Study of Wastewater Reclamation Using Backwashable Capillary Ultrafiltration And Encapsulated Reverse Osmosis Membrane Modules

by:
Hydranautics
401 Jones Rd.
Oceanside. CA 92054

Contract No. 1425-97-FC-81-30068

Water Treatment Technology Program Report No. 42

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Hydranautics has developed a new packaging configuration for spiral wound elements. This configuration is self-encapsulated and doe not require a pressure vessel housing. The encapsulated design eliminates o-rings between the feed and permeate streams and has th potential to provide more reliable retention of pathogens in reclamation of contaminated waters. This test program evaluated th effectiveness of the encapsulated design with respect to: retention of pathogens; reliability and convenience of monitoring membran element integrity; fouling tendency of the encapsulated design and effectiveness of cleaning procedures; and optimization of operatin parameters with respect to design of commercial systems. Results indicated: the encapsulated design enabled convenient monitorin of individual element integrity; Virus rejection tests resulted in S-log rejection; fouling rates were low and comparable to standar configurations; a cleaning procedure, after eight months of operation, resulted in complete restoration of permeate flux; tertiary effluen water is of good quality and enables stable operation of RO; and low fouling membranes can operate at high flux rate, provide stabl performance, and low fouling rates in reclamation of municipal effluents.

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Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

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

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1. EXECUTIVE SUMMARY

Hydranautics has developed a new packaging configuration for spiral wound elements. This new configuration is self-encapsulated and does not require a pressure vessel housing, hence it has been dubbed the "free" style. For this study, Hydranautics encapsulated its new neutrally charged, Low Fouling Composite reverse osmosis (RO) membrane, LFC1. The free design eliminates o-rings seals between the feed and permeate streams, and therefore has the potential to provide more reliable retention of pathogens in reclamation of contaminated water sources.

The objective of this test program was to evaluate the effectiveness of the encapsulated element design with respect to;

- Retention of pathogens
- Reliability and convenience of monitoring membrane element integrity
- Fouling tendency of the new element configuration and the effectiveness of cleaning procedures.
- Optimization of operating parameters with respect to the design of commercial systems.

This work was conducted in cooperation with the San Diego Metropolitan Waste Department. The pilot unit was operated at the San Pasqual Aqua 200 Research Facility in Escondido, California.

Results obtained during the test program indicate the following:

- The encapsulated element design enables convenient monitoring of individual element integrity in field conditions.
- Virus rejection tests indicate 5-log pathogen rejection by encapsulated elements.
- Fouling rates of encapsulated elements were low and comparable with fouling rates observed with the standard configuration elements operating in parallel.
- A simple cleaning procedure applied after eight months of operation consisting of the recirculation of an NaOH solution resulted in the complete restoration of permeate flux.
- Tertiary effluent water treated with HYDRAcap™ capillary ultrafiltration membrane is of good quality and enables stable operation of RO membranes.
- Low fouling membranes (LFC1) can operate at high flux rate, provide stable performance and low fouling rates in reclamation of municipal effluents.

2. BACKGROUND

2.1. IINTRODUCTION

The application of reverse osmosis technology for municipal wastewater reclamation traces back to the early stages of the commercialization of the RO process. It was soon realized that the application of membrane technology to the treatment of municipal effluent water represents a challenge due to the very high fouling potential of the water. Therefore, the development of an effective pretreatment process and the demonstration of performance stability was the main objective of the early studies (1, 2, 3, and 4). As early as the 1960's, the City of San Diego conducted the first testing program using RO technology for the reclamation of wastewater. This attempt was not successful due to severe membrane fouling (5). Since then, a number of field tests have been conducted at different sites, which has enabled the development of process parameters and system components used in commercial plants (6, 7, 8, 9).

The first large reverse osmosis plant operating on waste water began operation in the late 1970's as part of what is known as "Water Factory 21" in Orange County, California. This RO system has 5 MGD of product capacity and reduces the salinity of municipal wastewater after tertiary treatment. Product water is blended and then injected into local aquifers to prevent seawater intrusion (10, 11).

The next large RO system for water reclamation, the Arlington Desalter (12, 13), located in Riverside County, California, commenced operation in 1990. This system processes agricultural drainage water of about 1000 ppm TDS salinity, containing a high concentration of NO, (100 ppm) and SiO_2 (40 ppm). The plant produces 6 MGD of low salinity water by blending 4 MGD of RO permeate with 2 MGD of ground water. The blending ratio is determined by the limit of nitrate ion concentration in the blend water, which must be below 40 ppm (12). Today, a large number of new membrane projects for municipal waste water reclamation are under design or extensive pilot testing. In the majority, new, advanced membrane pretreatment methods are evaluated. The objective is to improve the stability of the RO membrane performance and to improve the process economics.

2.2. CONVENTIONAL PRETREATMENT

The municipal effluent after secondary treatment contains high concentrations of colloidal particles, suspended solids and dissolved organics. The municipal treatment process usually includes biological treatment (activated sludge clarification) which results in a high level of biological activity in the effluent. This effluent has to be treated to reduce the concentration of colloidal and solid particles and to arrest biological activity prior to the RO.

A typical conventional pretreatment configuration is shown in Fig. 1, which outlines the tertiary pretreatment process applied currently at Water Factory 21. The current pretreatment process is a result of evolution, improvements and simplification of the original design (5). The pretreatment consists of flocculation, lime clarification, recarbonation with CO,, settling, and slow gravity filtration. Chlorination controls the biological activity. The lime clarification is a very effective process for improving feed water quality. However, it is expensive, requires large area and produces sludge:, which can present disposal problems. In some smaller systems the lime clarification and gravity filtration is replaced by in-line flocculation followed by two stage pressure filtration and cartridge filtration. Typically, this simplified pretreatment produces effluent of lower quality than the lime clarification process, but the equipment is significantly smaller and simpler to operate.

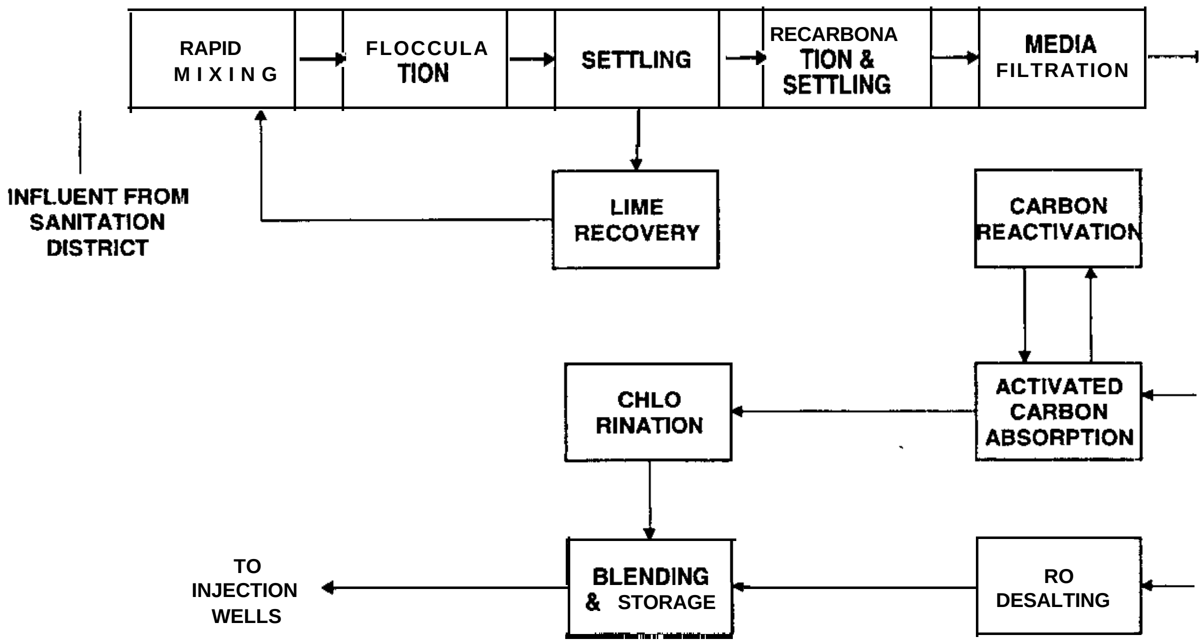


Figure l-Water factory 21 wastewater Reclamation system flow diagram

Water after conventional pretreatment has a high fouling potential for membranes. It is not uncommon for RO membranes in water reclamation applications to experience 25% - 30% per year average flux decline, even with frequent membrane cleanings.

2.3. ADVANCED PRETREATMENT

The benefit of membrane technology is the physically barrier layer between the feed and processed water streams. The use of this definite barrier in the RO pretreatment process has been proposed in the past (5). Ultrafiltration (UF) and microfiltration (MF) membranes have the ability to produce feed water of significantly better quality than the conventional pretreatment process based on lime clarification followed by media and cartridge filtration. However, the conventional, spiral wound configuration of ultrafiltration membrane elements is not suitable for the treatment of highly fouling wastewater. These UF elements could not operate at high permeate flux rates without severe fouling of the membrane surfaces and plugging of the feed channels. High cross flow feed velocities, required to reduce concentration polarization, resulted in high power consumption. (Concentration polarization is the buildup of salt concentration at the membrane surface that hinders the diffusion of water and contributes to membrane fouling). Membrane cleaning, frequently required, was cumbersome and not very effective in restoring permeate flux.

The new microfiltration and ultrafiltration technology offered recently (14) is based on a fat capillary membrane configuration. The capillary bore is of 0.7 - 0.9 mm diameter. The outside diameter of the capillary is in the range of 1.3 - 1.9 mm. Membrane material can consist of polypropylene, sulfonated polyether sulfone or cellulose acetate polymer. In some capillary element design configurations the feed - permeate flow direction is outside-in (i.e. feed water flushes the outside of the capillary fiber, water permeates through the wall and is collected as a permeate inside the fiber). Other element configurations have an inside-out flow direction.

There are two common properties of the new commercial capillary equipment;

1. Frequent, short duration, automatically sequenced flushing (or backflushing in some models) of the capillary fibers, which clean the membrane surface and enable stable permeate flux rates with little off-line time.

2. The ability to operate at very low feed cross flow velocity, or even in a direct filtration flow (dead end) mode.

The off-line time due to pulse cleaning is very short, compared to the off-line time of conventional filters for filter backwashing. The frequent pulse cleaning of the capillary membrane results in stable permeate flux rates. Required feed water pressure is in the range of 1 to 2 bar. Operation at low feed pressure and low rate of feed cross flow or in a direct filtration mode results in high recovery rates and very low power consumption, about 0.4 kWh/kgallon (0.1 kWhr/m^3) of filtrate. The membrane type is either microfiltration (nominal pore size 0.2 micron) or ultrafiltration (molecular weight cut off 100,000 - 200,000 Dalton). The dimensions of the capillary ultrafiltration modules are in the range of 40" - 52" (100 - 130 cm) long and 8" - 13" (20 - 32 cm) in diameter. In actual field operation, a single module can produce 8,000 - 40,000 gallons per day (30 - 150 m^3/day) of filtrate. Compared to conventional water treatment technology, the new process offers a modular design, high output capacity from a small footprint, no need for continuous handling and dosing of chemicals, and limited labor requirements. The major advantage, however is inherent to membrane technology: the existence of a membrane barrier between feed and permeate which enables a several log reduction of colloidal particles and pathogens.

This new capillary technology was developed initially for the treatment of potable water originating from surface sources. It has been extensively tested and a large number of systems, primarily utilizing microfiltration membranes, are already in operation. Following successful applications in potable water applications, the capillary technology was been tested as a potential pretreatment for RO systems operating on highly fouling water. One of the first targets was the RO processing of municipal effluents. The objectives were to replace the expensive and cumbersome conventional tertiary treatment and to increase the flux rate of the RO system. Field tests have been conducted for over three years now, and have confirmed the technological and economic feasibility (14). The results are promising and large commercial installations are under consideration (14). Large capacity systems, combining capillary UF pretreatment with RO technology are currently being designed. The capital cost of the capillary membrane pretreatment is estimated to be similar to the cost of the extensive multistage conventional pretreatment usually required for RO reclamation of the municipal waste water. The use of capillary technology will simplify the pretreatment system and reduce the use of chemicals. The new capillary technology is capable of reliably producing RO feed water with a very low concentration of colloidal particles and bacteria.

The present offering of commercial capillary products for the treatment of municipal effluents is included in Table 1.

Table 1. Offering of commercial capillary MF-UF products for treatment of municipal

Manufacturer	Memcor	Zenon	Pall	Aquasource	Hydranautics
Membrane material	Polypropylene	Proprietary	Proprietary	Cellulose acetate	Modified polysulfone
Type	MF	MF	UF	UF	UF
Configuration	Capillary	Capillary	Capillary	Capillary	Capillary
Nominal pore size/MWCO	0.2 micron	0.2 micron	13,000 Dalton	100,000 Dalton	100,000 - 200,000 Dalton
Fiber I.D.	0.3 mm	0.9 mm	0.8	0.94 mm	0.7mm
Fiber O.D.	0.7 mm	1.9 mm	1.4	1.3 mm	1.3 mm
Membrane area per module	22 m^2 233 ft^2	14 m^2 150 ft^2	7.5 m^2 61 ft^2	55.4 m^2 596 ft^2	25 m^2 270ft^2
Flow direction	out - in	out - in	out - in	in - out	in - out
Feed pressure range.	0.5 - 2 bar	< 0.5 bar vacuum	0.5 - 2 bar	0.5 - 2 bar	0.5 - 2 bar
Operation type	Dead end and cross flow	Immersed fibers	Cross flow	Partial cross flow	Dead end and cross flow
Capillary backflush	Compressed air backflush every 20min.	Filtrate backflush and air scouring	Filtrate backflush and air scouring	Filtrate backflush every 20 min.	Filtrate backflush every 20 - 30 min.
Typical module capacity	27 m^3/d 7000 gpd	13 m^3/d 3600 gpd	9.5 m^3/d 2500 gpd	130 m^3/d 36000 gpd	60 m^3/d 16000 gpd

A comprehensive description of the field tests of the new technology conducted at the Orange County Water Factory 2 1 test facility has been published recently (15).

2.4. SPIRAL WOUND RO MEMBRANE ELEMENTS

The concept of the spiral wound membrane element device was introduced shortly after the invention of the hollow fiber configuration (16). In the spiral wound configuration, two flat sheets of membrane are separated with a permeate collector channel material to form a "leaf." This assembly is sealed on three sides with the fourth side left open for permeate to exit (Fig 2).

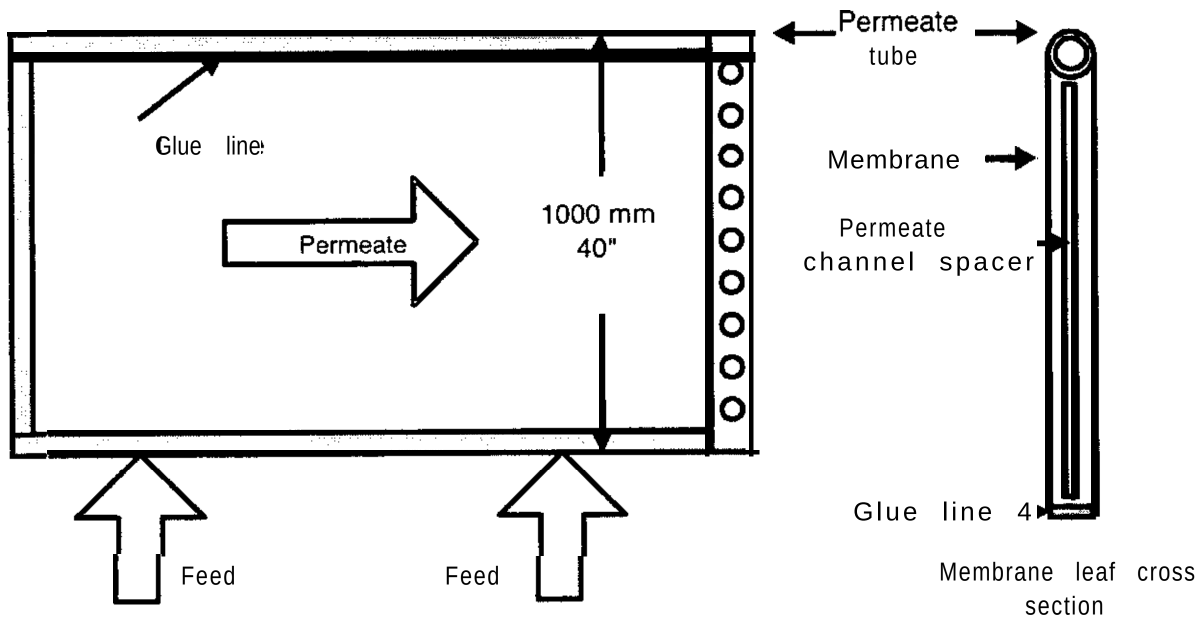


Figure 2-Conventional spiral wound module configuration

A feed/reject spacer material sheet is added to the leaf assembly. A number of these assemblies or leaves are wound around a central plastic permeate tube. The permeate tube is perforated and collects the permeate from the multiple leaf assembly. The typical industrial spiral wound membrane element is approximately 100 or 150 cm (40 or 60 inches) long and 10 or 20 cm (4 or 8 inches) in diameter. The feed/reject flow through the element is a straight axial path from the feed end to the opposite concentrate end, running parallel to the membrane surface. The feed/reject channel spacer induces turbulence and reduces concentration polarization, or buildup of salts at the membrane surface. Manufacturers specify reject flow requirements to control the concentration polarization by limiting permeate recovery rate per element to 10 - 20 percent. Therefore, the recovery rate is a function of the feed-reject path length. In order to operate at acceptable recoveries, spiral systems are usually staged with three to six membrane elements connected in series in a pressure tube (Fig. 3).

