/1999 18:33	1767	3641	5183	124	46	7.5	6.0	6.5	16.1	11.4	5.0	680	584	508	14	11	1.58	33	34	0.2	105	11	
		1348.76	07/14/1999 19:33	1767	3649	5174	123	45	7.5	5.9	6.6	16.1	11.4	5.0	684	587	512	14	11	1.59	33	34	0.2	105	11	
		1349.76	07/14/1999 20:33	1764	3636	5140	121	45	7.5	6.0	6.6	16.1	11.4	5.0	689	592	516	14	11	1.59	33	34	0.2	104	11	
		1350.76	07/14/1999 21:33	1761	3623	5128	118	42	7.5	6.0	6.6	16.1	11.4	5.0	694	597	520	14	11	1.60	32	33	0.2	104	11	
		1351.76	07/14/1999 22:33	1764	3610	5102	115	42	7.5	6.0	6.6	16.1	11.2	5.0	699	601	525	14	11	1.61	32	33	0.2	104	11	
		1352.76	07/14/1999 23:33	1757	3592	5071	111	42	7.5	6.0	6.6	16.1	11.2	5.2	704	606	529	14	11	1.61	32	33	0.2	105	11	
		1353.76	07/15/1999 0:33	1751	3578	5062	109	40	7.5	6.0	6.6	16.1	11.2	5.2	709	609	532	14	11	1.64	32	32	0.2	105	11	
		1355.76	07/15/1999 2:33	1744	3578	5035	105	40	7.6	6.0	6.7	16.1	11.2	5.2	714	615	537	14	11	1.63	31	32	0.2	105	11	
		1356.76	07/15/1999 3:33	1732	3552	5000	103	39	7.6	6.0	6.7	16.1	11.2	5.2	714	615	537	14	11	1.63	31	32	0.2	105	11	
		1357.76	07/15/1999 4:33	1723	3529	4965	102	38	7.6	6.1	6.7	16.1	11.2	5.2	716	616	538	14	11	1.64	31	32	0.2	105	11	
		1358.76	07/15/1999 5:33	1715	3516	4943	101	39	7.6	6.0	6.7	16.1	11.2	5.2	717	619	541	14	11	1.63	31	32	0.2	105	11	
		1359.76	07/15/1999 6:33	1721	3520	4955	101	37	7.6	6.0	6.7	16.1	11.2	5.2	721	622	543	14	11	1.63	31	32	0.2	105	11	
		1384.60	07/16/1999 7:24	1727	3569	4929	102	37	7.5	6.0	6.7	16.1	10.8	5.2	736	637	561	14	11	1.63	32	33	0.2	105	10	6.7
		1385.60	07/16/1999 8:24	1718	3570	4956	103	334	7.5	6.1	6.7	16.1	11.0	5.2	737	642	567	14	11	1.57	32	33	0.2	106	11	6.7
		1386.60	07/16/1999 9:24	1711	3565	4937	104	85	7.5	6.0	6.7	16.1	11.0	5.2	737	641	564	14	11	1.58	32	33	0.2	105	11	6.7
		1387.60	07/16/1999 10:24	1708	3561	4929	104	74	7.5	6.0	6.7	16.1	11.0	5.2	735	639	563	14	11	1.59	32	33	0.2	106	11	6.7
		1390.60	07/16/1999 13:24	1710	3596	4981	116	380	7.5	5.9	6.5	16.1	11.2	5.0	726	633	559	14	11	1.54	33	34	0.2	105	11	6.7
		1391.60	07/16/1999 14:24	1722	3630	5016	119	80	7.5	5.9	6.5	16.1	11.2	5.0	727	633	559	14	11	1.56	33	34	0.2	105	11	6.7
		1393.60	07/16/1999 16:24	1733	3654	5047	121	70	7.5	5.9	6.5	16.1	11.2	5.0	725	632	558	14	11	1.54	33	34	0.2	106	11	6.7
		1396.60	07/16/1999 19:24	1753	3693	5082	124	45	7.5	6.0	6.5	16.1	11.2	5.0	730	637	564	13	11	1.54	33	34	0.2	107	11	6.7
		1397.60	07/16/1999 20:24	1768	3690	4950	109	40	7.5	6.9	7.5	16.1	11.2	5.0	752	659	585	13	11	1.54	33	34	0.2	105	11	6.7
		1402.60	07/17/1999 1:24																							
		1403.60	07/17/1999 2:24																							
		1404.60	07/17/1999 3:24																							
		1406.60	07/17/1999 5:24																							
		1433.77	07/18/1999 8:34	1585	3463	4630	102	42	7.5	5.9	6.5	16.1	11.0	5.2	766	673	594	13	11	1.54	31	31	0.2	130	11	6.7
		1434.77	07/18/1999 9:34	1585	3458	4620	102	40	7.5	5.9	6.6	16.1	11.1	5.2	770	676	599	14	11	1.56	31	31	0.2	127	11	6.7
		1435.77	07/18/1999 10:34	1588	3458	4617	103	40	7.5	5.9	6.5	16.1	11.2	5.2	767	674	595	13	11	1.54	31	31	0.2	113	11	6.7
		1436.77	07/18/1999 11:34	1601	3489	4638	106	39	7.5	5.9	6.5	16.1	11.2	5.2	766	673	595	13	11	1.53	31	31	0.2	107	11	6.7
		1437.77	07/18/1999 12:34	1605	3503	4642	108	40	7.5	5.9	6.5	16.1	11.2	5.2	764	672	595	13	11	1.53	32	31	0.2	111	11	6.7
		1438.77	07/18/1999 13:34	1604	3503	4638	109	41	7.5	5.9	6.5	16.1	11.0	5.2	763	671	594	13	11	1.53	32	31	0.2	108	11	6.7
		1439.77	07/18/1999 14:34	1609	3516	4657	111	41	7.5	5.9	6.5	16.1	11.2	5.2	762	670	594	13	11	1.51	32	32	0.2	127	11	6.7
		1440.77	07/18/1999 15:34	1615	3525	4678	113	41	7.4	5.9	6.5	16.1	11.2	5.2	758	667	590	13	11	1.51	32	32	0.2	106	11	6.7
		1441.77	07/18/1999 16:34	1618	3547	4700	114	42	7.4	5.9	6.5	16.1	11.2	5.2	757	665	589	13	11	1.51	33	32	0.2	112	11	6.7
		1442.77	07/18/1999 17:34	1626	3570	4722	115	41	7.4	5.9	6.5	16.1	11.4	5.2	756	665	589	13	11	1.50	33	32	0.2	107	11	6.7
		1443.77	07/18/1999 18:34	1631	3578	4730	114	42	7.4	5.9	6.5	16.1	11.2	5.2	758	667	591	13	11	1.51	33	32	0.2	106	11	6.7
		1444.77	07/18/1999 19:34	1633	3587	4734	113	42	7.4	5.9	6.5	16.1	11.2	5.2	762	672	595	13	11	1.49	33	32	0.2	121	11	6.7
		1447.77	07/18/1999 22:34	1643	3600	4721	108	41	7.4	5.9	6.5	16.1	11.2	5.2	772	682	604	13	11	1.49	32	32	0.2	107	11	6.7
		1448.77	07/18/1999 23:34	1643	3600	4713	106	39	7.5	5.9	6.5	16.1	11.2	5.2	776	686	608	13	11	1.49	32	32	0.2	106	11	6.7
		1449.77	07/19/1999 0:34																							
		1450.77	07/19/1999 1:34																							
		1451.77	07/19/1999 2:34																							
		1452.77	07/19/1999 3:34																							
		1455.77	07/19/1999 6:34																							
		1458.56	07/19/1999 9:22																							
		1459.56	07/19/1999 10:22	1624	2693	3084	89	43	7.6	6.1	6.5	16.1	7.9	9.0	625	513	357	16	23	1.86	32	32	0.2	124	8	6.7
		1460.56	07/19/1999 11:22	1625	2930	3511	110	40	7.5	6.0	6.4	15.7	8.9	6.9	653	585	476	10	16	1.16	32	32	0.2	160	9	6.7
		1462.56	07/19/1999 13:22	1653	3307	4123	104	40	7.5	6.0	6.5	16.1	10.2	6.3	754	659	562	14	14	1.57	32	33	0.2	105	10	6.7
		1463.56	07/19/1999 14:22	1655	3339	4189	106	74	7.5	6.0	6.5	16.1	10.4	6.3	762	666	570	14	14	1.58	33	33	0.2	107	10	6.7
		1464.56	07/19/1999 15:22	1669	3352	4193	106	99	7.5	6.0	6.5	16.1	10.4	6.3	763	668	574	14	14	1.57	32	32	0.2	125	10	6.7
		1465.56	07/19/1999 16:22	1673	3365	4211	104	71	7.4	6.0	6.5	16.1	10.4	6.3	769	673	578	14	14	1.59	32	32	0.2	108	10	6.7
		1466.56	07/19/1999 17:22	1680	3374	4206	103	49	7.5	6.0	6.5	16.1	10.2	6.3	768	673	578	14	14	1.57	32	33	0.2	108	10	6.7
		1467.56	07/19/1999 18:22	1680	3374	4210	99	43	7.5	6.0	6.6	16.1	10.2	6.3	772	677	580	14	14	1.57	32	32	0.2	105	10	6.7
		1468.56	07/19/1999 19:22	1684	3383	4211	97	41	7.5	6.1	6.6	16.1	10.2	6.3	774	679	583	14	14	1.57	32	32	0.2	105	10	6.7
		1469.56	07/19/1999 20:22	1683	3369	4197	94	39	7.5	6.1	6.6	16.1	10.2	6.3	779	684	587	14	14	1.57	32	32	0.2	106	10	6.7
		1471.56	07/19/1999 22:22																							
		1473.56	07/20/1999 0:22																							
		1474.56	07/20/1999 1:22																							
		1476.56	07/20/1999 3:22																							
		1477.56	07/20/1999 4:22																							
		1479.56	07/20/1999 6:22																							
		1480.56	07/20/1999 7:22																							

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm^1.5) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
		1482.78	07/20/1999 9:35																							
		1483.78	07/20/1999 10:35	1622	3578	4652	90	50	7.5	6.1	6.7	15.5	10.6	5.2	753	668	594	12	11	1.50	32	31	0.2	300	10	6.7
		1484.78	07/20/1999 11:35	1623	2557	2847	81	50	7.5	6.2	6.5	16.1	7.3	9.4	576	465	293	16	25	1.84	32	32	0.2	105	7	6.7
		1485.78	07/20/1999 12:35	1644	3432	4330	89	52	7.5	5.9	6.5	16.3	10.8	5.9	746	653	564	13	13	1.50	32	32	0.2	198	10	6.7
		1486.78	07/20/1999 13:35	1671	3756	4894	118	50	7.5	6.0	6.6	12.8	8.3	2.1	639	577	527	9	7	1.44	32	32	0.2	104	8	6.7
		1487.78	07/20/1999 14:35	1715	3352	4101	103	47	7.5	6.0	6.5	15.3	9.1	6.3	715	626	530	13	14	1.58	32	32	0.2		9	6.7
		1489.78	07/20/1999 16:35	1763	2704	2992	97	42	7.5	6.1	6.5	16.1	6.9	10.3	578	461	273	17	27	1.94	33	32	0.3	130	7	6.7
		1490.78	07/20/1999 17:35	1767	2713	3000	96	44	7.5	6.2	6.5	16.3	6.9	10.3	579	462	274	17	27	1.90	33	32	0.3	124	7	6.7
		1491.78	07/20/1999 18:35	1780	2721	3009	97	42	7.5	6.2	6.5	16.1	6.9	10.2	579	462	273	17	27	1.94	33	32	0.3	123	7	6.7
		1492.78	07/20/1999 19:35	1789	2735	3035	97	43	7.5	6.2	6.5	16.1	6.9	10.2	582	463	275	17	27	1.96	33	32	0.3	143	7	6.7
		1493.78	07/20/1999 20:35	1792	2735	3027	96	43	7.5	6.1	6.5	16.1	6.8	10.2	586	467	276	17	28	1.96	32	32	0.3	137	7	6.7
		1495.78	07/20/1999 22:35	1775	2696	2981	92	42	7.5	6.1	6.5	16.1	6.6	10.2	591	472	280	17	28	1.97	32	32	0.3	141	6	6.7
		1496.78	07/20/1999 23:35	1758	2664	2947	90	40	7.5	6.1	6.5	16.1	6.6	10.2	592	473	280	17	28	1.97	32	32	0.3	150	6	6.7
		1497.78	07/21/1999 0:35	1742	2646	2925	89	40	7.5	6.1	6.5	16.3	6.8	10.2	595	476	282	17	28	1.94	32	31	0.3	141	7	6.7
		1500.78	07/21/1999 3:35	1718	2561	2841	73	40	7.5	7.0	7.3	16.1	6.6	10.5	605	486	290	17	28	1.97	31	31	0.3	116	6	6.7
		1501.78	07/21/1999 4:35	1702	2539	2815	72	35	7.5	7.0	7.3	16.1	6.6	10.5	608	488	291	17	28	1.99	31	31	0.3	127	6	6.7
		1502.78	07/21/1999 5:35	1689	2526	2793	71	34	7.5	7.0	7.3	16.1	6.8	10.5	610	488	292	18	28	2.01	31	31	0.3	119	7	6.7
		1503.78	07/21/1999 6:35	1690	2526	2793	72	32	7.5	7.0	7.3	16.1	6.8	10.5	608	488	292	17	28	1.99	31	31	0.3	112	7	6.7
		1504.78	07/21/1999 7:35	1690	2593	2895	72	30	7.5	7.0	7.4	16.1	7.1	10.0	632	514	330	17	27	1.94	31	31	0.3	134	7	6.7
		1506.14	07/21/1999 8:57	1685	2717	3083	91	37	7.5	6.1	6.5	14.6	6.8	8.4	602	505	364	14	20	1.84	31	31	0.3	206	7	6.7
		1507.14	07/21/1999 9:56	1675	2642	2979	91	40	7.5	6.1	6.5	14.8	6.7	8.8	595	494	340	15	22	1.89	31	31	0.2	157	6	6.7
		1509.14	07/21/1999 11:56	1662	2877	3335	93	41	7.5	6.1	6.5	15.5	7.9	8.0	685	586	455	14	19	1.74	32	32	0.3	190	8	6.7
7	Set target pH(conc) = 5.6	1532.92	07/22/1999 11:43	1655	2921	3392	99	75	7.6	5.8	6.3	15.7	8.3	7.7	725	625	497	14	19	1.71	32	33	0.3	118	8	5.6
		1533.92	07/22/1999 12:43	1672	2970	3467	102	65	7.5	5.8	6.3	15.7	8.4	7.7	728	631	505	14	18	1.67	32	34	0.3	114	8	5.6
		1534.92	07/22/1999 13:43	1694	3011	3519	105	52	7.5	5.8	6.3	15.7	8.3	7.7	727	630	504	14	18	1.67	33	34	0.3	114	8	5.6
		1535.92	07/22/1999 14:43	1758	3126	3642	112	49	7.5	5.8	6.2	15.7	8.3	7.7	726	630	505	14	18	1.65	33	34	0.3	167	8	5.6
		1536.92	07/22/1999 15:43	1791	3192	3722	115	47	7.5	5.8	6.2	15.7	8.5	7.8	727	631	506	14	18	1.65	33	35	0.3	110	8	5.6
		1537.92	07/22/1999 16:43	1795	3197	3738	116	49	7.5	5.8	6.2	15.7	8.5	7.7	727	631	506	14	18	1.65	33	34	0.3	108	8	5.6
		1538.92	07/22/1999 17:43	1790	4457	4739	111	52	7.5	6.7	6.7	13.4	10.0	3.4	828	788	749	6	6	0.88	34	35	0.2		10	5.6
		1539.92	07/22/1999 18:43	1781	3765	4694	120	50	7.5	5.9	6.5	14.8	9.6	5.2	802	725	648	11	11	1.44	34	35	0.2	133	9	5.6
		1540.92	07/22/1999 19:43	1770	3725	4703	128	50	7.5	5.9	5.6	14.8	9.8	5.3	802	722	644	12	11	1.49	33	35	0.3	110	9	5.6
		1541.92	07/22/1999 20:43	1761	3832	4822	148	51	7.5	4.9	5.2	15.3	10.2	5.2	801	719	640	12	11	1.47	33	34	0.2	110	10	5.6
		1542.92	07/22/1999 21:43				–																			
		1553.92	07/23/1999 8:43																							
		1554.92	07/23/1999 9:43	1675	2669	3042	155	661	7.4	5.3	3.9	15.8	7.1	9.4	470	348	179	18	24	2.08	32	33	0.3	246	7	5.6
		1555.92	07/23/1999 10:43	1666	2606	3089	105	246	7.5	5.7	6.7	16.1	7.7	9.0	503	380	217	18	24	2.04	32	34	0.3	265	7	
		1556.92	07/23/1999 11:43	1666	2842	3745	96	428	7.5	6.7	6.3	16.1	9.3	7.1	529	416	290	16	18	1.87	32	34	0.3	103	9	
		1558.65	07/23/1999 13:27	1700	3343	5017	132	77	7.5	4.8	6.9	16.1	11.4	5.0	623	515	431	16	12	1.78	32	34	0.3	309	11	5.6
		1560.21	07/23/1999 15:00	1711	3281	5264	175	80	7.5	6.4	3.3	16.1	11.0	4.8	618	516	430	15	13	1.68	33	35	0.3	193	11	5.6
		1561.21	07/23/1999 16:00	1726	3363	5235	170	72	7.4	4.7	4.9	16.1	11.2	4.8	611	508	424	15	12	1.69	33	35	0.4	170	11	5.6
		1563.21	07/23/1999 18:00	1775	3420	5393	182	58	7.4	6.4	3.4	16.1	11.2	4.8	620	519	433	15	13	1.66	34	35	0.3	148	11	5.6
		1565.21	07/23/1999 20:00	1824	3525	5521	186	51	7.5	6.2	3.5	16.1	11.2	5.0	625	526	439	14	13	1.62	33	35	0.2	117	11	5.6
		1566.21	07/23/1999 21:00	1824	3650	5417	175	50	7.5	4.1	5.9	16.1	11.4	5.0	621	518	434	15	12	1.71	33	35	0.3	149	11	5.6
		1567.21	07/23/1999 22:00	1819	3547	5314	125	48	7.5	4.6	7.1	16.1	11.2	5.0	647	540	455	15	12	1.76	33	34	0.3	125	11	5.6
		1568.21	07/23/1999 23:00	1814	3489	5264	116	48	7.5	6.7	6.7	16.1	11.1	4.8	657	552	464	15	13	1.72	33	34	0.3	121	11	5.6
		1569.21	07/24/1999 0:00	1801	3468	5225	115	47	7.5	6.0	6.7	16.1	11.2	5.2	659	553	465	15	13	1.74	32	34	0.3	109	11	5.6
		1570.21	07/24/1999 1:00	1789	3481	5233	133	49	7.5	5.1	6.2	16.1	11.2	5.0	649	545	457	15	13	1.74	32	34	0.3	131	11	5.6
		1572.21	07/24/1999 3:00	1775	3441	5180	127	50	7.5	5.0	6.3	16.1	11.2	5.0	658	551	464	15	13	1.76	32	33	0.3	117	11	5.6
		1573.21	07/24/1999 4:00	1765	3391	5136	103	39	7.5	7.1	7.5	16.2	11.0	5.2	667	561	472	15	13	1.72	32	33	0.4	121	11	5.6
		1574.21	07/24/1999 5:00	1753	3378	5113	102	31	7.6	7.1	7.5	16.1	11.0	5.2	667	560	471	15	13	1.76	32	33	0.2	120	11	5.6
		1575.21	07/24/1999 6:00	1748	3365	5092	103	31	7.6	7.1	7.5	16.1	11.2	5.2	665	558	470	15	13	1.76	32	33	0.2	105	11	5.6
		1576.21	07/24/1999 7:00	1752	3374	5097	104	29	7.6	7.1	7.5	16.1	11.2	5.0	664	558	469	15	13	1.74	32	33	0.2	111	11	5.6
		1577.67	07/24/1999 8:28	1750	3494	5502	123	38	7.5	5.5	5.9	19.0	13.5	5.7	783	651	547	19	15	1.70	32	33	0.3	330	13	5.6
8	4th Cleaning with Citric Acid (Stages 1 and 2)	1578.67	07/24/1999 9:28	1752	3481	5480	121	42	7.5	5.5	5.9	18.8	13.7	5.7	787	655	549	19	15	1.73	31	33	0.3	188	13	5.6
		1650.52	07/27/1999 9:19	1802	2531	2958	66	45	7.6	5.7	6.1	16.1	6.6	10.9	587	445	238	20	30	2.34	32	33	0.2	104	6	5.6
		1652.52	07/27/1999 11:19	1782	2846	3771	87	46	7.6	5.7	6.1	16.1	8.7	7.7	674	550	410	18	20	2.06	33	34	0.2	105	8	5.6
		1653.52	07/27/1999 12:19	1793	2921	3986	90	48	7.6	5.7	6.1	16.1	9.3	7.5	685	560	427	18	19	2.06	33	34	0.2	133	9	5.6
		1654.52	07/27/1999 13:19	1801	3330	5117	106	46	7.5	5.6	6.1	16.1	11.4	5.2	740	627	533	16	14	1.87	33	34	0.2	104	11	5.6
		1655.34	07/27/1999 14:08	1805	3342	5228	103	252	7.5	5.6	6.1	16.1	11.2	5.5	731	619	526	16	14	1.84	33	34	0.2	103	11	5.6
		1656.34	07/27/1999 15:08	1809	3317	5165	118	56	7.5	5.6	6.1	16.1	11.2	5.5	753	642	547	16	14	1.84	33	34	0.2	112	11	5.6
		1657.34	07/27/1999 16:08	1816	3339	5187	117	56	7.5	5.7	6.2	16.1	11.2	5.5	751	639	544	16	14	1.84	34	34	0.3	107	11	5.6
		1658.34	07/27/1999 17:08	1825	3355	5200	119	52	7.4	5.6	6.1	16.1	11.2	5.5	745	634	540	16	14	1.82	34	34	0.3	104	11	5.6
		1659.34	07/27/1999 18:08	1830	3369	5218	120	45	7.5	5.6	6.0	16.1	11.2	5.5	743	634	539	16	14	1.81	34	34	0.3	103	11	5.6
		1660.34	07/27/1999 19:08	1832	3365	5220	120	41	7.5	5.6	6.1	16.1	11.2	5.5	745	635	541	16	14	1.82	34	34	0.2	106	11	5.6
		1661.34	07/27/1999 20:08	1834	3363	5209	119	39	7.5	5.6	6.1	16.1	11.0	5.5	745	635	541	16	14	1.82	34	34	0.2	108	11	5.6
		1662.34	07/27/1999 21:08	1844	3370	5223	120	39	7.5	5.6	6.0	16.1	11.2	5.5	749	638	543	16	14	1.84	33	34	0.2	104	11	5.6
		1665.34	07/28/1999 0:08	1837	3346	5183	112	37	7.5	5.7	6.1	16.1	11.2	5.5	763	650	554	16	14	1.87	33	33	0.2	103	11	5.6
		1666.34	07/28/1999 1:08	1833	3336	5183	110	36	7.5	5.7	6.2	16.1	11.0	5.5	763	651	556	16	14	1.86	32	33	0.2	106	11	5.6
		1667.34	07/28/1999 2:08	1828	3329	5166	109	34	7.5	5.7	6.2	16.1	11.0	5.5	763	651	556	16	14	1.86	32	33	0.2	103	11	5.6
		1668.34	07/28/1999 3:08	1823	3330	5144	108	34	7.5	5.7	6.2	16.1	11.0	5.5	764	652	557	16	14	1.86	32	33	0.2	106	11	5.6
		1669.34	07/28/1999 4:08	1818	3323	5126	107	34	7.5	5.7	6.2	16.1	11.0	5.5	768	654	558	16	14	1.87	32	33	0.2	104	11	5.6
		1670.34	07/28/1999 5:08	1808	3303	5096	107	35	7.5	5.7	6.1	16.1	11.0	5.5	767	655	558	16	14	1.86	32	33	0.2	155	11	5.6
		1671.34	07/28/1999 6:08	1809	3307	5087	108	35	7.5	5.7	6.1	16.1	11.0	5.5	768	655	558	16	14	1.86	32	33	0.2	103	11	5.6
		1674.78	07/28/1999 9:35	1801	3290	5044	110	35	7.5	5.6	6.1	16.1	11.0	5.4	760	649	554	16	14	1.84	32	33	0.2	103	11	5.6
		1675.78	07/28/1999 10:35	1798	3325	5119	114	37	7.5	5.5	6.0	16.1	11.0	5.5	733	623	531	16	13	1.83	32	33	0.2	112	11	
		1676.78	07/28/1999 11:35	1796	3325	5097	112	38	7.5	5.6	6.0	16.1	11.2	5.5	733	624	531	16	14	1.81	32	33	0.2	103	11	
		1677.78	07/28/1999 12:35	1820	3476	5303	131	133	7.5	5.3	5.6	16.1	11.2	5.2	699	591	504	16	13	1.77	33	34	0.2	256	11	
		1678.78	07/28/1999 13:35	1841	3518	5369	137	79	7.5	5.3	5.4	16.1	11.2	3.8	695	589	502	15	13	1.75	33	34	0.2	111	11	
		1679.78	07/28/1999 14:35	1883	3587	5509	140	67	7.5	5.5	5.3	16.1	11.2	5.2	700	595	507	15	13	1.72	33	34	0.2	114	11	
		1680.78	07/28/1999 15:35	1906	3690	5562	142	327	7.4	5.2	5.9	16.1	11.2	5.3	693	587	500	15	13	1.74	34	34	0.2	113	11	
		1681.78	07/28/1999 16:35	1912	3667	5600	148	69	7.4	5.7	5.1	16.1	11.2	5.0	690	586	499	15	13	1.71	34	34	0.2	331	11	
		1682.78	07/28/1999 17:35	1916	3677	5556	128	74	7.5	5.5	6.2	16.1	11.2	5.3	700	595	508	15	13	1.72	34	34	0.2	107	11	
		1683.79	07/28/1999 18:35	1914	3671	5557	129	64	7.5	5.9	6.4	16.1	11.2	5.3	699	594	507	15	13	1.72	34	34	0.3	107	11	
		1684.78	07/28/1999 19:35	1907	3672	5572	136	54	7.5	5.2	6.0	16.1	11.2	5.3	696	591	504	15	13	1.74	34	34	0.2	105	11	
		1685.78	07/28/1999 20:35	1905	3671	5599	157	52	7.5	4.9	5.2	16.1	11.2	5.2	688	583	495	15	13	1.74	33	34	0.2	105	11	
		1686.78	07/28/1999 21:35	1911	3632	5523	144	51	7.5	5.6	5.1	16.1	11.2	5.2	701	596	508	15	13	1.74	33	34	0.2	235	11	
		1687.78	07/28/1999 22:35	1906	3637	5509	130	49	7.5	5.3	6.0	16.1	11.2	5.2	711	603	516	16	13	1.78	33	34	0.2	107	11	
		1688.78	07/28/1999 23:35	1905	3645	5528	147	49	7.5	4.9	5.3	16.1	11.2	5.2	703	595	508	16	13	1.77	33	33	0.2	104	11	
		1689.78	07/29/1999 0:35	1903	3610	5511	133	48	7.5	5.5	5.4	16.1	11.0	5.2	710	604	515	15	13	1.76	33	33	0.3	104	11	
		1690.78	07/29/1999 1:35	1899	3632	5515	135	47	7.5	5.0	5.6	16.1	11.0	5.2	714	606	517	16	13	1.77	32	33	0.2	105	11	
		1691.78	07/29/1999 2:35	1891	3583	5483	137	48	7.5	5.5	5.1	15.9	11.0	5.2	710	604	515	15	13	1.79	32	33	0.2	105	11	
		1692.78	07/29/1999 3:35	1879	3587	5439	126	47	7.5	5.2	5.9	16.1	11.0	5.2	719	610	522	16	13	1.79	32	33	0.2	105	11	
		1693.07	07/29/1999 3:52	1875	3587	5457	138	47	7.5	4.8	5.4	16.1	11.2	5.2	710	601	514	16	13	1.79	32	33	0.2	108	11	
		1693.78	07/29/1999 4:35	1864	3577	5440	149	46	7.5	5.1	4.9	16.1	11.2	5.2	707	599	511	16	13	1.79	32	33	0.2	105	11	
		1694.78	07/29/1999 5:35	1859	3507	5344	127	45	7.5	5.8	5.1	16.1	11.0	5.2	719	613	524	15	13	1.74	32	33	0.2	105	11	
		1695.78	07/29/1999 6:35	1865	3522	5338	115	46	7.5	5.6	6.1	16.1	11.0	5.2	727	619	529	16	13	1.78	32	32	0.2	104	11	
		1696.78	07/29/1999 7:35	1862	3521	5339	115	46	7.4	5.4	6.3	16.1	11.0	5.2	728	620	530	16	13	1.79	32	32	0.2	105	11	
		1697.78	07/29/1999 8:35	1843	3513	5339	116	46	7.4	5.2	6.3	16.1	11.0	4.0	725	616	526	16	13	1.79	32	33	0.3	104	11	
		1700.07	07/29/1999 10:52	1848	3474	6242	184	101	7.5	6.6	2.5	15.9	10.4	4.8	701	595	508	15	13	1.78	32	33	0.2		10	
		1701.31	07/29/1999 12:06	1870	3579	5507	131	77	7.5	6.1	4.6	15.9	10.8	5.0	707	603	519	15	12	1.76	32	33	0.2	117	10	
		1702.31	07/29/1999 13:06	1889	3632	5563	121	59	7.4	6.0	6.4	16.1	11.0	5.0	717	612	527	15	12	1.74	33	33	0.3	111	11	
		1703.31	07/29/1999 14:06	1901	3668	5615	124	54	7.4	5.7	6.7	16.1	11.2	5.0	716	607	522	16	12	1.79	33	34	0.3	110	11	
		1704.31	07/29/1999 15:06	1906	3690	5659	126	51	7.4	5.6	6.8	16.1	11.2	5.0	711	606	522	15	12	1.74	33	34	0.2	109	11	
		1705.31	07/29/1999 16:06	1908	3703	5680	128	52	7.3	5.6	6.9	16.1	11.2	5.0	709	604	520	15	12	1.72	33	34	0.3	108	11	
		1701.31	07/29/1999 12:06	1870	3579	5507	131	77	7.5	6.1	4.6	15.9	10.8	5.0	707	603	519	15	12	1.76	32	33	0.2	117	10	
		1702.31	07/29/1999 13:06	1889	3632	5563	121	59	7.4	6.0	6.4	16.1	11.0	5.0	717	612	527	15	12	1.74	33	33	0.3	111	11	
		1703.31	07/29/1999 14:06	1901	3668	5615	124	54	7.4	5.7	6.7	16.1	11.2	5.0	716	607	522	16	12	1.79	33	34	0.3	110	11	

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm$^{1.5}$) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
		1704.31	07/29/1999 15:06	1906	3690	5659	126	51	7.4	5.6	6.8	16.1	11.2	5.0	711	606	522	15	12	1.74	33	34	0.2	109	11	
		1705.31	07/29/1999 16:06	1908	3703	5680	128	52	7.3	5.6	6.9	16.1	11.2	5.0	709	604	520	15	12	1.72	33	34	0.3	108	11	
		1707.31	07/29/1999 18:06	1922	3716	5697	123	51	7.3	6.2	6.8	16.1	11.2	5.0	711	607	523	15	12	1.72	34	34	0.2	124	11	
		1708.31	07/29/1999 19:06	1929	3720	5702	125	52	7.3	6.6	6.6	16.1	11.2	5.0	710	607	522	15	12	1.70	34	34	0.2	124	11	
		1709.31	07/29/1999 20:06	1932	3712	5681	132	52	7.3	6.5	6.0	16.1	11.2	5.0	712	609	524	15	12	1.71	34	34	0.2	105	11	
		1710.31	07/29/1999 21:06	1936	3685	5709	152	53	7.3	6.3	3.7	16.1	11.0	5.0	712	608	523	15	12	1.71	33	34	0.2	110	11	
		1712.31	07/29/1999 23:06	1922	3668	5806	186	50	7.3	5.9	3.2	16.1	11.0	5.0	707	604	519	15	12	1.71	33	33	0.2	121	11	
		1713.31	07/30/1999 0:06	1920	3615	5756	176	49	7.3	5.9	3.3	16.1	10.9	5.0	712	608	523	15	12	1.73	32	33	0.2	105	10	
		1714.31	07/30/1999 1:06	1919	3596	5705	162	48	7.3	6.0	3.4	15.9	11.0	5.0	722	619	532	15	13	1.74	32	33	0.2	137	11	
		1715.31	07/30/1999 2:06	1910	3587	5632	148	48	7.3	6.2	3.6	16.1	11.0	5.0	730	625	538	15	13	1.73	32	33	0.2	105	11	
		1716.31	07/30/1999 3:06	1902	3592	5490	128	48	7.3	6.3	5.5	16.1	11.0	5.2	737	632	546	15	13	1.75	32	32	0.2	105	11	
		1717.31	07/30/1999 4:06	1899	3591	5516	116	47	7.3	6.3	6.1	16.1	11.0	5.2	746	639	552	16	13	1.78	32	32	0.2	104	11	
		1718.31	07/30/1999 5:06	1898	3587	5512	111	47	7.3	6.2	6.3	16.1	11.0	5.2	752	643	554	16	13	1.79	32	32	0.2	104	11	
		1720.31	07/30/1999 7:06	1906	3600	5534	108	46	7.3	6.1	6.7	16.1	11.0	5.2	756	647	557	16	13	1.79	32	32	0.2	105	11	
		1721.31	07/30/1999 8:06	1898	3600	5525	108	46	7.3	6.0	6.7	16.3	11.0	5.2	751	644	556	16	13	1.74	32	32	0.2	105	11	
		1722.31	07/30/1999 9:06	1871	3605	5525	122	209	7.3	5.3	6.0	16.1	11.2	5.2	732	626	540	15	13	1.76	32	32	0.2	115	11	
		1726.60	07/30/1999 13:24	1855	3623	5496	136	50	7.4	4.0	6.0	16.1	11.2	5.0	705	599	515	15	12	1.74	33	33	0.2	103	11	5.6
		1727.60	07/30/1999 14:24	1870	3725	5558	163	84	7.3	3.7	5.5	16.2	11.2	4.8	686	583	500	15	12	1.71	33	33	0.2	104	11	5.6
		1728.60	07/30/1999 15:24	1877	3745	5611	169	90	7.3	3.5	5.6	16.1	11.2	4.8	682	578	496	15	12	1.71	33	33	0.2	103	11	5.6
		1731.60	07/30/1999 18:24	1938	3812	5741	140	52	7.3	3.7	6.4	16.1	11.2	5.0	696	591	509	15	12	1.72	34	34	0.2	159	11	5.6
		1733.60	07/30/1999 20:24	1975	3845	5821	128	49	7.3	5.1	6.8	16.1	11.2	5.0	715	611	527	15	12	1.71	33	34	0.2	103	11	5.6
		1734.60	07/30/1999 21:24	1979	3832	5792	123	49	7.3	5.4	6.9	16.1	11.2	5.0	722	619	533	15	13	1.71	33	33	0.4	104	11	5.6
		1736.60	07/30/1999 23:24	1954	3756	5721	118	48	7.3	5.6	6.9	16.3	11.0	5.2	730	626	541	15	12	1.69	33	33	0.4	103	11	5.6
		1742.60	07/31/1999 5:24	1910	3626	5669	154	45	7.4	5.7	3.7	16.1	11.0	5.0	727	624	536	15	13	1.71	32	32	0.2	104	11	5.6
		1743.60	07/31/1999 6:24	1897	3600	5496	114	46	7.4	6.0	5.9	16.1	10.8	5.2	745	641	553	15	13	1.72	32	32	0.2	104	10	5.6
		1773.03	08/01/1999 11:50	1749	3339	5148	102	44	7.2	6.3	6.2	16.1	11.0	5.2	724	622	535	15	13	1.67	33	32	0.2	103	11	5.6
		1776.03	08/01/1999 14:50	1774	3400	5209	104	44	7.2	6.5	6.4	16.1	11.0	5.2	719	618	533	15	12	1.66	33	33	0.2	103	11	5.6
		1778.03	08/01/1999 16:50	1775	3387	5437	148	46	7.1	6.2	3.3	16.1	11.0	5.0	701	601	515	14	13	1.64	34	33	0.2	108	11	5.6
		1779.03	08/01/1999 17:50	1779	3615	5566	204	47	7.1	5.5	2.9	16.1	11.2	4.8	678	576	493	15	12	1.67	34	33	0.2	103	11	5.6
		1780.03	08/01/1999 18:50	1779	3635	5362	176	48	7.1	3.3	5.4	16.1	11.3	4.8	675	572	490	15	12	1.71	34	33	0.2	106	11	5.6
		1781.03	08/01/1999 19:50	1782	3462	5288	118	45	7.1	3.8	6.8	16.3	11.2	5.0	704	599	515	15	12	1.69	34	33	0.2	103	11	5.6
		1782.03	08/01/1999 20:50	1786	3435	5249	104	46	7.1	5.8	7.1	16.3	11.2	5.0	719	615	529	15	13	1.68	33	33	0.2	103	11	5.6
		1784.03	08/01/1999 22:50	1780	3392	5212	104	45	7.2	6.6	6.4	16.1	11.0	5.0	725	621	535	15	13	1.71	33	32	0.2	104	11	5.6
		1785.03	08/01/1999 23:50	1775	3383	5176	113	44	7.2	6.4	5.8	16.1	11.0	5.0	724	621	534	15	13	1.69	33	32	0.2	103	11	5.6
		1787.03	08/02/1999 1:50	1777	3359	5219	127	45	7.2	6.3	3.8	16.1	11.0	5.0	725	621	534	15	13	1.71	32	32	0.2	103	11	5.6
		1791.03	08/02/1999 5:50	1767	3352	5135	97	42	7.3	6.0	6.5	16.1	11.0	5.2	743	638	549	15	13	1.74	32	31	0.2	104	11	5.6
		1792.03	08/02/1999 6:50	1763	3356	5133	98	43	7.3	5.7	6.7	16.1	11.0	5.2	742	634	546	16	13	1.79	32	32	0.2	103	11	5.6
		1793.27	08/02/1999 8:04	1754	3361	5145	104	43	7.3	5.2	6.5	16.3	11.0	5.2	741	631	543	16	13	1.77	32	32	0.2	104	11	5.6
		1794.27	08/02/1999 9:04	1751	3383	5158	117	44	7.3	4.3	5.9	16.1	11.2	5.0	726	619	534	16	12	1.77	32	32	0.2	103	11	5.6
		1795.27	08/02/1999 10:04	1750	3413	5216	145	42	7.3	4.4	4.7	16.1	11.2	5.0	710	603	518	15	12	1.76	32	32	0.2	104	11	5.6
		1796.27	08/02/1999 11:04	1750	3321	5224	134	43	7.3	5.7	3.8	15.9	11.0	5.0	721	617	529	15	13	1.76	32	32	0.2	103	11	5.6
		1797.27	08/02/1999 12:04	1762	3356	5171	103	80	7.3	6.1	6.1	16.1	11.0	5.2	733	629	542	15	13	1.73	33	33	0.2	103	11	5.6
		1798.27	08/02/1999 13:04	1772	3397	5197	101	78	7.2	5.8	6.6	16.1	11.2	3.4	732	627	540	15	13	1.73	33	33	0.2	103	11	5.6
		1799.27	08/02/1999 14:04	1790	3441	5254	106	60	7.2	5.5	6.7	16.1	11.0	5.0	724	619	533	15	13	1.72	33	33	0.2	103	11	5.6
		1800.27	08/02/1999 15:04	1813	3503	5354	115	94	7.2	5.2	6.5	16.1	11.2	5.0	720	615	529	15	13	1.72	33	33	0.2	103	11	5.6
		1801.27	08/02/1999 16:04	1818	3542	5425	124	79	7.2	4.7	6.0	16.1	11.2	5.0	715	611	526	15	12	1.71	34	34	0.2	103	11	5.6
		1802.27	08/02/1999 17:04	1832	3627	5525	151	61	7.2	4.1	6.0	16.3	11.4	5.0	695	592	509	15	12	1.67	34	34	0.2	103	11	5.6
		1803.27	08/02/1999 18:04	1857	3610	5547	156	51	7.2	5.1	4.5	16.1	11.2	5.0	704	600	515	15	12	1.71	34	33	0.2	103	11	5.6
		1804.27	08/02/1999 19:04	1883	3610	5514	123	50	7.2	5.6	5.8	16.1	11.0	5.0	725	621	535	15	13	1.71	33	33	0.2	103	11	5.6
		1805.27	08/02/1999 20:04	1889	3658	5565	133	49	7.2	4.8	5.5	16.1	11.2	5.0	717	614	529	15	12	1.71	33	33	0.2	103	11	5.6
		1807.27	08/02/1999 22:04	1910	3672	5624	131	47	7.2	4.9	5.3	16.1	11.2	5.0	727	623	537	15	13	1.73	33	33	0.2	103	11	5.6
		1809.27	08/03/1999 0:04	1899	3658	5572	122	46	7.3	5.1	5.5	16.1	11.2	5.2	740	634	547	15	13	1.74	33	32	0.2	103	11	5.6
		1810.27	08/03/1999 1:04	1896	3631	5536	118	46	7.3	5.2	5.7	16.1	11.0	5.2	741	636	548	15	13	1.74	32	32	0.2	103	11	5.6
		1812.27	08/03/1999 3:04	1878	3587	5470	113	43	7.3	5.3	5.8	16.1	11.0	5.0	745	639	552	15	13	1.74	32	32	0.2	107	11	5.6
		1814.27	08/03/1999 5:04	1852	3529	5400	111	43	7.3	5.3	5.8	16.3	11.0	5.2	746	640	552	15	13	1.71	32	32	0.2	103	11	5.6
		1815.27	08/03/1999 6:04	1853	3538	5400	112	41	7.3	5.4	5.9	16.1	11.0	5.2	746	641	553	15	13	1.74	32	32	0.2	104	11	5.6
		1820.92	08/03/1999 11:43	1811	3477	5339	118	122	7.3	5.1	5.5	16.1	11.2	5.0	735	630	543	15	13	1.74	33	33	0.2	103	11	5.6
		1821.92	08/03/1999 12:43	1819	3494	5370	121	69	7.3	5.0	5.4	16.1	11.2	5.0	728	624	537	15	13	1.73	33	33	0.4	103	11	5.6
		1822.92	08/03/1999 13:43	1828	3512	5386	119	272	7.3	5.1	5.6	16.1	11.2	5.0	730	626	538	15	13	1.72	33	33	0.2	104	11	5.6
		1823.92	08/03/1999 14:43	1836	3521	5399	123	70	7.2	5.2	5.3	16.1	11.2	5.0	722	619	532	15	13	1.71	33	33	0.2	103	11	5.6
		1824.92	08/03/1999 15:43	1841	3547	5425	123	70	7.2	5.0	5.5	16.1	11.2	5.0	721	617	531	15	13	1.71	34	33	0.2	105	11	5.6
		1825.92	08/03/1999 16:43	1844	3546	5447	123	55	7.2	5.2	5.4	16.1	11.4	5.0	721	617	531	15	13	1.71	34	33	0.2	103	11	5.6
		1827.92	08/03/1999 18:43	1852	3552	5438	120	48	7.3	5.2	5.6	16.1	11.2	5.0	722	618	532	15	12	1.72	34	33	0.2	103	11	5.6
		1828.92	08/03/1999 19:43	1857	3578	5470	124	47	7.3	5.2	5.3	16.1	11.4	5.0	721	617	531	15	13	1.71	34	33	0.2	103	11	5.6
		1829.92	08/03/1999 20:43	1863	3579	5457	121	46	7.3	5.1	5.5	16.1	11.2	5.0	725	620	534	15	13	1.73	33	33	0.2	104	11	5.6
		1832.92	08/03/1999 23:43	1863	3574	5457	114	45	7.3	5.3	5.7	16.1	11.4	5.2	741	636	548	15	13	1.74	33	33	0.2	103	11	5.6
		1833.92	08/04/1999 0:43	1861	3556	5429	112	43	7.3	5.4	5.8	16.1	11.2	5.2	743	637	549	15	13	1.76	33	32	0.2	103	11	5.6
		1835.92	08/04/1999 2:43	1847	3520	5378	109	42	7.4	5.4	5.9	16.1	11.2	5.0	746	640	553	15	13	1.76	32	32	0.2	103	11	5.6
		1836.92	08/04/1999 3:43																							
		1837.92	08/04/1999 4:43																							
		1839.92	08/04/1999 6:43																							
		1840.92	08/04/1999 7:43	1795	3458	5309	111	45	7.4	5.5	6.1	16.1	11.2	5.0	736	629	542	15	13	1.76	32	32	0.2	114	11	5.6
		1841.27	08/04/1999 8:04	1754	3361	5145	104	43	7.3	5.2	6.5	16.3	11.0	5.2	741	631	543	16	13	1.77	32	32	0.2	104	11	5.6
		1842.27	08/04/1999 9:04	1751	3383	5158	117	44	7.3	4.3	5.9	16.1	11.2	5.0	726	619	534	16	12	1.77	32	32	0.2	103	11	5.6
		1843.27	08/04/1999 10:04	1750	3413	5216	145	42	7.3	4.4	4.7	16.1	11.2	5.0	710	603	518	15	12	1.76	32	32	0.2	104	11	5.6
		1844.41	08/04/1999 11:12	1771	3410	5220	112	74	7.4	5.3	5.8	16.1	11.2	3.2	726	620	534	15	13	1.74	32	32	0.2	108	11	
		1845.41	08/04/1999 12:12	1793	3476	5315	121	81	7.4	5.1	5.5	16.1	11.4	5.0	720	615	529	15	13	1.73	33	33	0.2	104	11	
		1846.41	08/04/1999 13:12	1806	3503	5378	128	65	7.3	5.0	5.3	16.3	11.4	5.0	715	610	525	15	12	1.69	33	33	0.2	103	11	
		1847.41	08/04/1999 14:12	1836	3552	5422	122	301	7.3	5.1	5.7	16.1	11.4	5.0	719	615	529	15	13	1.71	33	33	0.2	105	11	
		1848.41	08/04/1999 15:12	1854	3587	5527	136	78	7.3	5.3	4.7	16.1	11.4	5.0	711	607	523	15	12	1.71	34	33	0.2	103	11	
		1850.41	08/04/1999 17:12	1852	3583	5531	135	62	7.3	5.5	4.9	16.1	11.2	5.0	705	603	519	15	12	1.69	34	34	0.2	103	11	
		1851.41	08/04/1999 18:12	1847	3605	5525	127	54	7.3	4.9	5.7	16.1	11.4	5.0	709	605	521	15	12	1.71	34	34	0.2	104	11	
		1853.41	08/04/1999 20:12	1837	3583	5491	129	49	7.3	5.0	5.4	16.1	11.4	5.0	709	606	521	15	12	1.69	34	33	0.2	105	11	
		1855.41	08/04/1999 22:12	1834	3542	5417	123	48	7.3	5.2	5.5	16.1	11.4	5.0	719	615	530	15	12	1.71	34	33	0.2	103	11	
		1856.41	08/04/1999 23:12	1828	3525	5404	120	46	7.3	5.2	5.6	16.1	11.2	5.0	722	619	533	15	13	1.71	33	33	0.2	105	11	
		1857.41	08/05/1999 0:12	1815	3498	5364	117	47	7.3	5.3	5.7	16.1	11.2	5.0	727	622	536	15	13	1.73	33	32	0.2	103	11	
		1858.41	08/05/1999 1:12	1801	3476	5315	114	46	7.4	5.2	5.7	16.1	11.2	5.2	728	623	537	15	13	1.74	33	32	0.2	105	11	
		1859.41	08/05/1999 2:12	1790	3436	5264	111	44	7.4	5.3	5.8	16.1	11.2	5.0	729	625	538	15	13	1.72	33	32	0.3	118	11	
		1861.41	08/05/1999 4:12	1755	3369	5158	108	42	7.4	5.3	5.8	16.1	11.2	5.0	730	625	538	15	13	1.74	33	32	0.2	104	11	
		1862.41	08/05/1999 5:12	1739	3338	5109	107	43	7.4	5.3	5.8	16.1	11.2	5.2	731	626	540	15	13	1.74	32	32	0.3	105	11	
		1863.41	08/05/1999 6:12	1729	3316	5084	105	42	7.4	5.3	5.7	16.1	11.2	5.2	736	629	543	15	13	1.76	32	32	0.3	103	11	
		1864.41	08/05/1999 7:12	1728	3316	5082	105	43	7.4	5.3	5.8	16.3	11.4	5.2	700	598	514	15	12	1.66	34	34	0.2	104	11	5.6
		1877.67	08/05/1999 20:28	1741	3391	5209	118	46	7.3	5.1	5.5	16.1	11.4	5.0	707	605	520	15	12	1.69	34	33	0.2	104	11	5.6
		1878.67	08/05/1999 21:28	1750	3392	5200	116	47	7.3	5.1	5.5	16.1	11.4	5.0	712	608	524	15	12	1.72	34	33	0.2	105	11	5.6
		1879.67	08/05/1999 22:28	1740	3365	5148	111	46	7.4	5.3	5.8	16.1	11.2	5.0	719	615	529	15	13	1.71	34	33	0.2	104	11	5.6
		1880.67	08/05/1999 23:28	1726	3334	5118	107	45	7.4	5.4	6.0	16.1	11.4	5.0	725	620	534	15	13	1.72	33	33	0.2	103	11	5.6
		1881.67	08/06/1999 0:28	1712	3312	5065	103	44	7.4	5.5	6.0	16.1	11.2	5.0	726	621	535	15	13	1.73	33	33	0.2	104	11	5.6
		1882.67	08/06/1999 1:28	1706	3285	5017	101	42	7.4	5.5	6.1	16.1	11.4	5.0	728	624	537	15	13	1.73	33	33	0.2	105	11	5.6
		1885.67	08/06/1999 4:28	1658	3192	4854	96	41	7.4	5.5	6.1	16.1	11.2	5.0	731	626	540	15	13	1.74	32	32	0.2	105	11	5.6
		1886.67	08/06/1999 5:28	1642	3160	4797	94	40	7.4	5.5	6.1	16.1	11.2	5.2	732	626	540	15	13	1.74	32	32	0.2	104	11	5.6
		1888.89	08/06/1999 7:41	1636	3139	4765	91	40	7.4	5.6	6.2	16.1	11.2	5.2	737	631	543	15	13	1.74	32	32	0.2	105	11	5.6
		1889.67	08/06/1999 8:28	1630	3126	4745	91	40	7.4	5.6	6.2	16.1	11.2	5.2	736	630	543	15	13	1.74	32	32	0.3	105	11	5.6
		1890.67	08/06/1999 9:28	1627	3120	4726	93	62	7.4	5.5	6.2	16.1	11.2	5.0	731	625	538	15	13	1.74	32	32	0.2	181	11	
		1891.67	08/06/1999 10:28	1628	3134	4752	93	69	7.4	5.5	6.1	16.1	11.4	5.2	735	628	541	15	13	1.76	33	32	0.2	105	11	
		1892.67	08/06/1999 11:28	1639	3161	4792	97	51	7.5	5.4	6.0	16.1	11.2	5.2	727	622	537	15	12	1.74	33	32	0.3	103	11	
		1893.67	08/06/1999 12:28	1650	3190	4856	102	46	7.4	5.3	5.8	16.1	11.2	5.0	720	616	530	15	13	1.71	33	33	0.3	111	11	
		1894.67	08/06/1999 13:28	1665	3228	4888	106	45	7.4	5.2	5.7	16.1	11.4	5.0	715	611	526	15	12	1.71	33	33	0.3	103	11	
		1913.54	08/07/1999 8:20	1587	3102	4849	104	42	7.4	5.1	5.6	16.1	11.2	5.1	727	624	540	15	12	1.70	32	32	0.2	146	11	5.6
		1914.54	08/07/1999 9:20	1596	3085	4833	107	42	7.4	5.0	5.5	16.1	11.4	5.0	725	621	537	15	12	1.71	33	32	0.2	133	11	5.6
		1915.54	08/07/1999 10:20	1583	3076	4830	107	44	7.4	5.1	5.5	16.1	11.4	5.0	721	616	534	15	12	1.72	33	32	0.2	104	11	5.6

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm$^{1.8}$) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
		1917.54	08/07/1999 12:20	1580	3094	4861	115	43	7.4	4.9	5.1	16.1	11.4	5.0	714	609	527	15	12	1.72	33	33	0.2	103	11	5.6
		1919.54	08/07/1999 14:20	1609	3139	5016	139	43	7.4	5.3	4.0	16.1	11.4	4.8	698	595	514	15	12	1.69	34	33	0.2	105	11	5.6
		1920.54	08/07/1999 15:20	1626	3214	5042	144	43	7.3	4.9	4.4	16.1	11.6	4.8	691	588	508	15	12	1.71	34	33	0.2	168	11	5.6
		1921.54	08/07/1999 16:20	1673	3249	5068	115	43	7.3	6.0	5.5	16.1	11.4	4.8	715	613	531	15	12	1.67	34	33	0.2	105	11	5.6
		1923.54	08/07/1999 18:20	1707	3355	5210	112	45	7.3	5.1	6.5	16.1	11.6	4.8	712	609	528	15	12	1.69	34	34	0.2	111	11	5.6
		1925.54	08/07/1999 20:20	1698	3378	5217	143	46	7.3	4.4	5.1	16.1	11.6	4.8	691	588	509	15	12	1.71	34	33	0.2	207	11	5.6
		1926.54	08/07/1999 21:20	1688	3281	5245	147	46	7.3	5.5	3.8	16.1	11.2	4.8	700	597	517	15	12	1.69	34	33	0.2	104	11	5.6
		1927.54	08/07/1999 22:20	1674	3236	5055	110	45	7.3	5.9	5.7	16.1	11.2	4.8	722	619	537	15	12	1.71	34	33	0.2	105	11	5.6
		1929.54	08/08/1999 0:20	1641	3201	5005	119	44	7.4	5.1	5.0	16.1	11.4	5.0	717	614	532	15	12	1.71	33	32	0.2	106	11	5.6
		1930.54	08/08/1999 1:20	1625	3174	4926	110	44	7.4	5.0	5.6	16.1	11.4	5.0	726	620	537	15	12	1.74	33	32	0.2	103	11	5.6
		1931.54	08/08/1999 2:20	1607	3133	4897	108	42	7.4	5.1	5.5	16.1	11.4	5.0	727	621	538	15	12	1.74	33	32	0.2	104	11	5.6
		1932.54	08/08/1999 3:20	1587	3094	4850	105	42	7.4	5.1	5.6	16.1	11.4	5.0	730	624	541	15	12	1.74	33	32	0.2	103	11	5.6
		1933.54	08/08/1999 4:20	1570	3062	4800	103	43	7.4	5.2	5.6	16.1	11.4	5.0	731	625	542	15	12	1.74	33	32	0.2	291	11	5.6
		1935.54	08/08/1999 6:20	1565	3045	4775	101	41	7.4	5.2	5.7	16.1	11.4	5.0	733	627	543	15	12	1.76	33	32	0.2	105	11	5.6
		1936.54	08/08/1999 7:20	1557	3031	4761	99	42	7.4	5.3	5.7	16.3	11.4	5.0	736	629	546	15	12	1.73	32	32	0.2	104	11	5.6
		1937.19	08/08/1999 7:59	1547	3014	4743	98	40	7.4	5.3	5.8	16.1	11.4	5.0	737	630	547	15	12	1.76	32	32	0.2	104	11	5.6
		1939.19	08/08/1999 9:59	1523	2974	4663	100	41	7.4	5.2	5.6	16.1	11.4	5.0	725	619	536	15	12	1.74	33	32	0.2	105	11	5.6
		1941.19	08/08/1999 11:59	1525	2974	4678	105	42	7.4	5.1	5.5	16.1	11.4	4.8	716	611	529	15	12	1.72	33	32	0.2	104	11	5.6
		1942.19	08/08/1999 12:59	1529	2992	4716	106	42	7.4	5.0	5.4	16.1	11.4	5.0	716	612	530	15	12	1.72	33	32	0.2	113	11	5.6
		1944.19	08/08/1999 14:59	1540	3023	4729	107	44	7.3	5.1	5.6	16.1	11.6	4.8	711	607	525	15	12	1.71	34	33	0.2	107	11	5.6
		1946.19	08/08/1999 16:59	1563	3072	4755	89	30	7.3	6.8	7.3	16.1	11.7	4.6	712	608	528	15	12	1.71	34	33	0.4	119	11	5.6
		1948.19	08/08/1999 18:59	1572	3138	4706	90	28	7.3	6.8	7.3	16.1	11.4	4.8	711	611	533	15	11	1.65	34	33	0.2	159	11	5.6
		1949.19	08/08/1999 19:59	1568	3147	4640	89	29	7.3	6.8	7.3	16.1	11.4	4.8	715	614	538	15	11	1.66	34	33	0.2	131	11	5.6
		1951.19	08/08/1999 21:59	1558	3178	4540	85	26	7.3	6.8	7.4	16.1	11.2	4.8	727	627	552	15	11	1.66	34	33	0.2	111	11	5.6
		1952.19	08/08/1999 22:59	1550	3178	4482	82	27	7.3	6.9	7.4	16.1	11.2	4.8	733	633	558	15	11	1.66	33	32	0.2	113	11	5.6
		1955.19	08/09/1999 1:59	1533	3182	4359	76	26	7.4	6.9	7.4	16.1	11.2	5.0	746	647	574	14	11	1.64	33	32	0.2	111	11	5.6
		1956.19	08/09/1999 2:59	1524	3174	4323	75	25	7.4	6.9	7.4	16.1	11.2	5.0	748	649	575	14	11	1.64	33	32	0.2	117	11	5.6
		1957.19	08/09/1999 3:59	1515	3165	4280	74	26	7.4	6.9	7.5	16.1	11.2	5.0	751	651	578	14	11	1.64	33	32	0.2	110	11	5.6
		1958.19	08/09/1999 4:59	1505	3152	4240	73	24	7.4	6.9	7.5	16.1	11.2	5.0	749	649	576	15	11	1.66	33	32	0.2	121	11	5.6
		1959.19	08/09/1999 5:59	1501	3152	4228	73	24	7.4	6.9	7.5	16.1	11.2	5.0	751	652	579	14	11	1.64	33	32	0.2	111	11	5.6
		1960.19	08/09/1999 6:59	1499	3156	4227	72	24	7.4	6.9	7.4	16.1	11.2	5.0	756	656	583	14	11	1.64	33	32	0.2	112	11	5.6
		1961.22	08/09/1999 8:01	1499	3165	4228	71	25	7.4	6.9	7.5	16.1	11.2	4.9	759	660	586	14	11	1.64	33	32	0.2	111	11	5.6
		1962.22	08/09/1999 9:01	1502	3183	4202	72	25	7.4	6.9	7.5	16.1	11.2	5.0	757	658	585	14	11	1.63	33	32	0.2	117	11	5.6
		1963.22	08/09/1999 10:01	1503	3001	4650	106	39	7.4	5.0	5.5	16.1	11.4	4.8	704	600	521	15	12	1.71	33	32	0.2	117	11	5.6
		1965.22	08/09/1999 12:01	1528	2966	4510	105	64	7.3	5.0	5.5	16.1	11.2	5.2	691	586	501	15	12	1.74	33	32	0.2	128	11	5.6
		1966.22	08/09/1999 13:01	1532	2970	4540	109	66	7.3	5.1	5.2	16.1	11.2	5.2	683	579	495	15	12	1.71	33	33	0.2	119	11	5.6
		1967.22	08/09/1999 14:01	1540	2996	4549	105	53	7.3	5.2	5.6	16.1	11.2	5.2	686	583	498	15	12	1.72	34	33	0.2	108	11	5.6
		1969.22	08/09/1999 16:01	1549	3001	4540	111	83	7.3	5.1	5.3	16.1	11.2	5.2	680	576	490	15	13	1.72	34	33	0.2	117	11	5.6
		1970.22	08/09/1999 17:01	1558	3018	4570	109	81	7.3	5.2	5.4	16.1	11.2	5.2	681	576	491	15	12	1.72	34	33	0.2	114	11	5.6
		1971.22	08/09/1999 18:01	1566	3037	4604	109	58	7.3	5.1	5.5	16.1	11.2	5.2	679	574	489	15	12	1.72	35	34	0.2	140	11	5.6
		1972.22	08/09/1999 19:01	1572	3054	4614	109	51	7.3	5.1	5.5	16.1	11.2	5.2	682	578	492	15	12	1.72	35	34	0.3	123	11	5.6
		1973.22	08/09/1999 20:01	1570	3040	4521	83	40	7.3	6.8	7.3	16.1	11.2	5.0	690	587	503	15	12	1.71	34	33	0.3	123	11	5.6
		1974.22	08/09/1999 21:01	1569	3068	4461	81	30	7.3	6.9	7.4	16.1	11.2	5.0	696	594	510	15	12	1.70	34	33	0.3	127	11	5.6
		1975.22	08/09/1999 22:01	1562	3080	4355	79	29	7.4	6.9	7.4	16.1	11.0	5.2	707	605	523	15	12	1.69	34	33	0.3	132	11	5.6
		1976.22	08/09/1999 23:01	1557	3103	4258	76	27	7.4	6.9	7.4	16.1	11.0	5.2	716	614	534	15	12	1.69	33	32	0.3	130	11	5.6
		1977.22	08/10/1999 0:01	1545	3107	4170	73	26	7.4	6.9	7.4	16.1	11.0	5.2	722	620	541	15	12	1.69	33	32	0.3	134	11	5.6
		1978.22	08/10/1999 1:01	1538	3107	4104	70	26	7.4	6.9	7.4	16.1	11.0	5.2	727	625	545	15	12	1.69	33	32	0.3	127	11	5.6
		1983.22	08/10/1999 6:01	1474	3032	3864	62	22	7.4	6.9	7.5	16.1	10.8	5.4	735	633	556	15	11	1.67	33	32	0.3	154	10	5.6
		1984.22	08/10/1999 7:01	1461	3011	3818	61	22	7.4	6.9	7.5	16.1	10.8	5.4	736	635	558	15	11	1.66	32	32	0.3	133	10	5.6
9	Inc to 75%	1985.17	08/10/1999 7:58	1452	3001	3801	60	22	7.4	6.9	7.5	16.3	10.8	5.4	740	635	558	15	11	1.69	32	32	0.3	127	10	5.6
		1986.17	08/10/1999 8:58	1448	2842	3099	73	262	7.4	5.6	7.4	15.7	10.8	5.0	684	625	554	8	10	1.00	33	32	0.3	412	10	5.6
		1987.17	08/10/1999 9:58	1444	2983	4369	89	104	7.5	5.5	6.1	16.1	11.4	5.0	712	611	534	15	11	1.66	33	32	0.3	127	11	5.6
		1988.17	08/10/1999 10:58	1444	2969	4365	91	74	7.4	5.4	6.1	16.1	11.4	5.0	709	607	530	15	11	1.67	33	32	0.3	127	11	5.6
		1989.17	08/10/1999 11:58	1449	2979	4369	93	56	7.4	5.4	6.0	16.1	11.4	5.0	706	605	528	15	11	1.67	33	32	0.3	153	11	5.6
		1990.17	08/10/1999 12:58	1462	3010	4417	97	48	7.4	5.3	5.9	16.1	11.4	5.0	705	604	527	15	11	1.66	33	32	0.3	145	11	5.6
		1985.17	08/10/1999 7:58	1452	3001	3801	60	22	7.4	6.9	7.5	16.3	10.8	5.4	740	635	558	15	11	1.69	32	32	0.3	127	10	5.6
		1986.17	08/10/1999 8:58	1448	2842	3099	73	262	7.4	5.6	7.4	15.7	10.8	5.0	684	625	554	8	10	1.00	33	32	0.3	412	10	5.6
		1987.17	08/10/1999 9:58	1444	2983	4369	89	104	7.5	5.5	6.1	16.1	11.4	5.0	712	611	534	15	11	1.66	33	32	0.3	127	11	5.6
		1988.17	08/10/1999 10:58	1444	2969	4365	91	74	7.4	5.4	6.1	16.1	11.4	5.0	709	607	530	15	11	1.67	33	32	0.3	127	11	5.6
		1989.17	08/10/1999 11:58	1449	2979	4369	93	56	7.4	5.4	6.0	16.1	11.4	5.0	706	605	528	15	11	1.67	33	32	0.3	153	11	5.6
		1990.17	08/10/1999 12:58	1462	3010	4417	97	48	7.4	5.3	5.9	16.1	11.4	5.0	705	604	527	15	11	1.66	33	32	0.3	145	11	5.6
		1991.17	08/10/1999 13:58	1473	3032	4475	98	45	7.4	5.3	5.8	16.1	11.4	5.0	704	603	527	15	11	1.66	34	33	0.3	120	11	5.6
		1995.17	08/10/1999 17:58	1514	3223	4891	109	51	7.3	5.3	5.7	15.3	11.1	4.4	681	589	526	13	9	1.64	34	33	0.3	129	11	5.6
		1996.17	08/10/1999 18:58	1523	3241	4896	108	48	7.4	5.3	5.8	15.3	11.0	4.4	683	594	529	13	9	1.59	34	33	0.3	135	11	5.6
		1997.17	08/10/1999 19:58	1531	3272	4913	106	46	7.4	5.3	5.8	15.3	11.2	4.4	690	599	535	13	9	1.62	34	33	0.3	138	11	5.6
		1998.17	08/10/1999 20:58	1540	3285	4927	104	44	7.4	5.3	5.9	15.3	11.0	4.4	696	606	542	13	9	1.61	34	33	0.3	138	11	5.6
		1999.17	08/10/1999 21:58	1548	3294	4906	102	43	7.4	5.4	6.0	15.3	11.0	4.4	700	608	545	13	9	1.64	34	33	0.3	140	11	5.6
		2000.17	08/10/1999 22:58	1550	3303	4902	99	43	7.4	5.5	6.0	15.3	11.0	4.6	711	619	554	13	9	1.64	33	32	0.3	152	11	5.6
		2001.17	08/10/1999 23:58	1547	3294	4875	97	42	7.4	5.5	6.1	15.3	11.0	4.6	714	623	558	13	9	1.62	33	32	0.3	153	11	5.6
		2008.90	08/11/1999 7:42	1499	3028	4885	99	45	7.5	5.6	6.2	15.3	11.0	4.4	691	595	525	14	10	1.72	32	31	0.4		11	5.6
		2009.90	08/11/1999 8:42	1489	3005	4854	99	43	7.5	5.5	6.1	15.3	11.2	4.4	691	596	525	14	10	1.70	32	32	0.4	306	11	5.6
		2012.90	08/11/1999 11:42	1491	3010	4979	104	71	7.4	5.4	6.0	15.3	11.2	2.3	689	594	524	14	10	1.70	33	32	0.4	188	11	5.6
		2013.90	08/11/1999 12:42	1482	2986	4933	107	49	7.4	5.3	5.8	15.3	11.2	4.2	680	583	515	14	10	1.73	33	33	0.4	208	11	5.6
		2016.90	08/11/1999 15:42	1545	3126	5170	118	73	7.3	5.1	5.5	15.3	11.2	4.2	674	580	512	14	10	1.68	34	33	0.4	126	11	5.6
		2018.90	08/11/1999 17:42	1560	3147	5183	117	50	7.4	5.3	5.6	15.5	11.3	4.2	678	583	513	14	10	1.65	34	33	0.4	159	11	5.6
		2019.90	08/11/1999 18:42	1573	3170	5222	117	48	7.4	5.2	5.7	15.5	11.2	3.4	678	584	515	14	10	1.64	34	33	0.3	142	11	5.6
		2020.90	08/11/1999 19:42	1581	3180	5241	116	46	7.4	5.2	5.7	15.3	11.2	4.2	683	589	520	14	10	1.67	34	33	0.3	149	11	5.6
		2021.90	08/11/1999 20:42	1590	3198	5246	115	45	7.4	5.3	5.8	15.3	11.2	4.2	688	594	524	14	10	1.68	34	33	0.3	140	11	5.6
		2022.90	08/11/1999 21:42	1590	3178	5229	114	44	7.4	5.3	5.8	15.3	11.2	4.2	693	598	528	14	10	1.69	34	33	0.3	129	11	5.6
		2024.90	08/11/1999 23:42	1569	3147	5163	108	42	7.4	5.4	5.9	15.3	11.2	4.2	701	606	536	14	10	1.70	33	32	0.2	122	11	5.6
		2025.90	08/12/1999 0:42	1566	3133	5132	106	43	7.4	5.4	6.0	15.3	11.2	4.4	704	608	538	14	10	1.71	33	32	0.2	121	11	5.6
		2026.90	08/12/1999 1:42	1559	3120	5110	104	41	7.5	5.4	6.0	15.3	11.2	4.2	707	612	541	14	10	1.71	33	32	0.2	143	11	5.6
		2027.90	08/12/1999 2:42	1551	3094	5061	103	42	7.5	5.4	6.0	15.2	11.2	4.4	706	611	541	14	10	1.71	33	32	0.3	124	11	5.6
		2028.90	08/12/1999 3:42	1534	3062	5009	101	41	7.5	5.5	6.1	15.2	11.0	4.4	704	608	537	14	10	1.71	32	32	0.2	121	11	5.6
		2029.90	08/12/1999 4:42	1515	3018	4933	99	41	7.5	5.5	6.1	15.5	11.2	4.4	707	610	540	14	10	1.71	32	32	0.3	124	11	5.6
		2030.90	08/12/1999 5:42	1499	2988	4881	97	39	7.5	5.5	6.1	15.2	11.2	4.4	705	609	538	14	10	1.71	32	32	0.3	115	11	5.6
		2031.90	08/12/1999 6:42	1497	2979	4859	97	39	7.5	5.5	6.1	15.3	11.2	4.4	706	611	541	14	10	1.70	32	32	0.4	117	11	5.6
		2032.79	08/12/1999 7:35	1493	2970	4851	96	39	7.5	5.5	6.1	15.3	11.2	4.4	707	611	541	14	10	1.72	32	32	0.4	117	11	5.6
		2033.79	08/12/1999 8:35	1485	2957	4816	95	209	7.5	5.5	6.2	15.3	11.2	4.4	710	613	542	14	10	1.72	32	32	0.3	118	11	5.6
		2034.79	08/12/1999 9:35	1480	2947	4797	96	73	7.5	5.5	6.2	15.2	11.0	4.4	699	605	535	14	10	1.67	32	32	0.3	113	11	5.6
		2037.79	08/12/1999 12:35	1529	3178	5211	124	49	7.4	3.7	3.2	15.3	11.2	4.2	696	601	531	14	10	1.69	33	32	2.0	110	11	5.6
		2038.79	08/12/1999 13:35	1551	3170	5189	119	49	7.3	3.9	6.1	15.5	11.4	4.2	686	591	522	14	10	1.66	33	32	1.0	121	11	5.6
		2040.79	08/12/1999 15:35	1570	3289	5491	126	94	7.3	3.7	3.2	15.3	11.2	4.0	705	611	543	14	10	1.67	34	33	0.5	127	11	5.6
		2041.79	08/12/1999 16:35	1583	3326	5521	119	79	7.3	3.6	3.1	15.3	11.2	4.0	721	627	559	14	10	1.68	34	33	0.5	134	11	5.6
		2042.79	08/12/1999 17:35	1598	3325	5526	115	57	7.3	3.7	3.1	15.3	11.2	4.0	733	640	570	14	10	1.67	34	33	0.4	120	11	5.6
		2043.79	08/12/1999 18:35	1605	3330	5508	111	49	7.4	3.7	3.1	15.5	11.2	4.0	745	650	580	14	10	1.66	34	33	0.4	132	11	5.6
		2044.79	08/12/1999 19:35	1601	3290	5448	110	47	7.4	3.9	3.3	15.3	11.2	4.2	748	654	585	14	10	1.69	34	33	0.4	114	11	5.6
		2045.79	08/12/1999 20:35	1599	3207	5356	106	45	7.4	4.3	3.4	15.3	11.2	4.2	761	665	594	14	10	1.70	34	33	0.3	114	11	5.6
		2047.79	08/12/1999 22:35	1567	3103	5145	99	45	7.5	4.6	4.2	15.3	11.2	4.2	774	678	607	14	10	1.72	33	32	0.3	118	11	5.6
		2048.79	08/12/1999 23:35	1541	3050	5071	97	43	7.5	4.9	5.1	15.3	11.1	4.2	767	670	599	14	10	1.74	33	32	0.3	115	11	5.6
		2051.79	08/13/1999 2:35	1491	2939	4938	93	43	7.5	5.2	5.7	15.2	11.2	4.2	754	657	585	14	10	1.74	32	32	0.3	117	11	5.6
		2052.79	08/13/1999 3:35	1474	2908	4903	92	41	7.5	5.2	5.6	15.2	11.2	4.2	753	656	584	14	10	1.74	32	32	0.3	135	11	5.6
		2054.79	08/13/1999 5:35	1452	2868	4833	92	42	7.5	5.1	5.7	15.2	11.2	4.2	748	651	580	14	10	1.74	32	32	0.3	115	11	5.6
		2055.79	08/13/1999 6:35	1451	2863	4829	91	40	7.5	5.2	5.7	15.2	11.2	4.2	752	654	583	14	10	1.76	32	31	0.4	114	11	5.6
		2057.79	08/13/1999 8:35	1449	2854	4815	90	189	7.5	5.2	5.7	15.2	11.0	4.2	757	659	586	14	11	1.76	32	31	0.3	125	11	5.6
		2058.79	08/13/1999 9:35	1434	2832	4789	92	58	7.6	5.1	5.6	15.2	11.2	4.2	745	646	575	14	10	1.76	32	32	0.3	112	11	5.6
		2059.79	08/13/1999 10:35	1429	2815	4754	82	55	7.5	5.8	6.5	15.3	11.0	4.2	745	647	576	14	10	1.74	32	32	0.3	114	11	5.6
		2060.79	08/13/1999 11:35	1430	2850	4819	87	44	7.4	5.8	6.4	15.3	11.2	4.2	740	641	570	14	10	1.76	33	32	0.3	128	11	5.6
		2062.79	08/13/1999 13:35	1479	2943	4972	93	215	7.4	5.8	6.4	15.3	11.2	4.2	731	634	564	14	10	1.73	33	32	0.3	145	11	5.6
		2063.79	08/13/1999 14:35	1497	2988	5047	97	70	7.4	5.7	6.4	15.3	11.4	4.2	726	630	561	14	10	1.71	33	33	0.3	112	11	5.6

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed		Conductivity (uS/cm)					pH			Flow (Lpm)			Pressure (kPa)			Pressure Drop (psi)		PDC (psi/gpm$^{1.2}$)	Temperature			Particle		Target
		Time (hrs)	Date/Time	Feed	Interstage	Conc	Tot Perm	Samplvalve	Raw Feed	RO Feed	Concentrate	Feed	Tot Perm	Conc	Feed	Interstage	Conc	Stage 1	Stage 2	Stage 1	RO Feed	Raw	Turbidity	Index	Flux	pH
		2064.79	08/13/1999 15:35	1497	3001	5087	99	59	7.4	5.6	6.3	15.5	11.2	4.2	715	620	551	14	10	1.66	34	33	0.3	108	11	5.6
		2065.79	08/13/1999 16:35	1496	3001	5086	100	45	7.4	5.6	6.2	15.3	11.4	4.2	711	617	549	14	10	1.68	34	33	0.3	111	11	5.6
		2066.79	08/13/1999 17:35	1488	2983	5042	99	40	7.4	5.6	6.2	15.3	11.4	4.2	706	613	545	13	10	1.67	34	33	0.3	114	11	5.6
		2068.79	08/13/1999 19:35	1481	2970	5033	98	39	7.4	5.7	6.3	15.3	11.4	4.2	712	616	549	14	10	1.67	34	33	0.3	114	11	5.6
		2069.79	08/13/1999 20:35	1490	2970	5019	97	38	7.4	5.6	6.3	15.3	11.4	4.2	716	621	554	14	10	1.70	34	33	0.3	115	11	5.6
		2071.79	08/13/1999 22:35	1480	2939	4982	92	36	7.5	5.7	6.4	15.3	11.4	4.2	726	628	559	14	10	1.74	33	32	0.3	122	11	5.6
		2072.79	08/13/1999 23:35	1469	2921	4935	90	37	7.5	5.7	6.4	15.3	11.2	4.2	727	629	561	14	10	1.74	33	32	0.3	125	11	5.6
		2073.79	08/14/1999 0:35	1464	2904	4908	89	36	7.5	5.7	6.4	15.3	11.2	4.2	727	632	563	14	10	1.71	33	32	0.3	123	11	5.6
		2074.79	08/14/1999 1:35	1468	2908	4916	89	36	7.5	5.7	6.4	15.3	11.2	4.2	731	635	565	14	10	1.71	33	32	0.3	123	11	5.6
		2075.79	08/14/1999 2:35	1470	2903	4907	89	35	7.5	5.7	6.4	15.3	11.2	4.2	732	637	568	14	10	1.71	33	32	0.3	122	11	5.6
		2076.79	08/14/1999 3:35	1466	2894	4894	88	34	7.5	5.7	6.4	15.5	11.2	4.2	736	639	569	14	10	1.69	32	32	0.3	121	11	5.6
		2077.79	08/14/1999 4:35	1461	2876	4871	88	34	7.5	5.7	6.4	15.2	11.2	4.2	735	639	569	14	10	1.71	32	32	0.3	132	11	5.6
		2078.79	08/14/1999 5:35	1461	2876	4872	87	35	7.5	5.7	6.4	15.2	11.2	4.2	735	638	568	14	10	1.72	32	32	0.3	118	11	5.6
		2081.87	08/14/1999 8:40	1459	2899	4894	98	39	7.5	5.1	5.7	15.2	11.4	4.2	732	636	565	14	10	1.71	32	32	0.3	117	11	5.6
		2082.87	08/14/1999 9:40	1447	2885	4839	99	40	7.5	5.2	5.5	15.3	11.2	4.2	725	630	561	14	10	1.70	32	32	0.3	111	11	5.6
		2083.87	08/14/1999 10:40	1444	2885	4877	102	41	7.5	5.1	5.4	15.3	11.2	4.2	722	627	558	14	10	1.71	33	32	0.3	109	11	5.6
		2084.87	08/14/1999 11:40	1433	2868	4846	104	42	7.5	5.0	5.2	15.3	11.4	4.2	719	623	554	14	10	1.71	33	32	0.3	112	11	5.6
		2085.87	08/14/1999 12:40	1441	2898	4876	108	44	7.5	4.9	4.8	15.3	11.2	4.2	714	619	551	14	10	1.69	33	32	0.3	112	11	5.6
		2086.87	08/14/1999 13:40	1458	2939	4932	112	44	7.4	4.8	4.4	15.3	11.2	4.0	710	615	547	14	10	1.69	33	32	0.3	111	11	5.6
		2087.87	08/14/1999 14:40	1473	2992	5020	115	45	7.4	4.7	4.0	15.5	11.4	4.0	711	616	548	14	10	1.66	34	33	0.3	112	11	5.6
		2088.87	08/14/1999 15:40	1476	3032	5082	121	46	7.4	4.5	3.9	15.3	11.4	4.0	701	608	540	14	10	1.67	34	33	0.3	114	11	5.6
		2089.87	08/14/1999 16:40	1484	3045	5094	115	47	7.4	3.9	3.6	15.3	11.4	4.0	712	619	551	13	10	1.67	34	33	0.3	116	11	5.6
		2091.87	08/14/1999 18:40	1502	3059	5147	111	47	7.4	4.4	3.5	15.5	11.4	4.0	724	631	562	13	10	1.62	34	33	0.3	117	11	5.6
		2092.87	08/14/1999 19:40	1502	3046	5125	116	46	7.4	4.7	3.8	15.3	11.2	4.0	716	623	554	13	10	1.66	34	33	0.3	120	11	5.6
		2096.87	08/14/1999 23:40	1476	2925	4920	94	42	7.5	5.1	5.4	15.3	11.2	4.2	752	656	585	14	10	1.71	33	32	0.3	121	11	5.6
		2097.87	08/15/1999 0:40	1466	2908	4882	92	41	7.5	5.2	5.7	15.3	11.2	4.2	754	658	587	14	10	1.72	33	32	0.3	121	11	5.6
		2098.87	08/15/1999 1:40	1460	2894	4871	90	41	7.5	5.4	5.9	15.5	11.2	4.2	753	657	586	14	10	1.69	33	32	0.3	118	11	5.6
		2099.87	08/15/1999 2:40	1458	2881	4819	68	38	7.5	7.0	7.5	15.3	11.2	4.2	752	655	585	14	10	1.73	32	32	0.3	124	11	5.6
		2100.87	08/15/1999 3:40	1452	2925	4762	69	27	7.5	7.0	7.5	15.3	11.2	4.2	738	644	576	14	10	1.69	32	32	0.3	121	11	5.6
		2101.87	08/15/1999 4:40	1447	3005	4615	67	24	7.5	7.0	7.6	15.3	11.2	4.2	747	655	591	13	9	1.65	32	31	0.3	119	11	5.6
		2102.87	08/15/1999 5:40	1453	3098	4519	66	23	7.5	7.0	7.6	15.3	11.2	4.2	761	669	608	13	9	1.64	32	31	0.3	121	11	5.6
		2104.63	08/15/1999 7:26	1455	2996	4951	96	33	7.5	5.2	5.8	15.2	11.4	4.2	725	629	563	14	10	1.71	32	31	0.3	114	11	5.6
		2106.63	08/15/1999 9:26	1439	2952	4850	96	41	7.6	5.1	5.6	15.3	11.4	4.2	726	630	563	14	10	1.71	32	31	0.3	113	11	5.6
		2107.63	08/15/1999 10:26	1435	2938	4849	98	42	7.5	5.0	5.5	15.3	11.2	4.2	725	630	563	14	10	1.69	32	32	0.3	112	11	5.6
		2108.63	08/15/1999 11:26	1430	2934	4855	101	45	7.5	5.0	5.3	15.3	11.4	4.2	721	626	558	14	10	1.71	33	32	0.3	111	11	5.6
		2111.63	08/15/1999 14:26	1449	2992	4999	117	48	7.4	4.3	3.5	15.5	11.4	4.0	707	610	543	14	10	1.69	33	33	0.3	112	11	5.6
		2112.63	08/15/1999 15:26	1451	3054	5078	117	48	7.4	3.5	3.1	15.4	11.4	4.0	717	625	557	13	10	1.63	34	33	0.3	112	11	5.6
		2113.63	08/15/1999 16:26	1452	3095	5171	122	48	7.3	3.5	3.0	15.3	11.2	4.0	717	623	556	14	10	1.69	34	33	0.3	112	11	5.6
		2115.63	08/15/1999 18:26	1449	3117	5148	114	44	7.3	3.3	2.8	15.4	11.2	4.0	743	649	579	14	10	1.67	34	33	0.3	113	11	5.6
		2116.63	08/15/1999 19:26	1453	3114	5143	111	45	7.3	3.3	2.8	15.3	11.2	4.0	751	656	586	14	10	1.69	34	33	0.3	118	11	5.6
		2119.63	08/15/1999 22:26	1458	2988	4982	97	40	7.4	3.6	3.0	15.3	11.2	4.2	778	681	610	14	10	1.74	34	33	0.3	124	11	5.6
		2120.63	08/15/1999 23:26	1453	2960	4876	93	39	7.4	3.9	3.2	15.3	11.0	4.2	784	688	615	14	11	1.73	33	33	0.3	129	11	5.6
		2121.63	08/16/1999 0:26	1449	2908	4890	99	41	7.4	4.1	3.4	15.0	11.0	4.2	757	660	590	14	10	1.78	33	32	0.3	126	11	5.6
		2124.63	08/16/1999 3:26	1438	2841	4750	92	41	7.5	4.8	4.6	15.5	11.2	4.2	770	673	601	14	10	1.71	33	32	0.3	128	11	5.6
		2125.63	08/16/1999 4:26	1427	2810	4714	89	40	7.5	5.0	5.1	15.3	11.2	4.4	773	676	603	14	11	1.74	33	32	0.3	118	11	5.6
		2126.63	08/16/1999 5:26	1420	2788	4678	89	40	7.5	5.0	5.3	15.3	11.2	4.2	773	673	601	14	10	1.78	33	32	0.2	123	11	5.6
		2127.63	08/16/1999 6:26	1427	2796	4700	89	41	7.5	5.0	5.2	15.2	11.2	4.2	772	676	603	14	11	1.72	32	32	0.3	117	11	5.6
		2128.71	08/16/1999 7:30	1432	2810	4718	90	41	7.5	5.1	5.4	15.3	11.2	4.4	766	668	596	14	10	1.74	32	32	0.3	140	11	5.6
		2129.71	08/16/1999 8:30	1439	2832	4753	90	40	7.5	5.1	5.4	15.2	11.2	4.4	770	672	600	14	10	1.76	32	32	0.3	117	11	5.6
		2130.71	08/16/1999 9:30	1438	2831	4779	92	41	7.5	5.0	5.3	15.3	11.2	4.2	768	670	597	14	11	1.75	33	32	0.3	114	11	5.6
		2132.71	08/16/1999 11:30	1438	2837	4950	121	74	7.4	6.8	5.5	15.3	10.8	4.4	769	672	599	14	11	1.74	33	32	0.7		10	5.6
		2133.71	08/16/1999 12:30	1442	2877	4828	77	44	7.4	6.9	7.4	15.4	11.0	4.0	727	633	565	14	10	1.66	33	32	0.2	127	11	5.6
		2134.71	08/16/1999 13:30																							
		2135.71	08/16/1999 14:30	1499	3032	5061	96	238	7.3	6.7	7.3	15.3	11.0	4.0	707	614	548	14	10	1.67	34	33	0.3	128	11	5.6
		2139.71	08/16/1999 18:30	1507	3134	5218	112	48	7.3	3.5	3.1	15.3	11.0	4.0	742	649	579	13	10	1.67	34	33	0.2	114	11	5.6
		2143.71	08/16/1999 22:30	1517	3054	4938	89	44	7.4	5.0	6.8	15.5	11.0	4.2	749	653	584	14	10	1.69	33	33	0.2	127	11	5.6
		2145.71	08/17/1999 0:30	1499	2966	4961	98	42	7.4	5.1	5.3	15.3	11.2	1.5	752	655	585	14	10	1.72	33	32	0.2	184	11	5.6
		2146.71	08/17/1999 1:30	1497	2961	4947	96	43	7.5	5.2	5.5	15.3	11.2	1.7	757	660	588	14	10	1.73	33	32	0.3	130	11	5.6
		2147.71	08/17/1999 2:30	1492	2950	4934	95	42	7.5	5.2	5.7	15.3	11.2	1.7	754	658	587	14	10	1.72	33	32	0.2	126	11	5.6
		2149.71	08/17/1999 4:30	1469	2908	4872	92	42	7.5	5.2	5.7	15.3	11.0	1.7	756	659	589	14	10	1.72	33	32	2.0	123	11	5.6
		2150.71	08/17/1999 5:30	1459	2881	4833	92	42	7.5	5.2	5.7	15.2	11.0	1.5	757	659	589	14	10	1.74	33	32	0.3	123	11	5.6
		2151.71	08/17/1999 6:30	1465	2885	4840	93	40	7.5	5.2	5.6	15.2	11.2	1.1	759	663	591	14	10	1.73	33	32	2.0	121	11	5.6
		2154.16	08/17/1999 8:58	1461	2872	4841	93	191	7.5	5.2	5.7	15.2	11.0	4.2	762	664	592	14	10	1.76	32	31	0.6	117	11	5.6
		2156.17	08/17/1999 10:58	1439	2824	4762	94	55	7.4	5.2	5.7	15.3	11.0	4.2	757	660	589	14	10	1.74	32	32	0.5	119	11	5.6
		2158.17	08/17/1999 12:58	1457	2868	4851	100	45	7.4	5.1	5.4	15.3	11.0	4.2	747	650	579	14	10	1.74	33	32	0.7	108	11	5.6
		2160.17	08/17/1999 14:58	1517	3027	5096	112	226	7.4	4.9	5.4	15.3	11.2	4.2	729	631	563	14	10	1.75	34	32	0.6	117	11	5.6
		2161.17	08/17/1999 15:58	1526	3014	5090	103	81	7.3	5.7	5.6	15.3	11.2	4.2	733	640	569	14	10	1.67	34	33	0.6	110	11	5.6
		2162.16	08/17/1999 16:58	1526	3027	5090	95	62	7.3	5.6	6.4	15.3	11.2	4.2	737	643	574	14	10	1.69	34	33	0.9	112	11	5.6
		2165.17	08/17/1999 19:58	1526	2997	5026	102	42	7.3	6.0	5.5	15.3	11.2	4.2	737	645	575	13	10	1.65	33	33	1.6	125	11	5.6
		2167.17	08/17/1999 21:58	1517	2988	5017	94	42	7.4	5.6	6.2	15.3	11.2	4.2	747	652	581	14	10	1.69	33	32	2.0	134	11	5.6
		2168.17	08/17/1999 22:58	1504	2988	5011	100	42	7.4	5.0	5.8	15.3	11.2	4.2	743	647	576	14	10	1.71	33	32	2.0	139	11	5.6
		2169.17	08/17/1999 23:58	1490	2952	4982	103	43	7.4	5.3	5.1	15.3	11.2	4.2	743	648	577	14	10	1.71	33	32	0.7	128	11	5.6
		2170.17	08/18/1999 0:58	1478	2943	4925	99	42	7.4	5.0	5.7	15.3	11.2	4.2	751	654	584	14	10	1.72	33	32	1.9	130	11	5.6
		2172.17	08/18/1999 2:58	1460	2876	4841	96	42	7.4	5.1	5.5	15.2	11.0	4.2	752	655	584	14	10	1.73	32	32	2.0	126	11	5.6
		2174.17	08/18/1999 4:58	1434	2823	4762	93	41	7.4	5.1	5.5	15.2	11.2	4.2	753	657	585	14	10	1.73	32	31	0.7	121	11	5.6
		2175.17	08/18/1999 5:58	1421	2788	4714	92	42	7.4	5.1	5.5	15.5	11.0	4.2	756	660	587	14	11	1.68	32	31	2.0	127	11	5.6
		2176.16	08/18/1999 6:58	1421	2788	4714	92	40	7.4	5.1	5.5	15.2	11.2	4.2	758	662	589	14	11	1.73	32	31	0.4	131	11	5.6
		2181.73	08/18/1999 12:32	1452	2859	4765	92	45	7.3	5.1	6.3	15.3	11.2	4.2	756	660	587	14	11	1.71	33	32	1.2	116	11	5.6
		2182.73	08/18/1999 13:32	1471	2934	4880	103	42	7.4	4.7	5.9	15.3	11.2	4.2	745	647	576	14	10	1.74	33	32	2.0	125	11	5.6
		2184.73	08/18/1999 15:32	1512	3023	4940	102	128	7.3	5.1	6.2	15.3	11.2	4.2	747	651	581	14	10	1.72	34	33	0.7	121	11	5.6
		2185.73	08/18/1999 16:32	1558	3077	5135	109	64	7.3	5.1	5.5	15.3	11.2	4.2	749	655	584	14	10	1.69	33	33	1.0	111	11	5.6
		2186.73	08/18/1999 17:32	1574	3107	5219	111	51	7.3	5.4	5.3	15.3	11.2	4.2	752	656	585	14	10	1.71	34	33	2.0	114	11	5.6
		2188.73	08/18/1999 19:32	1555	3076	5157	106	44	7.4	5.2	5.5	15.3	11.2	4.2	753	659	587	14	10	1.69	34	33	1.7	124	11	5.6
		2189.73	08/18/1999 20:32	1544	3050	5117	103	43	7.4	5.3	5.8	15.3	11.2	4.2	752	657	586	14	10	1.69	34	33	0.5	123	11	5.6
		2190.73	08/18/1999 21:32	1534	3014	5009	76	39	7.4	6.9	7.4	15.3	11.2	4.2	767	671	600	14	10	1.71	33	33	0.8	126	11	5.6
		2191.73	08/18/1999 22:32	1517	3024	4936	75	28	7.4	7.0	7.5	15.3	11.2	4.2	756	660	591	14	10	1.71	33	32	1.1	135	11	5.6
		2192.73	08/18/1999 23:32	1501	3050	4797	72	23	7.5	7.0	7.5	15.3	11.0	4.2	758	665	599	14	10	1.67	33	32	1.5	134	11	5.6
		2193.73	08/19/1999 0:32	1491	3089	4686	68	22	7.5	7.0	7.6	15.5	11.0	4.2	768	675	610	13	9	1.63	33	32	2.0	133	11	5.6
		2194.73	08/19/1999 1:32	1480	3138	4575	65	22	7.5	7.0	7.6	15.3	11.0	4.2	775	684	622	13	9	1.64	33	32	1.7	134	11	5.6
		2195.73	08/19/1999 2:32	1467	3160	4439	62	21	7.5	7.0	7.6	15.3	10.8	4.2	779	691	631	13	9	1.58	33	32	2.0	151	10	5.6
		2197.73	08/19/1999 4:32	1435	3182	4210	58	21	7.5	7.0	7.6	15.0	10.8	4.4	782	696	639	13	8	1.58	32	32	2.0	131	10	5.6
		2198.73	08/19/1999 5:32	1424	3201	4129	56	20	7.5	7.0	7.6	15.0	10.6	4.4	785	700	644	12	8	1.56	32	32	0.9	134	10	5.6
		2202.80	08/19/1999 9:36	1423	3010	4706	85	73	7.5	5.6	6.2	15.3	11.2	4.4	757	664	599	13	9	1.65	32	31	1.1	118	11	5.6
		2203.80	08/19/1999 10:36	1406	2832	4755	97	68	7.4	5.4	6.1	15.3	10.6	1.0	707	613	546	14	10	1.69	33	32	0.3		10	5.6
		2204.80	08/19/1999 11:36	1408	2824	4726	99	50	7.4	5.4	5.9	15.3	11.0	2.7	706	613	546	13	10	1.67	33	32	1.5	134	11	5.6
		2205.80	08/19/1999 12:36	1422	2855	4788	101	44	7.4	5.3	5.9	15.3	11.2	4.0	712	618	551	14	10	1.67	33	32	0.4	209	11	5.6
		2207.80	08/19/1999 14:36	1471	2962	4968	107	45	7.4	5.2	5.8	15.3	11.2	4.2	715	622	554	13	10	1.67	34	33	0.3	114	11	5.6
		2211.80	08/19/1999 18:36	1523	3068	5064	86	35	7.4	6.9	7.5	15.3	11.0	4.0	720	627	559	13	10	1.65	34	33	0.3	108	11	5.6
		2212.80	08/19/1999 19:36	1523	3086	5024	86	30	7.4	6.9	7.5	15.3	11.0	4.0	719	626	559	13	10	1.65	34	33	0.3	110	11	5.6
		2214.80	08/19/1999 21:36	1512	3156	4845	80	25	7.5	7.0	7.5	15.4	11.2	4.2	733	643	580	13	9	1.59	34	33	0.3	110	11	5.6
		2215.80	08/19/1999 22:36	1501	3191	4711	76	24	7.5	7.0	7.6	15.3	11.2	4.2	746	656	595	13	9	1.60	33	33	0.3	112	11	5.6
		2216.80	08/19/1999 23:36	1484	3232	4567	71	23	7.5	7.0	7.6	15.3	11.0	4.2	757	668	610	13	9	1.58	33	32	0.3	119	11	5.6
		2217.80	08/20/1999 0:36	1471	3276	4435	68	24	7.5	7.0	7.6	15.3	10.9	4.2	769	682	625	13	8	1.56	33	32	0.3	124	10	5.6
		2220.80	08/20/1999 3:36	1429	3373	4131	59	22	7.5	7.0	7.6	15.3	10.8	4.4	792	709	654	12	8	1.49	33	32	0.3	135	10	5.6
		2222.80	08/20/1999 5:36	1409	3391	3977	57	22	7.5	7.0	7.6	15.0	10.6	4.4	795	714	661	12	8	1.49	33	32	0.3	137	10	5.6
		2223.80	08/20/1999 6:36	1408	3236	4589	88	27	7.5	5.6	6.3	15.3	10.8	4.4	768	680	623	13	8	1.56	33	32	0.3	147	10	5.6
		2224.75	08/20/1999 7:33	1411	3094	4540	63	34	7.5	7.0	7.4	15.3	11.0	4.4	776	688	626	13	9	1.58	32	32	0.3	131	11	5.6
		2225.75	08/20/1999 8:33	1411	3276	4378	62	27	7.5	7.0	7.6	15.0	10.6	4.4	790	707	650	12	8	1.52	32	32	0.3	125	10	5.6
		2230.47	08/20/1999 13:16	1450	3085	5069	98	50	7.4	5.4	6.0	15.4	11.4	4.0	738	648	587	13	9	1.59	33	32	0.2	140	11	5.6
		2230.75	08/20/1999 13:33	1454	3097	5091	99	50	7.4	5.4	6.0	15.3	11.2	4.0	736	645	585	13	9	1.62	33	32	0.2	118	11	5.6