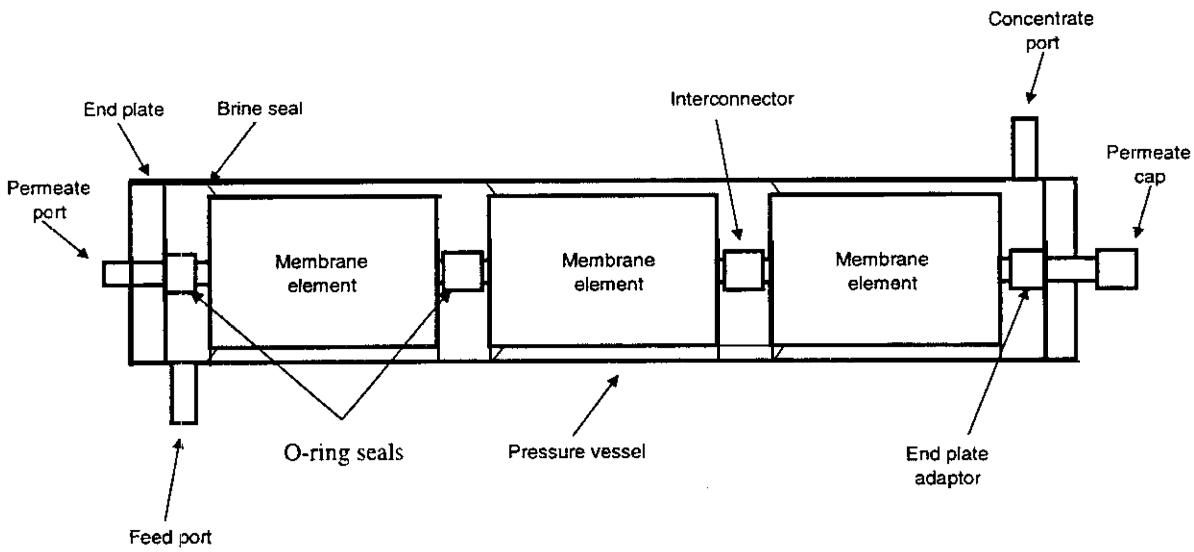


Figure 3-Pressure vessel with three membrane elements

The concentrate or reject stream from the first element becomes the feed to the following element, and so on for each element within the pressure tube. The reject stream from the last element exits the pressure tube as a concentrate. The permeate from each element enters the permeate collector tube and exits the vessel as a common permeate stream. A single pressure vessel with four to six membrane elements connected in series can be operated at up to 50-percent recovery under normal design conditions. The concentrate seal (similar to an o-ring) on the element feed end outer diameter prevents the feed/reject stream from bypassing the following element. Spiral wound elements are most commonly manufactured with flat sheet membrane of either a cellulose diacetate/triacetate (CA) blend or a thin film composite. A thin film composite membrane consists of a thin active layer of one polymer cast on a thicker supporting layer of a different polymer. The composite membranes usually exhibit higher rejection at lower operating pressures than the cellulose acetate blends. The composite membrane materials may be polyamide, polysulfone, polyurea, or other polymers. The spiral wound configuration of RO elements is the least affected by fouling by particulate matter in the feed water. Therefore, for the reclamation of highly fouling municipal effluents or polluted surface water, spiral wound RO elements are used almost exclusively.

3. APPLICATION OF RO MEMBRANES FOR PATHOGEN REMOVAL

3.1. THE CONVENTIONAL SPIRAL WOUND CONFIGURATION

RO membranes can be used to retain pathogens, which may be present in contaminated water source. The pores of the reverse osmosis membrane barrier layer are significantly smaller than the size of bacteria or viruses. However, there is always a possibility of permeate contamination by microbiological pollutants passing through structural defects. These defects may include:

- Membrane imperfections (pinholes)
- Damaged glue lines
- Damaged o-rings, which provide a separating seal between the feed and permeate streams. These o-rings are housed in the interconnectors that attach the permeate tubes of membranes in series together. O-rings are also present in the adapters that connect the first and last elements to the end plates of the pressure vessel. (Fig 3)

During the manufacturing process membrane elements undergo tests of structural integrity. The integrity tests include a bubble test (application of air pressure to the permeate side of membrane element), a vacuum test and the determination of salt rejection rate. After the elements are assembled into pressure vessels (which usually contain 6 - 7 elements connected in series), the determination of the integrity of individual elements is much more difficult. The tests which can be conducted while an element is installed in the system include probing of permeate conductivity and measurement of number of particles. Each of these is time consuming, and requires a significant level of expertise in the interpretation of the results. A bubble test or vacuum test cannot provide any meaningful indication of membrane integrity while elements are installed in a pressure tube. During the operation of the RO system, the feed water flow results in the creation of a significant axial force applied to the elements. This force can shift the elements back and forth inside the pressure vessel. This movement of elements may, in some cases, result in the breaking of the o-ring seals separating the feed and permeate streams. Large leaks can be easily identified by monitoring the permeate conductivity from individual pressure tubes. However small leaks, which can result in significant passage of pathogens, may remain undetected for some period of time.

3.2. THE ENCAPSULATED SPIRAL WOUND CONFIGURATION

The LFC1-FREE, or encapsulated element, is a new configuration, which consists of packaging a spiral wound membrane element into an individual pressure vessel. The schematic of the new configuration is shown in Fig. 4.

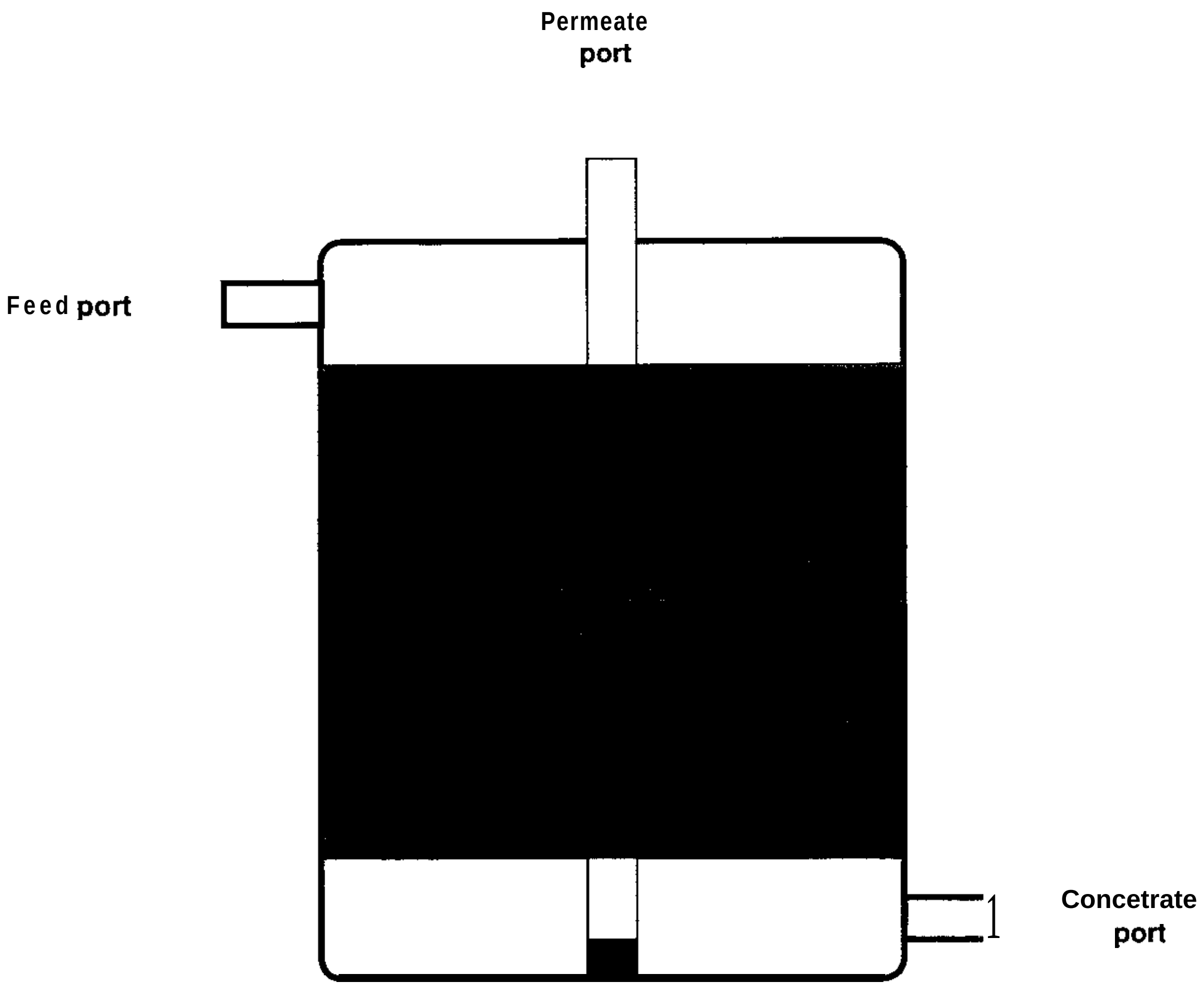


Figure 4-Encapsuled spiral wound element configuration

The encapsulation of individual elements has potential to be cost competitive with the conventional design of 6 -7 elements loaded into a single pressure vessel. The newer composite membrane technology provides membranes with high specific fluxes, allowing them to operate at low feed pressures typically below 200psi. Therefore, an inexpensive outer shell can be applied for element encapsulation.

The encapsulated element has advantages for applications where membrane barrier integrity is of special importance for the following reasons:

a) The encapsulated element configuration does not contain interconnector or adapter o-rings. This eliminates the possibility of leaks through the o-ring sealing surfaces.

b) The encapsulated elements are connected individually to a permeate manifold, allowing sampling to be taken from individual membranes. Therefore, any changes of permeate conductivity can be easily identified and localized.

c) The encapsulated elements allow for the possibility of continuous sampling of permeate from the permeate tubes while the elements are assembled into a system. This enables convenient determination of particle concentration in the permeate from a single element.

d) The encapsulated element configuration also enables the determination of element integrity. An in-situ vacuum test can be applied.

e) There is good probability that a meaningful, on line, bubble test (a permeate pressure holding test) can be developed for the encapsulated elements.

After the above listed advantages are demonstrated, engineering will be required to optimize the RO system design using encapsulated elements. The design should minimize the pressure drop which may be created in systems consisting of a number of encapsulated elements connected in series. In RO systems utilizing the conventional spiral wound configuration elements, the average apparent recovery rate per element is in the range of 6% - 10%. The low recovery rate per element is a result of the design requirement for sufficient cross flow feed velocity. This cross flow -velocity is required to reduce the concentration polarization at the membrane surface. In an RO system operating at 85% recovery the combined length of elements operating in series along the system would be 14 to 18 elements. To apply a similar arrangement to an RO system utilizing encapsulated elements, the entry and exit pressure losses at the feed-concentrate ports must be minirnized. Pressure drop in RO systems utilizing ultra-low pressure membranes may have a significant impact on performance.

4. EXPERIMENTAL RESULTS

4.1. MEMBRANE PREPARATION AND ELEMENT ROLLING

In order to assure good element integrity special precaution was observed during the preparation of materials for element construction. The flat sheet composite membrane was examined for the presence of surface defects. Double glue lines were applied to the "leaf' seals. A total of twelve 4" LFC1 elements were manufactured for this project; six elements in encapsulated configuration and six elements in standard configuration. Each element had four leaves and a nominal membrane area of 75 ft^2.

4.2. NOMINAL ELEMENT PERFORMANCE AND INTEGRITY TESTING

Elements were tested at standard test conditions. The standard test conditions are:

Feed pressure	225 psi
Feed salinity	1500 ppm NaCl
Recovery rate	15%
Feed temperature	25°C

The elements produced permeate fluxes in the range of 22 – 26 gfd (gallons per square foot per day) and salt rejections between 99.5% - 99.6%.

After this testing a vacuum hold test was performed by applying -20.9 in. Hg to the permeate side of the elements. The membranes were then isolated, and the vacuum decay rate was measured for one minute. In general, a vacuum decay rate of less than 5 in Hg per minute is acceptable. The results of the initial test of the LFC1 elements are included in Appendix A.

4.3. TEST SITE DESCRIPTION

Operation of the pilot unit was conducted at the San Pasqual Aqua 2000 Research Facility in Escondido, California. The San Pasqual municipal wastewater is processed through water hyacinth secondary treatment. After secondary treatment the water maintains a high load of suspended solids, and the turbidity is in the range of 10 – 20 NTU. This secondary effluent is processed by coagulation with ferrous salts and media filtration. The quality of tertiary effluent is included in Table 2, and has an average turbidity of about 2 NTU. This water flows into a holding tank where it is pumped to the HYDRAcap™ capillary ultrafiltration unit. The ultrafiltration unit is equipped with two 8" HYDRAcap™ capillary elements. A specification sheet for the HYDRAcap™ is included in Appendix B. The composition of the UF filtrate produced by the HYDRAcap™ operating on tertiary effluent is included in Table 2. The UF filtrate is pumped under pressure into two parallel manifolds of the RO unit. One manifold is connected to a pressure vessel housing three 4" LFC1 elements in standard spiral wound configuration. The other manifold is connected to three LFCI-FREE encapsulated elements connected in series. Each encapsulated element has a sampling port to enable individual permeate sampling from each element, while the RO system is in operation. The same ports are used to conduct the in-situ vacuum hold test. The schematic of the system is included in Fig 5.

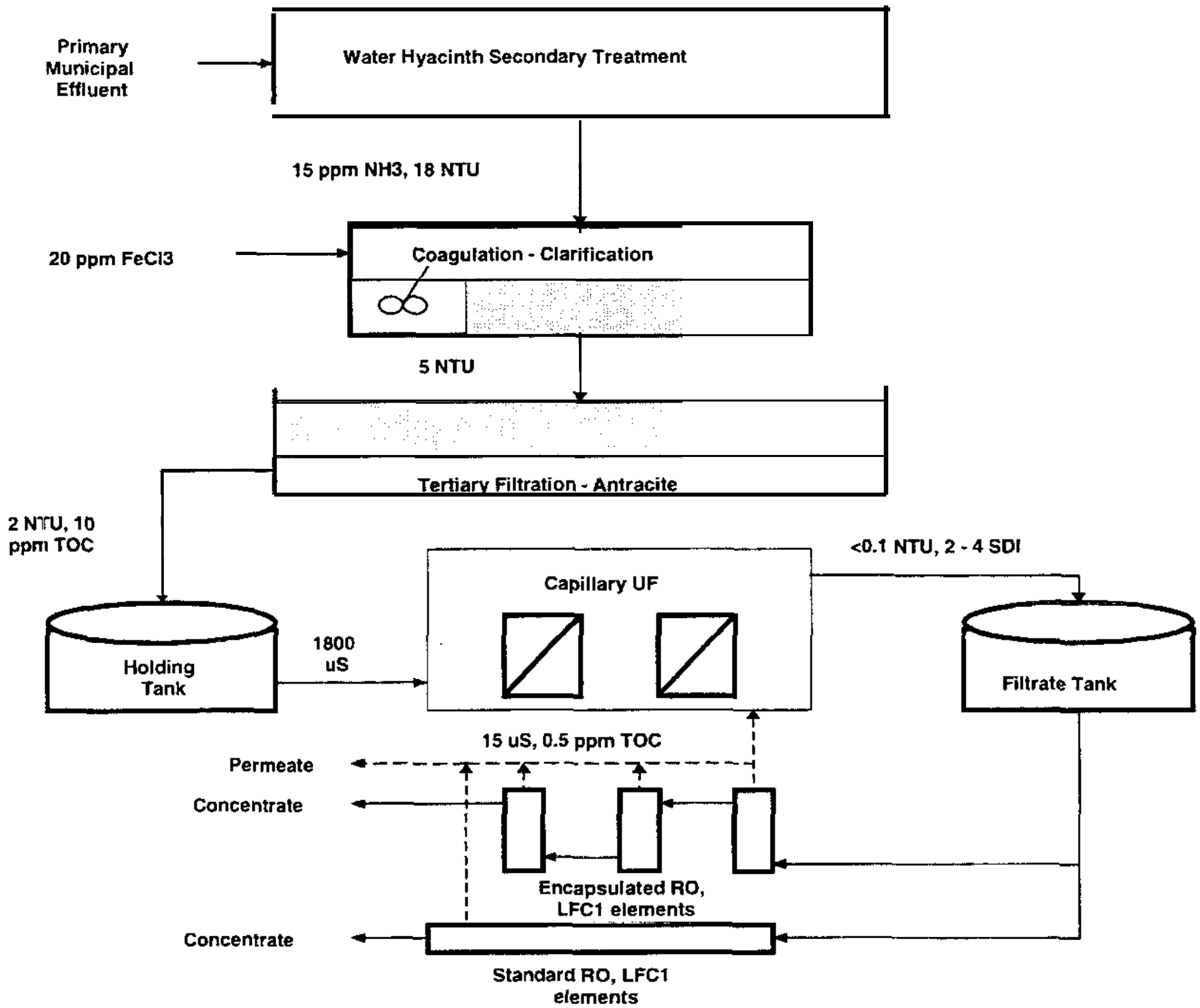


Figure S-Pilot Site at San Pasqual, California

A detailed process and instrumentation diagram (P&ID) of the test equipment is included in Appendix C. During the pilot testing period the water temperature fluctuated between 15°C to 28°C (Fig 6). Feed water conductivity fluctuated in the narrow range of 1500 – 1700 uS/cm (Fig. 7).

Table 2. San Pasqual analytical results

Parameter	UF Influent		UF Effluent		RO permeate	
	Average	Range	Ave.	Range	Ave.	Range
pH		7.3 - 7.5		7.4-8.1		5.7-6.4
Turbidity, NTU	2	0.5-5.2	0.07	0.04-0.15	0.05	0.03-0.09
Ammonia, ppm	12.2	1.8-21.7	12.3	1.3-20.0	0.3	0.01-l .o
Nitrate, ppm	8.9	8.6-9.5	7.5	7.5-7.6	0.4	0.3-0.5
Nitrite, ppm	8.6	8.6-8.7	5.9	5.9-5.9	0.18	0.18-0.18
Nitrate, TKN, ppm	12.7	7.1-18.2	12.6	8.8-l 8.0	0.29	0.12-0.64
Bromide, ppm	9.85	9.85-9.85	7.27	7.27-7.27	0.06	0.06-0.06
Chloride, ppm	264.5	231-288	257	242-280	1.32	0.71-2.28
Sulfate, ppm	298	247-339	291	241-321	0.4	0.3-l .4
Sodium, ppm	204	193-214	204	191-221	5	5 - 9
Silica, ppm	18	15-23	17	14-21	1	l - l
Iron, ppm	0.25	0.093-0.922	0.05	0.05-0.06	0.05	0.05-0.06
Chromium, ppb	5	1.9-10.2	2.9	1.4 - 6.0	1.1	1 .0 - 1.6
Calcium, ppm	74	74-74	79	72-83	1	l - l
Magnesium, ppm	39	38-38	39	36-41	3	3 - 3
Phosphorous, ppm	13.8	4.7-25.4	7.4	3.6-17.8	0.08	0.01-0.46
TDS, ppm			1106	1000	12	1 O-23
Hardness, ppm	389	330-427	395	347-448	5	5-6
Alkalinity, ppm	170	135-205	175	152-204	7	5 - 19
TOC, ppm	9.1	3.6 - 19.0	6.9	5.2 - 17.6	0.08	
UV-254	0.152	0.123-0.188	0.121	0.106-0.141	0.010	0.002-0.024
HPLC, cfu/ml	22.1e4	1.6e4-2.1e4	1.6	ND - 20	1.2	ND - 10
Total coliforms	8000		ND		ND	
Total chlorine, ppm	3.8	1 .o - 6.8	3.1	2.0 -3.9	3.5	2.0 - 5.2

Figure 6-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Apr98 to Nov98

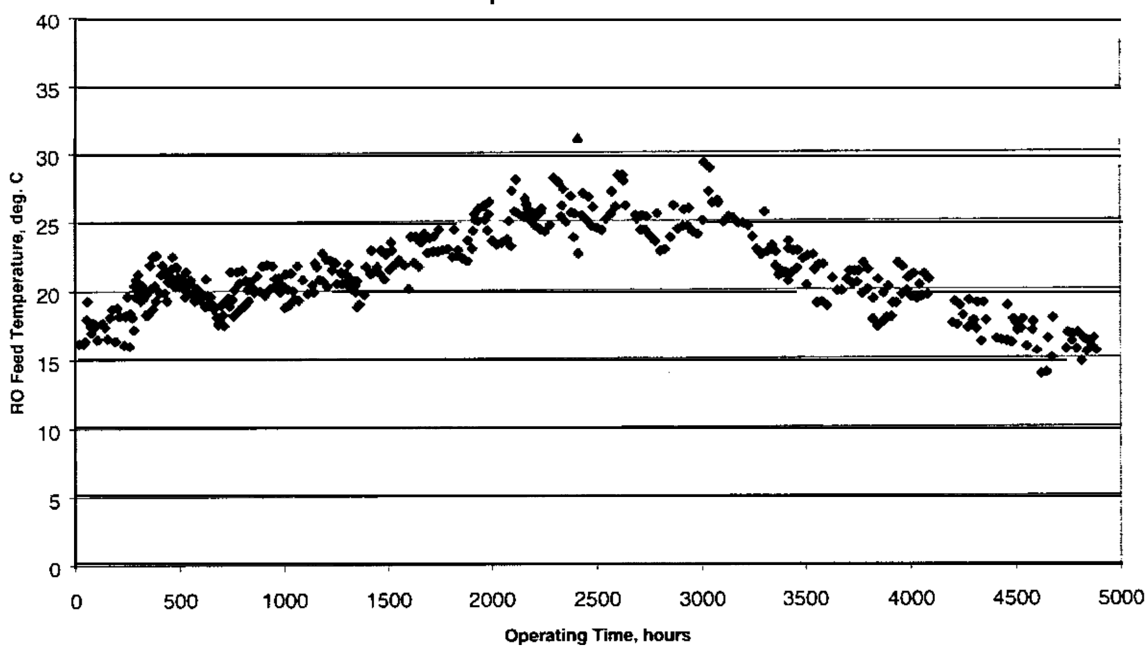
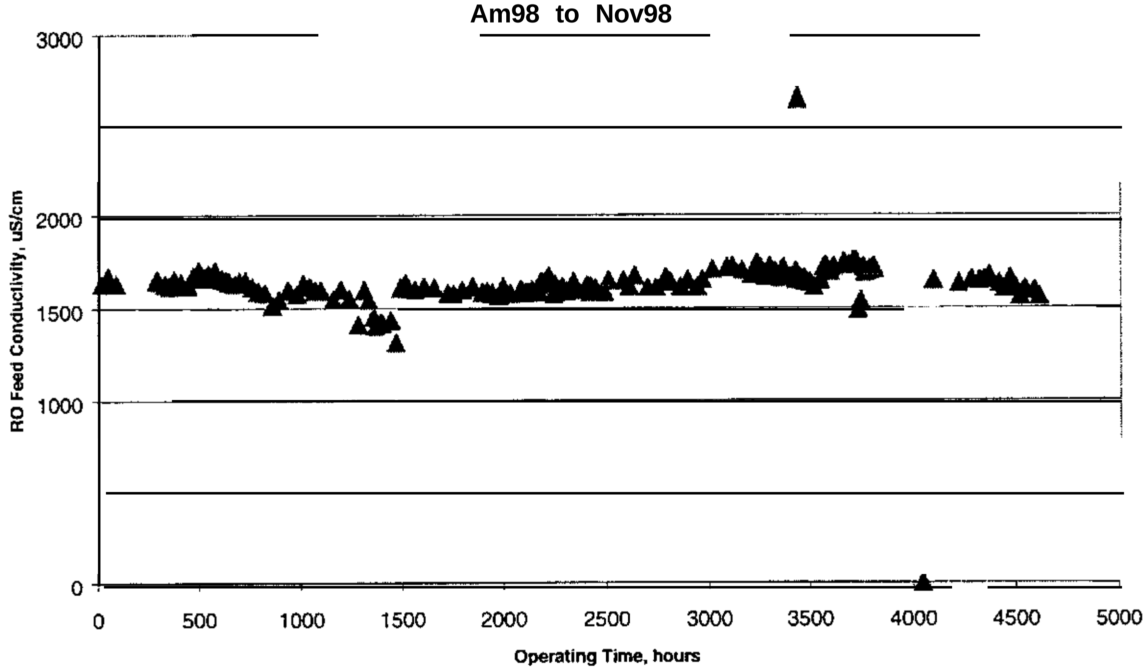


Figure 7-SAN PASQUAL SITE
Wastewter Effluent, Capillary UF Pretreatment
Am98 to Nov98



4.4 OPERATING PARAMETERS AND RESULTS

4.4.1 CAPILLARY UF EQUIPMENT

The UF pilot unit consists of two 8" HYDRAcap™ capillary ultrafiltration modules running in parallel. Flow through the capillaries is inside out, i.e., feed water enters the center of the capillary tubes and filters through the wall and is collected outside the fibers. The capillary material is Poly Ether Sulfone (PES). The UF unit runs in dead-end mode (no concentrate flow) with filtrate flow of 7 gpm (38 gfd) per element. Recovery is 100%. Here, recovery is synonymous with reverse osmosis technology and is equivalent to the Filtrate/Feed flow ratio as the unit is processing water. The conversion of feed water to filtrate is approximately 85%. Conversion considers that 15% of the filtrate is required for automatic backwash cycle. The unit also consists of one feed and one backwash pump, actuated valves, a control panel with a PLC to control backwash frequency and duration, a filtrate holding tank, a chlorine metering pump and a day storage tank. Flow and pressure are monitored with flow meters and pressure gauges. Two UF modules are needed to supply adequate flow to the RO units downstream.

Table 3. Representative operating parameters of the capillary UF pilot unit.

Parameter	Value
Number of capillary elements	2
Total Filtrate flow rate	14 gpm
Concentrate flow rate	0 gpm
Recovery	100%
Conversion	85%
Filtrate flux	38 gfd
Feed Pressure	20 psi
Baseline TMP*	4-6 psi (~0.3) bar

*Trans Membrane Pressure is the difference between the feed/concentrate and filtrate pressures.

The unit is operated in the following sequence:

Filtration step-

Feed pressure is applied to the inside of capillaries. The system operates in a dead end mode (100% recovery rate), and all feed water is converted to filtrate. This steps lasts between 15 – 30 min.

Backwash cycle-

The backwash cycle is a sequence of short steps. Initially, the concentrate valve is opened for a period of about 8 seconds and the inside of the capillaries are flushed with feed water. Next the feed pressure is reduced to ambient and filtrate pressure is applied to the outside of capillaries for a period of about 20 sec. Filtrate water permeates through the capillary walls, dislodges the foulants from the inside of the capillaries, and discharges them drain. During this step, chlorine is added to the filtrate at the level of about 20 ppm. The filtrate pressure is then reduced and the system stays idle (soak step) for about 20 seconds. The objective of the soak step is to allow the chlorine to oxidize the organic material deposited in the capillaries. After the soak step filtrate under pressure is again applied to the outside of the capillaries for a period of 12 seconds to rinse the chlorinated water from the system. The total time of the backwash cycle is about 60 sec. After the backwash the UF system is returned to normal operation. Periodically, when the TMP reaches 1.5 – 20 psi, the UF membranes are cleaned with 2% citric acid solution (low pH cleaning), followed with 0.5% NaOH solution (high pH cleaning). A detailed description of filtration, backwash and the cleaning procedure is included in Appendix D.

4.4.2. RO EQUIPMENT

The RO portion of the system contains two sets of three 4" membrane elements each operating in parallel. The membranes are Hydranautics new low fouling neutrally charged polyamide membrane (LFC1). One set of three membrane elements is housed in a standard pressure vessel. The other consists of three LFC1-Free membranes in a self-encapsulated configuration, i.e. stand alone membranes that do not require a pressure vessel. The encapsulated elements are also connected in series, i.e. concentrate outlet of one element is connected to the feed port of the next module. The permeate from all three encapsulated elements are combined together. However, the permeate line from each encapsulated membrane module can be individually accessed. Such a configuration provides the capability of in-situ integrity testing and individual permeate sampling for the membrane elements.

The filtrate from the UF system is collected in a tank and then fed to the RO membranes via two centrifugal pumps in series. The RO membranes further remove bacteria and viruses as well as dissolved solids. The instrumentation of the RO system includes a temperature gauge, permeate and concentrate rotameters, feed, concentrate and permeate pressure gauges. All conductivity readings of individual permeates are done by grab samples. A conductivity monitor of feed and combined permeate conductivity is included.

One of the objectives of the test program was to test the possibility of applying the encapsulated configuration to the design of commercial systems. For this reason, the encapsulated and standard configuration elements were operated in parallel at the same recovery and permeate flux rate. The summary of the RO unit operating conditions is given in Table 4.

Table 4. Operating conditions of the RO unit

Parameter				
Cumulative run time of the	0-2700	2700-3500	3500-4200	4200-4900
Recovery	40%	50%	60%	70%
Flux (gfd)	~11	~12	~13	16-20
Feed pressure (psi)	~80	~100	~160	~180

Analytical results for selected constituents are given in Table 2.

4.4.3. UF MEMBRANE PERFORMANCE RESULTS

The results of the HYDRAcap™ capillary UF operation are summarized in Fig. 8 through 14. Two UF elements were operated in parallel, designated as elements A and B. Fig 8 and 9 show the trans membrane pressure (TMP), which had to be applied to maintain the design filtrate flow. The TMP is calculated by subtracting the filtrate pressure from the average feed -concentrate pressure.

$$TMP = 0.5 * (P_f + P_c) - P_p$$

For the majority of the study, the TMP fluctuated between 4 – 12 psi. Some excursion of the TMP was experienced, mainly due to membrane fouling resulting from operating condition changes such as increased period between backwash operation (increased length of operating cycle) and increased permeate flux rate. Stable results were obtained with a filtrate flux rate at about 38 gfd between backwash intervals of 15 minutes. Both UF elements operated most of the time at flux rate of 38 gfd, (Fig 10 and 11) which corresponds to filtrate flow of 7 gpm per element (Fig 12). The filtrate turbidity was below 0.1 NTU while processing tertiary effluent of average turbidity of about 2 NTU (Fig 13 and 14). The silt density index (SDI) of the UP feed was unmeasurable. The SDI of the UP filtrate was in the range of 2 – 4. It is interesting that the HYDRAcap™ UF membrane had a marginal retention for dissolved organics. TOC reduction of about 20 % was obtained. The capillary UF membrane has a molecular weight cut off of about 150,000 Dalton, which provides insight on the size of the dissolved organic matter.

Figure E-SAN PASQUAL SITE,
Capillary UF Unit Operating on Wastewater, UF-A , (Feb98 to Nov98)

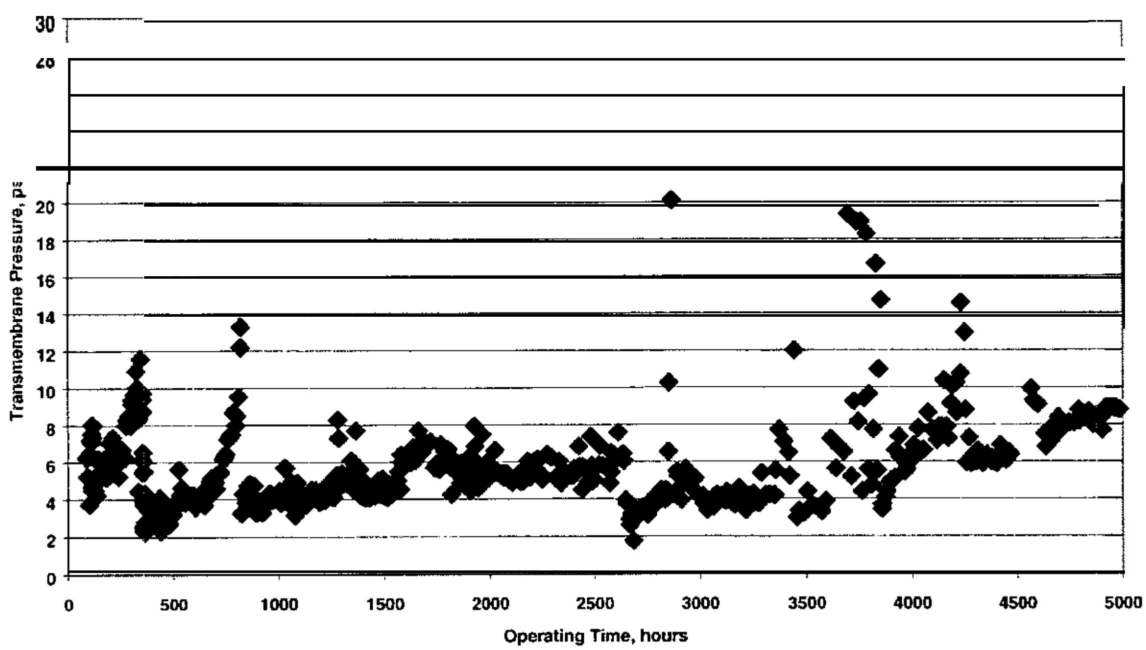


Figure 9-SAN PASQUAL SITE,
Capillary UF Unit Operating on Wastewater, UF-B , (Feb98 to Nov98)

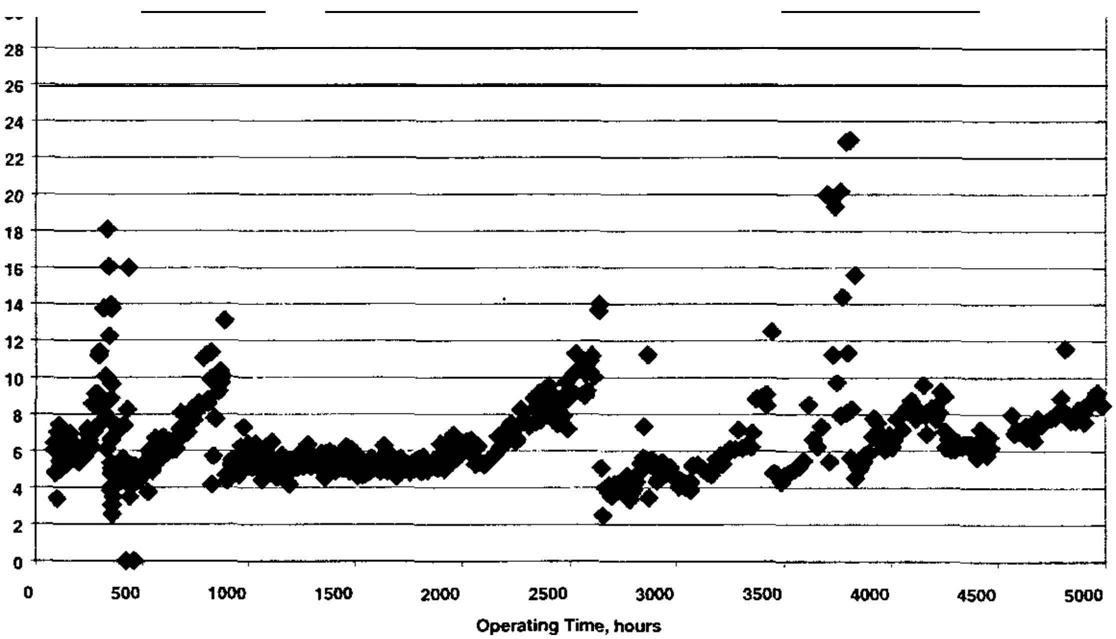


Figure IO-SAN PASQUAL SITE,
Capillary UF Unit Operating on Wastewater, UF-A,
(Feb98 to Nov98)

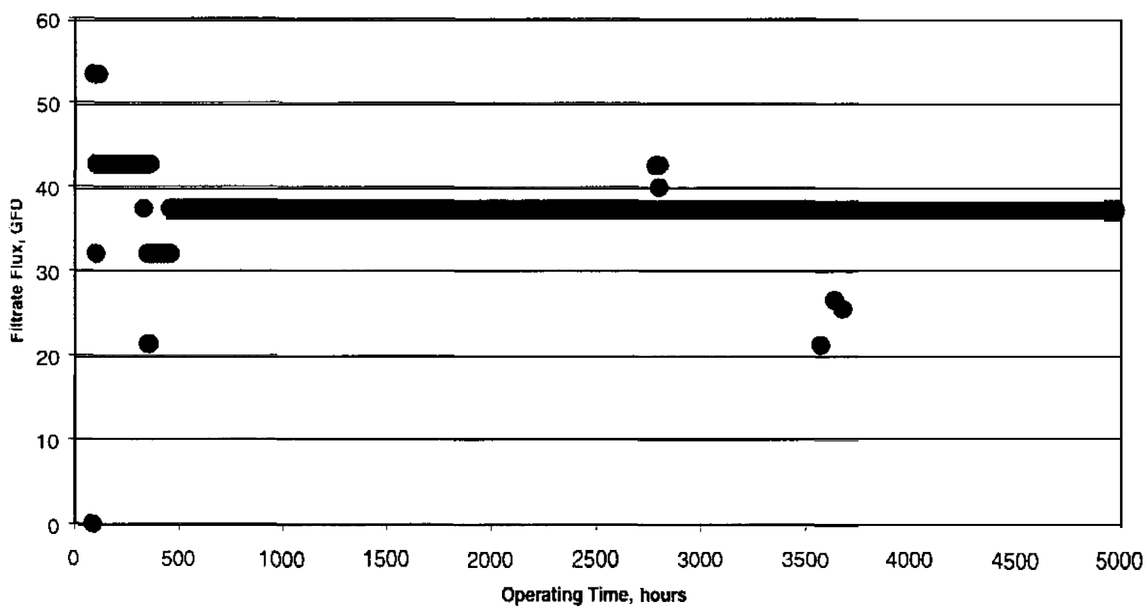


Figure 1 I-SAN PASQUAL SITE,
Capillary UF Unit Operating on Wastewater, UF-B,
(Feb98 to Nov98)

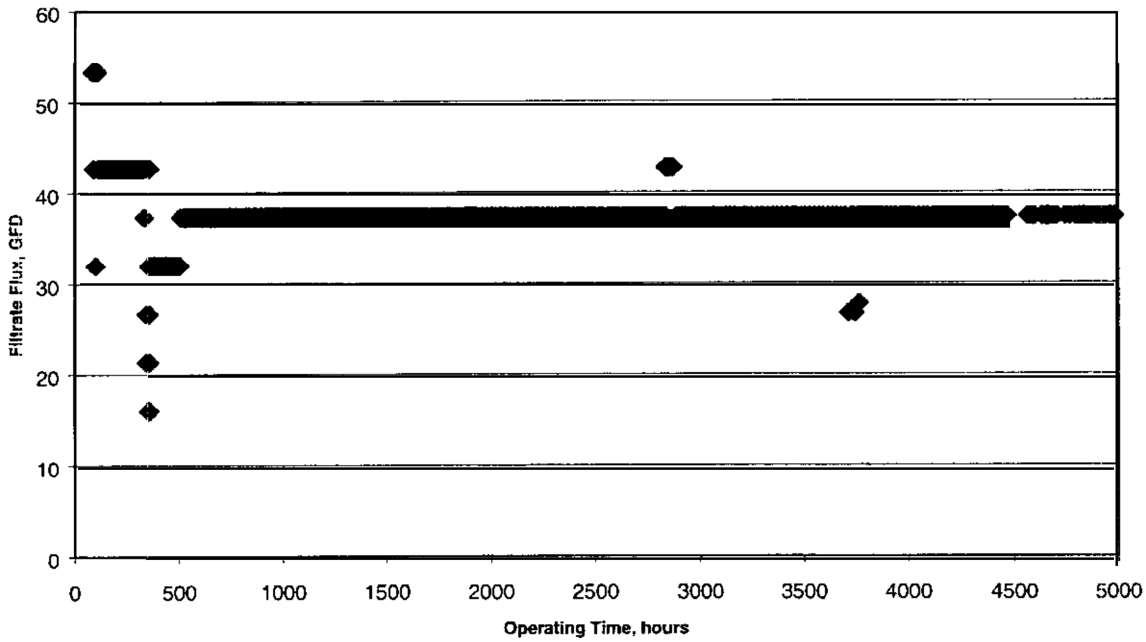


Figure 12-SAN PASQUAL SITE,
Capillary UF Unit Operating on Wastewater, (Feb98 to Nov98)