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm$^{1.5}$) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
		2231.47	08/20/1999 14:16	1457	3090	5007	100	230	7.4	5.4	6.0	15.5	11.2	4.0	737	646	584	13	9	1.59	33	32	0.3	130	11	5.6
		2231.75	08/20/1999 14:33	1457	3098	5087	100	233	7.4	5.4	6.0	15.3	11.4	4.0	735	644	584	13	9	1.61	33	32	0.3	115	11	5.6
		2228.75	08/20/1999 11:33	1424	3023	4715	94	68	7.4	5.4	6.0	15.3	11.2	4.0	733	644	583	13	9	1.60	33	32	0.2	148	11	5.6
		2233.75	08/20/1999 16:33	1485	3165	5156	105	55	7.4	5.3	5.8	15.3	11.2	4.0	730	640	579	13	9	1.60	34	33	0.2	118	11	5.6
		2234.75	08/20/1999 17:33	1493	3191	5191	106	49	7.4	5.3	5.8	15.3	11.4	4.0	728	640	579	13	9	1.58	34	33	0.2	146	11	5.6
		2235.75	08/20/1999 18:33	1497	3196	5191	105	46	7.4	5.3	5.8	15.3	11.4	4.0	733	644	583	13	9	1.60	34	33	0.3	116	11	5.6
		2236.47	08/20/1999 19:16	1489	3183	5174	103	45	7.4	5.3	5.9	15.3	11.4	4.0	735	645	585	13	9	1.60	34	33	0.3	113	11	5.6
		2237.47	08/20/1999 20:16	1479	3156	5122	100	45	7.4	5.4	5.9	15.3	11.4	4.0	741	651	590	13	9	1.60	34	33	0.3	120	11	5.6
		2237.75	08/20/1999 20:33	1478	3157	5118	99	44	7.4	5.4	6.0	15.3	11.4	4.0	741	651	590	13	9	1.60	34	33	0.3	150	11	5.6
		2238.47	08/20/1999 21:16	1474	3147	5096	97	44	7.4	5.4	6.0	15.3	11.4	4.0	747	655	595	13	9	1.63	34	33	0.3	153	11	5.6
		2238.75	08/20/1999 21:33	1471	3143	5083	96	44	7.4	5.4	6.1	15.3	11.4	4.2	748	658	597	13	9	1.62	34	33	0.3	139	11	5.6
		2239.47	08/20/1999 22:16	1466	3139	5064	94	43	7.5	5.5	6.1	15.3	11.2	4.1	749	660	599	13	9	1.60	34	33	0.3	117	11	5.6
		2239.75	08/20/1999 22:33	1466	3139	5048	93	42	7.5	5.5	6.1	15.3	11.2	4.0	752	662	601	13	9	1.62	34	33	0.3	121	11	5.6
		2240.47	08/20/1999 23:16	1462	3125	5016	91	42	7.5	5.5	6.1	15.3	11.2	4.2	757	667	606	13	9	1.62	33	33	0.3	123	11	5.6
		2240.75	08/20/1999 23:33	1462	3121	4997	90	41	7.5	5.5	6.2	15.3	11.4	4.2	758	668	607	13	9	1.62	33	33	0.3	123	11	5.6
		2241.47	08/21/1999 0:16	1453	3112	4971	88	42	7.5	5.6	6.2	15.3	11.2	4.2	762	672	611	13	9	1.62	33	32	0.3	137	11	5.6
		2241.75	08/21/1999 0:33	1452	3107	4959	88	40	7.5	5.6	6.2	15.3	11.3	4.2	761	672	610	13	9	1.60	33	32	0.3	128	11	5.6
		2243.47	08/21/1999 2:16	1443	3081	4915	85	39	7.5	5.6	6.3	15.3	11.2	4.2	768	678	617	13	9	1.62	33	32	0.3	170	11	5.6
		2244.75	08/21/1999 3:33	1427	3054	4867	83	39	7.5	5.6	6.3	15.3	11.2	4.2	768	678	617	13	9	1.62	33	32	0.3	127	11	5.6
		2245.47	08/21/1999 4:16	1418	3027	4827	81	39	7.5	5.6	6.3	15.3	11.2	4.2	772	681	621	13	9	1.62	33	32	0.3	132	11	5.6
		2245.75	08/21/1999 4:33	1413	3014	4818	81	40	7.5	5.7	6.3	15.3	11.2	4.2	773	682	621	13	9	1.62	33	32	0.3	132	11	5.6
		2247.75	08/21/1999 6:33	1401	2996	4807	84	39	7.5	5.4	6.0	15.5	11.4	4.2	775	685	623	13	9	1.58	33	32	0.3	143	11	5.6
		2248.59	08/21/1999 7:23	1400	2992	4801	85	41	7.5	5.4	6.0	15.3	11.4	4.2	773	682	621	13	9	1.62	33	32	0.3		11	5.6
		2249.48	08/21/1999 8:16	1391	2983	4762	88	42	7.5	5.2	5.7	15.3	11.2	4.2	768	677	616	13	9	1.64	33	32	0.3	119	11	5.6
		2249.59	08/21/1999 8:23	1391	2979	4766	89	42	7.5	5.2	5.7	15.3	11.4	4.2	768	677	616	13	9	1.64	33	32	0.3	118	11	
		2250.47	08/21/1999 9:16	1384	2966	4740	89	43	7.5	5.2	5.7	15.3	11.4	4.2	767	677	616	13	9	1.62	33	32	0.3	124	11	
		2251.59	08/21/1999 10:23	1384	2956	4730	90	43	7.5	5.1	5.6	15.3	11.2	4.2	764	672	611	13	9	1.65	33	32	0.3	116	11	
		2252.47	08/21/1999 11:16	1386	2966	4739	91	44	7.5	5.1	5.6	15.3	11.2	4.2	763	673	612	13	9	1.62	33	32	0.2	115	11	
		2253.59	08/21/1999 12:23	1392	2980	4753	92	46	7.4	5.2	5.6	15.3	11.4	4.2	764	674	613	13	9	1.62	33	32	0.3	131	11	
		2255.59	08/21/1999 14:23	1412	3041	4840	96	45	7.4	5.1	5.5	15.3	11.4	4.2	756	666	605	13	9	1.60	34	33	0.3	125	11	
		2256.59	08/21/1999 15:23	1422	2997	4762	79	46	7.4	5.3	5.7	15.3	11.4	4.2	764	676	615	13	9	1.58	34	33	0.3	124	11	
		2257.59	08/21/1999 16:23	1438	3085	4933	103	46	7.4	5.0	5.3	15.3	11.4	4.2	752	662	601	13	9	1.62	33	33	0.3	127	11	
		2258.59	08/21/1999 17:23	1444	3095	4898	97	45	7.4	4.9	5.8	15.3	11.4	4.2	762	671	610	13	9	1.64	33	33	0.3	126	11	
		2260.59	08/21/1999 19:23	1439	3120	4905	97	36	7.4	5.1	5.8	15.5	11.4	4.0	753	664	603	13	9	1.57	33	32	0.2	124	11	
		2261.59	08/21/1999 20:23	1435	3082	4926	99	42	7.4	5.2	5.4	15.3	11.2	4.0	752	661	601	13	9	1.64	33	32	0.3	126	11	
		2263.59	08/21/1999 22:23	1419	3046	4864	92	42	7.4	5.2	5.6	15.3	11.2	4.2	761	670	610	13	9	1.63	33	32	0.3	135	11	
		2264.59	08/21/1999 23:23	1408	3019	4819	89	43	7.4	5.3	5.7	15.3	11.2	4.2	766	671	611	14	9	1.69	33	32	0.2	124	11	
		2266.59	08/22/1999 1:23	1392	3005	4744	82	40	7.4	5.4	6.0	15.3	11.4	4.2	771	681	620	13	9	1.62	33	32	0.2	132	11	
		2270.59	08/22/1999 5:23	1374	2983	4656	79	39	7.5	5.5	6.1	15.3	11.2	4.2	779	689	628	13	9	1.62	33	32	0.3	131	11	
		2271.59	08/22/1999 6:23	1385	3005	4682	80	40	7.5	5.5	6.1	15.3	11.2	4.2	780	690	630	13	9	1.62	33	32	0.2	128	11	
		2298.67	08/23/1999 9:28	1326	2708	4463	79	38	7.4	5.3	5.5	14.8	11.0	4.2	790	697	629	14	10	1.75	30	29	0.2	117	11	5.6
		2304.52	08/23/1999 15:19	1235	2679	4366	107	49	7.2	3.1	6.4	15.3	11.6	4.0	721	623	560	14	9	1.74	31	31	0.2	118	11	5.6
		2298.68	08/23/1999 9:29	1326	2708	4457	79	39	7.4	5.2	5.5	14.8	11.0	4.2	790	697	630	14	10	1.75	30	29	0.2	117	11	5.6
		2297.87	08/23/1999 8:40	1344	2761	4533	81	39	7.4	5.1	5.6	15.0	11.0	4.2	792	698	631	14	10	1.72	30	29	0.2	119	11	5.6
		2299.67	08/23/1999 10:28	1305	2731	4440	84	84	7.4	4.7	5.8	15.3	11.2	1.7	782	687	621	14	10	1.69	30	29	0.2	134	11	5.6
		2300.68	08/23/1999 11:29	1277	2703	4399	85	62	7.4	3.7	5.9	15.3	11.4	4.0	774	675	610	14	9	1.78	30	30	0.2	131	11	5.6
		2301.67	08/23/1999 12:28	1248	2544	4210	58	51	7.3	5.9	7.0	15.0	11.2	4.0	785	691	624	14	10	1.72	31	30	0.2	120	11	5.6
		2302.68	08/23/1999 13:29	1233	2486	4246	64	42	7.2	6.6	6.2	15.3	11.2	4.2	776	681	611	14	10	1.70	31	30	0.2	117	11	5.6
		2303.68	08/23/1999 14:29	1229	2451	4189	78	46	7.2	6.4	3.8	15.3	11.2	3.8	756	662	592	14	10	1.69	31	30	0.2	125	11	5.6
		2321.42	08/24/1999 8:13	1229	2482	4334	75	36	7.4	5.3	6.0	15.3	11.4	4.2	774	676	606	14	10	1.76	31	30	0.2	127	11	5.6
		2322.42	08/24/1999 9:13	1212	2420	4215	56	46	7.4	6.9	7.5	15.3	11.4	4.0	779	682	611	14	10	1.74	31	30	0.2	142	11	5.6
		2323.42	08/24/1999 10:13	1200	2411	4167	57	37	7.4	6.9	7.5	15.3	11.4	4.0	762	666	599	14	10	1.72	31	30	0.2	139	11	5.6
		2324.42	08/24/1999 11:13	1198	2447	4105	57	31	7.4	6.9	7.5	15.3	11.2	3.8	761	666	600	14	10	1.69	31	31	0.2	145	11	5.6
		2325.42	08/24/1999 12:13	1215	2540	4110	60	23	7.3	6.9	7.5	15.3	11.2	4.0	769	676	613	13	9	1.67	32	31	0.2	151	11	5.6
		2326.42	08/24/1999 13:13	1232	2638	4070	61	23	7.3	6.8	7.4	15.3	11.4	4.0	772	680	621	13	9	1.64	32	31	0.2	162	11	5.6
		2327.42	08/24/1999 14:13	1263	2513	4233	101	30	7.3	5.5	4.2	15.3	11.0	4.0	701	607	537	14	10	1.68	32	31	0.2	179	11	5.6
		2328.42	08/24/1999 15:13	1294	2584	4360	94	194	7.3	5.1	5.6	15.3	11.2	4.2	713	617	547	14	10	1.71	32	32	0.2	153	11	5.6
		2329.42	08/24/1999 16:13	1319	2624	4430	95	64	7.3	5.2	5.7	15.3	11.2	4.2	716	618	548	14	10	1.73	33	32	0.2	146	11	5.6
		2330.42	08/24/1999 17:13	1332	2651	4475	94	50	7.3	5.3	5.7	15.3	11.2	4.2	716	620	549	14	10	1.71	33	32	0.2	150	11	5.6
		2331.42	08/24/1999 18:13	1346	2682	4514	93	44	7.3	5.3	5.9	15.3	11.4	4.2	720	624	553	14	10	1.70	33	32	0.2	173	11	5.6
		2332.42	08/24/1999 19:13	1352	2691	4527	91	41	7.4	5.5	6.1	15.3	11.2	4.2	721	625	554	14	10	1.71	33	32	0.2	162	11	5.6
		2333.42	08/24/1999 20:13	1362	2708	4541	89	39	7.4	5.5	6.2	15.3	11.2	4.2	725	628	557	14	10	1.72	33	32	0.2	173	11	5.6
		2334.42	08/24/1999 21:13	1370	2722	4559	87	38	7.4	5.6	6.2	15.3	11.2	4.2	727	630	560	14	10	1.73	33	32	0.2	173	11	5.6
		2335.42	08/24/1999 22:13	1378	2735	4585	85	38	7.4	5.7	6.4	15.3	11.2	4.2	732	634	564	14	10	1.76	32	32	0.2	164	11	5.6
		2336.42	08/24/1999 23:13	1384	2744	4589	84	37	7.5	5.7	6.4	15.3	11.2	4.2	735	638	567	14	10	1.72	32	32	0.2	162	11	5.6
		2337.42	08/25/1999 0:13	1383	2744	4585	81	37	7.5	5.8	6.5	15.3	11.2	4.2	737	640	569	14	10	1.73	32	32	0.2	157	11	5.6
		2338.42	08/25/1999 1:13	1380	2731	4578	80	35	7.5	5.8	6.5	15.3	11.1	4.2	738	641	569	14	10	1.74	32	31	0.2	150	11	5.6
		2339.42	08/25/1999 2:13	1374	2721	4559	78	34	7.5	5.9	6.6	15.5	11.2	4.2	740	643	570	14	11	1.69	32	31	0.2	150	11	5.6
		2340.42	08/25/1999 3:13	1364	2699	4532	77	35	7.5	5.9	6.6	15.3	11.2	4.2	738	642	570	14	10	1.72	32	31	0.2	148	11	5.6
		2341.42	08/25/1999 4:13	1353	2677	4492	77	35	7.5	5.9	6.6	15.3	11.2	4.2	738	641	569	14	10	1.74	32	31	0.2	152	11	5.6
		2342.42	08/25/1999 5:13	1344	2655	4462	76	35	7.5	5.9	6.6	15.3	11.0	4.2	736	638	567	14	10	1.74	32	31	0.2	137	11	5.6
		2343.42	08/25/1999 6:13	1345	2659	4462	76	35	7.5	5.9	6.6	15.3	11.2	4.2	737	641	569	14	11	1.72	32	31	0.2	141	11	5.6
		2344.42	08/25/1999 7:13	1348	2663	4472	76	35	7.5	5.9	6.6	15.5	11.2	4.2	738	642	568	14	11	1.69	32	31	0.2	143	11	5.6
		2344.73	08/25/1999 7:32	1348	2655	4476	76	35	7.5	5.9	6.6	15.3	11.2	4.2	741	644	572	14	11	1.73	32	31	0.2	136	11	5.6
		2345.73	08/25/1999 8:32	1340	2686	4501	76	36	7.5	5.9	6.8	15.3	11.2	4.2	728	631	559	14	10	1.73	32	31	0.2	151	11	5.6
		2346.73	08/25/1999 9:32	1339	2673	4498	81	36	7.5	5.8	6.5	15.3	11.2	4.2	722	627	556	14	10	1.70	32	31	0.2	111	11	5.6
		2347.73	08/25/1999 10:32	1339	2668	4497	83	58	7.6	5.7	6.4	15.3	11.2	4.2	721	625	554	14	10	1.72	32	31	0.2	111	11	5.6
		2348.73	08/25/1999 11:32	1353	2708	4546	92	48	7.5	5.4	5.9	15.3	11.2	4.2	713	618	548	14	10	1.69	32	31	0.2	110	11	5.6
		2349.73	08/25/1999 12:32	1371	2739	4607	100	72	7.5	5.1	5.6	15.5	11.2	4.2	709	613	543	14	10	1.67	32	32	0.2	112	11	5.6
		2350.73	08/25/1999 13:32	1382	2762	4665	104	62	7.4	5.0	5.3	15.3	11.2	4.2	709	612	543	14	10	1.72	33	32	0.2	110	11	5.6
		2351.73	08/25/1999 14:32	1391	2779	4665	98	71	7.4	5.2	5.8	15.3	11.2	4.2	714	618	548	14	10	1.70	33	32	0.2	113	11	5.6
		2352.73	08/25/1999 15:32	1406	2806	4739	106	58	7.4	5.2	5.2	15.3	11.2	4.2	715	619	549	14	10	1.70	33	32	0.2	111	11	5.6
		2353.73	08/25/1999 16:32	1399	2793	4691	102	49	7.4	5.2	5.5	15.3	11.2	4.2	716	621	551	14	10	1.70	33	32	0.2	122	11	5.6
		2354.73	08/25/1999 17:32	1396	2779	4674	99	44	7.4	5.2	5.7	15.3	11.2	4.2	720	624	554	14	10	1.70	33	32	0.2	111	11	5.6
		2355.73	08/25/1999 18:32	1404	2792	4682	97	44	7.4	5.3	5.9	15.3	11.2	4.2	724	627	557	14	10	1.72	33	32	0.2	129	11	5.6
		2356.73	08/25/1999 19:32	1418	2820	4713	96	43	7.4	5.4	6.0	15.5	11.2	4.2	726	630	559	14	10	1.69	33	32	0.2	123	11	5.6
		2357.73	08/25/1999 20:32	1456	2885	4810	96	42	7.5	5.5	6.1	15.3	11.0	4.2	730	634	563	14	10	1.71	33	32	0.2	125	11	5.6
		2358.73	08/25/1999 21:32	1585	3129	5184	102	40	7.5	5.5	6.1	15.3	11.0	4.2	740	643	573	14	10	1.72	33	32	0.2	129	11	5.6
		2359.73	08/25/1999 22:32	1710	3388	5550	108	42	7.5	5.6	6.1	15.3	11.2	4.4	752	657	585	14	10	1.71	33	32	0.2	130	11	5.6
		2360.73	08/25/1999 23:32	1804	3583	5844	113	42	7.5	5.6	6.2	15.5	11.2	4.4	761	665	594	14	10	1.67	32	32	0.2	130	11	5.6
		2361.73	08/26/1999 0:32	1826	3618	5911	113	42	7.5	5.6	6.2	15.3	11.2	4.4	763	669	596	14	11	1.67	32	32	0.2	128	11	5.6
		2362.73	08/26/1999 1:32	1812	3592	5875	109	41	7.5	5.7	6.3	15.4	11.0	4.4	763	669	596	14	11	1.66	32	32	0.2	219	11	5.6
		2363.73	08/26/1999 2:32	1760	3489	5721	104	42	7.5	5.7	6.4	15.5	11.0	4.4	763	668	596	14	10	1.67	32	32	0.2	208	11	5.6
		2364.73	08/26/1999 3:32	1704	3374	5550	100	41	7.5	5.7	6.4	15.3	11.0	4.4	761	665	594	14	10	1.72	32	32	0.2	140	11	5.6
		2365.73	08/26/1999 4:32	1639	3245	5356	97	41	7.5	5.7	6.4	15.3	11.1	4.4	756	660	587	14	11	1.71	32	31	0.2	142	11	5.6
		2366.73	08/26/1999 5:32	1584	3130	5189	93	40	7.5	5.7	6.4	15.3	11.2	4.4	753	658	585	14	11	1.71	32	31	0.2	148	11	5.6
		2367.73	08/26/1999 6:32	1550	3063	5079	91	38	7.5	5.7	6.4	15.5	11.2	4.4	751	653	581	14	10	1.71	32	31	0.2	151	11	5.6
		2368.99	08/26/1999 7:48	1517	2992	4987	89	39	7.5	5.7	6.4	15.3	11.2	4.4	753	657	584	14	11	1.72	32	31	0.2	137	11	5.6
		2369.99	08/26/1999 8:48	1486	2926	4881	89	61	7.5	5.7	6.3	15.3	11.2	4.2	747	651	579	14	11	1.71	32	31	0.2	129	11	5.6
		2370.99	08/26/1999 9:48	1462	2876	4797	89	58	7.5	5.7	6.3	15.3	11.2	4.2	742	646	574	14	10	1.72	32	32	0.2	130	11	5.6
		2371.99	08/26/1999 10:48	1445	2850	4757	89	46	7.5	5.6	6.2	15.3	11.2	4.2	740	644	573	14	10	1.71	32	32	0.2	130	11	5.6
		2372.99	08/26/1999 11:48	1436	2828	4731	91	41	7.5	5.5	6.2	15.3	11.2	4.2	737	641	569	14	10	1.71	33	32	0.2	131	11	5.6
		2373.99	08/26/1999 12:48	1440	2833	4744	94	41	7.4	5.5	6.1	15.3	11.2	4.2	736	640	569	14	10	1.71	33	32	0.2	127	11	5.6
		2374.99	08/26/1999 13:48	1442	2837	4758	96	41	7.4	5.4	6.0	15.3	11.2	4.2	732	636	565	14	10	1.71	33	32	0.2	129	11	5.6
		2375.99	08/26/1999 14:48	1469	2895	4819	99	41	7.4	5.4	6.0	15.3	11.2	4.2	728	633	563	14	10	1.71	33	32	0.2	131	11	5.6
		2376.99	08/26/1999 15:48	1529	2997	4920	102	76	7.4	5.5	6.0	15.3	11.2	4.4	725	630	559	14	10	1.68	33	33	0.2	129	11	5.6
		2392.75	08/27/1999 7:33	1392	2699	4440	76	36	7.5	5.8	6.5	15.3	11.2	4.4	752	656	583	14	11	1.72	32	31	0.2	133	11	5.6
		2397.75	08/27/1999 12:33	1379	2677	4418	82	39	7.5	5.6	6.3	15.3	11.2	4.4	736	641	569	14	11	1.69	33	32	0.2	134	11	5.6
		2399.75	08/27/1999 14:33	1398	2718	4457	85	67	7.4	5.6	6.2	15.3	11.2	4.4	731	637	564	14	11	1.69	33	32	0.2	151	11	5.6
		2400.75	08/27/1999 15:33	1411	2748	4497	86	52	7.4	5.6	6.2	15.3	11.2	4.4	731	636	565	14	10	1.69	34	33	0.2	134	11	5.6

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Conductivity Interstage	Conductivity Conc	Conductivity Tot Perm	Conductivity Samplvalve	pH Raw Feed	pH RO Feed	pH Concentrate	Flow (Lpm) Feed	Flow Tot Perm	Flow Conc	Pressure (kPa) Feed	Pressure Interstage	Pressure Conc	Pressure Drop (psi) Stage 1	Pressure Drop Stage 2	PDC (psi/gpm^1.5) Stage 1	Temperature RO Feed	Temperature Raw	Turbidity	Particle Index	Flux	Target pH
		2401.75	08/27/1999 16:33	1411	2753	4514	87	46	7.4	5.6	6.2	15.3	11.2	4.4	727	632	561	14	10	1.69	34	33	0.2	134	11	5.6
		2402.75	08/27/1999 17:33	1428	2793	4575	86	42	7.4	5.7	6.3	15.3	11.2	4.4	731	636	565	14	10	1.69	34	33	0.2	133	11	5.6
		2403.75	08/27/1999 18:33	1440	2806	4578	85	41	7.4	5.8	6.4	15.3	11.0	4.4	730	636	566	14	10	1.67	34	33	0.2	130	11	5.6
		2405.75	08/27/1999 20:33	1457	2833	4590	82	38	7.5	5.8	6.5	15.3	11.0	4.4	741	646	575	14	10	1.69	34	33	0.2	132	11	5.6
		2406.75	08/27/1999 21:33	1453	2819	4572	80	39	7.5	5.9	6.5	15.3	11.2	4.4	746	651	580	14	10	1.69	33	33	0.2	130	11	5.6
		2408.75	08/27/1999 23:33	1440	2783	4519	78	38	7.5	5.9	6.6	15.3	11.0	4.4	753	659	586	14	11	1.69	33	32	0.2	134	11	5.6
		2409.75	08/28/1999 0:33	1434	2770	4492	76	37	7.5	5.9	6.6	15.3	11.0	4.4	756	661	589	14	11	1.69	33	32	0.2	130	11	5.6
		2410.75	08/28/1999 1:33	1434	2779	4483	76	36	7.5	5.9	6.6	15.3	11.0	4.6	758	664	591	14	11	1.69	32	32	0.2	128	11	5.6
		2411.75	08/28/1999 2:33	1448	2788	4501	76	37	7.5	5.9	6.6	15.3	11.0	4.4	762	667	595	14	11	1.71	32	32	0.2	133	11	5.6
		2413.75	08/28/1999 4:33	1457	2809	4518	76	37	7.5	5.9	6.6	15.4	11.0	4.6	767	670	597	14	11	1.70	32	32	0.2	135	11	5.6
		2415.75	08/28/1999 6:33	1445	2790	4488	75	36	7.6	5.9	6.6	15.3	11.0	4.6	768	672	599	14	11	1.71	32	31	0.2	124	11	5.6
		2439.57	08/29/1999 6:22	1401	2706	4296	71	35	7.5	5.9	6.7	15.3	11.0	4.6	780	687	613	14	11	1.67	32	32	0.2	121	11	5.6
		2421.57	08/28/1999 12:22	1402	2712	4378	75	37	7.5	5.9	6.6	15.3	11.0	4.4	756	661	588	14	11	1.69	33	32	0.2	124	11	5.6
		2422.57	08/28/1999 13:22	1418	2744	4427	76	36	7.5	5.9	6.6	15.3	11.0	4.4	758	663	590	14	11	1.69	33	32	0.2	122	11	5.6
		2425.57	08/28/1999 16:22	1459	2846	4562	80	37	7.5	5.9	6.6	15.3	11.2	4.4	749	657	585	13	11	1.65	34	33	0.2	130	11	5.6
		2426.57	08/28/1999 17:22	1473	2873	4606	80	39	7.5	5.9	6.6	15.3	11.2	4.4	752	658	586	14	10	1.67	34	33	0.2	134	11	5.6
		2427.57	08/28/1999 18:22	1480	2890	4624	80	38	7.5	5.9	6.6	15.3	11.2	4.4	752	659	586	13	11	1.65	34	33	0.2	132	11	5.6
		2428.57	08/28/1999 19:22	1478	2882	4611	80	39	7.5	5.9	6.6	15.3	11.0	4.4	753	660	589	14	10	1.67	34	33	0.2	135	11	5.6
		2429.57	08/28/1999 20:22	1483	2882	4594	80	39	7.5	5.9	6.6	15.3	11.0	4.4	757	664	592	13	10	1.67	34	33	0.2	135	11	5.6
		2430.57	08/28/1999 21:22	1478	2868	4562	78	37	7.5	5.9	6.6	15.3	11.0	4.6	762	668	596	14	10	1.67	33	33	0.2	128	11	5.6
		2432.57	08/28/1999 23:22	1469	2846	4537	76	38	7.5	5.9	6.6	15.3	11.0	4.6	768	674	601	14	11	1.69	33	32	0.2	129	11	5.6
		2433.57	08/29/1999 0:22	1462	2854	4545	76	37	7.5	5.9	6.6	15.3	11.0	4.6	771	678	606	13	11	1.66	33	32	0.2	127	11	5.6
		2435.57	08/29/1999 2:22	1441	2801	4444	74	37	7.5	5.9	6.7	15.3	11.0	4.6	777	683	610	14	11	1.69	33	32	0.2	136	11	5.6
		2437.57	08/29/1999 4:22	1424	2761	4373	72	35	7.5	5.9	6.6	15.3	11.0	4.6	780	685	612	14	11	1.71	32	32	0.2	124	11	5.6
		2440.56	08/29/1999 7:21	1401	2712	4297	70	36	7.5	6.0	6.7	15.3	11.0	4.6	783	688	614	14	11	1.69	32	31	0.2	120	11	5.6
		2440.57	08/29/1999 7:22	1399	2712	4294	70	36	7.5	5.9	6.7	15.3	10.8	4.6	783	689	616	14	11	1.69	32	31	0.2	122	10	
		2441.56	08/29/1999 8:21	1389	2694	4259	70	35	7.5	5.9	6.7	15.3	11.0	4.6	783	689	615	14	11	1.69	32	31	0.2	122	11	
		2441.57	08/29/1999 8:22	1389	2695	4263	70	35	7.5	6.0	6.7	15.3	11.0	4.6	784	689	615	14	11	1.69	32	31	0.2	121	11	
		2442.56	08/29/1999 9:21	1379	2663	4211	70	36	7.6	5.9	6.7	15.3	10.8	4.6	777	684	611	14	11	1.67	32	31	0.2	123	10	
		2443.56	08/29/1999 10:21	1363	2673	4254	80	35	7.5	5.5	6.1	15.3	11.0	4.6	763	670	599	13	10	1.67	33	32	0.2	123	11	
		2444.56	08/29/1999 11:21	1363	2642	4127	63	41	7.5	5.4	7.2	15.5	11.0	4.6	777	683	610	14	11	1.64	33	32	0.2	127	11	
		2445.56	08/29/1999 12:21	1354	2686	4237	85	43	7.4	5.2	5.9	15.3	11.0	4.4	751	657	586	14	10	1.67	33	32	0.2	123	11	
		2446.56	08/29/1999 13:21	1367	2726	4296	87	43	7.4	5.1	5.8	15.3	11.2	4.4	751	657	586	14	10	1.67	33	33	0.2	122	11	
		2447.56	08/29/1999 14:21	1381	2775	4364	92	41	7.4	5.1	5.4	15.3	11.2	4.4	745	651	581	14	10	1.67	34	33	0.2	129	11	
		2448.56	08/29/1999 15:21	1394	2792	4395	91	45	7.4	5.1	5.5	15.3	11.2	4.4	747	655	585	13	10	1.65	34	33	0.2	127	11	
		2449.56	08/29/1999 16:21	1395	2713	4096	61	33	7.4	6.9	7.5	15.3	11.0	4.4	778	688	618	13	10	1.61	34	33	0.2	135	11	
		2450.56	08/29/1999 17:21	1395	2748	4033	62	26	7.4	6.9	7.5	15.3	11.0	4.2	783	693	625	13	10	1.60	34	33	0.2	143	11	
		2451.56	08/29/1999 18:21	1395	2783	3967	61	25	7.4	7.0	7.5	15.3	11.0	4.4	783	697	631	13	10	1.55	34	33	0.2	142	11	
		2453.56	08/29/1999 20:21	1393	2824	3822	60	25	7.5	7.0	7.5	14.8	10.4	4.4	789	706	644	12	9	1.55	34	33	0.2	150	10	
		2454.56	08/29/1999 21:21	1402	2855	3765	60	23	7.5	7.0	7.5	14.6	10.2	4.4	790	709	648	12	9	1.55	34	33	0.2	142	10	
		2457.56	08/30/1999 0:21	1400	2885	3642	58	24	7.5	7.0	7.5	14.4	9.8	4.6	799	723	663	11	9	1.49	33	32	0.2	134	9	
		2458.56	08/30/1999 1:21	1398	2885	3607	58	24	7.5	7.0	7.5	14.2	9.6	4.6	800	725	666	11	9	1.50	33	32	0.2	134	9	
		2459.56	08/30/1999 2:21	1400	2902	3585	57	23	7.5	7.0	7.6	14.2	9.6	4.8	802	726	668	11	8	1.52	33	32	0.2	131	9	
		2460.56	08/30/1999 3:21	1398	2898	3568	57	23	7.5	7.0	7.6	14.2	9.6	4.8	801	727	668	11	9	1.48	33	32	0.2	137	9	
		2461.56	08/30/1999 4:21	1394	2898	3550	58	24	7.5	7.0	7.6	14.2	9.3	4.8	803	728	669	11	9	1.49	33	32	0.2	130	9	
		2462.56	08/30/1999 5:21	1389	2889	3532	57	24	7.5	7.0	7.6	14.2	9.3	4.8	803	729	671	11	8	1.48	33	32	0.2	128	9	
		2463.56	08/30/1999 6:21	1395	2894	3532	57	24	7.5	7.0	7.6	14.0	9.3	4.8	803	728	670	11	8	1.52	32	32	0.2	139	9	
10	RO down due to raising Zenon full tank soak	2464.77	08/30/1999 7:34	1412	2920	3555	58	24	7.5	7.0	7.7	14.0	9.3	4.8	802	729	671	11	8	1.49	32	32	0.2	130	9	
		2518.34	09/01/1999 13:08	1590	3100	5843	141	95	6.9	4.8	5.5	15.3	11.2	4.0	918	809	741	16	10	1.95	33	32	0.3	126	11	5.6
		2520.34	09/01/1999 15:08	1602	3383	5755	205	64	6.9	3.0	2.5	15.0	10.8	4.2	881	810	738	10	10	1.30	34	33	0.4	110	10	5.6
		2522.34	09/01/1999 17:08	1596	3195	5257	146	50	7.1	3.3	2.9	13.4	9.1	4.0	803	719	656	12	9	1.82	34	33	0.5	120	9	5.6
		2525.34	09/01/1999 20:08	1547	2898	4897	97	27	7.4	6.9	7.3	13.8	9.8	4.0	798	711	648	13	9	1.81	34	33	0.3	120	9	5.6
		2526.34	09/01/1999 21:08	1535	2902	4927	113	39	7.4	5.5	5.8	14.0	9.9	4.0	798	710	646	13	9	1.78	34	33	0.3	116	10	5.6
		2527.34	09/01/1999 22:08	1525	2885	4871	106	36	7.5	5.6	6.1	13.8	9.8	4.0	798	710	646	13	9	1.82	33	33	0.3	121	9	5.6
		2529.34	09/02/1999 0:08	1502	2837	4797	95	34	7.6	5.9	6.4	13.8	9.8	4.2	799	712	648	13	9	1.82	33	32	0.3	115	9	5.6
		2530.34	09/02/1999 1:08	1494	2811	4762	90	33	7.6	6.0	6.6	13.8	9.6	4.2	799	713	649	13	9	1.80	33	32	0.3	121	9	5.6
		2531.34	09/02/1999 2:08	1482	2796	4722	86	30	7.7	6.1	6.6	13.8	9.8	4.2	801	715	651	13	9	1.80	33	32	0.3	114	9	5.6
		2532.34	09/02/1999 3:08	1468	2763	4682	85	31	7.7	6.1	6.6	13.8	9.6	4.2	803	715	651	13	9	1.82	33	32	0.3	121	9	5.6
		2533.34	09/02/1999 4:08	1452	2731	4631	84	30	7.7	6.1	6.6	13.8	9.6	4.2	800	714	650	13	9	1.80	33	32	0.3	114	9	5.6
		2534.34	09/02/1999 5:08	1434	2699	4576	83	30	7.7	6.0	6.6	13.8	9.6	4.2	803	715	651	13	9	1.82	32	32	0.3	119	9	5.6
		2535.34	09/02/1999 6:08	1429	2677	4546	83	31	7.7	6.0	6.5	13.8	9.6	4.2	800	713	649	13	9	1.82	32	32	0.3	114	9	5.6
		2536.34	09/02/1999 7:08	1429	2690	4546	84	31	7.6	6.0	6.6	13.8	9.6	4.2	803	715	650	13	9	1.82	32	31	0.3	118	9	5.6
		2537.34	09/02/1999 8:09	1434	2696	4568	85	32	7.6	6.0	6.5	13.8	9.6	4.2	803	716	652	13	9	1.82	32	31	0.3	118	9	
		2538.34	09/02/1999 9:08	1430	2613	4282	82	31	7.7	6.0	6.5	14.2	9.8	4.6	795	703	632	13	10	1.84	32	32	0.3	114	9	
		2540.34	09/02/1999 11:08	1421	3382	7729	104	39	7.7	6.1	6.8	15.9	13.3	2.5	953	861	820	13	6	1.56	33	32	0.3	114	13	
		2541.79	09/02/1999 12:35	1420	3388	7765	106	33	7.5	6.0	6.7	16.1	13.5	2.5	958	864	822	14	6	1.56	33	32	0.3	114	13	
		2542.79	09/02/1999 13:35	1436	2269	2876	76	34	7.5	6.0	6.3	16.9	8.9	9.0	609	474	315	20	23	2.07	33	32	0.3	112	9	
11	6th Cleaning (Citric Acid Stage 1on 9/3 and Stage 2 on 9/4)	2543.79	09/02/1999 14:35	1452	2309	2947	78	33	7.5	6.0	6.3	17.1	8.9	8.8	609	476	320	19	23	2.01	33	33	0.3	117	9	
	Acid Pump Failure on 9/5; Restart on 9/8 at 2 PM	2682.17	09/08/1999 8:58	1438	3185	4189	99	101	7.6	5.7	6.6	14.2	11.4	1.9	782	698	654	12	6	1.67	31	31	0.2		11	5.6
		2707.10	09/09/1999 9:54	1451	3000	5040	99	72	7.6	5.0	5.2	15.3	11.2	4.0	738	643	581	14	9	1.71	32	32	0.2	160	11	5.6
		2708.10	09/09/1999 10:54	1472	3029	5137	111	64	7.6	4.7	4.8	15.4	11.4	4.0	736	640	577	14	9	1.68	32	32	0.2	230	11	5.6
		2709.10	09/09/1999 11:54	1489	3073	5209	122	56	7.6	4.1	3.6	15.3	11.2	3.8	733	638	575	14	9	1.71	33	32	0.2	124	11	5.6
		2710.10	09/09/1999 12:54	1499	3153	5322	121	54	7.6	3.6	3.1	15.3	11.2	3.8	752	656	591	14	9	1.71	33	32	0.2	121	11	5.6
		2711.10	09/09/1999 13:54	1519	3220	5419	121	50	7.5	3.3	2.9	15.3	11.4	4.0	770	674	608	14	10	1.72	33	32	0.2	120	11	5.6
		2712.10	09/09/1999 14:54	1537	3007	5084	120	61	7.5	4.9	3.5	15.3	11.2	4.2	740	643	575	14	10	1.72	33	32	0.2	132	11	5.6
		2713.10	09/09/1999 15:54	1545	3056	5129	108	49	7.5	5.1	5.4	15.3	11.2	4.2	743	645	576	14	10	1.75	33	33	0.2	156	11	5.6
		2714.10	09/09/1999 16:54	1548	3064	5150	107	47	7.5	5.1	5.5	15.3	11.2	4.2	745	647	579	14	10	1.74	33	33	0.2	126	11	5.6
		2715.10	09/09/1999 17:54	1559	3082	5167	106	44	7.5	5.1	5.6	15.3	11.2	4.2	745	647	578	14	10	1.74	33	33	0.2	252	11	5.6
		2716.10	09/09/1999 18:54	1573	3095	5165	85	44	7.5	6.8	7.2	15.3	11.2	4.2	752	655	586	14	10	1.72	33	33	0.2	130	11	5.6
		2717.10	09/09/1999 19:54	1581	3149	5157	86	32	7.6	6.9	7.2	15.3	11.4	4.2	746	647	581	14	10	1.76	33	32	0.2	124	11	5.6
		2718.10	09/09/1999 20:54	1584	3253	4944	82	28	7.6	6.9	7.2	15.5	11.2	4.2	758	665	602	13	9	1.63	33	32	0.2	132	11	5.6
		2719.10	09/09/1999 21:54	1580	3371	4710	76	27	7.6	6.9	7.3	15.3	11.2	4.2	778	687	627	13	9	1.63	33	32	0.2	146	11	5.6
		2720.10	09/09/1999 22:54	1574	3486	4450	70	24	7.6	6.9	7.3	15.0	10.8	4.4	788	699	644	13	8	1.62	33	32	0.2	137	10	5.6
		2721.10	09/09/1999 23:54	1563	3601	4234	65	25	7.6	6.9	7.3	14.8	10.4	4.4	792	708	655	12	8	1.56	33	32	0.2	129	10	5.6
		2722.10	09/10/1999 0:54	1552	3687	4067	61	23	7.6	6.9	7.3	14.6	10.2	4.4	794	714	662	12	7	1.53	32	32	0.2	130	10	5.6
		2723.10	09/10/1999 1:54	1547	3744	3970	60	24	7.6	6.9	7.3	14.4	10.0	4.4	799	720	669	11	7	1.53	32	32	0.2	127	10	5.6
		2724.10	09/10/1999 2:54	1541	3770	3899	60	23	7.6	6.9	7.3	14.2	9.8	4.6	800	723	672	11	7	1.54	32	31	0.2	128	9	5.6
		2725.10	09/10/1999 3:54	1530	3770	3838	59	23	7.6	6.9	7.3	14.2	9.8	4.4	801	725	674	11	7	1.52	32	31	0.2	126	9	5.6
		2726.10	09/10/1999 4:54	1519	3255	4956	87	30	7.6	5.6	6.3	15.3	11.0	4.4	772	676	614	14	9	1.72	32	31	0.2	129	11	5.6
		2727.10	09/10/1999 5:54	1509	3139	4969	87	35	7.6	5.6	6.2	15.3	11.0	4.4	762	667	601	14	10	1.69	32	31	0.2	140	11	5.6
		2728.10	09/10/1999 6:54	1511	3120	4987	86	37	7.6	5.6	6.1	15.2	11.0	4.2	761	666	600	14	10	1.69	32	31	0.2	121	11	5.6
		2728.72	09/10/1999 7:31	1510	3115	4992	85	36	7.6	5.6	6.2	15.3	11.0	4.4	764	668	601	14	10	1.71	32	31	0.2	117	11	5.6
		2729.72	09/10/1999 8:31	1511	3136	5032	92	207	7.7	5.3	5.9	15.3	11.0	4.2	751	657	591	14	10	1.67	32	31	0.2	119	11	
		2730.72	09/10/1999 9:31	1508	3130	5010	93	63	7.7	5.3	5.8	15.3	11.0	4.2	745	650	584	14	10	1.69	32	31	0.2	117	11	
		2732.16	09/10/1999 10:58	1503	2992	5048	110	40	7.4	5.0	5.3	15.5	11.2	4.2	731	635	565	14	10	1.68	33	32	2.0	109	11	5.6
		2733.17	09/10/1999 11:58	1523	3069	5142	98	56	7.6	5.6	6.3	15.3	11.2	4.2	726	630	565	14	10	1.71	33	32	0.2	146	11	5.6
		2734.16	09/10/1999 12:58	1534	3100	5173	103	44	7.6	5.5	6.1	15.3	11.0	4.0	716	622	558	14	9	1.67	33	32	0.2	124	11	5.6
		2735.17	09/10/1999 13:58	1541	3117	5248	111	243	7.5	5.2	5.7	15.3	11.2	4.2	709	615	550	14	9	1.69	33	32	0.2	214	11	5.6
		2736.16	09/10/1999 14:58	1594	3211	5362	109	64	7.5	5.5	6.0	15.3	11.2	4.2	718	623	559	14	9	1.69	33	32	0.2	135	11	5.6
		2737.16	09/10/1999 15:57	1637	3304	5506	122	80	7.5	5.1	5.5	15.3	11.2	4.2	711	617	553	14	9	1.67	33	33	0.2	127	11	5.6
		2738.16	09/10/1999 16:57	1656	3357	5440	99	50	7.5	6.8	7.1	15.3	11.0	4.0	726	633	570	13	9	1.65	33	33	0.2	213	11	5.6
		2739.16	09/10/1999 17:58	1663	3451	5268	98	37	7.5	6.8	7.1	15.3	11.0	4.0	732	643	582	13	9	1.60	33	33	0.2	159	11	5.6
		2740.16	09/10/1999 18:58	1659	3615	4978	91	32	7.5	6.8	7.2	15.3	10.8	4.0	752	665	610	13	8	1.56	34	33	0.2	164	10	5.6
		2741.16	09/10/1999 19:58	1662	3867	4718	83	29	7.5	6.8	7.2	15.3	10.8	4.2	788	702	650	12	8	1.53	33	33	0.2	150	10	5.6

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm$^{1.2}$) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
		2742.16	09/10/1999 20:57	1661	4094	4525	76	25	7.6	6.8	7.2	15.3	10.6	4.4	819	736	685	12	7	1.48	33	33	0.2	162	10	5.6
		2743.16	09/10/1999 21:58	1657	4245	4360	70	26	7.6	6.8	7.2	15.3	10.4	4.6	843	763	712	12	7	1.44	33	32	0.2	162	10	5.6
		2744.16	09/10/1999 22:57	1652	4364	4186	66	25	7.6	6.8	7.2	15.0	10.6	4.6	872	793	742	12	7	1.45	33	32	0.2	169	10	5.6
	Inc in Feed P	2745.16	09/10/1999 23:57	1641	4429	3996	62	24	7.6	6.8	7.2	15.3	10.2	4.6	904	827	775	11	8	1.39	33	32	0.2	166	10	5.6
		2746.16	09/11/1999 0:57	1631	4427	3838	59	23	7.6	6.8	7.2	15.3	10.2	4.8	941	865	811	11	8	1.37	32	32	0.2	156	10	5.6
		2747.16	09/11/1999 1:57	1627	4388	3736	59	23	7.6	6.8	7.2	15.2	10.0	5.0	963	888	834	11	8	1.35	32	31	0.2	159	10	5.6
		2748.16	09/11/1999 2:57	1623	4356	3679	57	22	7.6	6.8	7.2	15.2	10.1	5.0	976	902	847	11	8	1.33	32	31	0.2	156	10	5.6
		2749.16	09/11/1999 3:57	1619	4337	3652	59	21	7.6	6.6	7.3	15.2	10.0	5.0	985	910	855	11	8	1.35	32	31	0.2	180	10	5.6
		2750.16	09/11/1999 4:57	1616	4314	3632	59	22	7.6	6.8	7.2	15.3	10.0	5.0	987	913	857	11	8	1.33	32	31	0.2	162	10	5.6
		2751.16	09/11/1999 5:57	1620	4316	3639	59	22	7.6	6.8	7.3	15.2	10.0	5.2	991	916	860	11	8	1.35	32	31	0.2	195	10	5.6
	End in Feed P	2752.16	09/11/1999 6:57	1627	4324	3657	61	21	7.6	6.8	7.3	15.2	10.0	5.2	995	920	864	11	8	1.36	32	31	0.2	161	10	5.6
		2753.16	09/11/1999 7:58	1623	3437	5520	113	26	7.6	4.6	5.7	15.2	11.0	4.2	748	654	591	14	9	1.67	32	31	0.2	163	11	5.6
		2754.16	09/11/1999 8:57	1622	3265	5401	101	39	7.6	5.3	5.7	15.3	11.0	4.2	741	646	580	14	10	1.69	32	31	0.2	158	11	
		2755.16	09/11/1999 9:57	1618	3331	5556	108	45	7.6	4.9	5.5	15.3	11.4	4.0	738	645	581	14	9	1.67	32	31	0.2	150	11	
		2756.16	09/11/1999 10:58	1611	3319	5557	109	46	7.6	5.0	5.4	15.3	11.4	4.0	740	646	584	13	9	1.67	32	32	0.2	143	11	
		2757.16	09/11/1999 11:57	1605	3304	5529	108	46	7.6	5.2	5.8	15.3	11.4	4.0	737	644	580	13	9	1.67	32	32	0.2	144	11	
		2758.16	09/11/1999 12:57	1614	3278	5557	110	47	7.6	5.6	5.3	15.3	11.4	4.0	740	646	583	13	9	1.67	32	32	0.2	146	11	
		2759.16	09/11/1999 13:57	1626	3389	5689	122	47	7.6	4.8	5.5	15.3	11.6	4.0	727	633	572	14	9	1.67	33	32	0.2	142	11	
		2760.69	09/11/1999 15:29	1639	3429	5569	110	45	7.5	4.5	6.6	15.3	11.4	4.0	729	627	568	15	9	1.82	33	32	0.2	138	11	
		2761.69	09/11/1999 16:29	1648	3362	5569	96	46	7.5	5.2	6.4	15.3	11.4	4.0	740	647	585	13	9	1.65	33	33	0.2	179	11	
		2762.69	09/11/1999 17:29	1655	3394	5612	93	43	7.5	6.8	7.1	15.3	11.4	4.0	740	648	586	13	9	1.63	33	33	0.2	157	11	
		2763.69	09/11/1999 18:29	1659	3506	5462	93	32	7.5	6.8	7.1	15.3	11.2	4.0	746	656	597	13	9	1.60	34	33	0.2	146	11	
		2764.69	09/11/1999 19:29	1656	3716	5070	88	29	7.5	6.8	7.1	15.3	11.2	4.2	774	688	634	13	8	1.55	34	33	0.2	145	11	
		2765.69	09/11/1999 20:29	1660	3952	4780	82	26	7.6	6.8	7.2	15.3	11.0	4.2	808	720	673	13	7	1.57	33	33	0.2	146	11	
		2766.69	09/11/1999 21:29	1659	4165	4617	77	26	7.6	6.8	7.2	15.3	11.0	4.4	834	752	704	12	7	1.47	33	32	0.2	151	11	
		2767.69	09/11/1999 22:29	1656	4369	4472	72	25	7.6	6.8	7.2	15.3	10.8	4.4	864	784	735	12	7	1.44	33	32	0.2	143	10	
		2768.69	09/11/1999 23:29	1662	4547	4331	68	23	7.6	6.8	7.2	15.3	10.8	4.6	899	821	771	11	7	1.40	33	32	0.2	142	10	
	Inc in Feed P	2769.69	09/12/1999 0:29	1662	4631	4195	65	24	7.6	6.8	7.2	15.3	10.6	4.6	938	863	812	11	7	1.35	33	32	0.2	140	10	
		2770.69	09/12/1999 1:29	1659	4610	4089	63	22	7.6	6.8	7.2	15.3	10.6	4.8	962	886	835	11	7	1.37	32	32	0.2	141	10	
		2771.69	09/12/1999 2:29	1659	4591	4031	64	23	7.6	6.9	7.3	15.3	10.6	4.8	972	899	847	11	8	1.31	32	31	0.2	137	10	
		2772.69	09/12/1999 3:29	1653	4565	3992	64	23	7.6	6.8	7.2	15.3	10.4	4.8	981	906	854	11	8	1.35	32	31	0.2	138	10	
		2773.69	09/12/1999 4:29	1649	4546	3969	63	23	7.6	6.8	7.2	15.3	10.4	5.0	985	911	858	11	8	1.33	32	31	0.2	134	10	
		2774.69	09/12/1999 5:29	1645	4529	3948	64	23	7.6	6.8	7.2	15.3	10.4	5.0	987	913	860	11	8	1.33	32	31	0.2	135	10	
	End in Feed P	2775.69	09/12/1999 6:29	1656	4798	3951	90	22	7.6	5.1	7.3	15.3	10.6	4.8	959	884	832	11	8	1.34	32	31	0.2	161	10	
		2777.30	09/12/1999 8:06	1662	3459	5696	112	44	7.6	4.9	5.5	15.2	11.4	4.0	754	660	597	14	9	1.69	32	31	0.2	124	11	
		2778.30	09/12/1999 9:06	1660	3397	5626	103	46	7.6	5.3	5.7	15.2	11.2	4.0	761	667	602	13	9	1.67	32	31	0.2	120	11	
		2779.30	09/12/1999 10:06	1658	3424	5743	115	46	7.6	4.7	5.6	15.3	11.2	4.0	747	652	591	14	9	1.69	32	31	0.2	117	11	
		2780.30	09/12/1999 11:06	1657	3372	5724	118	46	7.7	5.7	4.8	15.3	11.2	4.0	747	654	591	13	9	1.67	32	32	0.2	117	11	
		2781.30	09/12/1999 12:06	1664	3423	5689	113	45	7.7	5.3	5.8	15.3	11.4	4.2	748	655	592	13	9	1.67	32	32	0.2	115	11	
		2782.30	09/12/1999 13:06	1676	3477	5591	103	46	7.6	4.2	6.6	15.3	11.4	4.2	752	655	594	14	9	1.71	33	32	0.2	118	11	
		2783.30	09/12/1999 14:06	1684	3695	5961	155	47	7.6	3.3	5.6	15.3	11.4	4.0	716	623	564	13	9	1.65	33	32	0.2	117	11	
		2784.30	09/12/1999 15:06	1706	3413	5844	124	46	7.5	6.4	3.2	15.3	11.2	4.0	746	655	590	13	9	1.62	33	32	0.2	114	11	
		2785.30	09/12/1999 16:06	1722	3445	5713	115	46	7.5	6.4	4.2	15.3	11.2	4.0	745	651	587	14	9	1.67	33	32	0.2	123	11	
		2786.30	09/12/1999 17:06	1738	3574	6036	140	47	7.5	4.8	5.4	15.3	11.4	4.0	726	634	573	13	9	1.63	33	33	0.2	137	11	
		2787.30	09/12/1999 18:06	1751	3530	5853	104	48	7.5	5.6	6.1	15.3	11.2	4.0	747	653	591	14	9	1.67	34	33	0.2	121	11	
		2788.30	09/12/1999 19:06	1756	3530	5822	106	48	7.5	6.2	6.1	15.3	11.2	4.0	749	657	594	13	9	1.65	34	33	0.2	122	11	
		2789.30	09/12/1999 20:06	1760	3753	6030	147	48	7.6	4.7	6.3	15.3	11.4	4.0	716	621	562	14	9	1.69	33	33	0.2	119	11	
		2790.30	09/12/1999 21:06	1761	3543	5956	97	43	7.6	6.9	7.2	15.3	11.2	4.0	756	662	600	14	9	1.67	33	32	0.2	130	11	
		2791.30	09/12/1999 22:06	1755	3557	5939	96	31	7.6	6.9	7.3	15.3	11.2	4.0	753	659	597	14	9	1.69	33	32	0.2	128	11	
		2792.30	09/12/1999 23:06	1751	3566	5895	93	28	7.6	6.9	7.4	15.3	11.2	4.2	757	664	602	13	9	1.65	33	32	0.2	133	11	
		2793.30	09/13/1999 0:06	1745	3587	5833	89	27	7.7	6.9	7.3	15.3	11.2	4.2	764	671	611	13	9	1.67	33	32	0.2	130	11	
		2794.30	09/13/1999 1:06	1738	3606	5749	86	25	7.7	6.9	7.2	15.3	11.2	4.2	769	677	617	13	9	1.65	32	32	0.2	134	11	
		2795.30	09/13/1999 2:06	1735	3632	5661	84	24	7.7	6.9	7.4	15.3	11.2	4.2	778	684	626	14	8	1.67	32	32	0.2	130	11	
		2796.30	09/13/1999 3:06	1731	3645	5573	83	25	7.7	6.9	7.3	15.0	11.2	4.2	779	688	630	13	8	1.67	32	32	0.2	133	11	
		2797.30	09/13/1999 4:06	1725	3658	5502	82	24	7.7	6.9	7.3	15.2	11.0	4.2	783	692	635	13	8	1.63	32	31	0.2	133	11	
		2798.30	09/13/1999 5:06	1722	3672	5445	82	24	7.7	6.9	7.5	15.3	11.0	4.2	788	697	640	13	8	1.62	32	31	0.2	133	11	
		2799.30	09/13/1999 6:06	1714	3694	5388	81	24	7.7	6.9	7.3	15.2	11.0	4.2	794	703	646	13	8	1.63	32	31	0.2	134	11	
		2800.30	09/13/1999 7:06	1704	3699	5305	79	25	7.7	6.9	7.3	15.2	11.0	4.2	798	707	651	13	8	1.63	32	31	0.2	135	11	
		2800.63	09/13/1999 7:25	1705	3705	5270	78	25	7.7	6.9	7.3	15.5	11.0	1.3	803	711	655	13	8	1.62	32	31	0.2	153	11	5.6
		2801.63	09/13/1999 8:25	1691	3721	5194	76	24	7.7	6.9	7.3	15.2	11.0	4.2	808	717	662	13	8	1.62	32	31	0.2	132	11	5.6
		2802.63	09/13/1999 9:25	1681	3767	5089	75	24	7.7	6.9	7.3	15.3	11.0	4.2	813	722	669	13	8	1.62	32	31	0.2	124	11	5.6
		2803.63	09/13/1999 10:25	1679	3472	5869	117	36	7.7	5.0	5.6	15.2	11.3	4.0	752	649	592	15	8	1.85	32	31	0.2	123	11	5.6
		2804.63	09/13/1999 11:25	1687	3401	5666	92	228	7.7	5.9	6.1	15.2	11.2	4.2	764	669	606	14	9	1.71	32	32	0.2	118	11	5.6
		2805.63	09/13/1999 12:25	1704	3486	5724	99	73	7.7	3.9	6.8	15.3	11.6	4.2	753	657	596	14	9	1.72	33	32	0.2	115	11	5.6
		2806.63	09/13/1999 13:25	1713	3384	6062	151	65	7.6	6.1	3.1	15.0	11.2	4.0	736	644	581	13	9	1.67	33	32	0.2	112	11	5.6
		2807.50	09/13/1999 14:18	1724	3393	6252	149	407	7.6	6.2	2.9	15.3	11.2	4.0	740	648	584	13	9	1.64	33	32	0.2	111	11	5.6
		2808.49	09/13/1999 15:18	1754	3478	5995	124	84	7.5	6.4	3.2	15.3	11.2	4.0	756	662	599	14	9	1.67	33	32	0.2	111	11	5.6
		2809.49	09/13/1999 16:18	1779	3649	5969	112	88	7.5	3.3	6.7	15.3	11.4	4.0	746	643	581	15	9	1.83	33	32	0.2	111	11	5.6
		2810.49	09/13/1999 17:18	1797	3928	6537	193	66	7.5	6.0	2.7	15.2	11.2	4.0	727	634	572	13	9	1.68	33	32	0.2	107	11	5.6
		2811.49	09/13/1999 18:18	1810	3632	6036	102	55	7.6	4.0	6.5	15.3	11.2	4.2	768	673	610	14	9	1.69	33	32	0.2	126	11	5.6
		2812.49	09/13/1999 19:18	1821	3830	6661	181	52	7.6	6.2	2.6	15.0	11.2	4.0	742	651	586	13	9	1.65	33	32	0.2	105	11	5.6
		2814.49	09/13/1999 21:18	1829	3866	6439	167	47	7.6	5.6	3.7	15.3	11.4	4.0	742	649	585	13	9	1.65	33	32	0.2	106	11	5.6
		2816.49	09/13/1999 23:18	1825	3713	6050	109	45	7.7	4.4	7.0	15.2	11.2	4.2	769	668	606	15	9	1.82	32	32	0.2	111	11	5.6
		2818.49	09/14/1999 1:18	1816	3758	6062	118	43	7.7	4.3	6.5	15.2	11.2	4.2	761	662	599	14	9	1.76	32	31	0.2	117	11	5.6
		2820.49	09/14/1999 3:18	1795	3651	5930	103	44	7.7	4.3	6.8	15.2	11.2	4.2	773	673	610	15	9	1.80	32	31	0.2	118	11	5.6
		2822.49	09/14/1999 5:18	1782	3597	5895	99	43	7.7	3.8	6.7	15.2	11.2	4.2	782	682	617	14	9	1.78	32	31	0.2	114	11	5.6
		2823.49	09/14/1999 6:18	1775	3561	5892	95	43	7.7	4.4	6.6	15.2	11.2	4.2	785	688	623	14	9	1.74	32	31	0.2	112	11	5.6
		2825.49	09/14/1999 8:18	1779	3592	5899	98	43	7.7	4.6	6.7	15.2	11.2	4.2	789	687	622	15	9	1.83	32	31	0.2	111	11	5.6
		2826.49	09/14/1999 9:18	1779	3588	6014	116	46	7.7	4.8	5.0	15.2	11.4	4.2	789	692	627	14	10	1.73	32	31	0.2	110	11	
		2826.65	09/14/1999 9:27	1779	3552	6071	120	46	7.7	4.8	4.6	15.2	11.2	4.2	784	689	622	14	10	1.71	32	31	0.2	106	11	
		2828.65	09/14/1999 11:27	1773	3543	5849	92	37	7.7	6.9	7.3	15.2	11.2	2.7	788	692	626	14	10	1.71	32	31	0.2	120	11	
		2829.65	09/14/1999 12:27	1783																	32	32	0.2			
12	RO Unit down due to raising Zenon membranes	2830.65	09/14/1999 13:27	1783	3557	6046	115	243	7.6	5.1	5.3	15.2	11.4	4.0	759	664	597	14	10	1.71	32	32	0.2	140	11	
		2880.26	09/16/1999 15:03			3228	58	218	5.4	2.4	2.0	16.1	12.7	3.4	707	598	528	16	10	1.80	30	29	0.2	229	12	5.6
		2881.25	09/16/1999 16:03	1935	3788	6635	222	73	7.3	6.1	2.8	15.2	11.0	4.4	752	661	586	13	11	1.63	31	31	0.2	185	11	5.6
		2882.25	09/16/1999 17:03	2014	3814	6382	180	98	7.0	6.1	2.8	15.3	10.8	4.3	762	668	596	14	11	1.67	32	32	0.2	119	10	5.6
		2883.26	09/16/1999 18:03	2014	3823	6839	220	89	6.9	5.9	2.3	15.3	10.8	4.4	753	660	587	13	11	1.65	33	32	0.2	106	10	5.6
		2885.25	09/16/1999 20:03	1967	4434	6134	256	68	7.1	2.6	5.8	15.3	11.2	4.4	730	632	564	14	10	1.74	32	32	0.2	124	11	5.6
		2886.26	09/16/1999 21:03	1936	4444	6818	308	65	7.2	3.1	2.5	15.3	11.2	4.2	732	636	567	14	10	1.71	32	31	0.2	117	11	5.6
		2887.25	09/16/1999 22:03	1908	3623	6370	163	63	7.3	6.2	2.7	15.0	11.0	4.4	768	672	600	14	11	1.76	32	31	0.2	108	11	5.6
		2890.26	09/17/1999 1:03	1846	3966	6368	218	54	7.5	5.5	2.8	15.2	11.2	4.2	735	637	568	14	10	1.74	31	31	0.2	108	11	5.6
		2891.26	09/17/1999 2:03	1827	3555	5718	101	51	7.5	3.1	6.7	15.5	11.2	4.4	766	658	589	16	10	1.88	31	31	0.2	111	11	5.6
		2892.25	09/17/1999 3:03	1808	3419	6141	156	51	7.5	6.3	2.7	15.2	11.0	4.4	758	663	591	14	11	1.71	31	31	0.2	134	11	5.6
		2895.25	09/17/1999 6:03	1770	3734	5955	174	47	7.6	5.2	3.3	15.2	11.2	4.4	735	636	567	14	10	1.76	31	30	0.2	111	11	5.6
		2897.92	09/17/1999 8:43	1759	3397	5495	90	236	7.6	4.3	6.6	15.2	11.2	4.6	780	679	606	15	11	1.82	31	30	0.2		11	
		2899.25	09/17/1999 10:03	1753	3346	5827	128	76	7.6	6.4	3.0	15.2	11.0	4.4	762	667	594	14	11	1.69	31	30	0.2	121	11	
		2900.92	09/17/1999 11:43	1756	3332	5921	149	73	7.5	6.4	3.1	15.0	11.0	4.4	740	645	575	14	10	1.72	32	31	0.2	103	11	
		2901.26	09/17/1999 12:03	1760	3388	5445	106	71	7.5	6.5	5.7	15.3	11.0	4.4	754	659	587	14	10	1.71	32	31	0.2	104	11	
		2902.26	09/17/1999 13:03	1775	3610	5560	131	55	7.4	3.1	6.7	15.3	11.2	4.2	720	621	553	14	10	1.78	32	31	0.2	111	11	
		2903.25	09/17/1999 14:03	1799	3452	5859	131	277	7.4	6.4	3.1	15.3	11.2	4.4	748	654	583	14	10	1.69	32	32	0.2	104	11	
		2906.92	09/17/1999 17:43	1810	3459	6113	143	60	7.4	6.4	3.0	15.3	11.2	4.2	733	642	572	13	10	1.65	33	32	0.2	103	11	
		2907.92	09/17/1999 18:43	1813	3677	5731	126	52	7.4	3.6	6.9	15.3	11.2	4.4	716	618	552	14	10	1.74	33	32	0.2	104	11	
		2909.92	09/17/1999 20:43	1809	3494	5975	139	45	7.5	6.3	3.5	15.0	11.0	4.4	731	639	570	13	10	1.68	32	32	0.2	104	11	
		2910.92	09/17/1999 21:43	1807	3516	5765	115	44	7.5	5.9	5.4	15.3	11.0	4.4	742	647	578	14	10	1.69	32	31	0.2	106	11	
		2911.92	09/17/1999 22:43	1799	3526	5740	117	45	7.5	5.2	5.6	15.3	11.2	4.4	742	646	576	14	10	1.71	32	31	0.2	106	11	
		2912.92	09/17/1999 23:43	1792	3499	5674	106	43	7.5	5.5	6.3	15.3	11.0	4.4	751	654	584	14	10	1.72	32	31	0.2	110	11	
		2913.92	09/18/1999 0:43	1782	3486	5657	109	44	7.6	5.3	5.7	15.3	11.0	4.4	749	653	583	14	10	1.72	32	31	0.2	106	11	
		2914.92	09/18/1999 1:43	1775	3490	5660	109	42	7.6	5.2	5.8	15.3	11.0	4.4	752	654	584	14	10	1.74	32	31	0.2	107	11	

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed		Conductivity (uS/cm)					pH			Flow (Lpm)			Pressure (kPa)			Pressure Drop (psi)		PDC (psi/gpm$^{1.5}$)	Temperature			Particle		Target
		Time (hrs)	Date/Time	Feed	Interstage	Conc	Tot Perm	Samplvalve	Raw Feed	RO Feed	Concentrate	Feed	Tot Perm	Conc	Feed	Interstage	Conc	Stage 1	Stage 2	Stage 1	RO Feed	Raw	Turbidity	Index	Flux	pH
		2915.92	09/18/1999 2:43	1772	3486	5665	107	44	7.6	5.5	5.9	15.3	11.0	4.4	753	657	586	14	10	1.72	31	31	0.2	119	11	
		2919.92	09/18/1999 6:43	1750	3423	5569	96	41	7.6	5.7	6.7	15.2	11.0	4.6	774	676	603	14	11	1.76	31	30	0.2	103	11	
		2896.92	09/17/1999 7:43	1765	3650	5918	171	45	7.6	5.8	3.1	15.2	11.2	4.4	741	642	572	14	10	1.76	31	30	0.2	108	11	5.6
		2921.80	09/18/1999 8:36	1727	3378	5529	99	40	7.6	5.6	6.0	15.2	10.8	4.4	768	669	597	14	10	1.76	31	30	0.2	101	10	
		2922.80	09/18/1999 9:36	1719	3365	5485	99	41	7.6	5.5	6.0	15.3	10.8	4.4	762	665	594	14	10	1.73	31	31	0.2	103	10	
		2923.80	09/18/1999 10:36	1731	3383	5511	102	41	7.6	5.5	5.8	15.3	10.8	4.4	756	659	589	14	10	1.72	31	31	0.2	101	10	
		2924.80	09/18/1999 11:36	1743	3441	5529	109	43	7.6	5.2	5.9	15.3	10.8	4.4	748	651	581	14	10	1.74	32	31	0.2	101	10	
		2925.80	09/18/1999 12:36	1758	3468	5595	114	46	7.6	5.3	5.7	15.3	10.8	4.4	742	646	576	14	10	1.72	32	31	0.2	102	10	
		2926.80	09/18/1999 13:36	1787	3530	5675	119	47	7.5	5.0	5.5	15.3	10.8	4.4	740	644	575	14	10	1.71	32	32	0.2	101	10	
		2929.80	09/18/1999 16:36	1819	3579	5806	119	46	7.4	5.4	5.7	15.3	10.8	4.4	737	641	573	14	10	1.71	33	32	0.2	115	10	
		2930.80	09/18/1999 17:36	1819	3640	5882	136	46	7.4	5.1	5.5	15.3	11.0	4.4	717	621	554	14	10	1.71	33	32	0.2	105	11	
		2931.80	09/18/1999 18:36	1819	3678	5735	120	44	7.4	4.7	6.6	15.3	11.0	4.4	720	623	557	14	10	1.72	33	32	0.2	108	11	
		2932.80	09/18/1999 19:36	1817	3619	5896	129	45	7.5	5.5	5.4	15.3	10.8	4.4	724	633	565	13	10	1.61	33	32	0.2	110	10	
		2933.80	09/18/1999 20:36	1804	3579	5835	117	45	7.5	5.6	5.5	15.1	10.6	4.4	735	639	570	14	10	1.74	33	32	0.2	108	10	
		2934.80	09/18/1999 21:36	1790	3553	5718	112	42	7.5	5.1	5.5	15.3	10.8	4.4	737	642	573	14	10	1.72	32	32	0.2	105	10	
		2935.80	09/18/1999 22:36	1783	3516	5657	105	44	7.5	5.3	5.7	15.3	10.8	4.4	746	649	580	14	10	1.72	32	31	0.2	137	10	
		2936.80	09/18/1999 23:36	1780	3499	5643	102	41	7.5	5.4	5.9	15.2	10.8	4.4	753	657	586	14	10	1.73	32	31	0.2	104	10	
		2937.80	09/19/1999 0:36	1787	3508	5644	100	42	7.5	5.5	6.1	15.3	10.8	4.4	759	663	592	14	10	1.72	32	31	0.2	103	10	
		2938.80	09/19/1999 1:36	1786	3516	5665	100	42	7.6	5.5	5.9	15.3	10.8	4.4	763	666	596	14	10	1.73	31	31	0.2	104	10	
		2939.80	09/19/1999 2:36	1779	3496	5619	98	42	7.6	5.5	6.3	15.2	10.6	4.4	766	668	597	14	10	1.74	31	31	0.2	105	10	
		2940.80	09/19/1999 3:36	1765	3463	5586	96	40	7.6	5.6	6.0	15.2	10.6	4.6	769	671	600	14	10	1.76	31	30	0.2	101	10	
		2942.80	09/19/1999 5:36	1741	3397	5471	90	39	7.6	5.7	6.3	15.2	10.6	4.5	774	677	605	14	10	1.74	31	30	0.2	101	10	
		2943.80	09/19/1999 6:36	1735	3383	5440	89	38	7.6	5.7	6.2	15.2	10.8	4.6	775	679	606	14	11	1.73	31	30	0.2	101	10	
		2944.91	09/19/1999 7:43	1733	3375	5436	87	36	7.6	5.8	6.5	15.2	10.6	4.6	782	684	611	14	11	1.74	31	30	0.2	107	10	5.6
		2945.91	09/19/1999 8:43	1736	3375	5428	87	36	7.6	5.8	6.4	15.2	10.6	4.6	777	679	607	14	10	1.74	31	30	0.2	102	10	5.6
		2946.91	09/19/1999 9:43	1743	3400	5470	88	35	7.6	5.8	6.4	15.2	10.8	4.6	780	682	610	14	11	1.76	31	30	0.2	103	10	5.6
		2947.91	09/19/1999 10:43	1743	3397	5454	88	36	7.6	5.9	6.6	15.0	10.8	4.6	773	677	605	14	10	1.74	31	31	0.2	103	10	5.6
		2948.91	09/19/1999 11:43	1735	3379	5415	90	35	7.6	5.9	6.5	15.3	11.0	4.4	764	668	597	14	10	1.73	32	31	0.2	115	11	5.6
		2950.91	09/19/1999 13:43	1745	3402	5458	95	36	7.5	5.8	6.3	15.3	10.9	4.4	757	661	590	14	10	1.71	32	31	0.2	105	10	5.6
		2952.91	09/19/1999 15:43	1784	3494	5590	103	38	7.5	5.7	6.4	15.3	11.0	4.4	749	653	584	14	10	1.71	33	32	0.2	108	11	5.6
		2953.91	09/19/1999 16:43	1788	3462	5467	92	37	7.5	6.8	7.3	15.3	11.0	4.4	753	659	591	14	10	1.69	33	32	0.2	111	11	5.6
		2954.91	09/19/1999 17:43	1788	3481	5431	91	31	7.5	6.8	7.1	15.3	11.2	4.4	748	654	586	14	10	1.69	33	32	0.2	217	11	5.6
		2955.91	09/19/1999 18:43	1782	3481	5386	90	30	7.5	6.8	7.2	15.3	11.0	4.4	747	655	587	13	10	1.65	33	32	0.2	117	11	5.6
		2956.91	09/19/1999 19:43	1777	3491	5290	89	28	7.5	6.8	7.1	15.3	11.0	4.2	752	659	591	13	10	1.67	33	32	0.2	115	11	5.6
		2957.91	09/19/1999 20:43	1769	3509	5199	86	27	7.5	6.8	7.1	15.3	11.0	4.4	764	672	605	13	10	1.65	33	32	0.2	116	11	5.6
		2958.91	09/19/1999 21:43	1758	3534	5074	82	27	7.6	6.8	7.2	15.3	10.8	4.4	773	681	616	13	9	1.65	32	32	0.2	116	10	5.6
		2959.91	09/19/1999 22:43	1753	3548	4969	79	28	7.6	6.8	7.4	15.3	10.8	4.4	783	691	627	13	9	1.64	32	31	0.2	111	10	5.6
		2960.91	09/19/1999 23:43	1753	3570	4894	77	27	7.6	6.8	7.3	15.3	10.8	4.6	793	701	638	13	9	1.65	32	31	0.2	114	10	5.6
		2962.91	09/20/1999 1:43	1750	3610	4824	74	26	7.6	6.8	7.4	15.3	10.8	4.6	808	716	654	13	9	1.65	32	31	0.2	118	10	5.6
		2963.91	09/20/1999 2:43	1748	3627	4820	73	26	7.6	6.8	7.4	15.3	10.8	4.6	810	719	657	13	9	1.64	31	31	0.2	110	10	5.6
		2965.91	09/20/1999 4:43	1738	3619	4780	71	26	7.6	6.8	7.4	15.2	10.8	4.6	815	724	662	13	9	1.64	31	31	0.2	122	10	5.6
		2966.91	09/20/1999 5:43	1732	3685	5088	84	24	7.6	5.7	6.5	15.2	10.8	4.6	800	709	647	13	9	1.64	31	30	0.2	116	10	5.6
		2967.91	09/20/1999 6:43	1728	3583	5299	85	32	7.6	5.7	6.4	15.2	11.0	4.6	788	694	629	14	9	1.67	31	30	0.2	107	11	5.6
		2969.20	09/20/1999 8:00	1738	3680	5477	86	37	7.6	5.8	6.2	15.7	11.8	4.4	883	742	679	20	9	2.43	31	30	0.2		11	5.6
		2994.38	09/21/1999 9:11	1741	3694	5481	83	232	7.6	5.7	6.3	15.4	11.0	4.4	832	740	678	13	9	1.63	31	30	0.2	104	11	
		2995.38	09/21/1999 10:11	1730	3677	5454	84	66	7.6	5.7	6.4	15.2	11.0	4.4	824	733	672	13	9	1.63	31	30	0.2	104	11	
		2996.38	09/21/1999 11:11	1724	3863	5441	85	71	7.6	5.6	6.3	15.2	11.2	4.4	819	728	667	13	9	1.64	31	31	0.2	104	11	
		2997.38	09/21/1999 12:11	1722	3375	5644	110	57	7.5	6.2	4.9	15.2	10.8	4.6	792	701	633	13	10	1.62	32	31	0.2	105	10	
		2998.38	09/21/1999 13:11	1718	3272	4692	93	48	7.5	6.6	5.7	16.9	12.7	4.4	879	729	652	22	11	2.30	32	31	0.2	282	12	
		2999.38	09/21/1999 14:11	1754	3313	5908	111	370	7.5	6.4	2.7	15.3	11.0	4.4	779	683	611	14	11	1.73	32	31	0.2	111	11	
		3000.32	09/21/1999 15:07	1790	3973	5887	140	263	7.5	2.8	6.2	15.3	11.2	4.2	738	640	572	14	10	1.76	32	32	0.2	218	11	4.0
		3001.32	09/21/1999 16:07	1820	3984	5970	137	70	7.5	2.9	6.1	15.3	11.2	4.4	745	646	577	14	10	1.76	33	32	0.2	105	11	4.0
		3002.32	09/21/1999 17:07	1829	3948	5907	131	62	7.5	2.9	6.3	15.3	11.2	4.4	743	644	576	14	10	1.77	33	32	0.2	103	11	4.0
		3004.32	09/21/1999 19:07	1844	3553	5811	92	56	7.6	6.9	7.2	15.3	11.0	4.4	773	676	606	14	10	1.74	33	32	0.2	115	11	4.0
		3005.32	09/21/1999 20:07	1857	3593	5856	94	41	7.6	6.9	7.4	15.3	11.0	4.4	777	678	608	14	10	1.76	33	32	0.2	112	11	4.0
		3007.32	09/21/1999 22:07	1854	3651	5570	89	26	7.6	6.9	7.3	15.2	11.0	4.4	790	693	626	14	10	1.75	32	32	0.2	109	11	4.0
		3008.32	09/21/1999 23:07	1846	3744	5107	83	27	7.6	6.9	7.1	15.2	10.8	4.4	810	715	652	14	9	1.71	32	32	0.2	108	10	4.0
		3009.32	09/22/1999 0:07	1835	3867	4746	78	27	7.6	6.9	7.2	15.2	10.6	4.6	832	739	679	14	9	1.67	32	31	0.2	115	10	4.0
		3012.32	09/22/1999 3:07	1807	4009	4376	71	25	7.6	6.9	7.2	15.4	10.6	4.8	865	775	717	13	8	1.60	32	31	0.2	114	10	4.0
		3014.32	09/22/1999 5:07	1787	3974	4345	70	25	7.6	6.9	7.1	15.2	10.4	4.8	870	779	721	13	8	1.63	31	31	0.2	111	10	4.0
		3015.32	09/22/1999 6:07	1771	3938	4327	69	24	7.6	6.9	7.4	15.2	10.6	4.8	876	786	727	13	9	1.62	31	30	0.2	107	10	4.0
		3017.32	09/22/1999 8:07																							
		3023.39	09/22/1999 14:11	1760	3376	4291	97	35	7.4	5.1	6.8	14.0	9.8	4.2	711	622	558	13	9	1.80	31	30	0.2	191	9	4.0
		3024.40	09/22/1999 15:12	1777	3464	5391	106	40	7.4	5.5	5.7	15.2	11.2	4.4	787	688	617	14	10	1.76	31	30	0.2	134	11	4.0
		3040.97	09/23/1999 7:46	1718	3734	7421	91	30	7.6	5.8	6.4	15.7	12.5	3.3	933	836	781	14	8	1.68	30	29	0.2	102	12	5.6
13	Inc to 80%	3041.97	09/23/1999 8:46	1708	3685	7425	94	181	7.5	5.7	6.6	15.7	12.7	3.3	913	816	761	14	8	1.67	30	29	0.2	101	12	5.6
		3042.97	09/23/1999 9:46	1698	3664	7409	95	59	7.5	5.7	6.3	15.7	12.9	0.4	906	808	753	14	8	1.69	30	29	0.2	100	12	5.6
		3043.97	09/23/1999 10:46	1693	3686	7287	92	69	7.5	3.8	6.6	15.7	12.9	3.1	897	796	743	15	8	1.74	30	30	0.2	115	12	5.6
		3044.97	09/23/1999 11:46	1697	3557	8274	137	50	7.5	6.3	2.4	15.5	12.7	3.1	879	787	731	13	8	1.62	31	30	1.5	99	12	5.6
		3045.97	09/23/1999 12:46	1710	3686	7270	91	43	7.5	5.7	6.4	15.7	12.7	3.1	896	803	749	14	8	1.61	31	30	0.3	97	12	5.6
		3046.97	09/23/1999 13:46	1728	3765	7438	95	44	7.4	2.8	6.8	15.7	12.9	3.1	877	774	722	15	8	1.78	31	30	0.3	101	12	5.6
		3047.97	09/23/1999 14:46	1743	4482	8689	205	259	7.4	2.8	2.5	15.7	12.7	2.9	839	744	692	14	8	1.64	31	31	0.3	101	12	5.6
		3048.97	09/23/1999 15:46	1764	3713	8811	162	63	7.4	6.3	2.4	15.7	12.7	3.1	866	779	722	13	8	1.50	32	31	0.3		12	5.6
		3049.97	09/23/1999 16:46	1776	3929	7600	112	90	7.4	2.9	6.8	15.7	12.9	3.1	857	751	701	15	7	1.63	32	31	0.3		12	5.6
		3050.97	09/23/1999 17:46	1778	4298	8468	176	58	7.4	5.5	2.8	15.7	12.7	2.9	829	734	684	14	7	1.63	32	31	0.3	101	12	5.6
		3051.97	09/23/1999 18:46	1779	3773	8477	135	50	7.5	6.3	2.5	15.5	12.7	3.1	868	776	723	13	8	1.62	32	31	0.3	100	12	5.6
		3052.97	09/23/1999 19:46	1791	3864	7572	96	43	7.5	6.1	6.2	15.7	12.5	3.1	884	790	737	14	8	1.62	32	31	0.3	99	12	5.6
		3053.97	09/23/1999 20:46	1793	3895	7610	92	41	7.6	5.6	6.4	15.7	12.7	3.1	893	799	746	14	8	1.62	32	31	1.6	98	12	5.6
		3054.97	09/23/1999 21:46	1791	3877	7607	92	40	7.6	5.9	6.4	15.6	12.5	3.1	899	804	750	14	8	1.66	31	31	0.3	98	12	5.6
		3056.97	09/23/1999 23:46	1774	3770	7981	116	40	7.6	6.3	3.6	15.7	12.7	3.1	898	806	751	13	8	1.59	31	30	0.8	99	12	5.6
		3057.97	09/24/1999 0:46	1765	4046	7821	129	38	7.6	4.8	5.7	15.7	12.7	3.1	861	765	713	14	8	1.66	31	30	0.3	101	12	5.6
		3058.97	09/24/1999 1:46	1758	3948	7482	107	38	7.6	4.2	6.7	15.9	12.7	3.1	885	785	734	15	7	1.69	30	30	2.0	100	12	5.6
		3059.97	09/24/1999 2:46	1744	3796	7438	99	40	7.6	5.2	6.4	15.7	12.7	3.4	909	813	758	14	8	1.66	30	30	2.0	97	12	5.6
		3060.97	09/24/1999 3:46	1725	3769	7499	108	41	7.6	4.9	5.7	15.7	12.7	3.1	901	803	749	14	8	1.69	30	29	0.7	98	12	5.6
		3061.97	09/24/1999 4:46	1707	3716	7437	107	43	7.6	5.3	5.6	15.7	12.7	3.2	903	806	751	14	8	1.67	30	29	2.0		12	5.6
		3062.97	09/24/1999 5:46	1690	3672	7316	103	40	7.6	5.1	5.9	15.7	12.7	3.4	906	809	754	14	8	1.67	30	29	2.0	98	12	5.6
		3063.97	09/24/1999 6:46	1679	3628	7284	100	40	7.6	5.3	5.4	15.7	12.7	3.4	912	819	763	14	8	1.61	30	29	0.6	97	12	5.6
		3066.87	09/24/1999 9:40	1675	3632	7308	102	40	7.7	5.0	5.5	15.7	12.7	3.4	907	810	754	14	8	1.67	30	29	2.0	97	12	5.6
		3068.87	09/24/1999 11:40	1682	3705	7395	113	229	7.6	4.7	6.4	15.7	12.9	2.9	866	769	717	14	8	1.67	31	30	0.4	101	12	5.6
		3070.87	09/24/1999 13:40	1730	3713	7449	102	59	7.5	6.5	5.3	15.7	12.7	3.2	891	797	743	14	8	1.62	31	31	2.0	96	12	5.6
		3071.87	09/24/1999 14:40	1746	4045	7609	139	119	7.5	4.2	6.5	15.7	12.9	3.2	836	739	688	14	7	1.68	32	31	0.5	103	12	5.6
		3072.87	09/24/1999 15:40	1747	3803	7541	95	67	7.4	5.5	6.7	15.7	12.7	3.2	889	794	740	14	8	1.64	32	31	0.4	96	12	5.6
		3073.87	09/24/1999 16:40	1749	3783	7683	119	64	7.4	6.3	4.1	15.5	12.7	3.2	869	778	723	13	8	1.61	32	32	0.4	101	12	5.6
		3076.87	09/24/1999 19:40	1739	3783	7549	97	41	7.5	6.1	6.2	15.7	12.7	3.2	873	780	727	13	8	1.60	32	32	2.0	99	12	5.6
		3077.87	09/24/1999 20:40	1735	3788	7649	111	40	7.5	5.4	5.5	15.5	12.7	3.2	864	770	718	14	8	1.64	32	31	2.0	100	12	5.6
		3078.87	09/24/1999 21:40	1741	3814	7620	111	41	7.6	5.2	5.8	15.7	12.7	3.2	868	773	721	14	8	1.64	32	31	2.0	98	12	5.6
		3079.87	09/24/1999 22:40	1737	3792	7583	108	43	7.6	5.2	5.9	15.7	12.7	3.1	878	783	730	14	8	1.64	32	31	0.6	101	12	5.6
		3080.87	09/24/1999 23:40	1730	3783	7551	106	41	7.6	5.4	6.0	15.7	12.9	3.4	886	793	739	14	8	1.61	31	31	2.0	99	12	5.6
		3081.87	09/25/1999 0:40																							
		3082.87	09/25/1999 1:40																							
		3084.87	09/25/1999 3:40																							
		3085.87	09/25/1999 4:40																							
		3086.87	09/25/1999 5:40																							
		3087.87	09/25/1999 6:40	1683	3714	7485	113	49	7.5	5.4	5.5	15.7	12.7	3.2	873	777	723	14	8	1.66	31	30	0.9	230	12	5.6
		3088.87	09/25/1999 7:40	1687	3698	7448	109	44	7.5	5.2	5.8	15.7	12.7	3.2	883	787	733	14	8	1.66	31	30	1.3	110	12	5.6
		3089.00	09/25/1999 7:48																							
		3090.00	09/25/1999 8:48	1678	3690	7455	104	47	7.5	5.4	5.9	15.7	12.7	3.2	884	789	736	14	8	1.64	31	30	0.5	98	12	
		3091.00	09/25/1999 9:48	1674	3675	7442	106	44	7.5	5.3	5.9	15.7	12.7	3.2	878	783	730	14	8	1.64	31	30	1.1	97	12	
		3092.00	09/25/1999 10:48	1670	3672	7424	108	43	7.6	5.2	5.8	15.7	12.7	3.2	876	780	727	14	8	1.64	31	31	0.5	108	12	
		3093.00	09/25/1999 11:48	1675	3690	7446	110	43	7.5	5.3	6.0	15.7	12.7	3.2	868	772	720	14	8	1.66	31	31	0.4	97	12	

Table C-3
RO Operating Data
(Data History)

Stage	Event	Elapsed Time (hrs)	Date/Time	Conductivity (uS/cm) Feed	Interstage	Conc	Tot Perm	Samplvalve	pH Raw Feed	RO Feed	Concentrate	Flow (Lpm) Feed	Tot Perm	Conc	Pressure (kPa) Feed	Interstage	Conc	Pressure Drop (psi) Stage 1	Stage 2	PDC (psi/gpm$^{1.5}$) Stage 1	Temperature RO Feed	Raw	Turbidity	Particle Index	Flux	Target pH
		3094.00	09/25/1999 12:48	1696	3721	7535	115	43	7.5	5.1	5.5	15.7	12.9	3.2	866	771	720	14	7	1.64	32	31	1.2	97	12	
		3095.00	09/25/1999 13:48	1712	3765	7586	118	44	7.5	5.1	5.4	15.7	12.7	3.2	862	768	717	14	7	1.62	32	31	0.5	97	12	
		3096.00	09/25/1999 14:48	1717	3832	7637	120	42	7.5	5.1	5.8	15.7	12.9	3.2	857	763	712	14	7	1.62	32	31	0.8	96	12	
		3098.00	09/25/1999 16:48	1723	3743	7678	111	41	7.4	6.4	5.0	15.7	12.7	3.2	858	767	716	13	7	1.57	33	32	1.0	95	12	
		3100.00	09/25/1999 18:48	1718	3876	7872	149	39	7.4	6.0	3.5	15.5	12.7	2.9	821	737	687	12	7	1.48	33	32	0.7	95	12	
		3101.00	09/25/1999 19:48	1714	3779	7556	96	39	7.4	4.8	7.0	15.7	12.9	3.2	865	771	720	14	7	1.62	32	32	0.4	96	12	
		3102.00	09/25/1999 20:48	1707	3696	8019	151	39	7.4	6.3	3.2	15.7	12.7	2.9	842	757	705	12	8	1.47	32	31	0.4	96	12	
		3103.00	09/25/1999 21:48	1695	3777	7451	98	39	7.5	4.2	6.8	15.7	12.9	3.2	863	766	716	14	7	1.68	32	31	2.9	96	12	
		3104.00	09/25/1999 22:48	1692	3650	7600	130	38	7.5	6.1	4.2	15.7	12.7	3.2	846	756	704	13	8	1.56	32	31	1.1	97	12	
		3105.00	09/25/1999 23:48	1687	3681	7411	92	38	7.5	5.4	6.5	15.7	12.9	3.2	883	788	736	14	8	1.64	31	31	1.1	96	12	
		3107.00	09/26/1999 1:48																							
		3108.00	09/26/1999 2:48																							
		3109.00	09/26/1999 3:48																							
		3110.00	09/26/1999 4:48																							
		3111.00	09/26/1999 5:48																							
		3112.00	09/26/1999 6:48																							
		3115.10	09/26/1999 9:54	1683	4129	6564	163	96	7.4	6.5	3.1	15.5	12.3	2.7	835	756	698	11	8	1.38	31	30	0.3	118	12	5.6
		3116.10	09/26/1999 10:54	1684	3627	6473	105	34	7.4	6.6	3.0	15.7	11.8	2.9	873	779	726	14	8	1.62	31	31	0.3	101	11	5.6
		3117.10	09/26/1999 11:54	1693	3690	7041	90	29	7.4	5.0	6.9	15.7	11.4	3.1	871	776	725	14	7	1.64	31	31	0.3	246	11	5.6
		3118.10	09/26/1999 12:54	1705	3677	7352	108	29	7.4	6.6	4.5	15.7	11.4	3.1	866	773	721	14	8	1.61	32	31	0.3	112	11	5.6
		3121.10	09/26/1999 15:54	1731	3850	8018	172	28	7.4	6.2	3.2	15.7	12.1	2.9	825	736	685	13	7	1.54	32	32	0.4	98	12	5.6
		3122.10	09/26/1999 16:54	1735	4085	7609	152	28	7.4	3.5	6.9	15.7	12.3	2.9	808	713	665	14	7	1.63	33	32	0.5	96	12	5.6
		3123.10	09/26/1999 17:54	1733	3796	7484	104	28	7.3	6.1	6.5	15.7	12.5	3.2	857	764	713	14	7	1.60	33	32	1.6	95	12	5.6
		3125.10	09/26/1999 19:54	1719	4015	7529	145	29	7.4	3.3	6.7	15.7	12.9	3.0	816	720	672	14	7	1.66	32	32	1.3	95	12	5.6
		3126.10	09/26/1999 20:54	1706	3721	7331	104	28	7.4	6.4	6.0	15.7	12.7	3.2	865	772	721	14	7	1.60	32	31	2.0	94	12	5.6
		3127.10	09/26/1999 21:54	1705	3811	7926	166	27	7.4	6.2	2.8	15.7	12.5	2.9	835	745	694	13	7	1.55	32	31	0.8	94	12	5.6
		3128.10	09/26/1999 22:54	1696	3713	7366	98	27	7.4	4.9	7.0	15.7	12.7	3.2	868	770	719	14	7	1.69	32	31	0.8	96	12	5.6
		3130.10	09/27/1999 0:54	1675	3636	7243	92	27	7.4	5.9	6.5	15.7	12.5	3.2	881	787	735	14	8	1.62	31	31	0.7	94	12	5.6
		3131.10	09/27/1999 1:54	1673	3773	7358	116	27	7.4	4.5	6.5	15.7	12.7	3.2	847	751	700	14	7	1.66	31	30	2.0	98	12	5.6
		3132.10	09/27/1999 2:54	1675	3756	7547	135	26	7.5	4.8	5.7	15.7	12.7	2.9	839	745	694	14	7	1.62	31	30	0.4	94	12	5.6
		3133.10	09/27/1999 3:54	1670	3619	7342	103	27	7.5	5.6	5.6	15.7	12.7	3.2	874	779	727	14	8	1.64	31	30	0.6	94	12	5.6
		3135.10	09/27/1999 5:54	1657	3672	7405	117	29	7.5	5.0	5.5	15.7	12.7	3.2	859	762	710	14	8	1.67	31	30	2.0	94	12	5.6
		3136.10	09/27/1999 6:54	1660	3649	7327	110	29	7.5	5.1	5.4	15.7	12.7	3.2	871	776	724	14	8	1.64	31	30	1.0	94	12	5.6
		3136.90	09/27/1999 7:42	1678	3689	7434	113	29	7.5	5.2	5.2	15.7	12.7	3.2	871	776	724	14	8	1.64	31	30	0.9	94	12	5.6
		3137.10	09/27/1999 7:54	1679	3699	7433	111	28	7.5	4.9	5.4	15.7	12.7	3.2	875	780	728	14	8	1.64	31	30	2.0	98	12	5.6
		3137.90	09/27/1999 8:42	1681	3694	7412	115	30	7.5	5.0	5.5	15.7	12.7	3.2	871	776	723	14	8	1.64	31	30	2.0	94	12	
		3138.90	09/27/1999 9:42	1679	3668	7403	111	34	7.5	4.9	5.5	15.7	12.7	3.2	869	775	723	14	8	1.62	31	30	0.4	191	12	
		3139.90	09/27/1999 10:42	1680	3696	7150	112	251	7.6	5.3	6.0	15.5	12.5	3.2	886	791	738	14	8	1.68	31	30	0.5	182	12	
		3140.90	09/27/1999 11:42	1701	3729	7618	136	78	7.6	5.0	5.5	15.7	12.7	2.9	838	741	691	14	7	1.68	32	31	2.0	95	12	
		3141.90	09/27/1999 12:42	1716	3717	7613	121	77	7.5	6.3	4.6	15.7	12.7	3.2	865	774	722	13	8	1.57	32	31	2.0	94	12	
		3142.48	09/27/1999 13:17	1702	3681	7468	112	64	7.5	6.4	5.0	15.7	12.5	2.9	868	776	723	13	8	1.59	32	31	0.4	94	12	5.6
		3143.21	09/27/1999 14:00	1719	3850	7643	134	51	7.4	5.6	5.2	15.7	12.5	3.2	839	746	695	14	7	1.60	32	31	0.5	97	12	5.6
		3145.21	09/27/1999 16:00	1759	3917	7772	127	64	7.4	5.1	5.7	15.7	12.7	3.0	843	751	699	13	8	1.59	33	32	2.0	115	12	5.6
		3146.21	09/27/1999 17:00	1767	3898	7886	127	62	7.5	5.1	5.4	15.7	12.7	3.0	847	754	703	14	7	1.60	33	32	0.9	105	12	5.6
		3147.21	09/27/1999 18:00	1759	3881	7933	130	48	7.5	5.5	5.1	15.7	12.5	3.0	838	746	695	13	7	1.59	33	32	0.5	97	12	5.6
		3148.21	09/27/1999 19:00	1770	3921	7871	133	43	7.5	5.4	5.7	15.7	12.7	3.0	837	746	695	13	7	1.57	33	32	2.0	95	12	5.6
		3149.21	09/27/1999 20:00	1782	3952	7841	128	42	7.5	5.2	5.4	15.7	12.7	3.0	845	754	703	13	7	1.57	33	32	0.6	96	12	5.6
		3152.21	09/27/1999 23:00	1777	3930	7777	115	42	7.6	5.4	5.8	15.7	12.7	3.2	871	777	726	14	7	1.62	32	31	1.3	94	12	5.6
		3153.21	09/28/1999 0:00	1770	3890	7713	110	40	7.6	5.4	6.0	15.7	12.7	3.2	878	784	733	14	7	1.62	32	31	1.9	94	12	5.6
		3154.21	09/28/1999 1:00	1760	3872	7662	106	39	7.7	5.5	6.0	15.7	12.7	3.2	880	786	735	14	7	1.62	32	31	2.0	94	12	5.6
		3155.21	09/28/1999 2:00	1748	3854	7594	104	39	7.7	5.5	6.2	15.7	12.7	3.2	883	788	737	14	7	1.64	32	31	2.0	95	12	5.6
		3157.21	09/28/1999 4:00	1719	3778	7468	101	39	7.7	5.5	6.1	15.7	12.7	3.2	882	787	735	14	8	1.64	32	31	2.0	98	12	5.6
		3158.21	09/28/1999 5:00	1706	3729	7441	99	39	7.7	5.4	6.1	15.7	12.7	3.2	883	789	737	14	8	1.62	31	31	2.0	95	12	5.6
		3159.21	09/28/1999 6:00	1702	3716	7392	99	39	7.7	5.4	6.6	15.7	12.7	3.2	881	786	734	14	8	1.64	31	31	2.0	94	12	5.6
		3160.21	09/28/1999 7:00	1704	3735	7377	99	39	7.7	5.4	6.2	15.7	12.7	3.2	884	789	737	14	8	1.64	31	31	2.0	94	12	5.6
		3160.79	09/28/1999 7:35	1714	3535	6615	98	39	7.7	5.4	5.9	15.7	12.1	3.8	849	747	683	15	9	1.76	31	31	0.9	95	12	5.6
		3162.21	09/28/1999 9:00	1706	3539	6338	95	164	7.6	5.4	6.1	15.7	12.3	3.8	849	750	688	14	9	1.71	31	30	2.0	95	12	
		3163.21	09/28/1999 10:00	1696	3522	6358	94	60	7.6	5.4	6.0	15.7	12.3	3.8	849	751	690	14	9	1.69	31	30	0.8	95	12	
		3184.91	09/29/1999 7:43	1750	3957	5869	65	22	7.5	6.9	7.1	15.7	12.3	3.6	909	818	770	13	7	1.57	32	31	1.3	96	12	5.6
		3185.91	09/29/1999 8:43	1735	3837	6538	90	30	7.6	5.6	6.3	15.7	12.5	3.6	865	772	719	14	8	1.61	32	31	0.8	95	12	5.6
		3186.91	09/29/1999 9:43	1717	3770	6487	87	159	7.6	5.6	5.9	15.7	12.5	3.6	873	779	725	14	8	1.62	31	31	2.0	94	12	5.6
		3187.91	09/29/1999 10:43	1713	3743	6464	84	53	7.6	5.5	6.1	15.5	12.3	3.8	885	790	736	14	8	1.67	31	30	2.0	95	12	5.6
	Inc in Feed P	3188.91	09/29/1999 11:43	1729	3761	6468	84	58	7.6	5.5	6.1	15.7	12.3	3.8	906	809	754	14	8	1.67	30	29	0.6	94	12	5.6
		3189.92	09/29/1999 12:43	1750	3793	6521	86	45	7.5	5.3	6.1	15.7	12.3	3.8	912	816	760	14	8	1.66	30	29	2.0	94	12	5.6
		3190.91	09/29/1999 13:43	1769	3810	6487	84	41	7.5	5.4	5.9	15.7	11.0	3.8	917	824	768	14	8	1.61	29	28	2.0	94	11	5.6
		3191.91	09/29/1999 14:43	1793	3925	6812	85	97	7.5	5.5	6.5	15.7	12.3	3.8	939	844	789	14	8	1.64	29	28	0.5	94	12	5.6
		3192.91	09/29/1999 15:43	1797	3965	6843	86	71	7.5	5.4	6.3	15.7	12.5	3.8	938	842	787	14	8	1.66	29	28	2.0	94	12	5.6
		3193.91	09/29/1999 16:43	1789	3929	6752	84	53	7.5	5.4	6.0	15.8	12.3	3.8	940	844	790	14	8	1.63	29	28	2.0	93	12	5.6
		3197.91	09/29/1999 20:43	1798	3961	6755	80	36	7.5	5.5	6.4	15.7	12.3	3.8	949	853	799	14	8	1.66	29	28	2.0	94	12	5.6
		3199.91	09/29/1999 22:43	1808	3987	6729	77	36	7.5	5.6	6.4	15.7	12.3	3.8	954	858	805	14	8	1.66	29	28	1.7	92	12	5.6
		3200.91	09/29/1999 23:43	1811	4000	6713	76	34	7.6	5.7	6.4	15.7	12.3	3.8	957	861	808	14	8	1.66	29	28	2.0	92	12	5.6
		3201.91	09/30/1999 0:43	1802	4000	6667	75	34	7.6	5.7	6.3	15.7	12.3	3.8	956	861	808	14	8	1.64	29	28	2.0	92	12	5.6
		3205.91	09/30/1999 4:43	1808	4120	6015	62	23	7.6	6.9	7.5	15.7	12.1	3.6	987	896	848	13	7	1.57	29	28	1.8	95	12	5.6
		3206.91	09/30/1999 5:43	1808	4156	5957	62	22	7.6	6.9	7.2	15.7	12.3	3.8	992	901	854	13	7	1.57	29	28	2.0	94	12	5.6
		3210.92	09/30/1999 9:43	1821	4338	6852	80	33	7.6	5.7	6.4	15.7	12.5	3.6	977	886	840	13	7	1.57	29	28	2.0	98	12	5.6
		3211.92	09/30/1999 10:43	1807	4285	6773	80	279	7.6	5.7	6.1	15.7	12.3	3.3	973	882	836	13	7	1.57	29	28	0.5	101	12	5.6
		3212.92	09/30/1999 11:43	1824	4334	6870	82	100	7.6	5.6	6.5	15.7	12.5	3.6	973	882	837	13	7	1.57	29	28	2.0	95	12	5.6
		3215.92	09/30/1999 14:43	1851	4395	6992	85	292	7.5	5.6	6.2	15.7	12.5	3.6	963	872	828	13	6	1.57	30	29	2.0	95	12	5.6
		3217.92	09/30/1999 16:43	1868	4480	7076	86	54	7.5	5.7	6.4	15.7	12.5	3.6	955	865	821	13	6	1.56	31	30	1.2	93	12	5.6
		3219.92	09/30/1999 18:43	1859	4467	7023	84	62	7.6	5.7	5.9	15.7	12.5	3.6	942	854	811	13	6	1.52	31	30	2.0	94	12	5.6
		3220.92	09/30/1999 19:43	1850	4450	6979	82	46	7.6	5.7	6.2	15.7	12.5	3.6	949	861	817	13	6	1.52	31	30	2.0	95	12	5.6
		3221.92	09/30/1999 20:43	1843	4431	6922	79	38	7.6	5.7	6.9	15.7	12.5	3.6	956	868	824	13	6	1.52	31	30	2.0	96	12	5.6
		3222.92	09/30/1999 21:43	1840	4418	6860	78	36	7.6	5.8	6.3	15.7	12.5	3.6	964	875	832	13	6	1.54	30	30	0.7	94	12	5.6
		3223.92	09/30/1999 22:43	1840	4400	6808	76	35	7.6	5.8	6.3	15.7	12.5	3.8	970	882	838	13	6	1.52	30	29	2.0	93	12	5.6
		3224.92	09/30/1999 23:43	1835	4387	6763	75	34	7.6	5.8	6.4	15.7	12.5	3.6	976	887	843	13	6	1.54	30	29	1.7	105	12	5.6
		3225.92	10/01/1999 0:43	1830	4382	6710	74	33	7.6	5.8	6.6	15.7	12.3	3.6	980	891	847	13	6	1.54	30	29	2.0	94	12	5.6
		3226.92	10/01/1999 1:43	1825	4364	6683	74	33	7.6	5.8	6.3	15.7	12.3	3.6	978	889	846	13	6	1.54	30	29	2.0	94	12	5.6
		3227.92	10/01/1999 2:43	1817	4351	6653	74	32	7.6	5.8	6.4	15.7	12.3	3.6	984	895	851	13	6	1.54	30	29	2.0	94	12	5.6
		3229.92	10/01/1999 4:43	1791	4308	6578	72	33	7.6	5.8	6.4	15.7	12.5	3.6	988	899	855	13	6	1.54	30	29	0.5	93	12	5.6
		3230.92	10/01/1999 5:43	1779	4279	6526	71	33	7.6	5.8	6.5	15.7	12.3	3.6	991	901	857	13	6	1.55	30	29	2.0	93	12	5.6
		3231.92	10/01/1999 6:43	1784	4289	6555	71	32	7.6	5.8	6.8	15.6	12.3	3.8	992	903	858	13	6	1.55	30	29	2.0	92	12	5.6
		3232.90	10/01/1999 7:42	1800	4337	6640	71	33	7.6	5.8	6.3	15.7	12.5	3.8	1004	915	870	13	6	1.54	29	29	2.0	93	12	5.6
	End Inc in Feed P	3233.90	10/01/1999 8:42	1800	4324	6622	69	31	7.6	5.8	6.2	15.7	12.3	3.8	1013	923	878	13	7	1.56	29	28	1.0	93	12	5.6
14	RO Unit down due to decreasing Zenon MLSS	3308.51	10/04/1999 11:19																							
		3358.23	10/06/1999 13:02																							
		3359.23	10/06/1999 14:02	1778	3604	6883	136	219	7.4	6.1	2.9	15.0	11.4	3.5	825	729	669	14	9	1.77	30	30	0.1	140	11	5.6
		3361.23	10/06/1999 16:02	1784	3700	7745	161	120	7.4	6.1	2.7	15.2	11.4	3.3	836	747	692	13	8	1.60	31	30	0.1	88	11	5.6
		3363.23	10/06/1999 18:02	1767	3739	7193	122	71	7.5	6.3	3.8	15.2	11.2	3.1	846	752	698	14	8	1.68	31	31	0.1	88	11	5.6
		3364.23	10/06/1999 19:02	1790	3828	7307	108	59	7.5	3.9	6.6	15.2	11.4	3.4	847	752	698	14	8	1.71	31	31	0.1	88	11	5.6
		3365.23	10/06/1999 20:02	1808	4046	7382	160	74	7.6	3.5	6.3	15.2	11.4	3.2	813	717	667	14	7	1.71	31	30	0.1	92	11	5.6
		3367.23	10/06/1999 22:02	1785	3832	7443	154	47	7.7	5.2	5.2	15.2	11.9	3.2	822	728	676	14	8	1.69	30	30	0.1	92	11	5.6
		3368.23	10/06/1999 23:02	1767	3735	7280	123	42	7.7	5.0	5.2	15.2	11.8	3.4	851	757	704	14	8	1.69	30	30	0.1	89	11	5.6
		3369.23	10/07/1999 0:02	1748	3711	7176	117	38	7.7	5.2	5.7	15.2	11.8	3.4	856	761	708	14	8	1.70	30	29	0.1	123	11	5.6
		3371.23	10/07/1999 2:02	1712	3597	6974	95	34	7.8	6.2	7.0	15.2	12.1	3.4	876	781	726	14	8	1.71	30	29	0.1	89	12	5.6
		3372.23	10/07/1999 3:02	1693	3570	6918	96	30	7.8	6.0	6.7	15.2	12.1	3.4	871	776	721	14	8	1.71	30	29	0.1	93	12	5.6
		3375.23	10/07/1999 6:02	1639	3451	6712	89	27	7.8	6.3	6.9	15.2	12.1	3.4	874	778	723	14	8	1.73	30	29	0.1	88	12	5.6
		3376.23	10/07/1999 7:02	1625	3420	6650	87	26	7.8	6.3	6.9	15.2	12.1	3.4	876	779	724	14	8	1.74	29	29	0.2	88	12	5.6
		3377.23	10/07/1999 8:02	1634	3518	7012	103	27	7.8	5.5	6.4	15.2	12.5	3.4	876	781	729	14	8	1.71	29	29	1.3	89	12	