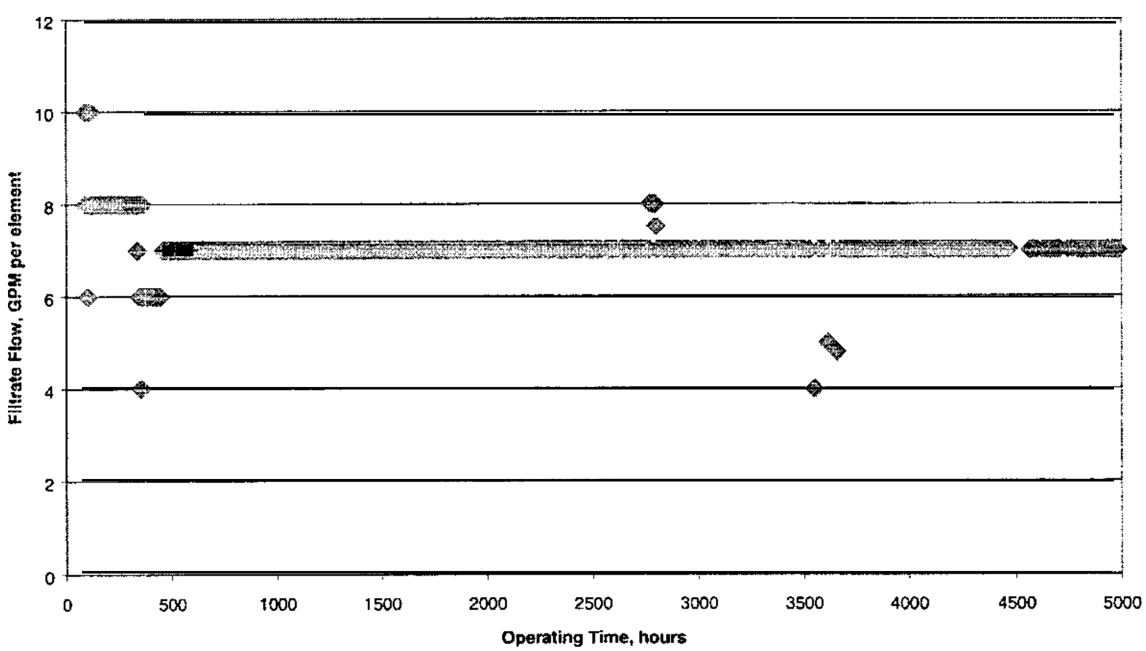


Figure 13-SAN PASQUAL SITE
Capillary UF Unit Operating on Waste Water
Turbidity Reduction, UF - A

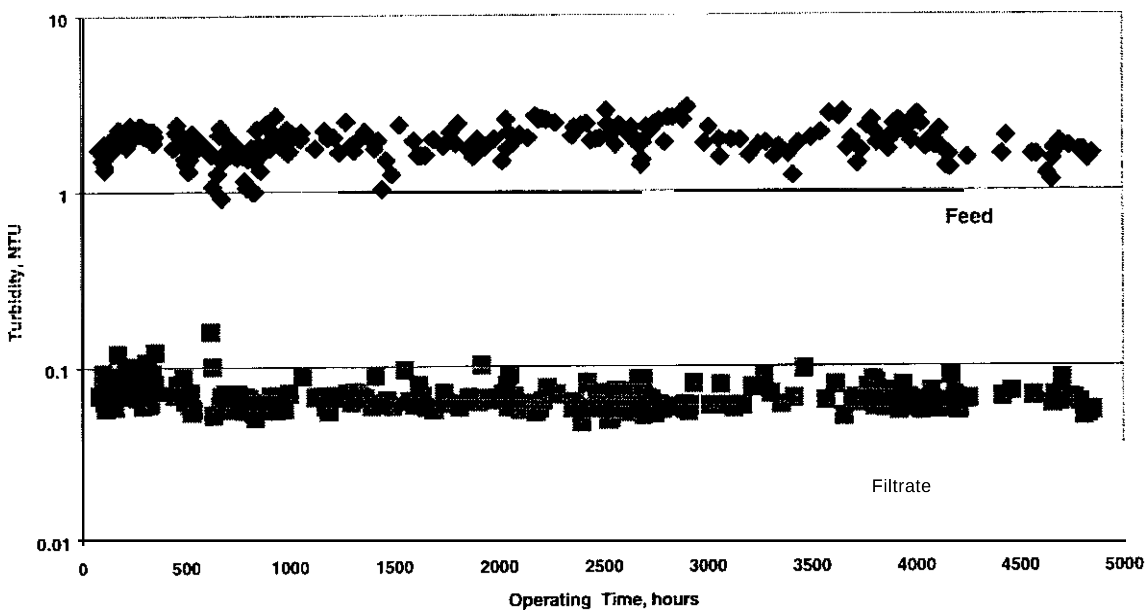
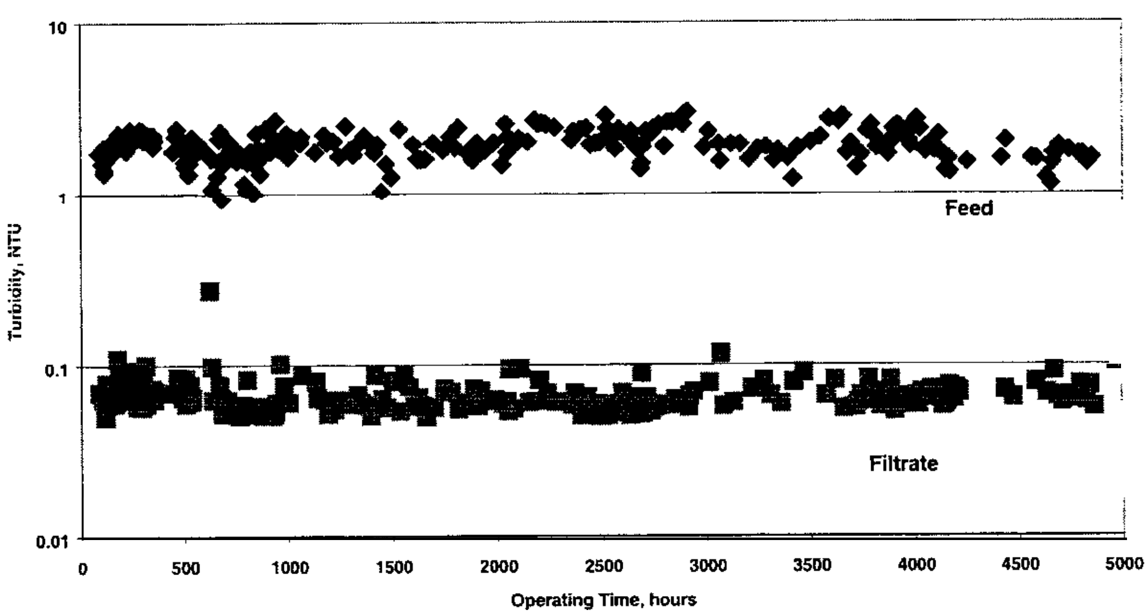


Figure 14-SAN PASQUAL SITE
Capillary UF Unit Operating on Waste Water
Turbidity Reduction, UF - B



4.4.4. RO MEMBRANES PERFORMANCE RESULTS

The results of the operation of the encapsulated and standard configuration LFC1 membrane elements are included in Fig. 15 – 21 and Fig. 22 – 28 respectively. The graphs include field data of permeate flow, average permeate flux, specific permeate flux (corrected for temperature and net driving pressure), permeate conductivity, salt rejection, recovery and feed pressure. Both the standard and encapsulated membrane elements operated at very similar conditions and exhibit similar performance. An important observation is related to the relative stability of the salt rejection, The feed water contains a high level of total chlorine (1 – 7 ppm) in the form of chloramines. The presence of chloramine prevents bacteria growth in the elements. The small decline of salt rejection, from 99.6 to 99.2, (Fig. 19 and 26) after eight months of field operation provides confirmation of previous findings that chloramines can be used to control biofouling in RO systems equipped with polyamide composite membranes. The LFC1 membranes operated at initial flux rate of 11 gfd, which was increased up to 16-20 gfd. The feed pressure remained stable (Fig. 21 & 28) and calculations of specific flux (Fig. 17 & 24) indicate very little decline of water permeability. The stability of specific flux is much higher than observed in the operation of the same type of membranes on conventionally pretreated municipal effluent. The typical RO membrane flux decline caused by fouling for conventionally pretreated efflent is in the range of 50 – 80%, and is quite common (16). This difference of fouling rates, in our opinion, is due to a significant reduction of colloidal particles by the HYDRAcap™ capillary membrane pretreatment

Figure 15-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Encapsulated LFC1 Membrane Elements
Apr98 to Nov98

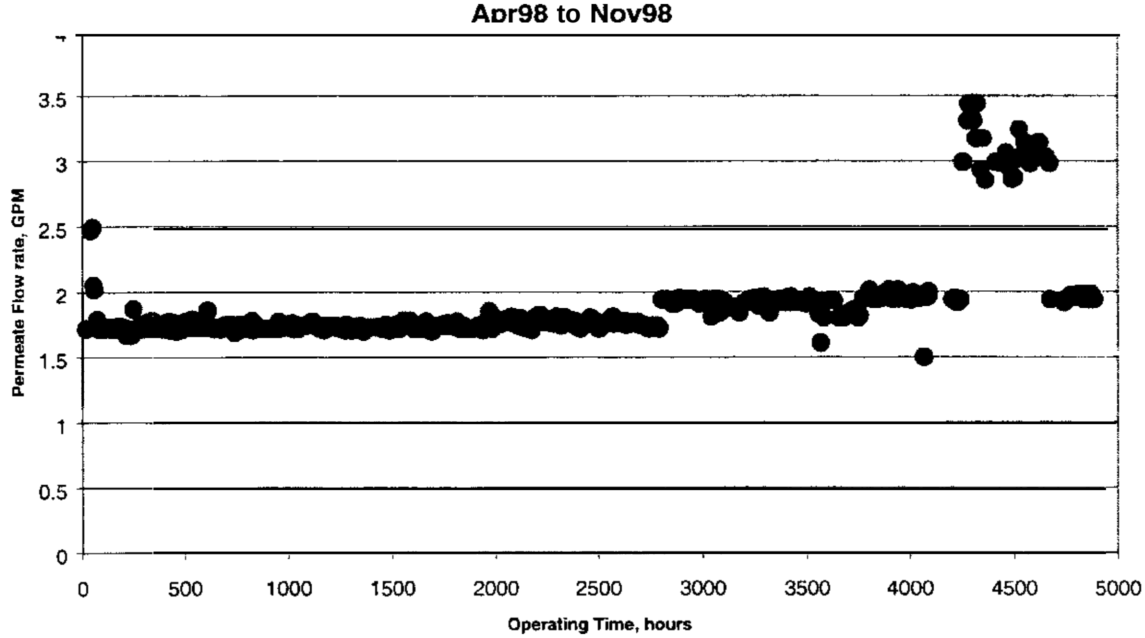


Figure 16-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Encapsulated LFC1 Membrane Elements
Apr98 to Nov98

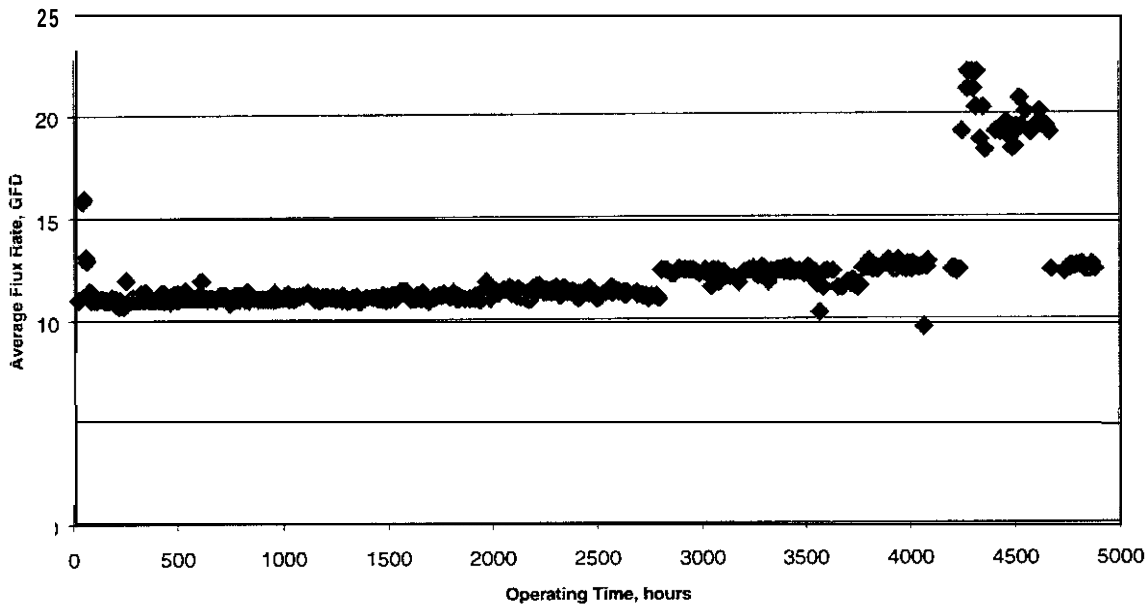


Figure 17-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Encapsulated LFC1 Membrane Elements
Apr98 to Nov98

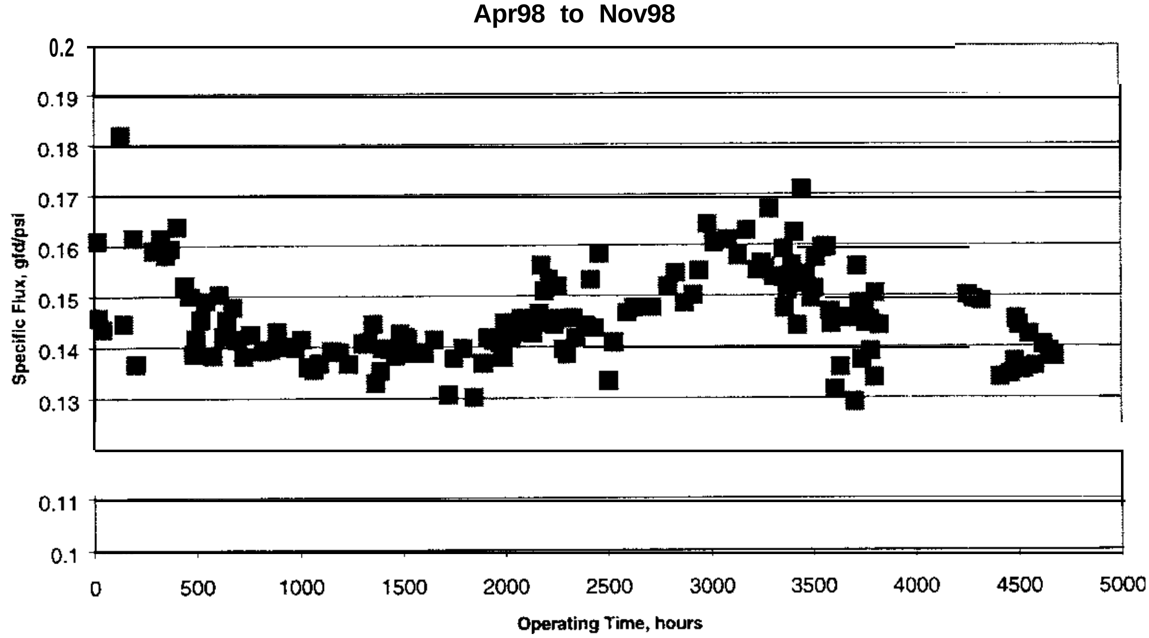


Figure l&SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Encapsulated LFC1 Membrane Elements
Apr98 to Nov98

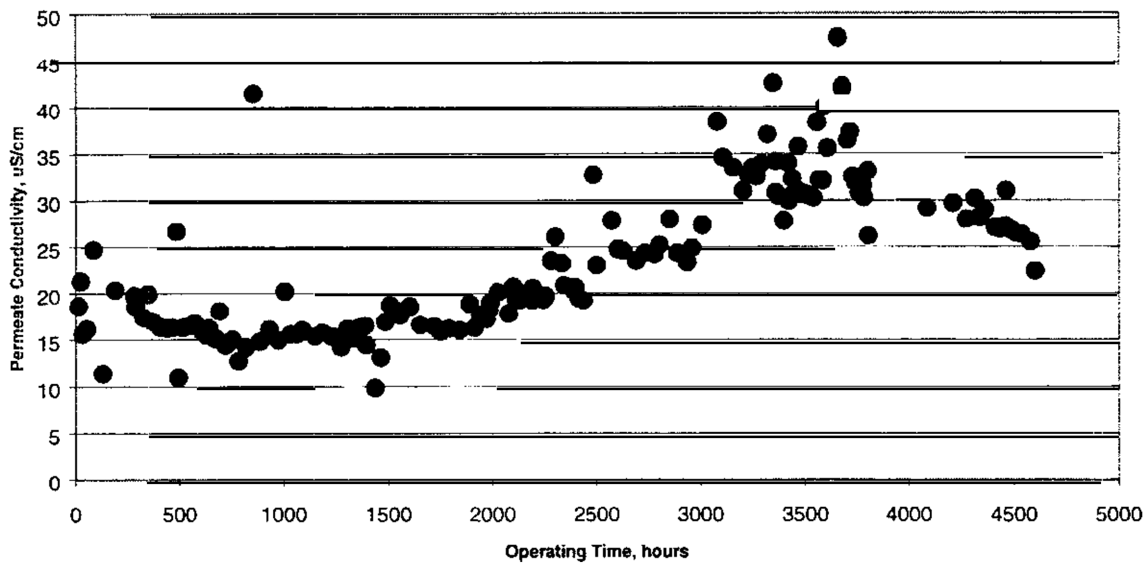


Figure 19-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Encapsulated LFC1 Membrane Elements
Apr98 to Nov98

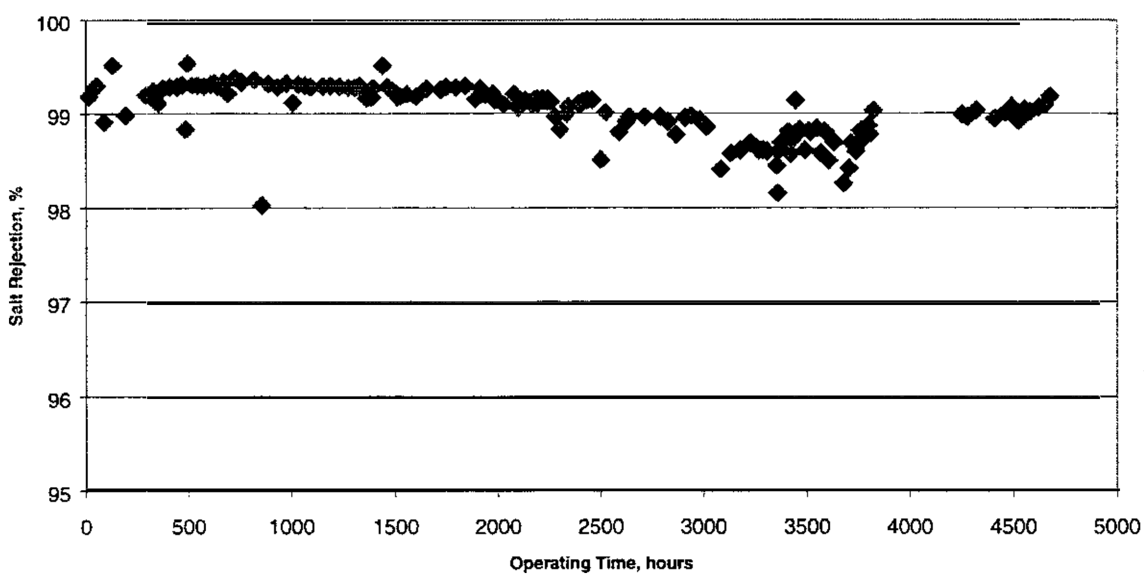


Figure 20-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Encapsulated LFC1 Membrane Elements
Apr98 to Nov 98

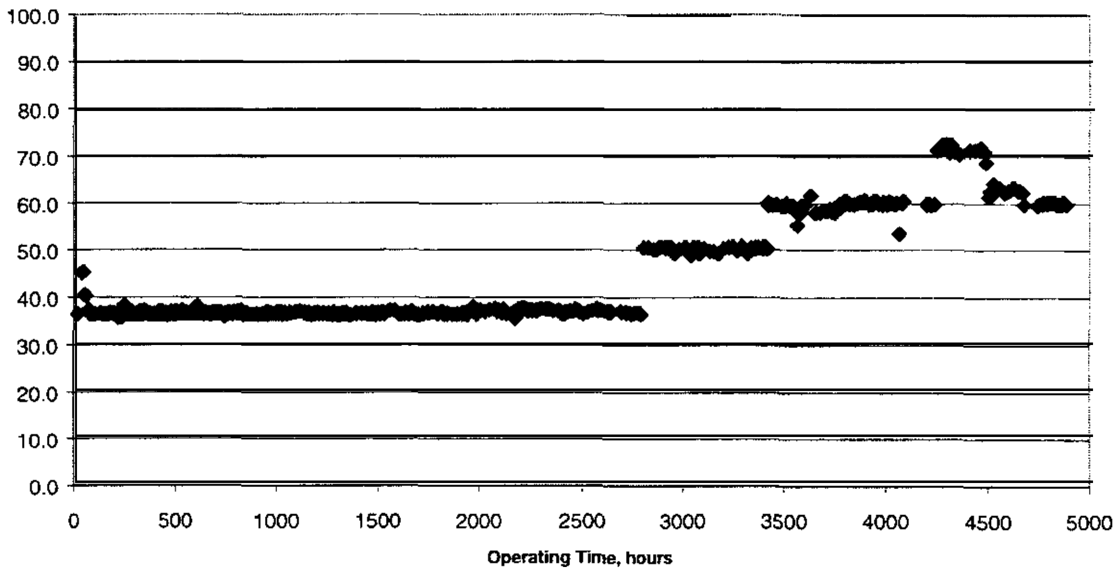


Figure 21-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
LFC1 Encapsulated RO Membrane Element
Apr98 to Nov98

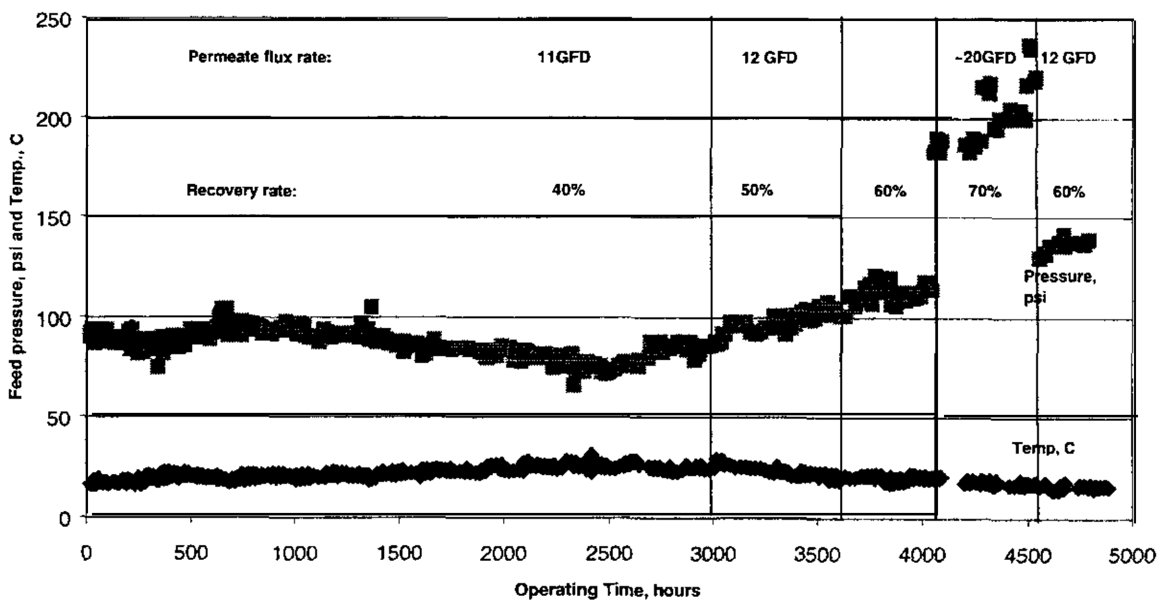


Figure 22-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Standard Configuration LFC1 Membrane Element
Apr98 to Nov98

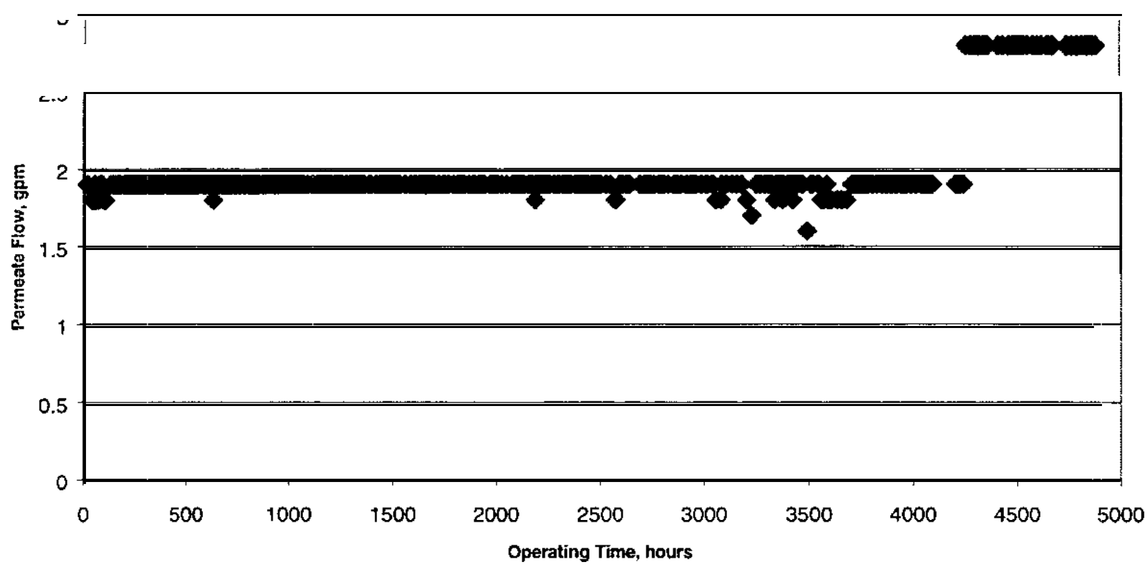


Figure 23-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Standard Configuration LFC1 Membrane Element
Apr98 to Nov98

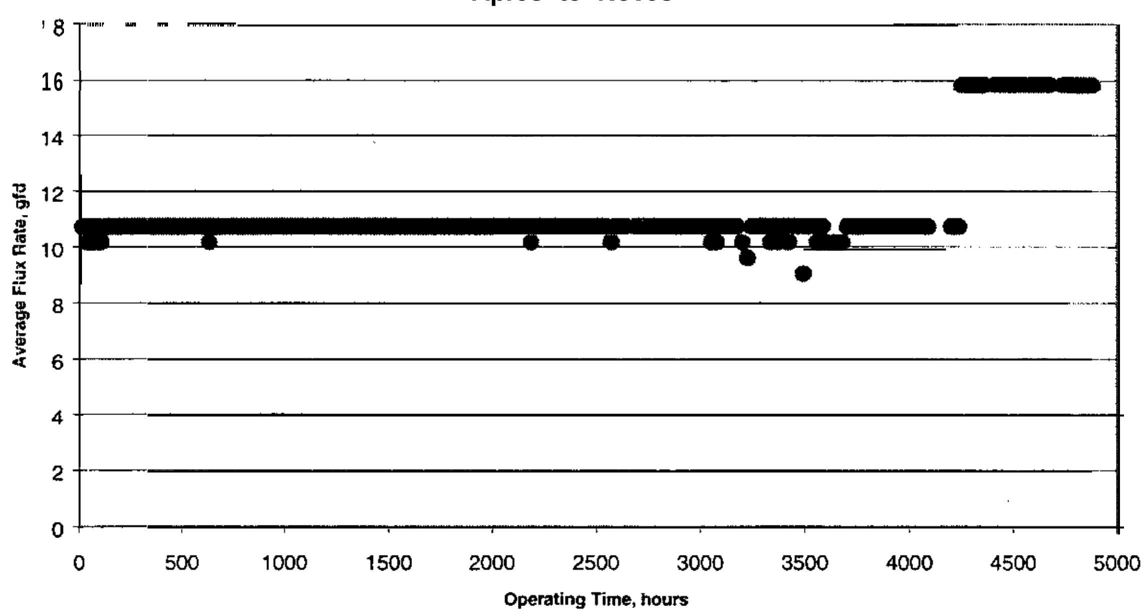


Figure 24-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Standard Configuration LFC1 Membrane Elements
Apr98 to Nov98

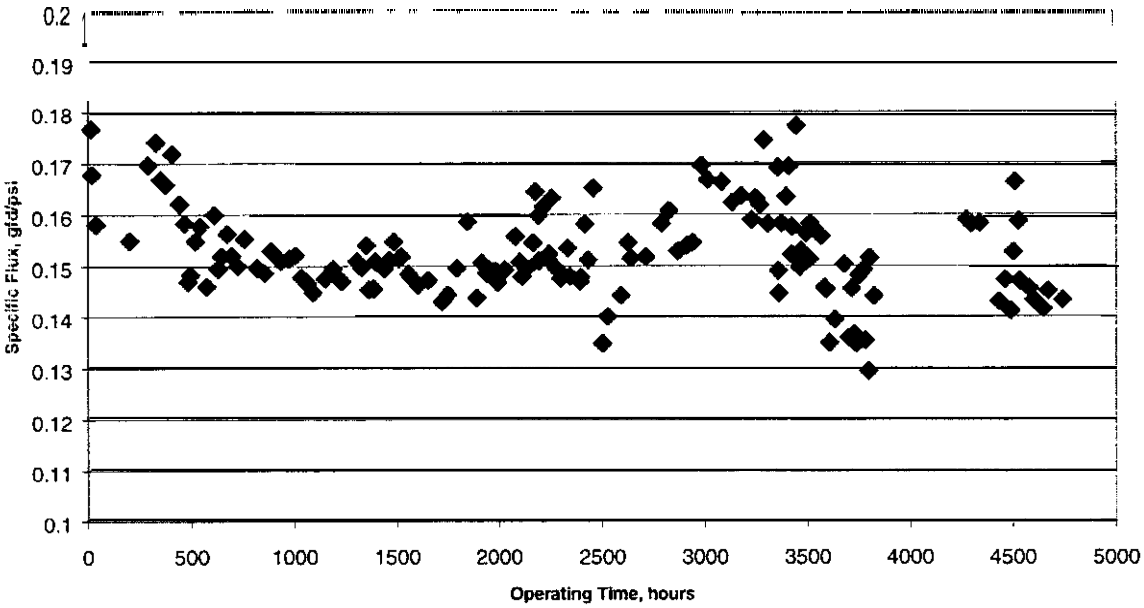


Figure 25-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Standard Configuration LFC1 Membrane Elements
Apr98 to Nov98

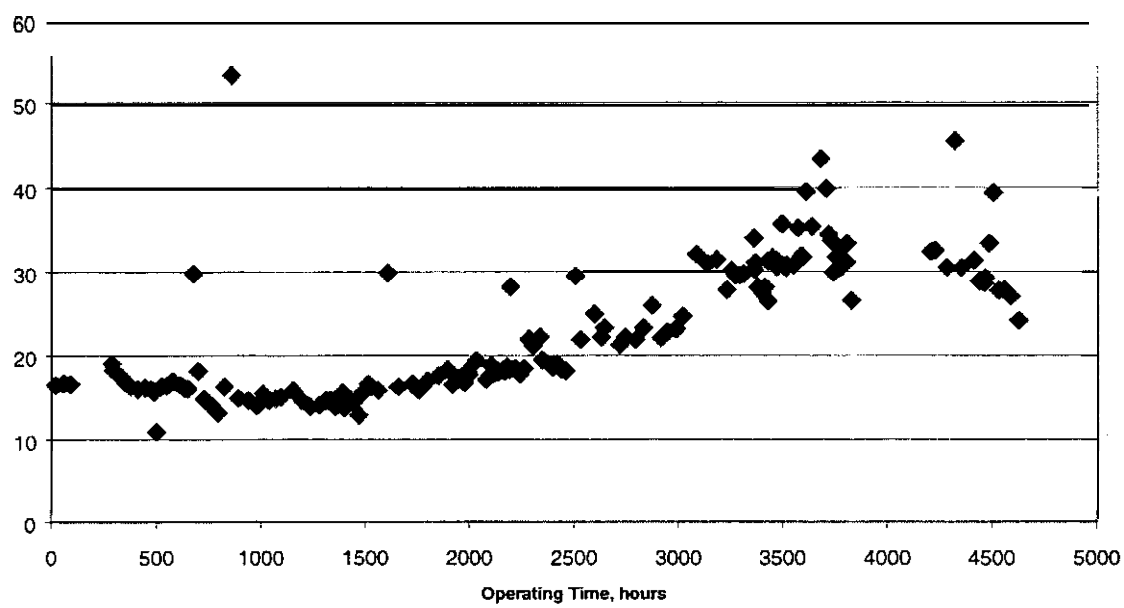


Figure 26-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Standard Configuration LFC1 Membrane Elements
Apr98 to Nov98

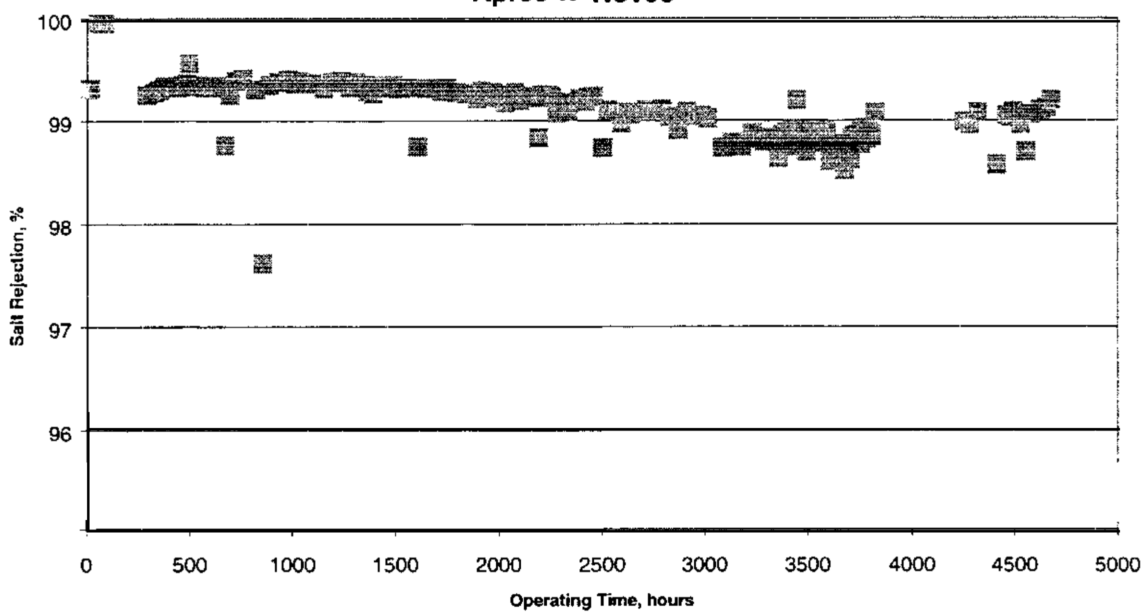


Figure 27-SAN PASQUAL SITE
Wastewater Effluent, Capillary UF Pretreatment
Standard LFC1 Membrane Elements
Apr98 to Nov 96