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
A	STARTUP		4/21/99 11:37 PM	14.96	32.04	68.42	0.39	0.99	0.96	1.00	97.40	2.60	648	94	1.118	3.54	13.58	3.59	19.3	8.9	1.43	79.04
			4/22/99 7:47 AM	14.43	30.05	60.00	0.37	0.99	1.01	1.00	97.45	2.55	677	99	1.093	3.32	12.74	3.37	19.6	8.5	1.33	75.78
			4/22/99 9:47 AM	14.30	30.45	59.46	0.38	0.99	0.96	1.00	97.34	2.66	671	98	1.112	3.34	12.81	3.38	18.9	9.1	1.30	76.86
			4/22/99 12:47 PM	14.50	33.64	73.56	0.44	0.99	1.17	1.00	96.98	3.02	657	95	1.144	3.32	12.73	3.36	18.6	7.3	1.44	76.88
			4/22/99 2:47 PM	14.70	35.07	75.04	0.48	0.99	1.26	1.00	96.77	3.23	648	94	1.171	3.24	12.45	3.29	18.5	7.3	1.66	75.35
			4/22/99 5:47 PM	14.89	37.20	82.05	0.53	0.99	1.32	1.00	96.47	3.53	648	94	1.202	3.07	11.77	3.11	16.3	6.7	1.76	76.10
			4/23/99 6:22 PM	14.36	42.14	111.82	0.80	0.99	1.35	1.00	94.45	5.55	805	117	1.208	2.13	8.18	2.16	11.3	3.3	2.09	82.71
			5/9/99 7:01 AM	13.05	41.76	55.31	0.51	0.99	1.05	1.01	96.13	3.87	698	102	1.168	3.23	12.39	3.27	18.0	8.2	1.02	75.47
			5/9/99 8:01 AM	13.09	41.88	55.93	0.51	0.99	1.09	1.00	96.07	3.93	697	101	1.165	3.20	12.29	3.25	17.8	8.0	1.03	74.47
			5/9/99 9:01 AM	13.03	41.85	55.84	0.53	0.98	1.05	1.00	95.91	4.09	698	102	1.168	3.23	12.39	3.27	17.9	8.0	1.03	75.47
			5/11/99 3:00 PM	14.25	52.60	73.46	1.50	0.97	1.14	1.00	89.44	10.56	1920	279	1.152	1.17	4.50	1.19	9.4	5.9	1.39	78.07
			5/17/99 12:00 AM	13.86	35.24	69.75	1.62	0.96	0.98	1.00	88.31	11.69	381	55	1.152	5.97	22.89	6.05	17.8	9.0	2.26	80.72
			5/18/99 1:57 PM	12.65	22.00	24.96	0.83	0.96	0.89	1.00	93.43	6.57	318	46	1.128	5.88	22.57	5.96	29.5	32.5	0.81	54.83
			5/19/99 12:57 AM	13.64	24.20	26.94	0.83	0.96	0.89	1.00	93.91	6.09	310	45	1.164	5.84	22.39	5.92	29.1	32.5	0.83	54.81
			5/19/99 1:48 PM	13.68	34.52	68.74	0.83	0.98	0.96	1.00	93.92	6.08	364	53	1.198	5.95	22.84	6.03	17.3	9.0	1.14	80.99
B	START OF TESTING	0.00	5/19/99 2:48 PM	13.82	35.19	70.25	0.83	0.98	1.07	1.00	93.99	6.01	376	55	1.205	5.65	21.69	5.73	17.4	9.1	1.12	79.05
		41.01	5/21/99 7:49 AM	13.63	50.91	56.04	0.83	0.98	0.91	1.00	93.90	6.10	757	110	1.155	2.73	10.49	2.77	12.8	6.4	1.68	77.84
		42.01	5/21/99 8:49 AM	13.55	51.82	56.26	0.83	0.98	1.05	1.00	93.87	6.13	829	121	1.161	2.52	9.65	2.55	14.0	6.6	1.65	74.70
		43.01	5/21/99 9:49 AM	13.51	53.76	60.90	1.03	0.97	1.36	1.00	92.36	7.64	835	121	1.171	2.30	8.82	2.33	13.5	6.0	1.96	70.03
		44.01	5/21/99 10:49 AM	13.51	78.74	119.52	1.42	0.98	2.01	1.00	89.51	10.49	854	124	1.175	2.45	9.40	2.48	11.5	2.9	3.85	77.46
		45.01	5/21/99 11:49 AM	13.58	78.36	166.55	1.41	0.98	2.70	1.00	89.61	10.39	741	108	1.185	2.76	10.58	2.80	10.9	2.8	5.63	78.07
		46.01	5/21/99 12:49 PM	13.68	71.79	154.34	1.51	0.98	2.84	1.00	88.98	11.02	806	117	1.202	2.21	8.48	2.24	8.9	2.9	5.87	74.97
		47.01	5/21/99 1:49 PM	13.84	65.24	140.56	1.53	0.98	2.56	1.00	88.92	11.08	862	125	1.209	1.85	7.11	1.88	7.5	2.7	5.52	74.97
		48.01	5/21/99 2:49 PM	13.93	61.14	131.72	1.55	0.98	1.76	1.00	88.85	11.15	965	140	1.219	1.76	6.76	1.78	6.9	2.9	6.74	81.56
		49.01	5/21/99 3:49 PM	13.94	57.23	115.76	1.53	0.98	1.63	1.00	88.99	11.01	1019	148	1.229	1.54	5.91	1.56	6.4	2.9	7.54	80.48
		50.01	5/21/99 4:49 PM	13.96	54.76	146.29	1.53	0.98	2.16	1.00	89.06	10.94	951	138	1.236	1.55	5.96	1.57	6.0	3.0	10.71	79.58
		51.01	5/21/99 5:49 PM	13.96	52.91	108.88	1.55	0.97	1.75	1.00	88.93	11.07	1054	153	1.240	1.34	5.15	1.36	5.7	2.9	9.33	77.72
		51.51	5/21/99 6:19 PM	13.95	52.08	107.15	1.45	0.98	1.81	1.00	89.60	10.40	1060	154	1.243	1.29	4.96	1.31	5.6	3.0	7.37	76.67
		52.51	5/21/99 7:19 PM	13.98	50.48	92.68	1.45	0.97	1.56	1.00	89.63	10.37	1105	161	1.240	1.20	4.62	1.22	5.6	2.9	7.12	76.62
		70.52	5/22/99 1:19 PM	13.74	37.26	56.17	1.36	0.96	1.51	1.00	90.12	9.88	1328	193	1.240	0.68	2.61	0.69	5.7	4.8	8.15	63.54
		71.52	5/22/99 2:19 PM	13.83	39.97	50.46	1.52	0.95	1.29	1.00	89.02	10.98	1330	193	1.250	0.72	2.75	0.73	6.3	4.8	5.84	64.91
		72.52	5/22/99 3:19 PM	13.91	41.72	53.69	1.56	0.95	1.29	1.00	88.76	11.24	1311	191	1.257	0.79	3.02	0.80	6.9	4.6	6.02	66.82
		73.52	5/22/99 4:19 PM	13.95	42.70	55.83	1.43	0.96	1.36	1.00	89.77	10.23	1295	188	1.265	0.81	3.12	0.82	7.2	4.8	5.82	66.26
		74.52	5/22/99 5:19 PM	13.96	43.76	55.80	1.56	0.96	1.18	1.00	88.82	11.18	1619	235	1.275	0.83	3.20	0.84	9.6	6.2	3.00	70.64
		75.52	5/22/99 6:19 PM	13.96	43.08	53.54	1.59	0.95	1.12	1.00	88.59	11.41	1625	236	1.275	0.85	3.25	0.86	9.8	6.3	2.64	71.06
		76.52	5/22/99 7:19 PM	13.93	41.88	59.98	1.58	0.96	1.32	1.00	88.63	11.37	1606	234	1.275	0.84	3.22	0.85	9.9	6.4	2.69	69.63
		77.52	5/22/99 8:19 PM	13.87	40.44	58.94	1.53	0.96	1.26	1.00	88.99	11.01	1610	234	1.265	0.85	3.24	0.86	10.2	6.4	2.37	70.64
		78.52	5/22/99 9:19 PM	13.86	38.99	54.75	1.48	0.96	1.19	1.00	89.34	10.66	1622	236	1.254	0.83	3.18	0.84	10.3	6.6	2.04	70.08
		79.52	5/22/99 10:19 PM	13.92	37.60	51.82	1.60	0.95	1.12	1.00	88.53	11.47	1633	237	1.243	0.83	3.18	0.84	10.3	6.8	1.82	70.21
		80.52	5/22/99 11:19 PM	13.91	36.37	53.38	1.57	0.95	1.19	1.00	88.69	11.31	1634	238	1.233	0.80	3.08	0.81	10.3	6.8	1.80	69.33
		81.52	5/23/99 12:19 AM	13.87	35.31	55.50	1.52	0.96	1.26	1.00	89.02	10.98	1632	237	1.226	0.79	3.03	0.80	10.3	7.0	1.76	68.84
		82.52	5/23/99 1:19 AM	13.85	34.47	54.55	1.49	0.96	1.26	1.00	89.21	10.79	1639	238	1.222	0.77	2.96	0.78	10.1	7.2	1.68	68.35
		83.52	5/23/99 2:19 AM	13.78	33.72	47.55	1.46	0.95	1.12	1.00	89.39	10.61	1663	242	1.215	0.75	2.86	0.76	10.1	7.0	1.45	67.85
		84.52	5/23/99 3:19 AM	13.71	33.00	49.27	1.44	0.95	1.18	1.00	89.50	10.50	1664	242	1.212	0.73	2.80	0.74	9.9	7.2	1.46	67.35
		85.52	5/23/99 4:19 AM	13.64	32.34	51.35	1.58	0.95	1.26	1.00	88.39	11.61	1664	242	1.212	0.71	2.73	0.72	9.8	7.0	1.53	66.79
		86.52	5/23/99 5:19 AM	13.57	31.80	50.27	1.58	0.95	1.20	1.00	88.34	11.66	1672	243	1.209	0.71	2.73	0.72	9.6	7.0	1.54	67.91
		88.39	5/23/99 7:11 AM	13.59	31.04	48.64	1.58	0.95	1.26	1.00	88.34	11.66	1684	245	1.205	0.66	2.52	0.67	9.3	6.9	1.57	65.10
		89.39	5/23/99 8:11 AM	13.58	30.84	45.01	1.58	0.95	1.13	1.00	88.35	11.65	1696	247	1.209	0.65	2.49	0.66	9.0	7.0	1.41	66.10
		90.39	5/23/99 9:11 AM	13.50	30.74	42.23	1.59	0.94	1.18	1.00	88.25	11.75	1704	248	1.215	0.61	2.34	0.62	9.1	6.9	1.35	62.75
		91.39	5/23/99 10:11 AM	13.44	30.55	44.35	1.58	0.95	1.24	1.00	88.23	11.77	1699	247	1.222	0.61	2.33	0.62	9.1	6.9	1.45	62.75
		92.39	5/23/99 11:11 AM	13.36	30.64	47.81	1.58	0.95	1.39	1.00	88.21	11.79	1742	253	1.233	0.59	2.25	0.60	9.2	7.0	1.53	61.66
		93.39	5/23/99 12:11 PM	13.48	30.84	45.41	1.59	0.95	1.25	1.00	88.18	11.82	1754	255	1.240	0.60	2.29	0.60	9.2	7.0	1.49	63.40
		94.39	5/23/99 1:11 PM	13.66	31.21	42.75	1.61	0.94	1.18	1.00	88.20	11.80	1760	256	1.250	0.57	2.20	0.58	9.0	7.0	1.36	62.73
		95.39	5/23/99 2:11 PM	13.78	31.55	48.45	1.61	0.95	1.32	1.00	88.31	11.69	1745	254	1.261	0.57	2.20	0.58	9.0	6.9	1.47	62.73
		96.39	5/23/99 3:11 PM	13.89	31.84	48.87	1.60	0.95	1.32	1.00	88.47	11.53	1743	254	1.272	0.57	2.18	0.58	9.1	6.9	1.58	62.73
		97.39	5/23/99 4:11 PM	13.93	32.09	48.99	1.63	0.95	1.32	1.00	88.31	11.69	1742	253	1.279	0.57	2.17	0.57	9.0	7.0	1.44	62.73
		98.39	5/23/99 5:11 PM	13.92	32.18	47.52	1.92	0.94	1.29	1.00	86.19	13.81	1747	254	1.286	0.56	2.16	0.57	9.2	7.0	1.39	62.76
		99.39	5/23/99 6:11 PM	13.93	32.17	46.84	1.88	0.94	1.30	1.00	86.54	13.46	1747	254	1.290	0.56	2.15	0.57	9.2	7.0	1.40	61.67
		100.39	5/23/99 7:11 PM	13.93	31.96	49.56	1.84	0.94	1.32	1.00	86.79	13.21	1742	253	1.290	0.58	2.22	0.59	9.2	7.2	1.39	63.38
		101.39	5/23/99 8:11 PM	13.93	31.60	46.70	1.80	0.94	1.30	1.00	87.07	12.93	1748	254	1.282	0.56	2.16	0.57	9.3	7.2	1.30	61.64
		102.39	5/23/99 9:11 PM	13.88	31.13	48.56	1.74	0.94	1.32	1.00	87.49	12.51	1744	254	1.272	0.57	2.18	0.58	9.3	7.2	1.39	62.73
		103.39	5/23/99 10:11 PM	13.81	30.66	45.52	1.69	0.94	1.30	1.00	87.78	12.22	1752	255	1.265	0.55	2.13	0.56	9.3	7.2	1.27	60.99
		104.39	5/23/99 11:11 PM	13.75	30.17	48.18	1.63	0.95	1.32	1.00	88.17	11.83	1747	254	1.254	0.58	2.21	0.58	9.5	7.2	1.34	62.73
		105.39	5/24/99 12:11 AM	13.71	29.80	45.25	1.59	0.95	1.24	1.00	88.43	11.57	1753	255	1.247	0.58	2.22	0.59	9.3	7.3	1.25	62.73
		106.39	5/24/99 1:11 AM	13.64	29.38	45.02	1.54	0.95	1.18	1.00	88.73	11.27	1755	255	1.236	0.60	2.29	0.61	9.3	7.5	1.21	64.47
		107.39	5/24/99 2:11 AM	13.57	29.01	46.71	1.51	0.95	1.26	1.00	88.85	11.15	1751	255	1.233	0.58	2.24	0.59	9.5	7.3	1.33	63.86
		108.39	5/24/99 3:11 AM	13.52	28.59	46.55	1.47	0.95	1.32	1.00	89.10	10.90	1753	255	1.229	0.57	2.19	0.58	9.5	7.5	1.28	62.09
		109.39	5/24/99 4:11 AM	13.45	28.26	43.49	1.44	0.95	1.24	1.00	89.33	10.67	1761	256	1.226	0.57	2.18	0.58	9.6	7.5	1.19	62.09
		110.39	5/24/99 5:11 AM	13.38	27.92	43.35	1.67	0.94	1.24	1.00	87.55	12.45	1762	256	1.222	0.57	2.19	0.58	9.6	7.5	1.18	62.06
		111.39	5/24/99 6:11 AM	13.33	27.64	43.28	1.65	0.94	1.19	1.00	87.60	12.40	1764	257	1.219	0.59	2.25	0.60	9.5	7.6	1.19	63.86
		112.89	5/24/99 7:42 AM	13.42	27.48	46.19	1.64	0.94	1.32	1.00	87.77	12.23	1753	255	1.219	0.57	2.20	0.58	9.6	7.6	1.27	62.08
		113.89	5/24/99 8:42 AM	13.52	27.14	42.11	1.63	0.94	1.17	1.00	87.95	12.05	1759	256	1.222	0.59	2.25	0.59	9.9	8.2	1.08	62.76
		114.89	5/24/99 9:42 AM	13.58	27.31	42.41	1.65	0.94	1.23	1.00	87.84	12.16	1759	256	1.233	0.57	2.17	0.57	9.8	8.0	1.11	60.98
1	After 1st Cleaning with Citric Acid (Stages 1 and 2)	147.69	5/25/99 6:29 PM	15.56	40.78	92.87	1.96	0.96	1.14	1.00	87.40	12.60	366	53	1.236	6.04	23.19	6.13	18.5	9.2	1.70	80.95
		148.69	5/25/99 7:29 PM	15.52	40.74	88.78	1.89	0.96	1.13	1.00	87.85	12.15	377	55	1.233	5.96	22.88	6.04	18.6	9.4	1.53	80.31
		149.69	5/25/99 8:29 PM	15.45	40.23	92.92	1.85	0.97	1.14	1.00	88.02	11.98	371	54	1.226	6.10	23.41	6.18	18.6	9.4	1.52	81.14
		150.69	5/25/99 9:29 PM	15.31	40.11	81.96	1.75	0.96	1.03	1.00	88.59	11.41	406	59	1.215	5.60	21.50	5.68	18.4	9.1	1.40	80.94
		151.69	5/25/99 10:29 PM	15.14	40.10	80.21	1.65	0.97	1.07	1.00	89.10	10.90	417	61	1.209	5.36	20.56	5.43	17.9	8.6	1.44	79.91
		152.69	5/25/99 11:29 PM	14.95	40.31	77.56	1.56	0.97	1.02	1.00	89.55	10.45	431	63	1.202	5.16	19.78	5.23	17.4	8.1	1.36	80.54
		153.69	5/26/99 12:29 AM	14.76	40.57	71.87	1.51	0.97	0.96	1.00	89.77	10.23	452	66	1.195	4.88	18.72	4.95	17.0	7.6	1.42	80.33
		154.69	5/26/99 1:29 AM	14.60	40.70	70.97	1.46	0.97	1.01	1.00	89.97	10.03	459	67	1.191	4.75	18.23	4.82	16.7	7.4	1.37	79.26
		155.69	5/26/99 2:29 AM	14.44	40.66	69.47	1.43	0.97	1.01	1.00	90.12	9.88	467	68	1.188	4.62	17.74	4.69	16.6	7.0	1.56	79.04
		156.69	5/26/99 3:29 AM	14.29	40.44	68.74	1.40	0.97	1.01	1.00	90.19	9.81	471	69	1.185	4.59	17.61	4.65	16.4	7.1	1.42	79.04
		157.69	5/26/99 4:29 AM	14.10	40.06	67.84	1.38	0.97	1.01	1.00	90.19	9.81	475	69	1.181	4.57	17.52	4.63	16.3	7.0	1.55	79.04
		158.69	5/26/99 5:29 AM	13.92	39.59	66.21	1.35	0.97	0.96	1.00	90.32	9.68	481	70	1.178	4.52	17.35	4.58	16.1	7.0	1.35	79.91
		159.69	5/26/99 6:29 AM	13.77	39.21	65.50	1.32	0.97	0.96	1.00	90.43	9.57	484	70	1.175	4.51	17.30	4.57	16.0	6.9	1.56	79.91
		160.69	5/26/99 7:29 AM	13.73	39.47	67.51	1.30	0.97	1.01	1.00	90.55	9.45	503	73	1.175	4.46	17.09	4.52	16.7	7.1	1.57	79.48
		161.69	5/26/99 8:29 AM	13.71	39.55	64.04	1.27	0.97	0.96	1.00	90.73	9.27	511	74	1.178	4.37	16.78	4.43	16.7	7.4	1.66	79.48
		162.69	5/26/99 9:29 AM	13.67	39.81	64.29	1.26	0.97	1.11	1.00	90.75	9.25	531	77	1.188	4.06	15.58	4.12	17.0	7.2	1.54	76.55
		184.58	5/27/99 7:23 AM	13.80	49.70	51.89	1.14	0.97	0.97	1.00	91.71	8.29	1145	167	1.171	1.78	6.83	1.80	11.5	7.2	1.53	74.41
		185.58	5/27/99 8:23 AM	13.76	24.43	22.36	0.99	0.95	0.88	1.00	92.81	7.19	574	83	1.161	2.26	8.69	2.30	20.0	28.2	1.05	45.99
		186.58	5/27/99 9:23 AM	13.70	53.95	59.89	1.31	0.96	1.01	1.00	90.47	9.53	1229	179	1.178	1.82	6.98	1.84	12.4	6.5	1.44	77.02
		188.57	5/27/99 11:22 AM	13.72	53.86	59.96	1.25	0.97	1.05	1.00	90.89	9.11	1350	196	1.195	1.61	6.18	1.63	12.0	6.8	1.57	75.98
		208.48	5/28/99 7:17 AM	13.58	43.12	47.69	1.11	0.96	1.06	1.00	91.84	8.16	1392	202	1.219	1.03	3.97	1.05	7.6	6.1	1.63	70.05
		209.48	5/28/99 8:17 AM	13.58	50.35	52.82	1.12	0.97	0.93	1.00	91.78	8.22	1806	263	1.219	1.20	4.59	1.21	10.8	7.5	1.64	76.22
		210.48	5/28/99 9:17 AM	13.55	49.53	52.19	1.14	0.97	1.21	1.00	91.55	8.45	1963	286	1.229	0.97	3.74	0.99	11.4	7.8	1.58	68.78
		233.77	5/29/99 8:34 AM																			

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
2	Dec to 50%	256.41	5/30/99 7:13 AM	13.53	23.12	24.86	0.95	0.95	0.89	1.00	92.94	7.06	272	40	1.185	5.44	20.88	5.52	24.4	28.6	0.82	51.83
		257.41	5/30/99 8:13 AM	13.73	23.57	25.75	0.97	0.95	0.93	1.00	92.93	7.07	276	40	1.188	5.34	20.50	5.42	24.8	29.0	0.83	50.77
		258.41	5/30/99 9:13 AM	13.84	23.81	25.70	0.94	0.95	0.91	1.00	93.18	6.82	275	40	1.195	5.34	20.48	5.41	24.8	29.0	0.82	51.30
		259.41	5/30/99 10:13 AM	13.93	24.31	26.65	0.94	0.95	0.91	1.00	93.26	6.74	277	40	1.202	5.49	21.06	5.56	24.7	28.3	0.84	52.81
		260.41	5/30/99 11:13 AM	14.00	24.59	26.77	1.02	0.95	0.91	1.00	92.72	7.28	276	40	1.209	5.47	20.98	5.54	24.5	28.3	0.83	52.81
		261.41	5/30/99 12:13 PM	14.10	25.00	26.97	1.04	0.95	0.91	1.00	92.65	7.35	277	40	1.219	5.39	20.69	5.47	24.4	28.1	0.83	52.76
		262.41	5/30/99 1:13 PM	14.22	25.29	27.17	0.97	0.95	0.90	1.00	93.17	6.83	267	39	1.226	5.46	20.95	5.54	24.0	27.5	0.83	52.88
		263.41	5/30/99 2:13 PM	14.32	25.62	27.62	1.00	0.95	0.92	1.00	93.00	7.00	265	39	1.236	5.46	20.95	5.53	24.0	27.6	0.84	52.37
		264.41	5/30/99 3:13 PM	14.44	25.95	27.86	1.16	0.95	0.91	1.00	91.96	8.04	264	38	1.243	5.51	21.16	5.59	23.8	27.5	0.84	52.85
		265.41	5/30/99 4:13 PM	14.44	26.16	27.34	1.13	0.95	0.91	1.00	92.20	7.80	265	39	1.250	5.40	20.72	5.48	23.9	27.5	0.82	52.33
		266.41	5/30/99 5:13 PM	14.42	26.24	27.83	1.15	0.95	0.90	1.00	92.04	7.96	264	38	1.257	5.51	21.14	5.58	23.8	27.6	0.83	53.37
		267.41	5/30/99 6:13 PM	14.34	26.11	27.66	1.18	0.94	0.90	1.00	91.79	8.21	264	38	1.257	5.50	21.10	5.57	24.0	27.4	0.83	53.37
		268.41	5/30/99 7:13 PM	14.26	25.90	27.52	1.09	0.95	0.90	1.00	92.33	7.67	264	38	1.254	5.52	21.17	5.59	23.8	27.4	0.83	53.35
		269.41	5/30/99 8:13 PM	14.23	25.53	27.46	1.14	0.95	0.90	1.00	91.97	8.03	266	39	1.247	5.51	21.15	5.59	24.0	27.5	0.83	53.35
		270.41	5/30/99 9:13 PM	14.11	25.17	26.96	1.10	0.95	0.90	1.00	92.20	7.80	266	39	1.240	5.42	20.80	5.50	24.0	27.4	0.83	52.87
		272.41	5/30/99 11:13 PM	13.95	24.76	26.41	0.99	0.95	0.89	1.00	92.91	7.09	278	40	1.222	5.36	20.58	5.44	24.5	28.1	0.82	53.36
		273.41	5/31/99 12:13 AM	13.90	24.55	26.33	0.95	0.95	0.89	1.00	93.17	6.83	279	41	1.215	5.37	20.62	5.45	24.6	28.1	0.82	53.36
		275.41	5/31/99 2:13 AM	13.91	24.30	26.62	0.90	0.96	0.93	1.00	93.54	6.46	279	41	1.209	5.31	20.38	5.38	24.4	28.3	0.84	51.78
		276.41	5/31/99 3:13 AM	13.89	24.18	26.30	0.99	0.95	0.91	1.00	92.88	7.12	281	41	1.205	5.27	20.24	5.35	24.5	28.3	0.83	52.32
		278.41	5/31/99 5:13 AM	13.80	23.93	25.86	0.99	0.95	0.89	1.00	92.83	7.17	283	41	1.198	5.28	20.27	5.36	24.4	28.3	0.82	52.85
		279.41	5/31/99 6:13 AM	13.73	23.77	25.73	0.96	0.95	0.89	1.00	92.98	7.02	283	41	1.195	5.29	20.30	5.36	24.4	28.3	0.82	52.85
		280.91	5/31/99 7:42 AM	13.82	23.85	25.91	0.96	0.95	0.91	1.00	93.05	6.95	283	41	1.195	5.19	19.91	5.26	24.4	28.4	0.83	51.83
		282.91	5/31/99 9:42 AM	13.92	23.49	24.80	1.03	0.95	0.90	1.00	92.60	7.40	231	34	1.202	5.44	20.88	5.52	20.8	25.0	0.81	49.73
		283.91	5/31/99 10:42 AM	14.37	24.22	26.03	1.16	0.94	0.91	1.00	91.90	8.10	224	33	1.209	5.56	21.33	5.64	20.6	24.7	0.83	49.73
		284.91	5/31/99 11:42 AM	14.10	24.35	25.97	1.04	0.95	0.92	1.00	92.63	7.37	220	32	1.219	5.75	22.08	5.83	20.8	24.5	0.83	50.30
		285.91	5/31/99 12:42 PM	14.23	24.96	26.17	1.28	0.94	0.90	1.00	91.00	9.00	221	32	1.229	5.82	22.32	5.90	20.9	24.5	0.82	51.44
		286.91	5/31/99 1:42 PM	14.29	27.52	32.05	1.24	0.95	0.93	1.00	91.29	8.71	299	44	1.240	5.39	20.69	5.47	23.0	22.9	0.85	58.50
		288.91	5/31/99 3:42 PM	14.48	31.71	43.56	1.43	0.95	0.94	1.00	90.12	9.88	363	53	1.261	5.14	19.74	5.21	20.9	16.6	0.90	68.79
		289.91	5/31/99 4:42 PM	14.49	32.00	43.57	1.44	0.95	0.94	1.00	90.07	9.93	363	53	1.265	5.13	19.67	5.20	20.9	16.5	0.90	68.79
		292.91	5/31/99 7:42 PM	14.52	31.88	42.34	1.41	0.95	0.91	1.00	90.28	9.72	366	53	1.265	5.09	19.51	5.16	20.9	16.4	0.88	68.79
		294.91	5/31/99 9:42 PM	14.39	31.12	41.99	1.36	0.95	0.95	1.00	90.56	9.44	371	54	1.247	5.01	19.22	5.08	20.9	16.5	0.88	67.75
		295.91	5/31/99 10:42 PM	14.33	30.80	41.40	1.35	0.95	0.92	1.00	90.62	9.38	375	55	1.236	5.00	19.18	5.07	20.9	16.5	0.88	68.47
		296.91	5/31/99 11:42 PM	14.28	30.62	42.11	1.30	0.95	0.95	1.00	90.87	9.13	385	56	1.226	4.98	19.11	5.05	21.5	16.9	0.89	68.08
		297.91	6/1/99 12:42 AM	14.27	30.29	42.10	1.25	0.96	0.98	1.00	91.21	8.79	388	56	1.219	4.90	18.82	4.97	21.5	16.8	0.90	67.05
		298.91	6/1/99 1:42 AM	14.24	30.04	41.56	1.25	0.96	0.95	1.00	91.19	8.81	389	57	1.212	4.91	18.84	4.98	21.4	16.9	0.89	67.77
		299.91	6/1/99 2:42 AM	14.19	29.83	41.43	1.24	0.96	0.95	1.00	91.27	8.73	391	57	1.205	4.92	18.87	4.99	21.4	16.9	0.90	67.75
		300.91	6/1/99 3:42 AM	14.14	29.63	41.29	1.21	0.96	0.95	1.00	91.43	8.57	394	57	1.202	4.90	18.79	4.96	21.5	16.9	0.90	67.75
		301.91	6/1/99 4:42 AM	14.10	29.42	40.73	1.21	0.96	0.95	1.00	91.39	8.61	396	58	1.198	4.81	18.47	4.88	21.3	17.0	0.89	67.42
		302.91	6/1/99 5:42 AM	14.04	29.17	39.39	1.18	0.96	0.92	1.00	91.59	8.41	400	58	1.191	4.80	18.41	4.86	21.4	16.9	0.87	67.47
		304.90	6/1/99 7:42 AM	13.98	29.09	40.03	1.18	0.96	0.92	1.00	91.54	8.46	411	60	1.191	4.81	18.45	4.88	21.9	17.1	0.88	68.09
3	2nd Cleaning with Citric Acid (Stage 1 Only)	305.90	6/1/99 8:42 AM	14.08	29.21	41.21	1.21	0.96	0.98	1.00	91.39	8.61	397	58	1.195	4.81	18.47	4.88	21.5	17.0	0.90	66.73
		328.42	6/2/99 7:13 AM	14.32	36.88	52.63	1.18	0.96	0.97	1.00	91.75	8.25	464	68	1.198	4.48	17.20	4.54	18.3	10.7	1.16	73.66
		329.42	6/2/99 8:13 AM	14.34	38.34	51.77	1.23	0.96	0.97	1.00	91.44	8.56	455	66	1.202	4.30	16.49	4.36	16.4	9.2	1.15	73.32
		331.42	6/2/99 10:13 AM	14.23	41.36	56.97	1.40	0.96	0.96	1.00	90.19	9.81	454	66	1.209	4.15	15.94	4.21	14.3	7.1	1.16	76.06
		334.42	6/2/99 1:13 PM	14.52	45.13	57.42	1.49	0.96	0.91	1.00	89.73	10.27	455	66	1.240	4.04	15.52	4.10	13.5	6.8	1.22	77.04
		337.42	6/2/99 4:13 PM	14.70	47.73	60.35	1.69	0.95	1.06	1.00	88.48	11.52	382	56	1.268	4.06	15.58	4.12	10.9	5.4	1.31	74.31
		352.50	6/3/99 7:18 AM	14.81	47.62	53.14	1.46	0.96	0.90	1.00	90.18	9.82	426	62	1.191	3.59	13.79	3.64	9.6	5.5	1.27	74.98
		353.50	6/3/99 8:18 AM	14.78	51.69	61.00	1.56	0.96	0.95	1.00	89.45	10.55	417	61	1.198	3.65	14.00	3.70	8.9	4.5	1.35	77.20
		357.50	6/3/99 12:18 PM	14.85	49.18	52.94	1.20	0.96	1.19	1.00	91.90	8.10	646	94	1.226	2.88	11.06	2.92	15.9	9.3	1.31	66.73
		359.45	6/3/99 2:15 PM	15.10	50.56	53.26	1.27	0.96	1.19	1.00	91.58	8.42	647	94	1.240	2.80	10.75	2.84	15.4	9.4	1.31	66.39
		362.45	6/3/99 5:15 PM	15.31	87.64	159.87	2.14	0.98	1.89	1.00	86.03	13.97	772	112	1.272	2.83	10.85	2.87	17.0	1.1	1.67	81.99
		363.45	6/3/99 6:15 PM	15.34	64.97	136.68	1.97	0.97	2.31	1.00	87.18	12.82	1069	155	1.282	1.57	6.01	1.59	9.9	1.5	3.31	74.25
		366.45	6/3/99 9:15 PM	15.74	49.42	88.53	1.83	0.96	1.19	1.00	88.40	11.60	1264	184	1.268	1.09	4.20	1.11	7.9	1.5	3.07	78.95
		367.45	6/3/99 10:15 PM	15.89	48.14	86.63	1.84	0.96	1.11	1.00	88.44	11.56	1278	186	1.257	1.07	4.10	1.08	7.8	1.5	2.97	79.89
		368.45	6/3/99 11:15 PM	15.87	46.90	84.95	1.84	0.96	1.19	1.00	88.42	11.58	1287	187	1.250	1.02	3.93	1.04	7.6	1.5	2.97	77.89
		369.45	6/4/99 12:15 AM	15.74	45.57	81.46	1.79	0.96	1.10	1.00	88.64	11.36	1300	189	1.247	0.99	3.82	1.01	7.5	1.5	2.89	78.85
		370.45	6/4/99 1:15 AM	15.57	44.30	80.55	1.77	0.96	1.20	1.00	88.64	11.36	1309	190	1.240	0.97	3.73	0.99	7.3	1.6	2.98	77.11
		373.45	6/4/99 4:15 AM	15.11	41.71	75.55	1.75	0.96	1.20	1.00	88.44	11.56	1329	193	1.233	0.92	3.53	0.93	7.4	1.6	2.76	76.29
		374.45	6/4/99 5:15 AM	14.98	41.15	67.51	1.70	0.96	1.01	1.00	88.64	11.36	1353	197	1.229	0.91	3.48	0.92	7.3	1.5	2.60	77.72
		375.45	6/4/99 6:15 AM	14.92	40.90	80.35	1.71	0.96	1.21	1.00	88.54	11.46	1319	192	1.229	0.93	3.57	0.94	7.2	1.6	2.98	77.69
		376.78	6/4/99 7:34 AM	14.96	40.73	79.27	1.53	0.97	1.31	1.00	89.74	10.26	1323	192	1.229	0.88	3.39	0.90	7.2	1.6	2.99	75.44
		377.78	6/4/99 8:35 AM	14.98	39.91	80.82	1.63	0.97	1.51	1.00	89.09	10.91	1315	191	1.226	0.87	3.34	0.88	7.4	1.6	3.12	72.25
		378.78	6/4/99 9:34 AM	14.93	40.39	73.27	1.66	0.96	1.37	1.00	88.92	11.08	1327	193	1.240	0.85	3.27	0.86	8.5	1.5	2.83	72.26
		378.78	6/4/99 9:35 AM	14.93	40.39	73.27	1.66	0.96	1.37	1.00	88.92	11.08	1327	193	1.240	0.85	3.27	0.86	8.5	1.5	2.83	72.26
		379.78	6/4/99 10:35 AM	14.86	21.75	21.25	0.96	0.95	0.89	1.00	93.54	6.46	1143	166	1.229	0.95	3.64	0.96	22.8	37.8	1.06	38.16
		380.78	6/4/99 11:35 AM	14.86	25.78	22.90	0.95	0.95	0.88	1.00	93.63	6.37	937	136	1.229	1.31	5.02	1.33	21.7	34.6	0.88	43.21
		381.78	6/4/99 12:35 PM	14.98	27.68	25.03	1.05	0.95	0.89	1.00	92.98	7.02	790	115	1.233	1.69	6.50	1.72	24.5	28.8	0.84	47.23
		382.56	6/4/99 1:22 PM	15.00	28.02	25.15	1.14	0.94	0.89	1.00	92.40	7.60	643	94	1.240	1.89	7.25	1.92	21.8	25.1	0.82	46.99
		383.56	6/4/99 2:22 PM	15.07	29.22	26.46	1.12	0.95	0.89	1.00	92.59	7.41	674	98	1.250	2.00	7.68	2.03	23.7	26.1	0.81	49.31
		384.56	6/4/99 3:22 PM	15.16	29.76	26.62	1.16	0.94	0.88	1.00	92.37	7.63	654	95	1.257	2.09	8.02	2.12	23.5	25.7	0.80	50.29
		401.20	6/5/99 8:00 AM																			
		402.19	6/5/99 8:59 AM	15.41	29.88	31.72	1.24	0.95	0.90	1.00	91.95	8.05	522	76	1.202	3.06	11.75	3.10	24.1	23.2	0.82	56.25
		403.19	6/5/99 9:59 AM	15.14	29.42	31.17	1.16	0.95	0.92	1.00	92.35	7.65	529	77	1.205	2.97	11.39	3.01	24.1	23.0	0.83	55.41
		404.19	6/5/99 10:59 AM	14.96	29.26	30.15	1.16	0.95	0.90	1.00	92.21	7.79	534	78	1.209	2.93	11.26	2.97	24.0	23.0	0.81	55.40
		405.19	6/5/99 11:59 AM	14.89	29.26	29.99	1.17	0.95	0.90	1.00	92.13	7.87	534	78	1.215	2.92	11.19	2.96	23.8	23.0	0.81	55.40
		407.19	6/5/99 1:59 PM	15.07	30.01	30.30	1.24	0.95	0.90	1.00	91.80	8.20	534	78	1.233	2.88	11.05	2.92	23.5	23.0	0.81	55.41
		408.19	6/5/99 2:59 PM	15.20	30.46	30.86	1.26	0.95	0.90	1.00	91.72	8.28	533	78	1.243	2.91	11.18	2.95	23.5	23.0	0.82	55.87
		409.19	6/5/99 3:59 PM	15.25	30.80	30.64	1.28	0.94	0.90	1.00	91.58	8.42	531	77	1.254	2.85	10.92	2.89	23.4	23.0	0.81	55.41
		410.19	6/5/99 4:59 PM	15.29	31.04	31.05	1.32	0.94	0.90	1.00	91.34	8.66	531	77	1.261	2.89	11.07	2.92	23.2	23.0	0.82	55.86
		412.19	6/5/99 6:59 PM	15.28	30.92	30.72	1.26	0.95	0.90	1.00	91.74	8.26	533	78	1.257	2.83	10.85	2.87	23.4	22.8	0.81	55.41
		413.19	6/5/99 7:59 PM	15.27	30.54	30.70	1.28	0.94	0.90	1.00	91.65	8.35	537	78	1.250	2.82	10.82	2.86	23.5	22.8	0.82	55.41
		414.19	6/5/99 8:59 PM	15.15	30.01	30.16	1.20	0.95	0.90	1.00	92.10	7.90	538	78	1.240	2.79	10.71	2.83	23.4	22.8	0.82	54.94
		415.19	6/5/99 9:59 PM	15.06	29.79	30.41	1.18	0.95	0.92	1.00	92.17	7.83	558	81	1.229	2.76	10.59	2.80	24.0	23.4	0.82	54.84
		416.19	6/5/99 10:59 PM	15.02	29.51	30.59	1.17	0.95	0.92	1.00	92.22	7.78	557	81	1.222	2.78	10.67	2.82	23.8	23.4	0.83	54.84
		419.19	6/6/99 1:59 AM	14.95	28.92	29.22	1.12	0.95	0.90	1.00	92.51	7.49	566	82	1.209	2.66	10.22	2.70	23.7	23.6	0.81	53.90
		420.19	6/6/99 2:59 AM	14.87	28.67	29.06	1.10	0.95	0.88	1.00	92.64	7.36	569	83	1.205	2.71	10.40	2.75	23.8	23.5	0.81	54.95
		421.19	6/6/99 3:59 AM	14.78	28.46	29.19	1.10	0.95	0.90	1.00	92.59	7.41	570	83	1.202	2.72	10.42	2.75	23.7	23.5	0.82	54.38
		422.19	6/6/99 4:59 AM	14.70	28.34	28.74	1.04	0.95	0.89	1.00	92.92	7.08	588	85	1.202	2.68	10.29	2.72	23.9	24.3	0.82	54.84
		423.19	6/6/99 5:59 AM	14.59	28.09	28.82	1.03	0.95	0.90	1.00	92.92	7.08	589	86	1.198	2.63	10.11	2.67	23.9	24.3	0.82	54.38
		424.45	6/6/99 7:15 AM	14.52	27.92	28.67	1.04	0.95	0.90	1.00	92.84	7.16	589	86	1.195	2.64	10.14	2.68	23.9	24.1	0.82	54.38
		426.45	6/6/99 9:15 AM	15.05	28.89	29.13	1.07	0.95	0.89	1.00	92.91	7.09	590	86	1.202	2.62	10.07	2.66	23.8	24.3	0.81	54.38
		427.45	6/6/99 10:15 AM	15.26	29.38	29.53	1.11	0.95	0.91	1.00	92.75	7.25	589	86	1.209	2.56	9.83	2.60	23.7	24.3	0.81	53.34
		428.45	6/6/99 11:15 AM	15.27	29.63	29.49	1.16	0.95	0.90	1.00	92.42	7.58	588	86	1.215	2.55	9.79	2.59	23.7	24.1	0.81	53.45
		429.45	6/6/99 12:15 PM	15.36	29.96	29.72	1.15	0.95	0.91	1.00	92.53	7.47	590	86	1.222	2.53	9.71	2.57	23.7	24.1	0.81	53.34
		430.45	6/6/99 1:15 PM	15.50	30.38	30.00	1.18	0.95	0.91	1.00	92.40	7.60	589	86	1.229	2.52	9.66	2.55	23.5	24.2	0.82	53.34
		431.45	6/6/99 2:15 PM	15.55	30.59	30.08	1.24	0.95	0.91	1.00	92.03	7.97	587	85	1.240	2.51	9.62	2.54	23.4	24.1	0.82	53.35
		432.45	6/6/99 3:15 PM	15.54	30.76	30.05	1.27	0.94	0.89	1.00	91.81	8.19	586	85	1.247	2.55	9.77	2.58	23.2	24.1	0.81	54.38
		433.45	6/6/99 4:15 PM	15.48	30.79	30.25	1.29	0.94	0.91	1.00	91.63	8.37	587	85	1.254	2.53	9.70	2.56	23.4	24.1	0.82	53.82

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		434.45	6/6/99 5:15 PM	15.46	30.84	30.20	1.31	0.94	0.91	1.00	91.51	8.49	585	85	1.257	2.53	9.71	2.56	23.3	24.1	0.82	53.82
		435.45	6/6/99 6:15 PM	15.44	30.84	29.86	1.33	0.94	0.89	1.00	91.40	8.60	586	85	1.261	2.52	9.66	2.55	23.4	24.0	0.81	54.38
		436.45	6/6/99 7:15 PM	15.42	30.66	30.13	1.29	0.94	0.91	1.00	91.65	8.35	588	85	1.257	2.52	9.66	2.55	23.5	24.0	0.82	53.83
		437.45	6/6/99 8:15 PM	15.33	30.21	29.64	1.29	0.94	0.89	1.00	91.60	8.40	589	86	1.250	2.53	9.70	2.56	23.5	23.8	0.82	54.38
		438.45	6/6/99 9:15 PM	15.24	29.80	29.48	1.27	0.94	0.91	1.00	91.66	8.34	592	86	1.240	2.49	9.54	2.52	23.5	24.0	0.82	53.34
		439.45	6/6/99 10:15 PM	15.13	29.42	29.23	1.17	0.95	0.90	1.00	92.28	7.72	594	86	1.229	2.50	9.58	2.53	23.4	24.0	0.82	53.34
		441.45	6/7/99 12:15 AM	14.98	28.84	29.22	1.15	0.95	0.92	1.00	92.32	7.68	612	89	1.212	2.46	9.43	2.49	23.8	24.6	0.83	52.80
		442.45	6/7/99 1:15 AM	14.91	28.59	28.23	1.08	0.95	0.89	1.00	92.73	7.27	619	90	1.209	2.44	9.36	2.47	24.0	24.8	0.81	53.34
		443.45	6/7/99 2:15 AM	14.86	28.35	28.14	1.06	0.95	0.89	1.00	92.88	7.12	621	90	1.202	2.44	9.37	2.47	23.8	24.7	0.81	53.34
		444.45	6/7/99 3:15 AM	14.83	28.17	28.08	1.08	0.95	0.89	1.00	92.74	7.26	621	90	1.198	2.45	9.40	2.48	23.8	24.8	0.82	53.34
		445.45	6/7/99 4:15 AM	14.75	27.97	27.94	1.09	0.95	0.91	1.00	92.60	7.40	624	91	1.195	2.40	9.21	2.43	23.7	24.9	0.82	52.31
		446.45	6/7/99 5:15 AM	14.68	27.80	27.81	1.05	0.95	0.91	1.00	92.86	7.14	626	91	1.195	2.39	9.17	2.42	23.8	24.9	0.82	52.32
		448.39	6/7/99 7:12 AM	14.55	27.43	27.55	1.05	0.95	0.93	1.00	92.78	7.22	627	91	1.191	2.35	9.00	2.38	23.7	24.8	0.82	51.29
		449.39	6/7/99 8:12 AM	14.53	27.48	27.50	1.05	0.95	0.93	1.00	92.77	7.23	628	91	1.195	2.34	8.97	2.37	23.5	25.0	0.82	51.28
		472.88	6/8/99 7:41 AM	14.92	26.65	25.34	0.90	0.96	0.88	1.00	93.95	6.05	494	72	1.198	2.79	10.69	2.82	22.5	31.7	0.81	48.22
		473.88	6/8/99 8:41 AM	14.92	26.60	25.34	0.89	0.96	0.88	1.00	94.01	5.99	496	72	1.202	2.76	10.59	2.80	22.4	31.6	0.82	48.07
		474.88	6/8/99 9:41 AM	14.87	26.69	25.26	0.95	0.95	0.90	1.00	93.64	6.36	495	72	1.209	2.70	10.34	2.73	22.4	31.6	0.81	47.17
4	3rd Cleaning (Citric Acid Stage 2 on 6/8; Citric Acid Stage 1 on 6/9; Caustic Stage 1 on 6/10)	475.88	6/8/99 10:41 AM	14.83	26.70	24.87	0.96	0.95	0.99	1.00	93.53	6.47	485	71	1.219	2.37	6.40	1.69	24.2	31.1	0.80	41.44
C	Operate Stage 1 Only at 60%	544.50	6/11/99 7:18 AM	14.19	26.77	23.28	0.56	0.97	0.89	1.00	96.08	3.92	399	58	1.198	3.30	8.89	2.35	24.2		0.69	46.15
		545.50	6/11/99 8:18 AM	14.25	28.02	24.31	0.57	0.97	0.91	1.00	96.01	3.99	455	66	1.198	3.22	8.68	2.29	26.9		0.69	47.00
		547.50	6/11/99 10:18 AM	14.29	28.51	24.42	0.61	0.97	0.89	1.00	95.72	4.28	450	65	1.219	3.26	8.79	2.32	26.8		0.69	47.89
		548.50	6/11/99 11:18 AM	14.20	28.56	24.25	0.63	0.97	0.89	1.00	95.59	4.41	452	66	1.226	3.23	8.71	2.30	26.8		0.69	47.89
		550.50	6/11/99 1:18 PM	14.29	29.05	23.97	0.65	0.97	0.86	1.00	95.43	4.57	452	66	1.247	3.24	8.74	2.31	26.8		0.67	48.84
		551.50	6/11/99 2:18 PM	14.37	29.43	24.72	0.67	0.97	0.87	1.00	95.37	4.63	449	65	1.258	3.30	8.89	2.35	26.7		0.69	49.34
		552.50	6/11/99 3:18 PM	14.44	29.81	24.62	0.67	0.97	0.86	1.00	95.38	4.62	449	65	1.268	3.27	8.81	2.33	26.8		0.68	49.77
		553.50	6/11/99 4:18 PM	14.46	30.05	24.65	0.66	0.97	0.84	1.00	95.44	4.56	449	65	1.279	3.30	8.90	2.35	26.8		0.68	50.72
		554.50	6/11/99 5:18 PM	14.37	30.09	24.50	0.64	0.97	0.86	1.00	95.54	4.46	448	65	1.283	3.24	8.74	2.31	26.6		0.68	49.78
		555.50	6/11/99 6:18 PM	14.32	29.84	24.64	0.62	0.97	0.86	1.00	95.70	4.30	448	65	1.283	3.30	8.91	2.35	26.6		0.68	50.25
		556.50	6/11/99 7:18 PM	14.26	29.51	24.43	0.59	0.97	0.85	1.00	95.83	4.17	449	65	1.275	3.31	8.92	2.36	26.6		0.68	50.49
		557.50	6/11/99 8:18 PM	14.21	29.13	24.24	0.58	0.97	0.86	1.00	95.92	4.08	451	66	1.265	3.26	8.80	2.33	26.7		0.68	49.77
		558.50	6/11/99 9:18 PM	14.19	28.81	24.21	0.56	0.97	0.86	1.00	96.03	3.97	453	66	1.254	3.27	8.83	2.33	26.7		0.69	49.77
		559.50	6/11/99 10:18 PM	14.10	28.30	23.67	0.54	0.97	0.84	1.00	96.14	3.86	456	66	1.243	3.28	8.85	2.34	26.6		0.68	49.77
		560.50	6/11/99 11:18 PM	14.00	27.92	23.66	0.53	0.97	0.84	1.00	96.25	3.75	458	67	1.233	3.30	8.89	2.35	26.8		0.68	50.24
		561.50	6/12/99 12:18 AM	13.98	27.68	23.64	0.49	0.97	0.84	1.00	96.49	3.51	461	67	1.226	3.29	8.88	2.35	26.8		0.69	50.24
		562.50	6/12/99 1:18 AM	13.98	27.55	23.38	0.49	0.97	0.85	1.00	96.46	3.54	461	67	1.219	3.25	8.75	2.31	26.8		0.68	49.29
		563.50	6/12/99 2:18 AM	14.05	27.60	23.74	0.49	0.97	0.86	1.00	96.48	3.52	460	67	1.216	3.27	8.80	2.33	26.7		0.69	49.29
		564.50	6/12/99 3:18 AM	14.02	27.51	23.72	0.49	0.97	0.86	1.00	96.50	3.50	461	67	1.216	3.25	8.77	2.32	26.8		0.69	49.29
		565.50	6/12/99 4:18 AM	14.02	27.48	23.35	0.49	0.97	0.85	1.00	96.50	3.50	462	67	1.212	3.26	8.78	2.32	26.8		0.68	49.29
		566.50	6/12/99 5:18 AM	13.98	27.39	23.29	0.49	0.97	0.85	1.00	96.49	3.51	463	67	1.209	3.26	8.79	2.32	26.7		0.68	49.29
		568.43	6/12/99 7:14 AM	14.02	27.39	23.50	0.49	0.97	0.84	1.00	96.50	3.50	463	67	1.205	3.27	8.82	2.33	26.8		0.68	49.76
		569.43	6/12/99 8:14 AM	13.93	27.23	23.24	0.49	0.97	0.85	1.00	96.47	3.53	462	67	1.212	3.26	8.78	2.32	26.6		0.68	49.29
		570.49	6/12/99 9:17 AM	13.85	27.11	23.44	0.50	0.97	0.86	1.00	96.37	3.63	461	67	1.215	3.25	8.77	2.32	26.8		0.69	49.29
		571.49	6/12/99 10:17 AM	13.78	26.49	22.87	0.54	0.97	0.90	1.00	96.09	3.91	407	59	1.219	3.18	8.57	2.27	24.2		0.69	45.69
		572.98	6/12/99 11:46 AM	13.70	26.45	22.27	0.55	0.97	0.87	1.00	95.96	4.04	398	58	1.229	3.23	8.70	2.30	23.7		0.68	46.63
		573.49	6/12/99 12:17 PM	13.73	26.61	22.55	0.56	0.97	0.89	1.00	95.92	4.08	398	58	1.233	3.22	8.68	2.29	23.8		0.69	46.15
		574.49	6/12/99 1:17 PM	13.82	27.02	22.70	0.59	0.97	0.89	1.00	95.77	4.23	397	58	1.243	3.20	8.63	2.28	23.9		0.68	46.16
		575.49	6/12/99 2:17 PM	13.88	27.43	23.02	0.61	0.97	0.89	1.00	95.61	4.39	395	58	1.254	3.26	8.78	2.32	23.8		0.69	46.69
		576.49	6/12/99 3:17 PM	13.93	27.81	22.88	0.63	0.97	0.89	1.00	95.49	4.51	394	57	1.265	3.17	8.54	2.26	23.9		0.68	46.16
		577.49	6/12/99 4:17 PM	13.93	27.93	22.88	0.64	0.97	0.87	1.00	95.44	4.56	392	57	1.272	3.24	8.74	2.31	23.8		0.68	47.18
		578.49	6/12/99 5:17 PM	13.95	27.97	23.07	0.64	0.97	0.88	1.00	95.41	4.59	379	55	1.279	3.25	8.78	2.32	23.3		0.68	46.62
		579.49	6/12/99 6:17 PM	13.95	28.01	23.06	0.63	0.97	0.88	1.00	95.49	4.51	382	56	1.279	3.24	8.73	2.31	23.3		0.68	46.65
		580.49	6/12/99 7:17 PM	13.93	27.85	22.99	0.61	0.97	0.88	1.00	95.64	4.36	383	56	1.275	3.24	8.73	2.31	23.3		0.68	46.63
		581.49	6/12/99 8:17 PM	13.91	27.58	23.50	0.59	0.97	0.92	1.00	95.76	4.24	401	58	1.268	3.18	8.57	2.26	20.8		0.70	45.77
		582.49	6/12/99 9:17 PM	13.88	27.36	22.99	0.57	0.97	0.87	1.00	95.91	4.09	395	57	1.258	3.32	8.95	2.36	23.8		0.69	47.72
		583.49	6/12/99 10:17 PM	13.84	26.98	22.70	0.55	0.97	0.85	1.00	96.04	3.96	396	58	1.243	3.35	9.03	2.39	23.7		0.68	48.21
		584.49	6/12/99 11:17 PM	13.75	26.65	22.55	0.53	0.97	0.87	1.00	96.11	3.89	399	58	1.233	3.28	8.84	2.34	23.9		0.68	47.17
		585.49	6/13/99 12:17 AM	13.66	26.28	22.40	0.52	0.97	0.87	1.00	96.17	3.83	401	58	1.226	3.28	8.85	2.34	23.9		0.69	47.18
		586.49	6/13/99 1:17 AM	13.63	26.11	22.14	0.52	0.97	0.83	1.00	96.22	3.78	401	58	1.219	3.37	9.08	2.40	23.9		0.68	48.70
		587.49	6/13/99 2:17 AM	13.56	25.99	22.28	0.51	0.97	0.85	1.00	96.22	3.78	402	59	1.212	3.38	9.12	2.41	23.9		0.68	48.20
		588.49	6/13/99 3:17 AM	13.52	25.91	22.06	0.50	0.97	0.84	1.00	96.28	3.72	413	60	1.212	3.36	9.07	2.40	24.5		0.68	48.73
		589.49	6/13/99 4:17 AM	13.48	25.65	21.92	0.51	0.97	0.84	1.00	96.23	3.77	403	59	1.209	3.39	9.14	2.41	23.9		0.68	48.72
		590.49	6/13/99 5:17 AM	13.47	25.78	21.99	0.50	0.97	0.84	1.00	96.30	3.70	416	61	1.209	3.35	9.03	2.38	24.5		0.68	48.73
		591.49	6/13/99 6:17 AM	13.52	25.82	22.06	0.50	0.97	0.84	1.00	96.32	3.68	415	60	1.205	3.37	9.08	2.40	24.5		0.68	48.73
		591.97	6/13/99 6:46 AM	13.54	25.82	21.89	0.50	0.97	0.82	1.00	96.29	3.71	415	60	1.205	3.37	9.08	2.40	24.3		0.68	49.20
		592.49	6/13/99 7:17 AM	13.53	25.82	21.82	0.50	0.97	0.82	1.00	96.32	3.68	417	61	1.205	3.35	9.02	2.38	24.5		0.67	49.12
		593.49	6/13/99 8:17 AM	13.46	25.70	22.05	0.50	0.97	0.83	1.00	96.31	3.69	415	60	1.205	3.37	9.08	2.40	24.5		0.68	49.24
		623.31	6/14/99 2:06 PM	13.64	42.27	38.57	0.63	0.98	0.89	1.00	95.39	4.61	620	90	1.243	3.01	8.11	2.14	17.0		0.91	68.47
		623.63	6/14/99 2:26 PM	13.72	42.45	42.48	0.63	0.98	0.92	0.92	95.41	4.59	609	89	1.243	3.06	8.25	2.18	16.9			67.76
		624.63	6/14/99 3:26 PM	13.78	42.15	42.10	0.63	0.98	1.12	0.91	95.43	4.57	634	92	1.251	2.57	6.93	1.83	17.0			59.53
		625.63	6/14/99 4:26 PM	13.80	42.62	42.39	0.62	0.98	0.92	0.89	95.53	4.47	651	95	1.261	2.83	7.62	2.01	17.0			66.40
		626.63	6/14/99 5:26 PM	13.77	42.53	42.25	0.60	0.98	0.92	0.90	95.67	4.33	638	93	1.265	2.83	7.63	2.01	17.2			66.73
		627.63	6/14/99 6:26 PM	13.71	41.97	41.66	0.59	0.98	1.01	0.90	95.71	4.29	624	91	1.268	2.71	7.30	1.93	16.6			63.28
		628.64	6/14/99 7:26 PM	13.70	41.42	41.24	0.58	0.98	1.04	0.90	95.79	4.21	627	91	1.261	2.62	7.07	1.87	16.4			61.84
		629.63	6/14/99 8:26 PM	13.61	40.87	40.82	0.56	0.98	1.09	0.90	95.88	4.12	630	92	1.254	2.53	6.83	1.80	16.4			59.74
		630.64	6/14/99 9:26 PM	13.60	40.47	40.52	0.55	0.98	1.09	0.90	95.94	4.06	632	92	1.247	2.50	6.73	1.78	16.4			59.30
		631.64	6/14/99 10:26 PM	13.66	40.31	40.52	0.55	0.98	1.06	0.90	95.98	4.02	634	92	1.243	2.54	6.85	1.81	16.2			60.35
		632.64	6/14/99 11:26 PM	13.64	40.10	40.40	0.54	0.98	1.06	0.90	96.03	3.97	638	93	1.236	2.49	6.72	1.78	16.3			59.94
		633.64	6/15/99 12:26 AM	13.63	39.76	40.18	0.54	0.98	1.04	0.88	96.06	3.94	638	93	1.233	2.50	6.74	1.78	16.1			59.94
		634.64	6/15/99 1:26 AM	13.60	39.46	40.06	0.53	0.98	1.09	0.90	96.10	3.90	642	93	1.229	2.44	6.59	1.74	16.2			58.86
		635.64	6/15/99 2:26 AM	13.54	39.17	39.84	0.53	0.98	1.12	0.90	96.12	3.88	641	93	1.226	2.41	6.50	1.72	16.0			57.79
		636.64	6/15/99 3:26 AM	13.45	38.78	39.47	0.52	0.98	1.06	0.89	96.11	3.89	642	93	1.226	2.45	6.61	1.75	16.0			59.49
		637.64	6/15/99 4:26 AM	13.40	38.53	39.25	0.52	0.98	1.06	0.90	96.16	3.84	644	94	1.222	2.45	6.62	1.75	15.9			59.50
		638.64	6/15/99 5:26 AM	13.32	38.19	38.96	0.51	0.98	1.09	0.90	96.18	3.82	645	94	1.219	2.41	6.50	1.72	16.0			58.42
		639.64	6/15/99 6:26 AM	13.31	37.98	38.80	0.51	0.98	1.06	0.88	96.20	3.80	647	94	1.215	2.41	6.50	1.72	15.9			58.42
		640.57	6/15/99 7:22 AM	13.47	38.10	39.05	0.51	0.98	1.06	0.91	96.22	3.78	648	94	1.212	2.46	6.63	1.75	15.9			59.50
		641.57	6/15/99 8:22 AM	13.54	38.28	39.22	0.52	0.98	1.01	0.88	96.19	3.81	647	94	1.212	2.51	6.75	1.78	15.9			60.60
		642.57	6/15/99 9:22 AM	13.53	38.36	39.26	0.52	0.98	1.04	0.87	96.13	3.87	648	94	1.212	2.41	6.50	1.72	15.9			59.06
		643.57	6/15/99 10:22 AM	13.51	38.58	39.31	0.54	0.98	1.06	0.90	96.01	3.99	645	94	1.226	2.44	6.58	1.74	15.7			59.50
		644.57	6/15/99 11:22 AM	13.47	38.83	39.22	0.55	0.98	1.06	0.90	95.94	4.06	645	94	1.233	2.43	6.55	1.73	15.9			59.50
		645.57	6/15/99 12:22 PM	13.56	39.13	39.44	0.56	0.98	1.07	0.90	95.89	4.11	643	94	1.240	2.41	6.50	1.72	15.7			59.23
		646.57	6/15/99 1:22 PM																			
		648.69	6/15/99 3:30 PM	13.97	30.81	30.46	0.56	0.97	0.85	0.86	96.02	3.98	532	77	1.265	2.82	7.60	2.01	19.9			54.30
		649.70	6/15/99 4:30 PM	14.51	32.60	32.20	0.60	0.97	0.89	0.85	95.90	4.10	492	72	1.268	2.87	7.73	2.04	23.3			52.87
		650.69	6/15/99 5:30 PM	14.66	32.85	32.41	0.60	0.97	0.89	0.86	95.91	4.09	491	71	1.272	2.92	7.89	2.08	22.9			53.35

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		651.70	6/15/99 6:30 PM	14.67	32.09	31.90	0.58	0.97	0.85	0.85	96.02	3.98			1.258				20.3			54.47
		652.69	6/15/99 7:30 PM	14.57	31.64	31.62	0.57	0.98	0.85	0.86	96.11	3.89	493	72	1.247	2.97	8.00	2.11	20.3			54.48
		653.70	6/15/99 8:30 PM	14.46	31.26	31.33	0.55	0.98	0.85	0.86	96.19	3.81	492	72	1.240	2.99	8.07	2.13	20.3			54.48
		654.69	6/15/99 9:30 PM	14.34	30.76	31.00	0.54	0.98	0.85	0.85	96.25	3.75	494	72	1.229	2.95	7.94	2.10	20.3			53.99
		655.70	6/15/99 10:30 PM	14.25	30.43	30.80	0.53	0.98	0.85	0.85	96.30	3.70	493	72	1.226	2.96	7.98	2.11	20.3			53.99
		656.70	6/15/99 11:30 PM	14.20	30.18	30.64	0.52	0.98	0.85	0.85	96.35	3.65			1.219				20.3			53.99
		657.70	6/16/99 12:30 AM	14.05	29.81	30.30	0.51	0.98	0.83	0.84	96.37	3.63	499	73	1.215	2.95	7.96	2.10	20.3			54.58
		658.70	6/16/99 1:30 AM																			
		659.69	6/16/99 2:30 AM																			
		660.70	6/16/99 3:30 AM																			
		661.69	6/16/99 4:30 AM																			
		662.70	6/16/99 5:30 AM																			
		663.69	6/16/99 6:30 AM																			
		665.70	6/16/99 8:30 AM	12.89	27.48	28.04	0.44	0.98	0.87	0.86	96.57	3.43	550	80	1.209	2.80	7.54	1.99	19.6			53.83
		665.74	6/16/99 8:32 AM	12.89	27.43	27.96	0.45	0.98	0.85	0.86	96.52	3.48	551	80	1.209	2.84	7.67	2.03	21.8			54.29
		688.45	6/17/99 7:15 AM	13.26	23.81	24.35	0.81	0.96	0.90	0.85	93.87	6.13	253	37	1.209	2.98	8.03	2.12	12.0			42.30
		689.45	6/17/99 8:15 AM	13.32	23.89	24.40	0.80	0.96	0.90	0.85	93.99	6.01	253	37	1.209	2.98	8.02	2.12	12.2			42.27
		690.45	6/17/99 9:15 AM	13.25	23.97	24.38	0.80	0.96	0.90	0.85	93.98	6.02	253	37	1.219	2.95	7.97	2.10	12.0			42.27
		691.45	6/17/99 10:15 AM	13.20	23.45	23.81	0.91	0.95	0.90	0.85	93.10	6.90	217	32	1.226	3.16	8.51	2.25	10.9			41.75
		736.85	6/19/99 7:39 AM	14.01	22.62	22.65	0.43	0.98	0.84	0.92	96.96	3.04	175	26	1.209	3.96	10.68	2.82	11.1			43.26
		738.85	6/19/99 9:39 AM	13.87	22.62	22.65	0.42	0.98	0.84	0.92	96.98	3.02	176	26	1.222	4.07	10.98	2.90	11.1			44.27
		739.85	6/19/99 10:39 AM	13.78	22.67	22.69	0.44	0.98	0.84	0.91	96.82	3.18	175	25	1.233	4.06	10.95	2.89	11.1			44.27
		740.85	6/19/99 11:39 AM	13.69	22.40	22.48	0.46	0.97	1.00	0.92	96.65	3.35	174	25	1.240	3.07	8.28	2.19	11.1			33.60
		741.85	6/19/99 12:39 PM	13.76	22.62	22.71	0.47	0.97	0.87	0.91	96.62	3.38	173	25	1.243	3.90	10.53	2.78	11.1			42.49
		742.85	6/19/99 1:39 PM	13.88	22.72	22.81	0.50	0.97	0.87	0.92	96.38	3.62	173	25	1.247	3.89	10.50	2.77	11.0			42.49
		743.85	6/19/99 2:39 PM	14.00	22.94	22.89	0.48	0.97	0.92	0.94	96.59	3.41	173	25	1.254	3.71	10.02	2.65	11.2			40.00
		744.85	6/19/99 3:39 PM	14.05	22.95	22.97	0.48	0.97	0.90	0.92	96.55	3.45	171	25	1.251	3.75	10.12	2.67	11.2			40.71
		745.85	6/19/99 4:39 PM	14.10	23.04	23.06	0.47	0.97	0.90	0.92	96.64	3.36	170	25	1.254	3.76	10.15	2.68	11.0			40.71
		746.85	6/19/99 5:39 PM	14.10	23.04	23.06	0.45	0.98	0.90	0.92	96.79	3.21	171	25	1.254	3.75	10.12	2.67	11.1			40.71
		747.85	6/19/99 6:39 PM	14.11	23.20	23.17	0.47	0.97	0.90	0.92	96.66	3.34	169	25	1.250	3.80	10.25	2.71	11.0			40.71
		748.85	6/19/99 7:39 PM	14.19	23.07	23.17	0.46	0.98	0.90	0.91	96.79	3.21	167	24	1.247	3.69	9.94	2.63	10.8			39.65
		760.20	6/20/99 7:00 AM																			
		763.20	6/20/99 10:00 AM	14.37	23.32	23.39	0.54	0.97	1.06	0.93	96.22	3.78	180	26	1.247	2.79	7.54	1.99	11.2			30.72
		764.20	6/20/99 11:00 AM	14.30	23.32	23.38	0.58	0.97	0.95	0.93	95.93	4.07	181	26	1.250	3.39	9.15	2.42	11.4			37.58
		765.20	6/20/99 12:00 PM	14.16	23.12	23.17	0.55	0.97	1.00	0.93	96.08	3.92	183	27	1.243	3.07	8.28	2.19	11.4			34.16
		766.20	6/20/99 1:00 PM	14.06	23.19	23.26	0.57	0.97	0.95	0.92	95.97	4.03	182	26	1.243	3.40	9.18	2.43	11.3			37.61
		767.20	6/20/99 2:00 PM	14.06	23.00	23.10	0.57	0.97	0.93	0.93	95.95	4.05	183	27	1.236	3.56	9.61	2.54	11.4			39.32
		768.20	6/20/99 3:00 PM	14.09	23.03	23.02	0.56	0.97	0.92	0.93	96.00	4.00	183	27	1.229	3.58	9.66	2.55	11.4			39.32
		769.20	6/20/99 4:00 PM	14.12	23.12	23.10	0.58	0.97	0.93	0.93	95.89	4.11	183	27	1.226	3.59	9.69	2.56	11.4			39.32
		770.20	6/20/99 5:00 PM	14.14	23.07	23.07	0.59	0.97	0.92	0.91	95.84	4.16	183	27	1.222	3.44	9.29	2.45	11.4			38.26
		771.20	6/20/99 6:00 PM	14.18	23.07	23.05	0.58	0.97	0.92	0.93	95.91	4.09	183	27	1.222	3.61	9.73	2.57	11.4			39.32
		772.20	6/20/99 7:00 PM	14.16	23.20	23.22	0.61	0.97	0.92	0.93	95.72	4.28	182	27	1.219	3.62	9.76	2.58	11.4			39.32
		773.20	6/20/99 8:00 PM	14.09	23.12	23.10	0.60	0.97	0.93	0.93	95.77	4.23	183	27	1.215	3.62	9.76	2.58	11.4			39.31
		774.20	6/20/99 9:00 PM	14.09	23.20	23.21	0.59	0.97	0.92	0.92	95.80	4.20	184	27	1.212	3.62	9.75	2.58	11.4			39.32
		775.20	6/20/99 10:00 PM	14.03	22.83	22.85	0.56	0.97	0.90	0.92	95.99	4.01	184	27	1.209	3.61	9.73	2.57	11.4			40.00
		776.20	6/20/99 11:00 PM	13.96	22.74	22.73	0.54	0.97	0.92	0.93	96.13	3.87	185	27	1.209	3.60	9.70	2.56	11.4			39.32
		777.20	6/21/99 12:00 AM	13.81	22.50	22.48	0.53	0.97	0.90	0.92	96.16	3.84	185	27	1.209	3.59	9.69	2.56	11.3			40.00
		778.20	6/21/99 1:00 AM	13.76	22.62	22.65	0.55	0.97	0.90	0.91	95.97	4.03	185	27	1.209	3.60	9.72	2.57	11.4			40.00
		779.20	6/21/99 2:00 AM	13.71	22.38	22.36	0.52	0.97	0.90	0.92	96.24	3.76	186	27	1.209	3.58	9.66	2.55	11.3			40.00
		780.20	6/21/99 3:00 AM	13.66	22.33	22.32	0.53	0.97	0.95	0.93	96.15	3.85	186	27	1.209	3.45	9.31	2.46	11.4			37.84
		781.20	6/21/99 4:00 AM	13.68	22.34	22.32	0.50	0.97	0.90	0.92	96.31	3.69	186	27	1.209	3.57	9.63	2.54	11.4			40.00
		782.20	6/21/99 5:00 AM	13.59	22.22	22.20	0.51	0.97	0.93	0.93	96.23	3.77	188	27	1.205	3.55	9.57	2.53	11.4			39.32
		783.20	6/21/99 6:00 AM	13.42	22.18	22.16	0.52	0.97	0.90	0.90	96.12	3.88	187	27	1.202	3.59	9.67	2.55	11.4			40.00
		808.48	6/22/99 7:17 AM	13.66	22.83	22.86	0.43	0.98	0.85	0.92	96.82	3.18	222	32	1.205	3.66	9.86	2.61	12.7			44.82
		809.48	6/22/99 8:17 AM	13.71	22.95	22.94	0.44	0.98	0.88	0.92	96.78	3.22	222	32	1.209	3.52	9.50	2.51	12.7			43.22
		810.48	6/22/99 9:17 AM	13.73	22.99	23.02	0.45	0.98	0.88	0.92	96.71	3.29	221	32	1.212	3.52	9.51	2.51	12.6			43.22
		811.48	6/22/99 10:17 AM	13.74	22.88	22.89	0.47	0.97	0.88	0.91	96.58	3.42	215	31	1.215	3.48	9.39	2.48	12.4			42.30
		816.77	6/22/99 3:34 PM	14.50	24.18	24.14	0.60	0.97	0.90	0.93	95.85	4.15	210	31	1.254	3.46	9.32	2.46	12.4			41.62
		817.77	6/22/99 4:34 PM	14.76	28.76	28.85	0.57	0.97	0.94	0.96	96.14	3.86	261	38	1.261	3.31	8.92	2.36	10.9			49.66
		818.77	6/22/99 5:34 PM	14.81	28.93	29.01	0.60	0.97	0.94	0.95	95.93	4.07	260	38	1.265	3.31	8.92	2.36	11.0			49.66
		819.77	6/22/99 6:34 PM	14.77	29.01	29.01	0.61	0.97	0.94	0.95	95.85	4.15	260	38	1.265	3.31	8.92	2.36	11.0			49.66
		820.77	6/22/99 7:34 PM	14.60	28.64	28.63	0.61	0.97	0.91	0.94	95.85	4.15	261	38	1.258	3.31	8.93	2.36	10.8			50.48
		821.77	6/22/99 8:34 PM	14.50	28.34	28.37	0.58	0.97	0.91	0.94	96.01	3.99	262	38	1.251	3.31	8.93	2.36	11.0			50.46
		822.77	6/22/99 9:34 PM	14.37	28.06	28.16	0.54	0.97	0.94	0.94	96.23	3.77	264	38	1.243	3.21	8.65	2.29	10.8			48.84
		823.77	6/22/99 10:34 PM	14.29	28.01	28.12	0.59	0.97	0.94	0.93	95.90	4.10	265	39	1.236	3.20	8.63	2.28	11.0			48.82
		824.77	6/22/99 11:34 PM	14.30	28.26	28.28	0.58	0.97	0.95	0.95	95.93	4.07	272	40	1.229	3.24	8.75	2.31	11.3			49.64
		825.77	6/23/99 12:34 AM	14.27	27.97	27.95	0.51	0.98	0.97	0.95	96.45	3.55	274	40	1.222	3.14	8.47	2.24	11.0			48.04
		826.77	6/23/99 1:34 AM	14.25	27.97	28.00	0.53	0.98	0.92	0.94	96.31	3.69	264	38	1.216	3.38	9.12	2.41	11.0			50.42
		827.77	6/23/99 2:34 AM	14.22	28.09	28.12	0.57	0.97	0.91	0.93	96.02	3.98	264	38	1.212	3.40	9.16	2.42	11.0			50.46
		828.77	6/23/99 3:34 AM	14.15	27.89	27.91	0.54	0.97	0.91	0.93	96.20	3.80	265	39	1.209	3.39	9.14	2.42	11.1			50.46
		829.77	6/23/99 4:34 AM	14.03	27.60	27.62	0.52	0.97	0.91	0.93	96.27	3.73	266	39	1.205	3.39	9.13	2.41	11.1			50.46
		830.77	6/23/99 5:34 AM	13.91	27.38	27.38	0.52	0.98	0.94	0.95	96.30	3.70	267	39	1.205	3.37	9.09	2.40	11.0			49.64
		831.77	6/23/99 6:34 AM	13.87	27.31	27.38	0.53	0.97	0.91	0.93	96.18	3.82	267	39	1.202	3.38	9.11	2.41	11.0			50.46
		856.85	6/24/99 7:39 AM	14.03	24.35	24.42	0.47	0.98	0.87	0.95	96.68	3.32	172	25	1.205	4.04	10.90	2.88	8.8			47.53
		857.29	6/24/99 8:05 AM	13.88	25.64	25.72	0.47	0.98	0.90	0.95	96.59	3.41	172	25	1.209	4.03	10.86	2.87	7.9			49.50
		861.89	6/24/99 12:42 PM	14.09	27.56	27.63	0.59	0.97	0.90	0.93	95.84	4.16	209	30	1.243	3.64	9.83	2.60	9.0			50.50
		862.89	6/24/99 1:42 PM	14.24	28.14	28.19	0.53	0.97	0.94	0.97	96.25	3.75	205	30	1.258	3.81	10.27	2.71	9.1			51.42
		863.89	6/24/99 2:42 PM	14.37	28.49	28.52	0.62	0.97	0.90	0.97	95.70	4.30	203	30	1.265	3.95	10.65	2.81	9.0			53.31
		864.89	6/24/99 3:42 PM	14.40	30.42	30.46	0.50	0.98	0.97	0.94	96.54	3.46	257	37	1.275	3.42	9.23	2.44	10.6			51.26
		881.89	6/25/99 8:42 AM	13.95	29.09	29.16	0.48	0.98	0.98	0.95	96.57	3.43	271	39	1.233	3.35	9.04	2.39	10.7			51.25
		882.89	6/25/99 9:42 AM	13.86	28.84	28.91	0.55	0.97	0.94	0.94	96.03	3.97	264	38	1.236	3.43	9.26	2.45	10.6			52.08
		883.89	6/25/99 10:42 AM	13.82	28.93	28.99	0.54	0.97	0.98	0.95	96.12	3.88	268	39	1.236	3.39	9.13	2.41	10.6			51.24
		885.33	6/25/99 12:08 PM	13.92	28.30	28.49	0.51	0.98	0.98	0.96	96.34	3.66	252	37	1.250	3.45	9.31	2.46	10.5			50.44
		886.33	6/25/99 1:08 PM	14.00	28.81	28.87	0.60	0.97	0.97	0.95	95.71	4.29	252	37	1.261	3.42	9.21	2.43	10.7			50.46
		886.92	6/25/99 1:43 PM	14.07	28.94	28.98	0.53	0.98	0.94	0.95	96.25	3.75	251	36	1.265	3.54	9.53	2.52	10.6			52.08
		887.92	6/25/99 2:43 PM	14.40	27.75	27.78	0.62	0.97	0.97	0.96	95.69	4.31	191	28	1.272	3.74	10.10	2.67	9.0			47.76
		887.92	6/25/99 2:43 PM	14.40	27.75	27.78	0.62	0.97	0.97	0.96	95.69	4.31	191	28	1.272	3.74	10.10	2.67	9.0			47.76
		929.01	6/27/99 7:49 AM	14.19	29.43	29.56	0.51	0.98	0.94	0.94	96.44	3.56	272	40	1.215	3.38	9.13	2.41	10.6			52.08
		930.00	6/27/99 8:48 AM	14.18	29.51	29.60	0.52	0.98	0.95	0.94	96.31	3.69	273	40	1.219	3.37	9.08	2.40	10.7			51.74
		931.00	6/27/99 9:48 AM	14.15	29.38	29.51	0.50	0.98	0.97	0.95	96.50	3.50	271	39	1.229	3.36	9.06	2.39	10.6			51.26
		932.00	6/27/99 10:48 AM	14.09	29.38	29.48	0.52	0.98	0.97	0.95	96.30	3.70	271	39	1.236	3.35	9.03	2.39	10.6			51.26
		933.00	6/27/99 11:48 AM	13.96	29.26	29.35	0.55	0.97	0.97	0.95	96.06	3.94	271	39	1.240	3.33	8.98	2.37	10.6			51.25
		934.00	6/27/99 12:48 PM	13.89	29.05	29.10	0.60	0.97	0.97	0.96	95.71	4.29	264	38	1.247	3.41	9.20	2.43	10.6			52.08
		935.00	6/27/99 1:48 PM	13.92	29.13	29.31	0.55	0.97	0.97	0.95	96.04	3.96	262	38	1.257	3.41	9.18	2.43	10.4			51.28
		936.00	6/27/99 2:48 PM	13.99	29.38	29.42	0.59	0.97	0.94	0.93	95.80	4.20	261	38	1.268	3.39	9.15	2.42	10.4			52.06
		937.00	6/27/99 3:48 PM	14.09	29.64	29.71	0.64	0.97	1.00	0.97	95.44	4.56	260	38	1.279	3.38	9.10	2.41	10.4			51.26
		938.00	6/27/99 4:48 PM	14.10	29.55	29.58	0.67	0.97	0.97	0.96	95.22	4.78	252	37	1.283	3.47	9.37	2.47	10.3			52.09
		939.00	6/27/99 5:48 PM	14.13	29.67	29.75	0.61	0.97	1.00	0.96	95.69	4.31	252	37	1.290	3.34	9.02	2.38	10.3			50.46
		941.00	6/27/99 7:48 PM	14.23	29.88	29.91	0.67	0.97	1.00	0.98	95.30	4.70	258	38	1.283	3.40	9.16	2.42	10.6			51.49
		942.00	6/27/99 8:48 PM	14.30	29.80	29.96	0.69	0.97	0.97	0.96	95.20	4.80	259	38	1.272	3.41	9.19	2.43	10.4			52.11

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		943.00	6/27/99 9:48 PM	14.37	29.75	29.88	0.60	0.97	0.97	0.97	95.84	4.16	261	38	1.258	3.42	9.22	2.44	10.4			52.10
		944.00	6/27/99 10:48 PM	14.32	29.58	29.68	0.62	0.97	1.01	0.99	95.64	4.36	262	38	1.251	3.42	9.22	2.44	10.3			51.24
		945.00	6/27/99 11:48 PM	14.24	29.59	29.68	0.55	0.98	0.97	0.96	96.17	3.83	270	39	1.240	3.35	9.03	2.39	10.6			51.24
		946.00	6/28/99 12:48 AM	14.18	29.51	29.52	0.61	0.97	0.97	0.96	95.70	4.30	273	40	1.233	3.33	8.98	2.37	10.6			51.25
		947.00	6/28/99 1:48 AM	14.10	29.30	29.31	0.55	0.97	0.94	0.96	96.08	3.92	272	40	1.229	3.45	9.31	2.46	10.6			52.84
		948.00	6/28/99 2:48 AM	14.06	29.17	29.27	0.60	0.97	0.94	0.94	95.76	4.24	273	40	1.222	3.36	9.06	2.39	10.6			52.08
		949.00	6/28/99 3:48 AM	14.00	29.05	29.14	0.50	0.98	0.94	0.94	96.41	3.59	274	40	1.219	3.36	9.05	2.39	10.6			52.08
		950.00	6/28/99 4:48 AM	13.95	28.92	29.06	0.57	0.97	0.94	0.94	95.89	4.11	275	40	1.215	3.35	9.04	2.39	10.7			52.08
		951.00	6/28/99 5:48 AM	13.89	28.80	28.90	0.54	0.97	0.97	0.96	96.10	3.90	275	40	1.215	3.35	9.04	2.39	10.6			51.24
		952.00	6/28/99 6:48 AM	13.87	28.71	28.81	0.55	0.97	0.97	0.96	96.07	3.93	275	40	1.212	3.36	9.06	2.39	10.6			51.25
		1049.11	7/2/99 7:54 AM	15.30	22.14	22.21	0.68	0.96	0.92	0.90	95.56	4.44	155	23	1.212	3.53	9.51	2.51	14.2			30.34
		1050.11	7/2/99 8:54 AM	15.32	22.39	22.41	0.67	0.96	0.90	0.90	95.61	4.39	161	23	1.212	3.58	9.65	2.55	14.3			31.94
		1051.11	7/2/99 9:54 AM	15.33	22.22	22.25	0.73	0.96	0.90	0.91	95.27	4.73	134	19	1.229	4.04	10.90	2.88	13.2			32.14
		1052.11	7/2/99 10:54 AM	15.21	22.26	22.33	0.74	0.96	0.87	0.91	95.16	4.84	136	20	1.236	4.36	11.76	3.11	13.0			35.26
		1053.11	7/2/99 11:54 AM	15.15	22.30	22.32	0.75	0.96	0.87	0.91	95.05	4.95	136	20	1.243	4.33	11.68	3.09	13.0			35.26
		1054.11	7/2/99 12:54 PM	15.20	22.51	22.57	0.74	0.96	0.91	0.92	95.11	4.89	151	22	1.250	3.90	10.52	2.78	13.7			33.67
		1055.11	7/2/99 1:54 PM	15.28	22.79	22.81	0.76	0.96	0.87	0.90	94.99	5.01	149	22	1.258	4.10	11.07	2.92	13.7			35.75
		1055.92	7/2/99 2:43 PM																			
		1125.34	7/5/99 12:08 PM	14.37	22.30	22.34	0.64	0.96	0.89	0.91	95.52	4.48	172	25	1.219	3.83	10.34	2.73	13.3			37.37
		1126.34	7/5/99 1:08 PM	14.57	22.38	22.41	0.68	0.96	1.03	0.91	95.31	4.69	154	22	1.223	2.97	8.00	2.11	12.3			27.27
		1127.34	7/5/99 2:08 PM	14.71	22.63	22.66	0.71	0.96	0.88	0.91	95.16	4.84	153	22	1.233	4.08	10.99	2.90	12.3			37.57
		1128.34	7/5/99 3:08 PM	14.93	23.07	23.10	0.84	0.96	0.86	0.91	94.36	5.64	152	22	1.212	4.36	11.77	3.11	12.3			39.31
		1129.34	7/5/99 4:08 PM	15.13	23.36	23.38	0.85	0.96	0.88	0.93	94.37	5.63	152	22	1.209	4.39	11.84	3.13	12.4			38.62
		1130.34	7/5/99 5:08 PM	15.23	23.49	23.51	0.76	0.96	0.93	0.93	94.99	5.01	150	22	1.209	4.04	10.89	2.88	12.4			35.26
		1131.34	7/5/99 6:08 PM	15.26	23.57	23.59	0.63	0.97	0.88	0.91	95.86	4.14	148	22	1.209	4.29	11.56	3.05	12.4			37.58
		1132.34	7/5/99 7:08 PM	15.32	23.50	23.55	0.76	0.96	0.91	0.92	95.02	4.98	149	22	1.216	4.05	10.92	2.89	12.4			35.87
		1133.34	7/5/99 8:08 PM	15.28	23.47	23.50	0.72	0.96	0.93	0.92	95.30	4.70	150	22	1.215	3.85	10.37	2.74	12.3			34.16
		1134.34	7/5/99 9:08 PM	15.24	23.36	23.38	0.68	0.96	0.91	0.92	95.52	4.48	150	22	1.216	4.02	10.84	2.86	12.4			35.87
		1136.34	7/5/99 11:08 PM	15.11	23.12	23.14	0.76	0.96	0.91	0.92	95.00	5.00	152	22	1.212	3.98	10.73	2.84	12.3			35.87
		1138.34	7/6/99 1:08 AM	14.98	22.91	22.93	0.70	0.96	0.91	0.92	95.33	4.67	154	22	1.205	3.96	10.69	2.82	12.3			35.87
		1139.34	7/6/99 2:08 AM	14.95	22.83	22.89	0.69	0.96	0.91	0.92	95.39	4.61	153	22	1.202	3.98	10.74	2.84	12.4			35.87
		1140.34	7/6/99 3:08 AM	14.95	22.83	22.85	0.68	0.96	0.90	0.92	95.44	4.56	153	22	1.202	4.00	10.79	2.85	12.4			36.07
		1141.34	7/6/99 4:08 AM	14.93	22.79	22.81	0.68	0.96	0.88	0.91	95.46	4.54	154	22	1.198	3.99	10.75	2.84	12.4			36.50
		1142.34	7/6/99 5:08 AM	14.91	22.74	22.77	0.67	0.96	0.91	0.92	95.47	4.53	154	22	1.198	3.97	10.71	2.83	12.3			35.88
		1143.34	7/6/99 6:08 AM	14.85	22.67	22.73	0.68	0.96	0.88	0.92	95.43	4.57	155	22	1.195	4.16	11.23	2.97	12.3			37.58
		1145.34	7/6/99 8:08 AM	14.98	22.59	22.62	0.73	0.96	0.85	0.91	95.15	4.85	140	20	1.198	4.37	11.78	3.11	11.0			37.82
		1146.34	7/6/99 9:08 AM	15.03	30.54	30.67	0.81	0.96	0.87	0.95	94.61	5.39	169	25	1.205	4.12	11.12	2.94	6.6			55.26
		1149.60	7/6/99 12:24 PM	14.96	31.36	31.45	0.64	0.97	0.94	0.95	95.71	4.29	267	39	1.198	3.51	9.46	2.50	10.6			52.95
		1150.73	7/6/99 1:32 PM																			
		1151.60	7/6/99 2:24 PM																			
		1152.60	7/6/99 3:24 PM	15.46	34.35	34.55	0.69	0.97	0.95	0.89	95.51	4.49	310	45	1.198	3.08	8.30	2.19	11.6			52.27
		1153.60	7/6/99 4:24 PM	15.46	33.26	33.42	0.71	0.97	0.98	0.92	95.44	4.56	306	45	1.202	3.03	8.16	2.16	10.9			50.90
		1154.60	7/6/99 5:24 PM	15.23	32.88	33.02	0.70	0.97	0.98	0.93	95.44	4.56	305	44	1.212	3.09	8.34	2.20	10.7			51.44
		1155.60	7/6/99 6:24 PM	14.85	32.08	32.23	0.68	0.97	0.98	0.91	95.41	4.59	298	43	1.222	3.06	8.26	2.18	10.6			50.90
		1157.60	7/6/99 8:24 PM	14.13	30.75	30.74	0.64	0.97	0.93	0.91	95.48	4.52	301	44	1.229	3.14	8.47	2.24	10.6			53.10
		1158.60	7/6/99 9:24 PM	13.97	30.33	30.50	0.62	0.97	0.95	0.91	95.58	4.42	302	44	1.226	3.09	8.33	2.20	10.6			52.27
		1159.60	7/6/99 10:24 PM	13.92	30.21	30.37	0.60	0.97	0.94	0.91	95.70	4.30	302	44	1.222	3.11	8.40	2.22	10.6			52.61
		1160.60	7/6/99 11:24 PM	13.97	30.29	30.45	0.59	0.97	0.95	0.91	95.78	4.22	301	44	1.219	3.12	8.40	2.22	10.6			52.27
		1162.60	7/7/99 1:24 AM	14.13	30.50	30.66	0.57	0.97	0.95	0.91	96.00	4.00	302	44	1.212	3.12	8.41	2.22	10.4			52.27
		1163.60	7/7/99 2:24 AM	14.20	30.62	30.78	0.56	0.98	0.92	0.90	96.07	3.93	302	44	1.209	3.13	8.44	2.23	10.6			53.07
		1164.60	7/7/99 3:24 AM	14.27	30.74	30.90	0.55	0.98	0.95	0.92	96.12	3.88	303	44	1.205	3.13	8.44	2.23	10.6			52.25
		1166.60	7/7/99 5:24 AM	14.33	30.74	30.91	0.56	0.98	0.92	0.91	96.10	3.90	304	44	1.198	3.14	8.46	2.24	10.6			53.10
		1167.60	7/7/99 6:24 AM	14.43	30.84	30.99	0.56	0.98	0.95	0.91	96.11	3.89	303	44	1.195	3.07	8.29	2.19	10.4			51.72
		1168.60	7/7/99 7:24 AM	14.63	31.17	31.35	0.57	0.98	0.95	0.91	96.13	3.87	303	44	1.191	3.09	8.32	2.20	10.4			51.73
		1169.60	7/7/99 8:24 AM	14.69	30.29	30.33	0.63	0.97	0.95	0.91	95.70	4.30	245	36	1.195	3.30	8.89	2.35	9.1			49.73
		1171.80	7/7/99 10:36 AM																			
		1172.60	7/7/99 11:24 AM																			
		1173.56	7/7/99 12:22 PM	14.94	25.37	30.26	0.75	0.97	0.95	0.92	95.00	5.00			1.236							49.10
		1174.95	7/7/99 1:45 PM	15.16	25.87	31.04	0.74	0.97	1.03	0.91	95.09	4.91			1.247							44.86
D	Both Stages On-Line at 50% with pH (feed) = 6.8	1176.51	7/7/99 3:19 PM	15.43	26.07	31.32	0.87	0.96	0.96	0.92	94.34	5.66	475	69	1.254	2.87	11.02	2.91	25.1	37.4		48.94
		1176.95	7/7/99 3:45 PM	15.52	26.23	31.40	0.88	0.96	0.96	0.93	94.31	5.69	474	69	1.258	2.87	11.01	2.91	25.0	37.4		48.94
		1177.95	7/7/99 4:45 PM	15.71	26.40	31.70	0.91	0.96	0.98	0.93	94.21	5.79	472	69	1.268	2.80	10.76	2.84	25.1	37.3		48.09
		1178.95	7/7/99 5:45 PM	15.77	26.53	31.82	0.92	0.96	0.96	0.91	94.18	5.82	470	68	1.275	2.80	10.74	2.84	24.9	37.3		48.09
		1179.95	7/7/99 6:45 PM	15.77	26.57	31.90	0.91	0.96	0.98	0.92	94.23	5.77	471	68	1.275	2.80	10.73	2.84	25.1	37.2		47.62
		1180.95	7/7/99 7:45 PM	15.71	26.48	31.77	0.90	0.96	0.96	0.92	94.28	5.72	473	69	1.275	2.83	10.87	2.87	25.1	37.3		48.45
		1181.95	7/7/99 8:45 PM	15.69	26.40	31.65	0.88	0.96	0.93	0.91	94.37	5.63	474	69	1.268	2.89	11.10	2.93	25.1	37.4		49.80
		1182.95	7/7/99 9:45 PM	15.63	26.40	31.57	0.86	0.96	0.93	0.91	94.49	5.51	475	69	1.261	2.90	11.13	2.94	25.1	37.4		49.79
		1183.95	7/7/99 10:45 PM	15.58	26.24	31.53	0.84	0.96	0.91	0.90	94.60	5.40	474	69	1.254	2.92	11.21	2.96	25.1	37.4		50.30
		1184.95	7/7/99 11:45 PM	15.63	26.19	31.49	0.83	0.96	0.94	0.91	94.70	5.30	477	69	1.243	2.88	11.06	2.92	25.1	37.6		48.94
		1185.95	7/8/99 12:45 AM	15.63	26.19	31.49	0.82	0.97	0.94	0.91	94.78	5.22	478	70	1.236	2.89	11.09	2.93	25.1	37.6		48.94
		1186.95	7/8/99 1:45 AM	15.62	26.11	31.42	0.81	0.97	0.92	0.91	94.83	5.17	479	70	1.229	2.90	11.14	2.94	25.3	37.6		49.44
		1187.95	7/8/99 2:45 AM	15.59	26.15	31.36	0.80	0.97	0.92	0.91	94.85	5.15	478	70	1.222	2.93	11.22	2.97	25.3	37.6		49.45
		1188.95	7/8/99 3:45 AM	15.56	26.07	31.28	0.80	0.97	0.94	0.92	94.88	5.12	480	70	1.219	2.92	11.21	2.96	25.2	37.7		48.95
		1189.95	7/8/99 4:45 AM	15.49	25.94	31.12	0.79	0.97	0.94	0.92	94.88	5.12	481	70	1.216	2.92	11.21	2.96	25.2	37.6		48.94
		1190.95	7/8/99 5:45 AM	15.41	25.78	30.96	0.79	0.97	0.94	0.91	94.87	5.13	481	70	1.212	2.88	11.05	2.92	25.2	37.7		48.58
		1191.95	7/8/99 6:45 AM	15.40	25.74	30.91	0.79	0.97	0.94	0.91	94.87	5.13	481	70	1.209	2.89	11.09	2.93	25.2	37.6		48.58
5	Inc to 60% with pH (feed) = 6.5	1196.78	7/8/99 11:35 AM	15.46	31.84	50.52	1.19	0.96	1.14	0.97	92.33	7.67	313	45	1.229	4.52	17.35	4.58	14.4	11.4		64.01
		1197.78	7/8/99 12:34 PM	15.48	31.64	49.12	1.33	0.96	1.18	1.06	91.42	8.58	343	50	1.236	4.46	17.10	4.52	8.5	11.7		65.10
		1198.79	7/8/99 1:35 PM	15.54	30.43	45.74	1.19	0.96	1.05	0.95	92.37	7.63	293	43	1.243	4.78	18.33	4.84	15.7	14.0		62.40
		1199.88	7/8/99 2:41 PM	15.85	30.26	43.54	1.17	0.96	0.99	0.95	92.64	7.36	283	41	1.258	4.86	18.64	4.93	15.8	15.0		62.09
		1200.78	7/8/99 3:35 PM	16.01	30.67	44.11	1.28	0.96	1.08	0.95	92.03	7.97	274	40	1.265	4.77	18.28	4.83	15.6	14.7		59.18
		1207.74	7/8/99 10:33 PM	16.07	33.34	41.46	1.15	0.96	1.06	1.35	92.84	7.16	332	48	1.216	4.52	17.36	4.59	14.2	10.7		69.91
6	Inc to 70% with pH (feed) = 6.0	1208.73	7/8/99 11:32 PM	15.50	34.94	52.53	1.16	0.97	1.00	1.24	92.54	7.46	369	54	1.212	4.57	17.52	4.63	13.9	9.1		76.14
		1209.73	7/9/99 12:32 AM	14.74	34.01	55.88	1.07	0.97	1.01	1.12	92.76	7.24	369	54	1.202	4.67	17.92	4.74	14.0	8.6		76.24
		1211.73	7/9/99 2:32 AM	13.34	31.34	50.74	0.91	0.97	1.19	1.18	93.15	6.85	390	57	1.191	4.31	16.54	4.37	13.9	8.4		73.66
		1212.73	7/9/99 3:32 AM	12.85	30.26	48.76	0.86	0.97	1.01	1.05	93.30	6.70	396	58	1.188	4.25	16.32	4.31	14.1	8.4		74.66
		1213.73	7/9/99 4:32 AM	12.59	29.71	47.65	0.83	0.97	1.12	1.06	93.38	6.62	399	58	1.185	4.16	15.95	4.21	13.9	8.4		72.37
		1214.73	7/9/99 5:32 AM	12.45	29.42	47.01	0.82	0.97	1.18	1.12	93.42	6.58	401	58	1.181	4.15	15.92	4.21	13.9	8.4		72.37
		1215.73	7/9/99 6:32 AM	12.39	29.26	46.59	0.81	0.97	1.12	1.07	93.44	6.56	403	59	1.178	4.14	15.90	4.20	13.9	8.2		72.35
		1216.73	7/9/99 7:32 AM	12.37	29.22	46.33	0.81	0.97	1.06	1.06	93.43	6.57	403	59	1.175	4.15	15.91	4.20	13.9	8.2		73.31
		1217.73	7/9/99 8:32 AM	12.33	31.62	54.00	0.87	0.97	1.68	1.45	92.95	7.05	428	62	1.175	3.98	15.28	4.04	13.2	6.8		73.66
		1219.73	7/9/99 10:32 AM	12.56	26.85	38.63	0.87	0.97	1.06	1.14	93.10	6.90	337	49	1.195	4.54	17.40	4.60	13.2	10.1		69.90
		1223.73	7/9/99 2:32 PM	13.89	31.09	54.56	1.24	0.96	1.14	1.21	91.08	8.92	337	49	1.226	5.01	19.24	5.08	13.8	9.4		76.25
		1224.73	7/9/99 3:32 PM	14.30	29.38	46.19	1.05	0.97	0.99	1.06	92.64	7.36	325	47	1.236	4.99	19.13	5.05	15.0	12.1		71.19
		1225.81	7/9/99 4:36 PM	14.74	30.54	46.95	1.22	0.96	1.01	1.05	91.75	8.25	308	45	1.243	5.05	19.37	5.12	14.7	11.7		70.18
		1226.73	7/9/99 5:32 PM	15.28	31.17	48.87	1.28	0.96	0.96	1.02	91.61	8.39	295	43	1.247	5.15	19.75	5.22	14.1	11.7		70.70