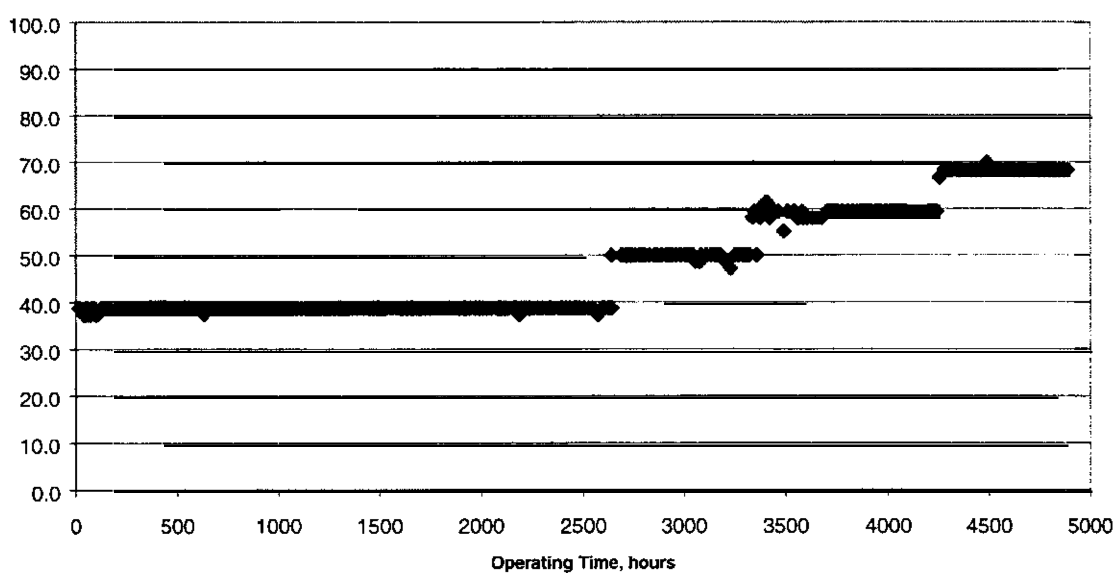
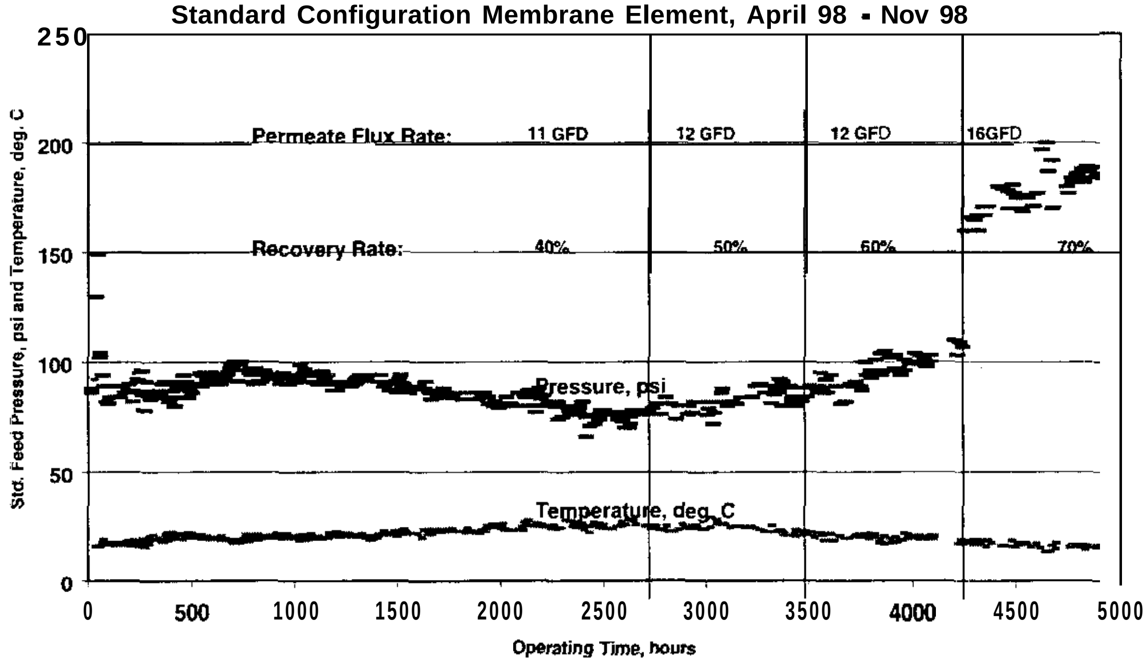


Figure 28-SAN PASQUAL SITE
Municipal Effluent Treated with capillary UF Pretreatment, LFC1
Standard Configuration Membrane Element, April 98 - Nov 98



4.5. VIRUS CHALLENGE RESULTS

Virus retention tests of HYDRAcap™ UF and LFC 1 RO membrane elements were conducted on June 25, 1998 and October 23, 1998. Each test consisted of a separate seeding of feed water to both the UF unit and the RO unit with MS2 stock seeding solution. The concentration of MS2 virus in the feed water was in the range of 10^5 to 10’ plaque forming units per ml (pfu/ml). Samples of UF filtrate and RO permeate were collected at the time intervals after the backwash of the capillary UF system. The details of the seeding protocol and the reports of each challenge test are included in Appendix E.

4.5.1. VIRUS RETENTION BY CAPILLARY UF MEMBRANES

The results of the MS2 virus challenge test are included in Fig. 29 and 30 for the first seeding test (June 98) and Fig. 32 and 33 for the second seeding test (October 23). Fig. 29, which includes results for module A, indicates an increase of MS2 virus concentration in the second and third filtrate samples. The first result corresponds to 5.2 log removal immediately after backwash. The subsequent results correspond to only 3.4 - 3.7 log removal. These results are consistent with the particle count results for module A taken on the evening prior to the next day challenge test. The particle count results in the filtrate indicated a step increase in particle size over 2 urn. This is indicative of broken fibers. The bubble test of module A conducted after the virus challenge test confirmed the presence of two broken fibers. Plugging the broken fibers with plastic pins repaired module A. The results for module B consistently indicated over 5 log virus removal (Fig. 30). The challenge test conducted on October 23 indicated 5 - 6 log virus removal for both UF modules (Fig. 32 & 33).

Figure 29-Virus rejection by capillary membrane Module A, two fibers broken. June 1999

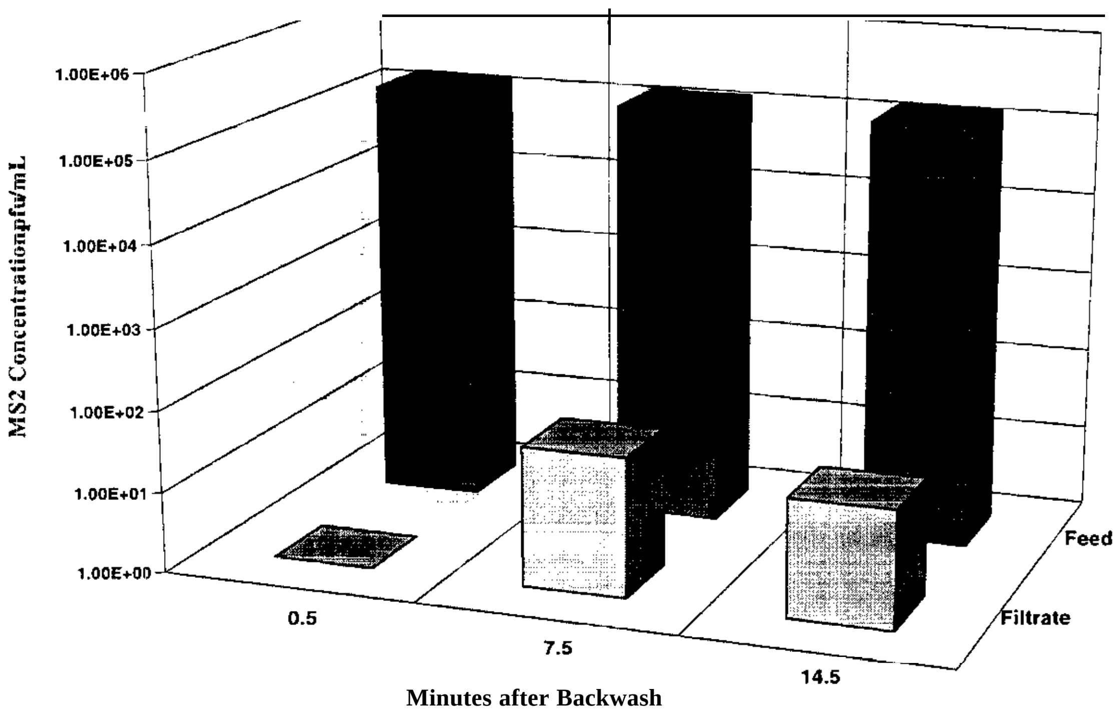


Figure 30-Virus rejection by capillary membrane Module B. June 1999

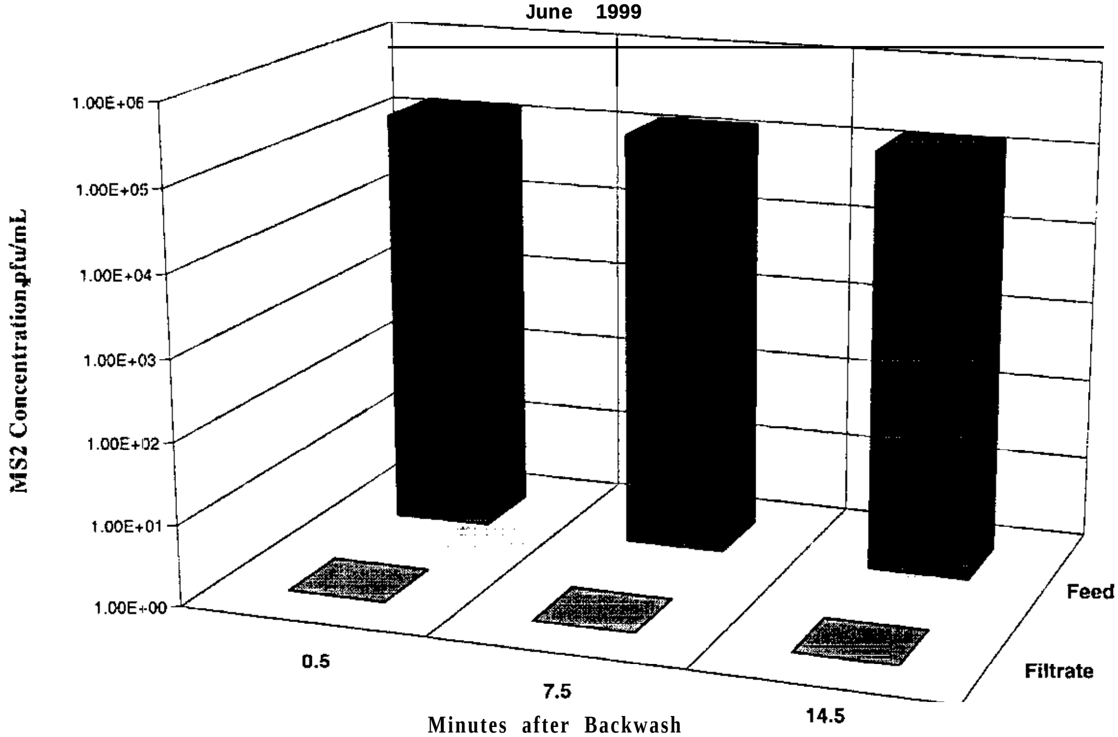


Figure 31-Virus rejection by LFC1 RO membranes
June 1998.

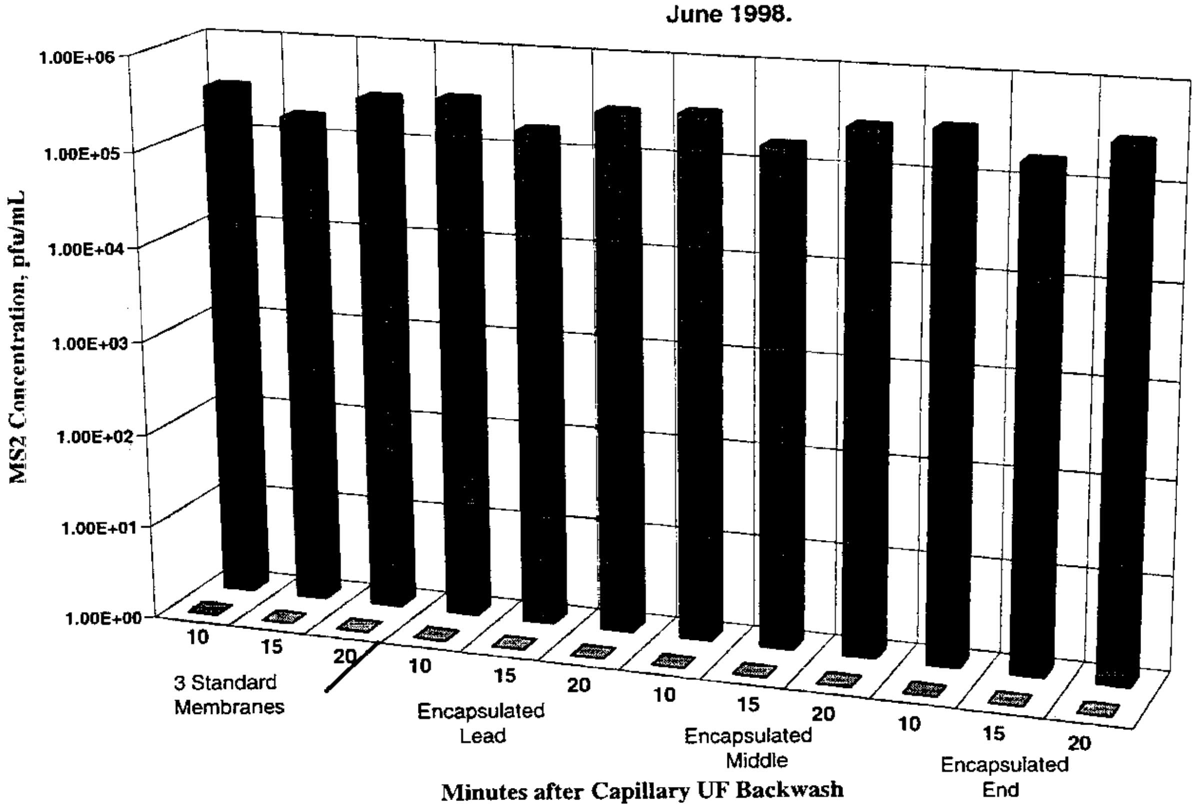


Figure 32-Virus rejection by capillary membrane UF-A,
October 1998

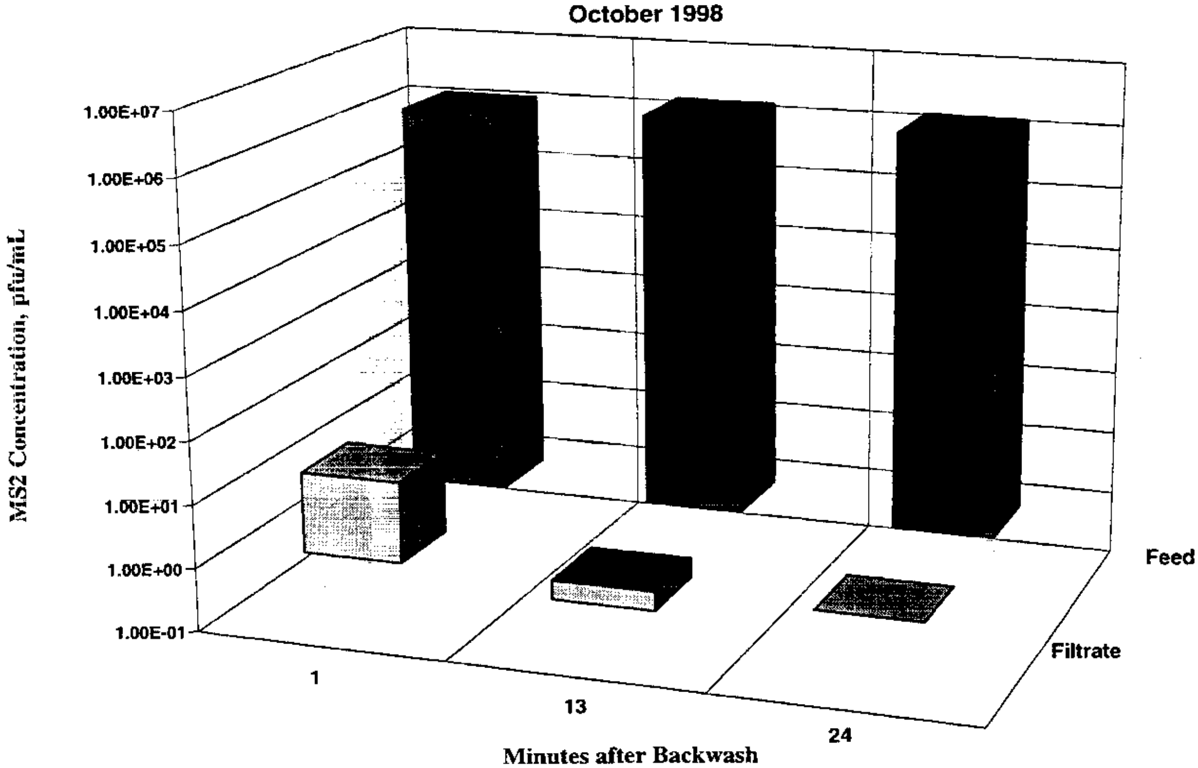


Figure 33-Virus rejection by capillary membranes. UF-B.
October 1998

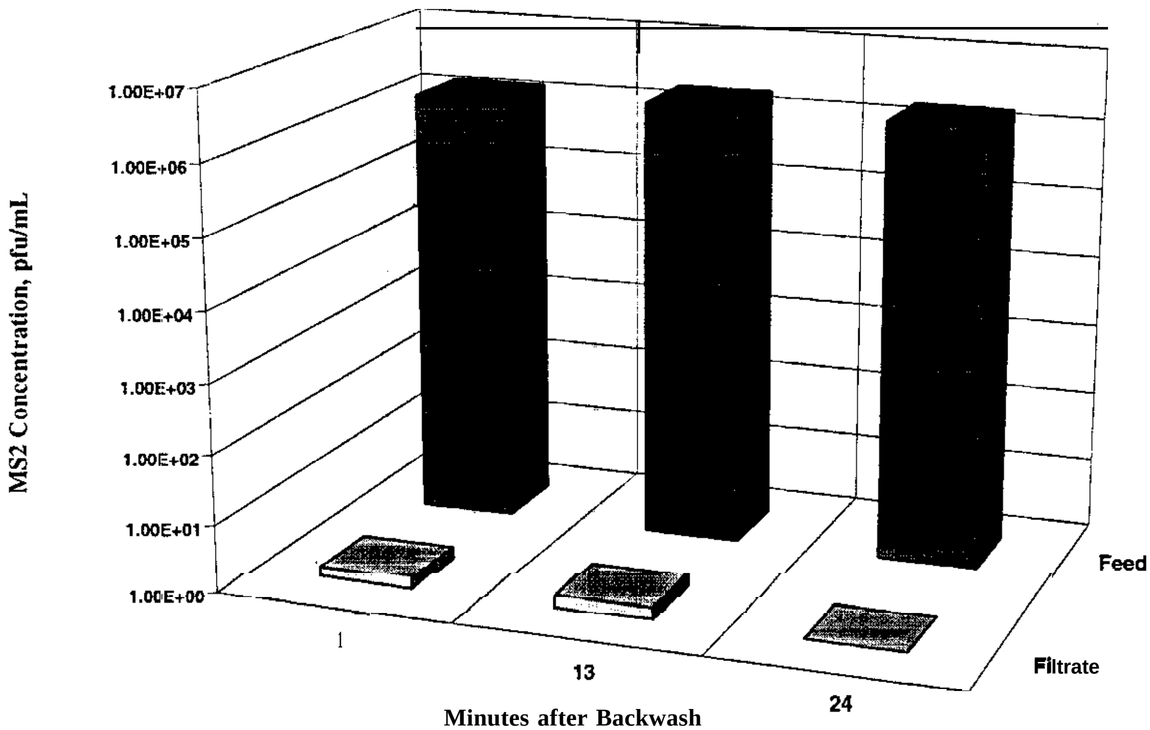
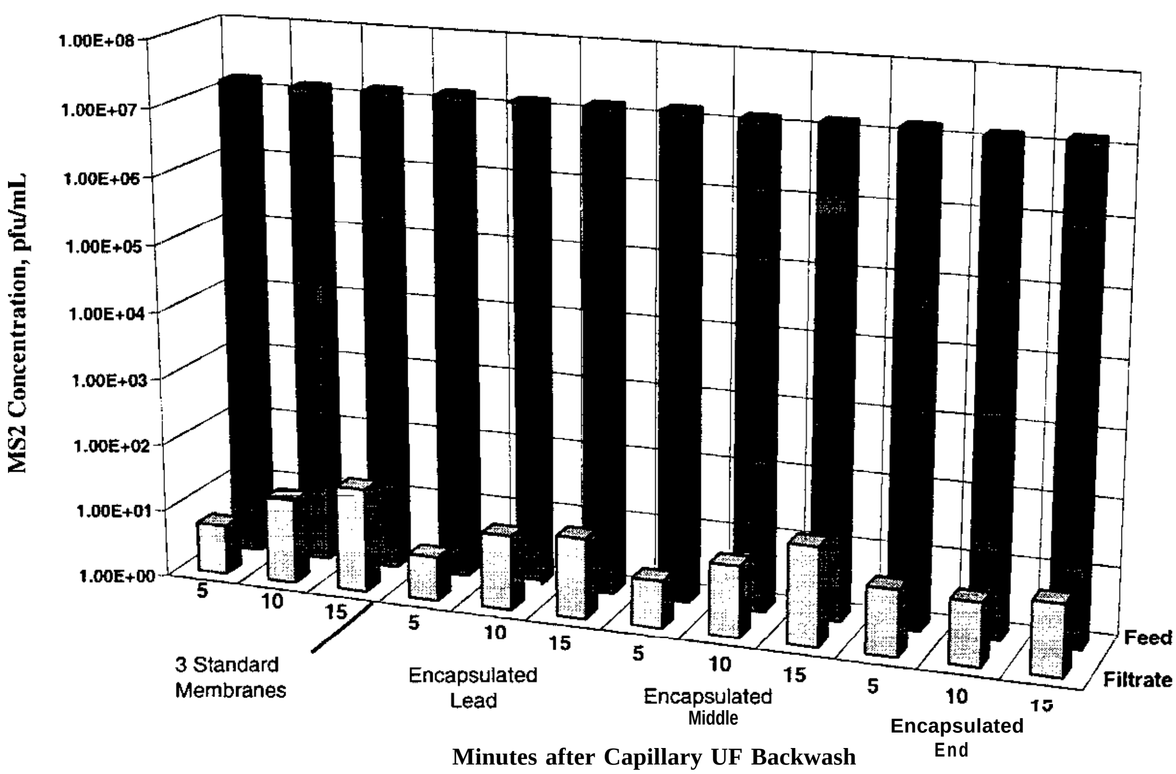