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		1352.76	7/14/99 11:33 PM	15.23	32.13	46.26	0.91	0.97	0.93	1.01	94.02	5.98	392	57	1.212	3.99	15.31	4.05	14.1	11.3		69.78
		1353.76	7/15/99 12:33 AM	15.17	32.00	46.17	0.89	0.97	0.93	1.01	94.14	5.86	396	58	1.205	3.97	15.24	4.03	14.4	11.3		69.76
		1355.76	7/15/99 2:33 AM	15.11	32.00	45.91	0.86	0.97	0.93	1.01	94.33	5.67	402	58	1.198	3.93	15.09	3.99	14.2	11.3		69.76
		1356.76	7/15/99 3:33 AM	15.00	31.75	45.57	0.84	0.97	0.93	1.01	94.39	5.61	403	59	1.195	3.93	15.09	3.99	14.2	11.3		69.78
		1357.76	7/15/99 4:33 AM	14.92	31.54	45.23	0.83	0.97	0.93	1.01	94.43	5.57	406	59	1.195	3.91	15.00	3.96	14.4	11.3		69.78
		1358.76	7/15/99 5:33 AM	14.85	31.42	45.02	0.82	0.97	0.93	1.01	94.46	5.54	409	59	1.191	3.89	14.93	3.95	14.2	11.4		69.78
		1359.76	7/15/99 6:33 AM	14.90	31.46	45.14	0.83	0.97	0.93	1.01	94.45	5.55	411	60	1.188	3.88	14.88	3.93	14.3	11.4		69.78
		1384.60	7/16/99 7:24 AM	14.95	31.92	44.89	0.84	0.97	1.01	1.02	94.41	5.59	427	62	1.205	3.54	13.60	3.59	14.3	11.1		67.19
		1385.60	7/16/99 8:24 AM	14.87	31.93	45.15	0.84	0.97	0.97	1.01	94.34	5.66	431	63	1.209	3.57	13.70	3.62	13.8	11.0		68.48
		1386.60	7/16/99 9:24 AM	14.81	31.88	44.96	0.85	0.97	0.97	1.01	94.27	5.73	430	63	1.215	3.56	13.64	3.60	13.8	11.1		68.47
		1387.60	7/16/99 10:24 AM	14.79	31.84	44.88	0.85	0.97	0.97	1.01	94.23	5.77	429	62	1.215	3.57	13.69	3.62	13.9	11.1		68.49
		1390.60	7/16/99 1:24 PM	14.81	32.17	45.38	0.94	0.97	0.97	1.04	93.62	6.38	422	61	1.240	3.63	13.92	3.68	13.5	10.7		69.77
		1391.60	7/16/99 2:24 PM	14.91	32.49	45.72	0.97	0.97	0.96	1.04	93.49	6.51	421	61	1.251	3.60	13.83	3.65	13.7	10.7		69.79
		1393.60	7/16/99 4:24 PM	15.01	32.72	46.02	0.99	0.97	0.97	1.04	93.39	6.61	418	61	1.261	3.59	13.79	3.64	13.5	10.7		69.77
		1396.60	7/16/99 7:24 PM	15.19	33.09	46.36	1.01	0.97	0.96	1.04	93.33	6.67	422	61	1.261	3.56	13.66	3.61	13.5	10.7		69.79
		1397.60	7/16/99 8:24 PM	15.32	33.05	45.09	0.89	0.97	0.97	1.08	94.18	5.82	447	65	1.254	3.38	12.99	3.43	13.5	10.7		69.77
		1402.60	7/17/99 1:24 AM																			
		1403.60	7/17/99 2:24 AM																			
		1404.60	7/17/99 3:24 AM																			
		1406.60	7/17/99 5:24 AM																			
		1433.77	7/18/99 8:34 AM	13.68	30.92	42.00	0.84	0.97	0.97	1.00	93.88	6.12	472	69	1.185	3.33	12.77	3.37	13.5	11.4		68.48
		1434.77	7/18/99 9:34 AM	13.68	30.88	41.91	0.83	0.97	0.95	1.00	93.92	6.08	475	69	1.185	3.32	12.75	3.37	13.7	11.3		68.92
		1435.77	7/18/99 10:34 AM	13.71	30.88	41.88	0.84	0.97	0.93	1.00	93.84	6.16	473	69	1.188	3.37	12.94	3.42	13.5	11.4		69.76
		1436.77	7/18/99 11:34 AM	13.83	31.17	42.08	0.87	0.97	0.93	1.00	93.71	6.29	471	69	1.198	3.36	12.88	3.40	13.4	11.3		69.78
		1437.77	7/18/99 12:34 PM	13.86	31.29	42.12	0.88	0.97	0.93	1.01	93.63	6.37	470	68	1.205	3.35	12.84	3.39	13.4	11.3		69.78
		1438.77	7/18/99 1:34 PM	13.85	31.29	42.08	0.89	0.97	0.97	1.01	93.56	6.44	469	68	1.212	3.27	12.56	3.32	13.4	11.3		68.47
		1439.77	7/18/99 2:34 PM	13.90	31.42	42.27	0.91	0.97	0.93	1.00	93.46	6.54	467	68	1.222	3.32	12.73	3.36	13.3	11.1		69.76
		1440.77	7/18/99 3:34 PM	13.95	31.50	42.46	0.92	0.97	0.93	1.00	93.40	6.60	464	67	1.233	3.32	12.73	3.36	13.2	11.1		69.78
		1441.77	7/18/99 4:34 PM	13.98	31.71	42.68	0.93	0.97	0.93	1.00	93.31	6.69	461	67	1.240	3.32	12.72	3.36	13.3	11.0		69.78
		1442.77	7/18/99 5:34 PM	14.05	31.93	42.89	0.94	0.97	0.89	1.00	93.29	6.71	460	67	1.247	3.37	12.92	3.41	13.1	11.1		71.07
		1443.77	7/18/99 6:34 PM	14.10	32.00	42.96	0.93	0.97	0.93	1.00	93.37	6.63	462	67	1.244	3.30	12.66	3.34	13.2	11.0		69.78
		1444.77	7/18/99 7:34 PM	14.11	32.09	43.01	0.92	0.97	0.93	1.00	93.48	6.52	466	68	1.240	3.28	12.58	3.32	13.1	11.1		69.78
		1447.77	7/18/99 10:34 PM	14.20	32.21	42.88	0.88	0.97	0.93	1.01	93.80	6.20	476	69	1.226	3.25	12.46	3.29	13.1	11.3		69.76
		1448.77	7/18/99 11:34 PM	14.20	32.21	42.80	0.87	0.97	0.93	1.01	93.91	6.09	480	70	1.222	3.23	12.39	3.27	13.1	11.3		69.78
		1449.77	7/19/99 12:34 AM																			
		1450.77	7/19/99 1:34 AM																			
		1451.77	7/19/99 2:34 AM																			
		1452.77	7/19/99 3:34 AM																			
		1455.77	7/19/99 6:34 AM																			
		1458.56	7/19/99 9:22 AM																			
		1459.56	7/19/99 10:22 AM	14.03	23.76	27.38	0.73	0.96	0.92	0.92	94.81	5.19	327	48	1.212	3.36	12.88	3.40	16.3	22.5		49.04
		1460.56	7/19/99 11:22 AM	14.04	25.95	31.37	0.90	0.96	0.98	1.01	93.61	6.39	391	57	1.219	3.16	12.14	3.21	9.8	15.9		57.00
		1462.56	7/19/99 1:22 PM	14.29	29.46	37.16	0.85	0.97	0.94	0.98	94.06	5.94	462	67	1.233	3.02	11.58	3.06	13.8	14.1		63.31
		1463.56	7/19/99 2:22 PM	14.31	29.76	37.78	0.86	0.97	0.91	0.97	93.97	6.03	468	68	1.240	3.02	11.60	3.06	13.8	13.9		64.59
		1464.56	7/19/99 3:22 PM	14.44	29.88	37.83	0.87	0.97	0.91	0.97	94.01	5.99	470	68	1.236	3.02	11.58	3.06	13.8	13.7		64.59
		1465.56	7/19/99 4:22 PM	14.47	30.01	37.99	0.85	0.97	0.91	0.97	94.11	5.89	475	69	1.233	3.00	11.50	3.04	14.0	13.9		64.56
		1466.56	7/19/99 5:22 PM	14.53	30.08	37.95	0.84	0.97	0.94	0.98	94.22	5.78	474	69	1.233	2.94	11.28	2.98	13.8	13.9		63.30
		1467.56	7/19/99 6:22 PM	14.53	30.08	37.99	0.81	0.97	0.94	0.98	94.42	5.58	478	69	1.236	2.91	11.18	2.95	13.8	14.0		63.30
		1468.56	7/19/99 7:22 PM	14.57	30.17	37.99	0.79	0.97	0.94	0.98	94.55	5.45	479	70	1.236	2.90	11.13	2.94	13.8	14.0		63.30
		1469.56	7/19/99 8:22 PM	14.56	30.04	37.86	0.76	0.97	0.94	0.98	94.75	5.25	485	70	1.233	2.88	11.04	2.92	13.8	14.0		63.30
		1471.56	7/19/99 10:22 PM																			
		1473.56	7/20/99 12:22 AM																			
		1474.56	7/20/99 1:22 AM																			
		1476.56	7/20/99 3:22 AM																			
		1477.56	7/20/99 4:22 AM																			
		1479.56	7/20/99 6:22 AM																			
		1480.56	7/20/99 7:22 AM																			
		1482.78	7/20/99 9:35 AM																			
		1483.78	7/20/99 10:35 AM	14.02	32.00	42.21	0.73	0.97	0.93	0.98	94.77	5.23	463	67	1.212	3.19	12.23	3.23	12.4	10.7		68.55
		1484.78	7/20/99 11:35 AM	14.02	22.51	25.17	0.66	0.97	0.94	0.95	95.28	4.72	279	41	1.216	3.62	13.87	3.67	16.1	24.8		45.15
		1485.78	7/20/99 12:35 PM	14.21	30.63	39.13	0.73	0.97	0.94	1.01	94.90	5.10	453	66	1.223	3.30	12.65	3.34	13.4	13.0		66.31
		1486.78	7/20/99 1:35 PM	14.45	33.68	44.54	0.96	0.97	2.10	1.94	93.33	6.67	366	53	1.226	3.13	11.99	3.17	8.9	7.3		65.17
		1487.78	7/20/99 2:35 PM	14.85	29.88	36.95	0.84	0.97	0.97	0.97	94.34	5.66	426	62	1.233	2.94	11.26	2.98	12.8	14.0		59.93
		1489.78	7/20/99 4:35 PM	15.28	23.85	26.52	0.79	0.96	0.90	0.90	94.83	5.17	265	39	1.243	3.51	13.47	3.56	17.0	27.3		42.57
		1490.78	7/20/99 5:35 PM	15.31	23.94	26.60	0.79	0.96	0.92	0.91	94.86	5.14	266	39	1.247	3.49	13.39	3.54	17.0	27.3		42.03
		1491.78	7/20/99 6:35 PM	15.43	24.02	26.68	0.79	0.96	0.90	0.90	94.89	5.11	265	39	1.247	3.50	13.44	3.55	17.0	27.4		42.58
		1492.78	7/20/99 7:35 PM	15.51	24.14	26.92	0.79	0.96	0.90	0.90	94.90	5.10	266	39	1.240	3.50	13.43	3.55	17.2	27.4		42.57
		1493.78	7/20/99 8:35 PM	15.54	24.14	26.84	0.79	0.96	0.90	0.91	94.93	5.07	270	39	1.233	3.47	13.33	3.52	17.2	27.7		42.56
		1495.78	7/20/99 10:35 PM	15.39	23.78	26.42	0.75	0.96	0.92	0.91	95.12	4.88	275	40	1.215	3.35	12.84	3.39	17.3	27.9		41.26
		1496.78	7/20/99 11:35 PM	15.23	23.49	26.11	0.74	0.96	0.92	0.91	95.17	4.83	278	40	1.209	3.34	12.82	3.39	17.3	27.9		41.28
		1497.78	7/21/99 12:35 AM	15.09	23.32	25.90	0.73	0.96	0.92	0.92	95.20	4.80	281	41	1.205	3.41	13.10	3.46	17.3	28.0		42.09
		1500.78	7/21/99 3:35 AM	14.87	22.54	25.12	0.60	0.97	0.90	0.91	96.00	4.00	292	42	1.191	3.22	12.36	3.26	17.3	28.4		41.27
		1501.78	7/21/99 4:35 AM	14.73	22.34	24.88	0.59	0.97	0.90	0.91	96.01	3.99	295	43	1.192	3.18	12.22	3.23	17.4	28.5		41.27
		1502.78	7/21/99 5:35 AM	14.61	22.22	24.68	0.58	0.97	0.88	0.91	96.02	3.98	298	43	1.188	3.27	12.55	3.31	17.6	28.4		42.56
		1503.78	7/21/99 6:35 AM	14.63	22.22	24.68	0.58	0.97	0.88	0.91	96.00	4.00	297	43	1.188	3.28	12.59	3.33	17.4	28.3		42.56
		1504.78	7/21/99 7:35 AM	14.63	22.83	25.62	0.59	0.97	0.90	0.91	95.97	4.03	324	47	1.188	3.10	11.89	3.14	17.0	26.7		43.87
		1506.14	7/21/99 8:57 AM	14.58	23.97	27.37	0.75	0.96	0.93	0.93	94.88	5.12	318	46	1.188	3.06	11.72	3.10	14.0	20.5		46.83
		1507.14	7/21/99 9:56 AM	14.49	23.28	26.40	0.74	0.96	0.93	0.92	94.86	5.14	307	45	1.195	3.07	11.78	3.11	14.6	22.3		44.93
		1509.14	7/21/99 11:56 AM	14.37	25.46	29.72	0.76	0.97	0.95	0.94	94.73	5.27	398	58	1.209	2.77	10.63	2.81	14.4	19.1		51.04
7	Set target pH(conc) = 5.6	1532.92	7/22/99 11:43 AM	14.31	25.87	30.26	0.81	0.96	0.95	0.95	94.35	5.65	437	64	1.229	2.61	10.02	2.65	14.4	18.6		53.00
		1533.92	7/22/99 12:43 PM	14.46	26.32	30.96	0.84	0.96	0.94	0.94	94.21	5.79	441	64	1.233	2.61	10.01	2.64	14.1	18.4		53.54
		1534.92	7/22/99 1:43 PM	14.66	26.70	31.45	0.86	0.96	0.95	0.94	94.14	5.86	438	64	1.240	2.58	9.91	2.62	14.1	18.4		53.02
		1535.92	7/22/99 2:43 PM	15.23	27.77	32.61	0.91	0.96	0.95	0.94	94.01	5.99	434	63	1.251	2.59	9.93	2.62	13.9	18.2		53.01
		1536.92	7/22/99 3:43 PM	15.53	28.39	33.36	0.94	0.96	0.92	0.94	93.94	6.06	432	63	1.258	2.65	10.16	2.68	13.9	18.2		54.35
		1537.92	7/22/99 4:43 PM	15.57	28.43	33.51	0.95	0.96	0.93	0.94	93.91	6.09	432	63	1.265	2.64	10.11	2.67	13.9	18.2		54.34
		1538.92	7/22/99 5:43 PM	15.52	40.35	43.05	0.91	0.97	1.01	1.42	94.17	5.83	574	83	1.275	2.30	8.84	2.33	5.9	5.6		74.58
		1539.92	7/22/99 6:43 PM	15.44	33.77	42.62	0.98	0.97	1.01	1.02	93.63	6.37	512	75	1.275	2.47	9.48	2.51	11.2	11.1		64.43
		1540.92	7/22/99 7:43 PM	15.35	33.39	42.71	1.05	0.96	0.97	1.01	93.16	6.84	510	74	1.272	2.54	9.75	2.58	11.6	11.3		65.83
		1541.92	7/22/99 8:43 PM	15.26	34.39	43.85	1.22	0.96	0.97	1.01	92.03	7.97	506	74	1.265	2.69	10.31	2.73	11.9	11.4		66.76
		1542.92	7/22/99 9:43 PM																			
		1553.92	7/23/99 8:43 AM																			
		1554.92	7/23/99 9:43 AM	14.49	23.53	26.99	1.27	0.94	0.93	0.90	91.23	8.77	164	24	1.209	6.01	23.07	6.09	17.7	24.5		44.63
		1555.92	7/23/99 10:43 AM	14.41	22.95	27.43	0.86	0.96	0.94	0.94	94.05	5.95	195	28	1.216	5.46	20.95	5.54	17.9	23.6		47.67
		1556.92	7/23/99 11:43 AM	14.41	25.13	33.57	0.78	0.97	0.95	0.97	94.57	5.43	224	33	1.222	5.76	22.09	5.84	16.4	18.2		58.11
		1558.65	7/23/99 1:27 PM	14.71	29.80	45.74	1.08	0.96	0.92	1.02	92.63	7.37	305	44	1.236	5.12	19.64	5.19	15.6	12.2		71.06
		1560.21	7/23/99 3:00 PM	14.81	29.22	48.13	1.44	0.95	1.05	1.02	90.28	9.72	299	43	1.250	4.98	19.12	5.05	14.7	12.5		68.49
		1561.21	7/23/99 4:00 PM	14.95	30.17	47.85	1.40	0.96	1.01	1.04	90.64	9.36	292	42	1.261	5.16	19.78	5.23	14.8	12.2		69.71
		1563.21	7/23/99 6:00 PM	15.39	30.51	49.38	1.50	0.95	1.01	1.03	90.27	9.73	296	43	1.275	5.02	19.25	5.08	14.5	12.5		69.77
		1565.21	7/23/99 8:00 PM	15.83	31.50	50.63	1.53	0.95	0.97	0.99	90.36	9.64	298	43	1.272	5.00	19.18	5.07	14.2	12.7		69.77

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		1566.21	7/23/99 9:00 PM	15.83	32.68	49.61	1.44	0.96	0.92	1.01	90.91	9.09	295	43	1.265	5.18	19.89	5.25	15.0	12.1		71.08
		1567.21	7/23/99 10:00 PM	15.78	31.71	48.61	1.02	0.97	0.97	1.03	93.51	6.49	319	46	1.254	4.74	18.20	4.81	15.4	12.4		69.76
		1568.21	7/23/99 11:00 PM	15.74	31.17	48.12	0.95	0.97	1.04	1.09	93.97	6.03	330	48	1.243	4.56	17.49	4.62	15.1	12.8		68.88
		1569.21	7/24/99 12:00 AM	15.62	30.96	47.75	0.94	0.97	0.93	1.00	93.96	6.04	333	48	1.236	4.60	17.67	4.67	15.3	12.8		69.77
		1570.21	7/24/99 1:00 AM	15.52	31.09	47.83	1.09	0.97	0.97	1.03	92.99	7.01	325	47	1.229	4.74	18.19	4.81	15.2	12.7		69.77
		1572.21	7/24/99 3:00 AM	15.39	30.71	47.32	1.04	0.97	0.97	1.03	93.22	6.78	334	49	1.216	4.67	17.91	4.73	15.4	12.7		69.77
		1573.21	7/24/99 4:00 AM	15.29	30.25	46.89	0.84	0.97	1.00	1.01	94.48	5.52	343	50	1.212	4.47	17.14	4.53	15.3	13.0		67.77
		1574.21	7/24/99 5:00 AM	15.19	30.13	46.66	0.84	0.97	0.97	1.00	94.49	5.51	343	50	1.212	4.47	17.14	4.53	15.4	13.0		68.47
		1575.21	7/24/99 6:00 AM	15.14	30.00	46.46	0.84	0.97	0.93	1.00	94.43	5.57	343	50	1.209	4.58	17.56	4.64	15.4	12.8		69.78
		1576.21	7/24/99 7:00 AM	15.18	30.08	46.50	0.85	0.97	0.97	1.04	94.39	5.61	342	50	1.205	4.60	17.65	4.66	15.3	13.0		69.78
		1577.67	7/24/99 8:28 AM	15.17	31.21	50.45	1.00	0.97	0.97	1.01	93.38	6.62	429	62	1.205	4.41	16.92	4.47	19.2	15.2		71.11
8	4th Cleaning with Citric Acid (Stages 1 and 2)	1578.67	7/24/99 9:28 AM	15.18	31.09	50.23	0.99	0.97	0.91	1.00	93.48	6.52	433	63	1.202	4.43	17.01	4.49	19.2	15.3		72.73
		1650.52	7/27/99 9:19 AM	15.63	22.27	26.21	0.54	0.97	0.87	0.88	96.57	3.43	250	36	1.219	3.67	14.08	3.72	20.5	30.1		41.25
		1652.52	7/27/99 11:19 AM	15.45	25.17	33.82	0.71	0.97	0.95	0.95	95.39	4.61	354	51	1.240	3.36	12.91	3.41	18.0	20.3		54.30
		1653.52	7/27/99 12:19 PM	15.55	25.87	35.86	0.74	0.97	0.90	0.93	95.26	4.74	361	52	1.247	3.51	13.47	3.56	18.0	19.3		58.10
		1654.52	7/27/99 1:19 PM	15.62	29.67	46.70	0.87	0.97	0.89	1.02	94.43	5.57	409	60	1.254	3.76	14.43	3.81	16.4	13.7		71.05
		1655.34	7/27/99 2:08 PM	15.65	29.78	47.78	0.84	0.97	0.89	0.96	94.60	5.40	398	58	1.261	3.78	14.49	3.83	16.2	13.6		69.77
		1656.34	7/27/99 3:08 PM	15.70	29.55	47.17	0.96	0.97	0.89	0.98	93.85	6.15	422	61	1.272	3.53	13.55	3.58	16.1	13.9		69.75
		1657.34	7/27/99 4:08 PM	15.75	29.76	47.38	0.95	0.97	0.89	0.98	93.94	6.06	418	61	1.279	3.54	13.60	3.59	16.2	13.8		69.76
		1658.34	7/27/99 5:08 PM	15.83	29.91	47.51	0.98	0.97	0.89	0.98	93.84	6.16	413	60	1.283	3.58	13.74	3.63	16.0	13.7		69.76
		1659.34	7/27/99 6:08 PM	15.88	30.04	47.68	0.99	0.97	0.89	0.98	93.79	6.21	412	60	1.283	3.59	13.78	3.64	15.9	13.8		69.76
		1660.34	7/27/99 7:08 PM	15.90	30.01	47.70	0.98	0.97	0.89	0.98	93.83	6.17	413	60	1.279	3.59	13.77	3.64	16.0	13.7		69.76
		1661.34	7/27/99 8:08 PM	15.92	29.98	47.60	0.97	0.97	0.93	0.98	93.88	6.12	413	60	1.275	3.53	13.54	3.58	16.0	13.7		68.47
		1662.34	7/27/99 9:08 PM	16.00	30.05	47.73	0.98	0.97	0.89	0.99	93.89	6.11	416	61	1.265	3.60	13.81	3.65	16.1	13.8		69.77
		1665.34	7/28/99 12:08 AM	15.94	29.83	47.35	0.92	0.97	0.89	0.99	94.24	5.76	430	63	1.240	3.56	13.64	3.60	16.4	13.9		69.76
		1666.34	7/28/99 1:08 AM	15.91	29.73	47.35	0.90	0.97	0.93	0.99	94.34	5.66	431	63	1.233	3.50	13.43	3.55	16.3	13.9		68.45
		1667.34	7/28/99 2:08 AM	15.86	29.66	47.18	0.89	0.97	0.93	0.99	94.39	5.61	431	63	1.229	3.51	13.46	3.56	16.3	13.9		68.47
		1668.34	7/28/99 3:08 AM	15.82	29.68	46.96	0.89	0.97	0.93	0.99	94.39	5.61	433	63	1.226	3.50	13.44	3.55	16.3	13.9		68.45
		1669.34	7/28/99 4:08 AM	15.77	29.61	46.79	0.88	0.97	0.93	0.99	94.44	5.56	436	63	1.226	3.48	13.35	3.53	16.4	13.9		68.45
		1670.34	7/28/99 5:08 AM	15.69	29.42	46.50	0.87	0.97	0.93	0.99	94.43	5.57	437	64	1.222	3.48	13.35	3.53	16.3	14.0		68.45
		1671.34	7/28/99 6:08 AM	15.69	29.46	46.42	0.88	0.97	0.93	0.99	94.40	5.60	437	64	1.219	3.49	13.38	3.53	16.3	14.0		68.45
		1674.78	7/28/99 9:35 AM	15.62	29.30	45.99	0.90	0.97	0.93	1.00	94.22	5.78	433	63	1.229	3.50	13.41	3.54	16.1	13.8		68.45
		1675.78	7/28/99 10:35 AM	15.60	29.63	46.72	0.93	0.97	0.93	0.98	94.05	5.95	406	59	1.236	3.71	14.23	3.76	16.0	13.4		68.45
		1676.78	7/28/99 11:35 AM	15.57	29.63	46.50	0.92	0.97	0.90	0.98	94.11	5.89	406	59	1.233	3.77	14.45	3.82	15.8	13.6		69.51
		1677.78	7/28/99 12:35 PM	15.79	31.04	48.50	1.07	0.97	0.93	0.99	93.20	6.80	370	54	1.254	4.09	15.68	4.14	15.5	12.7		69.76
		1678.78	7/28/99 1:35 PM	15.98	31.44	49.15	1.12	0.97	1.29	1.38	92.97	7.03	365	53	1.261	4.11	15.78	4.17	15.4	12.7		69.75
		1679.78	7/28/99 2:35 PM	16.36	32.09	50.51	1.14	0.97	0.93	0.99	93.00	7.00	366	53	1.272	4.07	15.63	4.13	15.1	12.8		69.75
		1680.78	7/28/99 3:35 PM	16.57	33.05	51.03	1.16	0.97	0.93	0.99	92.97	7.03	357	52	1.279	4.16	15.95	4.21	15.2	12.7		69.77
		1681.78	7/28/99 4:35 PM	16.62	32.84	51.40	1.21	0.96	0.96	1.03	92.70	7.30	354	52	1.279	4.19	16.06	4.24	15.0	12.7		69.77
		1682.78	7/28/99 5:35 PM	16.66	32.94	50.97	1.05	0.97	0.93	1.00	93.68	6.32	364	53	1.283	4.06	15.59	4.12	15.1	12.7		69.76
		1683.79	7/28/99 6:35 PM	16.64	32.87	50.97	1.06	0.97	0.93	1.00	93.66	6.34	363	53	1.283	4.08	15.64	4.13	15.1	12.7		69.76
		1684.78	7/28/99 7:35 PM	16.58	32.89	51.12	1.11	0.97	0.93	0.99	93.28	6.72	360	52	1.279	4.12	15.80	4.17	15.2	12.7		69.77
		1685.78	7/28/99 8:35 PM	16.55	32.88	51.39	1.29	0.96	0.93	0.98	92.21	7.79	352	51	1.272	4.24	16.27	4.30	15.2	12.7		69.75
		1686.78	7/28/99 9:35 PM	16.61	32.51	50.65	1.18	0.96	0.93	1.00	92.91	7.09	367	53	1.261	4.10	15.73	4.16	15.2	12.8		69.75
		1687.78	7/28/99 10:35 PM	16.57	32.56	50.51	1.06	0.97	0.93	1.00	93.57	6.43	375	54	1.254	4.04	15.48	4.09	15.6	12.7		69.76
		1688.78	7/28/99 11:35 PM	16.56	32.63	50.69	1.21	0.96	0.93	1.00	92.71	7.29	367	53	1.243	4.15	15.93	4.21	15.5	12.7		69.78
		1689.78	7/29/99 12:35 AM	16.54	32.30	50.53	1.09	0.97	0.97	1.00	93.39	6.61	375	55	1.240	4.00	15.35	4.06	15.4	13.0		68.47
		1690.78	7/29/99 1:35 AM	16.50	32.51	50.57	1.10	0.97	0.97	1.00	93.31	6.69	377	55	1.236	3.99	15.29	4.04	15.5	13.0		68.47
		1691.78	7/29/99 2:35 AM	16.43	32.05	50.26	1.12	0.97	0.93	0.99	93.16	6.84	376	55	1.233	4.01	15.39	4.07	15.4	13.0		69.35
		1692.78	7/29/99 3:35 AM	16.32	32.08	49.83	1.03	0.97	0.97	1.00	93.70	6.30	384	56	1.226	3.95	15.15	4.00	15.7	12.8		68.47
		1693.07	7/29/99 3:52 AM	16.29	32.08	50.00	1.13	0.97	0.93	0.99	93.04	6.96	376	55	1.226	4.11	15.78	4.17	15.7	12.7		69.76
		1693.78	7/29/99 4:35 AM	16.19	32.00	49.84	1.22	0.96	0.93	0.99	92.44	7.56	374	54	1.222	4.14	15.88	4.20	15.7	12.8		69.76
		1694.78	7/29/99 5:35 AM	16.15	31.33	48.90	1.04	0.97	0.97	1.01	93.54	6.46	389	57	1.219	3.93	15.06	3.98	15.3	13.0		68.47
		1695.78	7/29/99 6:35 AM	16.20	31.47	48.85	0.94	0.97	0.97	1.01	94.22	5.78	395	57	1.212	3.89	14.92	3.94	15.6	13.2		68.47
		1696.78	7/29/99 7:35 AM	16.17	31.47	48.86	0.94	0.97	0.97	1.01	94.17	5.83	396	58	1.209	3.88	14.90	3.94	15.7	13.2		68.47
		1697.78	7/29/99 8:35 AM	16.00	31.39	48.86	0.95	0.97	1.27	1.31	94.07	5.93	393	57	1.212	3.91	15.00	3.96	15.7	13.2		68.47
		1700.07	7/29/99 10:52 AM	16.04	31.03	57.69	1.51	0.96	1.13	0.91	90.58	9.42	352	51	1.229	4.06	15.57	4.11	15.3	12.7		65.44
		1701.31	7/29/99 12:06 PM	16.24	32.01	50.49	1.07	0.97	1.01	1.01	93.41	6.59	376	55	1.233	3.94	15.12	4.00	15.1	12.3		68.08
		1702.31	7/29/99 1:06 PM	16.42	32.51	51.03	0.99	0.97	1.01	1.02	93.96	6.04	382	56	1.240	3.93	15.06	3.98	15.3	12.4		68.49
		1703.31	7/29/99 2:06 PM	16.52	32.85	51.54	1.01	0.97	0.96	1.02	93.86	6.14	377	55	1.250	4.02	15.44	4.08	15.7	12.4		69.79
		1704.31	7/29/99 3:06 PM	16.57	33.05	51.97	1.03	0.97	0.97	1.01	93.77	6.23	374	54	1.261	4.02	15.43	4.08	15.2	12.3		69.79
		1705.31	7/29/99 4:06 PM	16.59	33.18	52.18	1.05	0.97	0.97	1.01	93.70	6.30	371	54	1.272	4.02	15.43	4.08	15.1	12.3		69.77
		1701.31	7/29/99 12:06 PM	16.24	32.01	50.49	1.07	0.97	1.01	1.01	93.41	6.59	376	55	1.233	3.94	15.12	4.00	15.1	12.3		68.08
		1702.31	7/29/99 1:06 PM	16.42	32.51	51.03	0.99	0.97	1.01	1.02	93.96	6.04	382	56	1.240	3.93	15.06	3.98	15.3	12.4		68.49
		1703.31	7/29/99 2:06 PM	16.52	32.85	51.54	1.01	0.97	0.96	1.02	93.86	6.14	377	55	1.250	4.02	15.44	4.08	15.7	12.4		69.79
		1704.31	7/29/99 3:06 PM	16.57	33.05	51.97	1.03	0.97	0.97	1.01	93.77	6.23	374	54	1.261	4.02	15.43	4.08	15.2	12.3		69.79
		1705.31	7/29/99 4:06 PM	16.59	33.18	52.18	1.05	0.97	0.97	1.01	93.70	6.30	371	54	1.272	4.02	15.43	4.08	15.1	12.3		69.77
		1707.31	7/29/99 6:06 PM	16.72	33.30	52.35	1.01	0.97	0.96	1.02	93.96	6.04	373	54	1.283	3.97	15.22	4.02	15.1	12.3		69.79
		1708.31	7/29/99 7:06 PM	16.78	33.34	52.40	1.02	0.97	0.97	1.02	93.89	6.11	372	54	1.283	3.98	15.26	4.03	14.9	12.4		69.78
		1709.31	7/29/99 8:06 PM	16.80	33.26	52.19	1.08	0.97	0.97	1.02	93.59	6.41	375	54	1.275	3.97	15.23	4.02	15.0	12.4		69.79
		1710.31	7/29/99 9:06 PM	16.84	33.01	52.47	1.25	0.96	1.01	1.02	92.58	7.42	374	54	1.261	3.95	15.14	4.00	15.0	12.4		68.48
		1712.31	7/29/99 11:06 PM	16.72	32.85	53.41	1.53	0.96	1.01	0.99	90.86	9.14	370	54	1.240	4.06	15.58	4.12	15.0	12.4		68.49
		1713.31	7/30/99 12:06 AM	16.69	32.35	52.92	1.45	0.96	1.04	1.00	91.33	8.67	375	55	1.233	3.97	15.22	4.02	15.1	12.4		67.49
		1714.31	7/30/99 1:06 AM	16.68	32.17	52.43	1.33	0.96	0.97	1.00	92.04	7.96	386	56	1.226	3.93	15.07	3.98	15.0	12.6		69.37
		1715.31	7/30/99 2:06 AM	16.60	32.08	51.71	1.21	0.96	1.01	1.02	92.70	7.30	394	57	1.223	3.86	14.82	3.92	15.1	12.7		68.47
		1716.31	7/30/99 3:06 AM	16.53	32.13	50.33	1.05	0.97	0.97	1.00	93.67	6.33	404	59	1.219	3.78	14.48	3.83	15.3	12.5		68.49
		1717.31	7/30/99 4:06 AM	16.51	32.13	50.58	0.95	0.97	0.97	1.00	94.26	5.74	410	60	1.215	3.73	14.30	3.78	15.5	12.7		68.49
		1718.31	7/30/99 5:06 AM	16.49	32.08	50.54	0.91	0.97	0.97	1.00	94.51	5.49	414	60	1.209	3.71	14.24	3.76	15.7	12.9		68.49
		1720.31	7/30/99 7:06 AM	16.57	32.21	50.76	0.88	0.97	0.97	1.00	94.67	5.33	417	61	1.205	3.70	14.18	3.75	15.7	13.0		68.47
		1721.31	7/30/99 8:06 AM	16.49	32.21	50.67	0.88	0.97	1.01	1.01	94.64	5.36	415	60	1.205	3.72	14.27	3.77	15.5	12.8		67.58
		1722.31	7/30/99 9:06 AM	16.26	32.26	50.66	1.00	0.97	0.93	0.98	93.87	6.13	398	58	1.212	3.93	15.06	3.98	15.4	12.6		69.77
		1726.60	7/30/99 1:24 PM	16.11	32.43	50.39	1.11	0.97	0.97	1.02	93.10	6.90	373	54	1.251	4.07	15.61	4.12	15.3	12.3		69.79
		1727.60	7/30/99 2:24 PM	16.24	33.39	50.99	1.34	0.96	1.02	1.06	91.74	8.26	355	52	1.258	4.24	16.29	4.30	15.1	12.0		69.46
		1728.60	7/30/99 3:24 PM	16.31	33.58	51.50	1.39	0.96	1.01	1.05	91.49	8.51	349	51	1.268	4.28	16.42	4.34	15.0	12.0		69.77
		1731.60	7/30/99 6:24 PM	16.86	34.21	52.78	1.15	0.97	0.96	1.02	93.17	6.83	357	52	1.283	4.14	15.90	4.20	15.1	12.0		69.78
		1733.60	7/30/99 8:24 PM	17.19	34.52	53.56	1.05	0.97	0.97	1.02	93.91	6.09	372	54	1.272	4.00	15.36	4.06	15.0	12.3		69.74
		1734.60	7/30/99 9:24 PM	17.23	34.39	53.28	1.01	0.97	0.97	1.03	94.15	5.85	380	55	1.261	3.95	15.17	4.01	15.0	12.5		69.79
		1736.60	7/30/99 11:24 PM	17.00	33.68	52.58	0.96	0.97	1.01	1.00	94.34	5.66	390	57	1.243	3.83	14.71	3.89	15.1	12.4		67.60
		1742.60	7/31/99 5:24 AM	16.61	32.46	52.07	1.27	0.96	1.01	1.01	92.38	7.62	391	57	1.212	3.92	15.04	3.97	15.0	12.8		68.48
		1743.60	7/31/99 6:24 AM	16.49	32.21	50.39	0.93	0.97	1.00	1.00	94.33	5.67	412	60	1.209	3.67	14.09	3.72	15.1	12.8		67.27
		1773.03	8/1/99 11:50 AM	15.15	29.76	47.01	0.84	0.97	0.97	0.98	94.47	5.53	403	59	1.243	3.71	14.25	3.76	14.7	12.7		68.49
		1776.03	8/1/99 2:50 PM	15.38	30.33	47.60	0.85	0.97	0.97	0.99	94.45	5.55	397	58	1.268	3.70	14.18	3.75	14.5	12.4		68.50
		1778.03	8/1/99 4:50 PM	15.39	30.21	49.81	1.21	0.96	1.01	0.98	92.14	7.86	375	55	1.282	3.87	14.83	3.92	14.4	12.6		68.48
		1779.03	8/1/99 5:50 PM	15.42	32.35	51.06	1.68	0.95	1.01	1.00	89.11	10.89	351	51	1.286	4.20	16.11	4.26	14.7	12.2		69.78
		1780.03	8/1/99 6:50 PM	15.43	32.54	49.08	1.45	0.96	1.00	1.04	90.61	9.39	352	51	1.282	4.22	16.17	4.27	15.0	12.0		70.01
		1781.03	8/1/99 7:50 PM	15.45	30.91	48.36	0.96	0.97	1.01	1.03	93.77	6.23	378	55	1.279	3.92	15.05	3.98	15.1	12.3		68.89
		1782.03	8/1/99 8:50 PM	15.49	30.66	47.98	0.85	0.97	1.01	1.04	94.53	5.47	393	57	1.268	3.80	14.58	3.85	15.0	12.6		68.90
		1784.03	8/1/99 10:50 PM	15.43	30.26	47.63	0.85	0.97	1.01	1.04	94.48	5.52	401	58	1.247	3.72	14.28	3.77	15.0	12.6		68.47

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		1785.03	8/1/99 11:50 PM	15.39	30.17	47.27	0.92	0.97	1.01	1.04	94.01	5.99	402	58	1.240	3.74	14.33	3.79	14.8	12.7		68.49
		1787.03	8/2/99 1:50 AM	15.41	29.95	47.69	1.04	0.97	1.01	1.03	93.27	6.73	402	58	1.229	3.77	14.46	3.82	15.0	12.7		68.49
		1791.03	8/2/99 5:50 AM	15.31	29.88	46.88	0.79	0.97	0.97	1.00	94.82	5.18	420	61	1.219	3.63	13.94	3.68	15.3	12.8		68.49
		1792.03	8/2/99 6:50 AM	15.28	29.92	46.86	0.80	0.97	0.97	1.00	94.76	5.24	417	61	1.215	3.67	14.07	3.72	15.7	12.8		68.47
		1793.27	8/2/99 8:04 AM	15.20	29.96	46.98	0.85	0.97	1.01	1.01	94.41	5.59	415	60	1.215	3.69	14.14	3.74	15.9	12.7		67.61
		1794.27	8/2/99 9:04 AM	15.17	30.17	47.10	0.96	0.97	0.97	1.03	93.66	6.34	403	59	1.223	3.84	14.74	3.90	15.5	12.4		69.77
		1795.27	8/2/99 10:04 AM	15.16	30.46	47.66	1.19	0.96	0.97	1.02	92.14	7.86	387	56	1.226	4.00	15.34	4.05	15.4	12.4		69.79
		1796.27	8/2/99 11:04 AM	15.16	29.59	47.74	1.10	0.97	0.97	1.00	92.77	7.23	398	58	1.226	3.81	14.61	3.86	15.1	12.9		69.36
		1797.27	8/2/99 12:04 PM	15.27	29.92	47.22	0.84	0.97	0.97	0.99	94.47	5.53	410	60	1.243	3.65	13.99	3.70	15.1	12.7		68.47
		1798.27	8/2/99 1:04 PM	15.36	30.30	47.48	0.83	0.97	1.45	1.55	94.62	5.38	407	59	1.254	3.71	14.24	3.76	15.1	12.7		69.78
		1799.27	8/2/99 2:04 PM	15.52	30.71	48.03	0.87	0.97	1.01	1.03	94.42	5.58	398	58	1.265	3.70	14.19	3.75	15.1	12.5		68.41
		1800.27	8/2/99 3:04 PM	15.73	31.29	49.01	0.94	0.97	0.97	1.02	94.01	5.99	391	57	1.272	3.81	14.63	3.87	15.1	12.6		69.77
		1801.27	8/2/99 4:04 PM	15.78	31.67	49.69	1.02	0.97	0.97	1.01	93.55	6.45	385	56	1.282	3.84	14.73	3.89	15.0	12.4		69.79
		1802.27	8/2/99 5:04 PM	15.90	32.46	50.67	1.24	0.96	0.97	1.01	92.20	7.80	365	53	1.282	4.12	15.82	4.18	14.9	12.1		70.18
		1803.27	8/2/99 6:04 PM	16.13	32.30	50.89	1.28	0.96	0.97	1.01	92.06	7.94	372	54	1.275	4.00	15.35	4.05	15.0	12.4		69.78
		1804.27	8/2/99 7:04 PM	16.36	32.30	50.56	1.00	0.97	1.01	1.03	93.86	6.14	391	57	1.272	3.74	14.35	3.79	15.0	12.6		68.48
		1805.27	8/2/99 8:04 PM	16.42	32.76	51.06	1.09	0.97	0.97	1.03	93.35	6.65	384	56	1.268	3.90	14.95	3.95	15.0	12.4		69.77
		1807.27	8/2/99 10:04 PM	16.60	32.89	51.63	1.07	0.97	0.97	1.03	93.54	6.46	391	57	1.254	3.87	14.84	3.92	15.1	12.5		69.78
		1809.27	8/3/99 12:04 AM	16.50	32.75	51.12	1.00	0.97	0.93	0.99	93.96	6.04	403	59	1.240	3.79	14.54	3.84	15.3	12.7		69.76
		1810.27	8/3/99 1:04 AM	16.48	32.50	50.77	0.96	0.97	0.97	0.99	94.15	5.85	406	59	1.236	3.71	14.22	3.76	15.2	12.7		68.49
		1812.27	8/3/99 3:04 AM	16.31	32.08	50.13	0.93	0.97	1.01	1.04	94.32	5.68	411	60	1.233	3.67	14.08	3.72	15.3	12.7		68.49
		1814.27	8/3/99 5:04 AM	16.08	31.55	49.45	0.91	0.97	1.01	1.01	94.35	5.65	414	60	1.229	3.65	14.02	3.70	15.3	12.8		67.60
		1815.27	8/3/99 6:04 AM	16.09	31.62	49.45	0.91	0.97	0.97	1.00	94.33	5.67	415	60	1.226	3.66	14.02	3.71	15.2	12.8		68.47
		1820.92	8/3/99 11:43 AM	15.71	31.05	48.86	0.96	0.97	0.97	1.02	93.87	6.13	407	59	1.247	3.74	14.34	3.79	15.2	12.7		69.78
		1821.92	8/3/99 12:43 PM	15.79	31.22	49.15	0.99	0.97	0.97	1.02	93.73	6.27	400	58	1.251	3.79	14.55	3.84	15.1	12.7		69.76
		1822.92	8/3/99 1:43 PM	15.87	31.38	49.31	0.97	0.97	0.97	1.02	93.87	6.13	401	58	1.258	3.76	14.43	3.81	15.1	12.7		69.78
		1823.92	8/3/99 2:43 PM	15.93	31.47	49.44	1.01	0.97	0.97	1.03	93.68	6.32	393	57	1.268	3.80	14.58	3.85	15.0	12.6		69.77
		1824.92	8/3/99 3:43 PM	15.98	31.71	49.70	1.01	0.97	0.97	1.02	93.68	6.32	391	57	1.275	3.81	14.60	3.86	15.0	12.6		69.77
		1825.92	8/3/99 4:43 PM	16.01	31.70	49.91	1.00	0.97	0.92	1.02	93.74	6.26	390	57	1.283	3.86	14.82	3.92	15.0	12.6		71.06
		1827.92	8/3/99 6:43 PM	16.08	31.75	49.82	0.98	0.97	0.96	1.03	93.91	6.09	391	57	1.282	3.78	14.52	3.83	15.1	12.5		69.85
		1828.92	8/3/99 7:43 PM	16.12	32.00	50.13	1.01	0.97	0.92	1.02	93.71	6.29	389	57	1.279	3.88	14.89	3.93	15.0	12.6		71.06
		1829.92	8/3/99 8:43 PM	16.18	32.01	50.01	0.99	0.97	0.97	1.03	93.87	6.13	392	57	1.272	3.80	14.57	3.85	15.1	12.6		69.77
		1832.92	8/3/99 11:43 PM	16.18	31.96	50.01	0.93	0.97	0.89	0.99	94.22	5.78	408	59	1.247	3.79	14.54	3.84	15.2	12.7		71.06
		1833.92	8/4/99 12:43 AM	16.16	31.80	49.73	0.92	0.97	0.93	0.99	94.33	5.67	411	60	1.240	3.72	14.28	3.77	15.4	12.7		69.76
		1835.92	8/4/99 2:43 AM	16.03	31.46	49.24	0.89	0.97	0.97	1.04	94.46	5.54	415	60	1.233	3.70	14.20	3.75	15.4	12.7		69.76
		1836.92	8/4/99 3:43 AM																			
		1837.92	8/4/99 4:43 AM																			
		1839.92	8/4/99 6:43 AM																			
		1840.92	8/4/99 7:43 AM	15.57	30.88	48.56	0.91	0.97	0.97	1.02	94.15	5.85	407	59	1.219	3.81	14.63	3.87	15.4	12.7		69.76
		1841.27	8/4/99 8:04 AM	15.20	29.96	46.98	0.85	0.97	1.01	1.01	94.41	5.59	415	60	1.215	3.69	14.14	3.74	15.9	12.7		67.61
		1842.27	8/4/99 9:04 AM	15.17	30.17	47.10	0.96	0.97	0.97	1.03	93.66	6.34	403	59	1.223	3.84	14.74	3.90	15.5	12.4		69.77
		1843.27	8/4/99 10:04 AM	15.16	30.46	47.66	1.19	0.96	0.97	1.02	92.14	7.86	387	56	1.226	4.00	15.34	4.05	15.4	12.4		69.79
		1844.41	8/4/99 11:12 AM	15.35	30.42	47.70	0.92	0.97	1.54	1.63	94.02	5.98	401	58	1.233	3.83	14.70	3.88	15.3	12.6		69.76
		1845.41	8/4/99 12:12 PM	15.55	31.04	48.63	0.99	0.97	0.92	1.02	93.61	6.39	393	57	1.251	3.93	15.08	3.98	15.1	12.6		71.08
		1846.41	8/4/99 1:12 PM	15.67	31.29	49.24	1.05	0.97	0.97	1.03	93.32	6.68	387	56	1.261	3.96	15.20	4.01	15.1	12.4		70.17
		1847.41	8/4/99 2:12 PM	15.93	31.76	49.66	1.00	0.97	0.92	1.02	93.72	6.28	389	57	1.272	3.91	14.98	3.96	15.0	12.5		71.07
		1848.41	8/4/99 3:12 PM	16.10	32.09	50.68	1.12	0.97	0.94	1.01	93.07	6.93	379	55	1.279	3.96	15.20	4.02	15.0	12.3		70.64
		1850.41	8/4/99 5:12 PM	16.08	32.05	50.72	1.11	0.97	0.97	1.01	93.12	6.88	374	54	1.297	3.91	15.00	3.96	14.8	12.3		69.77
		1851.41	8/4/99 6:12 PM	16.03	32.26	50.67	1.04	0.97	0.92	1.01	93.51	6.49	376	55	1.301	3.95	15.14	4.00	15.0	12.3		71.07
		1853.41	8/4/99 8:12 PM	15.94	32.05	50.34	1.05	0.97	0.92	1.01	93.39	6.61	378	55	1.293	3.95	15.16	4.01	14.8	12.4		71.07
		1855.41	8/4/99 10:12 PM	15.92	31.67	49.61	1.00	0.97	0.93	1.02	93.70	6.30	389	57	1.275	3.89	14.93	3.94	15.0	12.4		71.08
		1856.41	8/4/99 11:12 PM	15.87	31.50	49.49	0.98	0.97	0.97	1.02	93.81	6.19	393	57	1.265	3.81	14.62	3.86	15.0	12.5		69.78
		1857.41	8/5/99 12:12 AM	15.75	31.25	49.10	0.95	0.97	0.97	1.02	93.94	6.06	398	58	1.258	3.79	14.53	3.84	15.1	12.6		69.75
		1858.41	8/5/99 1:12 AM	15.62	31.04	48.63	0.93	0.97	0.93	0.99	94.04	5.96	401	58	1.251	3.78	14.51	3.83	15.3	12.5		69.78
		1859.41	8/5/99 2:12 AM	15.52	30.67	48.12	0.91	0.97	0.97	1.03	94.14	5.86	404	59	1.247	3.77	14.45	3.82	15.1	12.7		69.78
		1861.41	8/5/99 4:12 AM	15.21	30.04	47.10	0.88	0.97	0.97	1.03	94.19	5.81	408	59	1.240	3.75	14.39	3.80	15.2	12.6		69.78
		1862.41	8/5/99 5:12 AM	15.07	29.75	46.62	0.87	0.97	0.93	0.99	94.21	5.79	410	60	1.236	3.74	14.34	3.79	15.2	12.6		69.78
		1863.41	8/5/99 6:12 AM	14.97	29.54	46.38	0.86	0.97	0.93	0.99	94.25	5.75	414	60	1.229	3.72	14.27	3.77	15.4	12.5		69.76
		1864.41	8/5/99 7:12 AM	14.96	29.54	46.36	0.86	0.97	0.93	1.00	94.24	5.76	382	56	1.304	3.87	14.87	3.93	14.8	12.3		70.12
		1877.67	8/5/99 8:28 PM	15.08	30.25	47.59	0.96	0.97	0.92	1.01	93.62	6.38			1.297				14.8	12.4		71.09
		1878.67	8/5/99 9:28 PM	15.16	30.26	47.51	0.95	0.97	0.92	1.01	93.72	6.28	386	56	1.286	3.89	14.94	3.95	15.1	12.3		71.08
		1879.67	8/5/99 10:28 PM	15.07	30.01	47.01	0.91	0.97	0.97	1.02	93.96	6.04	397	58	1.275	3.74	14.36	3.79	15.0	12.5		69.78
		1880.67	8/5/99 11:28 PM	14.94	29.71	46.71	0.87	0.97	0.94	1.02	94.16	5.84	404	59	1.268	3.77	14.46	3.82	15.1	12.6		70.78
		1881.67	8/6/99 12:28 AM	14.82	29.51	46.20	0.84	0.97	0.97	1.02	94.31	5.69	406	59	1.258	3.71	14.23	3.76	15.1	12.6		69.78
		1882.67	8/6/99 1:28 AM	14.77	29.26	45.74	0.83	0.97	0.92	1.03	94.41	5.59	410	60	1.254	3.75	14.39	3.80	15.1	12.6		71.06
		1885.67	8/6/99 4:28 AM	14.33	28.39	44.16	0.78	0.97	0.97	1.03	94.56	5.44	418	61	1.236	3.67	14.08	3.72	15.2	12.6		69.78
		1886.67	8/6/99 5:28 AM	14.19	28.09	43.61	0.77	0.97	0.93	1.00	94.60	5.40	420	61	1.233	3.66	14.05	3.71	15.3	12.6		69.77
		1888.89	8/6/99 7:41 AM	14.14	27.89	43.31	0.75	0.97	0.93	1.00	94.72	5.28	425	62	1.229	3.63	13.91	3.68	15.3	12.7		69.79
		1889.67	8/6/99 8:28 AM	14.08	27.77	43.11	0.74	0.97	0.93	1.00	94.71	5.29	425	62	1.229	3.63	13.92	3.68	15.3	12.7		69.76
		1890.67	8/6/99 9:28 AM	14.06	27.72	42.93	0.76	0.97	0.97	1.04	94.61	5.39	421	61	1.236	3.64	13.98	3.69	15.3	12.6		69.76
		1891.67	8/6/99 10:28 AM	14.07	27.85	43.18	0.76	0.97	0.89	1.00	94.60	5.40	423	62	1.243	3.67	14.09	3.72	15.4	12.7		71.06
		1892.67	8/6/99 11:28 AM	14.17	28.09	43.56	0.79	0.97	0.92	0.99	94.42	5.58	416	61	1.254	3.64	13.96	3.69	15.2	12.4		69.86
		1893.67	8/6/99 12:28 PM	14.26	28.37	44.18	0.83	0.97	0.97	1.03	94.17	5.83	407	59	1.265	3.68	14.12	3.73	15.0	12.6		69.78
		1894.67	8/6/99 1:28 PM	14.40	28.72	44.49	0.86	0.97	0.92	1.03	94.01	5.99	402	58	1.272	3.78	14.51	3.83	15.0	12.4		71.08
		1913.54	8/7/99 8:20 AM	13.70	27.55	44.12	0.85	0.97	0.96	0.99	93.81	6.19	418	61	1.236	3.67	14.09	3.72	15.0	12.2		69.76
		1914.54	8/7/99 9:20 AM	13.80	27.38	43.96	0.87	0.97	0.93	1.00	93.69	6.31	415	60	1.243	3.74	14.34	3.79	15.0	12.3		70.98
		1915.54	8/7/99 10:20 AM	13.66	27.31	43.93	0.88	0.97	0.92	0.99	93.59	6.41	412	60	1.251	3.75	14.40	3.80	15.1	12.0		71.06
		1917.54	8/7/99 12:20 PM	13.64	27.47	44.23	0.94	0.97	0.92	0.98	93.12	6.88	404	59	1.265	3.78	14.50	3.83	15.1	12.0		71.06
		1919.54	8/7/99 2:20 PM	13.90	27.89	45.72	1.14	0.96	0.96	1.01	91.78	8.22	386	56	1.279	3.91	15.00	3.96	14.8	11.8		71.06
		1920.54	8/7/99 3:20 PM	14.05	28.59	45.97	1.18	0.96	0.92	1.01	91.60	8.40	379	55	1.290	4.03	15.45	4.08	15.0	11.7		72.36
		1921.54	8/7/99 4:20 PM	14.47	28.92	46.22	0.94	0.97	0.96	1.04	93.51	6.49	399	58	1.297	3.73	14.31	3.78	14.7	12.0		71.07
		1923.54	8/7/99 6:20 PM	14.78	29.91	47.61	0.92	0.97	0.94	1.03	93.79	6.21	391	57	1.305	3.82	14.66	3.87	14.9	11.8		71.79
		1925.54	8/7/99 8:20 PM	14.70	30.12	47.67	1.18	0.96	0.92	1.02	92.00	8.00	373	54	1.293	4.08	15.64	4.13	15.0	11.5		72.36
		1926.54	8/7/99 9:20 PM	14.61	29.21	47.94	1.21	0.96	1.01	1.01	91.73	8.27	381	55	1.286	3.87	14.84	3.92	14.9	11.7		69.77
		1927.54	8/7/99 10:20 PM	14.48	28.79	46.11	0.90	0.97	1.01	1.04	93.77	6.23	406	59	1.276	3.66	14.03	3.71	15.0	12.0		69.77
		1929.54	8/8/99 12:20 AM	14.18	28.47	45.62	0.98	0.97	0.93	0.99	93.12	6.88	404	59	1.258	3.80	14.58	3.85	15.0	12.0		71.05
		1930.54	8/8/99 1:20 AM	14.04	28.22	44.85	0.90	0.97	0.92	1.00	93.60	6.40	413	60	1.254	3.73	14.31	3.78	15.3	12.0		71.06
		1931.54	8/8/99 2:20 AM	13.88	27.84	44.58	0.89	0.97	0.92	0.99	93.61	6.39	415	60	1.247	3.73	14.32	3.78	15.3	12.0		71.06
		1932.54	8/8/99 3:20 AM	13.70	27.47	44.12	0.86	0.97	0.92	0.99	93.71	6.29	419	61	1.247	3.70	14.18	3.75	15.3	12.1		71.06
		1933.54	8/8/99 4:20 AM	13.55	27.18	43.65	0.84	0.97	0.92	0.99	93.77	6.23	421	61	1.244	3.68	14.13	3.73	15.3	12.1		71.06
		1935.54	8/8/99 6:20 AM	13.50	27.01	43.40	0.82	0.97	0.92	0.99	93.91	6.09	424	62	1.240	3.67	14.07	3.72	15.4	12.2		71.06
		1936.54	8/8/99 7:20 AM	13.43	26.89	43.26	0.81	0.97	0.97	1.00	93.96	6.04	427	62	1.236	3.66	14.03	3.71	15.4	12.1		70.16
		1937.19	8/8/99 7:59 AM	13.34	26.72	43.09	0.80	0.97	0.92	0.99	94.02	5.98	429	62	1.236	3.64	13.97	3.69	15.4	12.1		71.06
		1939.19	8/8/99 9:59 AM	13.13	26.36	42.32	0.82	0.97	0.92	0.99	93.77	6.23	420	61	1.251	3.68	14.11	3.73	15.3	12.1		71.07
		1941.19	8/8/99 11:59 AM	13.15	26.36	42.47	0.85	0.97	0.96	1.03	93.50	6.50	411	60	1.261	3.72	14.28	3.77	15.1	12.0		71.08
		1942.19	8/8/99 12:59 PM	13.18	26.52	42.83	0.86	0.97	0.92	0.98	93.44	6.56	411	60	1.268	3.70	14.21	3.75	15.1	12.0		71.08
		1944.19	8/8/99 2:59 PM	13.28	26.81	42.95	0.87	0.97	0.93	1.03	93.43	6.57	405	59	1.286	3.76	14.41	3.81	15.0	12.0		72.05
		1946.19	8/8/99 4:59 PM	13.49	27.26	43.20	0.73	0.97	0.96	1.08	94.60	5.40	405	59	1.301	3.74	14.34	3.79	15.0	11.7		72.37
		1948.19	8/8/99 6:59 PM	13.56	27.88	42.73	0.73	0.97	0.97	1.06	94.58	5.42	409	59	1.301	3.64	13.95	3.69	14.5	11.4		71.05
		1949.19	8/8/99 7:59 PM	13.53	27.97	42.10	0.72	0.97	0.96	1.07	94.65	5.35	414	60	1.293	3.61	13.84	3.66	14.6	11.1		71.07

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		1951.19	8/8/99 9:59 PM	13.44	28.25	41.14	0.69	0.97	1.01	1.09	94.87	5.13	430	63	1.276	3.46	13.27	3.50	14.5	11.0		69.77
		1952.19	8/8/99 10:59 PM	13.37	28.26	40.59	0.67	0.98	1.01	1.09	95.01	4.99	438	64	1.268	3.42	13.11	3.46	14.5	11.0		69.77
		1955.19	8/9/99 1:59 AM	13.22	28.29	39.41	0.62	0.98	0.97	1.07	95.29	4.71	455	66	1.251	3.33	12.78	3.38	14.4	10.7		69.77
		1956.19	8/9/99 2:59 AM	13.14	28.22	39.06	0.61	0.98	0.97	1.07	95.34	4.66	458	67	1.247	3.32	12.73	3.36	14.4	10.7		69.77
		1957.19	8/9/99 3:59 AM	13.06	28.13	38.66	0.60	0.98	0.97	1.08	95.39	4.61	462	67	1.243	3.30	12.67	3.35	14.4	10.7		69.78
		1958.19	8/9/99 4:59 AM	12.97	28.01	38.28	0.59	0.98	0.97	1.08	95.41	4.59	461	67	1.244	3.30	12.68	3.35	14.5	10.6		69.78
		1959.19	8/9/99 5:59 AM	12.93	28.01	38.15	0.59	0.98	0.97	1.08	95.43	4.57	464	68	1.243	3.28	12.60	3.33	14.4	10.6		69.76
		1960.19	8/9/99 6:59 AM	12.91	28.05	38.15	0.58	0.98	0.97	1.08	95.47	4.53	468	68	1.240	3.27	12.53	3.31	14.4	10.7		69.76
		1961.22	8/9/99 8:01 AM	12.91	28.14	38.16	0.58	0.98	0.98	1.10	95.53	4.47	472	69	1.240	3.24	12.43	3.28	14.4	10.7		69.78
		1962.22	8/9/99 9:01 AM	12.94	28.30	37.91	0.58	0.98	0.97	1.09	95.48	4.52	471	68	1.247	3.23	12.39	3.27	14.3	10.6		69.76
		1963.22	8/9/99 10:01 AM	12.95	26.60	42.20	0.87	0.97	0.96	1.02	93.32	6.68	402	59	1.251	3.84	14.72	3.89	15.0	11.6		71.07
		1965.22	8/9/99 12:01 PM	13.18	26.28	40.85	0.85	0.97	0.93	0.99	93.51	6.49	390	57	1.265	3.85	14.76	3.90	15.2	12.4		69.77
		1966.22	8/9/99 1:01 PM	13.21	26.32	41.14	0.89	0.97	0.93	0.98	93.23	6.77	382	56	1.268	3.92	15.02	3.97	15.0	12.3		69.75
		1967.22	8/9/99 2:01 PM	13.28	26.56	41.23	0.85	0.97	0.93	0.99	93.56	6.44	384	56	1.279	3.86	14.80	3.91	15.1	12.3		69.77
		1969.22	8/9/99 4:01 PM	13.36	26.60	41.14	0.91	0.97	0.93	0.99	93.21	6.79	378	55	1.297	3.87	14.85	3.92	15.1	12.6		69.76
		1970.22	8/9/99 5:01 PM	13.44	26.77	41.43	0.89	0.97	0.93	0.99	93.35	6.65	377	55	1.308	3.85	14.75	3.90	15.1	12.4		69.78
		1971.22	8/9/99 6:01 PM	13.51	26.94	41.76	0.89	0.97	0.93	0.99	93.38	6.62	374	54	1.312	3.87	14.84	3.92	15.1	12.4		69.77
		1972.22	8/9/99 7:01 PM	13.57	27.10	41.86	0.89	0.97	0.93	0.99	93.44	6.56	377	55	1.312	3.84	14.74	3.89	15.1	12.4		69.78
		1973.22	8/9/99 8:01 PM	13.55	26.97	40.96	0.68	0.98	0.96	1.05	95.00	5.00	388	56	1.301	3.76	14.42	3.81	15.0	12.2		69.77
		1974.22	8/9/99 9:01 PM	13.54	27.23	40.38	0.66	0.98	0.97	1.07	95.09	4.91	396	58	1.290	3.71	14.25	3.77	14.9	12.2		69.76
		1975.22	8/9/99 10:01 PM	13.48	27.34	39.37	0.64	0.98	0.98	1.06	95.24	4.76	410	60	1.276	3.55	13.64	3.60	14.8	12.0		68.47
		1976.22	8/9/99 11:01 PM	13.43	27.55	38.45	0.62	0.98	0.97	1.07	95.41	4.59	423	61	1.261	3.49	13.39	3.54	14.8	11.7		68.48
		1977.22	8/10/99 12:01 AM	13.33	27.60	37.61	0.60	0.98	0.97	1.09	95.53	4.47	431	63	1.254	3.44	13.19	3.49	14.8	11.6		68.47
		1978.22	8/10/99 1:01 AM	13.26	27.59	36.98	0.57	0.98	0.97	1.10	95.68	4.32	438	64	1.251	3.40	13.04	3.44	14.8	11.7		68.47
		1983.22	8/10/99 6:01 AM	12.69	26.89	34.70	0.51	0.98	0.97	1.08	96.02	3.98	454	66	1.240	3.25	12.45	3.29	14.7	11.3		67.18
		1984.22	8/10/99 7:01 AM	12.57	26.70	34.26	0.49	0.98	0.97	1.08	96.07	3.93	457	66	1.236	3.23	12.40	3.28	14.6	11.3		67.17
9	Inc to 75%	1985.17	8/10/99 7:58 AM	12.49	26.60	34.11	0.49	0.98	1.01	1.09	96.10	3.90	458	67	1.236	3.22	12.35	3.26	15.1	11.3		66.31
		1986.17	8/10/99 8:58 AM	12.46	25.13	27.52	0.59	0.97	0.97	1.41	95.23	4.77	453	66	1.240	3.25	12.47	3.29	8.5	10.3		68.96
		1987.17	8/10/99 9:58 AM	12.42	26.44	39.51	0.73	0.97	0.93	1.00	94.16	5.84	421	61	1.247	3.68	14.12	3.73	14.6	11.3		71.05
		1988.17	8/10/99 10:58 AM	12.42	26.31	39.47	0.74	0.97	0.93	1.00	94.02	5.98	417	61	1.254	3.69	14.16	3.74	14.7	11.3		71.05
		1989.17	8/10/99 11:58 AM	12.47	26.40	39.50	0.76	0.97	0.93	1.01	93.90	6.10	415	60	1.258	3.70	14.20	3.75	14.7	11.3		71.07
		1990.17	8/10/99 12:58 PM	12.59	26.69	39.97	0.79	0.97	0.93	1.01	93.72	6.28	412	60	1.265	3.70	14.21	3.75	14.6	11.3		71.06
		1985.17	8/10/99 7:58 AM	12.49	26.60	34.11	0.49	0.98	1.01	1.09	96.10	3.90	458	67	1.236	3.22	12.35	3.26	15.1	11.3		66.31
		1986.17	8/10/99 8:58 AM	12.46	25.13	27.52	0.59	0.97	0.97	1.41	95.23	4.77	453	66	1.240	3.25	12.47	3.29	8.5	10.3		68.96
		1987.17	8/10/99 9:58 AM	12.42	26.44	39.51	0.73	0.97	0.93	1.00	94.16	5.84	421	61	1.247	3.68	14.12	3.73	14.6	11.3		71.05
		1988.17	8/10/99 10:58 AM	12.42	26.31	39.47	0.74	0.97	0.93	1.00	94.02	5.98	417	61	1.254	3.69	14.16	3.74	14.7	11.3		71.05
		1989.17	8/10/99 11:58 AM	12.47	26.40	39.50	0.76	0.97	0.93	1.01	93.90	6.10	415	60	1.258	3.70	14.20	3.75	14.7	11.3		71.07
		1990.17	8/10/99 12:58 PM	12.59	26.69	39.97	0.79	0.97	0.93	1.01	93.72	6.28	412	60	1.265	3.70	14.21	3.75	14.6	11.3		71.06
		1991.17	8/10/99 1:58 PM	12.68	26.89	40.52	0.80	0.97	0.92	1.00	93.66	6.34	410	60	1.276	3.69	14.18	3.75	14.6	11.1		71.08
		1995.17	8/10/99 5:58 PM	13.05	28.67	44.52	0.89	0.97	0.95	1.01	93.15	6.85	386	56	1.305	3.71	14.22	3.76	13.3	9.2		72.42
		1996.17	8/10/99 6:58 PM	13.13	28.84	44.56	0.88	0.97	0.96	1.01	93.30	6.70	389	57	1.305	3.67	14.09	3.72	12.9	9.4		72.24
		1997.17	8/10/99 7:58 PM	13.20	29.13	44.73	0.86	0.97	0.91	1.01	93.45	6.55	394	57	1.301	3.70	14.19	3.75	13.1	9.4		73.60
		1998.17	8/10/99 8:58 PM	13.28	29.25	44.87	0.85	0.97	0.96	1.02	93.59	6.41	401	58	1.286	3.61	13.85	3.66	13.1	9.4		72.21
		1999.17	8/10/99 9:58 PM	13.35	29.33	44.66	0.83	0.97	0.96	1.03	93.78	6.22	404	59	1.275	3.61	13.86	3.66	13.3	9.2		72.23
		2000.17	8/10/99 10:58 PM	13.37	29.42	44.62	0.81	0.97	0.92	0.99	93.95	6.05	415	60	1.261	3.56	13.65	3.61	13.3	9.4		72.22
		2001.17	8/10/99 11:58 PM	13.34	29.33	44.37	0.79	0.97	0.92	0.99	94.06	5.94	419	61	1.254	3.54	13.58	3.59	13.1	9.4		72.22
		2008.90	8/11/99 7:42 AM	12.91	26.86	44.46	0.81	0.97	0.96	1.00	93.73	6.27	392	57	1.229	3.86	14.79	3.91	13.9	10.3		72.22
		2009.90	8/11/99 8:42 AM	12.82	26.65	44.16	0.81	0.97	0.91	1.00	93.72	6.28	394	57	1.233	3.90	14.98	3.96	13.8	10.4		73.60
		2012.90	8/11/99 11:42 AM	12.85	26.69	45.37	0.85	0.97	1.73	1.85	93.42	6.58	388	56	1.258	3.88	14.90	3.94	13.8	10.1		73.58
		2013.90	8/11/99 12:42 PM	12.76	26.48	44.93	0.87	0.97	0.96	1.03	93.15	6.85	380	55	1.265	3.94	15.13	4.00	14.0	10.0		73.58
		2016.90	8/11/99 3:42 PM	13.33	27.77	47.21	0.96	0.97	0.96	1.02	92.76	7.24	369	54	1.293	3.97	15.23	4.02	13.6	10.0		73.59
		2018.90	8/11/99 5:42 PM	13.45	27.97	47.34	0.96	0.97	0.98	1.04	92.87	7.13	371	54	1.301	3.97	15.24	4.03	13.7	10.2		73.32
		2019.90	8/11/99 6:42 PM	13.57	28.18	47.72	0.96	0.97	1.26	1.30	92.94	7.06	370	54	1.301	3.94	15.10	3.99	13.5	10.1		72.59
		2020.90	8/11/99 7:42 PM	13.64	28.27	47.90	0.95	0.97	0.96	1.03	93.02	6.98	375	55	1.297	3.90	14.96	3.95	13.5	10.1		73.59
		2021.90	8/11/99 8:42 PM	13.73	28.44	47.95	0.94	0.97	0.96	1.03	93.13	6.87	379	55	1.286	3.89	14.92	3.94	13.6	10.1		73.59
		2022.90	8/11/99 9:42 PM	13.73	28.26	47.78	0.93	0.97	0.96	1.04	93.24	6.76	384	56	1.276	3.87	14.84	3.92	13.7	10.2		73.58
		2024.90	8/11/99 11:42 PM	13.54	27.97	47.15	0.88	0.97	0.96	1.04	93.47	6.53	395	57	1.254	3.83	14.69	3.88	13.8	10.3		73.58
		2025.90	8/12/99 12:42 AM	13.51	27.84	46.85	0.87	0.97	0.91	0.99	93.58	6.42	397	58	1.247	3.82	14.67	3.87	13.8	10.2		73.58
		2026.90	8/12/99 1:42 AM	13.45	27.72	46.64	0.85	0.97	0.96	1.04	93.66	6.34	402	58	1.243	3.79	14.55	3.85	13.8	10.4		73.58
		2027.90	8/12/99 2:42 AM	13.38	27.47	46.16	0.84	0.97	0.91	1.00	93.71	6.29	402	59	1.240	3.80	14.57	3.85	13.8	10.3		73.59
		2028.90	8/12/99 3:42 AM	13.23	27.18	45.66	0.83	0.97	0.96	1.00	93.75	6.25	401	58	1.236	3.75	14.40	3.80	13.8	10.4		72.23
		2029.90	8/12/99 4:42 AM	13.05	26.77	44.93	0.81	0.97	0.96	1.01	93.81	6.19	406	59	1.236	3.77	14.48	3.83	14.1	10.2		72.59
		2030.90	8/12/99 5:42 AM	12.92	26.48	44.42	0.79	0.97	0.92	1.00	93.85	6.15	406	59	1.233	3.79	14.52	3.84	13.8	10.4		73.55
		2031.90	8/12/99 6:42 AM	12.89	26.40	44.21	0.79	0.97	0.91	1.01	93.86	6.14	409	59	1.233	3.76	14.43	3.81	13.8	10.3		73.58
		2032.79	8/12/99 7:35 AM	12.86	26.32	44.13	0.78	0.97	0.92	1.00	93.93	6.07	409	60	1.229	3.76	14.44	3.81	13.9	10.3		73.52
		2033.79	8/12/99 8:35 AM	12.79	26.20	43.79	0.78	0.97	0.91	1.01	93.93	6.07	412	60	1.229	3.74	14.35	3.79	13.9	10.4		73.58
		2034.79	8/12/99 9:35 AM	12.74	26.11	43.62	0.78	0.97	0.96	1.01	93.88	6.12	404	59	1.233	3.74	14.33	3.79	13.5	10.3		72.23
		2037.79	8/12/99 12:35 PM	13.18	28.26	47.61	1.01	0.97	0.96	1.00	92.32	7.68	390	57	1.247	3.90	14.96	3.95	13.7	10.3		73.58
		2038.79	8/12/99 1:35 PM	13.38	28.18	47.40	0.98	0.97	0.97	1.03	92.71	7.29	380	55	1.254	4.04	15.49	4.09	13.7	10.1		73.69
		2040.79	8/12/99 3:35 PM	13.55	29.29	50.34	1.04	0.97	1.01	1.03	92.36	7.64	392	57	1.283	3.77	14.47	3.82	13.5	9.8		73.59
		2041.79	8/12/99 4:35 PM	13.66	29.63	50.63	0.97	0.97	1.01	1.03	92.90	7.10	407	59	1.297	3.60	13.80	3.65	13.6	10.0		73.59
		2042.79	8/12/99 5:35 PM	13.80	29.63	50.68	0.94	0.97	1.01	1.04	93.18	6.82	418	61	1.305	3.48	13.34	3.52	13.5	10.1		73.58
		2043.79	8/12/99 6:35 PM	13.86	29.67	50.50	0.91	0.97	1.06	1.06	93.42	6.58	429	62	1.301	3.40	13.05	3.45	13.7	10.1		72.59
		2044.79	8/12/99 7:35 PM	13.83	29.30	49.92	0.90	0.97	0.96	1.00	93.52	6.48	434	63	1.297	3.37	12.92	3.41	13.6	10.1		73.59
		2045.79	8/12/99 8:35 PM	13.81	28.52	49.02	0.86	0.97	0.96	1.02	93.75	6.25	447	65	1.286	3.29	12.64	3.34	13.8	10.3		73.57
		2047.79	8/12/99 10:35 PM	13.52	27.55	46.98	0.81	0.97	0.96	1.04	94.01	5.99	467	68	1.261	3.22	12.35	3.26	14.0	10.3		73.56
		2048.79	8/12/99 11:35 PM	13.29	27.06	46.25	0.80	0.97	0.98	1.04	94.01	5.99	462	67	1.254	3.25	12.46	3.29	14.1	10.3		72.98
		2051.79	8/13/99 2:35 AM	12.85	26.03	44.97	0.76	0.97	0.96	1.03	94.09	5.91	453	66	1.236	3.38	12.99	3.43	14.1	10.4		73.59
		2052.79	8/13/99 3:35 AM	12.69	25.74	44.64	0.75	0.97	0.96	1.03	94.05	5.95	453	66	1.233	3.39	13.02	3.44	14.1	10.4		73.59
		2054.79	8/13/99 5:35 AM	12.50	25.37	43.95	0.75	0.97	0.96	1.03	94.02	5.98	451	66	1.229	3.42	13.12	3.47	14.1	10.3		73.59
		2055.79	8/13/99 6:35 AM	12.49	25.33	43.92	0.74	0.97	0.96	1.03	94.04	5.96	454	66	1.226	3.41	13.07	3.45	14.2	10.4		73.59
		2057.79	8/13/99 8:35 AM	12.47	25.24	43.78	0.74	0.97	1.01	1.03	94.09	5.91	459	67	1.215	3.33	12.79	3.38	14.2	10.6		72.23
		2058.79	8/13/99 9:35 AM	12.34	25.04	43.54	0.75	0.97	0.96	1.03	93.90	6.10	447	65	1.233	3.44	13.19	3.48	14.3	10.4		73.59
		2059.79	8/13/99 10:35 AM	12.29	24.88	43.20	0.67	0.98	1.01	1.03	94.53	5.47	449	65	1.236	3.35	12.86	3.40	14.1	10.3		72.22
		2060.79	8/13/99 11:35 AM	12.30	25.21	43.82	0.71	0.97	0.96	1.02	94.21	5.79	441	64	1.243	3.45	13.25	3.50	14.3	10.3		73.58
		2062.79	8/13/99 1:35 PM	12.74	26.07	45.30	0.76	0.97	0.96	1.02	94.02	5.98	429	62	1.258	3.51	13.47	3.56	14.0	10.1		73.59
		2063.79	8/13/99 2:35 PM	12.90	26.48	46.02	0.79	0.97	0.91	1.02	93.88	6.12	423	61	1.268	3.60	13.82	3.65	13.8	10.1		74.97
		2064.79	8/13/99 3:35 PM	12.90	26.61	46.41	0.81	0.97	1.01	1.02	93.71	6.29	411	60	1.283	3.59	13.79	3.64	13.7	10.1		72.65
		2065.79	8/13/99 4:35 PM	12.88	26.60	46.40	0.82	0.97	0.91	1.01	93.66	6.34	409	59	1.293	3.65	14.02	3.70	13.6	10.0		74.95
		2066.79	8/13/99 5:35 PM	12.81	26.44	45.97	0.81	0.97	0.91	1.01	93.67	6.33	406	59	1.297	3.67	14.09	3.72	13.5	10.0		74.96
		2068.79	8/13/99 7:35 PM	12.76	26.32	45.89	0.80	0.97	0.91	1.01	93.72	6.28	411	60	1.293	3.63	13.94	3.68	13.5	10.0		74.94
		2069.79	8/13/99 8:35 PM	12.83	26.32	45.75	0.79	0.97	0.91	1.01	93.84	6.16	415	60	1.283	3.63	13.92	3.68	13.8	9.8		74.95
		2071.79	8/13/99 10:35 PM	12.74	26.03	45.40	0.75	0.97	0.91	1.01	94.08	5.92	424	62	1.261	3.61	13.84	3.66	14.1	10.0		74.88
		2072.79	8/13/99 11:35 PM	12.65	25.87	44.94	0.74	0.97	0.96	1.02	94.17	5.83	426	62	1.254	3.55	13.60	3.59	14.1	10.0		73.58
		2073.79	8/14/99 12:35 AM	12.60	25.70	44.68	0.73	0.97	0.96	1.02	94.23	5.77	429	62	1.247	3.54	13.59	3.59	13.8	10.1		73.58
		2074.79	8/14/99 1:35 AM	12.64	25.74	44.76	0.72	0.97	0.96	1.02	94.28	5.72	432	63	1.243	3.53	13.55	3.58	13.8	10.1		73.52
		2075.79	8/14/99 2:35 AM	12.66	25.70	44.68	0.72	0.97	0.96	1.03	94.30	5.70	434	63	1.240	3.52	13.51	3.57	13.8	10.1		73.58
		2076.79	8/14/99 3:35 AM	12.62	25.61	44.54	0.72	0.97	1.01	1.04	94.31	5.69	437	64	1.236	3.51	13.47	3.56	13.9	10.2		72.62
		2077.79	8/14/99 4:35 AM	12.58	25.45	44.33	0.71	0.97	0.96	1.03	94.32	5.68	437	64	1.233	3.52	13.49	3.56	13.8	10.2		73.59
		2078.79	8/14/99 5:35 AM	12.58	25.45	44.34	0.71	0.98	0.96	1.03	94.34	5.66	436	63	1.233	3.52	13.52	3.57	13.9	10.2		73.59

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		2081.87	8/14/99 8:40 AM	12.56	25.66	44.55	0.80	0.97	0.91	1.02	93.61	6.39	434	63	1.229	3.62	13.89	3.67	13.8	10.3		74.95
		2082.87	8/14/99 9:40 AM	12.45	25.53	44.02	0.81	0.97	0.96	1.02	93.50	6.50	430	62	1.236	3.57	13.69	3.62	13.8	10.2		73.58
		2083.87	8/14/99 10:40 AM	12.43	25.53	44.38	0.83	0.97	0.96	1.01	93.32	6.68	426	62	1.247	3.57	13.69	3.62	13.8	10.0		73.58
		2084.87	8/14/99 11:40 AM	12.32	25.37	44.08	0.85	0.97	0.91	1.01	93.12	6.88	423	61	1.254	3.64	13.97	3.69	13.8	10.1		74.96
		2085.87	8/14/99 12:40 PM	12.40	25.65	44.37	0.88	0.97	0.96	1.01	92.90	7.10	418	61	1.258	3.61	13.83	3.66	13.6	10.0		73.58
		2086.87	8/14/99 1:40 PM	12.55	26.03	44.92	0.92	0.97	1.01	1.07	92.70	7.30	412	60	1.265	3.64	13.95	3.69	13.7	10.0		73.60
		2087.87	8/14/99 2:40 PM	12.68	26.53	45.77	0.94	0.97	1.01	1.07	92.60	7.40	411	60	1.275	3.69	14.15	3.74	13.7	10.0		73.96
		2088.87	8/14/99 3:40 PM	12.71	26.89	46.36	0.99	0.97	0.96	1.04	92.22	7.78	401	58	1.290	3.74	14.34	3.79	13.5	10.0		74.95
		2089.87	8/14/99 4:40 PM	12.78	27.01	46.48	0.94	0.97	0.96	1.04	92.64	7.36	411	60	1.297	3.62	13.90	3.67	13.5	10.0		74.96
		2091.87	8/14/99 6:40 PM	12.94	27.14	46.99	0.91	0.97	1.01	1.06	92.99	7.01	420	61	1.308	3.52	13.49	3.56	13.4	10.1		73.96
		2092.87	8/14/99 7:40 PM	12.94	27.02	46.78	0.95	0.97	1.01	1.05	92.67	7.33	414	60	1.305	3.51	13.49	3.56	13.5	10.0		73.58
		2096.87	8/14/99 11:40 PM	12.71	25.90	44.80	0.77	0.97	0.96	1.03	93.95	6.05	452	66	1.258	3.33	12.79	3.38	13.8	10.3		73.58
		2097.87	8/15/99 12:40 AM	12.62	25.74	44.43	0.75	0.97	0.96	1.03	94.05	5.95	456	66	1.251	3.33	12.76	3.37	14.0	10.3		73.58
		2098.87	8/15/99 1:40 AM	12.57	25.61	44.33	0.74	0.97	1.01	1.04	94.14	5.86	455	66	1.244	3.35	12.85	3.39	14.0	10.3		72.59
		2099.87	8/15/99 2:40 AM	12.55	25.49	43.82	0.55	0.98	0.96	1.04	95.60	4.40	454	66	1.236	3.38	12.96	3.42	14.0	10.1	1.48	73.58
		2100.87	8/15/99 3:40 AM	12.49	25.90	43.27	0.56	0.98	0.96	1.05	95.50	4.50	444	65	1.233	3.46	13.27	3.51	13.7	9.8		73.58
		2101.87	8/15/99 4:40 AM	12.45	26.64	41.86	0.55	0.98	0.96	1.08	95.62	4.38	460	67	1.229	3.35	12.86	3.40	13.4	9.2		73.58
		2102.87	8/15/99 5:40 AM	12.50	27.51	40.94	0.53	0.98	0.96	1.11	95.72	4.28	477	69	1.223	3.25	12.48	3.30	13.3	8.8		73.58
		2104.63	8/15/99 7:26 AM	12.52	26.56	45.09	0.79	0.97	0.91	1.00	93.72	6.28	427	62	1.219	3.71	14.23	3.76	13.8	9.7	2.91	74.95
		2106.63	8/15/99 9:26 AM	12.38	26.15	44.12	0.79	0.97	0.91	1.01	93.64	6.36	430	63	1.223	3.67	14.07	3.72	13.8	9.7	2.57	74.94
		2107.63	8/15/99 10:26 AM	12.34	26.02	44.12	0.80	0.97	0.96	1.01	93.51	6.49	430	63	1.233	3.57	13.71	3.62	13.6	9.8	2.56	73.58
		2108.63	8/15/99 11:26 AM	12.30	25.99	44.17	0.82	0.97	0.91	1.01	93.30	6.70	426	62	1.240	3.65	14.02	3.70	13.8	9.8	2.56	74.96
		2111.63	8/15/99 2:26 PM	12.47	26.53	45.56	0.96	0.97	1.01	1.06	92.32	7.68	407	59	1.272	3.73	14.30	3.78	14.0	9.7	2.91	73.94
		2112.63	8/15/99 3:26 PM	12.48	27.10	46.33	0.96	0.97	1.00	1.04	92.30	7.70	418	61	1.283	3.60	13.82	3.65	13.4	10.0	4.05	74.13
		2113.63	8/15/99 4:26 PM	12.49	27.48	47.22	1.00	0.97	1.01	1.00	91.99	8.01	415	60	1.293	3.53	13.56	3.58	13.7	9.8		73.57
		2115.63	8/15/99 6:26 PM	12.47	27.68	47.00	0.93	0.97	1.04	1.02	92.54	7.46	440	64	1.305	3.31	12.68	3.35	13.7	10.2		73.00
		2116.63	8/15/99 7:26 PM	12.50	27.66	46.95	0.91	0.97	1.01	1.01	92.73	7.27	447	65	1.304	3.25	12.48	3.30	13.7	10.2		73.58
		2119.63	8/15/99 10:26 PM	12.55	26.48	45.40	0.79	0.97	0.96	1.00	93.67	6.33	476	69	1.275	3.12	11.98	3.16	14.1	10.4		73.58
		2120.63	8/15/99 11:26 PM	12.51	26.23	44.37	0.76	0.97	1.01	1.02	93.92	6.08	485	71	1.268	3.02	11.60	3.06	14.0	10.6		72.20
		2121.63	8/16/99 12:26 AM	12.47	25.74	44.51	0.81	0.97	0.96	1.00	93.49	6.51	458	67	1.261	3.22	12.34	3.26	14.1	10.1		73.21
		2124.63	8/16/99 3:26 AM	12.37	25.12	43.16	0.75	0.97	1.01	1.05	93.90	6.10	474	69	1.247	3.20	12.29	3.25	14.1	10.4		72.59
		2125.63	8/16/99 4:26 AM	12.28	24.83	42.81	0.73	0.97	0.91	0.99	94.06	5.94	478	70	1.243	3.19	12.23	3.23	14.1	10.5		73.58
		2126.63	8/16/99 5:26 AM	12.21	24.63	42.47	0.72	0.97	0.96	1.04	94.08	5.92	477	69	1.240	3.20	12.29	3.25	14.4	10.4		73.58
		2127.63	8/16/99 6:26 AM	12.28	24.71	42.68	0.73	0.97	0.95	1.03	94.09	5.91	478	70	1.236	3.20	12.29	3.25	13.9	10.6		73.59
		2128.71	8/16/99 7:30 AM	12.31	24.83	42.85	0.74	0.97	0.91	0.99	94.02	5.98	470	68	1.233	3.27	12.53	3.31	14.1	10.4		73.58
		2129.71	8/16/99 8:30 AM	12.38	25.04	43.19	0.74	0.97	0.91	0.99	94.05	5.95	474	69	1.236	3.24	12.41	3.28	14.3	10.4		73.59
		2130.71	8/16/99 9:30 AM	12.37	25.03	43.44	0.75	0.97	0.96	1.03	93.90	6.10	470	68	1.243	3.24	12.43	3.28	14.1	10.5		73.58
		2132.71	8/16/99 11:30 AM	12.37	25.08	45.09	0.99	0.97	1.01	0.94	92.02	7.98	469	68	1.258	3.09	11.86	3.13	14.1	10.6		70.84
		2133.71	8/16/99 12:30 PM	12.41	25.46	43.91	0.63	0.98	1.10	1.09	94.92	5.08	432	63	1.258	3.42	13.14	3.47	13.6	10.0		71.56
		2134.71	8/16/99 1:30 PM																			
		2135.71	8/16/99 2:30 PM	12.91	26.89	46.16	0.79	0.97	1.06	1.06	93.90	6.10	407	59	1.275	3.59	13.77	3.64	13.5	9.7		72.24
		2139.71	8/16/99 6:30 PM	12.99	27.85	47.68	0.91	0.97	1.06	1.04	92.98	7.02	437	64	1.301	3.28	12.57	3.32	13.5	10.2		72.21
		2143.71	8/16/99 10:30 PM	13.08	27.10	44.97	0.73	0.97	1.06	1.07	94.42	5.58	448	65	1.272	3.26	12.51	3.31	14.0	10.0		71.24
		2145.71	8/17/99 12:30 AM	12.92	26.28	45.19	0.80	0.97	2.70	2.91	93.79	6.21	450	65	1.261	3.34	12.81	3.38	14.0	10.3		73.58
		2146.71	8/17/99 1:30 AM	12.89	26.23	45.06	0.78	0.97	2.38	2.57	93.95	6.05	455	66	1.258	3.31	12.71	3.36	14.0	10.4		73.58
		2147.71	8/17/99 2:30 AM	12.86	26.14	44.93	0.77	0.97	2.37	2.56	93.99	6.01	454	66	1.254	3.33	12.78	3.38	14.0	10.3		73.58
		2149.71	8/17/99 4:30 AM	12.65	25.74	44.34	0.75	0.97	2.52	2.56	94.03	5.97	457	66	1.247	3.26	12.53	3.31	14.0	10.2		72.02
		2150.71	8/17/99 5:30 AM	12.56	25.49	43.95	0.75	0.97	2.84	2.91	94.00	6.00	458	67	1.244	3.26	12.52	3.31	14.1	10.3		72.23
		2151.71	8/17/99 6:30 AM	12.61	25.53	44.03	0.76	0.97	3.74	4.05	94.01	5.99	461	67	1.240	3.31	12.71	3.36	14.0	10.4		73.59
		2154.16	8/17/99 8:58 AM	12.58	25.41	44.03	0.76	0.97	1.01	1.03	93.94	6.06	463	67	1.229	3.26	12.53	3.31	14.2	10.4		72.23
		2156.17	8/17/99 10:58 AM	12.38	24.96	43.27	0.77	0.97	1.01	1.04	93.78	6.22	461	67	1.236	3.26	12.51	3.31	14.1	10.4		72.22
		2158.17	8/17/99 12:58 PM	12.54	25.37	44.13	0.82	0.97	1.01	1.03	93.46	6.54	449	65	1.251	3.31	12.71	3.36	14.1	10.3		72.24
		2160.17	8/17/99 2:58 PM	13.07	26.85	46.50	0.91	0.97	0.96	1.02	93.01	6.99	424	62	1.275	3.51	13.46	3.56	14.1	10.0		73.59
		2161.17	8/17/99 3:58 PM	13.15	26.73	46.44	0.84	0.97	0.96	1.02	93.61	6.39	430	63	1.286	3.43	13.16	3.48	13.5	10.3		73.59
		2162.16	8/17/99 4:58 PM	13.15	26.85	46.44	0.78	0.97	0.96	1.02	94.07	5.93	433	63	1.290	3.39	13.02	3.44	13.6	10.1		73.59
		2165.17	8/17/99 7:58 PM	13.16	26.57	45.82	0.83	0.97	0.96	1.04	93.66	6.34	437	64	1.272	3.41	13.09	3.46	13.4	10.1	4.08	73.58
		2167.17	8/17/99 9:58 PM	13.08	26.48	45.74	0.77	0.97	0.96	1.04	94.12	5.88	444	65	1.258	3.39	13.01	3.44	13.7	10.3		73.60
		2168.17	8/17/99 10:58 PM	12.96	26.48	45.68	0.82	0.97	0.96	1.03	93.67	6.33	441	64	1.254	3.43	13.16	3.48	13.8	10.3		73.58
		2169.17	8/17/99 11:58 PM	12.83	26.15	45.40	0.84	0.97	0.96	1.03	93.44	6.56	443	64	1.247	3.43	13.17	3.48	13.8	10.3		73.58
		2170.17	8/18/99 12:58 AM	12.73	26.06	44.84	0.80	0.97	0.96	1.03	93.67	6.33	451	66	1.240	3.39	13.01	3.44	14.0	10.3		73.58
		2172.17	8/18/99 2:58 AM	12.57	25.45	44.03	0.79	0.97	1.01	1.03	93.74	6.26	454	66	1.233	3.32	12.75	3.37	14.0	10.4		72.23
		2174.17	8/18/99 4:58 AM	12.33	24.95	43.28	0.76	0.97	0.96	1.03	93.82	6.18	458	67	1.229	3.36	12.90	3.41	14.0	10.4		73.55
		2175.17	8/18/99 5:58 AM	12.22	24.63	42.81	0.75	0.97	1.06	1.05	93.83	6.17	462	67	1.229	3.27	12.56	3.32	13.8	10.5		71.25
		2176.16	8/18/99 6:58 AM	12.22	24.63	42.81	0.75	0.97	0.96	1.03	93.85	6.15	464	68	1.226	3.33	12.77	3.37	14.0	10.6		73.59
		2181.73	8/18/99 12:32 PM	12.49	25.29	43.31	0.75	0.97	0.96	1.04	93.96	6.04	460	67	1.261	3.26	12.53	3.31	13.8	10.5		73.45
		2182.73	8/18/99 1:32 PM	12.67	25.99	44.41	0.84	0.97	0.96	1.03	93.36	6.64	445	65	1.261	3.38	12.96	3.42	14.1	10.3		73.59
		2184.73	8/18/99 3:32 PM	13.03	26.81	44.99	0.84	0.97	0.96	1.05	93.58	6.42	446	65	1.275	3.33	12.78	3.38	14.0	10.1		73.59
		2185.73	8/18/99 4:32 PM	13.44	27.31	46.87	0.89	0.97	0.96	1.04	93.39	6.61	444	65	1.272	3.36	12.88	3.40	13.7	10.3		73.59
		2186.73	8/18/99 5:32 PM	13.58	27.60	47.69	0.91	0.97	0.96	1.03	93.31	6.69	443	64	1.279	3.35	12.84	3.39	13.8	10.3		73.59
		2188.73	8/18/99 7:32 PM	13.41	27.31	47.09	0.87	0.97	0.96	1.03	93.54	6.46	447	65	1.283	3.31	12.69	3.35	13.6	10.4		73.59
		2189.73	8/18/99 8:32 PM	13.32	27.06	46.70	0.84	0.97	0.96	1.03	93.69	6.31	446	65	1.279	3.32	12.74	3.37	13.7	10.3		73.59
		2190.73	8/18/99 9:32 PM	13.22	26.73	45.66	0.62	0.98	0.96	1.05	95.31	4.69	463	67	1.272	3.22	12.36	3.27	13.8	10.3		73.59
		2191.73	8/18/99 10:32 PM	13.07	26.82	44.95	0.61	0.98	0.96	1.05	95.34	4.66	454	66	1.265	3.30	12.65	3.34	13.8	10.0		73.60
		2192.73	8/18/99 11:32 PM	12.93	27.06	43.61	0.59	0.98	1.01	1.07	95.47	4.53	463	67	1.258	3.19	12.25	3.24	13.5	9.5		72.22
		2193.73	8/19/99 12:32 AM	12.84	27.43	42.54	0.56	0.98	1.06	1.11	95.67	4.33	477	69	1.250	3.12	11.97	3.16	13.5	9.4		71.26
		2194.73	8/19/99 1:32 AM	12.75	27.88	41.48	0.53	0.98	1.01	1.11	95.83	4.17	489	71	1.247	3.05	11.70	3.09	13.2	9.0		72.22
		2195.73	8/19/99 2:32 AM	12.63	28.09	40.17	0.51	0.98	1.06	1.14	95.98	4.02	499	73	1.244	2.94	11.28	2.98	12.8	8.7		70.86
		2197.73	8/19/99 4:32 AM	12.34	28.29	37.99	0.47	0.98	0.96	1.11	96.20	3.80	511	74	1.236	2.89	11.09	2.93	12.5	8.2		71.84
		2198.73	8/19/99 5:32 AM	12.25	28.46	37.22	0.46	0.98	1.01	1.12	96.26	3.74	517	75	1.233	2.81	10.77	2.85	12.4	8.1		70.46
		2202.80	8/19/99 9:36 AM	12.24	26.69	42.76	0.69	0.97	0.92	0.99	94.34	5.66	467	68	1.226	3.31	12.69	3.35	13.4	9.4		73.58
		2203.80	8/19/99 10:36 AM	12.09	25.04	43.20	0.79	0.97	4.47	4.08	93.43	6.57	416	60	1.251	3.44	13.20	3.49	13.7	9.8		69.44
		2204.80	8/19/99 11:36 AM	12.10	24.96	42.93	0.81	0.97	1.54	1.56	93.29	6.71	416	61	1.258	3.56	13.64	3.60	13.5	9.8		72.22
		2205.80	8/19/99 12:36 PM	12.23	25.25	43.52	0.82	0.97	1.02	1.07	93.27	6.73	419	61	1.258	3.58	13.72	3.62	13.5	9.8		73.19
		2207.80	8/19/99 2:36 PM	12.67	26.24	45.26	0.87	0.97	0.96	1.01	93.10	6.90	417	61	1.275	3.56	13.67	3.61	13.5	10.0		73.59
		2211.80	8/19/99 6:36 PM	13.13	27.23	46.19	0.70	0.98	1.06	1.08	94.64	5.36	418	61	1.293	3.45	13.22	3.49	13.4	9.8		72.23
		2212.80	8/19/99 7:36 PM	13.13	27.40	45.80	0.70	0.98	1.06	1.09	94.68	5.32	418	61	1.290	3.45	13.25	3.50	13.4	9.7		72.23
		2214.80	8/19/99 9:36 PM	13.03	28.05	44.07	0.65	0.98	1.00	1.08	95.02	4.98	440	64	1.275	3.38	12.96	3.42	13.1	9.1		72.83
		2215.80	8/19/99 10:36 PM	12.93	28.38	42.79	0.62	0.98	0.96	1.09	95.20	4.80	457	66	1.272	3.26	12.52	3.31	13.0	8.8		73.60
		2216.80	8/19/99 11:36 PM	12.78	28.76	41.40	0.58	0.98	1.01	1.12	95.46	4.54	473	69	1.268	3.10	11.89	3.14	12.8	8.5		72.22
		2217.80	8/20/99 12:36 AM	12.67	29.17	40.14	0.55	0.98	1.04	1.14	95.64	4.36	491	71	1.261	2.97	11.39	3.01	12.7	8.3		71.36
		2220.80	8/20/99 3:36 AM	12.29	30.08	37.23	0.48	0.98	1.01	1.14	96.10	3.90	525	76	1.250	2.78	10.66	2.82	12.1	8.0		70.84
		2222.80	8/20/99 5:36 AM	12.11	30.25	35.77	0.46	0.98	1.01	1.15	96.19	3.81	534	78	1.243	2.69	10.33	2.73	11.8	7.7		70.44
		2223.80	8/20/99 6:36 AM	12.10	28.80	41.61	0.71	0.97	1.02	1.01	94.09	5.91	488	71	1.240	3.02	11.58	3.06	12.7	8.2		70.59
		2224.75	8/20/99 7:33 AM	12.13	27.47	41.15	0.52	0.98	0.96	1.02	95.75	4.25	494	72	1.236	3.04	11.68	3.09	12.8	9.0		72.22
		2225.75	8/20/99 8:33 AM	12.13	29.17	39.59	0.51	0.98	1.01	1.04	95.84	4.16	517	75	1.229	2.81	10.79	2.85	12.1	8.3		70.46
		2230.47	8/20/99 1:16 PM	12.48	27.39	46.24	0.80	0.97	1.00	1.04	93.59	6.41	443	64	1.258	3.47	13.31	3.52	13.1	8.8		74.09
		2230.75	8/20/99 1:33 PM	12.52	27.50	46.45	0.81	0.97	1.01	1.02	93.53	6.47	439	64	1.258	3.43	13.17	3.48	13.1	8.8		73.59
		2231.47	8/20/99 2:16 PM	12.54	27.43	45.64	0.81	0.97	1.06	1.06	93.51	6.49	442	64	1.261	3.40	13.05	3.45	13.1	9.0		72.59
		2231.75	8/20/99 2:33 PM	12.54	27.51	46.41	0.82	0.97	0.96	1.03	93.50	6.50	438	64	1.268	3.47	13.33	3.52	13.1	8.8		74.93
		2228.75	8/20/99 11:33 AM	12.25	26.81	42.82	0.76	0.97	1.01	1.09	93.76	6.24	447	65	1.247	3.40	13.03	3.44	13.0	8.9		73.58