Figure 34-Virus rejection by RO membranes.
October 1998



4.52. VIRUS RETENTION BY RO MEMBRANES

The virus challenge results are included in Fig. 3 1 (June 98) and Fig. 34 (October 98). The first seeding results (Fig. 3 1) indicate the same level of virus rejection of over 5 log for both membrane element configurations: standard and encapsulated. The second seeding results (Fig. 34) indicate overall higher virus rejection, up to 6.7 Iog. On the average the virus rejection by the encapsulated elements was slightly higher than that measured for the standard elements. During the first seeding, the concentration of the MS2 virus in the feed was about 10^5 pfu/ml. The results of virus concentration in the permeate from all RO elements was less than 1 pfu/ml, practically below the detection limit. During the second seeding the concentration of MS2 virus in the feed was about 10^7 pfu/ml. The virus concentration in the filtrate was in the range of 5 to 35 pfu/ml. It is very likely that the lower virus rejection results during the first challenge are the result of lower concentration of the MS2 virus in the feed water. In other words, the June test did not have enough virus in the feed water to show detectable virus in the RO permeate.

4.6. ON LINE INTEGRITY DETERMINATION

4.6.1. INTEGRITY TEST OF UF MEMBRANE ELEMENTS

Commercially applied methods of testing the integrity of capillary membrane elements include particle counting, particle monitoring, air pressure hold test, bubble release test, turbidity measurement, and sonic test (18, 19, 20). All the above methods are feasible for monitoring membrane integrity in small systems consisting of a limited number of membrane elements. However, only the particle counting, particle monitoring and turbidity measurements are continuous monitoring methods. The other methods can be applied only when the block or membrane module is taken off line. Turbidity monitoring can be useful in detecting only large leaks.. In large capacity membrane treatment systems the particle counting and monitoring methods can only be effective if multiple sensors are applied. As described in a recent publication (19) the number of particle monitoring sensors per number of capillary modules depends on the sensitivity of apparatus and the concentration of particles in the feed water. Particle counters are relatively expensive and require a significant level of maintenance. Furthermore, after the existence of a leak in the UF/MF system has been established using either particle monitoring device, the module with compromised integrity has to be located in order to repair the broken fiber(s). Following the location of a leaking element, the leaking fiber(s) must be plugged or isolated. This can only be done off-line.

4.6.2. INTEGRITY TEST OF RO MEMBRANE ELEMENTS

The integrity of RO elements is determined by measuring salt passage, by a bubble test, or by a vacuum test. The salt passage determination is not very sensitive to small leaks. The other two tests are conducted on individual elements, and the elements must be outside the RO system. One of the objectives of this study was to test the advantage of the encapsulated configuration with respect to on-line determination of element integrity. As shown in the P&ID (Appendix C), the permeate tube of each encapsulated element is connected individually to the permeate manifold. The permeate tube also consists of a side port with a valve, which can be connected to the vacuum line required for the vacuum test. The encapsulated elements are assembled vertically in the pilot unit. To conduct a vacuum integrity test the feed pump is stopped and water from the element is drained by opening the dram valves on the feed and permeate lines. When draining is completed both drain valves are closed. The permeate side port is connected to a vacuum pump and the permeate side of the membrane is evacuated to a stable vacuum of about 20 inches of mercury. The valve on the vacuum line is then closed and the vacuum decline is measured. If the vacuum is higher than 15 inches of mercury after one minute, the element has good integrity. Only the encapsulated elements can undergo this in-situ vacuum test. The same vacuum test was conducted on both standard and encapsulated elements before installation in the system. The vacuum test results are listed in Table 5. All results indicate good membrane barrier integrity.

Table 5. Vacuum test results of standard and encapsulated elements

Date	Element S/N	Decline "Hg/min	Location	Element configuration
3/11/98	X01183	-1.20	At San Pasqual before install	Standard
	X01183	-1.40	At San Pasqual before install	Standard
	X01184	-0.60	At San Pasqual before install	Standard
	X01184	-0.20	At San Pasqual before install	Standard
	X01181	-[illegible]	At San Pasqual before install	Standard
	X01181	-0.30	At San Pasqual before install	Standard
3/12/98	x01 190	-0.25	At San Pasqual before install	Self encapsulated
	X01190	-0.30	At San Pasqual before install	Self encapsulated
	X01 187	-0.25	At San Pasqual before install	Self encapsulated
	X01 187	-0.20	At San Pasqual before install	Self encapsulated
	X01 185	-0.15	At San Pasqual before install	Self encapsulated
	X01 185	-0.10	At San Pasqual before install	Self encapsulated
4/28/98	XO1185	-0.59	In situ post 400hours operation	Self encapsulated
	XO1185	-0.59	In situ post 400hours operation	Self encapsulated
	XO1185	-0.15	In situ post 400hours operation	Self encapsulated
	X01185	-0.44	In situ post 400hours operation	Self encapsulated
	XO1 185	-0.59	In situ post 400hours operation	Self encapsulated
4/28/98	XO1190	-0.30	In situ post 400hours operation	Self encapsulated
	XO1190	-0.15	In situ post 400hours operation	Self encapsulated
	XO1190	-0.15	In situ post 400hours operation	Self encapsulated
	XO1190	-0.06	In situ post 400hours operation	Self encapsulated
	XO1190	-0.06	In situ post 400hours operation	Self encapsulated
4/28/98	XO1 187	-2.66	In situ post 400hours operation	Self encapsulated
	XO1 187	-0.59	In situ post 400hours operation	Self encapsulated
	XO1 187	-0.30	In situ post 400ours operation	Self encapsulated
	XO1187	-0.15	In situ posr 400hours operation	Self encapsulated
	XO1 187	-0.15	In situ post 400hours operation	Self encapsulated
6/10/98	XO1185	-0.30	Pre MS2 challenge-l 900 hours	Self encapsulated
	XO1185	-0.15	Pre MS2 challenae-1900 hours	Self encapsulated
	XO1190	-0.89	Pre MS2 challenge-l 900 hours	Self encapsulated
	XO1190	-0.59	Pre MS2 challenge-l 900 hours	Self encapsulated
	XO1190	-0.30	Pre MS2 challenge-1900 hours	Self encapsulated
	XO1190	-0.30	Pre MS2 challenge-1900 hours	Self encapsulated
	XO1187	0.00	Pre MS2 challenge-1900 hours	Self encapsulated
	XO1187	0.00	Pre MS2 challenge-1900 hours	Self encapsulated

5. RO MEMBRANE CLEANING STUDY

The specific flux results included in Fig. 17 and 24 indicate some degree of permeability decline during field operation. After the completion of the field operation the LFC1 elements were returned to Hydranautics and tested at nominal test conditions. The test results confirmed that the encapsulated and standard configuration elements lost, an average of 10% and 20% of the initial flux respectively. The salt rejection results were about the same as the initial values. After the test, the lead elements from each group were put aside for autopsy including flat cell membrane testing and membrane surface analysis. The remaining two elements from each group were cleaned by applying 0.25% NaOH solution. After cleaning the elements were tested again. The test results are summarized in Table 6. High pH cleaning completely restored the flux to the initial values. However, the salt rejection was reduced to some extend. For the encapsulated elements the salt rejection was reduced from 99.5% to 99.4%, and the standard element salt rejection was reduced from 99.6% to 99.2% as a result of cleaning.

Table 6. Performance change and cleaning results of the LFC1 membranes, San Pasqual (April - November 1998).

Position during test operation	Ex-Factory		After Operation		After Cleaning	
	Rejection %	Flux, gpd	Rejection %	Flux, gpd	Rejection %	Flux, gpd
&capsulated Element Configuration						
Lead	99.5	1629	99.6	1.512	Not cleaned	Not cleaned
Middle	99.5	1629	99.6	1466	99.4	1788
Tail	99.5	1684	99.6	1499	99.4	1788
Average	99.5	1647	99.6	1492	99.4	1788
Change %			+20	-9.4	-20	+8.5
Standard Element Configuration						
Lead	99.6	1908	99.5	1629	Not cleaned	Not cleaned
Middle	99.6	1908	99.6	1596	99.2	2317
Tail	99.6	2082	99.6	1578	99.2	1708
Average	99.6	1966	99.6	1601	99.2	2012
Change, %			0.0	-18.5	-100	+2.3

6. RO MEMBRANES AUTOPSY RESULTS

After cleaning, the tail elements, one from each group, were dye tested. After the dye test all elements were autopsied. The dye test consists of the operation of element at normal feed pressure with feed water containing dye (methyl violet). The objective of applying the dye test is to determine the presence of surface defects or leaks. After unrolling of dyed elements some minor surface defects were observed. No major leaks were found. On the membrane surface from ail elements a small amount of fouling deposit was found. No blockage of feed channels was observed. The report of autopsy results is included in Appendix F.

7. BACTERIOLOGICAL TESTS

Samples from the membrane surfaces were analyzed for the presence of bacteria. The feed water to the RO elements was treated with capillary UF membranes and a concentration of chloramines in the range of 1 – 7 ppm was maintained. The capillary membrane barrier prevented the majority of the bacteria from reaching the membrane elements and the presence of chloramines should have controled bacterial growth. Results of the tests indicated that some bacteria were present in the membrane elements. However, the presence of chloramines prevented growth, that would have affected element performance. No significant increase of pressure drop was observed. Results of the microbiological tests are included in Appendix G.

8. FLAT CELL RESULTS

After element autopsy, the membrane coupons were tested in flat cell apparatus. The results are summarized in Table 7. Table 7 also includes the element performance test results conducted before the autopsy. For comparison purposes, flat cell results of new LFC1 membrane are also included. Each result represents an average of six membrane samples. There is general agreement between element data and flat cell results. Some discrepancy can be expected due to membrane variability and the large difference of membrane area between the flat cells and elements. A listing of all flat cell results is included in Appendix H.

Table **7. Flat cell results**

Element	Element results after field operation		Flat cell results	
	Flux, gfd	Rej., %	Flux, gfd	Rej., %
New membrane			22.9	98.9
X0181 1	21.7	99.5	21.6	99.3
x01 184 *	30.9	99.2	30.9	99.4
X01183'	22.7	99.2	26.5	99.2
X01 185	21.2	99.6	24.5	99.3
x01190*	23.8	99.4	28.9	99.0
X01187 *	23.5	99.4	24.5	99.6

* Element has been cleaned before autopsy

9. SEM AND EDX TESTS

Samples of used membrane were examined using Scanning Electron Microscopy (SEM). The composition of the foulant layer was determined using X-ray Electron Diffraction (EDX). The results are included in Appendix I. The SEM pictures clearly indicate that the membrane surface contains bacteria and other fouling deposits. The EDX spectra enables a determination of the composition of fouling layer. The summary of EDX analysis for each element is included in Tables 8 through 13. For comparison each table includes the EDX spectra of a clean LFC1 membrane. The X-ray beam penetrates through the surface and reaches into the polysufone support layer of the membrane. The spectrum of a clean membrane sample shows the presence of carbon (about 63%), oxygen (about 16%) and sulfur (about 12%). The gold peak originates from the gold coating applied during sample preparation. Some of the spectra of membrane surfaces covered with a light deposit are similar to the spectra of the clean membrane (C, 0, S) but also include a small concentration of iron, silica and phosphorous. Some samples show the presence of chromium, origin of which is not clear at this time. The true composition of the foulant layer is determined by scraping the foulant from the membrane surface and analyzing it separately. These spectra (Table 8, scan #1), show the presence of organics and a high concentration of iron. The iron deposit originates most likely from the iron-based flocculant, FeC13, which is used in the tertiary treatment step of the feed water. The four membrane elements (SN # 01190, 01187, 01184, 01183) were cleaned only with a high pH solution of NaOH. The application of high pH cleaning solution is not effective in dissolving and removing iron deposits. It is important to note that the high pH cleaning restored the membrane flux completely despite the presence of foulant deposit clearly visible in the SEM pictures. It is possible that the cleaning operation increased the permeability of the fouling layer by removing organic material, which binds together colloidal particles.

Table 8. Concentration of constituents on membrane surface, element 01185.

Constituent of surface layer	Scan #1, foulant only	Scan #2, middle section	Scan #3, feed side	Control, clean LFC1 membr.
C	13.6	48.0	53.8	62.7
O	23.6	21.2	23.8	16.2
S	0.4	12.9	12.4	11.9
Fe	48.7	4.5	6.6	
Si	1.2	0.6	0.3	
P	1.7			
Cr	1.5	0.15	0.22	

Table 9. Concentration of constituents on membrane surface, element 01190.

Constituent of surface layer	Scan # 1, foulant only	Scan # 2, feed side	Scan # 3, middle section	Control, clean LFC1 membr.
C	18.3	49.6	50.9	62.7
0	27.2	21.9	21.5	16.2
S	1 .0	12.6	12.3	11.9
Fe	44.0	4.9	4.6	
Si	1	0.2	0.2	
P	0.6			

Table 10. Concentration of constituents on membrane surface, element 01187.

Constituent of surface layer	Scan #1, foulant only	Scan # 2, feed side	Scan #3, middle section	Control, clean LFC1 membr.
C	16.6	55.8	57.35	62.7
O	21.0	19.7	18.7	16.2
S		11.8	12.3	11.9
Fe	45.5	2.7	2.3	
Si	1.8	0.3	0.3	
P	0.8	0.1	0.22	

Table 11. Concentration of constituents on membrane surface, element 01181.

Constituent of surface layer	Scan # 1, heavy foulant layer	Scan #2, feed side	Scan # 3, concentrate side	Control, clean LFC1 membr.
C	66.4	62.5	62.7	62.7
O	23.8	15.2	15.49	16.2
S	3.5	11.86	11.8	11.9
Fe	0.35	0.25	0.25	
			0.12	

Table 12. Concentration of constituents on membrane surface, element 01184.

Constituent of surface layer	Scan #1, foulant only	Scan #2, feed side	Scan # 3, middle section	Control, clean LFC1 membr.
C	23.6	59.7	63.2	62.7
O	21.1	16.3	12.4	16.2
S	4.2	11.0	11.6	11.9
Fe	28.8	1.2		
Si	1.7	0.2	0.2	
P	1.1			

Table 13. Concentration of constituents on membrane surface, element 01183.

Constituent of -surface layer	Scan # 1, middle section	Scan #2, heavy foulant	Scan #3, heavy foulant	Control, clean LFC1 membr.
C	63.5	33.0	14.5	62.7
0	12.03	24.4	29.8	16.2
S	12.1	3.29	0.4	11.9
Fe		21.3	40.3	
Si		1.8	1.9	
P			0.6	
Cr		0.7	1.1	

10. SUMMARY AND CONCLUSIONS

The operation of the integrated membrane system (IMS), consisting of UF pretreatment followed by RO, confirmed that such a system configuration is very effective in providing stable performance in the reclamation of municipal effluents. The observed fouling rates of RO membranes were very low, in the range of 10 - 20%. Such fouling rates are significantly lower than those usually observed in other membrane systems operating in similar applications. In our opinion there are two reason for low fouling rates experienced during this study:

a) Use of membrane pretreatment reduces concentration of colloidal particles in the feed water. It is known (17) that the presence of colloidal particles in combination with high concentrations of organic matter forms ian impermeable layer on the membrane surface.

b) Another factor in reducing RO membrane water permeability is the adsorption of organics on the membrane surface (17). The LFC 1 membrane used in this study has a modified membrane surface, making it more hydrophilic than the conventional composite polyamide membrane material. The hydrophilic nature of the membrane potentially reduces the affinity and adsorption of hydrophobic organic material present in feed water. Furthermore, the bonds between deposited organics are not. very strong. The cleaning results demonstrate that the deposited organics are easily removed by the cleaning procedure.

The results of this work show that the encapsulated RO membrane elements can be configured into systems that operate similar to those designed around standard RO membranes. For applications where the barrier integrity is critical, the encapsulated elements offer some distinct advantages. The major advantage is the ability to perform an in-situ integrity test. Furthermore, the virus challenge results show slightly higher virus retention for encapsulated elements. Due to the small number of elements tested however, it is difficult to assess how meaningful these results actually are.