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		2233.75	8/20/99 4:33 PM	12.79	28.14	47.08	0.86	0.97	1.01	1.03	93.26	6.74	431	63	1.293	3.40	13.04	3.45	13.0	8.8		73.59
		2234.75	8/20/99 5:33 PM	12.86	28.38	47.42	0.86	0.97	0.96	1.03	93.27	6.73	430	62	1.297	3.47	13.30	3.51	12.8	8.9		74.94
		2235.75	8/20/99 6:33 PM	12.89	28.42	47.42	0.86	0.97	0.96	1.03	93.32	6.68	434	63	1.301	3.42	13.14	3.47	13.0	8.9		74.96
		2236.47	8/20/99 7:16 PM	12.83	28.30	47.26	0.84	0.97	0.96	1.03	93.44	6.56	436	63	1.301	3.41	13.08	3.46	13.0	8.8		74.96
		2237.47	8/20/99 8:16 PM	12.73	28.05	46.75	0.82	0.97	0.96	1.04	93.60	6.40	443	64	1.293	3.37	12.93	3.42	13.0	8.8		74.95
		2237.75	8/20/99 8:33 PM	12.72	28.06	46.71	0.81	0.97	0.96	1.04	93.64	6.36	443	64	1.290	3.38	12.96	3.42	13.0	8.8		74.95
		2238.47	8/20/99 9:16 PM	12.69	27.97	46.50	0.79	0.97	0.96	1.04	93.78	6.22	449	65	1.286	3.35	12.84	3.39	13.2	8.8		74.95
		2238.75	8/20/99 9:33 PM	12.67	27.93	46.37	0.79	0.97	0.91	0.99	93.80	6.20	452	66	1.283	3.33	12.79	3.38	13.1	8.8		74.95
		2239.47	8/20/99 10:16 PM	12.62	27.89	46.19	0.77	0.97	0.98	1.01	93.89	6.11	454	66	1.279	3.27	12.54	3.31	13.0	8.8		73.57
		2239.75	8/20/99 10:33 PM	12.62	27.89	46.03	0.76	0.97	1.01	1.04	94.00	6.00	456	66	1.276	3.26	12.49	3.30	13.1	8.8		73.60
		2240.47	8/20/99 11:16 PM	12.59	27.76	45.72	0.74	0.97	0.96	0.99	94.12	5.88	462	67	1.272	3.23	12.37	3.27	13.1	8.8		73.60
		2240.75	8/20/99 11:33 PM	12.59	27.72	45.54	0.74	0.97	0.91	1.00	94.15	5.85	464	67	1.268	3.28	12.60	3.33	13.1	8.8		74.96
		2241.47	8/21/99 12:16 AM	12.51	27.64	45.29	0.72	0.98	0.96	1.00	94.25	5.75	468	68	1.265	3.20	12.27	3.24	13.1	8.8		73.58
		2241.75	8/21/99 12:33 AM	12.49	27.60	45.18	0.72	0.98	0.93	1.00	94.28	5.72	468	68	1.261	3.24	12.45	3.29	12.9	9.0		74.36
		2243.47	8/21/99 2:16 AM	12.41	27.35	44.75	0.69	0.98	0.96	1.00	94.43	5.57	476	69	1.258	3.17	12.14	3.21	13.1	8.8		73.58
		2244.75	8/21/99 3:33 AM	12.27	27.10	44.28	0.68	0.98	0.96	1.00	94.50	5.50	478	69	1.254	3.16	12.14	3.21	13.1	8.8		73.58
		2245.47	8/21/99 4:16 AM	12.19	26.85	43.90	0.66	0.98	0.96	1.00	94.56	5.44	482	70	1.251	3.15	12.07	3.19	13.1	8.8		73.58
		2245.75	8/21/99 4:33 AM	12.15	26.73	43.81	0.66	0.98	0.96	1.00	94.57	5.43	483	70	1.251	3.14	12.03	3.18	13.1	8.8		73.58
		2247.75	8/21/99 6:33 AM	12.04	26.56	43.70	0.69	0.98	0.96	1.01	94.28	5.72	487	71	1.243	3.19	12.24	3.23	13.1	9.0		73.94
		2248.59	8/21/99 7:23 AM	12.03	26.52	43.65	0.70	0.97	0.91	1.00	94.21	5.79	484	70	1.240	3.22	12.34	3.26	13.1	8.8		74.94
		2249.48	8/21/99 8:16 AM	11.95	26.44	43.27	0.72	0.97	0.96	1.00	94.00	6.00	481	70	1.243	3.17	12.16	3.21	13.2	8.8		73.56
		2249.59	8/21/99 8:23 AM	11.95	26.40	43.31	0.72	0.97	0.91	1.00	93.96	6.04	481	70	1.243	3.23	12.39	3.27	13.2	8.8		74.92
		2250.47	8/21/99 9:16 AM	11.89	26.28	43.07	0.72	0.97	0.91	1.00	93.92	6.08	481	70	1.244	3.23	12.38	3.27	13.1	8.8		74.94
		2251.59	8/21/99 10:23 AM	11.89	26.19	42.97	0.73	0.97	0.96	1.00	93.85	6.15	477	69	1.247	3.18	12.22	3.23	13.4	8.8		73.56
		2252.47	8/21/99 11:16 AM	11.91	26.28	43.06	0.74	0.97	0.96	1.00	93.76	6.24	477	69	1.251	3.17	12.18	3.22	13.1	8.8		73.56
		2253.59	8/21/99 12:23 PM	11.96	26.41	43.19	0.75	0.97	0.92	1.00	93.72	6.28	478	69	1.258	3.20	12.27	3.24	13.1	8.8		74.62
		2255.59	8/21/99 2:23 PM	12.14	26.98	44.03	0.79	0.97	0.91	1.00	93.52	6.48	467	68	1.279	3.23	12.41	3.28	13.0	8.8		74.92
		2256.59	8/21/99 3:23 PM	12.23	26.57	43.28	0.65	0.98	0.91	1.02	94.72	5.28	477	69	1.286	3.15	12.07	3.19	12.8	8.9		74.93
		2257.59	8/21/99 4:23 PM	12.37	27.39	44.93	0.85	0.97	0.91	0.99	93.17	6.83	460	67	1.272	3.30	12.65	3.34	13.1	8.8		74.93
		2258.59	8/21/99 5:23 PM	12.42	27.48	44.59	0.79	0.97	0.91	1.01	93.61	6.39	470	68	1.268	3.24	12.42	3.28	13.2	8.8		74.92
		2260.59	8/21/99 7:23 PM	12.38	27.72	44.65	0.79	0.97	1.01	1.07	93.61	6.39	463	67	1.261	3.31	12.69	3.35	12.9	8.9		73.91
		2261.59	8/21/99 8:23 PM	12.35	27.36	44.85	0.81	0.97	1.01	1.05	93.44	6.56	460	67	1.254	3.28	12.59	3.33	13.2	8.7		73.54
		2263.59	8/21/99 10:23 PM	12.20	27.02	44.26	0.75	0.97	0.96	1.00	93.83	6.17	471	68	1.251	3.22	12.35	3.26	13.2	8.8		73.58
		2264.59	8/21/99 11:23 PM	12.10	26.77	43.82	0.73	0.97	0.96	1.00	94.00	6.00	474	69	1.251	3.19	12.26	3.24	13.7	8.7		73.58
		2266.59	8/22/99 1:23 AM	11.96	26.65	43.10	0.67	0.98	0.91	1.00	94.38	5.62	484	70	1.247	3.19	12.26	3.24	13.1	8.8		74.94
		2270.59	8/22/99 5:23 AM	11.80	26.44	42.25	0.65	0.98	0.96	1.01	94.52	5.48	495	72	1.243	3.08	11.81	3.12	13.1	8.8		73.56
		2271.59	8/22/99 6:23 AM	11.90	26.65	42.51	0.65	0.98	0.96	1.01	94.54	5.46	495	72	1.243	3.08	11.80	3.12	13.1	8.7		73.60
		2298.67	8/23/99 9:28 AM	11.38	23.89	40.40	0.65	0.97	0.91	0.99	94.31	5.69	509	74	1.151	3.18	12.18	3.22	13.5	9.8		74.25
		2304.52	8/23/99 3:19 PM	10.57	23.63	39.47	0.87	0.97	0.90	1.02	91.76	8.24	443	64	1.195	3.72	14.26	3.77	14.1	9.2		76.31
		2298.68	8/23/99 9:29 AM	11.38	23.89	40.35	0.64	0.98	0.91	0.99	94.35	5.65	509	74	1.151	3.17	12.17	3.22	13.5	9.7		74.23
		2297.87	8/23/99 8:40 AM	11.54	24.38	41.07	0.66	0.97	0.96	1.00	94.27	5.73	508	74	1.151	3.18	12.19	3.22	13.7	9.7		73.21
		2299.67	8/23/99 10:28 AM	11.19	24.10	40.19	0.69	0.97	2.37	2.49	93.86	6.14	501	73	1.151	3.29	12.61	3.33	13.7	9.7		73.56
		2300.68	8/23/99 11:29 AM	10.94	23.85	39.79	0.70	0.97	0.96	1.05	93.63	6.37	492	72	1.161	3.38	12.95	3.42	14.4	9.4		74.91
		2301.67	8/23/99 12:28 PM	10.69	22.38	37.99	0.47	0.98	0.96	1.06	95.58	4.42	510	74	1.175	3.16	12.14	3.21	13.7	9.7		74.60
		2302.68	8/23/99 1:29 PM	10.55	21.85	38.33	0.52	0.98	0.96	1.00	95.09	4.91	499	73	1.185	3.21	12.30	3.25	13.8	10.2		73.57
		2303.68	8/23/99 2:29 PM	10.52	21.53	37.79	0.63	0.97	1.06	1.12	94.00	6.00	482	70	1.192	3.30	12.67	3.35	13.6	10.1		73.58
		2321.42	8/24/99 8:13 AM	10.52	21.81	39.17	0.61	0.98	0.91	0.97	94.16	5.84	493	72	1.178	3.32	12.74	3.37	14.3	10.1		74.94
		2322.42	8/24/99 9:13 AM	10.37	21.24	38.04	0.45	0.98	0.96	1.04	95.64	4.36	501	73	1.181	3.26	12.51	3.31	14.1	10.3		74.94
		2323.42	8/24/99 10:13 AM	10.26	21.16	37.58	0.46	0.98	0.96	1.04	95.51	4.49	487	71	1.192	3.32	12.76	3.37	14.0	9.8		74.94
		2324.42	8/24/99 11:13 AM	10.25	21.49	36.99	0.47	0.98	1.06	1.11	95.44	4.56	489	71	1.198	3.24	12.42	3.28	13.6	9.6		73.60
		2325.42	8/24/99 12:13 PM	10.40	22.34	37.04	0.48	0.98	1.01	1.07	95.34	4.66	499	73	1.209	3.14	12.06	3.19	13.5	9.1		73.58
		2326.42	8/24/99 1:13 PM	10.55	23.24	36.65	0.50	0.98	0.96	1.10	95.26	4.74	504	73	1.216	3.15	12.09	3.19	13.3	8.6		74.93
		2327.42	8/24/99 2:13 PM	10.82	22.10	38.21	0.82	0.97	1.06	1.08	92.39	7.61	425	62	1.226	3.57	13.69	3.62	13.6	10.3		72.21
		2328.42	8/24/99 3:13 PM	11.09	22.75	39.42	0.77	0.97	0.96	1.02	93.10	6.90	431	63	1.233	3.56	13.68	3.61	13.8	10.3		73.59
		2329.42	8/24/99 4:13 PM	11.31	23.12	40.09	0.77	0.97	0.97	1.02	93.17	6.83	431	63	1.240	3.55	13.62	3.60	14.1	10.2		73.35
		2330.42	8/24/99 5:13 PM	11.43	23.37	40.52	0.77	0.97	0.96	1.02	93.28	6.72	430	63	1.247	3.53	13.55	3.58	13.8	10.3		73.59
		2331.42	8/24/99 6:13 PM	11.56	23.65	40.90	0.76	0.97	0.92	1.02	93.44	6.56	433	63	1.251	3.57	13.68	3.61	13.8	10.3		74.78
		2332.42	8/24/99 7:13 PM	11.60	23.74	41.02	0.74	0.97	0.96	1.02	93.62	6.38	434	63	1.251	3.50	13.42	3.54	13.8	10.3		73.59
		2333.42	8/24/99 8:13 PM	11.70	23.90	41.15	0.72	0.97	0.96	1.03	93.82	6.18	436	63	1.247	3.49	13.38	3.53	13.9	10.4		73.59
		2334.42	8/24/99 9:13 PM	11.77	24.02	41.33	0.71	0.97	0.96	1.03	93.95	6.05	438	64	1.240	3.49	13.40	3.54	14.0	10.2		73.59
		2335.42	8/24/99 10:13 PM	11.84	24.14	41.58	0.69	0.97	0.96	1.03	94.14	5.86	441	64	1.236	3.47	13.32	3.52	14.3	10.2		73.58
		2336.42	8/24/99 11:13 PM	11.89	24.22	41.61	0.68	0.97	0.96	1.03	94.27	5.73	444	65	1.233	3.46	13.28	3.51	13.9	10.4		73.58
		2337.42	8/25/99 12:13 AM	11.88	24.22	41.58	0.66	0.98	0.96	1.03	94.41	5.59	446	65	1.229	3.45	13.25	3.50	14.0	10.4		73.58
		2338.42	8/25/99 1:13 AM	11.86	24.10	41.50	0.65	0.98	1.00	1.03	94.52	5.48	448	65	1.226	3.40	13.04	3.45	14.1	10.4		72.44
		2339.42	8/25/99 2:13 AM	11.80	24.02	41.32	0.64	0.98	1.01	1.05	94.59	5.41	450	65	1.226	3.44	13.19	3.48	13.9	10.6		72.60
		2340.42	8/25/99 3:13 AM	11.71	23.81	41.06	0.63	0.98	0.96	1.03	94.61	5.39	450	65	1.226	3.44	13.19	3.48	13.9	10.4		73.58
		2341.42	8/25/99 4:13 AM	11.61	23.61	40.68	0.62	0.98	0.96	1.03	94.62	5.38	450	66	1.226	3.43	13.17	3.48	14.1	10.4		73.58
		2342.42	8/25/99 5:13 AM	11.53	23.40	40.39	0.62	0.98	1.01	1.03	94.65	5.35	448	65	1.226	3.38	12.98	3.43	14.1	10.4		72.22
		2343.42	8/25/99 6:13 AM	11.54	23.44	40.39	0.62	0.98	0.96	1.03	94.63	5.37	451	66	1.226	3.43	13.16	3.48	13.9	10.5		73.58
		2344.42	8/25/99 7:13 AM	11.57	23.48	40.49	0.62	0.98	1.01	1.05	94.64	5.36	451	66	1.223	3.44	13.20	3.49	13.9	10.8		72.60
		2344.73	8/25/99 7:32 AM	11.57	23.40	40.53	0.62	0.98	0.96	1.03	94.63	5.37	453	66	1.223	3.42	13.12	3.47	14.0	10.5		73.58
		2345.73	8/25/99 8:32 AM	11.50	23.69	40.77	0.62	0.98	0.96	1.02	94.59	5.41	440	64	1.223	3.52	13.51	3.57	14.0	10.4		73.58
		2346.73	8/25/99 9:32 AM	11.49	23.57	40.74	0.66	0.97	0.96	1.02	94.27	5.73	436	63	1.223	3.55	13.64	3.60	13.8	10.4		73.58
		2347.73	8/25/99 10:32 AM	11.49	23.52	40.73	0.68	0.97	0.96	1.02	94.08	5.92	435	63	1.219	3.57	13.71	3.62	13.9	10.3		73.58
		2348.73	8/25/99 11:32 AM	11.61	23.90	41.20	0.75	0.97	0.96	1.02	93.51	6.49	426	62	1.226	3.63	13.91	3.68	13.7	10.3		73.58
		2349.73	8/25/99 12:32 PM	11.78	24.18	41.79	0.82	0.97	1.01	1.03	93.07	6.93	420	61	1.236	3.65	14.00	3.70	13.8	10.1		72.60
		2350.73	8/25/99 1:32 PM	11.87	24.39	42.34	0.85	0.97	0.96	1.01	92.85	7.15	418	61	1.247	3.64	13.96	3.69	13.9	10.1		73.55
		2351.73	8/25/99 2:32 PM	11.95	24.55	42.34	0.80	0.97	0.96	1.02	93.29	6.71	423	62	1.254	3.57	13.71	3.62	13.8	10.1		73.59
		2352.73	8/25/99 3:32 PM	12.09	24.80	43.06	0.86	0.97	0.96	1.01	92.85	7.15	422	61	1.258	3.57	13.71	3.62	13.8	10.3		73.59
		2353.73	8/25/99 4:32 PM	12.02	24.68	42.60	0.83	0.97	0.96	1.02	93.06	6.94	425	62	1.258	3.55	13.61	3.60	13.8	10.3		73.58
		2354.73	8/25/99 5:32 PM	12.00	24.55	42.43	0.81	0.97	0.96	1.02	93.25	6.75	428	62	1.254	3.53	13.54	3.58	13.8	10.3		73.58
		2355.73	8/25/99 6:32 PM	12.07	24.67	42.51	0.79	0.97	0.96	1.03	93.42	6.58	431	63	1.251	3.51	13.49	3.56	13.9	10.3		73.58
		2356.73	8/25/99 7:32 PM	12.20	24.93	42.80	0.78	0.97	1.01	1.04	93.60	6.40	433	63	1.251	3.50	13.43	3.55	13.9	10.3		72.60
		2357.73	8/25/99 8:32 PM	12.53	25.53	43.74	0.78	0.97	1.01	1.04	93.77	6.23	433	63	1.247	3.44	13.21	3.49	13.8	10.4		72.20
		2358.73	8/25/99 9:32 PM	13.68	27.80	47.35	0.83	0.97	1.01	1.04	93.93	6.07	431	63	1.243	3.47	13.32	3.52	13.9	10.3		72.20
		2359.73	8/25/99 10:32 PM	14.80	30.21	50.92	0.89	0.97	0.91	1.00	94.02	5.98	432	63	1.240	3.53	13.56	3.58	13.8	10.4		73.58
		2360.73	8/25/99 11:32 PM	15.65	32.05	53.79	0.93	0.97	0.96	1.02	94.07	5.93	431	63	1.236	3.55	13.63	3.60	13.8	10.4		72.58
		2361.73	8/26/99 12:32 AM	15.84	32.38	54.45	0.92	0.97	0.93	1.00	94.18	5.82	432	63	1.236	3.53	13.54	3.58	13.5	10.6		73.22
		2362.73	8/26/99 1:32 AM	15.72	32.13	54.09	0.90	0.97	1.00	1.01	94.31	5.69	434	63	1.233	3.48	13.35	3.53	13.7	10.6		71.40
		2363.73	8/26/99 2:32 AM	15.26	31.17	52.58	0.85	0.97	1.01	1.01	94.41	5.59	438	64	1.233	3.44	13.21	3.49	13.8	10.4		71.24
		2364.73	8/26/99 3:32 AM	14.74	30.08	50.91	0.82	0.98	0.96	1.00	94.46	5.54	441	64	1.229	3.44	13.18	3.48	13.9	10.4		72.30
		2365.73	8/26/99 4:32 AM	14.17	28.88	49.02	0.79	0.97	0.93	1.00	94.43	5.57	441	64	1.226	3.47	13.33	3.52	13.8	10.5		73.02
		2366.73	8/26/99 5:32 AM	13.67	27.80	47.40	0.76	0.98	0.91	0.99	94.43	5.57	445	65	1.226	3.48	13.34	3.52	13.8	10.6		73.56
		2367.73	8/26/99 6:32 AM	13.37	27.18	46.33	0.75	0.98	0.96	1.01	94.42	5.58	444	65	1.223	3.49	13.39	3.54	14.1	10.4		72.58
		2368.99	8/26/99 7:48 AM	13.08	26.53	45.44	0.73	0.98	0.91	0.99	94.44	5.56	450	65	1.223	3.44	13.21	3.49	14.0	10.6		73.58
		2369.99	8/26/99 8:48 AM	12.80	25.91	44.42	0.73	0.97	0.96	1.04	94.30	5.70	447	65	1.226	3.46	13.26	3.50	13.8	10.5		73.60
		2370.99	8/26/99 9:48 AM	12.59	25.45	43.61	0.73	0.97	0.96	1.04	94.23	5.77	445	65	1.229	3.46	13.28	3.51	14.0	10.4		73.58
		2371.99	8/26/99 10:48 AM	12.44	25.21	43.23	0.73	0.97	0.96	1.04	94.13	5.87	445	65	1.236	3.45	13.23	3.50	13.8	10.4		73.58
		2372.99	8/26/99 11:48 AM	12.36	25.00	42.98	0.74	0.97	0.96	1.04	93.98	6.02	442	64	1.243	3.45	13.22	3.49	13.8	10.4		73.58
		2373.99	8/26/99 12:48 PM	12.39	25.05	43.10	0.77	0.97	0.96	1.04	93.79	6.21	441	64	1.247	3.44	13.21	3.49	13.8	10.3		73.58

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		2374.99	8/26/99 1:48 PM	12.40	25.09	43.23	0.78	0.97	0.96	1.04	93.70	6.30	437	64	1.254	3.46	13.27	3.51	13.8	10.3		73.59
		2375.99	8/26/99 2:48 PM	12.64	25.62	43.82	0.80	0.97	0.96	1.05	93.63	6.37	432	63	1.265	3.47	13.32	3.52	13.8	10.2		73.59
		2376.99	8/26/99 3:48 PM	13.18	26.57	44.79	0.83	0.97	0.92	1.02	93.68	6.32	424	62	1.272	3.51	13.47	3.56	13.6	10.4		73.57
		2392.75	8/27/99 7:33 AM	11.96	23.81	40.18	0.62	0.98	0.91	1.03	94.86	5.14	465	68	1.223	3.34	12.80	3.38	14.0	10.7		73.58
		2397.75	8/27/99 12:33 PM	11.85	23.61	39.98	0.67	0.97	0.91	1.02	94.37	5.63	450	65	1.254	3.36	12.88	3.40	13.7	10.5		73.57
		2399.75	8/27/99 2:33 PM	12.02	23.98	40.35	0.69	0.97	0.91	1.03	94.23	5.77	445	65	1.268	3.36	12.90	3.41	13.6	10.6		73.59
		2400.75	8/27/99 3:33 PM	12.13	24.26	40.73	0.70	0.97	0.91	1.03	94.20	5.80	443	64	1.276	3.36	12.88	3.40	13.7	10.4		73.59
		2401.75	8/27/99 4:33 PM	12.13	24.31	40.89	0.71	0.97	0.91	1.02	94.17	5.83	438	64	1.283	3.37	12.94	3.42	13.7	10.4		73.57
		2402.75	8/27/99 5:33 PM	12.28	24.68	41.48	0.70	0.97	0.91	1.02	94.31	5.69	440	64	1.290	3.34	12.81	3.38	13.7	10.4		73.59
		2403.75	8/27/99 6:33 PM	12.39	24.80	41.51	0.69	0.97	0.96	1.03	94.41	5.59	440	64	1.290	3.28	12.58	3.32	13.5	10.2		72.23
		2405.75	8/27/99 8:33 PM	12.54	25.05	41.62	0.67	0.98	0.96	1.04	94.64	5.36	449	65	1.276	3.25	12.46	3.29	13.7	10.4		72.23
		2406.75	8/27/99 9:33 PM	12.51	24.92	41.45	0.65	0.98	0.91	1.04	94.76	5.24	455	66	1.265	3.30	12.64	3.34	13.7	10.4		73.59
		2408.75	8/27/99 11:33 PM	12.39	24.59	40.94	0.63	0.98	0.96	1.04	94.90	5.10	464	68	1.251	3.20	12.30	3.25	13.6	10.6		72.22
		2409.75	8/28/99 12:33 AM	12.33	24.46	40.68	0.62	0.98	0.96	1.04	94.95	5.05	467	68	1.243	3.20	12.29	3.25	13.7	10.5		72.22
		2410.75	8/28/99 1:33 AM	12.33	24.55	40.60	0.62	0.98	0.92	1.00	95.00	5.00	470	68	1.236	3.20	12.28	3.24	13.6	10.6		72.22
		2411.75	8/28/99 2:33 AM	12.46	24.63	40.77	0.62	0.98	0.96	1.05	95.06	4.94	473	69	1.233	3.19	12.24	3.23	13.8	10.5		72.22
		2413.75	8/28/99 4:33 AM	12.54	24.83	40.93	0.62	0.98	0.95	1.02	95.09	4.91	476	69	1.229	3.18	12.21	3.23	14.0	10.5		71.48
		2415.75	8/28/99 6:33 AM	12.43	24.65	40.64	0.61	0.98	0.92	1.01	95.07	4.93	478	70	1.226	3.17	12.18	3.22	13.8	10.7		72.24
		2439.57	8/29/99 6:22 AM	12.04	23.89	38.83	0.58	0.98	0.92	1.02	95.21	4.79	498	72	1.233	3.03	11.63	3.07	13.5	10.7		72.22
		2421.57	8/28/99 12:22 PM	12.05	23.93	39.59	0.61	0.98	0.96	1.05	94.91	5.09	470	68	1.254	3.15	12.10	3.20	13.7	10.6		72.22
		2422.57	8/28/99 1:22 PM	12.19	24.22	40.06	0.62	0.98	0.96	1.05	94.91	5.09	471	68	1.258	3.14	12.06	3.19	13.7	10.6		72.22
		2425.57	8/28/99 4:22 PM	12.56	25.17	41.36	0.65	0.98	0.91	1.05	94.82	5.18	460	67	1.286	3.21	12.31	3.25	13.4	10.5		73.59
		2426.57	8/28/99 5:22 PM	12.69	25.41	41.77	0.65	0.98	0.91	1.05	94.89	5.11	460	67	1.286	3.21	12.30	3.25	13.5	10.4		73.59
		2427.57	8/28/99 6:22 PM	12.74	25.58	41.95	0.65	0.98	0.91	1.05	94.89	5.11	460	67	1.290	3.20	12.27	3.24	13.4	10.6		73.59
		2428.57	8/28/99 7:22 PM	12.73	25.50	41.83	0.65	0.98	0.96	1.05	94.86	5.14	462	67	1.286	3.13	12.03	3.18	13.5	10.4		72.23
		2429.57	8/28/99 8:22 PM	12.77	25.50	41.66	0.65	0.98	0.96	1.06	94.91	5.09	466	68	1.279	3.12	11.98	3.16	13.5	10.4		72.21
		2430.57	8/28/99 9:22 PM	12.72	25.37	41.36	0.64	0.98	0.92	1.01	94.98	5.02	471	69	1.268	3.11	11.95	3.16	13.5	10.4		72.21
		2432.57	8/28/99 11:22 PM	12.65	25.17	41.12	0.62	0.98	0.92	1.01	95.09	4.91	478	70	1.254	3.10	11.91	3.15	13.7	10.6		72.22
		2433.57	8/29/99 12:22 AM	12.59	25.24	41.19	0.62	0.98	0.93	1.01	95.07	4.93	482	70	1.247	3.10	11.88	3.14	13.5	10.5		72.01
		2435.57	8/29/99 2:22 AM	12.40	24.75	40.22	0.60	0.98	0.92	1.01	95.17	4.83	490	71	1.240	3.06	11.75	3.11	13.7	10.6		72.22
		2437.57	8/29/99 4:22 AM	12.25	24.38	39.55	0.59	0.98	0.92	1.02	95.21	4.79	494	72	1.233	3.05	11.71	3.09	13.8	10.6		72.22
		2440.56	8/29/99 7:21 AM	12.04	23.93	38.82	0.57	0.98	0.92	1.02	95.24	4.76	499	73	1.229	3.03	11.63	3.07	13.7	10.7		72.22
		2440.57	8/29/99 7:22 AM	12.03	23.93	38.79	0.57	0.98	0.96	1.02	95.24	4.76	500	73	1.229	2.97	11.38	3.01	13.7	10.6		70.84
		2441.56	8/29/99 8:21 AM	11.94	23.76	38.45	0.57	0.98	0.92	1.02	95.23	4.77	501	73	1.226	3.03	11.62	3.07	13.7	10.7		72.22
		2441.57	8/29/99 8:22 AM	11.94	23.77	38.49	0.57	0.98	0.92	1.02	95.23	4.77	501	73	1.226	3.03	11.62	3.07	13.7	10.7		72.22
		2442.56	8/29/99 9:21 AM	11.85	23.48	37.99	0.57	0.98	0.96	1.03	95.22	4.78	498	72	1.226	2.99	11.48	3.03	13.5	10.6		70.86
		2443.56	8/29/99 10:21 AM	11.71	23.57	38.41	0.65	0.97	0.92	1.00	94.42	5.58	484	70	1.247	3.08	11.84	3.13	13.5	10.4		72.22
		2444.56	8/29/99 11:21 AM	11.71	23.28	37.20	0.51	0.98	0.96	1.05	95.63	4.37	498	72	1.261	2.96	11.36	3.00	13.5	10.6		71.24
		2445.56	8/29/99 12:21 PM	11.62	23.69	38.24	0.70	0.97	0.96	1.05	94.01	5.99	471	69	1.265	3.12	11.97	3.16	13.5	10.3		72.21
		2446.56	8/29/99 1:21 PM	11.74	24.06	38.80	0.71	0.97	0.92	1.04	93.97	6.03	470	68	1.272	3.16	12.13	3.20	13.5	10.3		73.29
		2447.56	8/29/99 2:21 PM	11.87	24.51	39.46	0.75	0.97	0.91	1.04	93.68	6.32	462	67	1.279	3.21	12.31	3.25	13.5	10.1		73.54
		2448.56	8/29/99 3:21 PM	11.98	24.67	39.75	0.74	0.97	0.91	1.04	93.80	6.20	464	68	1.286	3.17	12.18	3.22	13.3	10.3		73.59
		2449.56	8/29/99 4:21 PM	11.99	23.94	36.91	0.50	0.98	0.97	1.12	95.84	4.16	503	73	1.293	2.86	10.98	2.90	13.1	10.1		72.09
		2450.56	8/29/99 5:21 PM	11.99	24.26	36.30	0.50	0.98	1.01	1.19	95.82	4.18	510	74	1.301	2.81	10.77	2.85	13.0	9.8		72.23
		2451.56	8/29/99 6:21 PM	11.99	24.59	35.67	0.50	0.98	0.96	1.16	95.83	4.17	515	75	1.304	2.77	10.63	2.81	12.5	9.5		72.22
		2453.56	8/29/99 8:21 PM	11.97	24.96	34.30	0.49	0.98	1.01	1.17	95.90	4.10	528	77	1.293	2.57	9.86	2.61	12.1	9.0		70.04
		2454.56	8/29/99 9:21 PM	12.05	25.25	33.77	0.49	0.98	1.01	1.18	95.95	4.05	532	77	1.283	2.52	9.67	2.56	11.8	8.8		69.61
		2457.56	8/30/99 12:21 AM	12.03	25.53	32.61	0.47	0.98	1.01	1.15	96.10	3.90	548	80	1.254	2.40	9.21	2.43	11.1	8.7		67.72
		2458.56	8/30/99 1:21 AM	12.02	25.53	32.28	0.47	0.98	1.01	1.14	96.10	3.90	551	80	1.251	2.34	8.99	2.38	10.9	8.6		67.27
		2459.56	8/30/99 2:21 AM	12.03	25.68	32.07	0.47	0.98	0.96	1.10	96.13	3.87	553	80	1.244	2.35	9.01	2.38	11.0	8.4		67.25
		2460.56	8/30/99 3:21 AM	12.02	25.65	31.90	0.47	0.98	0.96	1.11	96.13	3.87	553	80	1.244	2.35	9.00	2.38	10.8	8.6		67.27
		2461.56	8/30/99 4:21 AM	11.98	25.65	31.74	0.47	0.98	1.01	1.11	96.09	3.91	555	81	1.240	2.29	8.80	2.33	10.8	8.5		65.79
		2462.56	8/30/99 5:21 AM	11.94	25.57	31.57	0.47	0.98	1.01	1.11	96.10	3.90	557	81	1.240	2.29	8.77	2.32	10.8	8.4		65.79
		2463.56	8/30/99 6:21 AM	11.98	25.61	31.57	0.47	0.98	0.96	1.10	96.11	3.89	556	81	1.236	2.30	8.82	2.33	10.8	8.4		66.77
10	RO down due to raising Zenon full tank soak	2464.77	8/30/99 7:34 AM	12.14	25.85	31.79	0.47	0.98	0.96	1.10	96.13	3.87	555	81	1.233	2.31	8.85	2.34	10.6	8.4		66.77
		2518.34	9/1/99 1:08 PM	13.73	27.53	53.78	1.16	0.97	1.01	0.97	91.57	8.43	587	85	1.251	2.58	9.91	2.62	15.8	9.9		73.60
		2520.34	9/1/99 3:08 PM	13.83	30.17	52.91	1.69	0.95	1.01	0.93	87.77	12.23	578	84	1.282	2.46	9.45	2.50	10.3	10.5		71.86
		2522.34	9/1/99 5:08 PM	13.78	28.42	48.06	1.20	0.96	1.06	0.95	91.30	8.70	504	73	1.297	2.36	9.06	2.39	12.1	9.1		68.36
		2525.34	9/1/99 8:08 PM	13.34	25.65	44.57	0.79	0.97	1.01	1.03	94.05	5.95	506	74	1.286	2.54	9.73	2.57	12.6	9.1		70.80
		2526.34	9/1/99 9:08 PM	13.24	25.69	44.87	0.93	0.97	1.03	1.03	92.99	7.01	505	73	1.275	2.60	9.98	2.64	12.7	9.3		70.77
		2527.34	9/1/99 10:08 PM	13.14	25.53	44.33	0.87	0.97	1.01	1.02	93.41	6.59	506	74	1.268	2.57	9.86	2.60	12.7	9.3		70.79
		2529.34	9/2/99 12:08 AM	12.94	25.08	43.61	0.78	0.97	0.96	0.97	94.00	6.00	510	74	1.254	2.58	9.89	2.61	12.7	9.2		70.79
		2530.34	9/2/99 1:08 AM	12.87	24.84	43.27	0.73	0.97	1.01	0.98	94.31	5.69	512	74	1.251	2.52	9.68	2.56	12.5	9.2		69.28
		2531.34	9/2/99 2:08 AM	12.76	24.71	42.89	0.70	0.97	0.96	0.98	94.49	5.51	515	75	1.243	2.58	9.88	2.61	12.5	9.3		70.80
		2532.34	9/2/99 3:08 AM	12.63	24.40	42.51	0.69	0.97	1.01	0.97	94.52	5.48	516	75	1.243	2.51	9.64	2.55	12.7	9.3		69.30
		2533.34	9/2/99 4:08 AM	12.49	24.10	42.02	0.68	0.97	1.01	0.97	94.52	5.48	517	75	1.240	2.52	9.66	2.55	12.5	9.2		69.30
		2534.34	9/2/99 5:08 AM	12.33	23.81	41.49	0.68	0.97	1.01	0.97	94.50	5.50	520	76	1.236	2.51	9.63	2.54	12.7	9.2		69.30
		2535.34	9/2/99 6:08 AM	12.29	23.61	41.20	0.68	0.97	1.01	0.98	94.50	5.50	519	75	1.233	2.52	9.68	2.56	12.7	9.2		69.30
		2536.34	9/2/99 7:08 AM	12.29	23.73	41.20	0.68	0.97	1.01	0.98	94.45	5.55	521	76	1.229	2.52	9.67	2.56	12.7	9.4		69.30
		2537.34	9/2/99 8:09 AM	12.33	23.78	41.41	0.69	0.97	1.01	0.97	94.41	5.59	521	76	1.226	2.53	9.69	2.56	12.6	9.3		69.30
		2538.34	9/2/99 9:08 AM	12.30	23.02	38.67	0.66	0.97	0.96	0.97	94.59	5.41	514	75	1.229	2.60	9.99	2.64	13.4	10.3		68.65
		2540.34	9/2/99 11:08 AM	12.22	30.16	72.51	0.85	0.98	1.01	1.05	93.06	6.94	596	87	1.254	3.01	11.53	3.05	13.4	6.0		83.82
		2541.79	9/2/99 12:35 PM	12.21	30.21	72.88	0.87	0.98	1.02	1.06	92.88	7.12	599	87	1.265	3.02	11.57	3.06	13.7	6.1		84.02
		2542.79	9/2/99 1:35 PM	12.35	19.86	25.45	0.62	0.97	0.89	0.91	95.01	4.99	303	44	1.261	3.94	15.13	4.00	19.6	22.9		52.79
11	5th Cleaning (Citric Acid Stage 1on 9/3 and Stage 2 on 9/4)	2543.79	9/2/99 2:35 PM	12.49	20.23	26.10	0.63	0.97	0.93	0.93	94.92	5.08	303	44	1.272	3.91	14.99	3.96	19.3	22.5		52.13
	Acid Pump Failure on 9/5; Restart on 9/8 at 2 PM	2682.17	9/8/99 8:58 AM	12.37	28.32	37.79	0.81	0.97	1.47	2.46	93.47	6.53	519	75	1.198	3.10	11.90	3.14	12.1	6.4		80.49
		2707.10	9/9/99 9:54 AM	12.48	26.60	45.96	0.81	0.97	1.01	1.03	93.49	6.51	440	64	1.226	3.51	13.47	3.56	13.8	9.0		73.62
		2708.10	9/9/99 10:54 AM	12.67	26.87	46.90	0.91	0.97	0.99	1.04	92.82	7.18	434	63	1.233	3.61	13.84	3.66	13.8	9.2		74.24
		2709.10	9/9/99 11:54 AM	12.82	27.28	47.59	1.00	0.97	1.06	1.08	92.22	7.78	430	63	1.240	3.55	13.63	3.60	13.8	9.2		73.60
		2710.10	9/9/99 12:54 PM	12.91	28.02	48.69	0.99	0.97	1.06	1.06	92.33	7.67	445	65	1.247	3.42	13.11	3.46	13.8	9.4		73.60
		2711.10	9/9/99 1:54 PM	13.09	28.65	49.64	0.99	0.97	0.96	1.00	92.43	7.57	460	67	1.254	3.35	12.85	3.39	14.0	9.5		74.98
		2712.10	9/9/99 2:54 PM	13.25	26.66	46.39	0.98	0.97	0.96	1.03	92.60	7.40	436	63	1.258	3.46	13.27	3.51	13.9	10.0		73.60
		2713.10	9/9/99 3:54 PM	13.33	27.11	46.81	0.88	0.97	0.96	1.03	93.38	6.62	436	63	1.265	3.44	13.19	3.48	14.1	10.0		73.62
		2714.10	9/9/99 4:54 PM	13.36	27.19	47.02	0.87	0.97	0.96	1.03	93.45	6.55	438	64	1.265	3.43	13.15	3.47	14.1	10.0		73.62
		2715.10	9/9/99 5:54 PM	13.45	27.36	47.19	0.86	0.97	0.96	1.03	93.58	6.42	436	63	1.268	3.43	13.14	3.47	14.1	10.1		73.62
		2716.10	9/9/99 6:54 PM	13.58	27.48	47.17	0.69	0.98	0.96	1.04	94.92	5.08	443	64	1.265	3.38	12.97	3.43	14.0	10.0		73.60
		2717.10	9/9/99 7:54 PM	13.65	27.98	47.09	0.70	0.98	0.91	1.05	94.87	5.13	437	64	1.261	3.50	13.44	3.55	14.3	9.5		74.95
		2718.10	9/9/99 8:54 PM	13.67	28.96	45.03	0.67	0.98	1.01	1.11	95.10	4.90	460	67	1.254	3.29	12.62	3.33	13.5	9.1		72.62
		2719.10	9/9/99 9:54 PM	13.64	30.06	42.78	0.62	0.98	0.96	1.15	95.44	4.56	487	71	1.251	3.11	11.93	3.15	13.2	8.7		73.62
		2720.10	9/9/99 10:54 PM	13.58	31.14	40.28	0.57	0.98	0.96	1.15	95.82	4.18	506	74	1.244	2.90	11.12	2.94	12.8	8.0		71.86
		2721.10	9/9/99 11:54 PM	13.48	32.22	38.21	0.53	0.98	1.01	1.18	96.09	3.91	520	76	1.240	2.72	10.45	2.76	12.1	7.6		70.06
		2722.10	9/10/99 12:54 AM	13.39	33.03	36.62	0.50	0.98	1.01	1.21	96.27	3.73	529	77	1.237	2.63	10.08	2.66	11.6	7.5		69.63

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		2723.10	9/10/99 1:54 AM	13.35	33.57	35.70	0.49	0.98	1.01	1.22	96.33	3.67	538	78	1.229	2.55	9.78	2.58	11.4	7.4		69.19
		2724.10	9/10/99 2:54 AM	13.29	33.81	35.03	0.49	0.98	0.97	1.17	96.34	3.66	542	79	1.226	2.48	9.52	2.52	11.2	7.4		68.74
		2725.10	9/10/99 3:54 AM	13.19	33.81	34.45	0.48	0.98	1.01	1.23	96.36	3.64	545	79	1.223	2.47	9.49	2.51	11.1	7.4		68.74
		2726.10	9/10/99 4:54 AM	13.09	28.97	45.15	0.71	0.98	0.96	1.00	94.57	5.43	474	69	1.219	3.22	12.36	3.27	14.0	8.9		72.17
		2727.10	9/10/99 5:54 AM	13.01	27.89	45.27	0.71	0.98	0.96	0.99	94.53	5.47	463	67	1.216	3.31	12.69	3.35	13.6	9.6		72.24
		2728.10	9/10/99 6:54 AM	13.02	27.72	45.45	0.70	0.98	1.01	1.04	94.61	5.39	461	67	1.212	3.33	12.77	3.37	13.6	9.7		72.25
		2728.72	9/10/99 7:31 AM	13.01	27.67	45.49	0.70	0.98	0.96	0.99	94.65	5.35	463	67	1.209	3.32	12.75	3.37	13.8	9.7		72.24
		2729.72	9/10/99 8:31 AM	13.02	27.86	45.88	0.75	0.97	1.01	1.03	94.25	5.75	451	66	1.205	3.42	13.14	3.47	13.5	9.7		72.24
		2730.72	9/10/99 9:31 AM	13.00	27.81	45.66	0.76	0.97	1.01	1.03	94.16	5.84	445	65	1.223	3.42	13.13	3.47	13.6	9.7		72.24
		2732.16	9/10/99 10:58 AM	12.95	26.53	46.03	0.90	0.97	1.01	1.03	93.08	6.92	428	62	1.265	3.50	13.43	3.55	13.8	10.1		72.62
		2733.17	9/10/99 11:58 AM	13.12	27.23	46.94	0.80	0.97	0.96	1.01	93.93	6.07	422	61	1.240	3.63	13.91	3.67	13.8	9.5		73.60
		2734.16	9/10/99 12:58 PM	13.23	27.53	47.24	0.84	0.97	1.06	1.07	93.63	6.37	412	60	1.244	3.63	13.92	3.68	13.5	9.4		72.24
		2735.17	9/10/99 1:58 PM	13.29	27.69	47.97	0.91	0.97	0.96	1.00	93.15	6.85	403	59	1.247	3.77	14.47	3.82	13.6	9.4		73.60
		2736.16	9/10/99 2:58 PM	13.76	28.56	49.08	0.89	0.97	0.96	1.01	93.52	6.48	408	59	1.258	3.70	14.18	3.75	13.7	9.4		73.60
		2737.16	9/10/99 3:57 PM	14.15	29.43	50.50	1.00	0.97	0.96	1.01	92.93	7.07	397	58	1.261	3.78	14.51	3.83	13.5	9.4		73.60
		2738.16	9/10/99 4:57 PM	14.32	29.93	49.84	0.81	0.97	1.06	1.09	94.35	5.65	414	60	1.268	3.55	13.61	3.60	13.4	9.2		72.26
		2739.16	9/10/99 5:58 PM	14.38	30.81	48.17	0.80	0.97	1.06	1.14	94.42	5.58	427	62	1.272	3.43	13.14	3.47	12.9	8.9		72.25
		2740.16	9/10/99 6:58 PM	14.34	32.35	45.36	0.74	0.98	1.11	1.20	94.82	5.18	457	67	1.276	3.13	12.01	3.17	12.6	8.1		70.87
		2741.16	9/10/99 7:58 PM	14.37	34.73	42.85	0.67	0.98	1.06	1.21	95.31	4.69	501	73	1.272	2.86	10.99	2.90	12.4	7.5		70.87
		2742.16	9/10/99 8:57 PM	14.36	36.88	41.00	0.62	0.98	1.06	1.21	95.70	4.30	539	78	1.265	2.63	10.08	2.66	12.0	7.4		69.50
		2743.16	9/10/99 9:58 PM	14.33	38.32	39.42	0.57	0.98	1.05	1.20	96.02	3.98	569	83	1.258	2.45	9.41	2.49	11.6	7.4		68.14
		2744.16	9/10/99 10:57 PM	14.28	39.46	37.75	0.54	0.98	0.96	1.23	96.25	3.75	603	88	1.251	2.37	9.11	2.41	11.5	7.4		70.44
		2745.16	9/10/99 11:57 PM	14.19	40.08	35.96	0.50	0.98	1.10	1.30	96.44	3.56	641	93	1.244	2.16	8.28	2.19	11.2	7.5		66.78
		2746.16	9/11/99 12:57 AM	14.09	40.06	34.45	0.48	0.98	1.05	1.29	96.58	3.42	682	99	1.236	2.04	7.83	2.07	11.1	7.8		66.76
		2747.16	9/11/99 1:57 AM	14.06	39.68	33.49	0.48	0.98	1.05	1.27	96.61	3.39	707	103	1.233	1.93	7.41	1.96	10.9	7.8		65.41
		2748.16	9/11/99 2:57 AM	14.02	39.39	32.95	0.47	0.98	1.03	1.29	96.67	3.33	722	105	1.229	1.92	7.38	1.95	10.8	8.0		66.23
		2749.16	9/11/99 3:57 AM	13.99	39.20	32.70	0.48	0.98	1.05	1.30	96.59	3.41	731	106	1.226	1.88	7.21	1.91	10.9	8.0		65.41
		2750.16	9/11/99 4:57 AM	13.96	38.98	32.51	0.48	0.98	1.05	1.30	96.58	3.42	734	107	1.223	1.88	7.20	1.90	10.8	8.2		65.40
		2751.16	9/11/99 5:57 AM	14.00	39.00	32.58	0.48	0.98	1.01	1.25	96.56	3.44	737	107	1.223	1.87	7.17	1.90	10.9	8.1		65.41
		2752.16	9/11/99 6:57 AM	14.06	39.08	32.74	0.50	0.98	1.01	1.25	96.48	3.52	740	108	1.219	1.87	7.16	1.89	11.0	8.1		65.41
		2753.16	9/11/99 7:58 AM	14.02	30.68	50.62	0.92	0.97	1.01	1.00	93.43	6.57	435	63	1.209	3.54	13.57	3.58	13.5	9.2		72.23
		2754.16	9/11/99 8:57 AM	14.01	29.06	49.46	0.82	0.97	1.01	1.03	94.12	5.88	429	62	1.212	3.58	13.73	3.63	13.7	9.7		72.24
		2755.16	9/11/99 9:57 AM	13.98	29.68	50.97	0.89	0.97	0.96	1.04	93.66	6.34	425	62	1.223	3.72	14.26	3.77	13.5	9.2		74.96
		2756.16	9/11/99 10:58 AM	13.92	29.57	50.97	0.89	0.97	0.96	1.04	93.58	6.42	426	62	1.226	3.69	14.17	3.74	13.5	9.1		74.96
		2757.16	9/11/99 11:57 AM	13.86	29.43	50.71	0.89	0.97	0.96	1.04	93.61	6.39	425	62	1.229	3.70	14.19	3.75	13.5	9.3		74.96
		2758.16	9/11/99 12:57 PM	13.94	29.18	50.98	0.90	0.97	0.96	1.04	93.54	6.46	426	62	1.237	3.67	14.06	3.72	13.5	9.3		74.96
		2759.16	9/11/99 1:57 PM	14.05	30.23	52.26	1.00	0.97	0.91	1.03	92.89	7.11	410	60	1.240	3.86	14.82	3.92	13.5	9.0		76.34
		2760.69	9/11/99 3:29 PM	14.17	30.60	51.09	0.90	0.97	0.96	1.06	93.68	6.32	410	60	1.258	3.75	14.38	3.80	14.7	8.7		74.93
		2761.69	9/11/99 4:29 PM	14.24	29.97	51.09	0.79	0.98	0.96	1.07	94.49	5.51	425	62	1.265	3.59	13.79	3.64	13.4	9.1		74.96
		2762.69	9/11/99 5:29 PM	14.31	30.27	51.52	0.76	0.98	0.96	1.06	94.70	5.30	424	62	1.272	3.58	13.74	3.63	13.2	9.1		74.97
		2763.69	9/11/99 6:29 PM	14.34	31.34	50.05	0.76	0.98	1.01	1.09	94.72	5.28	436	63	1.276	3.41	13.08	3.46	13.0	8.5		73.61
		2764.69	9/11/99 7:29 PM	14.32	33.31	46.25	0.72	0.98	0.96	1.12	94.96	5.04	478	70	1.275	3.11	11.93	3.15	12.5	7.8		73.61
		2765.69	9/11/99 8:29 PM	14.36	35.54	43.45	0.67	0.98	1.01	1.20	95.34	4.66	520	76	1.268	2.82	10.83	2.86	12.7	6.8		72.23
		2766.69	9/11/99 9:29 PM	14.35	37.56	41.88	0.62	0.98	0.97	1.18	95.65	4.35	554	81	1.261	2.66	10.21	2.70	11.9	7.0		72.10
		2767.69	9/11/99 10:29 PM	14.32	39.50	40.49	0.59	0.98	1.01	1.22	95.91	4.09	588	86	1.251	2.48	9.52	2.52	11.6	7.1		70.88
		2768.69	9/11/99 11:29 PM	14.37	41.21	39.14	0.55	0.98	0.96	1.21	96.17	3.83	627	91	1.244	2.34	8.98	2.37	11.4	7.3		70.88
		2769.69	9/12/99 12:29 AM	14.37	42.02	37.84	0.53	0.98	1.01	1.25	96.35	3.65	671	98	1.240	2.15	8.25	2.18	10.9	7.4		69.50
		2770.69	9/12/99 1:29 AM	14.35	41.81	36.83	0.52	0.98	0.97	1.23	96.41	3.59	697	101	1.233	2.08	7.99	2.11	11.1	7.4		69.50
		2771.69	9/12/99 2:29 AM	14.34	41.64	36.29	0.52	0.98	0.97	1.25	96.40	3.60	710	103	1.229	2.05	7.86	2.08	10.6	7.6		69.50
		2772.69	9/12/99 3:29 AM	14.29	41.38	35.91	0.52	0.98	1.01	1.26	96.38	3.62	719	105	1.229	1.99	7.62	2.01	10.9	7.5		68.14
		2773.69	9/12/99 4:29 AM	14.25	41.20	35.70	0.52	0.98	0.97	1.21	96.39	3.61	724	105	1.226	1.98	7.59	2.00	10.8	7.7		68.14
		2774.69	9/12/99 5:29 AM	14.22	41.04	35.49	0.52	0.98	0.97	1.21	96.33	3.67	727	106	1.223	1.98	7.58	2.00	10.8	7.7		68.14
		2775.69	9/12/99 6:29 AM	14.32	43.62	35.53	0.73	0.97	0.96	1.27	94.88	5.12	699	102	1.219	2.10	8.06	2.13	10.9	7.6		69.50
		2777.30	9/12/99 8:06 AM	14.37	30.89	52.34	0.91	0.97	0.97	1.05	93.65	6.35	436	63	1.209	3.64	13.97	3.69	13.6	9.2		74.55
		2778.30	9/12/99 9:06 AM	14.35	30.30	51.65	0.84	0.97	1.01	1.06	94.13	5.87	444	65	1.216	3.51	13.48	3.56	13.5	9.4		73.61
		2779.30	9/12/99 10:06 AM	14.34	30.56	52.80	0.94	0.97	1.01	1.03	93.42	6.58	428	62	1.223	3.63	13.91	3.68	13.7	8.9		73.60
		2780.30	9/12/99 11:06 AM	14.33	30.07	52.61	0.96	0.97	1.01	1.04	93.26	6.74	429	62	1.229	3.59	13.79	3.64	13.5	9.2		73.60
		2781.30	9/12/99 12:06 PM	14.39	30.55	52.26	0.92	0.97	0.91	1.00	93.58	6.42	431	63	1.233	3.64	13.95	3.68	13.5	9.1		74.98
		2782.30	9/12/99 1:06 PM	14.49	31.05	51.31	0.84	0.97	0.92	1.03	94.18	5.82	434	63	1.240	3.59	13.77	3.64	14.0	9.0		74.65
		2783.30	9/12/99 2:06 PM	14.57	33.10	54.93	1.27	0.96	0.96	1.01	91.26	8.74	394	57	1.247	3.93	15.08	3.98	13.4	8.7		74.98
		2784.30	9/12/99 3:06 PM	14.77	30.46	53.79	1.01	0.97	1.01	1.04	93.15	6.85	424	62	1.254	3.56	13.67	3.61	13.1	9.4		73.60
		2785.30	9/12/99 4:06 PM	14.91	30.75	52.50	0.94	0.97	1.01	1.08	93.70	6.30	424	62	1.261	3.54	13.60	3.59	13.5	9.2		73.60
		2786.30	9/12/99 5:06 PM	15.05	31.97	55.67	1.14	0.97	0.96	1.03	92.39	7.61	400	58	1.268	3.81	14.62	3.86	13.2	9.0		74.97
		2787.30	9/12/99 6:06 PM	15.17	31.55	53.88	0.85	0.98	1.01	1.07	94.39	5.61	422	61	1.275	3.53	13.53	3.57	13.5	9.1		73.61
		2788.30	9/12/99 7:06 PM	15.22	31.55	53.57	0.87	0.97	1.01	1.08	94.30	5.70	426	62	1.276	3.49	13.40	3.54	13.4	9.2		73.61
		2789.30	9/12/99 8:06 PM	15.26	33.65	55.61	1.21	0.97	0.96	1.04	92.08	7.92	388	57	1.265	3.93	15.08	3.98	13.7	8.6		74.97
		2790.30	9/12/99 9:06 PM	15.26	31.67	54.89	0.79	0.98	1.01	1.06	94.79	5.21	428	62	1.261	3.51	13.48	3.56	13.5	9.1		73.60
		2791.30	9/12/99 10:06 PM	15.20	31.80	54.71	0.78	0.98	1.01	1.06	94.87	5.13	426	62	1.254	3.55	13.62	3.60	13.6	9.1		73.60
		2792.30	9/12/99 11:06 PM	15.17	31.89	54.29	0.76	0.98	0.97	1.01	95.02	4.98	431	63	1.247	3.51	13.48	3.56	13.4	9.1		73.36
		2793.30	9/13/99 12:06 AM	15.12	32.09	53.68	0.73	0.98	0.96	1.02	95.20	4.80	441	64	1.240	3.47	13.30	3.51	13.5	8.8		73.60
		2794.30	9/13/99 1:06 AM	15.05	32.26	52.85	0.70	0.98	0.96	1.03	95.35	4.65	449	65	1.237	3.41	13.10	3.46	13.4	8.7		73.60
		2795.30	9/13/99 2:06 AM	15.03	32.51	52.00	0.68	0.98	0.96	1.05	95.46	4.54	459	67	1.233	3.35	12.84	3.39	13.5	8.4		73.60
		2796.30	9/13/99 3:06 AM	14.99	32.64	51.13	0.68	0.98	0.91	1.05	95.49	4.51	465	68	1.229	3.32	12.72	3.36	13.2	8.4		74.63
		2797.30	9/13/99 4:06 AM	14.94	32.76	50.45	0.67	0.98	1.01	1.07	95.51	4.49	471	69	1.226	3.22	12.36	3.26	13.2	8.3		72.25
		2798.30	9/13/99 5:06 AM	14.91	32.89	49.89	0.67	0.98	1.01	1.08	95.52	4.48	477	69	1.223	3.19	12.23	3.23	13.1	8.3		72.24
		2799.30	9/13/99 6:06 AM	14.84	33.10	49.33	0.66	0.98	1.01	1.09	95.57	4.43	485	71	1.219	3.14	12.06	3.19	13.2	8.3		72.25
		2800.30	9/13/99 7:06 AM	14.75	33.14	48.52	0.64	0.98	1.01	1.10	95.66	4.34	492	72	1.216	3.11	11.94	3.15	13.2	8.1		72.25
		2800.63	9/13/99 7:25 AM	14.76	33.20	48.18	0.63	0.98	3.47	3.69	95.72	4.28	497	72	1.216	3.08	11.81	3.12	13.4	8.1		71.29
		2801.63	9/13/99 8:25 AM	14.63	33.35	47.45	0.62	0.98	1.01	1.12	95.78	4.22	505	73	1.212	3.04	11.66	3.08	13.1	8.0		72.23
		2802.63	9/13/99 9:25 AM	14.54	33.78	46.43	0.61	0.98	1.01	1.13	95.80	4.20	513	75	1.219	2.97	11.41	3.01	13.1	7.7		72.22
		2803.63	9/13/99 10:25 AM	14.52	31.01	54.03	0.96	0.97	1.00	1.02	93.39	6.61	426	62	1.219	3.67	14.07	3.72	14.9	8.3		73.93
		2804.63	9/13/99 11:25 AM	14.59	30.34	52.04	0.75	0.98	0.96	1.02	94.88	5.12	444	65	1.229	3.47	13.31	3.52	13.8	9.2		73.61
		2805.63	9/13/99 12:25 PM	14.74	31.14	52.61	0.81	0.98	0.86	1.01	94.49	5.51	432	63	1.240	3.67	14.09	3.72	14.0	8.9		76.34
		2806.63	9/13/99 1:25 PM	14.83	30.18	55.92	1.24	0.96	0.96	0.99	91.63	8.37	410	60	1.247	3.71	14.22	3.76	13.2	9.1		74.61
		2807.50	9/13/99 2:18 PM	14.92	30.26	57.79	1.23	0.97	1.01	0.98	91.79	8.21	408	59	1.251	3.71	14.25	3.76	13.2	9.4		73.62
		2808.49	9/13/99 3:18 PM	15.20	31.06	55.26	1.01	0.97	1.01	1.05	93.32	6.68	428	62	1.254	3.53	13.56	3.58	13.5	9.2		73.60
		2809.49	9/13/99 4:18 PM	15.42	32.67	55.01	0.92	0.97	0.96	1.07	94.06	5.94	412	60	1.258	3.73	14.30	3.78	14.8	9.0		74.98
		2810.49	9/13/99 5:18 PM	15.59	35.30	60.61	1.59	0.96	0.98	0.97	89.82	10.18	388	56	1.258	3.88	14.89	3.94	13.5	9.1		74.07
		2811.49	9/13/99 6:18 PM	15.70	32.51	55.67	0.84	0.98	0.96	1.02	94.67	5.33	436	63	1.254	3.47	13.31	3.52	13.7	9.2		73.62
		2812.49	9/13/99 7:18 PM	15.80	34.38	61.84	1.49	0.96	0.96	0.96	90.58	9.42	400	58	1.251	3.79	14.55	3.84	13.1	9.4		74.62
		2814.49	9/13/99 9:18 PM	15.87	34.72	59.65	1.37	0.96	0.96	1.01	91.38	8.62	404	59	1.240	3.86	14.80	3.91	13.4	9.3		74.98
		2816.49	9/13/99 11:18 PM	15.84	33.28	55.81	0.89	0.98	0.96	1.03	94.40	5.60	434	63	1.233	3.55	13.60	3.59	14.7	9.1		73.61
		2818.49	9/14/99 1:18 AM	15.75	33.70	55.92	0.97	0.97	0.96	1.02	93.87	6.13	427	62	1.226	3.62	13.90	3.67	14.3	9.2		73.61
		2820.49	9/14/99 3:18 AM	15.57	32.69	54.63	0.84	0.98	0.96	1.03	94.58	5.42	441	64	1.223	3.51	13.47	3.56	14.5	9.2		73.61
		2822.49	9/14/99 5:18 AM	15.45	32.18	54.29	0.81	0.98	0.96	1.03	94.78	5.22	451	66	1.216	3.46	13.27	3.51	14.4	9.4		73.61
		2823.49	9/14/99 6:18 AM	15.39	31.84	54.26	0.78	0.98	0.96	1.03	94.96	5.04	456	66	1.216	3.42	13.11	3.46	14.1	9.4		73.61
		2825.49	9/14/99 8:18 AM	15.43	32.13	54.33	0.80	0.98	0.96	1.03	94.83	5.17	457	66	1.209	3.43	13.17	3.48	14.8	9.4		73.61
		2826.49	9/14/99 9:18 AM	15.42	32.10	55.45	0.95	0.97	0.91	1.01	93.87	6.13	457	67	1.212	3.48	13.36	3.53	14.0	9.5		74.97
		2826.65	9/14/99 9:27 AM	15.42	31.76	56.01	0.98	0.97	0.96	1.00	93.63	6.37	452	66	1.212	3.46	13.26	3.50	13.8	9.7		73.61
		2828.65	9/14/99 11:27 AM	15.37	31.67	53.83	0.75	0.98	1.48	1.59	95.13	4.87	460	67	1.226	3.36	12.89	3.41	13.8	9.5		73.61

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		2829.65	9/14/99 12:27 PM																			
12	RO Unit down due to raising Zenon membranes	2830.65	9/14/99 1:27 PM	15.46	31.80	55.77	0.94	0.97	0.96	1.06	93.94	6.06	427	62	1.236	3.65	14.01	3.70	13.8	9.7		74.95
		2880.26	9/16/99 3:03 PM										542	79	1.155	3.42	13.13	3.47	15.7	10.2		78.86
		2881.25	9/16/99 4:03 PM	16.83	33.98	61.58	1.83	0.95	0.96	0.94	89.11	10.89	407	59	1.202	3.80	14.58	3.85	13.2	10.9		72.25
		2882.25	9/16/99 5:03 PM	17.54	34.23	59.08	1.48	0.96	1.04	1.05	91.58	8.42	418	61	1.233	3.54	13.59	3.59	13.5	10.5		70.88
		2883.26	9/16/99 6:03 PM	17.54	34.32	63.61	1.81	0.96	1.01	0.95	89.67	10.33	399	58	1.244	3.68	14.12	3.73	13.4	10.6		70.98
		2885.25	9/16/99 8:03 PM	17.12	40.12	56.63	2.12	0.94	0.91	1.04	87.63	12.37	395	57	1.233	3.89	14.93	3.94	14.1	10.0		73.60
		2886.26	9/16/99 9:03 PM	16.83	40.22	63.41	2.55	0.94	0.96	0.95	84.83	15.17	384	56	1.223	4.04	15.49	4.09	13.8	10.1		73.62
		2887.25	9/16/99 10:03 PM	16.59	32.43	58.96	1.33	0.96	0.91	0.96	91.95	8.05	425	62	1.212	3.61	13.85	3.66	14.0	10.5		73.25
		2890.26	9/17/99 1:03 AM	16.02	35.67	58.94	1.80	0.95	0.96	0.98	88.77	11.23	396	58	1.195	4.01	15.38	4.06	14.1	10.1		73.61
		2891.26	9/17/99 2:03 AM	15.86	31.79	52.55	0.83	0.98	0.96	1.06	94.79	5.21	432	63	1.195	3.67	14.09	3.72	15.6	10.1		72.61
		2892.25	9/17/99 3:03 AM	15.68	30.51	56.70	1.28	0.96	0.96	0.95	91.84	8.16	424	62	1.192	3.68	14.12	3.73	13.8	10.5		72.23
		2895.25	9/17/99 6:03 AM	15.34	33.47	54.87	1.43	0.96	0.92	0.97	90.66	9.34	405	59	1.182	3.96	15.18	4.01	14.3	10.1		73.61
		2897.92	9/17/99 8:43 AM	15.24	30.30	50.37	0.74	0.98	0.87	1.00	95.16	4.84	457	66	1.178	3.52	13.52	3.57	14.7	10.6		73.61
		2899.25	9/17/99 10:03 AM	15.19	29.82	53.62	1.05	0.97	0.96	0.98	93.10	6.90	435	63	1.192	3.59	13.76	3.64	13.7	10.7		72.25
		2900.92	9/17/99 11:43 AM	15.21	29.69	54.54	1.22	0.97	0.92	0.95	91.98	8.02	413	60	1.209	3.73	14.31	3.78	13.6	10.3		73.22
		2901.26	9/17/99 12:03 PM	15.25	30.21	49.89	0.87	0.97	0.96	1.05	94.31	5.69	436	63	1.212	3.52	13.49	3.56	13.8	10.4		72.24
		2902.26	9/17/99 1:03 PM	15.39	32.31	51.00	1.07	0.97	0.96	1.09	93.02	6.98	398	58	1.223	3.90	14.95	3.95	14.4	9.8		73.62
		2903.25	9/17/99 2:03 PM	15.60	30.82	53.93	1.07	0.97	0.91	1.00	93.14	6.86	421	61	1.226	3.68	14.10	3.73	13.6	10.4		73.62
		2906.92	9/17/99 5:43 PM	15.70	30.89	56.42	1.17	0.97	0.96	1.01	92.52	7.48	401	58	1.247	3.79	14.54	3.84	13.3	10.2		73.62
		2907.92	9/17/99 6:43 PM	15.73	32.93	52.67	1.04	0.97	0.91	1.03	93.42	6.58	390	57	1.247	3.90	14.97	3.95	14.1	9.7		73.62
		2909.92	9/17/99 8:43 PM	15.70	31.22	55.07	1.14	0.97	0.91	0.97	92.76	7.24	403	59	1.233	3.75	14.37	3.80	13.3	10.1		73.23
		2910.92	9/17/99 9:43 PM	15.67	31.42	53.01	0.94	0.97	0.96	1.02	94.00	6.00	416	60	1.226	3.65	14.00	3.70	13.7	10.1		72.24
		2911.92	9/17/99 10:43 PM	15.60	31.51	52.77	0.96	0.97	0.91	1.02	93.84	6.16	416	60	1.219	3.74	14.34	3.79	13.8	10.2		73.60
		2912.92	9/17/99 11:43 PM	15.54	31.26	52.12	0.86	0.97	0.96	1.03	94.44	5.56	426	62	1.212	3.60	13.83	3.65	14.0	10.3		72.22
		2913.92	9/18/99 12:43 AM	15.45	31.14	51.96	0.89	0.97	0.96	1.03	94.21	5.79	425	62	1.209	3.62	13.88	3.67	14.0	10.3		72.22
		2914.92	9/18/99 1:43 AM	15.39	31.17	51.99	0.89	0.97	0.96	1.02	94.21	5.79	427	62	1.205	3.61	13.87	3.66	14.1	10.3		72.22
		2915.92	9/18/99 2:43 AM	15.36	31.14	52.03	0.88	0.97	0.96	1.02	94.29	5.71	429	62	1.202	3.60	13.83	3.65	14.0	10.3		72.22
		2919.92	9/18/99 6:43 AM	15.17	30.55	51.09	0.79	0.98	0.92	0.98	94.81	5.19	451	66	1.188	3.47	13.31	3.52	14.2	10.6		72.23
		2896.92	9/17/99 7:43 AM	15.30	32.68	54.51	1.40	0.96	0.91	0.97	90.82	9.18	412	60	1.175	3.91	15.01	3.97	14.3	10.3		73.57
		2921.80	9/18/99 8:36 AM	14.96	30.13	50.71	0.81	0.98	1.01	1.02	94.58	5.42	446	65	1.188	3.44	13.21	3.49	14.3	10.4		70.87
		2922.80	9/18/99 9:36 AM	14.89	30.01	50.28	0.81	0.98	1.01	1.02	94.54	5.46	443	64	1.192	3.46	13.27	3.51	14.0	10.4		70.86
		2923.80	9/18/99 10:36 AM	14.99	30.17	50.53	0.83	0.97	1.01	1.02	94.44	5.56	436	63	1.202	3.48	13.36	3.53	14.0	10.3		70.86
		2924.80	9/18/99 11:36 AM	15.10	30.71	50.71	0.90	0.97	1.01	1.03	94.07	5.93	428	62	1.212	3.52	13.49	3.56	14.1	10.2		70.86
		2925.80	9/18/99 12:36 PM	15.24	30.96	51.35	0.93	0.97	1.01	1.02	93.89	6.11	421	61	1.223	3.55	13.61	3.60	13.9	10.2		70.88
		2926.80	9/18/99 1:36 PM	15.50	31.55	52.13	0.98	0.97	1.01	1.02	93.70	6.30	416	61	1.226	3.58	13.73	3.63	13.8	10.1		70.88
		2929.80	9/18/99 4:36 PM	15.79	32.01	53.41	0.98	0.97	1.02	1.02	93.82	6.18	409	59	1.251	3.55	13.63	3.60	13.8	10.0		70.56
		2930.80	9/18/99 5:36 PM	15.78	32.59	54.16	1.12	0.97	0.96	1.00	92.91	7.09	388	56	1.254	3.82	14.67	3.87	13.8	9.8		72.24
		2931.80	9/18/99 6:36 PM	15.78	32.95	52.72	0.98	0.97	0.96	1.03	93.78	6.22	394	57	1.258	3.76	14.42	3.81	13.9	9.7		72.23
		2932.80	9/18/99 7:36 PM	15.76	32.39	54.32	1.05	0.97	1.00	1.00	93.31	6.69	398	58	1.251	3.68	14.11	3.73	13.1	10.0		70.99
		2933.80	9/18/99 8:36 PM	15.65	32.01	53.70	0.96	0.97	1.01	0.99	93.88	6.12	407	59	1.240	3.55	13.62	3.60	13.8	10.0		70.43
		2934.80	9/18/99 9:36 PM	15.52	31.77	52.55	0.91	0.97	1.01	1.02	94.11	5.89	412	60	1.229	3.60	13.82	3.65	13.9	10.0		70.88
		2935.80	9/18/99 10:36 PM	15.46	31.42	51.95	0.86	0.97	1.01	1.03	94.44	5.56	422	61	1.219	3.55	13.62	3.60	14.0	10.1		70.86
		2936.80	9/18/99 11:36 PM	15.44	31.26	51.82	0.83	0.98	1.01	1.03	94.60	5.40	429	62	1.212	3.51	13.45	3.55	14.0	10.3		70.87
		2937.80	9/19/99 12:36 AM	15.50	31.34	51.82	0.82	0.98	1.02	1.03	94.73	5.27	435	63	1.205	3.46	13.29	3.51	14.0	10.3		70.58
		2938.80	9/19/99 1:36 AM	15.49	31.42	52.03	0.81	0.98	1.01	1.03	94.75	5.25	438	64	1.202	3.47	13.30	3.51	14.0	10.3		70.86
		2939.80	9/19/99 2:36 AM	15.42	31.23	51.59	0.80	0.98	1.06	1.03	94.82	5.18	441	64	1.198	3.38	12.98	3.43	14.1	10.3		69.51
		2940.80	9/19/99 3:36 AM	15.29	30.92	51.26	0.78	0.98	1.01	0.98	94.88	5.12	446	65	1.192	3.37	12.92	3.41	14.3	10.3		69.51
		2942.80	9/19/99 5:36 AM	15.08	30.30	50.14	0.73	0.98	1.04	1.02	95.15	4.85	454	66	1.185	3.32	12.75	3.37	14.1	10.5		69.49
		2943.80	9/19/99 6:36 AM	15.02	30.17	49.84	0.72	0.98	0.97	0.99	95.18	4.82	457	66	1.182	3.37	12.92	3.41	14.0	10.6		70.59
		2944.91	9/19/99 7:43 AM	15.01	30.09	49.80	0.71	0.98	1.01	0.99	95.26	4.74	462	67	1.175	3.30	12.65	3.34	14.1	10.6		69.51
		2945.91	9/19/99 8:43 AM	15.04	30.09	49.72	0.71	0.98	1.01	1.00	95.27	4.73	458	67	1.178	3.32	12.73	3.36	14.1	10.4		69.49
		2946.91	9/19/99 9:43 AM	15.09	30.33	50.13	0.72	0.98	0.96	0.99	95.25	4.75	459	67	1.188	3.34	12.83	3.39	14.3	10.5		70.87
		2947.91	9/19/99 10:43 AM	15.09	30.30	49.97	0.72	0.98	0.92	0.99	95.24	4.76	454	66	1.198	3.35	12.87	3.40	13.8	10.5		71.85
		2948.91	9/19/99 11:43 AM	15.03	30.13	49.59	0.73	0.98	0.96	1.04	95.12	4.88	447	65	1.205	3.45	13.25	3.50	14.0	10.3		72.24
		2950.91	9/19/99 1:43 PM	15.12	30.35	50.02	0.77	0.98	0.99	1.05	94.88	5.12	438	64	1.223	3.44	13.21	3.49	13.8	10.3		71.60
		2952.91	9/19/99 3:43 PM	15.47	31.22	51.30	0.85	0.97	0.96	1.04	94.54	5.46	426	62	1.244	3.51	13.46	3.56	13.8	10.1		72.22
		2953.91	9/19/99 4:43 PM	15.50	30.91	50.10	0.75	0.98	0.96	1.07	95.18	4.82	435	63	1.251	3.42	13.13	3.47	13.6	10.0		72.22
		2954.91	9/19/99 5:43 PM	15.50	31.09	49.75	0.74	0.98	0.91	1.07	95.21	4.79	430	63	1.261	3.49	13.40	3.54	13.6	10.0		73.59
		2955.91	9/19/99 6:43 PM	15.45	31.09	49.32	0.73	0.98	0.96	1.08	95.27	4.73	432	63	1.265	3.40	13.06	3.45	13.3	9.8		72.23
		2956.91	9/19/99 7:43 PM	15.41	31.18	48.38	0.73	0.98	1.01	1.15	95.29	4.71	439	64	1.258	3.37	12.93	3.42	13.5	9.8		72.23
		2957.91	9/19/99 8:43 PM	15.33	31.35	47.49	0.70	0.98	0.96	1.11	95.45	4.55	454	66	1.247	3.28	12.59	3.33	13.4	9.7		72.21
		2958.91	9/19/99 9:43 PM	15.24	31.59	46.29	0.67	0.98	1.01	1.14	95.59	4.41	467	68	1.237	3.16	12.12	3.20	13.3	9.4		70.90
		2959.91	9/19/99 10:43 PM	15.19	31.72	45.27	0.65	0.98	1.01	1.16	95.75	4.25	480	70	1.226	3.10	11.89	3.14	13.2	9.3		70.86
		2960.91	9/19/99 11:43 PM	15.19	31.93	44.55	0.62	0.98	0.96	1.12	95.89	4.11	493	72	1.219	3.04	11.66	3.08	13.4	9.1		70.86
		2962.91	9/20/99 1:43 AM	15.17	32.30	43.87	0.60	0.98	0.96	1.14	96.05	3.95	510	74	1.205	2.97	11.39	3.01	13.4	9.0		70.86
		2963.91	9/20/99 2:43 AM	15.14	32.46	43.83	0.59	0.98	0.96	1.14	96.09	3.91	513	75	1.202	2.96	11.36	3.00	13.2	9.0		70.86
		2965.91	9/20/99 4:43 AM	15.05	32.39	43.45	0.58	0.98	0.96	1.14	96.17	3.83	519	75	1.195	2.94	11.29	2.98	13.2	8.9		70.87
		2966.91	9/20/99 5:43 AM	15.00	33.01	46.42	0.68	0.98	0.96	1.06	95.45	4.55	497	72	1.192	3.08	11.82	3.12	13.2	9.0		70.87
		2967.91	9/20/99 6:43 AM	14.97	32.05	48.47	0.70	0.98	0.92	1.02	95.36	4.64	477	69	1.188	3.28	12.59	3.33	13.5	9.4		72.23
		2969.20	9/20/99 8:00 AM	15.06	32.96	50.20	0.70	0.98	0.87	1.06	95.33	4.67	537	78	1.185	3.14	12.07	3.19	20.5	9.1		75.62
		2994.38	9/21/99 9:11 AM	15.08	33.10	50.24	0.68	0.98	1.00	1.05	95.52	4.48	519	75	1.182	3.04	11.65	3.08	13.4	9.0		71.36
		2995.38	9/21/99 10:11 AM	14.98	32.93	49.98	0.68	0.98	0.96	1.03	95.44	4.56	512	75	1.192	3.05	11.69	3.09	13.2	8.9		72.23
		2996.38	9/21/99 11:11 AM	14.92	32.80	49.85	0.69	0.98	0.91	1.03	95.35	4.65	508	74	1.198	3.11	11.95	3.16	13.2	8.8		73.59
		2997.38	9/21/99 12:11 PM	14.91	30.10	51.82	0.90	0.97	0.96	0.95	93.96	6.04	474	69	1.209	3.18	12.21	3.23	13.1	9.9		70.87
		2998.38	9/21/99 1:11 PM	14.87	29.13	42.60	0.76	0.97	0.96	1.34	94.88	5.12	542	79	1.233	3.21	12.30	3.25	21.8	11.1		74.95
		2999.38	9/21/99 2:11 PM	15.19	29.51	54.41	0.90	0.97	0.96	0.96	94.05	5.95	449	65	1.223	3.39	13.00	3.44	14.0	10.5		72.24
		3000.32	9/21/99 3:07 PM	15.52	35.74	54.21	1.15	0.97	0.96	1.04	92.59	7.41	409	59	1.233	3.76	14.43	3.81	14.2	10.0		73.58
		3001.32	9/21/99 4:07 PM	15.80	35.84	55.02	1.12	0.97	0.91	0.99	92.90	7.10	411	60	1.244	3.71	14.22	3.76	14.3	10.1		73.60
		3002.32	9/21/99 5:07 PM	15.87	35.49	54.40	1.07	0.97	0.91	1.00	93.26	6.74	411	60	1.251	3.69	14.16	3.74	14.3	9.9		73.60
		3004.32	9/21/99 7:07 PM	16.01	31.77	53.46	0.75	0.98	0.96	1.03	95.30	4.70	442	64	1.254	3.36	12.88	3.40	14.1	10.2		72.23
		3005.32	9/21/99 8:07 PM	16.13	32.14	53.90	0.77	0.98	0.96	1.03	95.25	4.75	443	64	1.251	3.36	12.88	3.40	14.3	10.1		72.24
		3007.32	9/21/99 10:07 PM	16.10	32.69	51.11	0.73	0.98	0.96	1.09	95.48	4.52	466	68	1.237	3.23	12.38	3.27	14.1	9.7		72.23
		3008.32	9/21/99 11:07 PM	16.03	33.57	46.61	0.68	0.98	1.01	1.19	95.75	4.25	500	73	1.229	2.97	11.38	3.01	13.8	9.1		70.85
		3009.32	9/22/99 12:07 AM	15.92	34.73	43.12	0.64	0.98	1.00	1.22	95.99	4.01	534	78	1.223	2.75	10.55	2.79	13.5	8.7		69.76
		3012.32	9/22/99 3:07 AM	15.67	36.08	39.57	0.58	0.98	0.99	1.26	96.29	3.71	579	84	1.212	2.55	9.78	2.58	13.1	8.4		68.98
		3014.32	9/22/99 5:07 AM	15.50	35.75	39.28	0.57	0.98	1.01	1.24	96.34	3.66	585	85	1.198	2.50	9.60	2.54	13.2	8.4		68.13
		3015.32	9/22/99 6:07 AM	15.35	35.41	39.11	0.56	0.98	0.96	1.24	96.35	3.65	592	86	1.188	2.54	9.76	2.58	13.1	8.6		69.49
		3017.32	9/22/99 8:07 AM																			
		3023.39	9/22/99 2:11 PM	15.26	30.11	38.76	0.79	0.97	1.01	1.31	94.81	5.19	428	62	1.175	3.28	12.58	3.32	12.8	9.4		69.74
		3024.40	9/22/99 3:12 PM	15.41	30.93	49.36	0.87	0.97	0.91	1.08	94.36	5.64	468	68	1.182	3.43	13.15	3.48	14.3	10.4		73.61
		3040.97	9/23/99 7:46 AM	14.88	33.47	69.42	0.74	0.98	0.96	1.00	95.02	4.98	571	83	1.138	3.24	12.42	3.28	14.1	8.0		79.61
13	Inc to 80%	3041.97	9/23/99 8:46 AM	14.79	33.01	69.46	0.77	0.98	0.89	0.99	94.79	5.21	552	80	1.141	3.40	13.04	3.45	14.1	8.0		80.93
		3042.97	9/23/99 9:46 AM	14.69	32.81	69.30	0.78	0.98	6.39	7.61	94.70	5.30	544	79	1.151	3.47	13.32	3.52	14.2	8.0		82.28
		3043.97	9/23/99 10:46 AM	14.65	33.02	68.08	0.75	0.98	0.88	1.07	94.87	5.13	537	78	1.161	3.49	13.39	3.54	14.7	7.7		82.28
		3044.97	9/23/99 11:46 AM	14.69	31.80	78.02	1.12	0.98	0.89	0.92	92.36	7.64	500	73	1.171	3.65	14.02	3.70	13.4	8.1		82.02
		3045.97	9/23/99 12:46 PM	14.81	33.02	67.91	0.74	0.98	0.95	1.08	95.00	5.00	540	79	1.182	3.35	12.87	3.40	13.5	7.8		80.95
		3046.97	9/23/99 1:46 PM	14.96	33.77	69.59	0.78	0.98	0.88	1.07	94.80	5.20	511	74	1.192	3.58	13.72	3.62	15.0	7.6		82.28

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		3047.97	9/23/99 2:46 PM	15.10	40.58	82.24	1.69	0.97	1.02	0.97	88.80	11.20	450	65	1.198	3.97	15.23	4.02	13.8	7.5		80.95
		3048.97	9/23/99 3:46 PM	15.29	33.27	83.49	1.33	0.97	0.95	0.91	91.28	8.72	475	69	1.209	3.73	14.31	3.78	12.6	8.3		80.95
		3049.97	9/23/99 4:46 PM	15.39	35.32	71.22	0.92	0.98	0.88	1.07	94.05	5.95	484	70	1.219	3.68	14.14	3.74	15.4	7.2		82.26
		3050.97	9/23/99 5:46 PM	15.41	38.83	79.99	1.45	0.97	1.02	1.02	90.62	9.38	444	65	1.223	3.95	15.15	4.00	13.7	7.2		80.94
		3051.97	9/23/99 6:46 PM	15.42	33.84	80.08	1.11	0.98	0.90	0.95	92.81	7.19	482	70	1.226	3.62	13.91	3.67	13.4	7.7		81.83
		3052.97	9/23/99 7:46 PM	15.53	34.70	70.93	0.78	0.98	1.02	1.09	94.98	5.02	518	75	1.223	3.33	12.76	3.37	13.7	7.7		79.63
		3053.97	9/23/99 8:46 PM	15.55	34.99	71.32	0.75	0.98	0.95	1.08	95.16	4.84	526	77	1.212	3.36	12.88	3.40	13.7	7.7		80.95
		3054.97	9/23/99 9:46 PM	15.53	34.82	71.29	0.75	0.98	0.99	1.08	95.18	4.82	531	77	1.202	3.30	12.65	3.34	13.8	7.8		80.08
		3056.97	9/23/99 11:46 PM	15.38	33.81	75.06	0.95	0.98	0.95	1.02	93.81	6.19	524	76	1.178	3.47	13.30	3.51	13.4	8.0		80.95
		3057.97	9/24/99 12:46 AM	15.30	36.43	73.44	1.05	0.98	0.95	1.03	93.12	6.88	491	71	1.171	3.73	14.29	3.78	14.0	7.5		80.95
		3058.97	9/24/99 1:46 AM	15.24	35.49	70.04	0.88	0.98	1.01	1.10	94.24	5.76	520	76	1.165	3.53	13.56	3.58	14.5	7.4		79.95
		3059.97	9/24/99 2:46 AM	15.11	34.06	69.59	0.81	0.98	0.89	1.01	94.65	5.35	547	80	1.161	3.37	12.93	3.42	14.0	8.0		80.95
		3060.97	9/24/99 3:46 AM	14.93	33.80	70.20	0.88	0.98	0.95	1.06	94.08	5.92	537	78	1.158	3.44	13.21	3.49	14.2	7.8		81.01
		3061.97	9/24/99 4:46 AM	14.77	33.31	69.58	0.87	0.98	0.95	1.05	94.08	5.92	542	79	1.155	3.42	13.13	3.47	14.1	8.0		80.95
		3062.97	9/24/99 5:46 AM	14.62	32.89	68.37	0.85	0.98	0.89	0.99	94.22	5.78	548	80	1.155	3.39	12.99	3.43	14.1	8.0		80.95
		3063.97	9/24/99 6:46 AM	14.53	32.47	68.05	0.82	0.98	0.89	0.99	94.38	5.62	557	81	1.151	3.34	12.81	3.38	13.6	8.1		80.95
		3066.87	9/24/99 9:40 AM	14.49	32.51	68.29	0.83	0.98	0.89	0.98	94.26	5.74	549	80	1.158	3.37	12.92	3.41	14.1	8.1		80.95
		3068.87	9/24/99 11:40 AM	14.55	33.20	69.16	0.92	0.98	0.94	1.11	93.65	6.35	507	74	1.178	3.64	13.98	3.69	14.1	7.5		82.28
		3070.87	9/24/99 1:40 PM	14.98	33.27	69.70	0.84	0.98	0.95	1.06	94.42	5.58	530	77	1.198	3.37	12.94	3.42	13.7	7.8		80.95
		3071.87	9/24/99 2:40 PM	15.12	36.42	71.31	1.14	0.97	0.88	1.05	92.47	7.53	471	68	1.209	3.82	14.67	3.88	14.1	7.4		82.28
		3072.87	9/24/99 3:40 PM	15.13	34.13	70.63	0.78	0.98	0.94	1.06	94.86	5.14	524	76	1.223	3.34	12.83	3.39	13.8	7.8		80.96
		3073.87	9/24/99 4:40 PM	15.16	33.94	72.05	0.97	0.98	0.88	1.03	93.58	6.42	504	73	1.229	3.46	13.28	3.51	13.3	7.9		82.04
		3076.87	9/24/99 7:40 PM	15.06	33.94	70.71	0.80	0.98	0.94	1.05	94.72	5.28	509	74	1.233	3.41	13.08	3.46	13.5	7.7		80.96
		3077.87	9/24/99 8:40 PM	15.03	33.98	71.71	0.90	0.98	0.88	1.02	93.99	6.01	498	72	1.226	3.51	13.46	3.55	13.6	7.6		82.02
		3078.87	9/24/99 9:40 PM	15.08	34.23	71.42	0.91	0.98	0.94	1.04	93.96	6.04	502	73	1.216	3.51	13.45	3.55	13.8	7.5		80.95
		3079.87	9/24/99 10:40 PM	15.04	34.02	71.05	0.89	0.98	0.95	1.05	94.11	5.89	513	75	1.205	3.46	13.28	3.51	13.8	7.7		80.95
		3080.87	9/24/99 11:40 PM	14.98	33.94	70.73	0.87	0.98	0.83	0.99	94.22	5.78	523	76	1.195	3.48	13.35	3.53	13.5	7.8		82.28
		3081.87	9/25/99 12:40 AM																			
		3082.87	9/25/99 1:40 AM																			
		3084.87	9/25/99 3:40 AM																			
		3085.87	9/25/99 4:40 AM																			
		3086.87	9/25/99 5:40 AM																			
		3087.87	9/25/99 6:40 AM	14.56	33.28	70.06	0.93	0.98	0.95	1.03	93.64	6.36	512	74	1.175	3.56	13.66	3.61	13.9	7.8		80.95
		3088.87	9/25/99 7:40 AM	14.59	33.13	69.69	0.89	0.98	0.95	1.04	93.91	6.09	522	76	1.175	3.49	13.38	3.54	13.9	7.9		80.95
		3089.00	9/25/99 7:48 AM																			
		3090.00	9/25/99 8:48 AM	14.52	33.06	69.76	0.85	0.98	0.95	1.03	94.15	5.85	524	76	1.178	3.47	13.30	3.51	13.8	7.7		80.95
		3091.00	9/25/99 9:48 AM	14.48	32.92	69.63	0.87	0.98	0.95	1.03	94.00	6.00	519	75	1.188	3.47	13.33	3.52	13.8	7.7		80.94
		3092.00	9/25/99 10:48 AM	14.44	32.89	69.45	0.88	0.98	0.95	1.03	93.88	6.12	516	75	1.195	3.47	13.32	3.52	13.8	7.7		80.94
		3093.00	9/25/99 11:48 AM	14.49	33.05	69.68	0.90	0.98	0.95	1.03	93.82	6.18	508	74	1.202	3.51	13.45	3.55	14.0	7.5		80.94
		3094.00	9/25/99 12:48 PM	14.68	33.35	70.56	0.94	0.98	0.88	1.03	93.59	6.41	504	73	1.209	3.57	13.70	3.62	13.8	7.4		82.28
		3095.00	9/25/99 1:48 PM	14.82	33.77	71.08	0.97	0.98	0.95	1.03	93.48	6.52	499	73	1.219	3.52	13.50	3.57	13.7	7.4		80.95
		3096.00	9/25/99 2:48 PM	14.86	34.40	71.59	0.98	0.98	0.88	1.03	93.41	6.59	493	72	1.229	3.59	13.79	3.64	13.7	7.4		82.26
		3098.00	9/25/99 4:48 PM	14.92	33.56	72.01	0.91	0.98	0.94	1.02	93.92	6.08	494	72	1.244	3.49	13.38	3.54	13.3	7.4		80.96
		3100.00	9/25/99 6:48 PM	14.87	34.81	73.96	1.23	0.97	0.94	1.05	91.76	8.24	459	67	1.244	3.76	14.41	3.81	12.2	7.2		82.05
		3101.00	9/25/99 7:48 PM	14.84	33.90	70.77	0.78	0.98	0.88	1.04	94.74	5.26	502	73	1.237	3.51	13.47	3.56	13.7	7.4		82.29
		3102.00	9/25/99 8:48 PM	14.77	33.11	75.44	1.24	0.97	1.01	1.04	91.63	8.37	475	69	1.226	3.68	14.10	3.73	12.4	7.5		80.94
		3103.00	9/25/99 9:48 PM	14.67	33.88	69.72	0.80	0.98	0.88	1.04	94.57	5.43	502	73	1.219	3.56	13.66	3.61	14.1	7.2		82.28
		3104.00	9/25/99 10:48 PM	14.64	32.68	71.22	1.06	0.98	0.95	1.02	92.76	7.24	486	71	1.209	3.64	13.98	3.69	13.1	7.5		80.95
		3105.00	9/25/99 11:48 PM	14.60	32.97	69.32	0.75	0.98	0.88	1.04	94.87	5.13	523	76	1.202	3.46	13.27	3.51	13.8	7.5		82.26
		3107.00	9/26/99 1:48 AM																			
		3108.00	9/26/99 2:48 AM																			
		3109.00	9/26/99 3:48 AM																			
		3110.00	9/26/99 4:48 AM																			
		3111.00	9/26/99 5:48 AM																			
		3112.00	9/26/99 6:48 AM																			
		3115.10	9/26/99 9:54 AM	14.56	37.22	60.88	1.34	0.96	1.20	1.35	90.83	9.17	509	74	1.192	3.41	13.10	3.46	11.5	8.4		78.93
		3116.10	9/26/99 10:54 AM	14.57	32.46	59.98	0.85	0.98	1.30	1.29	94.13	5.87	538	78	1.195	3.11	11.93	3.15	13.6	7.7		75.62
		3117.10	9/26/99 11:54 AM	14.65	33.05	65.62	0.74	0.98	1.35	1.11	94.97	5.03	521	76	1.202	3.08	11.82	3.12	13.8	7.4		72.95
		3118.10	9/26/99 12:54 PM	14.76	32.93	68.73	0.88	0.98	1.35	1.07	94.03	5.97	509	74	1.212	3.13	11.99	3.17	13.5	7.5		72.97
		3121.10	9/26/99 3:54 PM	14.99	34.57	75.43	1.41	0.97	1.23	1.05	90.59	9.41	456	66	1.237	3.61	13.86	3.66	12.9	7.4		76.98
		3122.10	9/26/99 4:54 PM	15.02	36.80	71.31	1.24	0.97	1.14	1.12	91.73	8.27	446	65	1.240	3.77	14.45	3.82	13.8	7.0		78.65
		3123.10	9/26/99 5:54 PM	15.01	34.06	70.05	0.85	0.98	1.01	1.06	94.35	5.65	496	72	1.240	3.43	13.14	3.47	13.5	7.4		79.60
		3125.10	9/26/99 7:54 PM	14.89	36.13	70.50	1.19	0.97	0.94	1.12	92.03	7.97	455	66	1.229	3.89	14.92	3.94	14.0	6.9		82.27
		3126.10	9/26/99 8:54 PM	14.78	33.35	68.52	0.85	0.98	0.95	1.07	94.24	5.76	509	74	1.223	3.44	13.21	3.49	13.5	7.4		80.94
		3127.10	9/26/99 9:54 PM	14.76	34.20	74.50	1.36	0.97	1.08	1.05	90.76	9.24	468	68	1.212	3.71	14.23	3.76	13.1	7.4		79.61
		3128.10	9/26/99 10:54 PM	14.68	33.27	68.87	0.80	0.98	0.95	1.05	94.55	5.45	508	74	1.205	3.50	13.41	3.54	14.2	7.4		80.94
		3130.10	9/27/99 12:54 AM	14.49	32.55	67.64	0.75	0.98	1.01	1.06	94.81	5.19	527	77	1.195	3.34	12.83	3.39	13.6	7.6		79.61
		3131.10	9/27/99 1:54 AM	14.47	33.84	68.79	0.94	0.98	0.95	1.04	93.47	6.53	490	71	1.192	3.67	14.07	3.72	14.0	7.4		80.94
		3132.10	9/27/99 2:54 AM	14.49	33.68	70.69	1.10	0.97	1.01	1.08	92.39	7.61	479	70	1.188	3.76	14.42	3.81	13.7	7.4		80.94
		3133.10	9/27/99 3:54 AM	14.44	32.39	68.63	0.84	0.98	0.95	1.04	94.15	5.85	517	75	1.185	3.49	13.40	3.54	13.8	7.5		80.94
		3135.10	9/27/99 5:54 AM	14.33	32.89	69.26	0.96	0.98	0.95	1.02	93.31	6.69	500	73	1.185	3.61	13.85	3.66	14.1	7.5		80.95
		3136.10	9/27/99 6:54 AM	14.35	32.67	68.48	0.90	0.98	0.95	1.04	93.76	6.24	515	75	1.185	3.51	13.45	3.55	13.8	7.5		80.94
		3136.90	9/27/99 7:42 AM	14.52	33.05	69.55	0.93	0.98	0.95	1.03	93.62	6.38	512	75	1.181	3.54	13.57	3.59	13.8	7.5		80.95
		3137.10	9/27/99 7:54 AM	14.53	33.14	69.55	0.91	0.98	0.95	1.03	93.73	6.27	516	75	1.182	3.51	13.47	3.56	13.8	7.6		80.95
		3137.90	9/27/99 8:42 AM	14.54	33.10	69.33	0.94	0.98	0.95	1.04	93.55	6.45	513	75	1.181	3.54	13.57	3.58	13.8	7.7		80.94
		3138.90	9/27/99 9:42 AM	14.53	32.85	69.24	0.91	0.98	0.95	1.04	93.75	6.25	512	74	1.192	3.51	13.47	3.56	13.7	7.6		80.94
		3139.90	9/27/99 10:42 AM	14.54	33.11	66.71	0.92	0.98	0.95	1.06	93.70	6.30	534	78	1.192	3.31	12.70	3.35	13.8	7.7		80.68
		3140.90	9/27/99 11:42 AM	14.72	33.42	71.40	1.12	0.97	1.01	1.09	92.42	7.58	474	69	1.205	3.75	14.38	3.80	14.1	7.2		80.95
		3141.90	9/27/99 12:42 PM	14.85	33.31	71.35	0.99	0.98	0.95	1.03	93.33	6.67	503	73	1.212	3.51	13.47	3.56	13.2	7.6		80.94
		3142.48	9/27/99 1:17 PM	14.73	32.97	69.89	0.92	0.98	1.08	1.12	93.76	6.24	509	74	1.216	3.40	13.06	3.45	13.4	7.7		79.62
		3143.21	9/27/99 2:00 PM	14.89	34.57	71.65	1.10	0.97	1.01	1.03	92.61	7.39	476	69	1.223	3.62	13.89	3.67	13.5	7.4		79.62
		3145.21	9/27/99 4:00 PM	15.25	35.20	72.95	1.04	0.98	1.01	1.11	93.15	6.85	475	69	1.240	3.63	13.94	3.68	13.4	7.5		80.95
		3146.21	9/27/99 5:00 PM	15.31	35.02	74.10	1.04	0.98	1.01	1.09	93.22	6.78	476	69	1.247	3.61	13.86	3.66	13.5	7.4		80.97
		3147.21	9/27/99 6:00 PM	15.24	34.86	74.57	1.07	0.98	1.08	1.08	93.01	6.99	466	68	1.254	3.60	13.82	3.65	13.4	7.4		79.61
		3148.21	9/27/99 7:00 PM	15.34	35.24	73.95	1.09	0.98	1.01	1.10	92.91	7.09	468	68	1.251	3.66	14.06	3.71	13.2	7.4		80.93
		3149.21	9/27/99 8:00 PM	15.45	35.54	73.64	1.05	0.98	1.01	1.11	93.22	6.78	476	69	1.247	3.61	13.85	3.66	13.2	7.4		80.95
		3152.21	9/27/99 11:00 PM	15.40	35.33	73.00	0.94	0.98	0.95	1.04	93.89	6.11	502	73	1.219	3.50	13.43	3.55	13.7	7.4		80.95
		3153.21	9/28/99 12:00 AM	15.35	34.94	72.36	0.90	0.98	0.95	1.05	94.16	5.84	510	74	1.216	3.45	13.24	3.50	13.7	7.4		80.94
		3154.21	9/28/99 1:00 AM	15.25	34.78	71.84	0.87	0.98	0.95	1.05	94.32	5.68	514	75	1.212	3.44	13.19	3.48	13.7	7.4		80.94
		3155.21	9/28/99 2:00 AM	15.15	34.61	71.15	0.85	0.98	0.95	1.05	94.39	5.61	518	75	1.209	3.42	13.12	3.47	13.8	7.4		80.94
		3157.21	9/28/99 4:00 AM	14.89	33.89	69.89	0.82	0.98	0.95	1.05	94.47	5.53	521	76	1.205	3.41	13.09	3.46	13.8	7.5		80.94
		3158.21	9/28/99 5:00 AM	14.78	33.43	69.62	0.80	0.98	0.95	1.05	94.55	5.45	523	76	1.202	3.41	13.07	3.45	13.7	7.6		80.94
		3159.21	9/28/99 6:00 AM	14.73	33.31	69.13	0.81	0.98	0.95	1.05	94.52	5.48	522	76	1.202	3.41	13.09	3.46	13.8	7.6		80.95
		3160.21	9/28/99 7:00 AM	14.75	33.48	68.98	0.81	0.98	0.95	1.06	94.53	5.47	525	76	1.198	3.40	13.05	3.45	13.8	7.6		80.94
		3160.79	9/28/99 7:35 AM	14.84	31.60	61.38	0.80	0.98	0.96	1.00	94.60	5.40	501	73	1.195	3.40	13.05	3.45	14.8	9.3		76.94
		3162.21	9/28/99 9:00 AM	14.78	31.64	58.64	0.78	0.98	0.90	1.04	94.74	5.26	510	74	1.192	3.40	13.06	3.45	14.4	9.0		78.28
		3163.21	9/28/99 10:00 AM	14.68	31.47	58.85	0.77	0.98	0.90	1.03	94.75	5.25	511	74	1.195	3.39	13.00	3.44	14.2	8.8		78.27
		3184.91	9/29/99 7:43 AM	15.16	35.58	54.03	0.53	0.98	0.95	1.23	96.49	3.51	589	86	1.219	2.88	11.05	2.92	13.3	7.0		78.27
		3185.91	9/29/99 8:43 AM	15.03	34.45	60.63	0.73	0.98	0.89	1.08	95.14	4.86	527	77	1.216	3.29	12.61	3.33	13.5	7.7		79.61
		3186.91	9/29/99 9:43 AM	14.86	33.81	60.11	0.71	0.98	0.89	1.08	95.23	4.77	536	78	1.202	3.27	12.54	3.31	13.6	7.8		79.61

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		3187.91	9/29/99 10:43 AM	14.83	33.56	59.89	0.68	0.98	0.86	1.01	95.39	4.61	548	80	1.178	3.21	12.30	3.25	13.8	7.8		79.12
		3188.91	9/29/99 11:43 AM	14.97	33.72	59.92	0.68	0.98	0.90	1.03	95.44	4.56	568	83	1.151	3.17	12.15	3.21	14.1	8.0		78.28
		3189.92	9/29/99 12:43 PM	15.16	34.03	60.45	0.70	0.98	0.90	1.04	95.39	4.61	572	83	1.138	3.18	12.19	3.22	13.9	8.1		78.28
		3190.91	9/29/99 1:43 PM	15.34	34.19	60.11	0.69	0.98	1.23	1.05	95.52	4.48	580	84	1.125	2.85	10.93	2.89	13.5	8.1		70.30
		3191.91	9/29/99 2:43 PM	15.55	35.28	63.34	0.69	0.98	0.90	1.01	95.53	4.47	592	86	1.122	3.12	11.95	3.16	13.8	8.0		78.28
		3192.91	9/29/99 3:43 PM	15.58	35.66	63.65	0.70	0.98	0.85	1.01	95.50	4.50	590	86	1.115	3.20	12.27	3.24	14.0	8.0		79.57
		3193.91	9/29/99 4:43 PM	15.51	35.32	62.75	0.68	0.98	0.95	1.03	95.60	4.40	595	86	1.112	3.13	12.01	3.17	14.0	7.8		77.38
		3197.91	9/29/99 8:43 PM	15.60	35.62	62.78	0.66	0.98	0.90	1.03	95.79	4.21	603	88	1.109	3.09	11.87	3.14	14.0	7.9		78.26
		3199.91	9/29/99 10:43 PM	15.69	35.87	62.52	0.63	0.98	0.90	1.04	95.99	4.01	609	89	1.112	3.06	11.73	3.10	14.0	7.7		78.26
		3200.91	9/29/99 11:43 PM	15.71	35.99	62.36	0.62	0.98	0.90	1.04	96.06	3.94	612	89	1.112	3.04	11.66	3.08	14.0	7.7		78.26
		3201.91	9/30/99 12:43 AM	15.63	35.99	61.90	0.61	0.98	0.90	1.04	96.11	3.89	613	89	1.115	3.03	11.61	3.07	13.8	7.7		78.26
		3205.91	9/30/99 4:43 AM	15.69	37.13	55.46	0.51	0.99	1.01	1.24	96.77	3.23	664	97	1.128	2.72	10.42	2.75	13.2	7.0		76.94
		3206.91	9/30/99 5:43 AM	15.69	37.47	54.89	0.51	0.99	0.90	1.18	96.77	3.23	670	98	1.128	2.74	10.50	2.77	13.2	6.8		78.28
		3210.92	9/30/99 9:43 AM	15.80	39.21	63.74	0.65	0.98	0.89	1.09	95.86	4.14	634	92	1.125	2.95	11.33	2.99	13.2	6.7		79.61
		3211.92	9/30/99 10:43 AM	15.67	38.71	62.95	0.65	0.98	1.02	1.16	95.82	4.18	632	92	1.125	2.91	11.17	2.95	13.2	6.7		78.28
		3212.92	9/30/99 11:43 AM	15.83	39.17	63.91	0.67	0.98	0.89	1.08	95.79	4.21	630	92	1.125	2.97	11.40	3.01	13.2	6.6		79.61
		3215.92	9/30/99 2:43 PM	16.07	39.76	65.14	0.70	0.98	0.89	1.08	95.68	4.32	616	90	1.155	2.96	11.36	3.00	13.2	6.4		79.61
		3217.92	9/30/99 4:43 PM	16.22	40.57	65.97	0.70	0.98	0.89	1.08	95.68	4.32	606	88	1.175	2.96	11.35	3.00	13.1	6.4		79.61
		3219.92	9/30/99 6:43 PM	16.14	40.44	65.44	0.69	0.98	0.89	1.08	95.75	4.25	596	87	1.188	2.98	11.42	3.02	12.8	6.3		79.62
		3220.92	9/30/99 7:43 PM	16.06	40.28	65.01	0.67	0.98	0.89	1.08	95.85	4.15	604	88	1.185	2.94	11.29	2.98	12.8	6.4		79.61
		3221.92	9/30/99 8:43 PM	16.00	40.10	64.44	0.65	0.98	0.89	1.09	95.95	4.05	612	89	1.178	2.92	11.20	2.96	12.8	6.4		79.61
		3222.92	9/30/99 9:43 PM	15.97	39.98	63.82	0.64	0.98	0.89	1.10	96.01	3.99	622	90	1.168	2.90	11.12	2.94	13.0	6.3		79.61
		3223.92	9/30/99 10:43 PM	15.97	39.80	63.30	0.62	0.98	0.84	1.04	96.10	3.90	630	92	1.161	2.88	11.05	2.92	12.8	6.4		79.61
		3224.92	9/30/99 11:43 PM	15.93	39.68	62.85	0.61	0.98	0.90	1.11	96.15	3.85	636	93	1.158	2.86	10.96	2.90	12.9	6.4		79.57
		3225.92	10/1/99 12:43 AM	15.88	39.63	62.33	0.60	0.98	0.95	1.12	96.20	3.80	641	93	1.155	2.80	10.73	2.83	12.9	6.4		78.30
		3226.92	10/1/99 1:43 AM	15.83	39.46	62.06	0.61	0.98	0.96	1.12	96.18	3.82	641	93	1.151	2.81	10.77	2.85	12.9	6.3		78.29
		3227.92	10/1/99 2:43 AM	15.77	39.33	61.76	0.60	0.98	0.96	1.12	96.20	3.80	647	94	1.151	2.78	10.66	2.82	12.9	6.4		78.30
		3229.92	10/1/99 4:43 AM	15.53	38.92	61.02	0.59	0.98	0.90	1.12	96.23	3.77	654	95	1.148	2.81	10.76	2.84	12.9	6.4		79.63
		3230.92	10/1/99 5:43 AM	15.43	38.65	60.50	0.58	0.98	0.95	1.12	96.27	3.73	658	96	1.145	2.75	10.55	2.79	13.1	6.4		78.29
		3231.92	10/1/99 6:43 AM	15.46	38.74	60.79	0.58	0.98	0.89	1.05	96.26	3.74	659	96	1.141	2.75	10.57	2.79	12.9	6.4		78.61
		3232.90	10/1/99 7:42 AM	15.61	39.20	61.63	0.58	0.99	0.85	1.05	96.32	3.68	668	97	1.135	2.78	10.65	2.82	12.9	6.4		79.63
		3233.90	10/1/99 8:42 AM	15.61	39.08	61.46	0.56	0.99	0.90	1.06	96.38	3.62	677	98	1.125	2.72	10.43	2.76	13.1	6.6		78.28
14	RO Unit down due to decreasing Zenon MLSS	3308.51	10/4/99 11:19 AM																			
		3358.23	10/6/99 1:02 PM																			
		3359.23	10/6/99 2:02 PM	15.41	32.25	64.04	1.12	0.97	1.02	1.02	92.75	7.25	494	72	1.161	3.36	12.90	3.41	14.0	8.7		76.04
		3361.23	10/6/99 4:02 PM	15.47	33.15	72.68	1.32	0.97	1.14	0.96	91.46	8.54	479	70	1.192	3.38	12.98	3.43	12.9	8.0		75.00
		3363.23	10/6/99 6:02 PM	15.31	33.52	67.14	1.00	0.98	1.28	1.10	93.49	6.51	492	72	1.198	3.21	12.32	3.26	13.6	7.8		73.55
		3364.23	10/6/99 7:02 PM	15.52	34.36	68.28	0.89	0.98	1.13	1.03	94.29	5.71	454	66	1.198	3.55	13.61	3.59	13.8	7.8		74.99
		3365.23	10/6/99 8:02 PM	15.69	36.43	69.03	1.31	0.97	1.21	1.09	91.64	8.36	464	68	1.188	3.50	13.42	3.55	13.8	7.3		74.99
		3367.23	10/6/99 10:02 PM	15.48	34.40	69.64	1.26	0.97	1.08	1.07	91.86	8.14	492	72	1.168	3.48	13.36	3.53	13.7	7.5		77.73
		3368.23	10/6/99 11:02 PM	15.31	33.48	68.01	1.01	0.98	1.01	1.02	93.41	6.59	500	73	1.161	3.45	13.22	3.49	13.7	7.7		77.71
		3369.23	10/7/99 12:02 AM	15.15	33.26	66.96	0.95	0.98	1.01	1.02	93.70	6.30	522	76	1.155	3.32	12.73	3.36	13.8	7.7		77.71
		3371.23	10/7/99 2:02 AM	14.82	32.18	64.95	0.77	0.98	0.95	1.03	94.78	5.22	522	76	1.151	3.39	13.00	3.43	13.8	8.0		79.09
		3372.23	10/7/99 3:02 AM	14.65	31.93	64.40	0.78	0.98	0.95	1.03	94.65	5.35	526	77	1.148	3.37	12.93	3.42	13.8	8.0		79.09
		3375.23	10/7/99 6:02 AM	14.17	30.81	62.34	0.73	0.98	0.95	1.03	94.87	5.13	534	78	1.138	3.35	12.85	3.39	14.0	8.0		79.08
		3376.23	10/7/99 7:02 AM	14.04	30.51	61.73	0.71	0.98	0.95	1.03	94.94	5.06	538	78	1.135	3.33	12.78	3.38	14.1	8.0		79.08
		3377.23	10/7/99 8:02 AM	14.12	31.44	65.33	0.84	0.98	0.82	0.98	94.04	5.96	524	76	1.132	3.55	13.64	3.60	13.8	7.6		81.83
		3378.20	10/7/99 9:00 AM	14.12	31.68	65.33	0.82	0.98	2.42	2.21	94.21	5.79	517	75	1.132	3.36	12.90	3.41	13.6	7.7		76.35
		3379.20	10/7/99 10:00 AM	14.12	31.64	65.62	0.83	0.98	1.14	1.04	94.11	5.89	513	75	1.145	3.35	12.84	3.39	13.4	7.5		76.35
		3380.20	10/7/99 11:00 AM	14.12	31.98	66.99	0.86	0.98	1.22	1.09	93.92	6.08	512	74	1.155	3.33	12.76	3.37	13.4	7.4		76.35
		3381.20	10/7/99 12:00 PM	14.20	32.14	67.48	0.85	0.98	1.19	1.01	94.03	5.97	487	71	1.171	3.41	13.07	3.45	13.2	7.1		75.45
		3384.78	10/7/99 3:35 PM	14.56	32.75	67.96	0.90	0.98	1.26	1.10	93.79	6.21	466	68	1.212	3.45	13.22	3.49	11.3	7.1		75.58
		3386.11	10/7/99 4:55 PM	14.73	32.85	52.26	0.92	0.97	1.08	1.39	93.75	6.25	505	74	1.223	3.35	12.87	3.40	14.0	8.1		78.31
		3387.09	10/7/99 5:54 PM	14.73	33.26	56.93	0.95	0.97	1.08	1.28	93.57	6.43	502	73	1.226	3.37	12.92	3.41	13.7	7.8		78.32
		3388.11	10/7/99 6:55 PM	14.78	33.23	63.96	0.90	0.98	1.01	1.07	93.94	6.06	484	70	1.223	3.50	13.44	3.55	13.8	7.7		78.30
		3389.09	10/7/99 7:54 PM	14.78	33.23	65.92	0.92	0.98	1.08	1.04	93.74	6.26	496	72	1.212	3.39	13.00	3.44	13.8	7.6		76.97
		3390.11	10/7/99 8:55 PM	14.77	33.02	66.11	0.86	0.98	1.26	1.04	94.18	5.82	496	72	1.202	3.24	12.41	3.28	13.1	8.0		72.98
		3391.09	10/7/99 9:54 PM	14.70	32.81	65.76	0.85	0.98	1.20	1.04	94.20	5.80	498	72	1.188	3.32	12.74	3.37	13.9	7.8		74.30
		3391.11	10/7/99 9:55 PM	14.70	32.77	65.81	0.85	0.98	1.26	1.04	94.22	5.78	505	73	1.188	3.22	12.35	3.26	14.1	7.8		72.97
		3393.09	10/7/99 11:54 PM	14.43	32.05	64.48	0.83	0.98	1.26	1.04	94.27	5.73	509	74	1.168	3.25	12.46	3.29	14.1	8.0		72.99
		3394.09	10/8/99 12:54 AM	14.34	31.97	64.13	0.85	0.98	1.20	1.04	94.08	5.92	529	77	1.161	3.20	12.28	3.24	14.1	8.0		74.31
		3395.11	10/8/99 1:55 AM	14.27	31.55	63.17	0.71	0.98	1.26	1.05	95.04	4.96	544	79	1.158	3.06	11.75	3.10	14.1	8.1		72.97
		3396.11	10/8/99 2:55 AM	14.16	32.22	61.37	0.68	0.98	1.14	1.08	95.18	4.82	577	84	1.155	3.00	11.52	3.04	13.8	7.7		75.64
		3397.11	10/8/99 3:55 AM	14.05	33.35	58.54	0.65	0.98	1.07	1.05	95.35	4.65	609	89	1.151	2.85	10.94	2.89	13.5	7.0		75.64
		3398.11	10/8/99 4:55 AM	13.93	34.57	56.07	0.63	0.98	1.07	1.09	95.51	4.49	636	93	1.151	2.73	10.47	2.77	13.2	6.4		75.64
15	End of RoutineTesting	3399.11	10/8/99 5:55 AM	13.81	35.74	53.91	0.60	0.98	1.07	1.12	95.65	4.35	664	97	1.151	2.62	10.04	2.65	12.9	6.1		75.64
		3400.11	10/8/99 6:55 AM	13.70	36.80	52.14	0.58	0.98	1.07	1.15	95.77	4.23	669	97	1.148	2.60	9.99	2.64	12.7	5.9		75.64
		3401.11	10/8/99 7:55 AM	13.59	37.98	52.82	0.68	0.98	0.96	1.07	94.98	5.02	641	93	1.141	2.78	10.66	2.82	12.6	5.7		76.96
		3401.52	10/8/99 8:19 AM	13.59	35.20	57.50	0.75	0.98	1.13	1.05	94.47	5.53	518	75	1.138	3.39	13.02	3.44	13.7	6.1		74.65
		3439.22	10/9/99 10:01 PM	13.99	32.57	69.06	1.02	0.98	1.16	1.12	92.73	7.27	495	72	1.205	3.41	13.09	3.46	13.7	5.8		79.07
		3440.22	10/9/99 11:01 PM	13.94	32.39	68.67	0.99	0.98	1.08	1.05	92.92	7.08	501	73	1.195	3.40	13.06	3.45	13.7	5.9		79.07
		3441.22	10/10/99 12:01 AM	13.89	32.18	68.35	0.96	0.98	1.08	1.05	93.08	6.92	518	75	1.188	3.31	12.69	3.35	13.7	6.4		79.07
		3443.22	10/10/99 2:01 AM	13.70	31.42	67.07	0.86	0.98	1.37	1.05	93.72	6.28	524	76	1.171	3.09	11.85	3.13	13.9	6.4		73.61
		3444.22	10/10/99 3:01 AM	13.63	31.25	66.86	0.84	0.98	1.21	0.98	93.82	6.18	527	77	1.168	3.14	12.03	3.18	14.0	6.4		75.03
		3445.22	10/10/99 4:01 AM	13.52	31.00	66.35	0.82	0.98	1.14	0.98	93.91	6.09	529	77	1.161	3.20	12.28	3.24	14.0	6.4		76.33
		3446.22	10/10/99 5:01 AM	13.44	30.91	65.97	0.81	0.98	1.21	0.98	93.94	6.06	533	78	1.158	3.13	12.00	3.17	14.1	6.5		74.97
		3447.22	10/10/99 6:01 AM	13.35	30.66	65.45	0.80	0.98	1.08	0.98	93.97	6.03	530	77	1.151	3.28	12.59	3.33	14.0	6.4		77.71
		3448.22	10/10/99 7:01 AM	13.14	30.13	64.22	0.79	0.98	1.21	0.99	93.95	6.05	539	78	1.148	3.12	11.97	3.16	14.0	6.4		74.97
		3449.22	10/10/99 8:01 AM	13.02	29.97	63.69	0.78	0.98	1.01	0.99	94.01	5.99	532	77	1.145	3.34	12.83	3.39	13.9	6.6		79.07
		3451.06	10/10/99 9:51 AM	12.87	29.38	62.76	0.76	0.98	1.08	1.06	94.10	5.90	537	78	1.151	3.29	12.62	3.33	13.5	6.5		79.07
		3451.22	10/10/99 10:01 AM																13.8	6.7		77.71
		3452.22	10/10/99 11:01 AM																			
		3457.68	10/10/99 4:29 PM	13.29	31.67	70.26	1.05	0.97	1.10	1.14	92.12	7.88	464	67	1.219	3.73	14.30	3.78	12.9	5.8		81.82
		3458.16	10/10/99 4:58 PM	13.25	31.67	70.45	1.02	0.98	1.18	1.13	92.29	7.71	467	68	1.223	3.63	13.93	3.68	12.9	5.8		80.44
		3458.18	10/10/99 4:59 PM	13.25	31.51	70.76	1.02	0.98	1.18	1.13	92.32	7.68	466	68	1.223	3.64	13.96	3.69	12.8	5.8		80.44
		3459.16	10/10/99 5:58 PM	13.29	31.51	70.62	1.02	0.98	1.35	1.13	92.32	7.68	467	68	1.226	3.50	13.42	3.55	12.8	5.8		77.73
		3459.18	10/10/99 5:59 PM	13.29	31.55	70.80	1.01	0.98	1.27	1.13	92.40	7.60	467	68	1.226	3.56	13.64	3.60	12.8	5.9		79.07
		3460.18	10/10/99 6:59 PM	13.36	31.75	70.73	1.02	0.98	1.43	1.14	92.40	7.60	469	68	1.222	3.43	13.15	3.47	13.1	5.8		76.35
		3461.16	10/10/99 7:58 PM	13.40	31.67	70.25	1.02	0.98	1.60	1.15	92.42	7.58	479	70	1.219	3.24	12.44	3.29	13.1	5.8		73.60
		3462.16	10/10/99 8:58 PM	13.39	31.55	70.40	1.00	0.98	1.60	1.15	92.54	7.46	447	65	1.209	3.51	13.46	3.56	13.4	5.7		73.60
		3463.17	10/10/99 9:58 PM	13.27	33.68	74.55	1.56	0.96	1.29	1.17	88.22	11.78	479	70	1.202	3.60	13.80	3.65	13.2	5.6		80.43
		3463.40	10/10/99 10:12 PM	13.24	31.17	69.84	0.98	0.98	1.29	1.25	92.63	7.37	489	71	1.202	3.52	13.52	3.57	13.2	6.0		80.43
		3464.40	10/10/99 11:12 PM	13.19	31.04	69.39	0.98	0.98	1.29	1.25	92.61	7.39	488	71	1.195	3.55	13.62	3.60	13.2	6.0		80.40
		3465.40	10/11/99 12:12 AM	13.15	31.21	70.26	1.02	0.98	1.38	1.23	92.28	7.72	496	72	1.192	3.45	13.22	3.49	13.2	6.1		79.08
		3466.40	10/11/99 1:12 AM	13.09	30.79	69.36	0.95	0.98	1.64	1.23	92.75	7.25	494	72	1.188	3.29	12.61	3.33	13.4	5.9		74.98
		3467.40	10/11/99 2:12 AM	13.04	30.46	68.76	0.99	0.98	1.73	1.24	92.44	7.56	503	73	1.185	3.18	12.20	3.22	13.2	6.1		73.62
		3470.40	10/11/99 5:12 AM	13.29	31.46	69.96	0.99	0.98	1.51	1.14	92.53	7.47	512	74	1.181	3.19	12.25	3.24	13.2	6.1		74.98

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		3471.40	10/11/99 6:12 AM	13.47	31.80	70.40	0.94	0.98	1.51	1.15	93.01	6.99	507	74	1.178	3.23	12.40	3.28	13.3	6.1		74.98
		3472.40	10/11/99 7:12 AM	13.59	32.05	70.97	0.98	0.98	1.42	1.15	92.82	7.18	533	78	1.182	3.12	11.98	3.16	13.2	6.1		76.34
		3475.40	10/11/99 10:12 AM	13.61	33.22	78.94	1.03	0.98	2.00	1.37	92.42	7.58	512	74	1.178	3.20	12.29	3.25	12.9	5.6		74.98
		3476.40	10/11/99 11:12 AM	13.65	33.56	78.67	1.04	0.98	1.89	1.38	92.35	7.65	491	71	1.181	3.39	13.00	3.43	13.1	5.4		76.34
		3477.59	10/11/99 12:23 PM	13.61	32.72	75.05	1.04	0.98	1.81	1.30	92.33	7.67	503	73	1.195	3.21	12.33	3.26	13.2	5.5		74.96
		3478.27	10/11/99 1:04 PM	13.64	32.80	75.31	1.03	0.98	1.67	1.30	92.47	7.53	417	61	1.198	3.96	15.19	4.01	13.1	5.7		76.80
		3485.83	10/11/99 8:38 PM	14.39	31.14	60.15	1.08	0.97	1.08	1.11	92.48	7.52	520	76	1.209	3.24	12.42	3.28	13.5	7.4		76.94
		3486.80	10/11/99 9:36 PM	14.52	33.23	75.05	1.06	0.98	1.31	1.39	92.68	7.32	490	71	1.202	3.57	13.71	3.62	13.4	6.2		81.77
		3487.83	10/11/99 10:38 PM	14.56	33.77	72.76	1.02	0.98	1.11	1.19	92.98	7.02	497	72	1.198	3.48	13.34	3.52	13.2	6.2		81.42
		3488.83	10/11/99 11:38 PM	14.47	33.68	72.24	1.02	0.98	1.17	1.20	92.94	7.06	500	73	1.195	3.47	13.31	3.52	13.2	6.2		80.54
		3489.83	10/12/99 12:38 AM	14.31	33.26	71.54	0.99	0.98	1.16	1.11	93.06	6.94	502	73	1.195	3.39	13.01	3.44	13.2	6.2		79.07
		3490.83	10/12/99 1:38 AM	14.11	32.74	70.49	0.96	0.98	1.17	1.11	93.17	6.83	506	74	1.195	3.36	12.91	3.41	13.2	6.4		79.05
		3491.83	10/12/99 2:38 AM	13.99	32.46	69.62	0.94	0.98	1.39	1.11	93.26	6.74	508	74	1.192	3.19	12.23	3.23	13.3	6.4		74.97
		3492.83	10/12/99 3:38 AM	13.90	32.13	69.35	0.93	0.98	1.39	1.11	93.32	6.68	513	75	1.192	3.16	12.13	3.20	13.2	6.3		74.97
		3493.81	10/12/99 4:36 AM	13.81	31.97	68.91	0.91	0.98	1.47	1.11	93.39	6.61	514	75	1.188	3.10	11.90	3.15	13.2	6.4		73.59
		3494.83	10/12/99 5:38 AM	13.76	31.72	68.48	0.90	0.98	1.29	1.03	93.43	6.57	514	75	1.185	3.17	12.16	3.21	13.2	6.4		74.97
		3495.83	10/12/99 6:38 AM	13.63	31.47	67.82	0.89	0.98	1.30	1.04	93.50	6.50	515	75	1.185	3.16	12.14	3.21	13.2	6.4		74.97
		3496.83	10/12/99 7:38 AM	13.50	31.09	67.30	0.88	0.98	1.22	1.03	93.47	6.53	521	76	1.181	3.19	12.24	3.23	13.3	6.4		76.35
		3497.83	10/12/99 8:38 AM	13.39	30.84	66.90	0.87	0.98	1.15	1.03	93.49	6.51	519	76	1.175	3.28	12.58	3.32	13.3	6.5		77.69
		3498.81	10/12/99 9:36 AM	13.33	30.71	66.49	0.87	0.98	1.08	1.03	93.50	6.50	503	73	1.181	3.43	13.15	3.47	13.4	6.4		79.05
		3502.78	10/12/99 1:34 PM	13.83	32.01	68.83	0.95	0.98	1.16	1.10	93.09	6.91	492	72	1.205	3.43	13.17	3.48	13.4	6.2		79.07
		3504.80	10/12/99 3:36 PM																13.6	6.2		72.77
		3508.80	10/12/99 7:36 PM																			
		3509.80	10/12/99 8:36 PM																			
		3510.80	10/12/99 9:36 PM																			
		3511.80	10/12/99 10:36 PM																			
		3512.80	10/12/99 11:36 PM																			
		3513.80	10/13/99 12:36 AM																			
		3514.80	10/13/99 1:36 AM																			
		3515.80	10/13/99 2:36 AM																			
		3516.80	10/13/99 3:36 AM																			
		3518.80	10/13/99 5:36 AM																			
		3519.78	10/13/99 6:34 AM																			
		3520.80	10/13/99 7:36 AM																			
		3521.80	10/13/99 8:36 AM																			
		3522.80	10/13/99 9:36 AM																			
		3525.43	10/13/99 12:14 PM																			
		3551.49	10/14/99 2:17 PM																			
		3553.79	10/14/99 4:35 PM	13.56	33.87	77.57	0.98	0.98	2.00	1.39	92.81	7.19	443	64	1.233	3.53	13.56	3.58	12.5	5.0		74.96
		3554.49	10/14/99 5:17 PM	13.54	32.09	60.00	0.83	0.98	1.26	1.33	93.84	6.16	543	79	1.229	2.99	11.49	3.04	12.9	5.6		78.77
		3555.35	10/14/99 6:09 PM	13.53	37.17	61.27	0.89	0.98	1.64	1.40	93.43	6.57	627	91	1.229	2.41	9.25	2.45	11.8	3.9		74.26
		3556.87	10/14/99 7:40 PM	13.57	45.23	52.43	0.77	0.98	1.55	1.65	94.32	5.68	697	101	1.229	2.21	8.49	2.24	10.9	3.1		75.67
		3570.49	10/15/99 9:17 AM	12.28	43.12	49.73	0.71	0.98	1.38	1.62	94.23	5.77	715	104	1.188	2.39	9.18	2.43	11.2	3.1		79.06
		3570.79	10/15/99 9:35 AM	12.23	44.05	49.51	0.69	0.98	1.29	1.62	94.33	5.67	562	82	1.188	3.10	11.88	3.14	11.4	3.1		80.41
		3577.61	10/15/99 4:25 PM	13.52	8.79	64.95	1.28	0.97	1.19	1.36	90.53	9.47	569	83	1.240	2.99	11.47	3.03	11.2	9.4		81.82
		3579.37	10/15/99 6:10 PM	13.80	13.54	65.41	0.90	0.98	1.16	1.17	93.48	6.52	567	82	1.247	2.88	11.06	2.92	11.5	9.9		79.09
		3580.37	10/15/99 7:10 PM	13.82	16.64	65.24	0.89	0.98	1.15	1.09	93.53	6.47	577	84	1.243	2.79	10.70	2.83	11.5	9.9		77.71
		3581.37	10/15/99 8:10 PM	13.81	19.29	65.21	0.87	0.98	1.16	1.02	93.67	6.33	600	87	1.236	2.64	10.13	2.68	11.5	9.9		76.02
		3582.37	10/15/99 9:10 PM	13.67	21.11	68.94	0.87	0.98	1.14	1.02	93.64	6.36	597	87	1.226	2.74	10.52	2.78	11.4	9.3		77.86
		3583.37	10/15/99 10:10 PM	13.55	21.04	68.13	0.84	0.98	1.36	1.02	93.80	6.20	605	88	1.216	2.58	9.88	2.61	11.4	9.4		73.62
		3584.37	10/15/99 11:10 PM	13.45	20.87	67.67	0.82	0.98	1.29	1.02	93.92	6.08	607	88	1.205	2.64	10.12	2.67	11.5	9.4		74.98
		3585.37	10/16/99 12:10 AM	13.33	20.63	66.68	0.80	0.98	1.36	1.03	93.99	6.01	617	90	1.198	2.56	9.84	2.60	11.5	9.3		73.62
		3586.37	10/16/99 1:10 AM	13.25	20.47	66.16	0.78	0.98	1.29	1.03	94.09	5.91	621	90	1.195	2.60	9.98	2.64	11.5	9.4		74.98
		3587.37	10/16/99 2:10 AM	13.14	20.30	65.65	0.76	0.98	1.36	1.03	94.18	5.82	627	91	1.188	2.55	9.77	2.58	11.5	9.4		73.62
		3588.37	10/16/99 3:10 AM	13.03	20.14	64.95	0.75	0.98	1.36	1.03	94.22	5.78	633	92	1.185	2.53	9.70	2.56	11.5	9.6		73.60
		3590.37	10/16/99 5:10 AM	12.86	19.90	63.98	0.74	0.98	1.22	1.04	94.26	5.74	636	92	1.178	2.63	10.07	2.66	11.6	9.6		76.34
		3591.37	10/16/99 6:10 AM	12.82	19.78	63.72	0.74	0.98	1.15	1.04	94.21	5.79	613	89	1.178	2.77	10.64	2.81	11.5	9.6		77.70
		3591.93	10/16/99 6:44 AM	12.78	19.90	64.19	0.87	0.98	1.08	1.02	93.18	6.82	624	91	1.178	2.77	10.64	2.81	11.8	9.4		79.08
		3592.93	10/16/99 7:44 AM	12.82	19.90	64.01	0.82	0.98	1.01	1.03	93.59	6.41	630	92	1.178	2.79	10.70	2.83	11.6	9.5		80.44
		3593.93	10/16/99 8:44 AM	12.90	20.14	64.54	0.84	0.98	1.08	1.03	93.52	6.48	628	91	1.175	2.76	10.59	2.80	11.6	9.6		79.08
		3594.93	10/16/99 9:44 AM	12.92	20.11	64.64	0.82	0.98	1.01	1.03	93.64	6.36	627	91	1.178	2.81	10.77	2.84	11.7	9.4		80.44
		3595.93	10/16/99 10:44 AM	13.06	20.31	65.08	0.83	0.98	0.94	1.02	93.65	6.35	623	91	1.185	2.81	10.77	2.84	11.5	9.4		81.51
		3596.93	10/16/99 11:44 AM	13.14	20.51	65.92	0.84	0.98	1.01	1.03	93.61	6.39	613	89	1.195	2.83	10.85	2.87	11.5	9.4		80.44
		3597.93	10/16/99 12:44 PM	13.17	20.60	66.21	0.86	0.98	0.94	1.02	93.48	6.52	611	89	1.209	2.85	10.94	2.89	11.5	9.3		81.80
		3598.93	10/16/99 1:44 PM	13.09	20.48	65.41	0.86	0.98	0.87	1.03	93.41	6.59	604	88	1.216	2.92	11.20	2.96	11.2	9.3		83.18
		3599.93	10/16/99 2:44 PM	13.08	20.39	65.60	0.89	0.98	0.94	1.03	93.18	6.82	596	87	1.226	2.88	11.06	2.92	11.5	9.0		81.80
		3601.93	10/16/99 4:44 PM	13.15	20.57	66.08	0.89	0.98	0.94	1.02	93.20	6.80	580	84	1.247	2.92	11.19	2.96	11.2	9.2		81.80
		3602.93	10/16/99 5:44 PM	13.04	20.55	66.16	0.90	0.98	0.94	1.01	93.14	6.86	581	85	1.254	2.89	11.09	2.93	10.8	9.4		81.79
		3603.93	10/16/99 6:44 PM	12.96	20.58	66.01	0.86	0.98	0.94	1.01	93.34	6.66	592	86	1.254	2.84	10.91	2.88	10.9	9.3		81.81
		3604.93	10/16/99 7:44 PM	12.98	20.58	65.92	0.84	0.98	0.94	1.01	93.54	6.46	599	87	1.247	2.82	10.84	2.86	10.6	9.3		81.76
		3605.93	10/16/99 8:44 PM	12.94	20.50	65.79	0.84	0.98	0.94	1.01	93.50	6.50	605	88	1.233	2.83	10.86	2.87	10.8	9.6		81.82
		3606.93	10/16/99 9:44 PM	12.89	20.42	65.29	0.83	0.98	0.93	1.01	93.59	6.41	612	89	1.223	2.82	10.82	2.86	10.6	9.7		81.83
		3607.93	10/16/99 10:44 PM	12.86	20.30	64.54	0.80	0.98	0.94	1.02	93.80	6.20	620	90	1.215	2.80	10.74	2.84	10.9	9.7		81.80
		3608.93	10/16/99 11:44 PM	12.77	20.14	64.18	0.78	0.98	0.87	1.01	93.89	6.11	623	91	1.209	2.80	10.75	2.84	10.2	9.7		82.94
		3609.93	10/17/99 12:44 AM	12.68	19.94	63.49	0.75	0.98	0.94	1.02	94.08	5.92	631	92	1.205	2.78	10.65	2.81	11.2	9.6		81.81
		3610.93	10/17/99 1:44 AM	12.56	19.73	62.66	0.73	0.98	0.94	1.03	94.19	5.81	642	93	1.202	2.74	10.50	2.77	10.8	9.7		81.79
		3612.93	10/17/99 3:44 AM	12.29	19.32	61.50	0.69	0.98	0.94	1.03	94.35	5.65	644	94	1.195	2.74	10.52	2.78	10.0	10.1		81.81
		3613.93	10/17/99 4:44 AM	12.31	19.40	61.50	0.69	0.98	0.94	1.03	94.42	5.58	645	94	1.192	2.75	10.54	2.78	11.2	9.6		81.79
		3614.93	10/17/99 5:44 AM	12.30	19.40	61.41	0.68	0.98	0.87	1.02	94.48	5.52	653	95	1.192	2.71	10.41	2.75	11.3	9.6		82.86
		3617.72	10/17/99 8:31 AM	12.09	19.12	60.16	0.67	0.98	0.94	1.03	94.50	5.50	661	96	1.188	2.69	10.31	2.72	11.2	9.4		81.81
		3621.19	10/17/99 11:59 AM	12.38	19.69	61.30	0.69	0.98	0.94	1.04	94.45	5.55	659	96	1.198	2.67	10.25	2.71	11.1	9.4		81.79
		3622.19	10/17/99 12:59 PM	12.44	19.73	60.93	0.68	0.98	1.01	1.05	94.51	5.49	661	96	1.198	2.62	10.06	2.66	11.0	9.4		80.44
		3623.19	10/17/99 1:59 PM	12.54	19.93	61.18	0.70	0.98	0.87	1.04	94.45	5.55	659	96	1.202	2.66	10.22	2.70	10.9	9.4		82.92
		3624.19	10/17/99 2:59 PM	12.58	20.09	61.69	0.71	0.98	0.94	1.05	94.32	5.68	655	95	1.205	2.67	10.26	2.71	11.2	9.3		81.80
		3625.19	10/17/99 3:59 PM	12.66	20.21	62.28	0.73	0.98	0.94	1.04	94.21	5.79	655	95	1.209	2.67	10.23	2.70	11.1	9.3		81.78
		3626.19	10/17/99 4:59 PM	12.69	20.30	62.27	0.74	0.98	0.94	1.03	94.20	5.80	679	99	1.202	2.54	9.76	2.58	11.2	9.3		81.51
		3627.19	10/17/99 5:59 PM	12.75	20.25	61.86	0.71	0.98	0.94	1.06	94.47	5.53	690	100	1.178	2.60	9.96	2.63	11.1	9.6		81.79
		3628.19	10/17/99 6:59 PM	12.64	20.06	61.07	0.70	0.98	0.94	0.99	94.50	5.50	699	102	1.165	2.55	9.78	2.58	11.3	9.3		80.43
		3629.19	10/17/99 7:59 PM	12.63	19.98	60.69	0.69	0.98	0.91	0.99	94.55	5.45	711	103	1.155	2.53	9.69	2.56	11.3	9.3		81.01
		3630.19	10/17/99 8:59 PM	12.54	19.86	60.35	0.67	0.98	0.94	1.00	94.68	5.32	737	107	1.141	2.47	9.46	2.50	11.5	9.3		80.42
		3631.19	10/17/99 9:59 PM	12.40	19.49	58.83	0.58	0.98	0.94	1.01	95.31	4.69	767	112	1.135	2.38	9.14	2.42	11.4	9.5		80.44
		3632.19	10/17/99 10:59 PM	12.24	19.49	56.92	0.55	0.98	1.01	1.11	95.49	4.51	795	116	1.125	2.32	8.89	2.35	11.5	9.1		80.43
		3633.19	10/17/99 11:59 PM	12.07	19.40	55.32	0.52	0.98	0.94	1.05	95.66	4.34	818	119	1.115	2.27	8.72	2.30	11.4	8.7		80.41
		3634.19	10/18/99 12:59 AM	11.79	19.04	53.98	0.50	0.98	0.94	1.05	95.73	4.27	830	121	1.106	2.26	8.66	2.29	11.5	8.6		80.41
		3635.19	10/18/99 1:59 AM	11.54	18.72	52.49	0.48	0.98	1.01	1.06	95.82	4.18	855	124	1.096	2.17	8.34	2.20	11.6	8.5		79.05
		3636.19	10/18/99 2:59 AM	11.39	18.44	51.41	0.46	0.99	0.95	1.07	95.95	4.05	867	126	1.086	2.20	8.44	2.23	11.6	8.5		80.42
		3637.19	10/18/99 3:59 AM	11.29	18.24	50.55	0.45	0.99	0.95	1.01	96.01	3.99	883	128	1.074	2.15	8.24	2.18	11.5	8.5		79.04
		3638.19	10/18/99 4:59 AM	11.27	18.28	50.35	0.44	0.99	0.95	1.02	96.09	3.91	895	130	1.068	2.13	8.18	2.16	11.7	8.3		79.06
		3639.19	10/18/99 5:59 AM	11.42	18.52	50.73	0.44	0.99	0.95	1.02	96.13	3.87	904	131	1.058	2.13	8.16	2.16	11.8	8.3		79.05
		3640.19	10/18/99 6:59 AM	11.55	18.77	51.05	0.44	0.99	0.95	1.02	96.18	3.82	909	132	1.055	2.12	8.14	2.15	11.6	8.4		79.05

Table C-3
RO Operating Data
(Calculations)

Stage/Event	Comments	Elapsed Time (hrs)	STime	Feed	Interstage	Conc	Tot Prod	Rejection		(VfCf-VpCp/Vc)/Cc	Salt Rejection	Salt Passage	NDP		TCF	J (L m-2hr-1atm-1)	NPF (L/min)	NPF (gpm)	Stage 1	Stage 2	Conductivity balance from Col "I"	Recovery
		3641.19	10/18/99 7:59 AM	11.59	18.89	51.00	0.44	0.99	0.95	1.03	96.19	3.81	910	132	1.052	2.13	8.16	2.15	11.6	8.4		79.03
		3642.19	10/18/99 8:59 AM	11.53	18.89	50.54	0.43	0.99	0.95	1.03	96.23	3.77	921	134	1.058	2.09	8.01	2.12	11.5	8.4		79.03
		3643.19	10/18/99 9:59 AM	11.53	18.93	50.10	0.43	0.99	0.95	1.04	96.26	3.74	920	134	1.055	2.10	8.05	2.13	11.5	8.2		79.05
		3644.19	10/18/99 10:59 AM	0.00	0.00	42.43	0.33	0.98	0.95	0.00					1.037				11.5	8.0		79.03
		3695.29	10/20/99 2:05 PM																			
		3696.28	10/20/99 3:05 PM	12.30	28.14	61.44	0.67	0.98	1.09	1.11	94.54	5.46	594	86	1.046	3.34	12.80	3.38	14.1	6.8		80.44
		3697.28	10/20/99 4:05 PM	12.32	28.47	62.31	0.69	0.98	1.28	1.29	94.41	5.59	581	85	1.055	3.38	12.96	3.43	13.8	6.7		80.42
		3698.29	10/20/99 5:05 PM	12.29	28.46	62.86	0.68	0.98	1.18	1.17	94.44	5.56	576	84	1.064	3.38	12.96	3.42	14.0	6.5		80.43
		3699.28	10/20/99 6:05 PM	12.30	28.67	63.13	0.68	0.98	1.19	1.27	94.47	5.53	577	84	1.071	3.41	13.09	3.46	13.8	6.6		81.81
		3701.40	10/20/99 8:12 PM	12.42	29.01	63.97	0.68	0.98	1.17	1.16	94.56	5.44	605	88	1.074	3.19	12.24	3.23	13.9	6.4		80.43
		3704.11	10/20/99 10:55 PM	12.69	29.63	67.60	0.71	0.98	1.64	1.68	94.37	5.63	603	88	1.055	3.31	12.69	3.35	14.6	5.8		81.77
		3705.11	10/20/99 11:55 PM	12.65	29.67	69.04	0.68	0.98	1.32	1.32	94.60	5.40	604	88	1.052	3.31	12.70	3.36	14.4	6.0		81.77
		3706.11	10/21/99 12:55 AM	12.64	29.58	68.82	0.65	0.98	1.22	1.32	94.82	5.18	614	89	1.046	3.33	12.78	3.38	14.3	6.0		83.03
		3708.11	10/21/99 2:55 AM	12.49	29.17	67.87	0.62	0.98	1.29	1.21	95.02	4.98	621	90	1.037	3.22	12.34	3.26	14.6	5.9		80.39
		3709.11	10/21/99 3:55 AM	12.41	28.92	67.25	0.60	0.98	1.29	1.21	95.13	4.87	631	92	1.034	3.17	12.18	3.22	14.7	6.0		80.41
		3710.11	10/21/99 4:55 AM	12.31	28.51	66.14	0.54	0.99	1.29	1.22	95.58	4.42	637	93	1.031	3.15	12.10	3.20	14.5	6.1		80.43
		3711.11	10/21/99 5:55 AM	12.30	28.76	65.91	0.54	0.99	1.20	1.22	95.64	4.36	626	91	1.028	3.27	12.56	3.32	14.4	5.8		81.77
	END OF SPECIAL TESTING	3715.41	10/21/99 10:13 AM	12.39	30.67	66.37	0.55	0.99	1.64	1.65	95.56	4.44			1.034				13.8	5.1		81.53
A	AVERAGE							98.02			94.93	5.07					14.43	3.81				74.50
B(ALL)	AVERAGE							95.46			90.66	9.34					10.65	2.81				63.67
B(80%)								95.84			89.26	10.74					7.13	1.88				70.37
B(50%)								95.19			91.65	8.35					13.14	3.47				58.96
C	AVERAGE							97.16			95.90	4.10					9.02	2.38				47.88
D	AVERAGE							97.23			93.99	6.01					13.63	3.60				71.51
D(50%)								96.40			94.57	5.43					11.04	2.92				48.93
D(62%)								96.04			92.27	7.73					17.84	4.71				63.78
D(70%)								96.83			93.63	6.37					15.20	4.02				68.11
D(74%)								97.37			94.18	5.82					12.72	3.36				72.60
D(80%)								97.92			94.24	5.76					12.83	3.39				79.30

Table C-4
RO Water Quality Data

			FEED												CONCENTRATE					PERMEATE												REMOVALS			
Stage/Event	Date	Run Time (hrs)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	Total Chlorine (mg/L)	Free Chlorine (mg/L)	TDS (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (1000^{-1} CFU/100mL)	HPC (CFU/mL)	pH	Conductivity (uS/cm)	Turbidity (NTU)	SDI	TDS (mg/L)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	TDS (mg/L)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (CFU/100mL)	HPC (CFU/mL)	% TOC Removal	% TDS Removal	Log Reduction	% Turbidity Removal
	Fri 4/16/99		7.18	1,680.00		0.25		1.47	0.15	997.00					7.85	6,060.00	0.98		5,668.00	5.79	42.10		0.10		24.00										
	Sat 4/17/99																																		
	Sun 4/18/99																																		
	Mon 4/19/99		7.40	1,850.00		0.31	1.90	0.96	0.07	966.00					7.68	4,120.00	1.20		5,752.00	6.13	9.19		0.09		12.00			1.00			17.00				
	Tue 4/20/99					0.29	2.10	1.13	0.08				2				0.95						0.03							1.00				3.30	
A	Wed 4/21/99				7.99	0.22	2.30	1.54	0.11								0.80				0.04	0.50		0.50							32.00	93.74			
	Thu 4/22/99					0.16	2.00	1.54	0.10								0.70						0.04	0.50											75.00
	Fri 4/23/99				7.75	0.22	1.90	1.55	0.13				8000				0.75					0.50	0.06	0.40						22.00		93.55		5.56	72.73
	Sat 4/24/99																																		
	Sun 4/25/99																																		
	Mon 4/26/99																																		
	Tue 4/27/99		7.52	1,483.00		0.44		2.14	0.15				68000		7.73	3,380.00	0.89		11.00	6.35	54.00		0.06							5.00				7.13	86.36
	Wed 4/28/99																																		
	Thu 4/29/99																																		
	Fri 4/30/99																																		
	Sat 5/1/99																																		
	Sun 5/2/99																																		
	Mon 5/3/99																																		
	Tue 5/4/99																																		
	Wed 5/5/99																																		
	Thu 5/6/99																																		
	Fri 5/7/99																																		
	Sat 5/8/99																																		
	Sun 5/9/99																																		
	Mon 5/10/99		7.40	1,630.00	6.88	0.2		1.34	0.10	929.00					7.60	6,250.00	1.32		4,776.00	6.01	80.00	0.50	0.04		35.00						142.00	92.73	96.23		80.00
	Tue 5/11/99					0.23		1.58	0.10								1.35						0.05												78.26
	Wed 5/12/99																														56.00				
	Thu 5/13/99																																		
	Fri 5/14/99																																		
	Sat 5/15/99																																		
	Sun 5/16/99																																		
	Mon 5/17/99																																		
	Tue 5/18/99																																		
B	Wed 5/19/99																																		
	Thu 5/20/99	24.00				0.14	1.40	1.41	0.12								0.67						0.05	0.20		1.37	0.08								64.29
	Fri 5/21/99	48.00				0.12	1.60	1.22	0.10				96000				1.40						0.09	0.40		1.22	0.09			30.00				6.51	25.00
	Sat 5/22/99	72.00																																	
	Sun 5/23/99	96.00																																	
	Mon 5/24/99	120.00			6.18					966.00									2,796.00			0.50			70.00			7.00			170.00	91.91	92.75		
	Tue 5/25/99	144.00																																	
	Wed 5/26/99	168.00				0.26	1.30	1.10	0.07								0.56						0.15	0.40		0.96	0.05				200.00				42.31
	Thu 5/27/99	192.00				0.16	1.10	1.00	0.07								0.48						0.04	0.40		1.05	0.07								75.00
	Fri 5/28/99	216.00											30000																	100.00				5.48	
	Sat 5/29/99	240.00																																	
2	Sun 5/30/99	264.00																																	
	Mon 5/31/99	288.00	7.13	1,651.00		0.29	1.50	0.42	0.05						7.32	3,420.00	0.26		2,016.00	6.00	86.00		0.14	0.40	41.00	0.46	0.06								51.72
	Tue 6/1/99	312.00												3,900.00																	1,200.00				
	Wed 6/2/99	336.00				0.14	1.80	1.00	0.07								0.31						0.04	0.40		0.92	0.05								71.43
	Thu 6/3/99	360.00				0.18	1.60	0.69	0.06					1,500.00			0.41						0.10	0.20		0.68	0.06				10.00				44.44
	Fri 6/4/99	384.00				0.17	1.40	0.55	0.06				2200				0.23						0.06	0.20		0.52	0.04			31.00				4.85	64.71
	Sat 6/5/99	408.00																																	
	Sun 6/6/99	432.00																																	
	Mon 6/7/99	456.00			6.17					1,031.00	2.00			6,000.00					2,212.00			0.50			42.00						40.00	91.90	95.93		
	Tue 6/8/99	480.00											29000																	40.00				5.86	
	Wed 6/9/99	504.00																																	
	Thu 6/10/99	528.00																																	
C	Fri 6/11/99	552.00				0.11	1.40	1.67	0.12				24000				0.40						0.04	0.40		1.66	0.11			1,700.00				4.15	63.64

Table C-4
RO Water Quality Data

Stage/Event	Date	Run Time (hrs)	FEED												CONCENTRATE					PERMEATE												REMOVALS			
			pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	Total Chlorine (mg/L)	Free Chlorine (mg/L)	TDS (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (1000^{-1} CFU/100mL)	HPC (CFU/mL)	pH	Conductivity (uS/cm)	Turbidity (NTU)	SDI	TDS (mg/L)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	TDS (mg/L)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (CFU/100mL)	HPC (CFU/mL)	% TOC Removal	% TDS Removal	Log Reduction	% Turbidity Removal
	Sat 6/12/99	576.00																																	
	Sun 6/13/99	600.00																																	
	Mon 6/14/99	624.00	7.41	1,573.00		0.21	2.50	1.28	0.08						7.63	4,620.00	0.43			6.02	46.00		0.07			1.28	0.08								66.67
	Tue 6/15/99	648.00				0.13		2.37	0.11				150000				1.62						0.06			2.10	0.09			290.00				5.71	53.85
	Wed 6/16/99	672.00				0.22		1.74	0.10		8.00			4,400.00			0.26						0.05			1.91	0.12	4.00			350.00				77.27
	Thu 6/17/99	696.00				0.18		1.38	0.12								0.23						0.05			1.51	0.13								72.22
	Fri 6/18/99	720.00				0.21		1.73	0.16				57000				0.27						0.06			1.59	0.14			45.00				6.10	71.43
	Sat 6/19/99	744.00																																	
	Sun 6/20/99	768.00																																	
	Mon 6/21/99	792.00	7.48	1,554.00	6.71	0.14	1.80	2.64	0.13	920.00				170.00	7.63	2,700.00	0.25		1,548.00	6.21	67.00	0.50	0.05	0.30	34.00	2.57	0.06		2.00		6.00	92.55	96.30		64.29
	Tue 6/22/99	816.00				0.15	1.30	2.14	0.15				14000				0.20						0.05	0.50		2.14	0.15			9.00				6.19	66.67
	Wed 6/23/99	840.00				0.16		2.06	0.06								0.32						0.04			2.17	0.09								75.00
	Thu 6/24/99	864.00				0.18		1.56	0.11		4.00	2.00					0.36						0.06			1.66	0.13	2.00							66.67
	Fri 6/25/99	888.00				0.16		1.36	0.07		–		58000				0.25						0.05			1.36	0.07			27.00				6.33	68.75
	Sat 6/26/99	912.00																																	
	Sun 6/27/99	936.00																																	
	Mon 6/28/99	960.00	7.20	1,569.00		0.13		1.10	0.09	949.00					7.35	3,550.00	0.20		2,114.00	6.00	72.00		0.03		43.00	1.09	0.07	3.00			700.00		95.47		76.92
	Tue 6/29/99	984.00				0.12		1.47	0.12				380000				0.16						0.03			1.34	0.10			100.00				6.58	75.00
	Wed 6/30/99	1008.00				0.15		1.66	0.18								0.14						0.03			1.69	0.19				10.00				80.00
	Thu 7/1/99	1032.00				0.14		1.65	0.12								0.16						0.04			1.67	0.14								71.43
	Fri 7/2/99	1056.00				0.16		1.38	0.09				17000				0.18						0.05			1.45	0.10			10.00				6.23	68.75
	Sat 7/3/99	1080.00																																	
	Sun 7/4/99	1104.00																																	
	Mon 7/5/99	1128.00	7.09	1,544.00	6.82	0.15	2.20	1.98	0.13	961.00					7.13	4,000.00	0.20		1,444.00	6.03	65.00	0.50	0.06	0.20	56.00	1.96	0.09					92.67	94.17		60.00
	Tue 7/6/99	1152.00				0.14	1.80	1.67	0.16				3600				0.17						0.03	0.20		1.61	0.11			33.00	80.00			5.04	78.57
D	Wed 7/7/99	1176.00				0.12		0.94	0.11								0.22						0.04			0.92	0.08				80.00				66.67
	Thu 7/8/99	1200.00				0.14		1.71	0.16								0.38						0.05			1.44	0.10								64.29
	Fri 7/9/99	1224.00				0.09		1.16	0.11				15000				0.29						0.03			1.16	0.08			8.00				6.27	66.67
	Sat 7/10/99	1248.00																																	
	Sun 7/11/99	1272.00																																	
	Mon 7/12/99	1296.00	7.39	1,635.00		0.13		1.22	0.08	989.00					7.61	5,540.00	0.40		3,320.00	6.26	115.00		0.06		56.00	1.25	0.10				200.00		94.34		53.85
	Tue 7/13/99	1320.00				0.11		1.21	0.08				17000				0.30						0.04			1.30	0.10			8.00				6.33	63.64
	Wed 7/14/99	1344.00				0.14		1.57	0.15								0.44						0.05			1.64	0.18				10.00				64.29
	Thu 7/15/99	1368.00				0.14	1.70	1.30	0.17								0.35						0.05			1.47	0.12								64.29
	Fri 7/16/99	1392.00				0.14	1.50	1.58	0.20				70000				0.29						0.05			1.60	0.21			33.00				6.33	64.29
	Sat 7/17/99	1416.00																																	
	Sun 7/18/99	1440.00																																	
	Mon 7/19/99	1464.00	6.60	1,809.00	7.11	0.15	1.60	1.58	1.29	791.00					6.92	4,290.00	0.35		2,758.00	5.75	106.00	0.50	0.07		38.00	1.69	0.54					92.97	95.20		53.33
	Tue 7/20/99	1488.00				0.16	1.70	1.07	0.26				900				0.45						0.04			1.19	0.20			7.00				5.11	75.00
	Wed 7/21/99	1512.00				0.18	1.70	0.86	0.31								0.33						0.04			1.23	0.28								77.78
	Thu 7/22/99	1536.00				0.14	2.00	1.10	0.34								0.41						0.05			1.21	0.25			7.00					64.29
	Fri 7/23/99	1560.00				0.15	1.80	1.20	0.13				49000				0.33						0.04			1.25	0.20								73.33
	Sat 7/24/99	1584.00																																	
	Sun 7/25/99	1608.00																																	
	Mon 7/26/99	1632.00																																	
	Tue 7/27/99	1656.00				0.13		0.77	0.15				280000				0.35						0.05			0.91	0.08			33.00				6.93	61.54
	Wed 7/28/99	1680.00				0.13	1.60	1.56	0.40								0.27	2.20					0.06			1.56	0.38								53.85
	Thu 7/29/99	1704.00				0.08	1.30	1.29	0.18								0.26	2.10					0.03			1.56	0.45								62.50
	Fri 7/30/99	1728.00				0.12	1.40	0.72	0.12				580000				0.28	1.90					0.03			0.90	0.06			42.00				7.14	75.00
	Sat 7/31/99	1752.00																																	
	Sun 8/1/99	1776.00																																	
	Mon 8/2/99	1800.00	5.74	1,877.00	6.01	0.08	1.70	0.58	0.12	809.00					3.88	5,460.00	0.21	2.70	3,066.00	5.39	150.00	0.50	0.02		33.00	0.60	0.09				600.00	91.68	95.92		75.00
	Tue 8/3/99	1824.00				0.08	1.50	0.59	0.08				74000				0.36	1.60					0.04			0.60	0.13			8.00				6.97	50.00
	Wed 8/4/99	1848.00				0.1	1.40	0.15	0.08								0.32	2.10					0.05			0.15	0.05				600.00				50.00
	Thu 8/5/99	1872.00				0.13	1.40	0.03	0.03								0.41	1.20					0.11			0.02	0.02								15.38
	Fri 8/6/99	1896.00				0.13	1.40	0.34	0.06				13000				0.40	1.30					0.10			0.27	0.07			67.00				5.29	23.08
	Sat 8/7/99	1920.00																																	

Table C-4
RO Water Quality Data

			FEED												CONCENTRATE					PERMEATE												REMOVALS			
Stage/Event	Date	Run Time (hrs)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	Total Chlorine (mg/L)	Free Chlorine (mg/L)	TDS (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (1000^{-1} CFU/100mL)	HPC (CFU/mL)	pH	Conductivity (uS/cm)	Turbidity (NTU)	SDI	TDS (mg/L)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	TDS (mg/L)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (CFU/100mL)	HPC (CFU/mL)	% TOC Removal	% TDS Removal	Log Reduction	% Turbidity Removal
	Sun 8/8/99	1944.00																																	
	Mon 8/9/99	1968.00	5.82	1,740.00		0.22	1.20	0.09	0.05	864.00					5.68	4,550.00	0.34	1.60	2,936.00	5.52	128.00		0.10		44.00	0.04	0.03				11,000.00		94.91		54.55
	Tue 8/10/99	1992.00				0.09	1.40	0.07	0.05				110000				0.24	0.50					0.04			0.06	0.02			130.00				5.93	55.56
	Wed 8/11/99	2016.00				0.13	1.00	0.08	0.04								0.28						0.04			0.06	0.03				1,000.00				69.23
	Thu 8/12/99	2040.00				0.09	1.40	0.02	0.02								0.25						0.06			0.02	0.02								33.33
	Fri 8/13/99	2064.00				0.08	1.50	0.22	0.04				2000				0.24						0.04			0.25	0.04			67.00				4.47	50.00
	Sat 8/14/99	2088.00					1.50																												
	Sun 8/15/99	2112.00																																	
	Mon 8/16/99	2136.00	7.34	1,400.00	7.30	0.13		0.18	0.04	868.00					7.60	5,000.00	1.32		3,313.00	6.23	71.00	0.50	0.07		30.00	0.20	0.05				20.00	93.15	96.54		46.15
	Tue 8/17/99	2160.00				0.16	1.10	0.15	0.08				32000				0.22						0.08			0.24	0.06			92.00				5.54	50.00
	Wed 8/18/99	2184.00				0.09	0.80	0.04	0.03								0.18	0.30					0.03			0.03	0.02								66.67
	Thu 8/19/99	2208.00				0.09	0.80	0.03	0.03								0.40						0.05			0.02	0.02								44.44
	Fri 8/20/99	2232.00				0.06	0.90	0.90	0.09				40000				0.23						0.02			0.98	0.12			50.00				5.90	66.67
	Sat 8/21/99	2256.00																																	
	Sun 8/22/99	2280.00																																	
	Mon 8/23/99	2304.00	5.95	1,211.00		0.08	1.10	0.52	0.09	812.00					3.10	4,700.00	0.17	0.90	3,186.00	5.25	89.00		0.04		31.00	0.42	0.05						96.18		50.00
	Tue 8/24/99	2328.00				0.07	2.00	0.04	0.02								0.82						0.02			0.04	0.03								71.43
	Wed 8/25/99	2352.00				0.15		0.17	0.03								0.31						0.07			0.12	0.03								53.33
	Thu 8/26/99	2376.00				0.09	1.20	0.18	0.04								0.27	0.90					0.08			0.22	0.04								11.11
	Fri 8/27/99	2400.00				0.08	1.30	0.05	0.03								0.25	0.90					0.05			0.02	0.02								37.50
	Sat 8/28/99	2424.00																																	
	Sun 8/29/99	2448.00																																	
	Mon 8/30/99	2472.00																																	
	Tue 8/31/99	2496.00																																	
	Wed 9/1/99	2520.00																																	
	Thu 9/2/99	2544.00																																	
	Fri 9/3/99	2568.00																																	
	Sat 9/4/99	2592.00																																	
	Sun 9/5/99	2616.00																																	
	Mon 9/6/99	2640.00																																	
	Tue 9/7/99	2664.00																																	
	Wed 9/8/99	2688.00				0.09		0.96	0.14								0.26						0.04			0.98	0.16								55.56
	Thu 9/9/99	2712.00				0.12	1.50	1.37	0.16								0.31	1.80					0.06			1.29	0.14								50.00
	Fri 9/10/99	2736.00				0.07	2.20	1.14	0.12				84000				0.23	1.50					0.06			1.06	0.09			380.00				5.34	14.29
	Sat 9/11/99	2760.00																																	
	Sun 9/12/99	2784.00																																	
	Mon 9/13/99	2808.00	4.83	1,731.00	6.11	0.14	1.30	0.66	0.08	962.00	6.00	3.00		1,600.00	6.56	5,930.00	0.27	0.80	3,752.00	5.40	127.00	0.50	0.04		29.00	0.65	0.06	1.00			400.00	91.82	96.99		71.43
	Tue 9/14/99	2832.00				0.09	1.30	0.52	0.06								0.14	0.80					0.04			0.50	0.06								55.56
	Wed 9/15/99	2856.00					2.80											2.80																	
	Thu 9/16/99	2880.00																																	
	Fri 9/17/99	2904.00				0.12		0.07	0.04								0.33						0.06			0.02	0.02								50.00
	Sat 9/18/99	2928.00																																	
	Sun 9/19/99	2952.00																																	
	Mon 9/20/99	2976.00	5.82	1,893.00		0.09	1.80	0.90	0.09	1,006.00					6.13	5,890.00	0.24	1.90	4,012.00	5.44	93.00		0.03		38.00	0.98	0.10						96.22		66.67
	Tue 9/21/99	3000.00				0.24	1.80	0.04	0.03								1.58	1.10					0.06			0.08	0.04								75.00
	Wed 9/22/99	3024.00																																	
13	Thu 9/23/99	3048.00				0.11	1.70	1.02	0.08								0.44	2.30					0.03			1.10	0.12								72.73
	Fri 9/24/99	3072.00				0.08	2.80	0.82	0.11								0.21	3.00					0.02			0.73	0.12								75.00
	Sat 9/25/99	3096.00																																	
	Sun 9/26/99	3120.00																																	
	Mon 9/27/99	3144.00	6.49	1,720.00		0.09		0.20	0.05	987.00				1,700.00	7.02	6,940.00	0.47		5,186.00	5.69	107.00		0.05		62.00	0.07	0.02				330.00		93.72		44.44
	Tue 9/28/99	3168.00				0.09		0.16	0.06								0.31						0.02			0.19	0.05								77.78
	Wed 9/29/99	3192.00			6.57	0.08		0.20	0.04					1,600.00			0.41					0.50	0.04			0.16	0.03				340.00	92.39			50.00
	Thu 9/30/99	3216.00				0.08		1.64	0.16								0.29						0.03			1.56	0.14								62.50
	Fri 10/1/99	3240.00				0.1		1.39	0.09								0.35	1.50					0.02			1.45	0.09								80.00
	Sat 10/2/99	3264.00																																	
	Sun 10/3/99	3288.00																																	

Table C-4
RO Water Quality Data

			FEED												CONCENTRATE					PERMEATE												REMOVALS			
Stage/Event	Date	Run Time (hrs)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	Total Chlorine (mg/L)	Free Chlorine (mg/L)	TDS (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (1000^{-1} CFU/100mL)	HPC (CFU/mL)	pH	Conductivity (uS/cm)	Turbidity (NTU)	SDI	TDS (mg/L)	pH	Conductivity (uS/cm)	TOC (mg/L)	Turbidity (NTU)	SDI	TDS (mg/L)	Total Chlorine (mg/L)	Free Chlorine (mg/L)	Total Coliform (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Pseudomonas (CFU/100mL)	HPC (CFU/mL)	% TOC Removal	% TDS Removal	Log Reduction	% Turbidity Removal
	Mon 10/4/99	3312.00												1,000.00																	350.00				
	Tue 10/5/99	3336.00																																	
	Wed 10/6/99	3360.00																																	
	Thu 10/7/99	3384.00					1.60																												
	Fri 10/8/99	3408.00																																	
A	MEAN		7.46	1,556.50	7.54	0.25	2.07	1.62	0.12	929.00			38000		7.67	4,815.00	0.97		2,393.50	6.18	44.68	0.50	0.05	0.47	35.00					13.50	76.67	93.34	96.23	6.35	78.47
	MIN		7.40	1,483.00	6.88	0.16	1.90	1.34	0.10	929.00			8000		7.60	3,380.00	0.70		11.00	6.01	0.04	0.50	0.04	0.40	35.00					5.00	32.00	92.73	96.23	5.56	72.73
	MAX		7.52	1,630.00	7.99	0.44	2.30	2.14	0.15	929.00			68000		7.73	6,250.00	1.35		4,776.00	6.35	80.00	0.50	0.06	0.50	35.00					22.00	142.00	93.74	96.23	7.13	86.36
B	MEAN		7.13	1,651.00	6.18	0.18	1.46	0.92	0.08	998.50	2.00		39300	3,274.18	7.32	3,420.00	0.54		2,341.33	6.00	86.00	0.50	0.08	0.33	51.00	0.90	0.06	7.00		50.25	110.29	91.90	94.34	5.67	54.86
	MIN		7.13	1,651.00	6.17	0.12	1.10	0.42	0.05	966.00	2.00		2200	1,500.00	7.32	3,420.00	0.23		2,016.00	6.00	86.00	0.50	0.04	0.20	41.00	0.46	0.04	7.00		30.00	10.00	91.90	92.75	4.85	25.00
	MAX		7.13	1,651.00	6.18	0.29	1.80	1.41	0.12	1,031.00	2.00		96000	6,000.00	7.32	3,420.00	1.40		2,796.00	6.00	86.00	0.50	0.15	0.40	70.00	1.37	0.09	7.00		100.00	1,200.00	91.91	95.93	6.51	75.00
C	MEAN		7.30	1,560.00	6.77	0.16	1.83	1.71	0.12	943.33	5.66	2.00	87950	864.87	7.44	3,717.50	0.32		1,702.00	6.07	62.50	0.50	0.05	0.32	44.33	1.71	0.11	2.88	2.00	276.75	65.18	92.61	95.32	5.79	69.84
	MIN		7.09	1,544.00	6.71	0.11	1.30	1.10	0.06	920.00	4.00	2.00	3600	170.00	7.13	2,700.00	0.14		1,444.00	6.00	46.00	0.50	0.03	0.20	34.00	1.09	0.06	2.00	2.00	9.00	6.00	92.55	94.17	4.15	53.85
	MAX		7.48	1,573.00	6.82	0.22	2.50	2.64	0.18	961.00	8.00	2.00	380000	4,400.00	7.63	4,620.00	1.62		2,114.00	6.21	72.00	0.50	0.07	0.50	56.00	2.57	0.19	4.00	2.00	1,700.00	700.00	92.67	96.30	6.58	80.00
D	MEAN		6.22	1,668.44	6.62	0.11	1.53	0.70	0.13	898.67	6.00	3.00	97636	1,444.35	6.06	5,366.67	0.36	1.57	3,503.22	5.66	109.56	0.50	0.05		40.11	0.72	0.11	1.00		66.57	276.43	92.40	95.56	5.97	57.29
	MIN		4.83	1,211.00	6.01	0.06	0.80	0.02	0.02	791.00	6.00	3.00	900	1,000.00	3.10	4,290.00	0.14	0.30	2,758.00	5.25	71.00	0.50	0.02		29.00	0.02	0.02	1.00		7.00	10.00	91.68	93.72	4.47	11.11
	MAX		7.39	1,893.00	7.30	0.24	2.80	1.71	1.29	1,006.00	6.00	3.00	580000	1,700.00	7.61	6,940.00	1.58	3.00	5,186.00	6.26	150.00	0.50	0.11		62.00	1.69	0.54	1.00		380.00	11,000.00	93.15	96.99	7.14	80.00

Appendix D. Laboratory Reports

CH2MHILL
Applied Sciences Group

CH2M HILL
Applied Sciences Group
2300 NW Walnut Blvd
Corvallis, OR
97330-3538
P.O. Box 428
Corvallis, OR
97339-0428
Tel 541.752.4271
Fax 541.752.0276

September 22, 1999

McAllen WWTP #2, City of

149462.A1.ZG

RE: Analytical Data for McAllen WWTP #2, City of
Applied Sciences Group Reference No. 9964

Dear Angie Fernandez/PHX:

On August 18, 1999, CH2M HILL Applied Sciences Group received four samples with a request for analysis of selected parameters.

The analytical results and associated quality control data are enclosed. Any unusual difficulties encountered during the analysis of your samples are discussed in the case narrative. Subcontracted analyses reports are attached.

Under CH2M HILL policy, your samples will be stored for 30 days after reporting. If you have not given us prior instructions for disposal, we will contact you if any samples require disposal as hazardous waste.

CH2M HILL Applied Sciences Group appreciates your business and looks forward to serving your analytical needs again. If you should have any questions concerning the data, or if you need additional information, please call Ms. Kathy McKinley at (541) 758-0235, extension 3120.

Sincerely,

Kelly Ensor
Senior Administrative Assistant

Enclosures

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL Applied Sciences Group Reference No. 9964

Sample ID	Client Sample ID	Date Collected	Time Collected
996401	ZGP	8/17/99	7:30
996402	ROP	8/17/99	7:30
996403	ROC	8/17/99	7:30
996404	WWTP#2Effluent	8/17/99	7:30

CASE NARRATIVE
VOLATILES

Lab Reference No.: 9964

Client/Project: McAllen WWTP #2, City of

I. Holding Times:
All acceptance criteria were met.

II. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. Duplicate Sample(s):
Not Applicable.

D. Spike Sample(s):
Not Applicable.

E. Surrogate Recoveries:
All acceptance criteria were met.

F. Lab Control Sample(s):
All acceptance criteria were met.

G. Other:
None

III. Documentation Exceptions:
None

IV. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CASE NARRATIVE
GENERAL CHEMISTRY

Lab Reference No.: 9964

Client/Project: McAllen WWTP #2, City of

I. Holding Time:
All acceptance criteria were met.

II. Analysis:

A. Calibration:
Bromide recovery (132%) in final calibration verification exceeded acceptance criteria. All other acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. Matrix Spike Sample(s):
Bromide matrix spike recovery (200%) exceeded acceptance criteria. All other acceptance criteria were met.

D. Duplicate Sample(s):
All acceptance criteria were met.

E. Lab Control Sample(s):
All acceptance criteria were met.

F. Other:
Not applicable.

IV. Documentation Exceptions:
None.

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CASE NARRATIVE
METALS

Lab Reference No.: 9964

Client/Project: McAllen WWTP #2, City of

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None.

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. ICP Interference Check Sample:
All acceptance criteria were met.

D. Spike Sample(s):
All acceptance criteria were met.

E. Duplicate Sample(s):
All acceptance criteria were met.

F. Laboratory Control Sample(s):
All acceptance criteria were met.

G. ICP Serial Dilution:
Not Required.

H. Other:
None

IV. Documentation Exceptions:
None

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ROC**	**Lab Sample ID:**	**996403**
Project Name:	McAllen WWTP #2, City of	Date Received:	08/18/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Trevino	Analyzed By:	MG/DK/MS
Sampling Date:	08/17/1999	Reviewed By:	S
Sampling Time:	7:30		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
N-Nitrate	0.20	35.4		mg/L	EPA 353.2	08/19/1999
N-Total Kjeldahl	2.0	2.72		mg/L	EPA 351.4	08/25/1999
Total Dissolved Solids	5	3,230		mg/L	EPA 160.1	08/23/1999
TOC	5.0	33.7		mg/L	EPA 415.1/2	08/19/1999
Total Phosphate-P	0.25	9.89		mg/L	EPA 365.2/4	08/19/1999

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**WWTP#2Effluent**	**Lab Sample ID:**	**996404**
Project Name:	McAllen WWTP #2, City of	Date Received:	08/18/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Trevino	Analyzed By:	MG/DK/MS
Sampling Date:	08/17/1999	Reviewed By:	
Sampling Time:	7:30		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
N-Nitrate	0.04	2.96		mg/L	EPA 353.2	08/19/1999
N-Total Kjeldahl	2.0	2.0	U	mg/L	EPA 351.4	08/25/1999
Total Dissolved Solids	5	799		mg/L	EPA 160.1	08/24/1999
TOC	0.50	8.39		mg/L	EPA 415.1/2	08/19/1999
Total Phosphate-P	0.25	2.98		mg/L	EPA 365.2/4	08/19/1999

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ZGP**	**Lab Sample ID:**	**996401**
Project Name:	McAllen WWTP #2, City of	Date Received:	08/18/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Trevino	Analyzed By:	DK/MG/MS/JJB
Sampling Date:	08/17/1999	Reviewed By:	
Sampling Time:	7:30		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity (as CaCO3)	2.0	121		mg/L	EPA 310.2	08/23/1999
Bromide	0.020	0.132		mg/L	EPA 300.0-B	08/19/1999
Chloride	1.0	160		mg/L	EPA 300.0-A	08/23/1999
Color (APHA) Apparent	---	22		color units	EPA 110.2	08/18/1999
Fluoride	0.10	1.07		mg/L	EPA 300.0-A	08/23/1999
N-Nitrate	0.10	9.55		mg/L	EPA 353.2	08/19/1999
N-Total Kjeldahl	2.0	2.0	U	mg/L	EPA 351.4	08/25/1999
Silica-React.	0.40	15.1		mg/L	SM4500-Si D	09/01/1999
Sulfate	1.0	150		mg/L	EPA 300.0-A	08/23/1999
Total Dissolved Solids	5	774		mg/L	EPA 160.1	08/23/1999
TOC	0.50	7.48		mg/L	EPA 415.1/2	08/19/1999
Total Phosphate-P	0.25	2.48		mg/L	EPA 365.2/4	08/19/1999
UV-254	0.009	0.129		asb/cm	SM5910	08/19/1999

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ZGP**	**Lab Sample ID:**	**996401**
Project Name:	McAllen WWTP #2, City of	Date Received:	8/18/99
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Trevino	Reported By:	JG
Sampling Date:	08/17/99	Reviewed By:	
Sampling Time:	07:30		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Aluminum, Al	45.6	111		µg/L	SW6010B	08/27/99
Arsenic, As	3.9	3.9	U	µg/L	SW6010B	08/27/99
Barium, Ba	0.81	56.2		µg/L	SW6010B	08/27/99
Cadmium, Cd	0.38	2.7		µg/L	SW6010B	08/27/99
Calcium, Ca	21.3	72100		µg/L	SW6010B	08/27/99
Chromium, Cr	7.2	7.2	U	µg/L	SW6010B	08/27/99
Iron, Fe	2.8	31.9		µg/L	SW6010B	08/27/99
Lead, Pb	2.3	28.4		µg/L	SW6010B	08/27/99
Magnesium, Mg	41.0	20400		µg/L	SW6010B	08/27/99
Manganese, Mn	1.0	14.5		µg/L	SW6010B	08/27/99
Mercury, Hg	0.25	0.25	U	µg/L	SW7470A	08/23/99
Potassium, K	1810	17800		µg/L	SW6010B	08/27/99
Selenium, Se	6.8	6.8	U	µg/L	SW6010B	08/27/99
Silver, Ag	8.0	8.0	U	µg/L	SW6010B	08/27/99
Sodium, Na	5930	157000		µg/L	SW6010B	08/27/99
Strontium, Sr	28.6	1870		µg/L	SW6010B	08/27/99
Zinc, Zn	2.3	46.3		µg/L	SW6010B	08/27/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ZGP**	**Lab Sample ID:**	**996401**
Project Name:	McAllen WWTP #2, City of	Analysis Method:	SW 8260B
Project Manager:	Angie Fernandez/PHX	Units:	µg/L
Sampled By:	R. Trevino	Date Received:	8/18/99
Date Collected:	8/17/99	Date Analyzed:	8/27/99
Time Collected:	7:30	Dilution Factor:	1
Type:	Grab	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	As Received	Reviewed By:	DAH

Analyte	**CAS #**	**Reporting Limit**	**Sample Result**	**Qualifier**
Purgeable Volatiles				
Vinyl Chloride	75-01-4	1.0	1.0	U
trans-1,2-Dichloroethene	156-60-5	1.0	1.0	U
cis-1,2-Dichloroethene	156-59-4	1.0	1.0	U
1,1,1-Trichloroethane	71-55-6	1.0	1.0	U
Carbon Tetrachloride	56-23-5	1.0	1.0	U
Trichloroethene	79-01-6	1.0	1.0	U
1,4-Dichlorobenzene	106-46-7	1.0	1.0	U
Dibromofluoromethane	1868-53-7		94%	SS
1,2-Dichloroethane-d4	17068-07-0		89%	SS
Toluene-d8	2037-26-5		103%	SS
p-Bromofluorobenzene	460-00-4		103%	SS

E=Estimated value above instrument calibration range
J=Estimated value below reporting limit
U=Not detected at specified reporting limit
SS=Surrogate standard

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ZGP**	**Lab Sample ID:**	**996401**
Project Name:	McAllen WWTP #2, City of	Analysis Method:	SM 5710.D
Project Manager:	Angie Fernandez/PHX		
Sampled By:	R. Trevino	Date Received:	8/18/99
Date Collected:	8/17/99	Report Revision No.:	0
Time Collected:	7:30	Analyzed By:	BDW
Type:	Grab	Reviewed By:	SAG
Matrix:	Water		
Basis:	As Received		

SDS-HAA/THM Formation Potential Test Conditions

Set-up Date/Time	Target Contact Time (h:mm)	Initial pH	Contact pH	Contact Temperature (°C)	Chlorine Dosage (mg/L)
8/23/99 9:34	72:00	7.7	7.8	23	10.10

Chlorine Demand Test Results

Take-off Date/Time	Actual Contact Time (h:mm)	Measured pH	Measured Temperature (°C)	Chlorine Residual (mg/L)
8/26/99 13:10	75:36	7.8	23	0.68

CH2M HILL Applied Sciences Laboratory

Client Information	**Lab Information**
Client Sample ID: ROP	**Lab Sample ID: 996402**
Project Name: McAllen WWTP #2, City of	Date Received: 08/18/1999
Project Manager: Angie Fernandez/PHX	Report Revision No.: 0
Sampled By: R. Trevino	Analyzed By: DK/MG/MS/JJB
Sampling Date: 08/17/1999	Reviewed By: [signature] / [initials]
Sampling Time: 7:30	
Type: Grab	
Matrix: Water	
Basis: As Received	

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity (as CaCO3)	2.0	14		mg/L	EPA 310.2	08/23/1999
Bromide	0.020	0.020	U	mg/L	EPA 300.0-B	08/19/1999
Chloride	0.10	9.73		mg/L	EPA 300.0-A	08/23/1999
Color (APHA) Apparent	---	5	U	color units	EPA 110.2	08/18/1999
Fluoride	0.10	0.32		mg/L	EPA 300.0-A	08/23/1999
N-Nitrate	0.01	1.11		mg/L	EPA 353.2	08/19/1999
N-Total Kjeldahl	2.0	2.0	U	mg/L	EPA 351.4	08/25/1999
Silica-React.	0.40	0.65		mg/L	SM4500-Si D	09/01/1999
Sulfate	0.10	4.00		mg/L	EPA 300.0-A	08/23/1999
Total Dissolved Solids	5	33		mg/L	EPA 160.1	08/23/1999
TOC	0.50	0.63		mg/L	EPA 415.1/2	08/19/1999
Total Phosphate-P	0.05	0.10		mg/L	EPA 365.2/4	08/19/1999

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ROP**	**Lab Sample ID:**	**996402**
Project Name:	McAllen WWTP #2, City of	Date Received:	8/18/99
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Trevino	Reported By:	JG
Sampling Date:	08/17/99	Reviewed By:	
Sampling Time:	07:30		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Aluminum, Al	45.6	45.6	U	µg/L	SW6010B	08/27/99
Arsenic, As	3.9	3.9	U	µg/L	SW6010B	08/27/99
Barium, Ba	0.81	0.81	U	µg/L	SW6010B	08/27/99
Cadmium, Cd	0.38	0.38	U	µg/L	SW6010B	08/27/99
Calcium, Ca	21.3	714		µg/L	SW6010B	08/27/99
Chromium, Cr	7.2	7.2	U	µg/L	SW6010B	08/27/99
Iron, Fe	2.8	9.9		µg/L	SW6010B	08/27/99
Lead, Pb	2.3	2.3	U	µg/L	SW6010B	08/27/99
Magnesium, Mg	41.0	197		µg/L	SW6010B	08/27/99
Manganese, Mn	1.0	1.0	U	µg/L	SW6010B	08/27/99
Mercury, Hg	0.25	0.25	U	µg/L	SW7470A	08/23/99
Potassium, K	181	1360		µg/L	SW6010B	08/27/99
Selenium, Se	6.8	6.8	U	µg/L	SW6010B	08/27/99
Silver, Ag	8.0	8.0	U	µg/L	SW6010B	08/27/99
Sodium, Na	593	13000		µg/L	SW6010B	08/27/99
Strontium, Sr	28.6	28.6	U	µg/L	SW6010B	08/27/99
Zinc, Zn	2.3	7.2		µg/L	SW6010B	08/27/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**ROP**	**Lab Sample ID:**	**996402**
Project Name:	McAllen WWTP #2, City of	Analysis Method:	SW 8260B
Project Manager:	Angie Fernandez/PHX	Units:	µg/L
Sampled By:	R. Trevino	Date Received:	8/18/99
Date Collected:	8/17/99	Date Analyzed:	8/27/99
Time Collected:	7:30	Dilution Factor:	1
Type:	Grab	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	As Received	Reviewed By:	DAH

Analyte	CAS #	Reporting Limit	Sample Result	Qualifier
Purgeable Volatiles				
Vinyl Chloride	75-01-4	1.0	1.0	U
trans-1,2-Dichloroethene	156-60-5	1.0	1.0	U
cis-1,2-Dichloroethene	156-59-4	1.0	1.0	U
1,1,1-Trichloroethane	71-55-6	1.0	1.0	U
Carbon Tetrachloride	56-23-5	1.0	1.0	U
Trichloroethene	79-01-6	1.0	1.0	U
1,4-Dichlorobenzene	106-46-7	1.0	1.0	U
Dibromofluoromethane	1868-53-7		96%	SS
1,2-Dichloroethane-d4	17068-07-0		96%	SS
Toluene-d8	2037-26-5		104%	SS
p-Bromofluorobenzene	460-00-4		103%	SS

E=Estimated value above instrument calibration range
J=Estimated value below reporting limit
U=Not detected at specified reporting limit
SS=Surrogate standard

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**ROP**	**Lab Sample ID:**	**996402**
Project Name:	McAllen WWTP #2, City of	Analysis Method:	SM 5710.D
Project Manager:	Angie Fernandez/PHX		
Sampled By:	R. Trevino	Date Received:	8/18/99
Date Collected:	8/17/99	Report Revision No.:	0
Time Collected:	7:30	Analyzed By:	BDW
Type:	Grab	Reviewed By:	[illegible]
Matrix:	Water		
Basis:	As Received		

SDS-HAA/THM Formation Potential Test Conditions

Set-up Date/Time	Target Contact Time (h:mm)	Initial pH	Contact pH	Contact Temperature (°C)	Chlorine Dosage (mg/L)
8/23/99 9:42	72:00	6.0	7.8	23	1.30

Chlorine Demand Test Results

Take-off Date/Time	Actual Contact Time (h:mm)		Measured pH	Measured Temperature (°C)	Chlorine Residual (mg/L)
8/26/99 13:14	75:32		7.8	23	0.24

Formation Potential Test Conditions

Client ID	Lab ID	FP Dose	Free Residual	Free Demand	Total Residual	FP Temp.	Measured pH	FP Start	FP Take-Off	FP Time H:M	FP Time (Hour)
McALLEN-ZGP	996401	10.10	0.68	9.42	--	23	7.78	8/23/99 9:34	8/26/99 13:10	75:36	75.60
McALLEN-ROP	996402	1.30	0.24	1.06	--	23	7.77	8/23/99 9:42	8/26/99 13:14	75:40	75.67

Formation Potential Trihalomethanes (THMs) Disinfection By-Products, (ug/L)

Client ID	Lab ID	FP CHCl3	FP BDCM	FP DBCM	FP CHBr3	FP TTHM
McALLEN-ZGP-3D	300301	150	38.8	9.5	<1	**198**
McALLEN-ROP-3D	300302	3.7	1.7	<1	<1	**5.4**

CHCl3 = Chloroform
BDCM = Bromodichloromethane
DBCM = Dibromochloromethane
CHBr3 = Bromoform

EPA TTHM Stage 1 MCL = 80 ug/L
EPA TTHM Stage 2 MCL = 40 ug/L

Formation Potential Haloacetic Acids (HAAs) Disinfection By-Products (ug/L)

Client ID	Lab ID	FP MCAA *	FP MBAA *	FP DCAA *	FP TCAA *	FP BCAA	FP DBAA *	FP HAA5	FP HAA6
McALLEN-ZGP-3D	300301	8.6	1.4	49.9	57.3	12.8	1.6	**119**	**132**
McALLEN-ROP-3D	300302	<2	<1	1.1	<1	<1	<1	**1.1**	**1.1**

MCAA = Monochloroacetic acid
MBAA = Monobromoacetic acid
DCAA = Dichloroacetic acid
TCAA = Trichloroacetic acid

BCAA = Bromochloroacetic acid
DBAA = Dibromoacetic acid
** These compounds make up the HAA5*
= Estimated value

EPA HAA5 Stage 1 MCL = 60 ug/L
EPA HAA5 Stage 2 MCL = 30 ug/L

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**McAllen-ZGP-3d**	**Lab Sample ID:**	**300301**
Project Name:	McAllen WWTP #2, City of	Date Received:	8/26/99
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	B. Warloe	Analyzed By:	DAH
Date Collected:	8/26/99	Reviewed By:	mbos
Time Collected:	Not Indicated		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	CAS #	MCL*	Reporting Limit	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Haloacetic Acids								
Chloroacetic acid	79-11-8		2.0	8.6		µg/L	SM 6251.B	9/3/99
Bromoacetic acid	79-08-3		1.0	1.4		µg/L	SM 6251.B	9/3/99
Dichloroacetic acid	79-43-6		5.0	51.4		µg/L	SM 6251.B	9/16/99
Trichloroacetic acid	76-03-9		5.0	56.0		µg/L	SM 6251.B	9/16/99
Bromochloroacetic acid	5589-96-3		1.0	12.8		µg/L	SM 6251.B	9/3/99
Dibromoacetic acid	631-64-1		1.0	1.6		µg/L	SM 6251.B	9/399
HAA5		60	5.0	119		µg/L	SM 6251.B	9/16/99
2,3-Dibromopropanoic aci	600-05-5			116%	SS			
Trihalomethanes								
Chloroform	67-66-3		5.0	150		µg/L	EPA 502.2	9/1/99
Bromodichloromethane	75-27-4		1.0	38.8		µg/L	EPA 502.2	8/31/99
Dibromochloromethane	124-48-1		1.0	9.5		µg/L	EPA 502.2	8/31/99
Bromoform	75-25-2		1.0	1.0	U	µg/L	EPA 502.2	8/31/99
TTHM		80	1.0	198		µg/L	EPA 502.2	9/1/99
1,2-Dichloroethane-d4	17068-07-0			102%	SS			

U=Not detected at specified reporting limit
*=MCL according to Stage 1 of D/DBP rule
SS=Surrogate standard

CH2M HILL Applied Sciences Laboratory

Client Information		**Lab Information**	
Client Sample ID:	**McAllen-ROP-3d**	**Lab Sample ID:**	**300302**
Project Name:	McAllen WWTP #2, City of	Date Received:	8/26/99
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	B. Warloe	Analyzed By:	DAH
Date Collected:	8/26/99	Reviewed By:	mbos
Time Collected:	Not Indicated		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	CAS #	MCL*	Reporting Limit	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Haloacetic Acids								
Chloroacetic acid	79-11-8		2.0	2.0	U	µg/L	SM 6251.B	9/3/99
Bromoacetic acid	79-08-3		1.0	1.0	U	µg/L	SM 6251.B	9/3/99
Dichloroacetic acid	79-43-6		1.0	1.1		µg/L	SM 6251.B	9/3/99
Trichloroacetic acid	76-03-9		1.0	1.0	U	µg/L	SM 6251.B	9/3/99
Bromochloroacetic acid	5589-96-3		1.0	1.0	U	µg/L	SM 6251.B	9/3/99
Dibromoacetic acid	631-64-1		1.0	1.0	U	µg/L	SM 6251.B	9/3/99
HAA5		60	1.0	1.1		µg/L	SM 6251.B	9/3/99
2,3-Dibromopropanoic aci	600-05-5			115%	SS			
Trihalomethanes								
Chloroform	67-66-3		1.0	3.7		µg/L	EPA 502.2	8/31/99
Bromodichloromethane	75-27-4		1.0	1.7		µg/L	EPA 502.2	8/31/99
Dibromochloromethane	124-48-1		1.0	1.0	U	µg/L	EPA 502.2	8/31/99
Bromoform	75-25-2		1.0	1.0	U	µg/L	EPA 502.2	8/31/99
TTHM		80	1.0	5.4		µg/L	EPA 502.2	8/31/99
1,2-Dichloroethane-d4	17068-07-0			99%	SS			

U=Not detected at specified reporting limit
*=MCL according to Stage 1 of D/DBP rule
SS=Surrogate standard

CH2MHILL Applied Sciences Lab
CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

CVO 2300 NW Walnut Boulevard
Corvallis, OR 97330-3638
(541) 752-4271 FAX (541) 752-0276

COC #

Project #	Purchase Order #
Project Name: McAllen Reuse Pilot Study	
Company Name: City Of McAllen	
Project Manager or Contact & Phone #: Kathy McKinley	Report Copy to: Kathy McKinley
Requested Completion Date: ASAP	Site ID: WWTP#2
Sample Disposal: Dispose ☑ Return ☐	

THIS AREA FOR LAB USE ONLY

Lab #: 9964	Page 1 of 3
Lab PM	Custody Review
Log In	LIMS Verification
pH	Custody Seals Y N (Y circled)
	Ice Y N (Y circled)
QC Level 1 2 3 Other	
Cooler Temperature: 4	

Requested Analytical Method # / **Preservative**

Date	Time	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	UV 254 (Ice)	SDS HAAS, SDS THMS (Ice)	SDS HAAS SDS THMS (Ice)	TKN, NO3-NO2, T-Phosphorous (H_2SO_4)	TKN, NO3-NO2, T-Phosphorous (H_2SO_4)	TDS (Ice)	TKN, NO3-NO2, T-Phosphorous (H_2SO_4)	TKN, NO3-NO2, T-Phosphorous (H_2SO_4)	TDS (Ice)	Alternate Description	Lab ID
8/17/99	07:30		✓	✓			ZGP		1	✓										1
8/17/99	"		✓	✓			ROP [illegible]		1		✓									2
8/17/99	"		✓	✓			ZGP [illegible]		1			✓								1
8/17/99	"		✓	✓			ROC		1				✓							3
8/17/99	"		✓	✓			ROP		1					✓						2
8/17/99	"		✓	✓			ROC		1						✓					3
8/17/99	"		✓	✓			ZGP		1							✓				1
8/17/99	"		✓	✓			WWTP#2 Effluent		1								✓			4
8/17/99	"		✓	✓			WWTP#2 Effluent		1									✓		4

Relinquished By: Rosie Villarreal	Date/Time: 8/17/99 7:25	Received By: X K	Empty Bottles: 9	Date/Time: 8/17/99 07:25
Sampled By and Title: X K (Please sign and print name) Ramon Trevino	Date/Time: 8/17/99 7:30	Relinquished By: X K	(Please sign and print name) Ramon Trevino	Date/Time: 8/17/99 7:39
Received By: Rosie Villarreal (Please sign and print name) Rosie VillARREAL	Date/Time: 8/17/99 7:39	Relinquished By: Rosie Villarreal	(Please sign and print name) Rosie VillARREAL	Date/Time: 8/17/99
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS Fed-Ex Other	Shipping #	

Special Instructions:

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

CH2MHILL Applied Sciences Lab
CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

CVO 2300 NW Walnut Boulevard
Corvallis, OR 97330-3538
(541) 752-4271 FAX (541) 752-0276

COC # ______

Project #	Purchase Order #

Project Name: McAllen Reuse Pilot Study

Company Name: City Of McAllen

Project Manager or Contact & Phone #: Kathy Mckinley

Report Copy to: Kathy Mckinley

Requested Completion Date: ASAP

Site ID: WWTP#2

Sample Disposal: Dispose ☑ Return ☐

THIS AREA FOR LAB USE ONLY

Lab #	9964	Page 2	of 3
Lab PM		Custody Review	
Log In		LIMS Verification	
pH		Custody Seals	Y N (Y circled)
		Ice	Y N (Y circled)
QC Level 1 2 3		Other	
Cooler Temperature	4		

Requested Analytical Method #

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	TOC (Preservative: H_2SO_4)	VOCs-8260 (Preservative: HCl)	TOC (Preservative: H_2SO_4)	TOC (Preservative: H_2SO_4)	TOC (Preservative: H_2SO_4)	VOCs-8260 (Preservative: HCl)	Alternate Description	Lab ID
8/17/99	7:30		✓	✓			2GP		2	✓							1
8/17/99	7:30		✓	✓			ROP		2		✓						2
8/17/99	7:30		✓	✓			ROP		2			✓					2 4
8/17/99	7:30		✓	✓			WWTP#2 Effluent		2				✓				3
8/17/99	7:30		✓	✓			ROC		2					✓			1
8/17/99	7:30		✓	✓			2GP		2						✓		

Relinquished By: Rosie Villareal	Date/Time: 8/17/99 7:25	Received By: X R —	Empty Bottles: 14	Date/Time: 8/17/99 7:25
Sampled By and Title: X R — (Please sign and print name) Ramm Trevino	Date/Time: 8/17/99 7:30	Relinquished By: X R —	(Please sign and print name) Ramm Trevino	Date/Time: 8/17/99 7:39
Received By: Rosie Villareal (Please sign and print name) Rosie Villarreal	Date/Time: 8/17/99 7:39	Relinquished By: Rosie Villareal	(Please sign and print name) Rosie Villarreal	Date/Time: 8/17/99
Received By: (Please sign and print name)	Date/Time:	Shipped Via: UPS Fed-Ex Other ______	Shipping #	

Special Instructions:

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Clien

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COC #

Project #	
Purchase Order #	
Project Name	McAllen Reuse Pilot Study
Company Name	City of McAllen
Project Manager or Contact & Phone #	Kathy McKinley
Report Copy to:	Kathy McKinley
Requested Completion Date:	ASAP
Site ID	WWTP#2
Sample Disposal:	Dispose ☑ Return ☐

THIS AREA FOR LAB USE ONLY

Lab #	9964
Page	3 of 3
Lab PM	
Custody Review	
Log In	
LIMS Verification	
pH	
Custody Seals	Y / N (Y circled)
Ice	Y / N (Y circled)
QC Level	1 2 3 Other
Cooler Temperature	4

Requested Analytical Method #

	Al, Ba, Ca, Fe, Mg, Mn, K, Na, Sr, As, Cd, Cr, Pb, Hg, Se, As, Zn	Alkalinity, TDS, Color, Bromide, Chloride, Fluoride, Sulfate, Reactive Silica	Al, Ba, Ca, Fe, Mg, Mn, K, Na, Sr, As, Cd, Cr, Pb, Hg, Se, Ag, Zn	Alkalinity, TDS, Color, Bromide, Chloride, Fluoride, Sulfate, Reactive Silica
Preservative	HNO3	Ice	HNO3	Ice

Date	Time	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Metals (HNO3)	Alkalinity etc. (Ice)	Metals (HNO3)	Alkalinity etc. (Ice)	Alternate Description	Lab ID
8/17/99	7:30		✓	✓			ROP		1	✓					2
8/17/99	7:30		✓	✓			ROP		1		✓				2
8/17/99	7:30		✓	✓			ZGP		1			✓			1
8/17/99	7:30		✓	✓			ZGP		1				✓		1

Relinquished By: Rosie Villarreal	Date/Time: 8/17/99	Received By: X R	Empty Bottles: 4	Date/Time: 8/17/99
Sampled By and Title (Please sign and print name): X R Ramon Trevino	Date/Time: 8/17/99 7:30	Relinquished By (Please sign and print name): X R Ramon Trevino		Date/Time: 8/17/99 07:39
Received By (Please sign and print name): Rosie Villarreal ROSIE VILLARREAL	Date/Time: 8/17/99 07:39	Relinquished By (Please sign and print name): Rosie Villarreal ROSIE VILLARREAL		Date/Time: 8/17/99
Received By (Please sign and print name):	Date/Time:	Shipped Via: UPS Fed-Ex Other	Shipping #:	

Special Instructions:

Instructions and Agreement Provisions on Reverse Side

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Ms. Anne McKee-Robbins
CH2M HILL/CVO
2300 N.W. Walnut Blvd.
Corvallis, OR 97330

Columbia Analytical Services Report
City of McAllen
D9901502/D1227

September 13, 1999

Submitted by:

Bryan Jones

Bryan Jones
Project Manager/Client Services

TABLE OF CONTENTS

CAS Lab Reference No.: D1227
Level 1

Organic Data Qualifiers

A-- This qualifier indicates that a TIC is a suspected aldol-condensation product

B-- This flag is used when the analyte is found in the associated blank as well as the sample. This notation indicates possible blank contamination and suggests that the data user evaluate these compounds and their amounts carefully.

C-- The "C" flag indicates the presence of this compound has been confirmed by the GC/MS analysis.

D-- This qualifier is used for all the compounds identified in an analysis at a secondary dilution factor. "D" qualifiers are used only for the samples reported at more than one dilution factor.

E-- This flag indicates that the value reported exceeds the linear calibration range for that compound. Therefore, the sample should be reanalyzed at the appropriate dilution. The "E" qualified amount is an estimated concentration, and the results of the dilution will be reported on a separate Form I.

I-- The qualifier indicates that the reporting limit to the "I" qualifier has been raised. It is used when the chromatographic interference prohibits detection of a compound at a level below the concentration expressed on the Form I.

J-- Indicates an estimated value. It is used when the data indicates the presence of a target compound below the reporting limit or the presence of a Tentatively Identified Compound (TIC).

N-- This qualifier indicates presumptive evidence of a compound. This flag is only used for Tentatively Identified Compounds (TIC), where the identification is based on a mass spectral library research. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, the "N" qualifier is not used.

P-- This qualifier is used for Pesticide/Aroclor target analytes when there is a greater than 25% difference for detected concentrations between the two columns. The lower of the two values is reported on Form I and flagged with a "P".

U-- Indicates the compound was analyzed for but not detected. The number adjacent to the "U" qualifier indicates the reporting limit for that compound. The reporting limit can vary from sample to sample depending on dilution factors or percent moisture adjustments when indicated.

Organic Sample ID Qualifiers

The qualifiers that may be appended to the Lab Sample ID and/or the Client Sample ID for organic analysis are defined below:

DL-- Diluted reanalysis. Indicates that the results were determined in an analysis of a secondary dilution of a sample or extract. A digit to indicate multiple dilutions of the sample or extract may follow the "DL" suffix. The results of more than one diluted reanalysis may be reported.

MS-- Matrix spike (may be followed by a digit to indicate multiple matrix spikes within a sample set).

MSD-- Matrix spike duplicate (may be followed by a digit to indicate multiple matrix spikes within a sample set).

R-- Reanalysis. The extract was reanalyzed without re-extraction. The "R" is not used if the sample was also re-extracted. May be followed by a digit to indicate multiple reanalysis of the sample at the same dilution.

RE-- Re-extraction analysis. The sample was re-extracted and reanalyzed. May be followed by a digit to indicate multiple re-extracted analysis of the same sample at the same dilution.

Sample ID Cross-reference Table

CAS Lab Sample ID		Client Sample ID	Collect Date	Sample Matrix	Additional Description
FS = Field Sample					
D1227001	FS	ZGPERMEATE	08/17/99	Water	
D1227002	FS	ROPERMEATE	08/17/99	Water	

The above lab sample ID's and cross reference information apply to samples as received by the laboratory. Modifiers to the lab sample ID may be added for internal tracking purposes. Any modified sample ID will be reflected in the appropriate case narrative only.

GC ORGANOCHLORINE PESTICIDES

CASE NARRATIVE
GC ORGANOCHLORINE PESTICIDES

CAS Lab Reference No./SDG.: D1227

Project: City of McAllen

I. RECEIPT

No exceptions were encountered unless a Sample Receipt Exception Report is attached to the Chain-of-Custody included with this data package.

II. HOLDING TIMES

A. Sample Preparation: All holding times were met.

B. Sample Analysis: All holding times were met.

III. METHOD

Preparation: SW-846 3520C
Cleanup: NA
Analysis: SW-846 8081A

IV. PREPARATION

Sample volume may vary based on the amount of sample received per container.

V. ANALYSIS

A. Calibration. In the ending CCV, toxaphene, exceeded 15%D however the average of all analytes was within therefore no corrective action was taken.

1. Retention Time Windows: All analytes were within criteria.

2. Degradation: All acceptance criteria were met.

B. Blanks: All acceptance criteria were met.

C. Surrogates: All acceptance criteria were met.

D. Internal Standards: All acceptance criteria were met.

E. Spikes: All acceptance criteria were met.

F. Samples: Sample analysis proceeded normally.

I certify that this data package is in compliance with the terms and conditions agreed to by the client and Columbia Analytical Services, both technically and for completeness, except for the conditions noted above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designated person, as verified by the following signature.

SIGNED: J. Watega 9/10/99 Reviewer: Stephen Walker 9-10-99
Jerry Wategа
Scientist, GC Organics

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

PWB10820

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

Lab Sample ID: PWB10820

Matrix: WATER Level: LOW

Lab File ID: B0904010

Sample Wt/Vol: 1.000 L

Date Received:

Extract Vol: 10 ML

Date Extracted: 08/20/99

Column: DB5

Date Analyzed: 09/04/99

Extraction Type: Continuous

Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	gamma-BHC (Lindane)	0.0032	0.020	0.020	U
72-20-8	Endrin	0.0021	0.020	0.020	U
72-43-5	Methoxychlor	0.017	0.040	0.040	U
8001-35-2	Toxaphene	0.23	0.50	0.50	U

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

PWB10820LCS

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

Lab Sample ID: PWB10820LCS

Matrix: WATER Level: LOW

Lab File ID: B0904008

Sample Wt/Vol: 1.000 L

Date Received:

Extract Vol: 10 ML

Date Extracted: 08/20/99

Column: DB5

Date Analyzed: 09/04/99

Extraction Type: Continuous

Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	gamma-BHC (Lindane)	0.0032	0.020	0.56	
72-20-8	Endrin	0.0021	0.020	0.52	
72-43-5	Methoxychlor	0.017	0.040	0.46	
8001-35-2	Toxaphene	0.23	0.50	0.50	U

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

PWB10820LCS

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

Matrix: WATER Level: LOW

Sample Wt/Vol: 1.000 L

Extract Vol: 10 ML

Column: DB5

Extraction Type: Continuous

Lab Sample ID: PWB10820LCS

Lab File ID: B0904009

Date Received:

Date Extracted: 08/20/99

Date Analyzed: 09/04/99

Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	gamma-BHC (Lindane)	0.0032	0.020	0.020	U
72-20-8	Endrin	0.0021	0.020	0.090	
72-43-5	Methoxychlor	0.017	0.040	0.075	
8001-35-2	Toxaphene	0.23	0.50	5.1	

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

ZGPERMEATE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227 Lab Sample ID: D1227001

Matrix: WATER Level: LOW Lab File ID: B0904011

Sample Wt/Vol: 1.000 L Date Received: 08/18/99

Extract Vol: 10 ML Date Extracted: 08/20/99

Column: DB5 Date Analyzed: 09/04/99

Extraction Type: Continuous Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	gamma-BHC (Lindane)	0.0032	0.020	0.024	
72-20-8	Endrin	0.0021	0.020	0.020	U
72-43-5	Methoxychlor	0.017	0.040	0.040	U
8001-35-2	Toxaphene	0.23	0.50	0.50	U

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

ROPERMEATE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

Lab Sample ID: D1227002

Matrix: WATER Level: LOW

Lab File ID: B0904012

Sample Wt/Vol: 1.000 L

Date Received: 08/18/99

Extract Vol: 10 ML

Date Extracted: 08/20/99

Column: DB5

Date Analyzed: 09/04/99

Extraction Type: Continuous

Dilution Factor: 1.0

CAS NO. COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9-----gamma-BHC (Lindane)	0.0032	0.020	0.020	U
72-20-8-----Endrin	0.0021	0.020	0.020	U
72-43-5-----Methoxychlor	0.017	0.040	0.040	U
8001-35-2---Toxaphene	0.23	0.50	0.50	U

2C
WATER SEMIVOLATILE SURROGATE RECOVERY

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

	LAB ID	CLIENT ID.	S1 #	S2 #	S2	TOT OUT
01	PWB10820LCS	PWB10820LCS	107	86		0
02	PWB10820LCS	PWB10820LCS	105	72		0
03	PWB10820	PWB10820	102	76		0
04	D1227001	ZGPERMEATE	105	74		0
05	D1227002	ROPERMEATE	68	47		0
06						
07						
08						
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29						
30						

		QC LIMITS
S1	= Tetrachloro-m-xylene	(45-125)
S2	= Decachlorobiphenyl	(34-133)

Column to be used to flag recovery values
* Values outside of contract required QC limits
D Surrogates diluted out

3E
WATER PESTICIDE LAB CONTROL SAMPLE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227 Column: DB5

LCS - Sample No.: PWB10820

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
gamma-BHC (Lindane)	0.5000	0.0000	0.5583	112	73-125
Endrin	0.5000	0.0000	0.5193	104	43-134
Methoxychlor	0.5000	0.0000	0.4603	92	73-142

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 3 outside limits

COMMENTS: ______________________

3E
WATER PESTICIDE LAB CONTROL SAMPLE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227 Column: DB5

LCS - Sample No.: PWB10820

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Toxaphene	5.000	0.0000	5.095	102	41-126

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 1 outside limits

COMMENTS: ______

4B
SEMIVOLATILE METHOD BLANK SUMMARY

Client ID.

PWB10820

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

Lab File ID: B0904010 Lab Sample ID: PWB10820

Date Extracted: 08/20/99 Extraction Type: CONT

Date Analyzed: 09/04/99 Time Analyzed: 2010

Matrix: WATER Level:(low/med) LOW

Instrument ID: GCB

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	CLIENT ID.	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED
01	PWB10820LCS	PWB10820LCS	B0904008	09/04/99
02	PWB10820LCS	PWB10820LCS	B0904009	09/04/99
03	ZGPERMEATE	D1227001	B0904011	09/04/99
04	ROPERMEATE	D1227002	B0904012	09/04/99
05				
06				
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7B
PESTICIDE CONTINUING CALIBRATION CHECK

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Instrument ID: GCB   Case No.: D1227   SDG No.: D1227

Lab File ID: B0904004   CCV Date/Time: 09/04/99 1517

GC Column: DB5   ICAL Date/Time (1st pt): 08/23/99 0959

ICAL Date/Time (Last pt): 08/23/99 1314

Units : ug/mL

COMPOUND	AVERAGE RF	RF	CURVE	%D	MAX %d
alpha-BHC	2.751	2.834	AVG	3.0	15.0
beta-BHC	0.871	0.873	AVG	0.2	15.0
delta-BHC	2.640	2.722	AVG	3.1	15.0
gamma-BHC (Lindane)	2.495	2.682	AVG	7.5	15.0
Heptachlor	2.542	2.637	AVG	3.7	15.0
Aldrin	2.351	2.464	AVG	4.8	15.0
Heptachlor epoxide	2.134	2.243	AVG	5.1	15.0
Endosulfan I	1.886	1.816	AVG	-3.7	15.0
Dieldrin	2.243	2.299	AVG	2.5	15.0
4,4'-DDE	1.919	1.835	AVG	-4.4	15.0
Endrin	1.972	1.946	AVG	-1.3	15.0
Endosulfan II	1.832	1.774	AVG	-3.2	15.0
4,4'-DDD	1.503	1.447	AVG	-3.8	15.0
Endosulfan sulfate	1.801	1.593	AVG	-11.5	15.0
4,4'-DDT	1.717	1.709	AVG	-0.4	15.0
Methoxychlor	0.903	0.865	AVG	-4.2	15.0
Endrin ketone	1.951	1.832	AVG	-6.1	15.0
Endrin aldehyde	1.334	1.278	AVG	-4.2	15.0
alpha-Chlordane	2.115	2.176	AVG	2.9	15.0
gamma-Chlordane	2.117	2.087	AVG	-1.4	15.0
Tetrachloro-m-xylene	1.075	1.146	AVG	6.6	20.0
Decachlorobiphenyl	1.920	1.713	AVG	-10.8	20.0

FORM VII

7B
PESTICIDE CONTINUING CALIBRATION CHECK

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Instrument ID: GCB Case No.: D1227 SDG No.: D1227

Lab File ID: B0904005 CCV Date/Time: 09/04/99 1605

GC Column: DB5 ICAL Date/Time (1st pt): 08/22/99 1725

ICAL Date/Time (Last pt): 08/22/99 2040

Units : ug/mL

COMPOUND	AVERAGE RF	RF	CURVE	%D	MAX %d	
Toxaphene	0.044	0.038	AVG	-12.0	15.0	
(2)	0.047	0.039	AVG	-17.6	15.0	<-
(3)	0.050	0.048	AVG	-4.3	15.0	

FORM VII

7B

PESTICIDE CONTINUING CALIBRATION CHECK

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Instrument ID: GCB Case No.: D1227 SDG No.: D1227

Lab File ID: B0904020 CCV Date/Time: 09/05/99 0417

GC Column: DB5 ICAL Date/Time (1st pt): 08/23/99 0959

ICAL Date/Time (Last pt): 08/23/99 1314

Units : ug/mL

COMPOUND	AVERAGE RF	RF	CURVE	%D	MAX %d	
alpha-BHC	2.751	3.182	AVG	15.7	15.0	<-
beta-BHC	0.871	0.968	AVG	11.2	15.0	
delta-BHC	2.640	2.951	AVG	11.8	15.0	
gamma-BHC (Lindane)	2.495	2.825	AVG	13.2	15.0	
Heptachlor	2.542	2.917	AVG	14.7	15.0	
Aldrin	2.351	2.658	AVG	13.1	15.0	
Heptachlor epoxide	2.134	2.365	AVG	10.8	15.0	
Endosulfan I	1.886	1.963	AVG	4.1	15.0	
Dieldrin	2.243	2.438	AVG	8.7	15.0	
4,4'-DDE	1.919	1.922	AVG	0.2	15.0	
Endrin	1.972	2.030	AVG	2.9	15.0	
Endosulfan II	1.832	1.892	AVG	3.3	15.0	
4,4'-DDD	1.503	1.543	AVG	2.6	15.0	
Endosulfan sulfate	1.801	1.684	AVG	-6.5	15.0	
4,4'-DDT	1.717	1.732	AVG	0.9	15.0	
Methoxychlor	0.903	0.864	AVG	-4.3	15.0	
Endrin ketone	1.951	1.960	AVG	0.5	15.0	
Endrin aldehyde	1.334	1.342	AVG	0.6	15.0	
alpha-Chlordane	2.115	2.222	AVG	5.1	15.0	
gamma-Chlordane	2.117	2.223	AVG	5.0	15.0	
Tetrachloro-m-xylene	1.075	1.249	AVG	16.2	20.0	
Decachlorobiphenyl	1.920	1.792	AVG	-6.6	20.0	

FORM VII

7B
PESTICIDE CONTINUING CALIBRATION CHECK

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Instrument ID: GCB | Case No.: D1227 | SDG No.: D1227

Lab File ID: B0904021 | CCV Date/Time: 09/05/99 0506

GC Column: DB5 | ICAL Date/Time (1st pt): 08/22/99 1725

ICAL Date/Time (Last pt): 08/22/99 2040

Units : ug/mL

COMPOUND	AVERAGE RF	RF	CURVE	%D	MAX %d	
Toxaphene	0.044	0.039	AVG	-10.4	15.0	
(2)	0.047	0.036	AVG	-24.2	15.0	<-
(3)	0.050	0.043	AVG	-12.5	15.0	

FORM VII

PESTICIDE ANALYTICAL SEQUENCE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1227 SDG No.: D1227

GC Column: DB5 ID: 0.53 (mm) ICAL Date(s): 08/22/99 08/23/99

Instrument ID: GCB

	CLIENT SAMPLE NO.	LAB SAMPLE ID	DATE ANALYZED	TIME ANALYZED
01	PSTD#3 PEST	PSTD#3 PEST	09/04/99	1517
02	PSTD#3 TOX	PSTD#3 TOX	09/04/99	1605
03	PWB10820LCS	PWB10820LCS	09/04/99	1832
04	PWB10820LCS	PWB10820LCS	09/04/99	1921
05	PWB10820	PWB10820	09/04/99	2010
06	ZGPERMEATE	D1227001	09/04/99	2058
07	ROPERMEATE	D1227002	09/04/99	2147
08	PSTD#3 PEST	PSTD#3 PEST	09/05/99	0417
09	PSTD#3 TOX	PSTD#3 TOX	09/05/99	0506
10				
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☐ LRD 5090 Caterpillar Road, Redding, CA 96003-1412, (916) 244-5227 FAX (916) 244-4109
☐ LKW Canviro Analytical Laboratories, Inc., 50 Bathurst, Unit 12, Waterloo, Ontario, Canada N2V 2C5, (519) 747-2575 FAX (519) 747-3806
☐ CVO 2300 NW Walnut Boulevard, Corvallis, OR 97330-3638, (541) 752-4271 FAX (541) 752-0276

COC # 9801827

Project #	
Purchase Order #	
Project Name	McAllen ReUse Pilot Study
Company Name	City of McAllen
Project Manager or Contact & Phone #	Kathy McKinley 541/758-0235 #3144
Report Copy to:	Kathy McKinley 541-758-0235
Requested Completion Date:	ASAP
Site ID	City of McAllen NWTP#2
Sample Disposal:	Dispose ☑ Return ☐

Requested Analytical Method #: (1) Endrin, Lindane, Methoxychlor, Toxaphene; (2) Endrin, Lindane, Methoxychlor, Toxaphene

Preservative

Date	Time	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Endrin, Lindane, Methoxychlor, Toxaphene	Endrin, Lindane, Methoxychlor, Toxaphene	Alternate Description	Lab ID
8/17/99	07:30		✓	✓			2G Permeate		2	✓			1
8/17/99	07:30		✓	✓			RO Permeate		2		✓		2

THIS AREA FOR LAB USE ONLY

Lab #	D1227
Page	of
Lab PM	
Custody Review	screened 8/18/99
Log In	8/18/99
LIMS Verification	
pH	
Custody Seals	Y N
Ice	Y N
QC Level	1 2 3 Other
Cooler Temperature	2C

Relinquished By	Rosie Villarreal	Empty Bottles: 4	Date/Time: 07:25 8/17/99	Received By: XR	Empty Bottles: 4	Date/Time: 8/17/99 07:25
Sampled By and Title	XR (Please sign and print name) Ramon Trevino		Date/Time: 07:30 8/17/99	Relinquished By: XR	(Please sign and print name) Ramon Trevino	Date/Time: 8/17/99 07:39
Received By	Rosie Villarreal (Please sign and print name) Rosie Villarreal		Date/Time: 07:39 8/17/99	Relinquished By: Rosie Villarreal	(Please sign and print name) Rosie Villarreal	Date/Time: 8/17/99
Received By	Christine E Sutton (Please sign and print name)		Date/Time: 8/18/99 1000	Shipped Via: UPS (Fed-Ex) Other	Shipping #: 812900725209	

Special Instructions:

018

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client
REV 1/97 LAB FORM 340

Columbia Analytical Services inc.
An Employee-Owned Company

5090 Caterpillar Road
Redding Ca., 96003
Phone: 530-244-5227
Fax: 530-244-4109

SAMPLE RECEIPT EXCEPTION REPORT

Sample Batch Number: D1227	Client/Project: CITY of McALLEN

		Comments:
	1. No custody seal as required by project.	9) COC STATES CLIENT ID IS ZG PERMEATE. CONTAINER LABELS SAY ZENOGEM PERMEATE
	2. Analysis, description, date/time of collection not provided.	
	3. Samples broken or leaking on receipt.	
	4. Temperature of samples inappropriate for analysis requested.	
	5. Container inappropriate for analysis requested.	
	6. Inadequate sample volume.	
	7. Preservation inappropriate for analysis requested.	
	8. Samples received out of holding time for analysis requested.	
X	9. Descrepencies between COC form and container labels.	
	10. Other	

FRACTION(S) AFFECTED (specify which fraction was affected by the exceptions detailed above by writing the number of the exception next to it)

Unpreserved:	Metals:	GC Volatiles:	GC/MS Volatiles:
Cyanide:	Extractables:	Extractables:	Other (specify):

Corrective Actions Taken:

Not Required

BW 8/19/99

Notified:
___Client
___Client Services

By: [signature]
Date: 8/18/99

Sound Analytical Services, Inc.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 Pacific Hwy East • Tacoma, WA 98424
(253) 922-2310 • FAX (253) 922-5047
e-mail: sainc1@uswest.net

TRANSMITTAL MEMORANDUM

DATE: September 13, 1999

TO: Kathy McKinley
CH2M Hill
2300 NW Walnut Blvd.
Corvallis, OR 97330-3538

PROJECT: McAllen Reuse Pilot Study

REPORT NUMBER: 83466

Enclosed are the test results for two samples received at Sound Analytical Services on August 18, 1999.

The report consists of this transmittal memo, analytical results, quality control reports, a copy of the chain-of-custody, a list of data qualifiers and analytical narrative when applicable, and a copy of any requested raw data.

Should there be any questions regarding this report, please contact me at (253) 922-2310.

Sincerely,

Katie Downie

Katie Downie
Project Manager

Sound Analytical Services, Inc.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 Pacific Hwy East • Tacoma, WA 98424
(253) 922-2310 • FAX (253) 922-5047
e-mail: saincl@uswest.net

ANALYTICAL NARRATIVE

Client: CH2M Hill — Date: September 13, 1999

Project: McAllen Reuse Pilot Study — Lab No.: 83466

Delivered By: Federal Express

Condition of samples upon receipt: Samples were received in good condition. Chain of custody was in order.

Sample Identification:

Lab. No.	Client ID	Date Sampled	Matrix
83466-1	Zenogem Permeate	08-17-99	Liquid
83466-2	RO Permeate	08-17-99	Liquid

SAMPLE PREPARATION AND ANALYSIS

ORGANOCHLORINE HERBICIDES

Samples 83466-1 and 83466-2 were analyzed for organochlorine herbicides in accordance with EPA SW-846 Method 8151A GC/MS Modified. Samples 83466-1 and 83466-2 were extracted in accordance with EPA SW-846 Method 3510C on 8-24-99 and analyzed on 08-24-99. The samples were extracted and analyzed within the required holding time.

EPA SW-846 Method 8151A has been modified to include the use of a mass spectrometer (MS) for quantitation of the herbicides. The introduction to Method 8151A allows the use of the MS as a qualitative confirmation of detected compounds.

The relative percent difference (RPD) between the percent recoveries of Silvex in the blank spike and blank spike duplicate exceeded the quality control; acceptance limits. No corrective action was taken because there was no remaining sample volume for reextraction. The RPD has been flagged "N".

All other quality control parameters were within the acceptance limits.

No difficulties were encountered during the organochlorine herbicide analyses.

SOUND ANALYTICAL SERVICES, INC.

Client Name	CH2M Hill
Client ID:	ZENOGEM PERMEATE
Lab ID:	83466-01
Date Received:	8/18/99
Date Prepared:	8/24/99
Date Analyzed:	8/24/99
% Solids	-
Dilution Factor	10

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

			Recovery Limits	
Surrogate	**% Recovery**	**Flags**	**Low**	**High**
2,4-Dichlorophenylacetic acid	100		48	124

Analyte	**Result (ug/L)**	**PQL**	**MDL**	**Flags**
2,4-D	ND	0.095	0.083	
Silvex (2,4,5-TP)	ND	0.095	0.077	

SOUND ANALYTICAL SERVICES, INC.

Client Name	CH2M Hill
Client ID:	RO PERMEATE
Lab ID:	83466-02
Date Received:	8/18/99
Date Prepared:	8/24/99
Date Analyzed:	8/24/99
% Solids	-
Dilution Factor	10

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

Surrogate	**% Recovery**	**Flags**	**Recovery Limits Low**	**Recovery Limits High**
2,4-Dichlorophenylacetic acid	102		48	124

Analyte	**Result (ug/L)**	**PQL**	**MDL**	**Flags**
2,4-D	ND	0.1	0.09	
Silvex (2,4,5-TP)	ND	0.1	0.083	

SOUND ANALYTICAL SERVICES, INC.

Lab ID:	Method Blank - HB876
Date Received:	-
Date Prepared:	8/24/99
Date Analyzed:	8/24/99
% Solids	-
Dilution Factor	10

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

Surrogate	% Recovery	Flags	Recovery Limits Low	Recovery Limits High
2,4-Dichlorophenylacetic acid	97.6		48	124

Analyte	Result (ug/L)	PQL	MDL	Flags
2,4-D	ND	0.1	0.087	
Silvex (2,4,5-TP)	ND	0.1	0.081	

SOUND ANALYTICAL SERVICES, INC.

Blank Spike/Blank Spike Duplicate Report

Lab ID:	HB876
Date Prepared:	8/24/99
Date Analyzed:	8/24/99
QC Batch ID:	HB876

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

Compound Name	Blank Result (ug/L)	Spike Amount (ug/L)	BS Result (ug/L)	BS % Rec.	BSD Result (ug/L)	BSD % Rec.	RPD	Flag
Dalapon	0	5	2.91	58.2	3.07	61.4	5.4	
Dicamba	0	5	3.65	73	4.42	88.4	19	
2,4-D	0	5	5.24	105	4.81	96.2	-8.7	
Pentachlorophenol	0	5	5.3	106	5.77	115	8.1	
Silvex (2,4,5-TP)	0	5	4.36	87.2	3.2	64	-31	N
Dinoseb	0	5	4.44	88.8	4.11	82.2	-7.7	
MCPA	0	5	5.43	109	4.63	92.6	-16	

Chlorinated Herbicides by USEPA Method 8151A GC/MS Modified

Aquired 6/12/1999
Valid until12/12/99

8151 SURROGATE ACCEPTANCE CRITERIA

Surrogate	Water low %Rec	Water high %Rec	Soil Low %Rec	Soil High %Rec
2,4,6 - Tribromophenol	48	124	65	131
2,4-Dichlorophenylacetic Acid	48	142	60	142

8151 SPIKE ADVISORY LIMITS FOR %RECOVERY AND RPD

Compound Name	Water low %Rec	Water high %Rec	Water RPD %Rec	Soil Low %Rec	Soil High %Rec	Soil RPD %Rec
Dalapon	23	114	27	22	87	22
Dicamba	31	148	45	25	150	24
2,4-D	29	149	24	21	152	28
Pentachlorophenol	56	146	28	31	156	25
Silvex (2,4,5-TP)	42	129	19	54	149	22
Dinoseb	50	155	40	54	148	27
2,4-DB	29	125	25	31	123	32
MCPA	65	127	26	46	154	41

8151 SPIKE ADVISORY LIMITS FOR TCLP % RECOVERY AND RPD

Compound Name	Leachate Low %Rec	Leachate high %Rec	Leachate RPD
2,4-D	36	137	36
Silvex (2,4,5-TP)	42	149	36

SOUND ANALYTICAL SERVICES, INC.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE: (253) 922-2310 - FAX: (253) 922-5047

DATA QUALIFIERS AND ABBREVIATIONS

B1: This analyte was detected in the associated method blank. The analyte concentration was determined not to be significantly higher than the associated method blank (less than ten times the concentration reported in the blank).

B2: This analyte was detected in the associated method blank. The analyte concentration in the sample was determined to be significantly higher than the method blank (greater than ten times the concentration reported in the blank).

C1: Second column confirmation was performed. The relative percent difference value (RPD) between the results on the two columns was evaluated and determined to be $\leq$ 40%.

C2: Second column confirmation was performed. The RPD between the results on the two columns was evaluated and determined to be > 40%. The higher result was reported unless anomalies were noted.

M: GC/MS confirmation was performed. The result derived from the original analysis was reported.

D: The reported result for this analyte was calculated based on a secondary dilution factor.

E: The concentration of this analyte exceeded the instrument calibration range and should be considered an estimated quantity.

J: The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

MCL: Maximum Contaminant Level

MDL: Method Detection Limit

See analytical narrative.

ND: Not Detected

PQL: Practical Quantitation Limit

X1: Contaminant does not appear to be "typical" product. Elution pattern suggests it may be __________ .

X2: Contaminant does not appear to be "typical" product.

X3: Identification and quantitation of the analyte or surrogate was complicated by matrix interference.

X4: RPD for duplicates was outside advisory QC limits. The sample was re-analyzed with similar results. The sample matrix may be nonhomogeneous.

X4a: RPD for duplicates outside advisory QC limits due to analyte concentration near the method practical quantitation limit/detection limit.

X5: Matrix spike recovery was not determined due to the required dilution.

X6: Recovery and/or RPD values for matrix spike(/matrix spike duplicate) outside advisory QC limits. Sample was re-analyzed with similar results.

X7: Recovery and/or RPD values for matrix spike(/matrix spike duplicate) outside advisory QC limits. Matrix interference may be indicated based on acceptable blank spike recovery and/or RPD.

X7a: Recovery and/or RPD values for this spiked analyte outside advisory QC limits due to high concentration of the analyte in the original sample.

X8: Surrogate recovery was not determined due to the required dilution.

9: Surrogate recovery outside advisory QC limits due to matrix interference.

Sound Analytical Services, Inc.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 Pacific Hwy East • Tacoma, WA 98424
(253) 922-2310 • FAX (253) 922-5047
e-mail: sainc1@uswest.net

SAS Lab No. 83466

TURNAROUND REQUEST (business days)
Standard (10 days) ____
RUSH: 24 hrs ____ 48 hrs ____ 5 day ____

CHAIN OF CUSTODY/REQUEST FOR LABORATORY ANALYSIS

Client: City of McAllen
Project Name: McAllen Reuse Pilot Study
Contact: Kathy McKinley-Applied Sciences
Phone No.: 541/758-0235 ext. 3144
Fax No.: 541/766-2852
Email: kmckinle@ch2m.com

Analyses Requested

Lab Use Only	Sample ID	Date	Time	Matrix	# of Containers	2,4-D; 2,4,5-TP; Silvex	2,4-D; 2,4,5-TP Silvex
1	Zenogem Permeate	8/17/99	07:30	Liquid	1	✓	
2	RO Permeate	8/17/99	07:30	Liquid	1		✓

	Signature	Printed Name	Firm	Time/Date
Relinquished By:	R —	Ramon Trevino	City of McAllen	09:40 8/17/99
Received By	Rosie Villareal	Rosie Villarreal	City of McAllen	8/17/99 08:40
Relinquished By:	Rosie Villareal	Rosie Villarreal	City of McAllen	8/17/99
Received By	MHodgman	MHodgman	SAS	9:00 8/18/99
Relinquished				
Received By				

Special Instructions

COC No. ____________

Page ____ of ____

10/3

ENERGY LABORATORIES, INC.
SHIPPING: 2393 SALT CREEK HIGHWAY • CASPER, WY 82601
MAILING: P.O. BOX 3258 • CASPER, WY 82602
E-mail: energy@trib.com • FAX: (307) 234-1639 • PHONE: (307) 235-0515 • TOLL FREE: (888) 235-0515

CASE NARRATIVE

DATE: September 21, 1999
TO: Kathy McKinley
FROM: Sheryl Garling
RE: CH2MHill Water Samples

SAMPLE NUMBERS: 32370 001 through 002

Samples Zenogem Permeate and RO Permeate were received on August 18, 1999. Samples were shipped using Energy Laboratories, Inc. contract service with UPS. The overnight option was used for shipping the samples to the laboratory. Samples were in good condition and properly preserved.

No analytical problems were indicated for this sample delivery group.

The methods used are methods published by US EPA for drinking water analyses. The methods used are as follows:

Radium 226 - EPA Method 903.0 (alpha emitting),
Radium 228 - EPA Method 904.0, and
Gross Alpha -EPA Method 900.1 (gross alpha minus uranium and radon).

The standard detection limits for these methods are 0.2 pCi/L, 1.0 pCi/L, and 1.0 pCi/L, respectively. The initial e-mail response incorrectly identified methods and detection limits.

If additional information is required, please advise.

ENERGY LABORATORIES, INC.
SHIPPING: 2393 SALT CREEK HIGHWAY • CASPER, WY 82601
MAILING: P.O. BOX 3258 • CASPER, WY 82602
E-mail: energy@trib.com • FAX: (307) 234-1639 • PHONE: (307) 235-0515 • TOLL FREE: (888) 235-0515

Billings • Casper • Gillette • Rapid City

LABORATORY ANALYSIS REPORT - CH_2M HILL

Project:	McAllen Reuse Pilot Study	
Sample ID:	Zenogem Permeate	RO Permeate
Laboratory ID:	32370-001	32370-002
Sample Matrix:	Water	
Sample Date/Time:	08-17-99 @ 07:30	
Date Received:	08-18-99	
Report Date:	September 12, 1999	

Radiometric		Method	Reporting Limit	Units	Results	
Radium-226	^{226}Ra	903.0	0.2	pCi/L	<0.2	<0.2
Radium Precision ±					-	-
Radium-228	^{228}Ra	904.0	1.0	pCi/L	<1.0	<1.0
Radium Precision ±					-	-
Gross Alpha	Gross α	900.1	1.0	pCi/L	<1.0	<1.0
G. Alpha Precision ±					-	-

lmh r:\Reports\Clients.99\CH2M_Hill\Water\rc32370-001.xls

Log In No. 32370

ELI

RADIOCHEMICAL QUALITY ASSURANCE REPORT - CH_2M HILL

Laboratory ID Range:	32370-001-002
Sample Matrix:	Water
Sample Date / Time:	08-17-99 @ 07:30
Date Received:	08-18-99
Report Date:	September 12, 1999

	Method	Relative Percent Difference[1]	Spike Recovery (Percent)[2]	LCS Recovery (Percent)	Method Blank (pCi/L)[3]	Date Analyzed	Analyst
Laboratory #:		56010-001	90156-001		GA-18633		
Gross Alpha:	900.1	0.0	92	98	<1.0	08-24-99	RS
Laboratory #:		32627-001	32428-003		RA-186		
Radium-226:	903.0	0.8	98	104	<0.2	09-07-99	RS
Laboratory #:		32443-001	32443-002		228-212		
dium-228:	904.0	0.0	117	119	<1.0	09-10-99	LMH

(1) These values are an assessment of analytical precision. The acceptance range is 0-20% for sample results above 10 times the reporting limit. This range is not applicable to samples with results below 10 times the reporting limit.

(2) These values are an assessment of analytical accuracy. They are a percent recovery of the spike addition. ELI performs a matrix spike on 10 percent of all samples for each analytical method.

(3) Uranium is reported in mg/L.

eport Approved By: D. Yaeda

Reviewed By: Eckl

lmh r:\Reports\Clients.99\CH2M_Hill\Water\rc32370-001.xls

Log In No. 32370

Log In. No.

99CASA446C

ENERGY LABORATORIES • Billings • Casper • Gillette • Rapid City

ENERGY LABORATORIES, INC — **CHAIN OF CUSTODY RECORD**

Mail Only: PO Box 3258 • Casper, WY • 82602-3258

UPS/FedEx Deliveries: 2393 Salt Creek Highway • Casper, WY • 82601

toll free 1 235-0515
voice 307-235-0515
fax 307-234-1639

For Sample Tracking Purposes, Please Provide Contact Name and Telephone #'s as Indicated *(SEE BACK OF FORM FOR EXAMPLES AND INSTRUCTIONS)*

Project Name / Location / Purchase Order # / Bid #: McAllen Reuse Pilot Study / McAllen, TX. / NO. P.O.#

Name / Phone # / Fax #: Kathy McKinley CH2M Hill / 541-758-0235 #3144 / 541-766-2852

Send Invoice to: Kathy McKinley CH2M Hill Applied Sciences Group (call @ above phone number)

Send Report to: Same as above

Special Requests: Stnd TAT

Comments, Special Instructions, etc.:

Type of Analyses Requested

Date	Time	composite	grab sample	Sample I.D.	Number of containers (Sample Type: A (W) S V U O — Air Water Soils/solids Vegetation Urine Other)	Radium 226, Radium 228, Gross Alpha	Radium 226, Radium 228, Gross Alpha				
8/17/99	07:30		✓	ZenoGem Permeate	1	X					
8/17/99	07:30		✓	RO Permeate	1		X				
				ARS-A7							

1. Sampler: (signature)	Date	Time	Received by: (signature)	2. Relinquished by: (signature)	Date	Time	Received by: (signature)
R——	8/17/99	07:30	Rosie Villareal	Rosie Villareal	8/17/99		
3. Relinquished by: (signature)	**Date**	**Time**	**Received by: (signature)**	**4. Relinquished by: (signature)**	**Date**	**Time**	**Received at Laboratory by: (signature)**
					8-18-99	10:15	Kris Parrish

9-8-99

ENERGY LABORATORIES, INC.'S CHAIN OF CUSTODY RECORD

Mail Only: PO Box 3258 • Casper, WY • 82602-3258

UPS/FedEx Deliveries: 2393 Salt Creek Highway • Casper, WY • 82602

voice 307-235-0515
fax 307-234-1639

For Sample Tracking Purposes, Please Provide Contact Name and Telephone #'S As Indicated (SEE BACK OF FORM FOR EXAMPLES AND INSTRUCTIONS)

Project Name / Location / Purchase Order #
Thunderbasin Town of Hope No PO #

Name / Phone # / Fax #
Jeff Jones @ (307) 555-1515, (307) 555-5555 fax

Send Invoice to: Jeff Jones
PO Box Nowhere
Hope, WY 80000

Send Report to: Bob Brown
PO Box Somewhere
USA, WY 81111

Special Requests: Please fax results as soon as possible Thank you.

Date	Time	composite	grab sample	Sample I.D.	Number of containers (Sample Type: A W S V U O — Air Water Soils/solids Vegetation Urine Other)	Asbestos - TEM	IOC's - RADs	NO_2, NO_3, F	VOCs - 502.2	SOCs - 504, 505, 508	SOCs - 515, 531.1	Comments, Special Instructions, etc.
1995												
5/28	11:35		X	Entry to Distribution	4	X			X			Phase II SDWA Primary
5/28	11:45		X	Distribution Tap	9		X	X		X	X	"

1. Sampler: (signature)	Date	Time	Received by: (signature)	2. Relinquished by: (signature)	Date	Time	Received by: (signature)
Jeff Jones	5-28-95	12:05p	Harry Truckers	Harry Truckers	5-28-95	13:15p	Sheryl A. Garling
3. Relinquished by: (signature)	**Date**	**Time**	**Received by: (signature)**	**4. Relinquished by: (signature)**	**Date**	**Time**	**Received at Laboratory by:**
N/A	N/A	N/A	N/A	Sheryl A. Garling	5-28-95	14:00p	Roger A. Garling

Instructions:

(1) A completed Chain-of-Custody must be submitted with all samples
(2) Special Requests area can include (but not limited to) the following:
- Turnaround status, Rush status, Due Date, etc.
- Special mailing instructions:
  - send copy of Report and/or Invoice to a second party
  - send copy of Report to a Government Agencies (EPA, etc.)
- Public Water System (PWS) Number
- Do you want samples returned to you or disposed of?

Scope of Work/Instructions

CH2M HILL Point of Contact for Final report/Invoicing

CH2M HILL
Kathy McKinley
2300 NW Walnut Blvd.
Corvallis, OR 97330

Phone: 541/758-0235 ext. 3144
FAX: 541/766-2852

Analytical Methods/Prices:
Radium 226 by EPA 903.0 for $40 per sample
Radium 228 by EPA 904.0 for $50 per sample
Gross Alpha by EPA 903.0 for $35 per sample

Sample Delivery: $25
Return Cooler/Samples: $6.40

The laboratory shall clearly and completely document and justify the preparation and analysis procedures when modifications to the methods have been made/requested.

Holding Times: Samples must be analyzed within EPA holding for each analytical method specified. CH2M HILL will deliver samples to the laboratory in a timely manner to facilitate the meeting of holding times.

Quality Assurance/Quality Control Requirements: QA/QC procedures will follow the protocols set forth in the EPA methods.

Data Package: A final data package must be submitted to CH2M HILL. The package will include: a lab narrative and data summary.

The laboratory narrative will include:

A description of any deviation from the prescribed methodologies or protocols as discussed in this SOW.

Summarization of quality control information exceeding the laboratory's acceptance criteria, a discussion of possible reasons for these discrepancies, and a description of corrective action taken.

All blank values exceeding three times the average method blank will be addressed.

A synopsis of all holding times achieved.

A discussion of any other analytical problems that may have been encountered.

Turnaround Time: Standard (3 weeks)

CH2MHILL
Applied Sciences Group

CH2M HILL
Applied Sciences Group
2300 NW Walnut Blvd
Corvallis, OR
97330-3538
P.O. Box 428
Corvallis, OR
97339-0428
Tel 541.752.4271
Fax 541.752.0276

October 26, 1999

McAllen WWTP #2, City of

149462.A1.ZG

RE: Analytical Data for McAllen WWTP #2, City of
Applied Sciences Group Reference No. 3089

Angie Fernandez/PHX:

On September 15, 1999, CH2M HII ... Group received four samples with a request for analysis of selected para ... attached.

The analytical results and associate ... usual difficulties encountered during the ... case narrative.

4 PO Conc WWTP

Under CH2M HILL policy, your ... ting. If you have not given us prior instructio ... nples require disposal as hazardous waste.

CH2M HILL Applied Sciences (... rward to serving your analytical needs ag ... ning the data, or if you need additional informati ... 758-0235, extension 3120.

Sincerely,

Kelly Ensor
Senior Administrative Assistant

Enclosures

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL Applied Sciences Group Reference No. 3089

Sample ID	Client Sample ID	Date Collected	Time Collected
308901	ZGP	09/14/1999	08:50
308902	ROP	09/14/1999	08:50
308903	WWTP#2Effluent	09/14/1999	08:50
308904	ROC	09/14/1999	08:50

CASE NARRATIVE
VOLATILES

Lab Reference No.: 3089

Client/Project: McAllen WWTP #2, City of

I. Holding Times:
All acceptance criteria were met.

II. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. Duplicate Sample(s):
All acceptance criteria were met.

D. Spike Sample(s):
All acceptance criteria were met.

E. Surrogate Recoveries:
All acceptance criteria were met.

F. Lab Control Sample(s):
All acceptance criteria were met.

G. Other:
None

III. Documentation Exceptions:
None

IV. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: Joseph A. Hardy

CASE NARRATIVE
GENERAL CHEMISTRY

Lab Reference No.: 3089

Client/Project: McAllen WWTP #2, City of

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. Matrix Spike Sample(s):
All acceptance criteria were met.

D. Duplicate Sample(s):
All acceptance criteria were met.

E. Lab Control Sample(s):
All acceptance criteria were met.

F. Other:
Not applicable.

IV. Documentation Exceptions:
None.

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ______________________

Reviewed by: ______________________

CASE NARRATIVE
METALS

Lab Reference No.: 3089

Client/Project: McAllen WWTP #2, City of

I. Holding Time:
All acceptance criteria were met.

II. Digestion Exceptions:
None.

III. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. ICP Interference Check Sample:
All acceptance criteria were met.

D. Spike Sample(s):
All acceptance criteria were met.

E. Duplicate Sample(s):
All acceptance criteria were met.

F. Laboratory Control Sample(s):
All acceptance criteria were met.

G. ICP Serial Dilution:
Not Required.

H. Other:
None

IV. Documentation Exceptions:
None

V. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Prepared by: ____________________

Reviewed by: ____________________

CH2M HILL
Applied Sciences Group
2300 NW Walnut Blvd
Corvallis, OR
97330-3538
P.O. Box 428
Corvallis, OR
97339-0428
Tel 541.752.4271
Fax 541.752.0276

CH2MHILL
Applied Sciences Group

October 4, 1999

McAllen WWTP #2, City of

149462.A1.ZG

RE: Analytical Data for McAllen WWTP #2, City of
Applied Sciences Group Reference No. 3089 & 3113

Angie Fernandez/PHX:

On September 15, 1999, CH2M HILL Applied Sciences Group received four samples with a request for analysis of selected parameters. From two of these samples, CH2M HILL Applied Sciences Group generated two samples with a request for analysis of selected parameters.

The analytical results and associated quality control data are enclosed. Any unusual difficulties encountered during the analysis of your samples are discussed in the case narrative.

Under CH2M HILL policy, your samples will be stored for 30 days after reporting. If you have not given us prior instructions for disposal, we will contact you if any samples require disposal as hazardous waste.

CH2M HILL Applied Sciences Group appreciates your business and looks forward to serving your analytical needs again. If you should have any questions concerning the data, or if you need additional information, please call Ms. Kathy McKinley at (541) 758-0235, extension 3120.

Sincerely,

Kelly Ensor
Senior Administrative Assistant

Enclosures

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL Applied Sciences Group Reference No. 3089 & 3113

Sample ID	Client Sample ID	Date Collected	Time Collected
308901	ZGP	9/14/99	8:50
308902	ROP	9/14/99	8:50
308903	WWTP#2Effluent	9/14/99	8:50
308904	ROC	9/14/99	8:50
311301	ZGP-3D	9/20/99	
311302	ROP-3D	9/20/99	

CASE NARRATIVE
DBPs/ORGANICS

Lab Reference No.: 3089 & 3113

Client/Project: McAllen WWTP #2, City of

I. Holding Times:
All acceptance criteria were met.

II. Analysis:

A. Calibration:
All acceptance criteria were met.

B. Blanks:
All acceptance criteria were met.

C. Duplicate Sample(s):
All acceptance criteria were met.

D. Spike Sample(s):
All acceptance criteria were met.

E. Surrogate Recoveries:
All acceptance criteria were met.

F. Lab Control Sample(s):
All acceptance criteria were met.

G. Other:
None

III. Documentation Exceptions:
None

IV. I certify that this data package is in compliance with the terms and conditions agreed to by the client and CH2M HILL, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designee, as verified by the following signature.

Prepared by: ______________________________

Reviewed by: ______________________________

Formation Potential Test Conditions

Client ID	Lab ID	FP Dose	Free Residual	Free Demand	Total Residual	FP Temp.	Measured pH	FP Start	FP Take-Off	FP Time H:M	FP Time (Hour)
ZGP	308901	10.00	0.21	9.79	--	23	7.9	9/17/99 12:05	9/20/99 13:17	73:12	73.20
ROP	308902	1.60	0.71	0.89	--	23	7.7	9/17/99 12:12	9/20/99 13:21	73:09	73.15

Formation Potential Trihalomethanes (THMs) Disinfection By-Products, (ug/L)

Client ID	Lab ID	FP CHCl3	FP BDCM	FP DBCM	FP CHBr3	FP TTHM
ZGP-3D	311301	105	77.6	51.5	9.5	244
ROP-3D	311302	2.9	2.9	2.5	<1	8.3

CHCl3 = Chloroform
BDCM = Bromodichloromethane
DBCM = Dibromochloromethane
CHBr3 = Bromoform

EPA TTHM Stage 1 MCL = 80 ug/L
EPA TTHM Stage 2 MCL = 40 ug/L

Formation Potential Haloacetic Acids (HAAs) Disinfection By-Products (ug/L)

Client ID	Lab ID	FP MCAA *	FP MBAA *	FP DCAA *	FP TCAA *	FP BCAA	FP DBAA *	FP HAA5	FP HAA6
ZGP-3D	311301	7.5	3.2	39.8	31.3	22.8	8.8	90.6	113
ROP-3D	311302	<2	<1	1.1	<1	<1	<1	1.1	1.1

MCAA = Monochloroacetic acid
MBAA = Monobromoacetic acid
DCAA = Dichloroacetic acid
TCAA = Trichloroacetic acid

BCAA = Bromochloroacetic acid
DBAA = Dibromoacetic acid
** These compounds make up the HAA5*

EPA HAA5 Stage 1 MCL = 60 ug/L
EPA HAA5 Stage 2 MCL = 30 ug/L

CH2M HILL
Applied Sciences Group

2300 NW Walnut Blvd., Corvallis, OR 97330-3538
P.O. Box 428, Corvallis, OR 97339-0428

Tel 541.752.4271
Fax 541.752.0276

2nd Set ROC
4 WWTP Eff

CH2M HILL Applied Sciences Laboratory

Client Information

Client Sample ID: ROC

Project Name: McAllen WWTP #2, City of
Project Manager: Angie Fernandez/PHX
Sampled By: R. Villareal
Sampling Date: 09/14/1999
Sampling Time: 8:50
Type: Grab
Matrix: Water
Basis: As Received

Lab Information

Lab Sample ID: 308904

Date Received: 09/15/1999
Report Revision No.: 0
Analyzed By: MG/MAS/DHK
Reviewed By:

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
N-Nitrate/Nitrite	0.20	24.4		mg/L	EPA 353.2	09/20/99
N-Total Kjeldahl	2.0	3.6		mg/L	EPA 351.4	09/21/99
Total Dissolved Solids	10	4,330		mg/L	EPA 160.1	09/20/99
TOC	5.0	22.6		mg/L	EPA 415.1/2	09/21/99
Total Phosphate-P	1.0	10.5		mg/L	EPA 365.2/4	09/21/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**WWTP#2Effluent**	**Lab Sample ID:**	**308903**
Project Name:	McAllen WWTP #2, City of	Date Received:	09/15/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Villareal	Analyzed By:	MG/MAS/DHK
Sampling Date:	09/14/1999	Reviewed By:	
Sampling Time:	8:50		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
N-Nitrate/Nitrite	0.04	3.94		mg/L	EPA 353.2	09/20/99
N-Total Kjeldahl	2.0	2.0	U	mg/L	EPA 351.4	09/21/99
Total Dissolved Solids	10	1,060		mg/L	EPA 160.1	09/20/99
TOC	0.50	6.10		mg/L	EPA 415.1/2	09/20/99
Total Phosphate-P	0.10	1.78		mg/L	EPA 365.2/4	09/21/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

2nd Set IPR

Client Information		Lab Information	
Client Sample ID:	**ZGP**	**Lab Sample ID:**	**308901**
Project Name:	McAllen WWTP #2, City of	Date Received:	09/15/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Villareal	Analyzed By:	MG/MAS/JJB/DHK
Sampling Date:	09/14/1999	Reviewed By:	MB DHK
Sampling Time:	8:50		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity (as CaCO3)	2.0	153		mg/L	EPA 310.2	09/24/99
Bromide	0.020	0.322		mg/L	EPA 300.0-B	09/20/99
Chloride	2.0	281		mg/L	EPA 300.0-A	09/22/99
Color (APHA) Apparent	---	17		color units	EPA 110.2	09/15/99
Fluoride	0.10	1.14		mg/L	EPA 300.0-A	09/22/99
N-Ammonia	0.10	0.10	U	mg/L	EPA 350.3	09/23/99
N-Nitrate/Nitrite	0.04	7.90		mg/L	EPA 353.2	09/20/99
N-Total Kjeldahl	2.0	2.0	U	mg/L	EPA 351.4	09/21/99
Silica-React.	0.4	16.1		mg/L	SM4500-Si D	09/23/99
Sulfate	2.0	247		mg/L	EPA 300.0-A	09/22/99
Total Dissolved Solids	10	1,950		mg/L	EPA 160.1	09/20/99
TOC	0.50	5.90		mg/L	EPA 415.1/2	09/20/99
Total Phosphate-P	0.10	2.89		mg/L	EPA 365.2/4	09/21/99
UV-254	0.009	0.126		asb/cm	SM5910	09/15/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	ZGP	Lab Sample ID:	308901
Project Name:	McAllen WWTP #2, City of	Date Received:	09/15/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Villareal	Reported By:	JG
Sampling Date:	09/14/99	Reviewed By:	AW
Sampling Time:	08:50		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Aluminum, Al	100	100	U	µg/L	SW6010B	10/14/99
Arsenic, As	10.0	10.0	U	µg/L	SW6010B	10/14/99
Barium, Ba	25.0	61.6		µg/L	SW6010B	10/14/99
Cadmium, Cd	5.0	5.0	U	µg/L	SW6010B	10/14/99
Calcium, Ca	500	86900		µg/L	SW6010B	10/14/99
Chromium, Cr	10.0	10.0	U	µg/L	SW6010B	10/14/99
Iron, Fe	100	100	U	µg/L	SW6010B	10/14/99
Lead, Pb	3.0	3.0	U	µg/L	SW6010B	10/14/99
Magnesium, Mg	500	25600		µg/L	SW6010B	10/14/99
Manganese, Mn	10.0	17.0		µg/L	SW6010B	10/14/99
Mercury, Hg	0.3	0.3	U	µg/L	SW7470A	09/28/99
Potassium, K	2000	29900		µg/L	SW6010B	10/14/99
Selenium, Se	7.0	7.0	U	µg/L	SW6010B	10/14/99
Silver, Ag	10.0	10.0	U	µg/L	SW6010B	10/14/99
Sodium, Na	1000	253000		µg/L	SW6010B	10/14/99
Strontium, Sr	100	2000		µg/L	SW6010B	10/14/99
Zinc, Zn	20.0	54.4		µg/L	SW6010B	10/14/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**ZGP**	**Lab Sample ID:**	**308901**
Project Name:	McAllen WWTP #2, City of	Analysis Method:	SW 8260B
Project Manager:	Angie Fernandez/PHX	Units:	µg/L
Sampled By:	R. Villareal	Date Received:	9/15/99
Date Collected:	9/14/99	Date Analyzed:	9/27/99
Time Collected:	8:50	Dilution Factor:	1
Type:	Grab	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	As Received	Reviewed By:	SAH

Analyte	CAS #	Reporting Limit	Sample Result	Qualifier
Purgeable Volatiles				
Vinyl Chloride	75-01-4	1.0	1.0	U
trans-1,2-Dichloroethene	156-60-5	1.0	1.0	U
cis-1,2-Dichloroethene	156-59-4	1.0	1.0	U
1,1,1-Trichloroethane	71-55-6	1.0	1.0	U
Carbon Tetrachloride	56-23-5	1.0	1.0	U
Trichloroethene	79-01-6	1.0	1.0	U
1,4-Dichlorobenzene	106-46-7	1.0	1.0	U
Dibromofluoromethane	1868-53-7		103%	SS
1,2-Dichloroethane-d4	17068-07-0		94%	SS
Toluene-d8	2037-26-5		115%	SS
p-Bromofluorobenzene	460-00-4		95%	SS

E=Estimated value above instrument calibration range
J=Estimated value below reporting limit
U=Not detected at specified reporting limit
SS=Surrogate standard

CH2M HILL Applied Sciences Laboratory

Client Information

Client Sample ID: ROP

Project Name: McAllen WWTP #2, City of
Project Manager: Angie Fernandez/PHX
Sampled By: R. Villareal
Sampling Date: 09/14/1999
Sampling Time: 8:50
Type: Grab
Matrix: Water
Basis: As Received

Lab Information

Lab Sample ID: 308902

Date Received: 09/15/1999
Report Revision No.: 0
Analyzed By: MG/MAS/JJB/DHK
Reviewed By: [signature]

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
General Chemistry						
Alkalinity (as CaCO3)	2.0	16		mg/L	EPA 310.2	09/24/99
Bromide	0.020	0.020	U	mg/L	EPA 300.0-B	09/20/99
Chloride	0.10	15.2		mg/L	EPA 300.0-A	09/22/99
Color (APHA) Apparent	---	5		color units	EPA 110.2	09/15/99
Fluoride	0.10	0.45		mg/L	EPA 300.0-A	09/22/99
N-Ammonia	0.10	0.10	U	mg/L	EPA 350.3	09/23/99
N-Nitrate/Nitrite	0.01	1.08		mg/L	EPA 353.2	09/20/99
N-Total Kjeldahl	2.0	2.0	U	mg/L	EPA 351.4	09/21/99
Silica-React.	0.4	0.9		mg/L	SM4500-Si D	09/23/99
Sulfate	0.10	5.31		mg/L	EPA 300.0-A	09/22/99
Total Dissolved Solids	10	72		mg/L	EPA 160.1	09/20/99
TOC	0.50	0.52		mg/L	EPA 415.1/2	09/20/99
Total Phosphate-P	0.10	0.10	U	mg/L	EPA 365.2/4	09/21/99

U=Not detected at specified reporting limits

CH2M HILL
Applied Sciences Group

2300 NW Walnut Blvd., Corvallis, OR 97330-3538
P.O. Box 428, Corvallis, OR 97339-0428

Tel 541.752.4271
Fax 541.752.0276

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**ROP**	**Lab Sample ID:**	**308902**
Project Name:	McAllen WWTP #2, City of	Date Received:	09/15/1999
Project Manager:	Angie Fernandez/PHX	Report Revision No.:	0
Sampled By:	R. Villareal	Reported By:	JG
Sampling Date:	09/14/99	Reviewed By:	
Sampling Time:	08:50		
Type:	Grab		
Matrix:	Water		
Basis:	As Received		

Analyte	MRL	Sample Result	Qualifier	Units	Analysis Method	Date Analyzed
Aluminum, Al	100	100	U	µg/L	SW6010B	10/14/99
Arsenic, As	10.0	10.0	U	µg/L	SW6010B	10/14/99
Barium, Ba	25.0	25.0	U	µg/L	SW6010B	10/14/99
Cadmium, Cd	5.0	5.0	U	µg/L	SW6010B	10/14/99
Calcium, Ca	500	833		µg/L	SW6010B	10/14/99
Chromium, Cr	10.0	10.0	U	µg/L	SW6010B	10/14/99
Iron, Fe	100	100	U	µg/L	SW6010B	10/14/99
Lead, Pb	3.0	3.0	U	µg/L	SW6010B	10/14/99
Magnesium, Mg	500	500	U	µg/L	SW6010B	10/14/99
Manganese, Mn	10.0	10.0	U	µg/L	SW6010B	10/14/99
Mercury, Hg	0.3	0.3	U	µg/L	SW7470A	09/28/99
Potassium, K	2000	2000	U	µg/L	SW6010B	10/14/99
Selenium, Se	7.0	7.0	U	µg/L	SW6010B	10/14/99
Silver, Ag	10.0	10.0	U	µg/L	SW6010B	10/14/99
Sodium, Na	1000	16200		µg/L	SW6010B	10/14/99
Strontium, Sr	100	100	U	µg/L	SW6010B	10/14/99
Zinc, Zn	20.0	20.0	U	µg/L	SW6010B	10/14/99

U=Not detected at specified reporting limits

CH2M HILL Applied Sciences Laboratory

Client Information		Lab Information	
Client Sample ID:	**ROP**	**Lab Sample ID:**	**308902**
Project Name:	McAllen WWTP #2, City of	Analysis Method:	SW 8260B
Project Manager:	Angie Fernandez/PHX	Units:	µg/L
Sampled By:	R. Villareal	Date Received:	9/15/99
Date Collected:	9/14/99	Date Analyzed:	9/27/99
Time Collected:	8:50	Dilution Factor:	1
Type:	Grab	Report Revision No.:	0
Matrix:	Water	Reported By:	MCB
Basis:	As Received	Reviewed By:	DAK

Analyte	CAS #	Reporting Limit	Sample Result	Qualifier
Purgeable Volatiles				
Vinyl Chloride	75-01-4	1.0	1.0	U
trans-1,2-Dichloroethene	156-60-5	1.0	1.0	U
cis-1,2-Dichloroethene	156-59-4	1.0	1.0	U
1,1,1-Trichloroethane	71-55-6	1.0	1.0	U
Carbon Tetrachloride	56-23-5	1.0	1.0	U
Trichloroethene	79-01-6	1.0	1.0	U
1,4-Dichlorobenzene	106-46-7	1.0	0.6	J
Dibromofluoromethane	1868-53-7		110%	SS
1,2-Dichloroethane-d4	17068-07-0		102%	SS
Toluene-d8	2037-26-5		115%	SS
p-Bromofluorobenzene	460-00-4		104%	SS

E=Estimated value above instrument calibration range
J=Estimated value below reporting limit
U=Not detected at specified reporting limit
SS=Surrogate standard

CH2M HILL Applied Sciences Lab
CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

CVO 2300 NW Walnut Boulevard
Corvallis, OR 97330-3638
(541) 752-4271 FAX (541) 752-0276

COC # ____

Project #	
Purchase Order #	
Project Name	McAllen Re Use Pilot Study
Company Name	City of mcallen
Project Manager or Contact & Phone #	Kathy McKinley
Report Copy to:	Kathy McKinley
Requested Completion Date:	ASAP
Site ID	W.W.T.P. #2
Sample Disposal:	Dispose ☑ Return ☐

THIS AREA FOR LAB USE ONLY

Lab #	3089
Page	1 of 3
Lab PM	
Custody Review	
Log In	
LIMS Verification	
pH	
Custody Seals	Y N
Ice	Y N
QC Level	1 2 3 Other ____
Cooler Temperature	2

Sampling Date	Sampling Time	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	TOC	VOCS-8260	TOC	TOC	TOC	VOCS-8260	Alternate Description	Lab ID
Preservative										H_2SO_4	HCl	H_2SO_4	H_2SO_4	H_2SO_4	HCl		
9/14/99	08:50		✓				ZGP	✓	2	✓							1
9/14/99	08:50		✓	✓			ROP	✓	3		✓						2
9/14/99	08:50		✓	✓			ROP	✓	2			✓					2
9/14/99	08:50		✓	✓			WWTP#2 Effluent	✓	2				✓				3
9/14/99	08:50		✓	✓			ROC	✓	2					✓			4
9/14/99	08:50		✓	✓			ZGP	✓	2						✓		1

Relinquished By: Rosie Villarreal	Date/Time 9/14/99 08:30	Received By: X Javier Hinojosa	Empty Bottles: 13	Date/Time 9/14/99 08:30	
Sampled By and Title: X Javier Hinojosa (Please sign and print name) Javier Hinojosa	Date/Time 9/14/99 08:50	Relinquished By: X Javier Hinojosa	(Please sign and print name) Javier Hinojosa	Date/Time 9/14/99 08:55	
Received By: Rosie Villarreal (Please sign and print name) Rosie Villarreal	Date/Time 9/14/99 08:55	Relinquished By: Rosie Villarreal	(Please sign and print name) Rosie Villarreal	Date/Time 9/14/99	
Received By: (Please sign and print name)	Date/Time 9/15/99 1330	Shipped Via: UPS Fed-Ex Other ____	Shipping #		

Special Instructions:

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

CH2M HILL Applied Sciences Lab
CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

CVO 2300 NW Walnut Boulevard
Corvallis, OR 97330-3538
(541) 752-4271 FAX (541) 752-0276

COC # ____

Project #	
Purchase Order #	
Project Name	McAllen Reuse Pilot Study
Company Name	City Of McAllen
Project Manager or Contact & Phone #	Kathy McKinley
Report Copy to:	Kathy McKinley
Requested Completion Date:	ASAP
Site ID	WWTP#2
Sample Disposal:	Dispose ☑ Return ☐

THIS AREA FOR LAB USE ONLY

Lab #	3089
Page	2 of 3
Lab PM	
Custody Review	
Log In	
LIMS Verification	
pH	
Custody Seals	(Y) N
Ice	(Y) N
QC Level 1 2 3 Other	
Cooler Temperature	2

Requested Analytical Method # / **Preservative**

Date	Time	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	UV 254 (Ice)	SDS HAAs, SDS THMs (Ice)	TKN, NO_3-NO_2/N, T-Phosphorous (H_2SO_4)	SDS HAAs, SDS THMs (Ice)	TKN, NO_2-NO_3/N, T-Phosphorous, NH_3-N (H_2SO_4)	TDS (Ice)	TKN, NO_2-NO_3/N, T-Phosphorous, NH_3-N (H_2SO_4)	TKN, NO_2-NO_3/N, T-Phosphorous (H_2SO_4)	TDS (Ice)	Alternate Description	Lab ID
9/14/99	08:50		✓	✓			ZGP		1	✓										1
9/14/99	08:50		✓	✓			ROP		1		✓									2
9/14/99	08:50		✓	✓			ZGP		1				✓							1
9/14/99	08:50		✓	✓			RDC		1			✓								4
9/14/99	08:50		✓	✓			ROP		1					✓						2
9/14/99	08:50		✓	✓			RDC		1						✓					4
9/14/99	08:50		✓	✓			ZGP		1							✓				1
9/14/99	09:01		✓	✓			WWTP#2 Effluent		1								✓			3
9/14/99	09:01		✓	✓			WWTP#2 Effluent		1									✓		3

Relinquished By: Rosie Villarreal	Date/Time: 9/14/99 08:30	Received By: X [signature]	Empty Bottles: 9	Date/Time: 9/14/99 08:30
Sampled By and Title: X [signature] (Please sign and print name) Javier Hinojosa	Date/Time: 9/14/99 08:50	Relinquished By: X [signature] (Please sign and print name) Javier Hinojosa		Date/Time: 9/14/99 08:55
Received By: Rosie Villarreal (Please sign and print name) Rosie Villarreal	Date/Time: 9/14/99 08:55	Relinquished By: Rosie Villarreal (Please sign and print name) Rosie Villarreal		Date/Time: 9/14/99
Received By: [signature] (Please sign and print name)	Date/Time: 9/15/99 1320	Shipped Via: UPS (Fed-Ex) Other ____	Shipping #	

Special Instructions:

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

CH2M HILL Applied Sciences Lab
CHAIN OF CUSTODY RECORD
AND AGREEMENT TO PERFORM SERVICES

CVO 2300 NW Walnut Boulevard
Corvallis, OR 97330-3538
(541) 752-4271 FAX (541) 752-0276

COC #

Project #:
Purchase Order #:
Project Name: McAllen Reuse Pilot Study
Company Name: City Of McAllen
Project Manager or Contact & Phone #: Kathy McKinley
Report Copy to: Kathy McKinley
Requested Completion Date: ASAP
Site ID: NWTP#2
Sample Disposal: Dispose ☑ Return ☐

Requested Analytical Method # / Preservative:
1. Al, Ba, Ca, Fe, Mg, Mn, K, Na, Sr, As, Cd, Cr, Pb, Hg, Se, Ag, Zn — HNO3
2. Alkalinity, TDS, Color, Bromide, Chloride, Fluoride, Sulfate, Reactive Silica — Ice
3. Al, Ba, Ca, Fe, Mg, Mn, K, Na, Sr, As, Cd, Cr, Pb, Hg, Se, Ag, Zn — HNO3
4. Alkalinity, TDS, Color, Bromide, Chloride, Fluoride, Sulfate, Reactive Silica — Ice

Date	Time	COMP	GRAB	WATER	SOIL	AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Method 1	Method 2	Method 3	Method 4	Alternate Description	Lab ID
9/14/99	08:50		✓	✓			ROP		1	✓					Z
9/14/99	08:50		✓	✓			ROP		1		✓				Z
9/14/99	08:50		✓	✓			ZGP		1			✓			1
9/14/99	08:50		✓	✓			ZGP		1				✓		1

THIS AREA FOR LAB USE ONLY
Lab # 3089 Page 3 of 3
Lab PM:
Custody Review:
Log In:
LIMS Verification:
pH:
Custody Seals (Y) N
Ice (Y) N
QC Level 1 2 3 Other
Cooler Temperature 2

Relinquished By: Rosie Villarreal — Date/Time: 9/14/99 08:30
Received By: X Javier Hinojosa — Empty Bottles: 4 — Date/Time: 9/14/99 08:30
Sampled By and Title (Please sign and print name): X Javier Hinojosa, Javier Hinojosa — Date/Time: 9/14/99 08:50
Relinquished By (Please sign and print name): X Javier Hinojosa, Javier Hinojosa — Date/Time: 9/14/99 08:55
Received By (Please sign and print name): Rosie Villarreal, Rosie Villarreal — Date/Time: 9/14/99 08:55
Relinquished By (Please sign and print name): Rosie Villarreal, Rosie Villarreal — Date/Time: 9/14/99
Received By (Please sign and print name): [signature] — Date/Time: 9/15/99 1320
Shipped Via: UPS (Fed-Ex) Other
Shipping #:
Special Instructions:

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

Columbia Analytical Services INC.
An Employee-Owned Company

Ms. Anne McKee-Robbins
CH2M HILL/CVO
2300 N.W. Walnut Blvd.
Corvallis, OR 97330

Columbia Analytical Services Report
City of McAllen
D9901720/D1454

October 20, 1999

Submitted by:

Karen Sellers

Karen Sellers
Project Manager/Client Services

TABLE OF CONTENTS

CAS Lab Reference No.: D1454
Level 1

(This report contains a total of 16 pages.)

Organic Data Qualifiers

A -- This qualifier indicates that a TIC is a suspected aldol-condensation product

B -- This flag is used when the analyte is found in the associated blank as well as the sample. This notation indicates possible blank contamination and suggests that the data user evaluate these compounds and their amounts carefully.

C -- The "C" flag indicates the presence of this compound has been confirmed by the GC/MS analysis.

D -- This qualifier is used for all the compounds identified in an analysis at a secondary dilution factor. "D" qualifiers are used only for the samples reported at more than one dilution factor.

E -- This flag indicates that the value reported exceeds the linear calibration range for that compound. Therefore, the sample should be reanalyzed at the appropriate dilution. The "E" qualified amount is an estimated concentration, and the results of the dilution will be reported on a separate Form I.

I -- The qualifier indicates that the reporting limit to the "I" qualifier has been raised. It is used when the chromatographic interference prohibits detection of a compound at a level below the concentration expressed on the Form I.

J -- Indicates an estimated value. It is used when the data indicates the presence of a target compound below the reporting limit or the presence of a Tentatively Identified Compound (TIC).

N -- This qualifier indicates presumptive evidence of a compound. This flag is only used for Tentatively Identified Compounds (TIC), where the identification is based on a mass spectral library research. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, the "N" qualifier is not used.

P -- This qualifier is used for Pesticide/Aroclor target analytes when there is a greater than 25% difference for detected concentrations between the two columns. The lower of the two values is reported on Form I and flagged with a "P".

U -- Indicates the compound was analyzed for but not detected. The number adjacent to the "U" qualifier indicates the reporting limit for that compound. The reporting limit can vary from sample to sample depending on dilution factors or percent moisture adjustments when indicated.

Organic Sample ID Qualifiers

The qualifiers that may be appended to the Lab Sample ID and/or the Client Sample ID for organic analysis are defined below:

DL -- Diluted reanalysis. Indicates that the results were determined in an analysis of a secondary dilution of a sample or extract. A digit to indicate multiple dilutions of the sample or extract may follow the "DL" suffix. The results of more than one diluted reanalysis may be reported.

MS -- Matrix spike (may be followed by a digit to indicate multiple matrix spikes within a sample set).

MSD -- Matrix spike duplicate (may be followed by a digit to indicate multiple matrix spikes within a sample set).

R -- Reanalysis. The extract was reanalyzed without re-extraction. The "R" is not used if the sample was also re-extracted. May be followed by a digit to indicate multiple reanalysis of the sample at the same dilution.

RE -- Re-extraction analysis. The sample was re-extracted and reanalyzed. May be followed by a digit to indicate multiple re-extracted analysis of the same sample at the same dilution.

Sample ID Cross-reference Table

CAS Lab Sample ID		Client Sample ID	Collect Date	Sample Matrix	Additional Description
FS = Field Sample					
D1454001	FS	ZGPERMEATE	09/23/99	Water	ZGPERMEATE
D1454002	FS	ROPERMEATE	09/23/99	Water	ROPERMEATE

The above lab sample ID's and cross reference information apply to samples as received by the laboratory. Modifiers to the lab sample ID may be added for internal tracking purposes. Any modified sample ID will be reflected in the appropriate case narrative only.

GC ORGANOCHLORINE PESTICIDES

CASE NARRATIVE
GC ORGANOCHLORINE PESTICIDES

CAS Lab Reference No./SDG.: D1454

Project: City of McAllen

I. RECEIPT

No exceptions were encountered unless a Sample Receipt Exception Report is attached to the Chain-of-Custody included with this data package.

II. HOLDING TIMES

A. Sample Preparation: All holding times were met.

B. Sample Analysis: All holding times were met.

III. METHOD

Preparation: SW-846 3520C
Cleanup: NA
Analysis: SW-846 8081A

IV. PREPARATION

Sample volume may vary based on the amount of sample received per container.

V. ANALYSIS

A. Calibration. All acceptance criteria were met.

1. Retention Time Windows: All analytes were within criteria.

2. Degradation: All acceptance criteria were met.

B. Blanks: All acceptance criteria were met.

C. Surrogates: All acceptance criteria were met.

D. Internal Standards: All acceptance criteria were met.

E. Spikes: All acceptance criteria were met.

F. Samples: Sample analysis proceeded normally.

I certify that this data package is in compliance with the terms and conditions agreed to by the client and Columbia Analytical Services, both technically and for completeness, except for the conditions noted above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or designated person, as verified by the following signature.

SIGNED: J. Watega 10/20/99 Reviewer: [signature]
Jerry Watega
Scientist, GC Organics

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

ZGPERMEATE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1454 SDG No.: D1454

Matrix: WATER Level: LOW

Sample Wt/Vol: 1.050 L

Extract Vol: 10 ML

Column: DB5

Extraction Type: Continuous

Lab Sample ID: D1454001

Lab File ID: B1001024

Date Received: 09/24/99

Date Extracted: 09/27/99

Date Analyzed: 10/02/99

Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	-----gamma-BHC (Lindane)	0.0032	0.020	0.011	J
72-20-8	-----Endrin	0.0021	0.020	0.0093	J
72-43-5	-----Methoxychlor	0.017	0.040	0.040	U
8001-35-2	---Toxaphene	0.23	0.50	0.50	U

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

ROPERMEATE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1454 SDG No.: D1454

Matrix: WATER Level: LOW

Sample Wt/Vol: 1.050 L

Extract Vol: 10 ML

Column: DB5

Extraction Type: Continuous

Lab Sample ID: D1454002

Lab File ID: B1001025

Date Received: 09/24/99

Date Extracted: 09/27/99

Date Analyzed: 10/02/99

Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	-----gamma-BHC (Lindane)	0.0032	0.020	0.020	U
72-20-8	-----Endrin	0.0021	0.020	0.020	U
72-43-5	-----Methoxychlor	0.017	0.040	0.040	U
8001-35-2	---Toxaphene	0.23	0.50	0.50	U

FORM I SW846

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT ID.

PWB10927

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1454   SDG No.: D1454   Lab Sample ID: PWB10927

Matrix: WATER   Level: LOW   Lab File ID: B1001023

Sample Wt/Vol: 1.000 L   Date Received:

Extract Vol: 10 ML   Date Extracted: 09/27/99

Column: DB5   Date Analyzed: 10/02/99

Extraction Type: Continuous   Dilution Factor: 1.0

CAS NO.	COMPOUND Units: ug/L	MDL	RL	RESULT	Q
58-89-9	gamma-BHC (Lindane)	0.0032	0.020	0.020	U
72-20-8	Endrin	0.0021	0.020	0.020	U
72-43-5	Methoxychlor	0.017	0.040	0.040	U
8001-35-2	Toxaphene	0.23	0.50	0.50	U

2C

WATER SEMIVOLATILE SURROGATE RECOVERY

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1454 SDG No.: D1454

	LAB ID	CLIENT ID.	S1 #	S2 #	S2	TOT OUT
01	PWB10927LCS	PWB10927LCS	93	74		0
02	PWB10927LCS	PWB10927LCS	92	80		0
03	PWB10927	PWB10927	96	89		0
04	D1454001	ZGPERMEATE	112	73		0
05	D1454002	ROPERMEATE	106	62		0
06						
07						
08						
09						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

		QC LIMITS
S1	= Tetrachloro-m-xylene	(45-125)
S2	= Decachlorobiphenyl	(34-133)

\# Column to be used to flag recovery values
* Values outside of contract required QC limits
D Surrogates diluted out

3E
WATER PESTICIDE LAB CONTROL SAMPLE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1454 SDG No.: D1454 Column: DB5

LCS - Sample No.: PWB10927

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
gamma-BHC (Lindane)	0.5000	0.0000	0.5002	100	73-125
Endrin	0.5000	0.0000	0.4876	98	43-134
Methoxychlor	0.5000	0.0000	0.4194	84	73-142

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 3 outside limits

COMMENTS: ______________________

3E
WATER PESTICIDE LAB CONTROL SAMPLE

Lab Name: COLUMBIA ANALYTICAL SERVICES - REDDING

Case No.: D1454 SDG No.: D1454 Column: DB5

LCS - Sample No.: PWB10927

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Toxaphene	5.000	0.0000	4.895	98	41-126

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 1 outside limits

COMMENTS: ______________________

CHAIN OF CUSTODY DOCUMENTATION

Columbia Analytical Services INC.
An Employee-Owned Company

CHAIN OF CUSTODY

5090 Caterpillar Road • Redding, CA 96003 • Phone: (530) 244-5227 • FAX: (530) 244-4109

COC # № 00802

Project #	
Purchase Order #	
Project Name	McAllen Reuse Pilot Study
Company Name	City of McAllen
Project Manager or Contact & Phone #	Kathy McKinley 541-758-0235
Report Copy to:	Kathy McKinley
Requested Completion Date:	ASAP
Site ID	City of mcAllen WWTP#2
Sample Disposal:	Dispose ☑ Return ☐

Requested Analytical Method #

Method	Preservative (to be filled out by customer)
Endrin, Lindane, Toxaphene, Methoxychlor	H_2SO_4
Endrin, Lindane, Toxaphene, Methoxychlor	H_2SO_4

Sampling Date	Sampling Time	Type: COMP	Type: GRAB	Matrix: WATER	Matrix: SOIL	Matrix: AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Endrin, Lindane, Toxaphene, Methoxychlor (H_2SO_4)	Endrin, Lindane, Toxaphene, Methoxychlor (H_2SO_4)	Alternate Description	Lab ID
9/23/99			✓	✓			ZGPermeate		4	✓			-1
9/23/99			✓	✓			ROPermeate		4		✓		-2

THIS AREA FOR LAB USE ONLY

Lab #	D1454
Page	1 of 1
Lab PM	tag verified LS 9/24/99
Custody Review	
Log In	
LIMS Verification	
pH	
Custody Seals	(Y) N
Ice	(Y) N
QC Level	(1) 2 3 Other
Cooler Temperature	5.0°C

	(Please sign and print name)	Date/Time		(Please sign and print name)	Date/Time
Sampled By and Title: [signature] R.O. Tech,	Enrique Perez	9/23/99 8:30	Relinquished By: [signature]	Enrique Perez	9/23/99 @ 8:40
Received By: Rosie Villarreal	Rosie Villarreal	9/23/99 8:40	Relinquished By: Rosie Villarreal	Rosie Villarreal	9/23/99
Received By: [signature]	Merle McCullough	9-24-99 0930	Shipped Via: UPS (Fed-Ex) Other	Shipping # 812900725117	

Special Instructions:
Samples were collected on 9/23/99

INVOICE INFORMATION

P.O. #

Bill To

0010

Distributions – Original - Lab, Yellow - Lab, Pink - Client

Columbia Analytical Services inc.
An Employee-Owned Company

5090 Caterpillar Road
Redding Ca., 96003
Phone: 530-244-5227
Fax: 530-244-4109

SAMPLE RECEIPT EXCEPTION REPORT

Sample Batch Number: D 1454 | Client/Project: City of McAllen

		Comments:
	1. No custody seal as required by project.	2) No time sampled recorded on
✓	2. Analysis, description, date/time of collection not provided.	COC. Time taken from container labels.
	3. Samples broken or leaking on receipt.	
	4. Temperature of samples inappropriate for analysis requested.	
	5. Container inappropriate for analysis requested.	
	6. Inadequate sample volume.	
	7. Preservation inappropriate for analysis requested.	
	8. Samples received out of holding time for analysis requested.	
	9. Descrepencies between COC form and container labels.	
	10. Other	

[redacted]

Corrective Actions Taken:

None Required BW 9/28/99

[redacted]

Sound Analytical Services, Inc.

ANALYTICAL & ENVIRONMENTAL CHEMISTS

4813 Pacific Hwy East • Tacoma, WA 98424

(253) 922-2310 • FAX (253) 922-5047

e-mail: sainc1@uswest.net

84099

TRANSMITTAL MEMORANDUM

DATE: September 23, 1999

TO: Kathy McKinley
City of McAllen
4100 Idela
McAllen, TX 78503

PROJECT: McAllen Re-Use Pilot Study

REPORT NUMBER: 84099

Enclosed are the test results for two samples received at Sound Analytical Services on September 15, 1999.

The report consists of this transmittal memo, analytical results, quality control reports, a copy of the chain-of-custody, a list of data qualifiers and analytical narrative when applicable, and a copy of any requested raw data.

Should there be any questions regarding this report, please contact me at (253) 922-2310.

Sincerely,

Darla Powell

Darla Powell
Project Manager

SOUND ANALYTICAL SERVICES, INC.

Client Name	City of McAllen
Client ID:	ZENOGEM PERMEATE
Lab ID:	84099-01
Date Received:	9/15/99
Date Prepared:	9/21/99
Date Analyzed:	9/22/99
% Solids	-
Dilution Factor	10

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

			Recovery Limits	
Surrogate	**% Recovery**	**Flags**	**Low**	**High**
2,4-Dichlorophenylacetic acid	86.4		48	124

Analyte		**Result (ug/L)**	**PQL**	**MDL**	**Flags**
2,4-D	ND		0.096	0.084	
Silvex (2,4,5-TP)	ND		0.096	0.077	

SOUND ANALYTICAL SERVICES, INC.

Client Name	City of McAllen
Client ID:	RO PERMEATE
Lab ID:	84099-02
Date Received:	9/15/99
Date Prepared:	9/21/99
Date Analyzed:	9/22/99
% Solids	-
Dilution Factor	10

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

Surrogate	% Recovery	Flags	Recovery Limits Low	Recovery Limits High
2,4-Dichlorophenylacetic acid	73.6		48	124

Analyte	Result (ug/L)	PQL	MDL	Flags
2,4-D	ND	0.1	0.087	
Silvex (2,4,5-TP)	ND	0.1	0.081	

SOUND ANALYTICAL SERVICES, INC.

Lab ID:	Method Blank - HB885
Date Received:	-
Date Prepared:	9/21/99
Date Analyzed:	9/22/99
% Solids	-
Dilution Factor	10

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

			Recovery Limits	
Surrogate	**% Recovery**	**Flags**	**Low**	**High**
2,4-Dichlorophenylacetic acid	67.8		48	124

Analyte		**Result (ug/L)**	**PQL**	**MDL**	**Flags**
2,4-D	ND		0.1	0.087	
Silvex (2,4,5-TP)	ND		0.1	0.081	

SOUND ANALYTICAL SERVICES, INC.

Blank Spike/Blank Spike Duplicate Report

Lab ID:	HB885
Date Prepared:	9/21/99
Date Analyzed:	9/22/99
QC Batch ID:	HB885

Chlorinated Herbicides by USEPA Method 8151GC/MS Modified

Compound Name	Blank Result (ug/L)	Spike Amount (ug/L)	BS Result (ug/L)	BS % Rec.	BSD Result (ug/L)	BSD % Rec.	RPD	Flag
2,4-D	0	5	4.73	94.6	4.48	89.6	-5.4	
Silvex (2,4,5-TP)	0	5	5.44	109	5.17	103	-5.7	

SOUND ANALYTICAL SERVICES, INC.

ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE: (253) 922-2310 - FAX: (253) 922-5047

DATA QUALIFIERS AND ABBREVIATIONS

B1: This analyte was detected in the associated method blank. The analyte concentration was determined not to be significantly higher than the associated method blank (less than ten times the concentration reported in the blank).

B2: This analyte was detected in the associated method blank. The analyte concentration in the sample was determined to be significantly higher than the method blank (greater than ten times the concentration reported in the blank).

C1: Second column confirmation was performed. The relative percent difference value (RPD) between the results on the two columns was evaluated and determined to be $\leq$ 40%.

C2: Second column confirmation was performed. The RPD between the results on the two columns was evaluated and determined to be > 40%. The higher result was reported unless anomalies were noted.

M: GC/MS confirmation was performed. The result derived from the original analysis was reported.

D: The reported result for this analyte was calculated based on a secondary dilution factor.

E: The concentration of this analyte exceeded the instrument calibration range and should be considered an estimated quantity.

J: The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

MCL: Maximum Contaminant Level

MDL: Method Detection Limit

N: See analytical narrative.

ND: Not Detected

PQL: Practical Quantitation Limit

X1: Contaminant does not appear to be "typical" product. Elution pattern suggests it may be ________.

X2: Contaminant does not appear to be "typical" product.

X3: Identification and quantitation of the analyte or surrogate was complicated by matrix interference.

X4: RPD for duplicates was outside advisory QC limits. The sample was re-analyzed with similar results. The sample matrix may be nonhomogeneous.

X4a: RPD for duplicates outside advisory QC limits due to analyte concentration near the method practical quantitation limit/detection limit.

X5: Matrix spike recovery was not determined due to the required dilution.

X6: Recovery and/or RPD values for matrix spike(/matrix spike duplicate) outside advisory QC limits. Sample was re-analyzed with similar results.

X7: Recovery and/or RPD values for matrix spike(/matrix spike duplicate) outside advisory QC limits. Matrix interference may be indicated based on acceptable blank spike recovery and/or RPD.

X7a: Recovery and/or RPD values for this spiked analyte outside advisory QC limits due to high concentration of the analyte in the original sample.

X8: Surrogate recovery was not determined due to the required dilution.

X9: Surrogate recovery outside advisory QC limits due to matrix interference.

9°C

Sound Analytical Services, Inc.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 Pacific Hwy East • Tacoma, WA 98424
(253) 922-2310 • FAX (253) 922-5047
e mail. sainc1@uswest.net

Y4

SAS Lab No. 84099

~~TURNAROUND REQUEST~~ (business days)
Standard (10 days) ___
RUSH: ~~24 hrs~~ 48 hrs ___ 5 day ___

CHAIN OF CUSTODY/REQUEST FOR LABORATORY ANALYSIS

Client: City OF McAllen

Project Name: McAllen Re-Use Pilot Study

Contact: Kathy McKinley - Applied Sciences

Phone No.: 541-758-0235 #3144

Fax No.: 541-766-2852

Email: kmckinle@ch2m.com

Analyses Requested

Lab Use Only	Sample ID	Date	Time	Matrix	# of Containers	2,4-D; 2,4,5-TP Silvex	2,4-D; 2,4,5-TP Silvex
1	Zenogem Permeate	9/14/99	08:50	Liquid	1	✓	
2	RO Permeate	9/14/99	08:50	Liquid	1		✓

	Signature	Printed Name	Firm	Time/Date
Relinquished By:	[signature]	Javier Hinojosa	City of McAllen	9/14/99 08:55
Received By	Rosie Villarreal	Rosie Villarreal	City of McAllen	9/14/99 08:55
Relinquished By:	Rosie Villarreal	Rosie Villarreal	City of McAllen	9/14/99
Received By	S Giang	Giang	SAS	9/15/99 930Am
Relinquished By:				
Received By				

Special Instructions

COC No. ___

Page ___ of ___

ENERGY LABORATORIES, INC.
SHIPPING: 2393 SALT CREEK HIGHWAY • CASPER, WY 82601
MAILING: P.O. BOX 3258 • CASPER, WY 82602
E-mail: energy@trib.com • FAX: (307) 234-1639 • PHONE: (307) 235-0515 • TOLL FREE: (888) 235-0515

CASE NARRATIVE

DATE: October 5, 1999
TO: Kathy McKinley
FROM: Sheryl Garling
RE: CH2MHill Water Samples

SAMPLE NUMBERS: 32965 001 through 002

Samples Zenogem Permeate and RO Permeate were received on September 15, 1999. Samples were shipped using Energy Laboratories, Inc. contract service with UPS. The overnight option was used for shipping the samples to the laboratory. Samples were in good condition and properly preserved.

No analytical problems were indicated for this sample delivery group.

The methods used are methods published by US EPA for drinking water analyses. The methods used are as follows:

Radium 226 - EPA Method 903.0 (alpha emitting),
Radium 228 - EPA Method 904.0, and
Gross Alpha -EPA Method 900.1 (gross alpha minus uranium and radon).

The standard detection limits for these methods are 0.2 pCi/L, 1.0 pCi/L, and 1.0 pCi/L, respectively. The initial e-mail response incorrectly identified methods and detection limits.

If additional information is required, please advise.

ENERGY LABORATORIES, INC.
SHIPPING: 2393 SALT CREEK HIGHWAY • CASPER, WY 82601
MAILING: P.O. BOX 3258 • CASPER, WY 82602
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PHONE: (307) 235-0515 • TOLL FREE: (888) 235-0515
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Helena • Rapid City

LABORATORY ANALYSIS REPORT - CH_2M HILL

Project:	McAllen Reuse Pilot Study	
Sample ID:	Zenogem Permeate	RO Permeate
Laboratory ID:	32965-001	32965-002
Sample Matrix:	Water	
Sample Date/Time:	09-14-99/0850	
Date Received:	09-15-99	
Report Date:	October 4, 1999	

Radiometric		Method	Reporting Limit	Units	Results	
Radium-226	^{226}Ra	903.0	0.2	pCi/L	<0.2	<0.2
Radium Precision ±					-	-
Radium-228	^{228}Ra	904.0	1.0	pCi/L	<1.0	<1.0
Radium Precision ±					-	-
ross Alpha	Gross α	900.1	1.0	pCi/L	<1.0	<1.0
G. Alpha Precision ±					-	-

lmh r:\Reports\Clients.99\CH2M_Hill\Water\rc32965-001.xls

Log In No. 99-32965

ELI

RADIOCHEMICAL QUALITY ASSURANCE REPORT - CH_2M HILL

Laboratory ID Range:	32965-001-002
Sample Matrix:	Water
Sample Date / Time:	09-14-99/0850
Date Received:	09-15-99
Report Date:	October 4, 1999

	Method	Relative Percent Difference[1]	Spike Recovery (Percent)[2]	LCS Recovery (Percent)	Method Blank (pCi/L)	Date Analyzed	Analyst
Laboratory #:		32996-002	32880-022		GA-40		
Gross Alpha:	900.1	0.0	104	106	<1.0	10-01-99	RS
Laboratory #:		32880-001	32880-022		RA-206		
Radium-226:	903.0	0.0	100	101	<0.2	09-29-99	RS
boratory #:		32880-010	32880-020		228-235		
Radium-228:	904.0	0.0	79	77	<1.0	10-04-99	LMH

(1) These values are an assessment of analytical precision. The acceptance range is 0-20% for sample results above 10 times the reporting limit. This range is not applicable to samples with results below 10 times the reporting limit.

(2) These values are an assessment of analytical accuracy. They are a percent recovery of the spike addition. ELI performs a matrix spike on 10 percent of all samples for each analytical method.

Report Approved By: D. Haida

Reviewed By: [signature]

lmh r:\Reports\Clients.99\CH2M_Hill\Water\rc32965-001.xls

Log In No. 99-32965

ENERGY LABORATORIES

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ENERGY LABORATORIES, INC. CHAIN OF CUSTODY RECORD

Mail Only: PO Box 3258 • Casper, WY • 82602-3258
UPS/FedEx Deliveries: 2393 Salt Creek Highway • Casper, WY • 82601

toll free 1-235-0515
voice 307-235-0515
fax 307-234-1639

For Sample Tracking Purposes, Please Provide Contact Name and Telephone #'s as Indicated *(SEE BACK OF FORM FOR EXAMPLES AND INSTRUCTIONS)*

Project Name / Location / Purchase Order # / Bid #
McAllen Reuse / McAllen /
Pilot Study / Texas /

Name / Phone # / Fax #
Kathy McKinley / 541-758-0235 / 54-766-28~~E~~52
CH2M Hill / # 3144

Send Invoice to: Kathy McKinley
CH2M Hill Corvallis OR.
~~same as above~~

Send Report to:

Special Requests

Comments, Special Instructions, etc.

Date	Time	composite	grab sample	Sample I.D.	Number of containers (Sample Type: A W S V U O — Air Water Soils/solids Vegetation Urine Other)	Radium 226, Gross Alpha	Radium 228	Radium 224, Gross Alpha	Radium 228				Comments, Special Instructions, etc.
9/14/99	08:50		✓	Zenogem Permeate	1	✓							
9/14/99	08:50		✓	RO Permeate	1			✓					
				UPS-A1									

1. Sampler: (signature)	Date	Time	Received by: (signature)	2. Relinquished by: (signature)	Date	Time	Received by: (signature)
Jaime Hinojosa	9/14/99	01:50	Rosie Villareal	Rosie Villareal	9/14/99	~~08:35~~	
3. Relinquished by: (signature)	**Date**	**Time**	**Received by: (signature)**	**4. Relinquished by: (signature)**	**Date**	**Time**	**Received at Laboratory by: (signature)**
					9/15/99	1600	[signature]

10-6-99

ENERGY LABORATORIES, INC.'S CHAIN OF CUSTODY RECORD

Mail Only: PO Box 3258 • Casper, WY • 82602-3258 voice 307-235-0515
UPS/FedEx Deliveries: 2393 Salt Creek Highway • Casper, WY • 82602 fax 307-234-1639

For Sample Tracking Purposes, Please Provide Contact Name and Telephone #'S As Indicated (SEE BACK OF FORM FOR EXAMPLES AND INSTRUCTIONS)

Project Name / Location / Purchase Order #
Thunderbasin Town of Hope No PO #

Name / Phone # / Fax #
Jeff Jones @ (307) 555-1515, (307) 555-5555 fax

Send Invoice to: Jeff Jones
PO Box Nowhere
Hope, WY 80000

Send Report to: Bob Brown
PO Box Somewhere
USA, WY 81111

Special Requests: Please fax results as soon as possible Thank you.

Date	Time	composite	grab sample	Sample I.D.	Number of containers (Sample Type: A W S V U O — Air Water Soils/solids Vegetation Urine Other)	Asbestos - TEM	IOC's - RADs	NO_2, NO_3, F	VOCs - 502.2	SOCs - 504, 505, 508	SOCs - 515, 531.1	Comments, Special Instructions, etc.
1995												
5/28	11:35		X	Entry to Distribution	4	X			X			Phase II SDWA Primary
5/28	11:45		X	Distribution Tap	9		X	X		X	X	"

	Date	Time			Date	Time	
1. Sampler: (signature) Jeff Jones	5-28-95	12:05p	Received by: (signature) Harry Truckers	2. Relinquished by: (signature) Harry Truckers	5-28-95	13:15p	Received by: (signature) Sheryl A. Garling
3. Relinquished by: (signature) N/A	N/A	N/A	Received by: (signature) N/A	4. Relinquished by: (signature) Sheryl A. Garling	5-28-95	14:00p	Received at Laboratory by: Roger A. Garling

Instructions:

(1) A completed Chain-of-Custody must be submitted with all samples
(2) Special Requests area can include (but not limited to) the following:
- Turnaround status, Rush status, Due Date, etc.
- Special mailing instructions:
  - send copy of Report and/or Invoice to a second party
  - send copy of Report to a Government Agencies (EPA, etc.)
- Public Water System (PWS) Number
- Do you want samples returned to you or disposed of?

Appendix E. RO Spent Cleaning Solution Analysis

United States Department of the Interior
Bureau of Reclamation
Water Treatment Engineering and Research Group
Reclamation Service Center
P.O. Box 25007
Building 56, Denver Federal Center, Attn: D-8230
Denver, Colorado 80225-0007

FAXOGRAM

Date: 6/10/99

To: Jim Lozier / Angie Fernandez

Company: CH2MHill

Fax Number:

From: Michelle USBR

Fax Number: (303) 445-6329 Telephone Number: (303) 445-2245

Number of pages 7 (including cover sheet)

Message: Copy of the Cleaning Solution analysis. They are sending out for the SO_4. I'll let you know.

Michelle

DATA TRANSMITTAL FAX COVER

Environmental Research Chemistry Laboratory, D-8240
US Bureau of Reclamation - Technical Service Center
PO Box 25007, Denver CO 80225-0007
Margaret Lake, Laboratory Manager, 303-445-2181
Douglas Craft, QC Officer, 303-445-2182
FAX 303-445-6326

DATE: 6/10/99

FROM: Barb Frost PHONE: X2190

TO: Michelle Chapman MAIL CODE:

OFFICE: FAX NUMBER:

PROJECT: McAllen DO LAB NUMBERS: K5313-1

SAMPLES COLLECTED ON: 6/1/99 NUMBER OF SAMPLES: 1

ANALYSES PERFORMED BY: BF / VM

This is an electronic transmission of analytical results. The final data and memorandum with appropriate formal review and requested QC reports will follow. The data in the attached report has been reviewed by the laboratory QC Officer (or designate) and meets TSC Chemistry Laboratory precision and accuracy requirements unless qualified in the section below. Please review your data and let us know if there are problems that require corrective action.

QUALIFIERS: The following issues may affect the usability of your data: ICV for Ca biased low by <0.5%. CCV was acceptable.

MESSAGE: Contract SO_4 and final memo will follow.

APPROVAL Barb Frost Barb Frost 6/10/99
Client Representative (for) QC Officer Date

PAGE 1 OF ____

REVIEWED-QUALIFIED
SEE COMMENTS
Barb Frost 6/10/99
(for) LAB QC OFFICER DATE

SAMPLE LOG-IN SUMMARY

USBR ENVIRONMENTAL RESEARCH CHEMISTRY LABORATORY

Denver, Colorado

Job Control No: McAllen-99 **Project Name:** McAllen W-R **Client Reps:** Barb Frost

Login Date: 6/3/99 **Description:** Cleaning Solution **Client Name:** M. Chapman-Wilber

Chem Lab#	Client SampleID	Analysis	Sample Type	Sampled Date	Due Date	COC#
K5313-1	McAllen		cleaning soln.	6/1/99	6/10/99	
	unfiltered/unacidified, SO4/Ca/Fe/Al/Ba/Si	200.7_ICP	ICP Metals			
		300.0_ANIONS	Ion chromatography of anions			
		365.1,365.2_totP	total phosphorous by Perstorp autoanalyzer			

SAMPLE SUBMITTAL REQUEST FORM **SHEET 1 OF ____**

Environmental Research Chemistry Laboratory, D-8240
U.S. Bureau of Reclamation - Technical Service Center
Building 56, Room 2340, Denver Federal Center, PO Box 25007, Denver, CO 80225-007
Margaret Lake, Laboratory Manager, 303-445-2181

Today's Date: 6/2/99 Report Data By: 6/10/99

Samples Submitted By: Michelle Chapman Wilbert Telephone: X2264

Mailing Address: D-8230 FAX/LAN: ____

Project Name: McAllen W.R Job Number/WOID: D5945

Sample Collection Location: McAllen Sample Collected By: Javier.

Sampling Date(s): 6/1/99 Type of Samples: Cleaning So Number of Samples: 2

Samples Filtered? No Samples Preserved? No (describe) Custody Form Required? No

Official Data Report To: Michelle C Wilbert

Copies To: ____ QC Report Requested? ____

Special Instructions: ~~[illegible]~~, Aluminum, Barium, Sulfate, Silica, Phosphate

SAMPLE IDENTIFIERS	Requested Analyses	Method or Det Lim
1. Calcium		
2. Iron		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

ATTACH ADDITIONAL LIST FOR MORE SAMPLES - ATTACH CHAIN OF CUSTODY FORMS IF REQUIRED

Report of Chemical Analyses

Client: McAllen W-R
Samples Collected: 6/1/99

U.S. Department of the Interior - Bureau of Reclamation
PO Box 25007, Building 56, Room 2300, Denver Federal Center
Denver CO 80225-0007

Laboratory Number	Sample ID	SiO_2 mg/L	TP-P mg/L
K5313-1	McAllen	2.53	11.9
	Detection limit:	0.02	0.005
	Date Analyzed:	6/9/99	6/7/99
	Analyst:	bf	vm
	EPA Method:	200.7	365.1

Chem Lab#: K5313-1
Station ID: McAllen
MoreID:
Chain-Of-Custody:
Sample Type: cleaning soln.

Sampled Date: 6/1/99
Received Date: 6/2/99
Login Date: 6/3/99
Note: unfiltered/unacidified, SO4/Ca/Fe/Al/Ba/Si

Analyte	Method_Ref	Result	Units	Qualifier	MDL	Date Extract	Date Analyzed	Dilution
Al	200.7 EPA	5530	µg/L		30		6/10/99	1
Ba	200.7 EPA	449	µg/L		4		6/10/99	1
Ca	200.7 EPA	26	mg/L		0.03		6/10/99	1

U: Not Detected at Listed MDL.
J : Estimated .
MDL: Method Detection Limit.

Chem Lab#: K5313-1
Station ID: McAllen
MoreID:
Chain-Of-Custody:
Sample Type: cleaning soln.

Sampled Date: 6/1/99
Received Date: 6/2/99
Login Date: 6/3/99
Note: unfiltered/unacidified, SO4/Ca/Fe/Al/Ba/Si

Analyte	Method_Ref	Result	Units	Qualifier	MDL	Date Extract	Date Analyzed	Dilution
Fe	200.7 EPA	722	µg/L		4		6/10/99	1

U: Not Detected at Listed MDL.
J : Estimated .
MDL: Method Detection Limit.

Appendix F. ZenoGem Permeate Ion Analysis

Table F-1

ZenoGem Permeate Scale Potential

Parameter	Units	6/9/99	6/11/99	6/14/99	6/16/99	6/21/99	6/23/99	Average
Alkalinity	mg/L as $CaCO_3$	150		190		158		166
Total Phosphorus	mg/L as P			2.72		2.26		2.49
Sulfate	mg/L	250	214	214				226
Aluminum[a]	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Barium	mg/L	0.06	0.06	0.06	0.05	0.05	0.06	0.06
Calcium Hardness	mg/L	360		348		360		356
Iron[a]	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1

[a]Not dectected at specified reporting limits for each sampling event.

Appendix G. RO Element Autopsy

PURPOSE AND LOCATION OF AUTOPSY

Purpose of Autopsy: McAllen, TX Wastewater Reclamation Project: Determination of scaling in end element.

Date and Place: October 29, 1999, USBR WTER Pilot Plant Lab, Denver, CO.

Date of This Report: 12/30/99

Names of Observers:

Frank Leitz
Bill Boegli
Michelle Chapman Wilbert
Kim Linton
Qian Zhang

ELEMENT IDENTIFICATION

Manufacturer:	Hydranautics
Element Location:	Housing #6, 2nd element
Serial Number:	X03529
Element Dimensions:	2.5 in. x 40 in.
Number of Leaves:	2
Size of Leaves:	92.1 cm x 71.1cm Total Area 84.5 cm x 63.5cm Active Area per side (2.1 m^2 per element or 22.1 ft^2)

OPERATING HISTORY

The RO system was operated for six months on site at the McAllen,TX South Waste Water Treatment Plant. Screened de-gritted sewage was first treated in a Zenogem bioreactor/microfiltration system, then chlorine and ammonia was added and the Zenogem effluent was forwarded to the RO system. The RO element array was a 2x2x1x1 and had 3 elements per vessel for a total of 18 elements in the system. RO recovery rates were set from 50% to 80% of 15.2 L/min feed flow.

Sulfuric acid and antiscalent were added to prevent scaling. However, due to changes in the chemical character of the Zenogem effluent, or excessive gas formation in the acid tank which caused the acid feed pump to loose it's prime, the pH was not controlled well at all times. This resulted in a loss of permeate flow from the last vessel.

Also, traditional constituents used in an RO projection do not include phosphorous compounds. The researchers involved in this project began to suspect that phosphorous salts were the cause of excessive scale problems due to the nature of waste water treatment. Attempts at adjusting the pH to control phosphorous salts included running a projection with non-RO software to determine the potential for phosphate scaling. A range of pH settings and two control points for pH were tested in an attempt to control the scaling problems. The pH ranges tested were from 5.5 to 7 on the feed, and 5.5 to 6 on the concentrate. The lower pH control ranges were in response to this non-RO projected information.

Scaling also caused operators to clean the system approximately 4 times with a low pH solution at a pH of about 3. A high pH solution was not used to clean the membranes as there was no indication of biofouling and the system's performance was recovered using the acid cleanings.

DESCRIPTION OF EVENTS LEADING TO AUTOPSY

This element was subjected to one needle hole to help evaluate the integrity test methods.

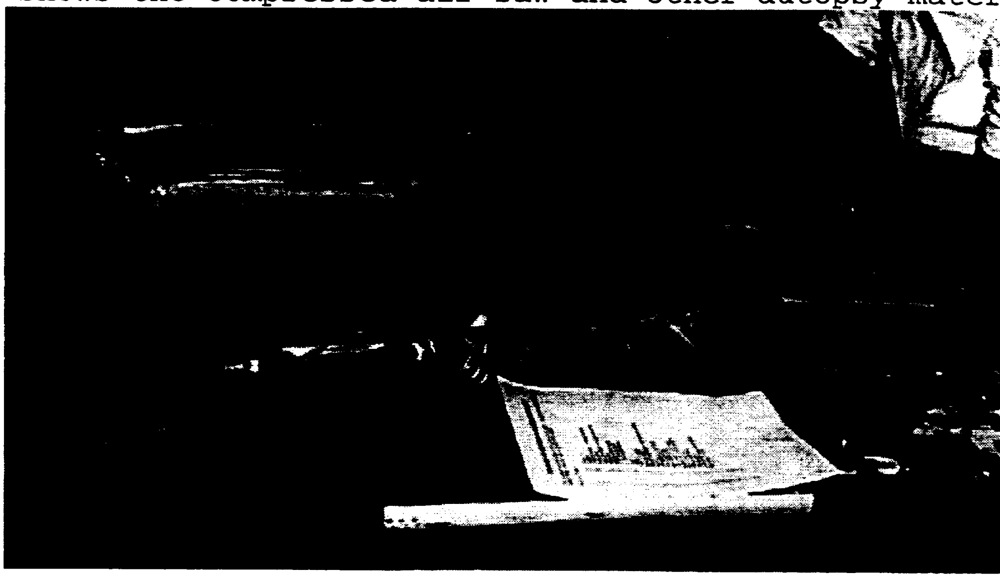
Subject element was the second to last element of the last vessel (vessel #6). Permeate recovery flow from the last vessel varied from 1.4 L/min to 0.01 L/min. The last fouling was a result of turning off the acid feed pump for approximately 8 hours.

This autopsy was primarily done to determine how deep the hole in the membrane leaves had penetrated, and to determine the general nature of the scaling composition.

NARRATIVE DESCRIPTION OF AUTOPSY PROCEDURE

Fiberglass wrapping was cut open and peeled or pried off.

Picture shows the compressed air saw and other autopsy materials.



Anti-telescoping devices were removed and tape wrap was unwound.

Unwound membrane and separated spacer material from first leaf.

Measured leaf dimensions and active area.

A squeegee was used to wipe both sides of one leaf. DI water was used to liquefy the fouling substance

Applied congo red dye to the first leaf.

Samples were cut from the feed and reject ends of the second leaf for SEM analysis. Feed side is Sample 2 and the reject side is Sample 3.

OBSERVATIONS

There was a crack, ~2 cm long, ~10 cm from the feed end.

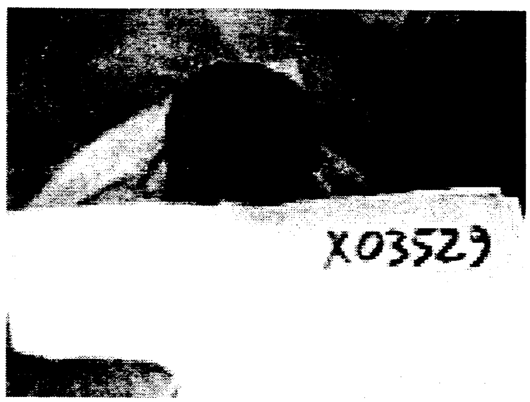
Sample #1 is the piece of fiberglass with the crack.

The brine seal was in good condition; it was saved as Sample #2

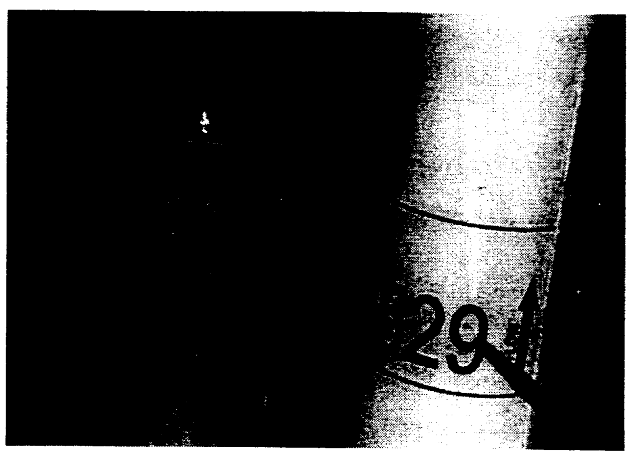
There was extra glue, possibly rubber cement, under the tape at the ends of the element-- probably to keep the end caps tight. Sample #3 is a bit of the glue peeled away from the end.

There was no evidence of the crack extending into the membrane material.

Picture was taken of the feed end of the rolled element.



Hole location was marked on the outer fiberglass cover from where a needle had been poked into the membrane. Picture taken of hole location in element. The hole location is shown in the fiberglass wrap and in the number 9 of the tape wrap.



At least 2 leaves had holes which were identified using a magnifying glass (10x). The hole on the on the outer leaf was a cresent shape which is the same shape that would be formed by the tip of the hypodermic needle used to inflict the damage. The second hole protruded out, which would also be consistent with the direction the needle would penetrate.

The glue line appeared to have attracted more fouling material than the active area of the leaf. This may be due to the excessive use of glue.

Dye test on the second leaf with congo red dye took evenly over the membrane surface. This could be damage from low pH. There was no evidence of the hole extending beyond the tape wrap.

Test and Test Objective: No additional tests were done on this element.

DISCUSSION AND CONCLUSIONS

This element had at least two holes from the needle puncture which penetrated the active area of the membrane. The visible damage was configured in such a way that it can be attributed to the needle. One of the holes was cresent shaped and poked inward. The hole on the opposite leaf protruded outward.

SPIRAL WOUND MEMBRANE ELEMENT AUTOPSY

PURPOSE AND LOCATION OF AUTOPSY
Purpose of Autopsy: McAllen, TX Wastewater Reclamation Project: Determination of scaling in end element.
Date and Place: October 29, 1999, USBR WTER Pilot Plant Lab, Denver, CO.
Date of This Report: 11/21/1999
Names of Observers: Frank Leitz Michelle Chapman Wilbert Kim Linton

ELEMENT IDENTIFICATION	
Manufacturer:	Hydranautics
Element Type:	LFC1X 2540
Element Location:	Housing #3, 2nd element
Serial Number:	X03531
Element Dimensions:	2.5 in. x 40 in.
Number of Leaves:	2
Size of Leaves:	91.8cm x 72.4cm Total Area 83.8cm x 62.8cm Active Area of one side (2.1 m^2 per element or 22.6 ft^2)

OPERATING HISTORY

The RO system was operated for six months on site at the McAllen,TX South Waste Water Treatment Plant. Screened de-gritted sewage was first treated in a Zenogem bioreactor/microfiltration system, then chlorine and ammonia was added and the Zenogem effluent was forwarded to the RO system. The RO element array was a 2x2x1x1 and had 3 elements per vessel for a total of 18 elements in the system. RO recovery rates were set from 50% to 80% of 15.2 L/min feed flow.

Sulfuric acid and antiscalent were added to prevent scaling. However, due to changes in the chemical character of the Zenogem effluent, or excessive gas formation in the acid tank which caused the acid feed pump to loose it's prime, the pH was not controlled well at all times. This resulted in a loss of permeate flow from the last vessel.

Also, traditional constituents used in an RO projection do not include phosphorous compounds. The researchers involved in this project began to suspect that phosphorous salts were the cause of excessive scale problems due to the nature of waste water treatment. Attempts at adjusting the pH to control phosphorous salts included running a projection with non-RO software to determine the potential for phosphate scaling. A range of pH settings and two control points for pH were tested in an attempt to control the scaling problems. The pH ranges tested were from 5.5 to 7 on the feed, and 5.5 to 6 on the concentrate. The lower pH control ranges were in response to this non-RO projected information.

Scaling also caused operators to clean the system approximately 4 times with a low pH solution at a pH of about 3. A high pH solution was not used to clean the membranes as there was no indication of biofouling and the system's performance was recovered using the acid cleanings.

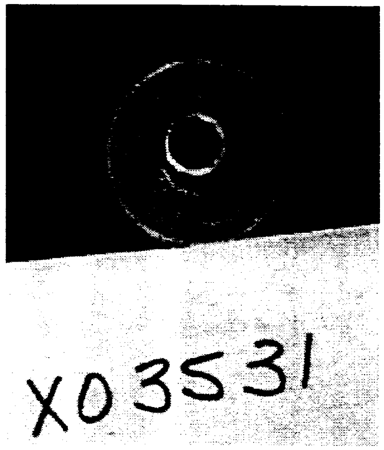
DESCRIPTION OF EVENTS LEADING TO AUTOPSY

Subject element was the second element in housing #3, one of two vessels that received flow first. Permeate recovery flow from this vessel varied from 2.8 L/min to 2.3 L/min. This element was subject to two holes punctured with a hypodermic needle. The fouling on the membrane was a result of turning off the acid feed pump for approximately 8 hours.

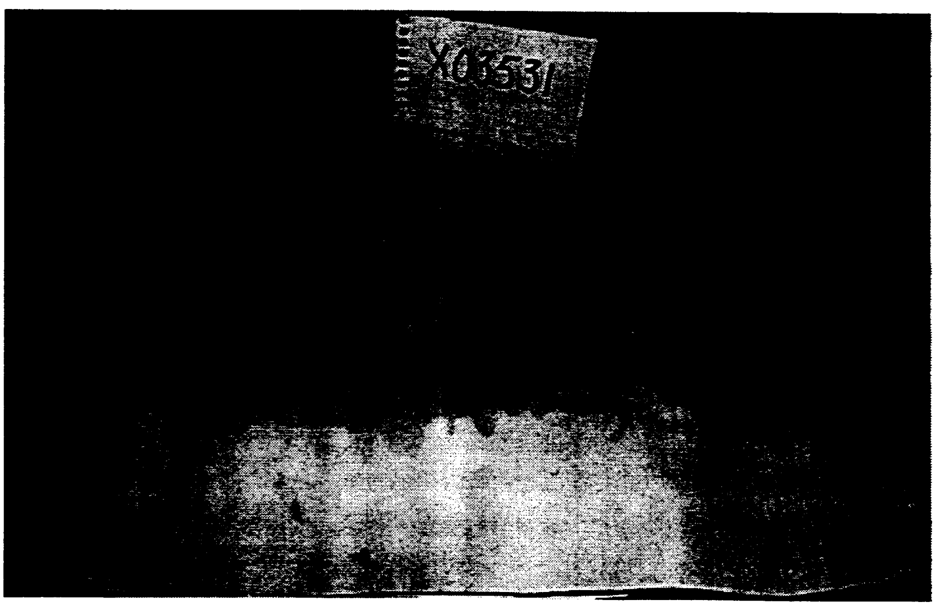
This autopsy was primarily done to determine the size and extent of damage resulting from the hypodermic needle. In addition, the general nature of the membrane and scaling composition is of interest.

NARRATIVE DESCRIPTION OF AUTOPSY PROCEDURE

Fiberglass wrapping was cut open and peeled or pried off. Sample #1 is the fiberglass with the 2 holes marked.
Anti-telescoping devices were removed.
Photographed the feed end of the element.



Tape wrap was unwound.
Measured the total area and active area of one side of one leaf.
Applied congo red dye to the first leaf. Photograph of the dye stained membrane.



Sample #2 is a cutting from the leaf with the 2 holes in the glue line.

OBSERVATIONS

There were no cracks in this element fiberglass casing.

Two needle holes were visible in the fiberglass and tape wrap at a distance of 17.75 cm (~7 in) from the reject end.

The membrane was wound backwards - which probably makes no difference in performance, but does make autopsy confusing.

There were little black flecks on the membrane surface.

Glue lines were all solid.

Dye test showed no pin hole damage. There were only 2 holes in the glue line, neither of which extended through the hard, thick glue.

Test and Test Objective: Chemical analysis of fouling material on leaf 1

Organization Performing Test: USBR Chemistry Lab
Date: Submitted November 1, 1999

Observations from Test:

The analysis methods used for TDS, TSS, SO4, and Cl do not used acid to digest the samples. The method used for SO4 and Cl was EPA method 300.0A,ion chromatography. The other metals, except for phosphorous were digested with nitric acid and analyzed using the ICP (inductively coupled plasma) EPA method 30.15. Phosphorous is also digested, but under EPA method 365.1.

The results from both housing #3 and #6 are shown for comparison.

Analytes	Housing #3 concentration (mg/L)	Equivalent Anions => Ox. State * Conc. / At. Wt.	Equivalent Cations => Ox. State * Conc. / At. Wt.	Housing #6 concentration (mg/L)	Anions => Ox. State * Conc. / At. Wt.	Cations => Ox. State * Conc. / At. Wt.
Total P	36.69	-3.6		135.2	-13.1	
Al	2.52		0.3	9.1		1.0
Ba	7.02		0.1	20.8		0.3
Fe	1.1		0.1	3.8		0.2
Ca	76.5		3.8	298.0		14.9
K	2.7		0.1	4.8		0.1
Mg	4.07		0.3	13.4		1.1
Na	21.3		0.9	38.0		1.7
Si	2.46		0.4	7.4		1.1
SO4	15.7	-0.3		20.6	-0.4	
Cl	21.6	-0.6		33.7	-1.0	
Totals		-4.5	5.9		-14.5	20.3

DISCUSSION AND CONCLUSIONS

The holes did not penetrate through the heavy glue line into the permeable membrane surface.

The solids precipitated onto the membrane surface originally come from a saturated solution. When the autopsy is done, de-ionized water is used to rinse the scrapings from the surface of the membrane. Since the samples are scraped from the membrane using DI water, the concentration expressed as a value in milligrams per liter is not meaningful as a concentration unless it is expressed in equivalents.

When the concentrations are interpreted as equivalents, it can then be shown in both housing #3 and housing #6 that there are roughly the same number of equivalents of calcium and phosphorous in each housing. This indicates that the predominant form of what was left on the membrane was most likely calcium phosphate (hydroxy apetite). Housing #6 had a larger amount than housing #3 resulting in the flow almost ceasing in housing #6.

When dye was applied to the element from the 6th housing, it did not adhere. That membrane element was the second membrane from the end of the system. The membrane in the 3rd housing at the front end of the system absorbed the dye indicating damage to the membrane surface. One possible reason why is that the acid solution was stronger at the front end of the system, especially if there was a problem with the chemical feed system and the pH dropped towards 2. Another possible explanation is the phosphate scale acted as a buffer to protect the membrane surface from the sulfuric acid in the end of the system. Phosphoric acid is a weaker acid than sulfuric. Using the 1st ionization constants, phosphoric acid would be a pH of about 3, and sulfuric is less than 2. Using the second ionization constant, phosphoric acid would be a pH of about 8, and sulfuric would still be about 2. As the water became more saturated with calcium phosphorous, the sulfuric acid became buffered significantly.

PURPOSE AND LOCATION OF AUTOPSY

Purpose of Autopsy: McAllen, TX Wastewater Reclamation Project: Determination of scaling in end element.

Date and Place: October 29, 1999, USBR WTER Pilot Plant Lab, Denver, CO.

Date of This Report: 12/30/1999

Names of Observers:

Frank Leitz
Michelle Chapman Wilbert
Kim Linton

ELEMENT IDENTIFICATION

Manufacturer:	Hydranautics
Element Type:	LFC1X 2540
Element Location:	Housing #6, final element
Serial Number:	X03536
Element Dimensions:	2.5 in. x 40 in.
Number of Leaves:	2
Size of Leaves:	92.1cm x 72.7cm Total Area 82.6cm x 62.2cm Active Area per side (2 m^2 per element or 22.1 ft^2)

OPERATING HISTORY

The RO system was operated for six months on site at the McAllen,TX South Waste Water Treatment Plant. Screened de-gritted sewage was first treated in a Zenogem bioreactor/microfiltration system, then chlorine and ammonia was added and the Zenogem effluent was forwarded to the RO system. The RO element array was a 2x2x1x1 and had 3 elements per vessel for a total of 18 elements in the system. RO recovery rates were set from 50% to 80% of 15.2 L/min feed flow.

Sulfuric acid and antiscalent were added to prevent scaling. However, due to changes in the chemical character of the Zenogem effluent, or excessive gas formation in the acid tank which caused the acid feed pump to loose it's prime, the pH was not controlled well at all times. This resulted in a loss of permeate flow from the last vessel.

Also, traditional constituents used in an RO projection do not include phosphorous compounds. The researchers involved in this project began to suspect that phosphorous salts were the cause of excessive scale problems due to the nature of waste water treatment. Attempts at adjusting the pH to control phosphorous salts included running a projection with non-RO software to determine the potential for phosphate scaling. A range of pH settings and two control points for pH were tested in an attempt to control the scaling problems. The pH ranges tested were from 5.5 to 7 on the feed, and 5.5 to 6 on the concentrate. The lower pH control ranges were in response to this non-RO projected information.

Scaling also caused operators to clean the system approximately 4 times with a low pH solution at a pH of about 3. A high pH solution was not used to clean the membranes as there was no indication of biofouling and the system's performance was recovered using the acid cleanings.

DESCRIPTION OF EVENTS LEADING TO AUTOPSY

Subject element was the last element of the last vessel (vessel #6). Permeate recovery flow from the last vessel varied from 1.4 L/min to 0.01 L/min. This fouling was a result of turning off the acid feed pump for approximately 8 hours.

This autopsy was primarily done to determine if phosphate salts were of primary concern, or not. In addition, the general nature of the scaling composition is of interest.

NARRATIVE DESCRIPTION OF AUTOPSY PROCEDURE

The membrane was inspected during the autopsy at every step. First, the fiberglass wrapping was cut open using an air-powered cast saw set to cut at a shallow depth. The wrapping was then peeled or pried off. Anti-telescoping devices were removed from both ends of the membrane. Finally, the tape wrap was removed.

A squeegee was used to wipe both sides of the first leaf. DI water was used to liquefy the fouling substance. The material was collected in a sample jar labeled as Sample 1.

Researchers then applied a strong red red dye, congo red, to the second leaf.

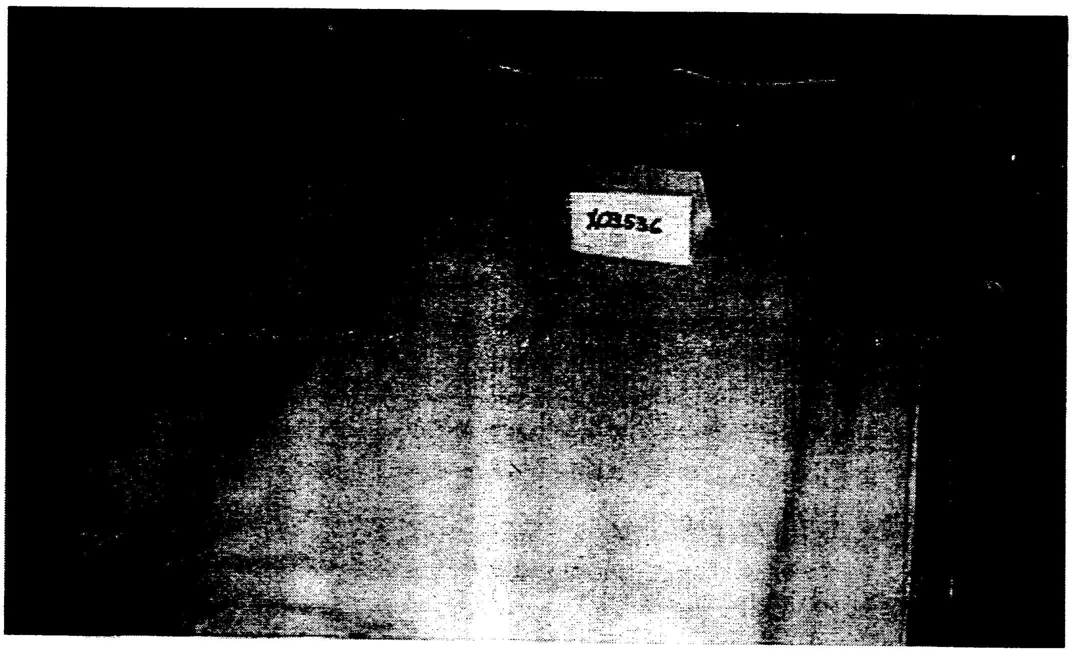
Samples were cut from the feed and reject ends of the second leaf for SEM analysis with DI water added to the baggie to keep the membrane supple. Feed side is Sample 2 and the reject side is Sample #3.

The material was collected from the first leaf was funneled into a sample jar labeled as Sample #4.

OBSERVATIONS

The scrapings from the first element were a brownish pink color. The pink may be dye. No visible scaling was apparent.

Dye test on the second leaf with congo red was negative indicating no structural damage or biofouling on the membrane surface. Dye will highlight biofouling as the dye adheres to a surface ripe with organisms.



Test and Test Objective: Chemical analysis of fouling material on leaf 1

Organization Performing Test: USBR Chemistry Lab

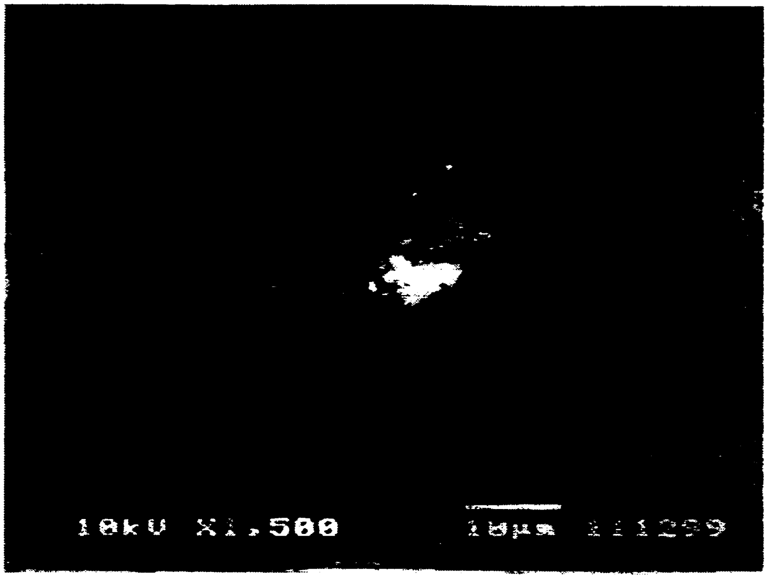
Date: Submitted November 1, 1999

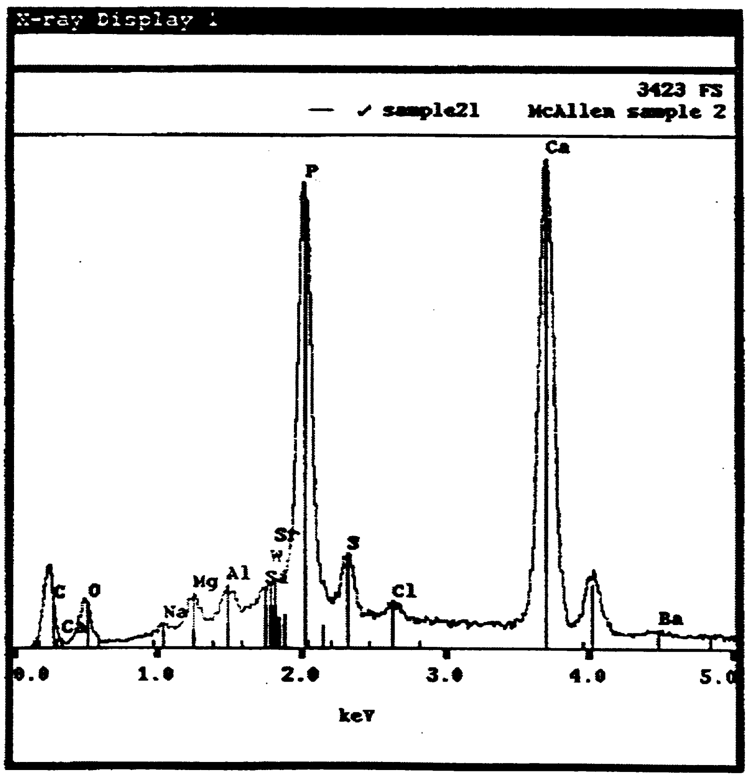
Test Results

Analytes	Housing #3 concentration (mg/L)	Equivalent Anions => Ox. State * Conc. / At. Wt.	Equivalent Cations => Ox. State * Conc. / At. Wt.	Housing #6 concentration (mg/L)	Anions => Ox. State * Conc. / At. Wt.	Cations => Ox. State * Conc. / At. Wt.
Total P	36.69	-3.6		135.2	-13.1	
Al	2.52		0.3	9.1		1.0
Ba	7.02		0.1	20.8		0.3
Fe	1.1		0.1	3.8		0.2
Ca	76.5		3.8	298.0		14.9
K	2.7		0.1	4.8		0.1
Mg	4.07		0.3	13.4		1.1
Na	21.3		0.9	38.0		1.7
Si	2.46		0.4	7.4		1.1
SO4	15.7	-0.3		20.6	-0.4	
Cl	21.6	-0.6		33.7	-1.0	
Totals		-4.5	5.9		-14.5	20.3

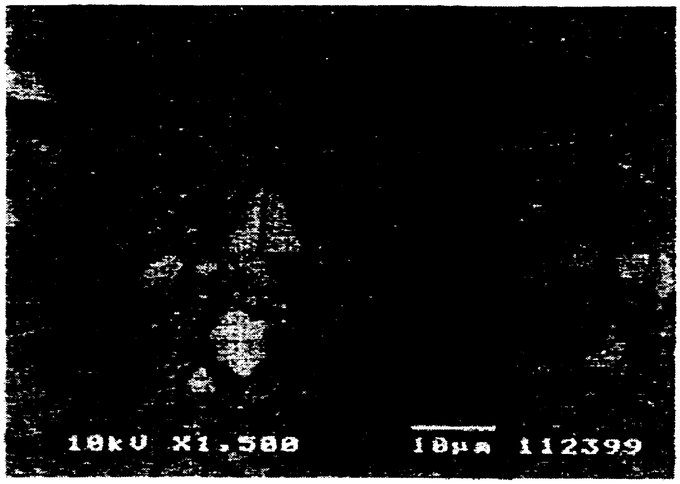
Observations from Test:

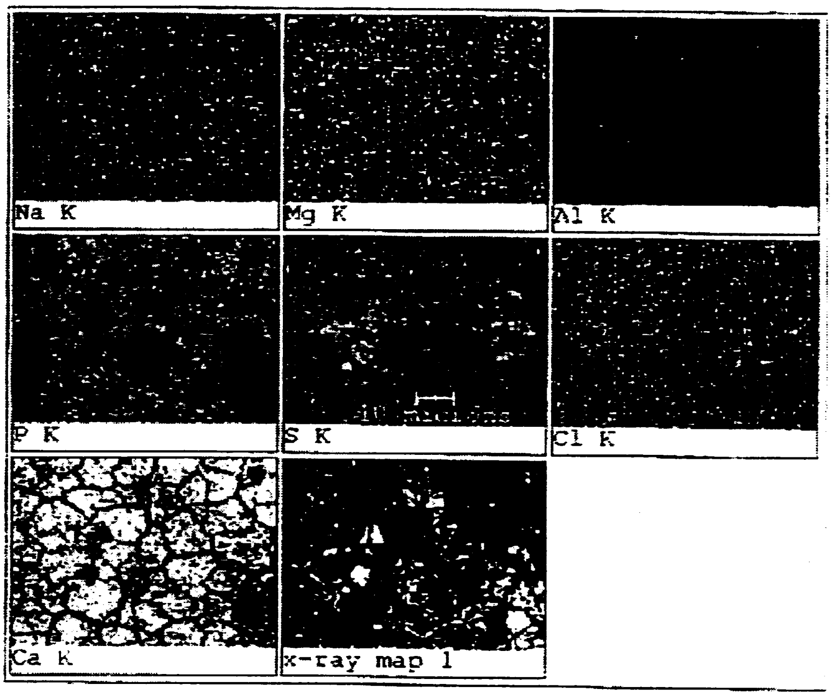
The analysis methods used for TDS, TSS, SO4, and Cl do not used acid to digest the samples. The method used for SO4 and Cl was EPA method 300.0A,ion chromatography. The other metals, except for phosphorous were digested with nitric acid and analyzed using the ICP (inductively coupled plasma) EPA method 30.15. Phosphorous is also digested, but under EPA method 365.1.





Test and Test Objective: SEM/Elemental Analysis of membrane samples from the second leaf to determine the nature of the scalant for element number X03536.
Organization Performing Test: USBR
Date: Submitted November 1, 1999





SEM Distribution map of sampled elements for membrane # X03536

DISCUSSION AND CONCLUSIONS

SEM Test:

The X-ray display peaks should be interpreted as a qualitative analysis, not a quantative one. This analysis captures the energy spikes from the entire picture, not just the particle in the middle. The sample was hit with 10 kV of energy and magnified 3,500 times. Certainly, phosphorous and calcium are prevalent peaks. Barium and sulfur also show strong peaks on other samples not shown as part of this report because they are redundant to the information captured in the body of this report.

Although no visible scaling was apparent to the naked eye, this analysis clearly shows a fine silt-like layer covers the surface of the membrane. It appears from the distribution map that there is an even covering of these elements across the face of the membrane. The particle in the middle does not seem to be of a different character as compared to the rest of the scale layer.

Chemical Analysis of Scraping:

The solids precipitated onto the membrane surface originally come from a saturated solution. When the autopsy is done, de-ionized water is used to rinse the scrapings from the surface of the membrane. Since the samples are scraped from the membrane using DI water, the concentration expressed as a value in milligrams per liter is not meaningful as a concentration unless it is expressed in equivalents.

Using equivalents, it can then be shown in both housing #3 and housing #6 that there are roughly the same number of equivalents of calcium and phosphorous in each housing. This indicates that the predominant form of what was left on the membrane was most likely calcium phosphate (hydroxy apetite). Housing #6 had a larger amount than housing #3 resulting in the flow almost ceasing in housing #6.

Appendix H. ZENON Budget Proposals

ZeeWeed® Tertiary Treatment System

BUDGET PROPOSAL for a ZeeWeed® Membrane Filtration Tertiary Filtration Treatment System for the City of McAllen, Texas Proposal Number #374-98 Rev. 2.0

Submitted to:

CH2M Hill
1620 W. Fountain Head Pkwy. #550
Tempe, AZ 85282

Attention:

Jim Lozier / Fair Miller

Submitted by:

ZENON Environmental Systems – Municipal Division
845 Harrington Court
Burlington, Ontario
L7N 3P3

December 7, 1999

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1.0 COMMERCIAL INFORMATION

1.1 Pricing Summary

The budget pricing to supply equipment and services as described in this proposal is as follows:

ZeeWeed® Membrane Tertiary Treatment System including membranes, permeate pumps, membrane air scour blowers, instruments and control system & equipment F.O.B. McAllen, Texas.

Four (4) Train ZeeWeed® Membrane Tertiary Treatment System to treat a maximum daily hydraulic capacity of 8.5 MGD.

Process equipment will be supplied loose, i.e. not on skids, for installation by others.

Fixed Capacity Flow	**8.5 MGD**	
Budgetary System Price		**US $5,075,000.00**

Validity

Pricing is for budgetary purposes only and does not constitute a final offer of sale.

Taxes and Duties

No taxes or duties or brokerage are included in the above pricing. Any taxes, duties, tariffs of any type are for the account of the Purchaser.

Field Service

The equipment pricing above includes Field Service from ZENON Technicians for assistance with the equipment installation, commissioning, operator training and process start-up assistance.

Any additional days of Field Service required will be at ZENON's Standard per diem rate of US$650 per day plus living and travelling expenses.

Terms of Payment

The budgetary pricing quoted in this proposal is based on the following payment terms

- 15% with Purchase Order
- 25% on submission of General Arrangement Drawings

- 50% on shipment of equipment or notification that equipment is ready to ship (partial shipments permitted)
- 10% within 30 days of equipment start up or within 60 days of equipment shipment whichever is sooner.

Performance & Maintenance Bonds

The cost of providing performance or maintenance bonds is not included. If required these will be at additional cost.

Equipment Shipment and Delivery

A typical drawing submission and equipment shipment schedule is indicated below. Drawing submission milestones and equipment shipment periods are quoted from the date of acceptance of a formal signed Purchase Order:

Submission of GA Drawings:	8 to 10 weeks from acceptance of P.O
Drawing Approval:	3 weeks from submission of drawings
Equipment Shipment:	24 to 26 weeks from acceptance of P.O.
Plant Operation Manuals:	2 weeks after shipment of equipment to site
Operator Training:	When preferred by Customer but no later than 2 weeks prior to the scheduled plant start-up

The above estimated delivery schedule is presented based on current workload backlogs and production capacity. If a formal purchase order is not received within the period of validity of this proposal, the delivery schedule is subject to review and adjustment.

The estimated delivery period quoted is presented based on review ***and approval*** of equipment shop drawings within a two (2) week period. Any delay in approval of shop drawings may affect the proposed shipment schedule.

Quality Basis

For the purposes of establishing a quality basis for equipment supply, reference is made herein to particular equipment manufactured by certain suppliers. The term "***or equal***" where used herein shall be deemed to mean "ZENON Approved Equivalent". ZENON reserves the right to substitute equipment that ZENON considers to be of equal quality and suitability for the intended application from alternative suppliers to those named herein. With regard to determining the suitability or otherwise of any particular manufacturer's equipment for inclusion as part of the ZeeWeed® system, ZENON's decision shall be final.

1.2 Standard Terms and Conditions

ZENON's Standard Terms and Conditions apply.

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1.3 ZENON STANDARD TERMS AND CONDITIONS

Seller desires to provide its Customers with prompt and efficient service. However, to negotiate individually the Terms and Conditions of each Sales contract would substantially impair Seller's ability to provide such service. Accordingly, Products and Services furnished by Seller are sold only on the Terms and Conditions stated herein. Notwithstanding any terms or conditions on Customer's order, Seller's performance of any contract is expressly made conditional on Customer's agreement to Seller's Terms and Conditions of Sale unless otherwise specially agreed to in writing by Seller. In the absence of such agreement, commencement of performance and/or shipment shall be for Customer's convenience only and shall not be deemed or construed to be acceptance of Customer's Terms and Conditions, or any of them. If a contract is not earlier formed by mutual agreement in writing, acceptance of any Product or Service shall be deemed acceptance of the Terms and Conditions stated herein. All contracts for the Sale of Products shall be construed under and governed by the law of the location of Seller's plant at Burlington, Ontario, Canada.

QUOTATION AND PRICES

All quotations are subject to the Terms and Conditions stated herein as well as any additional Terms and Conditions that may appear on the face hereof. In the case of a conflict between the Terms and Conditions stated herein and those appearing on the face hereof, the latter shall control. Seller's prices and quotations are subject to the following:

a) All published prices are subject to change without notice.

b) **UNLESS OTHERWISE SPECIFIED IN WRITING, ALL QUOTATIONS EXPIRE THIRTY (30) DAYS AFTER DATE THEREOF, MAY BE TERMINATED EARLIER BY NOTICE AND CONSTITUTE ONLY SOLICITATIONS FOR OFFER TO PURCHASE**; further, budgetary quotations and estimates are for preliminary information only and shall neither constitute offers, nor impose any obligation or liability upon Seller.

c) Unless otherwise stated in writing by Seller, all prices quoted shall be exclusive of transportation, insurance, taxes (including, without limitation, any sales, use, or similar tax, and any tax levied on or assessed to Seller after Product shipment by reason of Seller's retention of a security interest as provided herein), license fees, customs fees, duties and other charges related thereto and Customer shall report and pay any and all such shipping charges, premiums, taxes, fees, duties and other charges related thereto, and shall hold Seller harmless therefrom, provided that, if Seller, in its sole discretion, chooses to make any such payment, Customer shall reimburse Seller in full upon demand.

d) Stenographic, typographical and clerical errors are subject to correction.

e) Prices quoted are for Products only and do not include technical data, proprietary right of any kind, patent rights, qualification, environmental or other than Seller's standard tests and other than Seller's normal domestic commercial packaging unless expressly agreed to in writing by Seller.

f) Published weights and dimensions are approximate only. Certified dimension drawings can be obtained upon request. Manuals, drawings or other documentation required hereupon must be referenced specifically.

This is merely a quotation, and the technology disclosed herein may be covered by one or more ZENON Environmental Inc. (ZENON) patents or patent applications. Any disclosure in this offer does not hereby grant, and nothing contained in the offer shall obligate ZENON to grant, an option to obtain a license to any technology or any other rights under any patent now or hereafter owned or controlled by ZENON.

TERMS OF PAYMENT

Unless credit is granted or otherwise specified in writing, payment is due upon shipment. All payments on approved credit accounts shall be due in full thirty (30) days from date of invoice. Past due balances shall be subject to a service charge of 1-1/2% per month (18% per annum), but not more than the amounts allowed by law. Partial shipments will be billed as made and payments therefor are subject to the above terms. Payment shall not be withheld for delay in delivery of required documentation unless a separate price is stated therefor, and then only to the extent of the price stated for such undelivered documentation. Seller may cancel or delay delivery of Products in the event Customer fails to make prompt payment therefor, or in the event of an arrearage in Customer's account with Seller. Seller hereby retains a security interest in the Products finished until Customer has made payment in full in accordance with the terms hereof. Customer shall cooperate fully with Seller to execute such documents and to accomplish such filings and/or recordings thereof as Seller may deem necessary for the protection of Seller's interest in the Products furnished.

TRANSPORTATION AND RISK OF LOSS

Transportation will normally follow Customer's shipping instructions, but Seller reserves the right to ship Products freight collect and to select the means of transportation and routing when Customer's instructions are deemed unsuitable. Unless otherwise advised, Seller may insure to full value of the Products or declare full value thereof to the transportation company at the time of shipment and all freight and insurance costs shall be for Customer's account. Risk of loss and/or damage shall pass to Customer at the FOB point, which shall be the point of manufacture or such other place as Seller shall specify in writing, notwithstanding installation by or under supervision of Seller. Confiscation or destruction of, or damage to, Products shall not release, reduce or in any way affect the liability of Customer therefor. All Products must be inspected upon receipt and claims should be filed with the transportation company when there is evidence of shipping damage, either concealed or external. Notwithstanding any defect or nonconformity, or any other matter, risk or loss and/or damage shall remain with the Customer until the Products are returned at Customer's expense to such place as Seller may designate in writing. Customer, at its expense, shall fully insure Products against all loss and/or damage until Seller has been paid in full therefor, or the Products have been returned, for whatever reason, to Seller.

PERFORMANCE

Seller will make all reasonable effort to observe its dates indicated for performance. However, Seller shall not be liable in any way because of any delay in performance hereupon due to unforeseen circumstances or to causes beyond its control, including, without limitation, strike, lockout, riot, war, fire, act of God, accident, failure or breakdown of components necessary to order completion, subcontractor, supplier or customer caused delays, inability to obtain or substantial rises in the price of labour, materials or manufacturing facilities, curtailment of, or failure to obtain sufficient, electrical or other energy supplies, or compliance with any law, regulation or order, whether valid or invalid of any cognizant governmental body or any instrument thereof whether now existing or hereafter created. Performance shall be deemed suspended during, and extended for, such time as any such circumstances or causes delay its execution. Whenever such circumstances or causes are remedied, Seller will make, and Customer shall accept, performances hereupon. In addition, Seller's inventories and current production must be allocated so as to comply with applicable Government regulations. In the absence of such regulations, Seller reserves the right, in its sole discretion, to allocate inventories and current production and substitute suitable materials when, in its opinion, such allocation or substitution is necessary due to such circumstances or causes. No penalty clause of any kind shall be effective. As used herein, "performance" shall include, without limitations, fabrication, shipment, delivery, assembly, installation, testing, and warranty repair or replacement as applicable.

ACCEPTANCE

The furnishing by Seller of a Product to the Customer shall constitute acceptance of that Product by Customer, unless notice of defect or nonconformity is received by Seller within thirty (30) days of receipt of the Product at Customer's designated receiving address; provided that, for Product for which Seller agrees in writing to perform acceptance testing after installation, the completion of Seller's applicable acceptance tests, or execution of Seller's acceptance form

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by Customer, shall constitute acceptance of the Product by Customer. Notwithstanding the foregoing, any use of a Product by Customer, its agents, employees, contractors or licensees for any purpose, after receipt thereof, shall constitute acceptance of that Product by Customer. Seller may repair or, at its option, replace defective or non-conforming parts after receipt of notice of defect or nonconformity.

ASSIGNMENTS AND TERMINATIONS

Any assignment by Customer of any contract hereupon without the express written consent of Seller is void. No order may be terminated by Customer except by mutual agreement in writing. Terminations by mutual agreement are subject to the following conditions:

a) Customer will pay, at applicable contract prices, for all Products which are completely manufactured and allocable to Customer at the time of Seller's receipt of notice of termination.

b) Customer will pay all costs, direct and indirect, which have been incurred by Seller with regard to Products which have not been completely manufactured at the time of Seller's receipt of notice of termination.

c) Customer will pay a termination charge on all other determined costs and other charges. To reduce termination charges, Seller will divert completed parts, material or work-in-process from terminated contracts to other Customer's whenever, in Seller's sole discretion, it is practicable to do so.

PATENTS AND OTHER INDUSTRIAL PROPERTY RIGHTS

Seller will hold Customer harmless, as set forth herein, in respect to any claim that the design or manufacture of any Product in Seller's commercial line of Products, or manufactured to specifications set by Seller and furnished herein, constitutes an infringement of any patent or other industrial property rights of the United States or Canada. Seller will pay all damages and costs, either awarded in a suit or paid, in Seller's sole discretion, by way of settlement, which are based on such claim of infringement, provided that Seller is notified promptly in writing of such claim of infringement but there is no liability whatsoever herein with respect to any claims settled by Customer without Seller's prior written consent. In the event that Seller is required to hold Customer harmless hereupon, Seller will, in its sole discretion and at its own expense, either procure for Customer the right to continue using said Product, replace it with a non-infringing product, or remove it and refund an equitable portion of the selling price and transportation costs thereof. **THIS SHALL CONSTITUTE SELLER'S ENTIRE LIABILITY FOR ANY CLAIM BASED UPON OR RELATED TO ANY ALLEGED INFRINGEMENT OF ANY PATENT OR OTHER INDUSTRIAL RIGHTS.** Customer shall hold Seller harmless against any expense, loss, costs or damages resulting from claimed infringement of patents, trademarks, or other industrial property rights arising out of compliance by Seller with Customer's designs, specifications, or instructions. **SELLER DISCLAIMS LIABILITY FOR U.S. OR CANADIAN PATENT OR COPYRIGHT INFRINGEMENT ARISING FROM USE OR MANUFACTURE BY ANYONE OF INVENTIONS IN CONNECTION WITH PRODUCTS OR SERVICES SOLD, USED, OR INTENDED FOR SALE OR USE, IN PERFORMING CONTRACTS WITH THE UNITED STATES OR CANADA.**

WARRANTY

1. Unless otherwise agreed to in writing, Seller warrants its Products to be free from defects in material or workmanship for a period of 12 months from the shipment of Product by Seller, provided that such Product are used, cleaned and maintained in accordance with the Seller's instructions. This warranty does not apply to normally replaceable parts or components such as filter cartridges, pump seals, membranes etc., (see below for membrane warranties).

2. Customer undertakes to give immediate notice to Seller if goods or performance appear defective and to provide Seller with reasonable opportunity to make inspections and tests. If Seller is not at fault, Customer shall pay Seller the costs and expenses of the inspections and tests.

3. Seller's obligations under this warranty is limited to the repair or replacement at its factory, or any device or part thereof which shall prove to have been thus defective. If Customer asks Seller to replace defective parts at Customer's premises, Customer agrees to pay for any traveling time and expenses, plus the Seller's labour to complete the replacement/repair.

4. Goods shall not be returned to Seller without Seller's permission. Seller will provide Customer with a "Return Material Authorization" number to use for returned goods. All returns are F.O.B. - Burlington, Ontario, Canada.

5. Warranty on the membranes applies only if the membrane element(s) has been operated and cleaned according to Seller's instructions. When either permeate or concentrate flow drops by 10% from the original rates at the same operating conditions, cleaning must be initiated or the warranty will be null and void. Elements must be clean and be kept moist. They should be shipped to Seller in water-tight bags and must be protected from freezing. **WARNING** – if element conditions of use given in Seller's instructions are not followed, the warranty will be null and void.

IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION, AND ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF THE SELLER, UNLESS SUCH OTHER WARRANTIES, OBLIGATIONS OR LIABILITIES ARE EXPRESSLY AGREED TO IN WRITING BY SELLER, ARE NULL AND VOID.

DAMAGES AND LIABILITY

SELLER'S LIABILITY FOR DAMAGES SHALL NOT EXCEED THE PAYMENT, IF ANY, RECEIVED BY SELLER FOR THE UNIT OF PRODUCT OR SERVICE FURNISHED OR TO BE FURNISHED, AS THE CASE MAY BE, WHICH IS THE SUBJECT OF CLAIM OR DISPUTE. IN NO EVENT WILL SELLER BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES, OF ANY KIND, HOWEVER CAUSED, ARISING OUT OF, OR IN ANY WAY CONNECTED WITH, THE PRODUCTS FURNISHED BY SELLER TO CUSTOMER.

DISPUTES

All disputes under any contract concerning Products not otherwise resolved between Seller and Customer shall be resolved in a court of competent jurisdiction for the location of Seller's plant at Burlington, Ontario, Canada, and no other place. Provided that, in Seller's sole discretion, such action may be heard in some other place designated by Seller, if necessary to acquire jurisdiction over third persons, so that the dispute can be resolved in one action. Customer hereby consents to the jurisdiction of such court or courts and agrees to appear in any such action upon written notice thereof. No action, regardless of form arising out of, or in any way connected with, the Products or Services furnished by Seller, may be brought by Customer more than one (1) year after the cause of action has occurred. If any part, provision or clause of the Terms and Conditions of Sale, or the application thereof to any person or circumstances, is held invalid, void or unenforceable, such holding shall not affect and shall leave valid all other parts, provisions, clauses or applications of the Terms and Conditions remaining, and to this end the Terms and Conditions shall be treated as severable.

2.0 SYNOPSIS OF THE ZEEWEED® TERTIARY TREATMENT PROCESS

ZeeWeed® ultrafiltration system is a proprietary ZENON process technology that produces high quality treated water by drawing raw water through immersed ZeeWeed® membrane modules. ZeeWeed® "Outside-In", hollow-fibre membranes are manufactured ultrafiltration (UF) pore size. The ZeeWeed® UF Membranes have an absolute pore size of 0.1 microns and thus ensure removal of particulate matter greater than 0.1 microns in size such as most particulate matter, **including bacteria, solids, *Giardia* cysts and *Cryptosporidium* oocysts,** cannot enter the treated effluent stream. The ZeeWeed® Membrane ensures removal of a large percentage of impurities. The ZeeWeed membranes produce a high quality effluent, optimal for post-treatment by reverse osmosis.

The membranes operate under a slight vacuum created within the hollow membrane fibres by a permeate pump. Treated water is drawn through the membranes, enters the hollow fibres and is pumped out to the treated water storage tank (or distribution system). Air flow is introduced at the bottom of the membrane modules to create turbulence which scrubs and cleans the outside of the membrane fibres allowing them to operate at a high flux. The aeration also oxidizes iron and organic compounds, resulting in a treated water quality that is better than that provided by ultrafiltration alone.

ZeeWeed® membranes are immersed and therefore can tolerate high levels of solids. This is a main advantage when used as a tertiary treatment plant, since the ZeeWeed plant continues to operate well even when the upstream clarifier is upset and rejects solids to the UF. The capacity to handle solids also means that there is no need to pre-treat the clarified effluent, avoiding therefore the costs of sand filters or cartridge filters often required by other membrane technologies.

ZeeWeed® membranes have the additional benefit of being chlorine resistant up to concentrations of 1,000 mg/L. Therefore, influent water can be pre-chlorinated or the membranes can be easily cleaned, even when heavy fouling occurred.

The ZeeWeed® Membrane Technology process consistently produces high quality water, as the membranes are not subjected to stress, pressurization or rapid pressure fluctuations. Membrane cleaning by backpulsing is achieved by reversing the permeate flow and backwashing the fibre's lumen with permeate at low pressure (due to the high permeability of the ZeeWeed® membrane, the backpressure during backpulsing is low). The small variations in operating pressure occur smoothly over relatively long periods so that at no time is the membrane stressed. This, in turn, results in a membrane filtered permeate with the lowest sustainable particle count on the market.

3.0 FEATURES & BENEFITS OF THE ZEEWEED® SYSTEM

High Treated Effluent Quality

ZENON's ZeeWeed® Membrane Tertiary Treatment System is a cost effective method for membrane filtration removal of solids and is particularly recommended for treatment of the following contaminants in water:

Feed Water Element	Treated Water Quality
Suspended Solids	≥ 6 log removal
Average Turbidity	≤ 0.1 NTU
Particle Counts	Average ≤ 5/mL, size range > 2 microns

Note: *The information provided in this section of the proposal is general only and is intended only to indicate what is capable of being achieved with ZeeWeed® Membrane Water Treatment Technology based on consideration of specific raw water qualities and the type of treatment processes utilized.*

Since the presence of air is continuous or semi-continuous in the process tank, materials which will readily oxidize, such as iron in its ferrous state, will be micro-precipitated and separated by the membrane, therefore producing a better quality water than if treated by ultrafiltration alone.

Advantages of an "Outside-In" Immersed Membrane

a) Single Step Treatment

The ZeeWeed® membrane is an outside-in membrane where the flow of water is from the outside of the membrane to the inside of the hollow fibre. This means that the inside of the membrane only comes in contact with clean, filtered water. The solids to be removed remain outside of the membrane where they do not cause fouling and plugging.

b) Low Energy Requirement.

Being immersed allows ZENON's ZeeWeed® Membranes to operate under a slight vacuum instead of under a high positive pressure, as do other membranes on the market. The ZeeWeed® Membrane operates under a differential pressure of 5"Hg to 18"Hg (5-20 ft H_2O) vacuum. This operational energy is very low and to ZENON's knowledge is the lowest in the membrane market.

c) Ability to Operate in a High Solids Environment

The ZeeWeed® membranes are immersed within the process tank, where suspended solids can exist without interfering with membrane operation. The operating flux rates of ZeeWeed® membrane modules are, for all practical purposes, independent of the solids content and turbidity of the raw water supply. This reflects in its capacity to operate well in a solids environment seen when the clarifiers get upset.

d) *Stable and Low Particle Counts in the Effluent*

The low energy backpulse of an immersed membrane does not produce significant expansion of the membrane pores. Expansion of the membrane pores, which results from high energy air backpulsing of the membranes as utilized in some types of membrane systems, can result in high particle counts immediately following backpulsing. This expansion of the membrane pores may potentially permit the passage of particles of larger sizes through the membranes until the membrane fibre fully relaxed from the expansion induced by the backpulsing process. Such systems cannot reliably use particle counters to verify the membrane integrity.

With the ZeeWeed® Membrane system expansion of the membrane pores is insignificant and the ZeeWeed® process consistently produces high quality treated water, which remains stable at all phases of plant operation.

Resistance to Oxidizing Chemicals

The ZeeWeed® membrane is resistant to chlorine and other typical water treatment plant oxidants (such as chlorine dioxide and potassium permanganate) in concentrations as high as 1,000 mg/L. This means that it is possible to pre-chlorinate the water without having to add a de-chlorination step such as Granular Activated Carbon (GAC) or bisulfite injection, which not only requires periodic chemical filling and maintenance, but also adds an unnecessary compound into the water. Where prechlorination is desired, chemical resistance also provides protection against dechlorination equipment failure, which could lead to severe damage of a chlorine sensitive membrane. Finally, chlorine resistance also allows for easy disinfection of the membrane and the plant should this be required.

Exceptional Membrane Durability

The ZeeWeed® membrane has been designed to be exceptionally durable and resistant to breakage. To achieve a high level of membrane durability ZENON utilizes a patented internal support on which the membrane is caste. This provides resistance to the membrane and protects it against tearing and breakage without reducing its flux capacity.

Simplicity of Operation

The ZeeWeed® process is an easy and inexpensive system to operate both in terms of maintenance costs and personnel requirements. Since treatment is a single stage process, there is no need for coagulants (except for colour and organics removal), clarifiers or sand filters as with some other membrane systems. Instead the plant operators are only required to ensure they maintain proper membrane permeating conditions by maintaining the permeate pumps and blowers in operation.

Ruggedness of Operation / Operational Flexibility

The ZeeWeed® Treatment Process consistently produces high quality treated effleunt irrespective of seasonal, operational and weather related variations in the source raw water quality, since the membranes can operate equally well in low or high solids concentrations and at varying temperatures:

- without clogging

- without the need for pressurized air backpulsing cycles which consistently stress the membranes and lead to premature failure
- without any detrimental effects on the membrane flux since the ZeeWeed® membrane was developed for environments of high solids concentrations
- without breaking since the hollow fibre membrane is a composite developed to be both highly durable structurally as well as chemically resistant to outside elements

4.0 ZEEWEED® TERTIARY TREATMENT PLANT

Design Parameters

The table below summarizes the main design parameters on which the proposed ZeeWeed® Tertiary Treatment System has been designed.

Design Flow	Raw Water	Treated Water
Design Flow		
Fixed Capcity Flow	9.435 MGD	8.5 MGD

Note 1: The plant should be able to operate at 95% recovery, however, the recovery equipment has been sized for 90% and the average given above at 90%, is to allow for operations flexibility.

4.0 ZEEWEED® TERTIARY TREATMENT PLANT

Design Philosophy and Equipment Selection

ZENON proposes to offer a four (4) Process Stream Membrane Treatment Plant with each process train designed to produce a continuous treated water output of 1/4 of the required capacity of the plant. In the event of any type of operational problem or failure with one train the plant will function at 75% of the nominal average day flow design capacity, by adjusting the vacuum applied to the operating membrane modules. Future plant expansion, if and when required, can be achieved by adding additional treatment units.

The equipment proposed is designed for simplicity of operation. All plant operations are automatically controlled via a PLC. There are no normal operations that require manual operation of valves, pump speeds, etc. The system design philosophy is to reduce as far as possible the potential for system problems caused by operator error.

The treatment system proposed by ZENON does not include a chlorine dosing system to add residual chlorine to the treated effluent.

CONCRETE, EQUIPMENT LOOSE

The ZeeWeed® Membrane Tertiary Treatment System is designed with major process equipment supplied loose for installation on concrete pads. The ZeeWeed® membranes are supplied for installation in concrete tanks (by others) within Zenon supplied membrane support beams. The membrane air scour blowers are supplied loose for installation within an acoustically insulated blower room to minimize the noise transmission to the rest of the plant. Reject water will flow by gravity to the disposal point. The plant control panel will be supplied loose so that it can be either wall mounted adjacent to the plant or located in a separate control room depending on the Owner's preference.

5.0 MAJOR EQUIPMENT

The list below summarizes the major equipment and the quantities of items included for the ZenoGem® plant design.

SCOPE OF SUPPLY SYNOPSIS for the ZeeWeed® Plant

Item	Size	Units	Quantity
Raw Water Feed			
Raw Influent Feed Pumps			Not Incl.
Inlet & Discharge Isolating Valves			Not Incl.
Discharge Check Valves			Not Incl.
Piping Manifold			Not Incl.
Wet Well Level Switches			Not Incl.
VFD's			Not Incl.
Raw Water Screening			
Raw Influent Screen			Not Incl.
Raw Influent Grinder			Not Incl.
Raw Influent Flowmeter			Not Incl.
Raw Influent Flow Control Flowmeter			Not Incl.
Raw Influent Flow Control Valve			Not Incl.
Membranes/Membrane Cassettes			
Individual Membrane Modules			640
Membrane Cassettes			80
Process Tanks & Frames			
Membrane Support Frames			Incl.
Process Tanks			Not Included
Permeate Collection Headers			4
Air Scour Headers			4
Permeate Pumps			
Permeate Pumps	2,497	USgpm	5
VFD's/Control Valves	50	HP	4
Piping Manifold			Not Incl.
Valves			Incl.
Air Extraction System			
Air Removal Separation Columns			4
Vacuum Pumps	24	scfm	3
Backpulse System			
Backpulse Water Storage Tank	6,480	USg	2
Hypochlorite Storage Tank	106	USg	1
Hypochlorite Feed Pumps	6.9	USgphr	2
Item	**Size**	**Units**	**Quantity**

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Air Blowers			
Membrane Air Scour Blowers incl. Silencers	5,129	Scfm	3
Inlet & Discharge Isolation Valves			6
Discharge Check Valves			3
Inlet Control Valves			Incl.
Chemical Addition System (if required)			
Chemical Storage Tank			Not Incl.
Chemical Feed Pumps			Not Incl.
CIP System			
CIP Chemical Storage Tank			Incl.
CIP Chemical Feed Pump			Incl.
Instruments			
Permeate Flowmeters			4
Permeate Header Pressure Transducers			4
Process Tank Level Transmitters			4
Process Tank Level Switches			16
pH Transmitters			Not Incl.
Turbidimeters			1
Particle Counters			4
Membrane Blower Flow Switches			3
Permeate Pump Pressure Gauges			4
Membrane Air Scour Blower Pressure Gauges			3
Control Panel			
PLC-based Control Panel			1
Back-Up PLC			Not Incl.
Electrical			
MCC Panel			Not Included
Miscellaneous			
Air Compressor			2
Air Drier			1
Monorail for Cassette Removal			Not Incl.
Field Service Allowed			Days
Installation Supervision			5
Mechanical Checkout			5
Operator Training			2
Process Start-Up			3
Commissioning			5
TOTAL MAN-DAYS			20
TOTAL No. TRIPS			3
Freight			
Delivery to Site			Incl.

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6.0 ATTACHMENTS

Plant Power Consumption and Estimated Yearly Operating Cost

Table 9.1.1 Connected Power and Estimated Power Consumption at Average Day Flow

City of McAllen Eff Filtration Rev 2

Average Day Flow 8,500,026 USgpd 32,173 m3/day

Maximum Day Flow 8,500,026 USgpd 32,173 m3/day

ITEM #	TOTAL QTY	EQUIPMENT DESCRIPTION		# Operating Pumps Blowers etc.	Design Capacity	Discharge Head	Duty Point Efficiency	Equipment Operating BHP	Motor HP	Total Equipment BHP	Total Connected HP	Motor Efficiency %	Equipment kW	Hours / Day Continuous Operation	Energy Cost per year
1	-	Raw Water/Wastewater Screen	n/a	-				-	-	-	-	-	-	24.00	-
2	4.00	Permeate Pumps	By Zenon	4.00	1,664.32 USgpm	35.00 ft	81.00	18.44	30.00	73.76	120.00	91.40	60.18	22.40	36,901
3	-	Backpulse Pumps	n/a	-	- USgpm	30.00 ft	-	-	-	-	-	-	-	6.40	-
4	-	Recirculation Pumps	n/a	-	- USgpm	10.00 ft	55.00	-	-	-	-	-	-	24.00	-
5	-	Sludge Wasting Pumps	n/a	-	- USgpm	30.00 ft	50.00	-	-	-	-	-	-	2.00	-
6	-	Reject Water Pumps	n/a	-	- USgpm	25.00 ft	55.00	-	-	-	-	-	-	24.00	-
7	3.00	Membrane Air Scour Blowers	By Zenon	2.00	3,840.00 scfm	4.25 psi	n/a	110.49	200.00	220.97	600.00	94.60	174.19	24.00	114,440
8	-	Process Air Blowers	n/a	-	- scfm	6.00 psi	n/a	-	-	-	-	-	-	24.00	-
9	-	Miscellaneous Air Blowers	n/a	-	- scfm	6.00 psi	n/a	-	-	-	-	-	-	24.00	-
10	-	Anoxic Zone Mixers	n/a	-			n/a	-	-	-	-	-	-	24.00	-
11	3.00	Air Separation System Vacuum Pumps	By Zenon	2.00	22.25 acfm	18.00 Ins Hg	n/a	2.25	3.00	4.50	9.00	87.50	3.84	24.00	2,520
12	2.00	Backpulse Sodium Hypochlorite - Metering	By Zenon	1.00	0.099 USgpm	50.00 ft	n/a	0.10	0.10	0.10	0.21	100.00	0.08	3.20	7
13	-	CIP Wash Pump	n/a	-	- USgpm	30.00 ft	55.00	-	-	-	-	-	-	0.02	-
14		CIP Chemical Metering	n/a		USgpm			-		-	-		-		-
15	-	Chemical Feed #1 System #1 - Metering	n/a	-	1.365 USgpm	50.00 ft	n/a	-	0.50	-	-	100.00	-	24.00	-
16	-	Chemical Feed #1 System #2 - Metering	n/a	-	0.101 USgpm	50.00 ft	n/a	-	0.03	-	-	100.00	-	24.00	-
17	-	Chemical Feed #1 System #3 - Metering	n/a	-	0.057 USgpm	50.00 ft	n/a	-	0.03	-	-	100.00	-	24.00	-
18	-	Chemical Feed #1 System #4 - Metering	n/a	-	0.101 USgpm	50.00 ft	n/a	-	0.03	-	-	100.00	-	24.00	-
18	2.00	Air Compressors	By Zenon	1.00	52.00 scfm	100.00 psi	n/a	18.75	25.00	18.75	50.00	91.30	15.31	6.00	2,515
19	2.00	Air Driers	By Zenon	1.00	75.00 scfm		n/a	-	-	-	-	80.00	-	6.00	-
20	1.00	Controls & Instrumentation	By Zenon								1.34		1.00	24.00	657
21	1.00	Miscellaneous	By Zenon								1.34		1.00	24.00	657
		Total Connected Power									**781.89 HP**				
		Total Operating Power								**318.09 BHP**			**255.59 kW**		
		Total Operating Cost												**US$**	**157,696**

Notes

Energy Costs based on 0.0750 US$ per kW.hr

Power Consumption of other plant equipment required (raw water feed pumps, high lift pumps etc.) is not included by ZENON

Where operating efficiencies are not known, the equipment operating power is assumed to be 75% of the motor nameplate power rating

The operating hours for the permeate pump are corrected for the downtime during backpulse cycles (and Membrane Pressure Decay Test Cycles if applicable)

Permeate Pump Backpulses every 15 mins for 30 seconds 2,496 USgpm @ 30.00 ft TDH = 24.89 BHP

Motor Efficiencies indicated are typical only. Efficiencies used are usually within 2% of actual when motor is operating within 50-100% of its full load rating

Operation of Air Compressor is assumed to be only 25% of time

Operation of the Sodium Hypochlorite Pumps is intermittent - operation for 25% of time is used for energy calculation

Blower Energy Consumption Estimated as : 6.770 BHP per 1,000 scfm per psig.

The motor sizes in the above table are preliminary only and estimated based on the information available at the time of preparing this proposal. It must be understood that at the time of proposal preparation, final headlosses or pressure drops in piping systems have not been calculated accurately Motor sizes are subject to confirmation (and if necessary adjustment) during final design. Use of the above information for sizing or selection of any ancillary equipment is entirely at the USER's own risk. Whilst the motor sizes indicated above are ZENON's best estimate based on design criteria assumed during preparation of the proposal, ZENON accepts no responsibility for the absolute accuracy of the information contained herein.

Table 9.2.2 Estimated Total Annual Operating Cost
City of McAllen Eff Filtration Rev 2

Average Day Flow	8,500,026	USgpd	32,173	m3/day
Maximum Day Flow	8,500,026	USgpd	32,173	m3/day

Item			Cost per year	
Electrical Equipment - Zenon		Calculated at Average Day Flow	157,696	US$
Electrical Equipment - Others			-	US$
Backpulse Chemicals	Sodium Hypochlorite	Calculated at Average Day Flow	8,232	US$
CIP Chemical #1	MC-1		3,211	US$
CIP Chemical #2	Sodium Hypochlorite - 250 mg/L		4,435	US$
CIP Neutralization Chemical #1			175	US$
CIP Neutralization Chemical #2			117	US$
Suggested Membrane Accrual			190,905	US$
Estimated Total Annual Operating Cost			**364,772**	**US$**

Notes

Backpulse Chemical Consumption		**Sodium Hypochlorite**	
Sodium Hypochlorite Consumption		71.91	Litres per day
Sodium Hypochlorite Consumption		26,248	Litres per year
Sodium Hypochlorite Cost	US$	0.31	per Litre
CIP Cleaning Chemical #1		**MC-1**	
Design Dosage		2,000.00	mg/L
Solution Concentration		50.00	%
Specific Gravity		1.240	
Wash Frequency		1.00	times / year
Chemical Consumption per Wash (all tanks)		1,918.24	Litres
Total Annual Chemical Consumption		1,918.24	Litres
Chemical Cost	US$	1.67	per Litre
Chemical Cost	US$	2.70	per kg
CIP Cleaning Chemical #2		**Sodium Hypochlorite - 250 mg/L**	
Design Dosage		250.00	mg/L
Solution Concentration		10.80	%
Specific Gravity		1.168	
Wash Frequency		12.00	times / year
Chemical Consumption per Wash (all tanks)		1,178.52	Litres
Total Annual Chemical Consumption		14,142.26	Litres
Chemical Cost	US$	0.31	per Litre
CIP Neutralization Chemical #1		**Sodium Hydroxide**	
Design Dosage		625.00	mg/L
Solution Concentration		50.00%	
Specific Gravity		1.520	
Wash Frequency		1.00	times / year
Chemical Consumption per Wash (all tanks)		489.02	Litres
Total Annual Chemical Consumption		489.02	Litres
Chemical Cost	US$	0.36	per Litre
Chemical Cost	US$	0.47	per kg
CIP Neutralization Chemical #2		**Sodium Bisulfite**	
Design Dosage		146.00	mg/L
Solution Concentration		38.00%	
Specific Gravity		1.290	
Wash Frequency		12.00	times / year
Chemical Consumption per Wash (all tanks)		177.11	Litres
Total Annual Chemical Consumption		2,125.32	Litres
Chemical Cost	US$	0.06	per Litre
Chemical Cost	US$	0.55	per kg

ZenoGem®/ZeeWeed® BUDGET PROPOSAL for the City of McAllen, Texas Wastewater Treatment Plant

BUDGET PROPOSAL # 374-98 Rev 1

Submitted to:

CH2M Hill
1620 W. Fountain Head Pkwy. #550
Tempe, AZ 85282

Attention:

Jim Lozier & Fair Miller

Submitted by:

ZENON Environmental Systems – Municipal Division
845 Harrington Court
Burlington, Ontario
L7N 3P3

December 7, 1999

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1999

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1.0 COMMERCIAL INFORMATION

1.1 PRICING SUMMARY

The budget pricing to supply equipment and services as described in this proposal is as follows:

One (1) ZenoGem® Membrane Bioreactor Waste Treatment System including membranes, aeration system, pumps, blowers, instruments, control system and equipment, FOB McAllen Texas.

Process equipment will be supplied loose, i.e. not on skids, for installation by others.

Fixed Capacity Flow	**8.5 MGD**	
Budgetary System Price		**US$ 8,620,000.00**

Validity

Pricing is for budgetary purposes only and does not constitute a final offer of sale.

Taxes and Duties

No taxes or duties or brokerage are included in the above pricing. Any taxes, duties, tariffs of any type are for the account of the Purchaser.

Field Service

The equipment pricing above includes Field Service from ZENON Technicians for assistance with the equipment installation, commissioning, operator training and process start-up assistance.

Any additional days of Field Service required will be at ZENON's Standard per diem rate of US$650 per day plus living and traveling expenses.

Terms of Payment

The budgetary pricing quoted in this proposal is based on the following payment terms

- 15% with Purchase Order
- 30% on submission of General Arrangement Drawings
- 50% on shipment of equipment or notification that equipment is ready to ship (partial shipments permitted)
- 5% within 30 days of equipment start up or within 60 days of equipment shipment whichever is sooner.

Performance & Maintenance Bonds

The cost of providing performance or maintenance bonds is not included. If required these will be at additional cost.

Equipment Shipment and Delivery

A typical drawing submission and equipment shipment schedule is indicated below. Drawing submission milestones and equipment shipment periods are quoted from the date of acceptance of a formal signed Purchase Order:

Submission of GA Drawings:	8 to 10 weeks from acceptance of P.O
Drawing Approval:	3 weeks from submission of drawings
Equipment Shipment:	24 to 26 weeks from acceptance of P.O.
Plant Operation Manuals:	2 weeks after shipment of equipment to site
Operator Training:	When preferred by Customer but no later than 2 weeks prior to the scheduled plant start-up

The above delivery schedule is presented based on current workload backlogs and production capacity. If a formal purchase order is not received within the period of validity of this proposal, the delivery schedule is subject to review and adjustment.

The delivery period quoted is presented based on review ***and approval*** of equipment shop drawings within a two (2) week period. Any delay in approval of shop drawings may affect the proposed shipment schedule.

Quality Basis

For the purposes of establishing a quality basis for equipment supply, reference is made herein to particular equipment manufactured by certain suppliers. The term "***or equal***" where used herein shall be deemed to mean "ZENON Approved Equivalent". ZENON reserves the right to substitute equipment that ZENON considers to be of equal quality and suitability for the intended application from alternative suppliers to those named herein. With regard to determining the suitability or otherwise of any particular manufacturer's equipment for inclusion as part of the ZeeWeed® system, ZENON's decision shall be final.

Definitions

For the purposes of defining milestone dates for payments, commencement of equipment warranties and turnover of responsibility for the operation of equipment from ZENON to the OWNER, the following definitions apply:

Commissioning	Commissioning of the plant is defined as the date when wastewater first flows through the plant.

Substantial Completion — Substantial Completion is defined as the date when the equipment supplied first meets the required treatment quality and quantities as defined in accordance with Performance Warranties. In cases where the equipment supplied is designed for a future plant design capacity it is the responsibility of the Owner to provide wastewater in sufficient quantities for the performance tests within the time frame outlined in section 7.0 (Performance Warranties).

On the date Substantial Completion is achieved:

1. Equipment and Process Warranties start.
2. Responsibility for the plant operation transfers from ZENON to the OWNER.
3. Holdbacks become due and payable.

OWNER — For the purposes of this document the term "OWNER" shall be also deemed to include the OWNER's appointed agents or assigns who will be responsible for the operation of the equipment / plant / treatment facility.

Equipment Drawings, Plans & Specifications

Unless otherwise specified, ZENON will furnish as part of this order the following types of drawings:

1. Process Flow Diagram
2. Process and Instrumentation Diagrams
3. General Arrangement Drawings showing equipment dimensions and weights required for the equipment foundations (foundations by others), and the utility requirements for the process equipment being furnished by ZENON with the System being supplied.
4. Standard sub-vendors dimensional outline drawings for the items of major process equipment (e.g. pumps, blowers, air compressors) which are necessary for the purchaser to complete its engineering and installation.
5. Standard sub-vendors equipment cut sheets for the major process equipment and other equipment items (major instruments and system components)
6. Electrical Drawings including Single Line Diagrams, Control Panel Layouts and Interconnecting Wiring Diagrams.
7. Assembly Drawings including General Equipment Layouts, deemed necessary by ZENON to be required for the Purchaser's field forces to erect the equipment.

Flow Definitions

For the purposes of defining membrane plant capacity after flow equalization, the following definitions shall apply:

Average daily flow. The average flowrate occurring over a 24-hour period based on total annual flowrate data.

Maximum daily flow. The maximum flowrate that occurs over a 24-hour period based on annual operating data.

Maximum daily four hour flow. The maximum sustained flowrate that occurs over a 4-hour period based on annual operating data.

Peak hourly flow. The peak sustained hourly flowrate occurring during a 24-hour period based on annual operating data.

Minimum daily flow. The minimum flowrate that occurs over a 24-hour period based on annual operating data.

Minimum hourly flow. The minimum sustained hourly flowrate occurring over a 24-hour period based on annual operating data.

Sustained flow. The flowrate value sustained or exceeded for a specified number of consecutive days based on annual operating data.

Maximum monthly average flow. This is the flow that is obtained by taking the month with the highest total flow and dividing by the number of days in that month. It provides information on the highest average flow that can be sustained for a one month period.

1.2 STANDARD TERMS AND CONDITIONS

ZENON's Standard Terms and Conditions apply.

ZENON STANDARD TERMS AND CONDITIONS

Seller desires to provide its Customers with prompt and efficient service. However, to negotiate individually the Terms and Conditions of each Sales contract would substantially impair Seller's ability to provide such service. Accordingly, Products and Services furnished by Seller are sold only on the Terms and Conditions stated herein. Notwithstanding any terms or conditions on Customer's order, Seller's performance of any contract is expressly made conditional on Customer's agreement to Seller's Terms and Conditions of Sale unless otherwise specially agreed to in writing by Seller. In the absence of such agreement, commencement of performance and/or shipment shall be for Customer's convenience only and shall not be deemed or construed to be acceptance of Customer's Terms and Conditions, or any of them. If a contract is not earlier formed by mutual agreement in writing, acceptance of any Product or Service shall be deemed acceptance of the Terms and Conditions stated herein. All contracts for the Sale of Products shall be construed under and governed by the law of the location of Seller's plant at Burlington, Ontario, Canada.

QUOTATION AND PRICES

All quotations are subject to the Terms and Conditions stated herein as well as any additional Terms and Conditions that may appear on the face hereof. In the case of a conflict between the Terms and Conditions stated herein and those appearing on the face hereof, the latter shall control. Seller's prices and quotations are subject to the following:

a) All published prices are subject to change without notice.

b) **UNLESS OTHERWISE SPECIFIED IN WRITING, ALL QUOTATIONS EXPIRE THIRTY (30) DAYS AFTER DATE THEREOF, MAY BE TERMINATED EARLIER BY NOTICE AND CONSTITUTE ONLY SOLICITATIONS FOR OFFER TO PURCHASE**; further, budgetary quotations and estimates are for preliminary information only and shall neither constitute offers, nor impose any obligation or liability upon Seller.

c) Unless otherwise stated in writing by Seller, all prices quoted shall be exclusive of transportation, insurance, taxes (including, without limitation, any sales, use, or similar tax, and any tax levied on or assessed to Seller after Product shipment by reason of Seller's retention of a security interest as provided herein), license fees, customs fees, duties and other charges related thereto and Customer shall report and pay any and all such shipping charges, premiums, taxes, fees, duties and other charges related thereto, and shall hold Seller harmless therefrom, provided that, if Seller, in its sole discretion, chooses to make any such payment, Customer shall reimburse Seller in full upon demand.

d) Stenographic, typographical and clerical errors are subject to correction.

e) Prices quoted are for Products only and do not include technical data, proprietary right of any kind, patent rights, qualification, environmental or other than Seller's standard tests and other than Seller's normal domestic commercial packaging unless expressly agreed to in writing by Seller.

f) Published weights and dimensions are approximate only. Certified dimension drawings can be obtained upon request. Manuals, drawings or other documentation required hereupon must be referenced specifically.

This is merely a quotation, and the technology disclosed herein may be covered by one or more ZENON Environmental Inc. (ZENON) patents or patent applications. Any disclosure in this offer does not hereby grant, and nothing contained in the offer shall obligate ZENON to grant, an option to obtain a license to any technology or any other rights under any patent now or hereafter owned or controlled by ZENON.

TERMS OF PAYMENT

Unless credit is granted or otherwise specified in writing, payment is due upon shipment. All payments on approved credit accounts shall be due in full thirty (30) days from date of invoice. Past due balances shall be subject to a service charge of 1-1/2% per month (18% per annum), but not more than the amounts allowed by law. Partial shipments will be billed as made and payments therefor are subject to the above terms. Payment shall not be withheld for delay in delivery of required documentation unless a separate price is stated therefor, and then only to the extent of the price stated for such undelivered documentation. Seller may cancel or delay delivery of Products in the event Customer fails to make prompt payment therefor, or in the event of an arrearage in Customer's account with Seller. Seller hereby retains a security interest in the Products finished until Customer has made payment in full in accordance with the terms hereof. Customer shall cooperate fully with Seller to execute such documents and to accomplish such filings and/or recordings thereof as Seller may deem necessary for the protection of Seller's interest in the Products furnished.

TRANSPORTATION AND RISK OF LOSS

Transportation will normally follow Customer's shipping instructions, but Seller reserves the right to ship Products freight collect and to select the means of transportation and routing when Customer's instructions are deemed unsuitable. Unless otherwise advised, Seller may insure to full value of the Products or declare full value thereof to the transportation company at the time of shipment and all freight and insurance costs shall be for Customer's account. Risk of loss and/or damage shall pass to Customer at the FOB point, which shall be the point of manufacture or such other place as Seller shall specify in writing, notwithstanding installation by or under supervision of Seller. Confiscation or destruction of, or damage to, Products shall not release, reduce or in any way affect the liability of Customer therefor. All Products must be inspected upon receipt and claims should be filed with the transportation company when there is evidence of shipping damage, either concealed or external. Notwithstanding any defect or nonconformity, or any other matter, risk or loss and/or damage shall remain with the Customer until the Products are returned at Customer's expense to such place as Seller may designate in writing. Customer, at its expense, shall fully insure Products against all loss and/or damage until Seller has been paid in full therefor, or the Products have been returned, for whatever reason, to Seller.

PERFORMANCE

Seller will make all reasonable effort to observe its dates indicated for performance. However, Seller shall not be liable in any way because of any delay in performance hereupon due to unforeseen circumstances or to causes beyond its control, including, without limitation, strike, lockout, riot, war, fire, act of God, accident, failure or breakdown of components necessary to order completion, subcontractor, supplier or customer caused delays, inability to obtain or substantial rises in the price of labour, materials or manufacturing facilities, curtailment of, or failure to obtain sufficient, electrical or other energy supplies, or compliance with any law, regulation or order, whether valid or invalid of any cognizant governmental body or any instrument thereof whether now existing or hereafter created. Performance shall be deemed suspended during, and extended for, such time as any such circumstances or causes delay its execution. Whenever such circumstances or causes are remedied, Seller will make, and Customer shall accept, performances hereupon. In addition, Seller's inventories and current production must be allocated so as to comply with applicable Government regulations. In the absence of such regulations, Seller reserves the right, in its sole discretion, to allocate inventories and current production and substitute suitable materials when, in its opinion, such allocation or substitution is necessary due to such circumstances or causes. No penalty clause of any kind shall be effective. As used herein, "performance" shall include, without limitations, fabrication, shipment, delivery, assembly, installation, testing, and warranty repair or replacement as applicable.

ACCEPTANCE

The furnishing by Seller of a Product to the Customer shall constitute acceptance of that Product by Customer, unless notice of defect or nonconformity is received by Seller within thirty (30) days of receipt of the Product at Customer's designated receiving address; provided that, for Product for which Seller agrees in writing to erform acceptance testing after installation, the completion of eller's applicable acceptance tests, or execution of Seller's acceptance form by Customer, shall constitute acceptance of the Product by Customer. Notwithstanding the foregoing, any use of a Product by Customer, its agents, employees, contractors or licensees for any purpose, after receipt thereof, shall constitute acceptance of that Product by Customer. Seller may repair or, at its option, replace defective or non-conforming parts after receipt of notice of defect or nonconformity.

ASSIGNMENTS AND TERMINATIONS

Any assignment by Customer of any contract hereupon without the express written consent of Seller is void. No order may be terminated by Customer except by mutual agreement in writing. Terminations by mutual agreement are subject to the following conditions:

a) Customer will pay, at applicable contract prices, for all Products which are completely manufactured and allocable to Customer at the time of Seller's receipt of notice of termination.

b) Customer will pay all costs, direct and indirect, which have been incurred by Seller with regard to Products which have not been completely manufactured at the time of Seller's receipt of notice of termination.

c) Customer will pay a termination charge on all other determined costs and other charges. To reduce termination charges, Seller will divert completed parts, material or work-in-process from terminated contracts to other Customer's whenever, in Seller's sole discretion, it is practicable to do so.

PATENTS AND OTHER INDUSTRIAL PROPERTY RIGHTS

Seller will hold Customer harmless, as set forth herein, in respect to any claim that the design or manufacture of any Product in Seller's commercial line of Products, or manufactured to specifications set by Seller and furnished herein, constitutes an infringement of any atent or other industrial property rights of the United States or Canada. Seller will pay all damages and costs, either awarded in a suit or paid, in Seller's sole discretion, by way of settlement, which are based on such claim of infringement, provided that Seller is notified promptly in writing of such claim of infringement but there is no liability whatsoever herein with respect to any claims settled by Customer without Seller's prior written consent. In the event that Seller is required to hold Customer harmless hereupon, Seller will, in its sole discretion and at its own expense, either procure for Customer the right to continue using said Product, replace it with a non-infringing product, or remove it and refund an equitable portion of the selling price and transportation costs thereof. **THIS SHALL CONSTITUTE SELLER'S ENTIRE LIABILITY FOR ANY CLAIM BASED UPON OR RELATED TO ANY ALLEGED INFRINGEMENT OF ANY PATENT OR OTHER INDUSTRIAL RIGHTS.** Customer shall hold Seller harmless against any expense, loss, costs or damages resulting from claimed infringement of patents, trademarks, or other industrial property rights arising out of compliance by Seller with Customer's designs, specifications, or instructions. **SELLER DISCLAIMS LIABILITY FOR U.S. OR CANADIAN PATENT OR COPYRIGHT INFRINGEMENT ARISING FROM USE OR MANUFACTURE BY ANYONE OF INVENTIONS IN CONNECTION WITH PRODUCTS OR SERVICES SOLD, USED, OR INTENDED FOR SALE OR USE, IN PERFORMING CONTRACTS WITH THE UNITED STATES OR CANADA.**

WARRANTY

1. Unless otherwise agreed to in writing, Seller warrants its Products to be free from defects in material or workmanship for a period of 12 months from the shipment of Product by Seller, provided that such Product are used, cleaned and maintained in accordance with the Seller's instructions. This warranty does not apply to normally replaceable parts or components such as filter cartridges, pump seals, membranes etc., (see below for membrane warranties).

2. Customer undertakes to give immediate notice to Seller if goods or performance appear defective and to provide Seller with reasonable opportunity to make inspections and tests. If Seller is not at fault, Customer shall pay Seller the costs and expenses of the inspections and tests.

3. Seller's obligations under this warranty is limited to the repair or replacement at its factory, or any device or part thereof which shall prove to have been thus defective. If Customer asks Seller to replace defective parts at Customer's premises, Customer agrees to pay for any traveling time and expenses, plus the Seller's labour to complete the replacement/repair.

4. Goods shall not be returned to Seller without Seller's permission. Seller will provide Customer with a "Return Material Authorization" number to use for returned goods. All returns are F.O.B. - Burlington, Ontario, Canada.

5. Warranty on the membranes applies only if the membrane element(s) has been operated and cleaned according to Seller's instructions. When either permeate or concentrate flow drops by 10% from the original rates at the same operating conditions, cleaning must be initiated or the warranty will be null and void. Elements must be clean and be kept moist. They should be shipped to Seller in water-tight bags and must be protected from freezing. **WARNING** – if element conditions of use given in Seller's instructions are not followed, the warranty will be null and void.

IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION, AND ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF THE SELLER, UNLESS SUCH OTHER WARRANTIES, OBLIGATIONS OR LIABILITIES ARE EXPRESSLY AGREED TO IN WRITING BY SELLER, ARE NULL AND VOID.

DAMAGES AND LIABILITY

SELLER'S LIABILITY FOR DAMAGES SHALL NOT EXCEED THE PAYMENT, IF ANY, RECEIVED BY SELLER FOR THE UNIT OF PRODUCT OR SERVICE FURNISHED OR TO BE FURNISHED, AS THE CASE MAY BE, WHICH IS THE SUBJECT OF CLAIM OR DISPUTE. IN NO EVENT WILL SELLER BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES, OF ANY KIND, HOWEVER CAUSED, ARISING OUT OF, OR IN ANY WAY CONNECTED WITH, THE PRODUCTS FURNISHED BY SELLER TO CUSTOMER.

DISPUTES

All disputes under any contract concerning Products not otherwise resolved between Seller and Customer shall be resolved in a court of competent jurisdiction for the location of Seller's plant at Burlington, Ontario, Canada, and no other place. Provided that, in Seller's sole discretion, such action may be heard in some other place designated by Seller, if necessary to acquire jurisdiction over third persons, so that the dispute can be resolved in one action. Customer hereby consents to the jurisdiction of such court or courts and agrees to appear in any such action upon written notice thereof. No action, regardless of form arising out of, or in any way connected with, the Products or Services furnished by Seller, may be brought by Customer more than one (1) year after the cause of action has occurred. If any part, provision or clause of the Terms and Conditions of Sale, or the application thereof to any person or circumstances, is held invalid, void or unenforceable, such holding shall not affect and shall leave valid all other parts, provisions, clauses or applications of the Terms and Conditions remaining, and to this end the Terms and Conditions shall be treated as severable.

2.0 ZENOGEM® PROCESS DESCRIPTION

The ZenoGem® Process is a proprietary ZENON technology that consists of a suspended growth biological reactor integrated with a microfiltration membrane system, based on the ZeeWeed® hollow fibre membrane. Essentially, the microfiltration system replaces the solids separation function of secondary clarifiers and sand filters in a conventional activated sludge system.

The ZeeWeed® microfiltration membranes are typically submerged in the aeration tank, in direct contact with the mixed liquor. Through the use of a suction duty pump, a vacuum is applied to a header connecting the membranes. The vacuum draws the treated water through the hollow fibre microfiltration membranes and into the pump. Treated water is then discharged by the pump. The energy associated with permeate pumping is relatively small. An airflow is introduced to the bottom of the membrane module producing turbulence which scours the external surface of the hollow fibres transferring rejected solids away from the membrane surface. This airflow also provides a large portion of the process biological oxygen requirements; the remainder is provided by a diffused aeration system. Waste sludge is pumped directly from the aeration tank.

The ZenoGem® technology effectively overcomes the problems associated with poor settling of sludge in conventional activated sludge processes. The ZenoGem® technology permits bioreactor operation with considerably higher mixed liquor solids concentrations than conventional activated sludge systems which are limited by sludge settling. The ZenoGem® process is typically operated at a mixed liquor suspended solids (MLSS) concentration in the range of 8,000 to 12,000 mg/L. The elevated biomass concentrations allow for highly effective removal of both soluble and particulate biodegradable material in the waste stream. The ZenoGem® process combines the unit operations of aeration, secondary clarification and filtration into a single process, simplifying operation and greatly reducing space requirements.

Since the ZenoGem® process can be operated at elevated MLSS concentrations, extended solids retention times (SRTs) are readily attainable. Accurate SRT control is very simple since no solids are lost in the effluent. Many municipal ZenoGem® plants are operated with SRTs exceeding 25 days. These extended SRTs ensure complete nitrification even under extreme cold weather operating conditions. At extended SRTs, sludge yields can be considerably less than conventional aerobic processes, due to endogenous decay.

The ZenoGem® process is readily adapted for denitrification if total nitrogen removal is required. The elevated levels of biomass become readily anoxic in the absence of aeration, ensuring high denitrification rates. An upstream anoxic zone and mixer readily accommodates denitrification; this can be incorporated in the ZenoGem® tank design.

The ZenoGem® process is ideally suited for phosphorus removal, where required. Through the addition of metal salts such as alum or ferric chloride to the raw wastewater or mixed liquor, soluble phosphorus in the waste stream can be precipitated. The ZeeWeed® membranes have a pore size that provides an absolute barrier to the discharge of precipitated phosphorus. The phosphorus is retained in the mixed liquor and removed with the waste activated sludge. The ZenoGem® process can reliably achieve significantly lower effluent phosphorus concentrations than conventional municipal treatment processes.

3.0 ZENOGEM® ADVANTAGES

Effluent Quality

Depending on the specific application and design requirements, a ZenoGem® plant can achieve either high quality nitrified effluent or with the addition of an anoxic zone, high quality denitrified effluent. Phosphorus removal is readily achieved through the addition of metal salts to the feed wastewater or mixed liquor. Typically, ZenoGem® systems are capable of achieving the following effluent qualities.

BOD	< 2 mg/L Note 1
TSS	< 2 mg/L Note 1
TN	< 10 mg/L Note 1 (cool climate)
	< 3 mg/L Note 1 (hot climate)
TP	< 0.1 mg/L
Turbidity	< 1 NTU
Total Coliforms	< 100 cfu/100 mL
Faecal Coliforms	< 20 cfu/ 100 mL

Note 1: ***The information provided in this section of the proposal is general only and is intended only to indicate what is the ZeeWeed®/ZenoGem® Membrane Wastewater Treatment Technology is capable of achieving. For the specific design treated wastewater quality, based on the consideration of specific raw wastewater characteristics and the required discharge criteria for the treated effluent, refer to Section 4.0.***

Compact Plant

The ZenoGem® process can operate at mixed liquor suspended solids (MLSS) concentrations in the range of 8,000 to 12,000 mg/L, which is substantially greater than conventional activated sludge processes. This allows for conventional organic loading rates to be achieved with much lower hydraulic residence times. In addition, the ZenoGem® process requires a single tank in which aeration and solids separation are both achieved. If required, sludge digestion can also be accomplished in this tank. This single stage process results in an overall plant footprint substantially smaller than conventional tertiary wastewater treatment plants.

Expandability

Since the ZenoGem® equipment is modular in nature, plant expansion can be phased. Civil works can be designed for ultimate flow while membranes are added in phases as plant operating capacity dictates.

Simple Operation

Since the ZenoGem® process uses membranes to perform solid/liquid separation, there is no requirement for sludge to settle and thus no need for a secondary clarifier or polishing filters. Sludge is wasted directly from the aeration tank at a solids concentration in the range of 1.5 to 2.0 percent solids. The result is a single system which is simple to operate.

Lower Sludge Yield

The ZenoGem® plant can be operated at extended solids retention times (SRTs) allowing for lower net solids yields than conventional municipal treatment processes.

Process Reliability

Since the ZenoGem® plant is typically operated at low organic loading rates and the membrane provides an absolute barrier to particulate discharge, ZenoGem® effluent quality is not susceptible to hydraulic or organic surges which can negatively affect effluent quality in conventional activated sludge and fixed film plants. At periods of low flow (and organic load), the sludge within the reactor basin simply digests itself, without affecting the effluent quality.

Advantages of an "Outside-In" Membrane

a) Resistance To Fouling

The ZeeWeed® membrane is an outside-in membrane where the flow of water is from the outside of the membrane to the inside of the hollow fibre, meaning that the inside only sees clean, micro-filtered water. The bacteria and inert solids to be removed from the wastewater remain outside the membrane and never enter the membrane to cause fouling.

b) Low Energy

Being immersed allows for the operation of the ZeeWeed® membrane under a slight vacuum (suction) instead of under positive pressure like other membranes on the market. The ZeeWeed® membrane operates under a vacuum of between -2 to -8 psi. The pump energy requirements to achieve this vacuum are relatively small.

Exceptional Membrane Durability

The ZeeWeed® membrane has been designed for exceptional durability and resistance to breakage. To achieve this high level of membrane durability ZENON utilizes a patented internal support to which the membrane is bonded. This support strengthens the membrane and protects it against tearing and breakage without reducing its flux capacity.

4.0 ZENOGEM® PLANT

The proposed ZenoGem® plant is designed to continuously treat an average daily flow of 8.5 MGD. The ZenoGem® plant is a six (6) train system and the capacity of each parallel train is .1.417 MGD.

The ZenoGem® plant is capable of producing an effluent meeting or exceeding the following criteria:

Design Parameters

Firm Capcity Flow 8.5 MGD

Parameter	Influent		Effluent	
BOD	200	mg/L	≤2	mg/L
TSS	150	mg/L	≤2	mg/L
TKN	46	mg/L	≤3	mg/L
TN	46	mg/L	≤17	mg/L
TP	9	mg/L	≤1	mg/L
Wastewater Temperature	≥20	°C	≥20	°C

Equipment Selection

The main process equipment for the ZenoGem® plant, including permeate pumping equipment, membrane air scour blowers and supplemental aeration blowers, CIP membrane cleaning system, air extraction system, controls and other miscellaneous items, is designed for installation within equipment buildings (equipment buildings not included in ZENON's scope of supply).

The sizing of the main process equipment selected is as follows. Section 5.0 gives further details of the equipment items included by ZENON for this project.

Bioreactor (Process) Tank(s)

The bioreactors will consist of concrete tanks (concrete tanks not in ZENON's scope of supply). Six (6) individual process streams are required, each with the minimum dimensions of 160 ft long x 20 ft wide x 17 ft high (15 ft SWD). Each process tank will have an anoxic/aerobic and an aerated membrane zone separated by a baffle (baffle not included in ZENON's scope of supply).

Membrane cassettes will be supported by structural steel beams that will span between the concrete walls of the process tanks and will use the concrete walls as supports.

Process Tanks

Total Bioreactor Volume	2.154	MUS gallons
Design HRT	6	hours
Number of Membrane Trains	6	
Number of Bioreactor Tanks	6	
Volume of Each Bioreactor	359,000	US gallons

Length of Each Bioreactor	160	ft
Width of Each Bioreactor	20	ft
Side Water Depth of Bioreactor	15	ft

Note: Process tanks may be of concrete construction or fabricated steel tanks, whichever suits the client's preferences and are not included in ZENON's scope of supply.

Tank dimensions are preliminary only and may change slightly once final detail design commences.

ZW-500 Micro-Filtration Membrane Modules

Membrane Design Flux Rate	11.55	gfd at Fixed Capacity Daily flow
Minimum Design Liquid Temperature	20	°C
# Membrane Modules	1104	
# Membrane Cassettes	138	(8 modules per Cassette)

ZENON is committed to continuous development and invests continuously in research to develop better and higher flux membranes. For this reason ZENON reserves the right to change the number of membranes in its design, if by way of membrane technology improvements the permeability or operating flux rates of the membranes have been improved. This does not change the warranty since ZENON guarantees the design flow capacity and the operational performance of the membrane system.

Aeration System

The design air flow required for the fine bubble aeration system used with the ZenoGem® plant is approximately 5,550 scfm at the plant design capacity.

Aeration Blowers

Three (3) aeration blowers are included - two duty blower and one common stand-by unit. Each blower has a design capacity of 2,775 scfm. The aeration blowers are equipped with variable frequency drives (VFDs) to allow air delivery and dissolved oxygen levels in the wastewater to be controlled according to the system air requirements.

Membrane Air Blowers

Four (4) blowers are included for the membrane air scouring - four duty blower and one common stand-by unit The total required capacity of membrane air scouring is approximately 21,983 scfm. Each blower has a design capacity of 7,328 scfm.

Permeate Pumps

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Seven (7) permeate pumps are included - six duty pumps and two shelf spares. Each pump is designed for a maximum permeate flow of 1,110 USgpm. The pumps will also provide backpulse flow at 2,880 USgpm The speed of the permeate pumps is controlled via VFD units according to the liquid level in the bioreactor tanks.

Sludge Recirculation Pumps

Seven (7) sludge recirculation pumps are included - six duty pumps and one shelf spare. Each pump is designed for a flow of 3,395 USgpm. The recirculation pumps are provided with VFD units to allow flow variation to allow optimization of the system process performance.

Sludge Wasting Pumps

Seven (7) sludge wasting pumps are included – eight duty pumps and one shelf spare. Each pump is designed for a flow of 207 USgpm.

Miscellaneous

No influent screening facilities are included. There must be existing screening and/or primary clarifiers upstream of what will become the ZenoGem® aeration (bioreactor) tanks. The screening equipment must be capable of screening particles down to 3.0 mm to prevent hair and other stringy materials from tangling with the membranes.

Equipment Installation cost is not included.

5.0 MAJOR EQUIPMENT

The list below summarizes the major equipment and the quantities of items included for the ZenoGem® plant design.

SCOPE OF SUPPLY SYNOPSIS
for the ZenoGem® Plant

Item	Size	Units	Quantity
Raw Wastewater Feed			
Raw Influent Feed Pumps			Not Incl.
Inlet & Discharge Isolating Valves			Not Incl.
Discharge Check Valves			Not Incl.
Piping Manifold			Not Incl.
Wet Well Level Switches			Not Incl.
VFD's			Not Incl.
Raw Water Screening			
Raw Influent Screen			Not Incl.
Raw Influent Grinder			Not Incl.
Raw Influent Flowmeter			Not Incl.
Raw Influent Flow Control Flowmeter			Not Incl.
Raw Influent Flow Control Valve			Not Incl.
Membranes/Membrane Cassettes			
Individual Membrane Modules			1,104
Membrane Cassettes			138
Process Tanks & Frames			
Membrane Support Beam(s)			Included
Process Tanks			Not Incl.
Permeate Collection Headers			6
Air Scour Headers			6
Permeate Pumps			
Permeate Pumps	1,110	USgpm	7
VFD's	50	HP	6
Piping Manifold			Not Incl.
Valves			Incl.
Air Extraction System			
Air Removal Separation Columns			6
Vacuum Pumps	22	scfm	3
Backpulse System			
Backpulse Water Storage Tank	5,160	gallons	2
Hypochlorite Storage Tank	106	gallons	1
Hypochlorite Feed Pumps	6.08	USgphr	3

Item	Size	Units	Quantity
DIP Tank Cleaning System			
DIP Tank			Not Incl.
Chemical Wash Pump			Incl.
Monorail & Pulley/Hoist for membrane removal			Not Incl.
Sludge Recirculation			
Sludge Recirculation Pumps	3,935	USgpm	7
Inlet & Discharge Isolation Valves			N/A
Discharge Check Valves			N/A
Piping			Not Incl.
VFD's	2.5	HP	6
Sludge Wasting			
Sludge Wasting Pumps	206.6	USgpm	7
Inlet & Discharge Isolation Valves			6
Discharge Check Valves			6
Piping			Not Incl.
VFD's			N/A
Air Blowers			
Membrane Air Scour Blowers incl. Silencers	7,328	scfm	4
Inlet & Discharge Isolation Valves			4
Discharge Check Valves			4
Inlet Control Valves			4
Aeration System Blowers incl. Silencers	2,775	scfm	3
Inlet & Discharge Isolation Valves			3
Discharge Check Valves			3
VFD's	200	hp	3
Biological Aeration System			
Fine Bubble Diffuser System			Incl.
Phosphorus Removal System (if required)			
Chemical Storage Tank	9,600	USg	1
Chemical Feed Pumps	112	USgphr	2
Instruments			
Permeate Flowmeters			6
Permeate Header Pressure Transducers			6
Process Tank Level Transmitters			6
Process Tank Level Switches			48
Dissolved Oxygen Sensors			6
pH Transmitters			N/A
Turbidimeters			6
Turbidimeter Calibration Kits			1

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Membrane Blower Flow Switches			4
Aeration Blower Flow Switches			3

Item	**Size**	**Units**	**Quantity**
Permeate Pump Pressure Gauges			6
Membrane Air Scour Blower Pressure Gauges			4
Aeration Blower Pressure Gauges			3
Recirculation Pump Pressure Gauges			N/A
Sludge Wasting Pump Pressure Gauges			6
Control Panel			
PLC-based Control Panel			1
Back-Up PLC			Not Incl.
Electrical			
MCC Panel			Not Incl.
Miscellaneous			
Air Compressor			2
Air Drier			1
Field Service Allowed			Days
Installation Supervision			10
Mechanical Checkout			6
Operator Training			8
Process Start-Up			3
Commissioning			3
TOTAL MAN-DAYS			30
TOTAL No. TRIPS			3
Freight			
Delivery to Site			Incl.

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6.0 ATTACHMENTS

Plant Power Consumption and Estimated Yearly Operating Cost

Table 9.1.1 Connected Power and Estimated Power Consumption at Average Day Flow
City of McAllen (ZenoGem) Rev 1

Average Day Flow	**8,500,132**	**USgpd**	**32,173**	**m3/day**
Maximum Day Flow	**8,500,132**	**USgpd**	**32,173**	**m3/day**

ITEM #	TOTAL QTY	EQUIPMENT DESCRIPTION		# Operating Pumps Blowers etc.	Design Capacity		Discharge Head		Duty Point Efficiency	Equipment Operating BHP	Motor HP	Total Equipment BHP	Total Connected HP	Motor Efficiency %	Equipment kW	Hours / Day Continuous Operation	Energy Cost per year
1	-	Raw Water/Wastewater Screen	n/a	-						-	-	-	-	-	-	24.00	-
2	6.00	Permeate Pumps	By Zenon	6.00	1,109.56	USgpm	35.00	ft	81.00	12.29	20.00	73.76	120.00	90.20	60.98	22.40	37,392
3	-	Backpulse Pumps	n/a	-	2,880.00	USgpm	30.00	ft	74.00	29.94	40.00	-	-	-	-	6.40	-
4	6.00	Recirculation Pumps	By Zenon	6.00	3,935.25	USgpm	10.00	ft	55.00	18.35	25.00	110.08	150.00	91.30	89.91	24.00	59,068
5	6.00	Sludge Wasting Pumps	By Zenon	6.00	206.60	USgpm	30.00	ft	50.00	3.18	5.00	19.07	30.00	87.50	16.25	2.00	890
6	-	Reject Water Pumps	n/a	-	-	USgpm	25.00	ft	55.00	-	-	-	-	-	-	24.00	-
7	4.00	Membrane Air Scour Blowers	By Zenon	3.00	5,520.00	scfm	4.25	psi	n/a	153.32	250.00	459.97	1,000.00	95.00	361.05	24.00	237,213
8	3.00	Process Air Blowers	By Zenon	2.00	2,775.00	scfm	6.00	psi	n/a	114.89	150.00	229.77	450.00	94.20	181.89	24.00	119,501
9	-	Miscellaneous Air Blowers	n/a	-	-	scfm	6.00	psi	n/a	-	-	-	-	-	-	24.00	-
10	6.00	Anoxic Zone Mixers	By Zenon	6.00					n/a	-	-	-	-	80.00	-	24.00	-
11	3.00	Air Separation System Vacuum Pumps	By Zenon	2.00	22.25	acfm	18.00	Ins Hg	n/a	2.25	3.00	4.50	9.00	87.50	3.84	24.00	2,520
12	3.00	Backpulse Sodium Hypochlorite - Metering	By Zenon	1.50	0.066	USgpm	50.00	ft	n/a	0.03	0.03	0.04	0.09	100.00	0.03	3.20	3
13	-	CIP Wash Pump	n/a	-	-	USgpm	30.00	ft	55.00	-	-	-	-	-	-	0.03	-
14		CIP Chemical Metering	n/a			USgpm				-		-	-		-		-
15	2.00	Chemical Feed #1 System #1 - Metering	By Zenon	1.00	1.140	USgpm	50.00	ft	n/a	0.50	0.50	0.50	1.00	100.00	0.37	24.00	245
16	-	Chemical Feed #1 System #2 - Metering	n/a	-	0.101	USgpm	50.00	ft	n/a	-	0.03	-	-	100.00	-	24.00	-
17	-	Chemical Feed #1 System #3 - Metering	n/a	-	0.057	USgpm	50.00	ft	n/a	-	0.03	-	-	100.00	-	24.00	-
18	-	Chemical Feed #1 System #4 - Metering	n/a	-	0.065	USgpm	50.00	ft	n/a	-	0.02	-	-	100.00	-	24.00	-
18	2.00	Air Compressors	By Zenon	1.00	52.00	scfm	100.00	psi	n/a	18.75	25.00	18.75	50.00	91.30	15.31	6.00	2,515
19	1.00	Air Driers	By Zenon	1.00	75.00	scfm			n/a	-	-	-	-	80.00	-	6.00	-
20	1.00	Controls & Instrumentation	By Zenon										1.34		1.00	24.00	657
21	1.00	Miscellaneous	By Zenon										1.34		1.00	24.00	657
		Total Connected Power											**1,812.77 HP**				
		Total Operating Power										**916.44 BHP**			**731.64 kW**		
		Total Operating Cost														**US$**	**460,661**

Notes

Energy Costs based on 0.0750 US$ per kW.hr
Power Consumption of other plant equipment required (raw water feed pumps, high lift pumps etc.) is not included by ZENON
Where operating efficiencies are not known, the equipment operating power is assumed to be 75% of the motor nameplate power rating
The operating hours for the permeate pump are corrected for the downtime during backpulse cycles (and Membrane Pressure Decay Test Cycles if applicable)
Permeate Pump Backpulses every 15 mins for 30 seconds 1,664 USgpm @ 30.00 ft TDH = 16.59 BHP
Motor Efficiencies indicated are typical only. Efficiencies used are usually within 2% of actual when motor is operating within 50-100% of its full load rating
Operation of Air Compressor is assumed to be only 25% of time
Operation of the Sodium Hypochlorite Pumps is intermittent - operation for 25% of time is used for energy calculation
Blower Energy Consumption Estimated as : 6.536 BHP per 1,000 scfm per psig.

The motor sizes in the above table are preliminary only and estimated based on the information available at the time of preparing this proposal. It must be understood that at the time of proposal preparation, final headlosses or pressure drops in piping systems have not been calculated accurately Motor sizes are subject to confirmation (and if necessary adjustment) during final design. Use of the above information for sizing or selection of any ancillary equipment is entirely at the USER's own risk. Whilst the motor sizes indicated above are ZENON's best estimate based on design criteria assumed during preparation of the proposal, ZENON accepts no responsibility for the absolute accuracy of the information contained herein.

Table 9.2.2 **Estimated Total Annual Operating Cost**
City of McAllen (ZenoGem) Rev 1

Average Day Flow	8,500,132	USgpd	32,173	m3/day
Maximum Day Flow	8,500,132	USgpd	32,173	m3/day

Item			Cost per year	
Electrical Equipment - Zenon		Calculated at Average Day Flow	460,661	US$
Electrical Equipment - Others			-	US$
Backpulse Chemicals	Sodium Hypochlorite	Calculated at Average Day Flow	8,232	US$
CIP Chemical #1	MC-1		220	US$
CIP Chemical #2	Sodium Hypochlorite - 250 mg/L		304	US$
Chemical #1	Aluminum Sulphate (Liquid @ 48.5%)	Calculated at Average Day Flow	201,764	US$
Suggested Membrane Accrual			329,311	US$
Estimated Total Annual Operating Cost			1,000,492	US$

Notes

Backpulse Chemical Consumption		**Sodium Hypochlorite**	
Sodium Hypochlorite Consumption		71.91	Litres per day
Sodium Hypochlorite Consumption		26,248	Litres per year
Sodium Hypochlorite Cost	US$	0.31	per Litre
CIP Cleaning Chemical #1		**MC-1**	
Design Dosage		2,000.00	mg/L
Solution Concentration		50.00	%
Specific Gravity		1.240	
Wash Frequency		1.00	times / year
Chemical Consumption per Wash (all tanks)		131.54	Litres
Total Annual Chemical Consumption		131.54	Litres
Chemical Cost	US$	1.67	per Litre
Chemical Cost	US$	2.70	per kg
CIP Cleaning Chemical #2		**Sodium Hypochlorite - 250 mg/L**	
Design Dosage		250.00	mg/L
Solution Concentration		10.80	%
Specific Gravity		1.168	
Wash Frequency		12.00	times / year
Chemical Consumption per Wash (all tanks)		80.81	Litres
Total Annual Chemical Consumption		969.76	Litres
Chemical Cost	US$	0.31	per Litre
CIP Neutralization Chemical #1		**Sodium Hydroxide**	
Design Dosage		-	mg/L
Solution Concentration		50.00%	
Specific Gravity		1.520	
Wash Frequency		1.00	times / year
Chemical Consumption per Wash (all tanks)		-	Litres
Total Annual Chemical Consumption		-	Litres
Chemical Cost	US$	0.36	per Litre
Chemical Cost	US$	0.47	per kg
CIP Neutralization Chemical #2		**Sodium Bisulfite**	
Design Dosage		-	mg/L
Solution Concentration		38.00%	
Specific Gravity		1.290	
Wash Frequency		12.00	times / year
Chemical Consumption per Wash (all tanks)		-	Litres
Total Annual Chemical Consumption		-	Litres
Chemical Cost	US$	0.06	per Litre
Chemical Cost	US$	0.55	per kg
Chemical Feed System #1		**Aluminum Sulphate (Liquid @ 48.5%)**	
Design Dosage		90.00	mg/L
Solution Concentration		48.50	%
Specific Gravity		1.335	
Chemical Consumption		4,472.10	Litres per day
Chemical Consumption		1,632,315	Litres per year
Chemical Cost	US$	0.12	per Litre
Chemical Cost	US$	0.19	per kg

PROPOSAL

990212-M

845 Harrington Court, Burlington, Ontario, L7N 3P3
Tel. No.: (905) 639-6320 Fax No.: (905) 639-1812

DATE:	**November 29, 1999**
PREPARED FOR:	**CH2M Hill**
ATTENTION:	**Mr. Jim Lozier**
FROM:	**Roland Lamoca**
Re:	**McAllen South WWTP**

ITEMS COVERED:

Packaged water treatment plant incorporating Reverse Osmosis treatment.

The plant is to be designed for three trains, each with an effluent flowrate of 2.3 MGD of final product from the Reverse Osmosis system. The projected recovery rates from each unit operations have been established in the specifications provided CH2M Hill and are estimated at 80% - 85%.

The preliminary design criteria are:

	One Reverse Osmosis Train
Effluent Flow (MGD)	2.3 MGD
System Recovery (%)	80 – 85 %

SCOPE OF SUPPLY:

Three Reverse Osmosis System Trains - Each:

- eighty-eight (88) 6 element long membrane pressure vessels, 400 psi rating, arranged in a 50:28:10 array configuration for optimal cross-flow conditions.
- five hundred twenty eight (528) Hydranautics spiral wrap high rejection type membrane modules. Six membrane elements will be installed in each membrane pressure vessel. A total membrane area of 192,720 ft2 is supplied,
- one (1) duplexed 5 micron prefiltration cartridge system, isolatable for cartridge replacement,
- one (1) horizontal, split case centrifugal-type feed supply pump, 1880 USgpm @530 ftH, 1780 rpm TEFC, Goulds or equal,

ZENON

845 Harrington Court, Burlington, Ontario, L7N 3P3
Tel. No.: (905) 639-6320 Fax No.: (905) 639-1812

- one (1) sodium metabisulfite chemical injection system with chlorine analyzer, Prominent or equal,
- one (1) antiscalant injection system, Prominent or equal,
- one (1) acid injection system with pH probe and controller, Prominent or equal,
- one (1) lot process instrumentation for the RO system, includes feed conductivity, permeate conductivity, permeate flow transmitter, concentrate flow transmitter, concentrate pressure transmitter, membrane feed pressure transmitter, permeate pressure transmitter, feed supply residual chlorine analyzer, and feed supply pH.
- one (1) lot process valves for the RO system, Bray or equal,
- one (1) lot process low pressure piping Sched. 10 304 SS,
- one (1) lot process high pressure piping Sched. 10 316 SS,
- one (1) NEMA 4 PLC based control panel (Allen Bradley PLC complete with PanelView Operator Interface),

One Reverse Osmosis System Clean In Place Tank:

- one (1) skid mounted membrane cleaning tank with prefiltration cartridge system, and cleaning pump (316SS Goulds, or equal) and controls,

PRICE ESTIMATE: **US$ 2,300,000.00**

TERMS:
- All pricing in Dollars, FOB ZENON Burlington, Ontario.
- Duty, if applicable, is not included. Any Taxes, if applicable, are extra.
- Shipment shall be 20 - 24 weeks from receipt of order.
- Payment Terms: 15% with order, 25% on submission of drawings, 50% on equipment shipment, 10 % on start-up or thirty days whichever is less, all terms are Net 30.
- ZENON's Terms and Conditions as attached shall apply.
- This is a budgetary estimate only at this time, and does not constitute a binding offer of supply by ZENON.

FAX

— RECEIVED —
JAN 18 2000
CH2M HILL/PHOENIX

ZENON *Water for the World*

Project Number: 990212-M

TO:	CH2M Hill	**FAX:**	480 966 9450
ATTN.:	Ms. Fair Miller	**PHONE:**	480 966-8577 x 249
cc:	Jim Lozier - CH2M Hill Dave Bingham - ZENON	**cc FAX:**	
DATE:	18 January, 2000	**# OF PAGES (Including Cover):**	5
FROM:	Roland Lamoca Manager, Technical Support Division Industrial Wastewater Division		

SUBJECT: McAllen Reverse Osmosis Operating Cost Estimates - Revision

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Hello Fair and Jim;

The operating costs have been revisied based on our discussions today.

The higher pressure we had included previously accounted for a 5 year operation with a 10% flux decline/year. This is typical of ZENON's experience, but may not reflect recent experiences you have noted. As agreed upon, the following have been based on your experiences.

Please feel free to contact ZENON if you have any questions.

Regards,

R. Lamoca

Roland Lamoca

If you do not receive all pages, please call Lisa Ashton as soon as possible.

ZENON Environmental Systems Inc.
845 Harrington Court, Burlington, Ontario, L7N 3P3 Telephone: (905) 639-6320 Fax: (905) 639-1812
email:. rlamoca@zenonenv.comhttp:/ / www.zenonenv.com

Operating Cost Summary

Item	*Assumptions*	*Annual Cost, US$*
Power Consumption	(based on $0.07 /kW-hr)	$357,495 /year
Steam Consumption	(based on $5.00 /1000 lb)	
Membrane Replacement (every 5 years)	(based on current prices, subject to change)	$190,179 /year
Cartridge Filter Replacement (once per year)	(based on current prices, subject to change)	$24,637 /year
Annual Process Chemical Cost		$130,698 /year
Annual Cleaning Chemical Cost		$15,144 /year

TOTAL ANNUAL OPERATING COSTS		**$718,152 /year**
Water Volume Produced Annually:	(based on 4800 USgpm)	2,522.9 Million gallons per year
Operating Cost per Thousand Gallons		**$0.28 /1000 gallons**

Operating Cost - Power

Power Consumption

Unit	# of units	Power/unit	Total power
Pre-treatment Chemical Mixers, 0.25 Hp	total of 6	0.2 kW	1.1 kW
1st Pass - R.O. Process Pump, 260 Hp	total of 3	194.0 kW	581.9 kW
Reverse Osmosis CIP Pump, 125 Hp	total of 1	93.3 kW	Intermittent use

RO process pump pressure is 165 psi @ 1883 USgpm each

Total Power Requirement		**583 kW**
Operating period	Days / year	365 days
	Hours / day	24 hours
	Utility rate ($/kW-hr)	$0.07 /kW-hr
Annual Power Consumption Cost		**$357,495 /year**

Operating Cost - Elements

Membrane Replacement (every 5 years)

Membrane Element	# of elements	Unit Price,US$	Extended price, US$
8" HYDRANAUTICS 8040-LFC1	total of 1584	$600 each	$950,894

Membrane pricing assumes negotiated pre-purchase price and is to be verified.

Membrane Replacement Cost $\boxed{\$190{,}179\ /year}$

Cartridge Filter Replacement (once per year)

Filter Cartridge	# of cartridges	Unit Price,US$	Extended price, US$
FILTERITE QMPT050-300USM8	total of 324	$62 each	$20,158
FILTERITE QMPT050-300USM8	total of 72	$62 each	$4,479

Cartridge Filter Replacement Cost $\boxed{\$24{,}637\ /year}$

Operating Cost - Process Chemicals

Process Chemical Requirements

Chemical	Annual Consumption	Unit Cost,US$	Annual Cost, US$
Sulphuric acid	**10374 USgallons**	$0.04 /lb	$5,745 /year
Sodium bisulphite	**12288 USgallons**	$0.25 /lb	$2,594 /year
Antiscalant	**9892 USgallons**	$3.27 /litre	$122,359 /year

Annual Process Chemical Cost **$130,698 /year**

Operating Cost - Cleaning Chemicals

Cleaning Chemicals / Preservative Requirements

Chemical	Annual Consumption	Unit Cost,US$	Annual Cost, US$
Organic Acid: MC-1	**3788 kilograms**	$2.29 /kg	$8,658 /year
Alkali Surfactant: MC-4	**568 kilograms**	$3.06 /kg	$1,738 /year
Sanitizer: MP-1	**947 litre**	$5.01 /litre	$4,748 /year

Annual Cleaning Chemical Cost **$15,144 /year**

Appendix I. ZenoGem and ZeeWeed Cost Comparison

Appendix I: ZenoGem® & ZeeWeed Comparison
Capital and O&M Costs

Item		ZenoGem®		ZeeWeed®
Fine Screening	$	20,000	$	20,000
ZenoGem® / ZeeWeed® System[a]	$	8,620,000	$	5,075,000
Bioreactor/Equalization / ZeeWeed Tanks	$	1,307,808	$	162,468
Installation	$	2,155,000	$	1,268,750
Installed Costs Subtotal	**$**	**12,102,808**	**$**	**6,526,218**
ZenoGem / ZeeWeed Equipment Building	$	288,000	$	84,000
Installed Costs and Building Cost Subtotal	**$**	**12,390,808**	**$**	**6,610,218**
Unit Process Noncomponent Costs				
Yard Piping Allowance (10%)	$	1,239,081	$	661,022
Site Electrical Allowance (8%)	$	991,265	$	528,817
Site I&C Allowance (5%)	$	619,540	$	330,511
Site Civil Allowance (5%)	$	619,540	$	330,511
Unit Process Subtotal	**$**	**15,860,234**	**$**	**8,461,079**
Contingency (10%)	$	1,586,023	$	846,108
Contractor Overhead & Mark-up (10%)	$	1,586,023	$	846,108
Total Construction Cost	**$**	**19,032,281**	**$**	**10,153,295**
Engineering & Administration (15%)	$	2,854,842	$	1,522,994
Total Capital Cost	**$**	**21,887,123**	**$**	**11,676,289**
Total Capital Unit Cost ($/1,000 gallon)	**$**	**9.28**	**$**	**4.95**
Amortized Capital Cost (20yr @ 6.5%)	**$**	**1,986,396**	**$**	**1,059,698**
Operation & Maintenance Costs				
Major Chemical Costs				
Backpulse Chemicals: Sodium Hypochlorite	$	8,232	$	8,232
CIP Chemical #1: MC-1	$	220	$	3,211
CIP Chemical #2: Sodium Hypochlorite (250 mg/L)	$	304	$	4,435
CIP Neutralization Chemical #1: Sodium Hydroxide	$	-	$	175
CIP Neutralization Chemical #2: Sodium Bisulfite	$	-	$	117
Major Power Costs				
Screening	$	-	$	-
Aeration Basins	$	-	$	419,000
Permeate Pumps	$	37,392	$	36,901
Recirculation Pumps	$	59,068	$	74,500
Sludge Wasting Pumps	$	890	$	-
Membrane Air Scour Blowers	$	237,213	$	114,440
Process Air Blowers	$	119,501	$	-
Anoxic Zone Mixers	$	-	$	-
Air Separation System Vacuum Pumps	$	2,520	$	2,520
Backpulse Sodium Hypochlorite - Metering	$	3	$	7
Chemical Feed #1 - Metering	$	245	$	-
Air Compressors	$	2,515	$	2,515
Air Driers	$	-	$	-
Controls & Instrumentation	$	657	$	657
Miscellaneous	$	657	$	657
Membrane Replacement Costs	$	329,311	$	190,905
Labor	$	280,800	$	218,400
Total Annual Operation & Maintenance Cost	**$**	**1,079,528**	**$**	**1,076,672**
Total Annual O&M Unit Cost ($/1,000 gallon)	**$**	**0.46**	**$**	**0.46**
Total Annual Cost	**$**	**3,065,924**	**$**	**2,136,370**
Total Annual Unit Cost ($/1,000 gallon)	**$**	**1.30**	**$**	**0.91**

[a] Detailed listing of components comprising ZenoGem and ZeeWeed systems are presented in Appendix H.