The instrumental analysis results (SEM and EDX) give some insight into the operation of IMS on municipal effluent. The important observations are:

a) The presence of chloramine enables control of biological activity and effectively prevents biofouling.

b) In this environment, (presence of chloramines in municipal effluent feed) the composite polyamide LFC1 membrane is sufficiently stable with respect to salt rejection.

c) In spite of UF membrane pretreatment, foulants did accumulate on the membrane surface. The EDX spectra enable foulant identification as being composed mainly of organic material, iron (probably mixed hydroxide form) and silica. The iron probably originates from iron salt flocculation in the tertiary treatment step. Silica could be introduced to the feed water from a fine dust deposit. There is also indication of presence of chromium of unknown origin.

During the latter period of the tests the LFC1 membrane elements operated at relatively high flux rates, without a noticeable increase of the fouling rate. If such high fouling rates could be sustained in long term operation they would have a significant impact on RO system costs for wastewater reclamation. It is prudent for further testing to confirm the feasibility of such a system design.

11. ACKNOWLEDGEMENTS

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SPECIAL ESPA ELEMENT WET TEST DATA SHEET

Dale: 2-19-98

Operator: MIKE

Element Type: 4040-UHT-LFCI

RO / DI H2O Cond.: 0.74 u mhos   pH: 4.93

(See Codes) TEST CATEGORY: SPECIALS P

TEST CATEGORY CEODES: See PD TB 1020

TEST CONDITIONS: See PD TB 1020

Serial Number	Ves #	RUN #	pH	FEED Temp.	FEED Cond.	BRINE Cond.	BRINE GPM	PRODUCT Cond.	PRODUCT GPM	D P	FEED NaCl	BRINE NaCl	FB % NaCl	PRODUCT NaCl	% REJ	GPD	Stat *
X01179	1/1	1	7.0	19.0	2840	3370	9	20	1.1	14	1477.4	1615.2	1546.3	9.20	99.4	1,908	
X01180	1/2	1	7.0	19.0	2840	3370	9	17	1.1	14	1615.2	1753.1	1684.1	7.82	99.5	1,908	
X01181	2/1	1	7.0	19.0	2840	3490	9	14	1.1	13	1477.4	1646.4	1561.9	6.44	99.6	1,908	
X01182	2/2	1	7.0	19.0	2840	3490	9	18	1.1	13	1646.4	1815.5	1731.0	8.28	99.5	1,908	
X01183	3/1	1	7.0	19.0	2840	3500	9	13	1.2	13	1477.4	1649.0	1563.2	5.98	99.6	2,082	
X01184	3/2	1	7.0	19.0	2840	3500	9	15	1.1	13	1649.0	1820.7	1734.9	6.90	99.6	1,908	
	4/1	1	7.0	19.0	2840					-	1477.4	#######	######	#######	######	######	
	4/2	1	7.0	19.0	2840					-	#######	#######	######	#######	######	######	
	1/1									-	#######	#######	######	#######	######	######	
	1/2									-	#######	#######	######	#######	######	######	
	2/1									-	#######	#######	######	#######	######	######	
	2/2									-	#######	#######	######	#######	######	######	
	3/1									-	#######	#######	######	#######	######	######	
	3/2									-	#######	#######	######	#######	######	######	
	4/1									-	#######	#######	######	#######	######	######	
	4/2									-	#######	#######	######	#######	######	######	

HOW MANY PASSED:			
	AVERAGE		
	AVERAGE ALL	######	######

Status Codes: See PD TB 1020

PR FM 8500-A Rev.F

ESPA ELEMEN' WET .EST DATA SHEET

Dale ↓	Operalor ↓	(See Codes+) TEST CATEGORY:	TEST CATEGORY CODES	TEST CONDITIONS
3/2/98	S. ALT		See PD TB 1020.	See PD TB 1020.

Element Type: LFC1 FREE

RO / DI H_2O Cond.: 12.7 μ mhos   pH: 7.

Serial Number	Ves #	RUN #	pH	FEED Temp.	FEED Cond.	BRINE Cond.	BRINE GPM	PRODUCT Cond.	PRODUCT GPM	A P	FEED NaCl	BRINE NaCl	FB % NaCl	PROD NaCl	% REJ	GPD	Stat
X01190	1/1	/	6.51	20.8	2850	3160	9.0	16.0	1.0	/	1610	1785	1698	8	99.5	1629	✓
X01185	1/2	↓	↓	21.8	2840	3240	8.0	17.1	1.0	↓	1572	1778	1675	8.3	99.5	1629	✓
X01187	2/1	↓	↓	23.0	2840	3200	8.7	18.0	1.1		1541	1736	1639	8.6	99.5	1684	✓
X01188	2/2	↓	↓	23.2	2850	3240	8.4	19.6	1.1	↓	1546	1758	1652	9.4	99.4	1684	
X01189	3/1	↓	↓	23.8	2840	3160	8.6	20.5	0.9		1509	1679	1594	9.6	99.4	1337	
X01186	3/2	↓	↓	24.5	2840	3240	8.7	20.1	1.15	↓	1486	1703	1595	9.3	99.4	1681	
	4/1	↓	↓	↓	↓												
	4/2	↓	↓	↓	↓	↓	↓			↓	VACUUM TEST						
	1/1												INITIAL	FINAL	TIME		
	1/2	↓	↓	↓	↓	↓	↓			↓	TEST APPARATUS		-24.7	-24.2	5min		
	2/1	↓	↓	↓	↓						X01190		-21.4	-20.6	5min		
	2/2	↓	↓	↓	↓	↓	↓			↓	X01185		-21.0	-20.2	10min		
	3/1	↓	↓	↓	↓						X01187		-21.0	-20.4	5min		
	3/2	↓	↓	↓	↓	↓	↓			↓	X01188		[illegible]	-20.0	13min		
	4/1	↓	↓	↓	↓						X01189		-21.0	-20.1	[illegible]		
	4/2	↓	↓	↓	↓	↓	↓			↓	X01186		-21.7	-19.7	20min		

HOW MANY PASSED: AVERAGE →

* Status Codes: See PD TB 1020.

For8040 & 8540: Rear REJ % x 1.00053 **RearGPDy1.069**

HYDRAcap™ Membrane

Configuration	Capillary
Membrane Polymer	Hydrophilic polyether sulfone
MWCO	1 00,000- 150,000 Daltons
Nominal Membrane area	270 ft^2 (25 m^2)
Capillary ID/OD	0.031" (0.8mm)/0.047" (1.2mm)
Application Data:	
Typical filtrate flux range	36-75 gfd (60-130L/m^2•hr)
PH range	2-13
Chlorine tolerance	200 ppm
Peroxide tolerance	200 ppm
Operating mode	cross-flow or dead-end (direct flow), backwashable
Maximum operating temperature	104°F (40°C)
*Transmembrane pressure (TMP) range	4-22 psig (28-150 kPa
Typical Process Conditions	
Backwash pressure	35 psig (240 kPa)
Backwash flow	35 gpm (8m^3/hr)
Backwash frequency	10-30 minutes
Backwash duration	30-60 seconds
Disinfection frequency	1-4x/hour
Disinfection duration	-1 minute
Disinfection chemicals	NaOCl (hypochlorite) and H_2O_2 (peroxide)
Cleaning frequency	1-2/month
Cleaning chemical types:	Citric acid NaOH NaOH+EDTA

*TMP = (Feed P + Conc P)/2 -- Filtrate P

HYDRANAUTICS
High Performance Membrane Products
A NITTO DENKO CORPORATION

APPENDIX C

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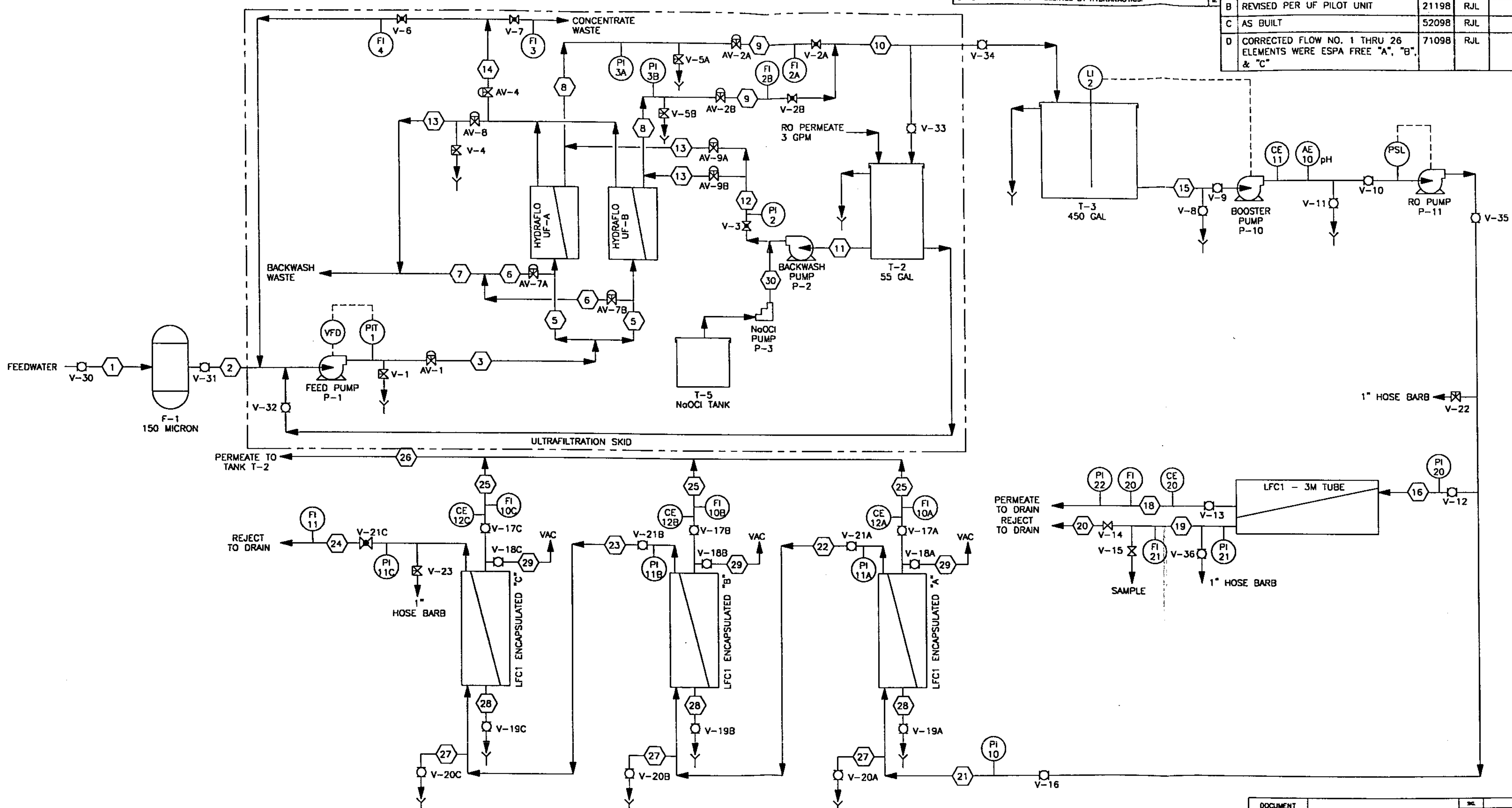
REVISIONS

LTR	DESCRIPTION	DATE	BY	APPROVED
A	Added FI-11,PI-11X	111997	Alt	
B	REVISED PER UF PILOT UNIT	21198	RJL	
C	AS BUILT	52098	RJL	
D	CORRECTED FLOW NO. 1 THRU 26 ELEMENTS WERE ESPA FREE "A", "B", & "C"	71098	RJL	



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
FLOW	gpm	14	14	14		7	25	25	7	7	14	25	25	25	0	10	4.9		1.9	3	3	4.9	4.3	3.7	3	0.6	1.8	0.1	0.1	1 SCFM	200 mL/min	0.3 mL/min
PRESSURE	psig	10	7	20		20	10	10	5-15	5-15	5-15	30	30	30	0	1	110		5	100	10	110	107	104	10	5	5	110	1	-0.8 ATM	30	30
PIPE SIZE	inches		1 1/2	1 1/4		1 1/4	1 1/4	1 1/4	1	1	1 1/2	1 1/4	1 1/4	1 1/4	1 1/4	2	3/4		1/2	3/4	3/4	3/4	3/4	3/4	3/4	1/2	3/4	1/4	1/2	1/4	3/8	3/8
MATERIAL			PVC			PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	SST		PVC	SST	PVC	SST	PVC	PVC	PVC	PVC	PVC	SST	PVC	PVC	PFA TUBING	PFA TUBING

DOCUMENT STATUS		SIG.	
		DATE	
DO NOT SCALE			
DRAWN RJL	DATE 11-13-97		
CHECKED			
APPROVED			
APPROVED			
5-20-98RJL			
WEIGHT	FILE ROSY401A		

HYDRANAUTICS
Oceanside, California U.S.A.

TITLE PIPING & INSTRUMENTATION

SAN PASCUAL PILOT UNIT

SIZE	DRAWING NO.	REV
D	ROSY-401	D
SCALE NONE	SHEET 1 OF 1	

OPERATION SEQUENCE OF CAPILLARY UF SYSTEM

Normal Operation-Direct Flow

Direct flow is synonymous with "dead-end" flow, i.e. all feed water is forced through the membrane and exits as filtrate. This is equivalent to having no concentrate stream flow, and thus maximizes the recovery of the system. During normal operation, the feed pump is ON and the backwash and metering pump are OFF. Automatic valves AV-1, AV-2A, and AV-2B are OPEN, while AV-4, AV-7A,B, AV-8 and AV-9A,B are CLOSED. Globe valves on the individual filtrate lines control the amount of filtrate flow.

Normal Operation-Crossflow

This mode is the similar to a standard reverse osmosis system in that a concentrate stream allows continuous removal of rejected matter. In crossflow, AV-1, AV-2A,B. and AV-4 are OPEN. The concentrate stream is sent directly to drain.

Backwash

Backwash is necessary to remove the particulate matter that accumulates on the membrane surface. Each element is backwashed individually, and the sequence is the same for each.. The backwash cycle is initiated and controlled by a timer in the PLC and consists of the following steps:

Fast Flush

Here the feed pump remains ON and ramps up to full capacity. All of the feed water is forced out the concentrate line in an effort to physically blow the particulate matter off the inner surface of the membranes. AV-1 and AV-8 are OPEN.

During the remainder of the backwash cycles, the feed pump is OFF and the backwash and metering pumps are ON. (The metering pump may only come on during selected cycles). The backwash pump produces -35gpm and runs at 25-35 psi depending upon the TMP.

Bottom Backwash

The backwash pump is initiated, and the feed pump shuts OFF. Backwash water is introduced into the filtrate side of the membranes and is removed out of the feed (bottom) end to drain. Valves AV-7A, and AV-QA, are OPEN. The chlorine feed pump is initiated and remains ON until the soak cycle.

Top 'Backwash

Similar to bottom backwash, but the water exits out the concentrate (top) line to drair. Valves AV-QA and AV-8 are OPEN.

Full Backwash

This is a combination *of* both top and bottom backwash. Backwash water *is* fed through the filtrate line and exits out both the concentrate and the feed lines to drain. This is the same as the final rinse cycle, only no chlorine is used in the final rinse.

Soak Cycle

Essentially, this is a pause where the chlorinated water has time to disinfect the membranes. All valves are CLOSED, and all pumps are OFF.

Flush

As previously mentioned, same as Full Backwash.

Table 1. UF pilot sequencing control

	Normal Operation			Backwash				
	Direct Flow	Crossflow	Fast Flush	Bottom	Top	Full	Soak	Flush
Feed Pump	On	On	On	Off	Off	Off	Off	Off
Backwash Pump	Off	Off	Off	On	On	On	Off	On
Chlorine Pump	Off	Off	Off	On	On	Off	Off	Off
AV-1	Open	Open	Open	Closed	Closed	Closed	Closed	Closed
AV-2A	Open	Open	Closed	Closed	Closed	Closed	Closed	Closed
AV-2B	Open	Open	Closed	Closed	Closed	Closed	Closed	Closed
AV-4	Closed	Open	Closed	Closed	Closed	Closed	Closed	Closed
AV-7A	Closed	Closed	Closed	Open	Closed	Open	Closed	Open
AV-7B	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
AV-8	Closed	Closed	Open	Closed	Open	Open	Closed	Open
AV-9A	Closed	Closed	Closed	Open	Open	Open	Closed	Open
AV-9B	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed

Note: All Valves are Normally Closed Except AV-1

Hydracap UF Cleaning Protocol:

Cleaning is necessary when the Trans Membrane Pressure (TMP) rises to ~15psi. The unit has been cleaned successfully by heating the following solutions to 38°C and recirculating them through the feed side of the membranes with the filtrate valves CLOSED for 1 hour each, followed by the filtrate valves partially OPEN for 15 minutes. This cleaning is done individually for each membrane, with a flow rate of 10gpm. The solutions are then backwashed to drain at the end of each cycle, followed by three backwashes with RO permeate water.

Solution I- 2% Citric Acid pH -2.2 Solution 2- 0.5% NaOH pH~12.0

Table 2- Hydracap UF Backwash conditions and Net water production

Operating Hours	100-300	425-850	900-2800	2800-2865	2900-3350	3350+
Step in Cycle (seconds)						
Normal	900	900	900	1500	1500	1500
Backwash						
Fast Flush	5	5	9	9	9	9
Bottom*	7	7	7	7	7	7
Top*	7	7	7	7	7	7
Top/Bottom*	12	10	12	12	12	12
Soak	17	15	15	15	15	15
Final Flush – Top/Bottom	12	16	10	10	10	10
Total	60	60	60	60	60	60
*Denotes Chlorine addition						
NaOCl Concentration (ppm)	~100	~100	~25	~25	~25	~25
BW Pump Flow (gpm)	35	35	35	35	35	35
Forward Flush Flow (gpm)	40	40	40	40	40	40
Chlorine frequency	1:1	1:1	1:1	1:1	1:1	1:1
Total cycle time (sec)	960	960	960	1560	1560	1560
% Time-production	93.8%	93.8%	93.8%	96.2%	96.2%	96.2%
% Time-FF to drain	0.5%	0.5%	0.9%	0.6%	0.6%	0.6%
% Time-BW to drain	4.0%	4.2%	3.8%	2.3%	2.3%	2.3%
% Time-Chlorine soak	1.8%	1.6%	1.6%	1.0%	1.0%	1.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

FLOWS						
Filtrate Flow Rate (gpm)	8	8	7	8	7	7
Concentrate Flow Rate (gpm)	0	1	0	0	0	0
Recovery	100%	89%	100%	100%	100%	100%
Production per cycle step (gallons)						
Filtrate flow	120.0	120.0	105.0	200.0	175.0	175.0
Concentrate Flow	0.0	-15.0	0.0	0.0	0.0	0.0
FF to Drain	-3.3	-3.3	-6.0	-6.0	-6.0	-6.0
BW to drain	-22.2	-23.3	-21.0	-21.0	-21.0	-21.0
Net:	94.5	78.3	78.0	173.0	148.0	148.0
% production -Conversion	79%	65%	74%	87%	85%	85%
Backwash source	RO Per	RO Per	RO Perm	RO Perm	RO Perm	UF Filt
pH 2.5 Backwash frequency	none	none	1/day	1/day	1/day	1/day

TECHNICAL MEMORANDUM

MONTGOMERY WATSON

To: Mark Wilf and Steve Ah **Date:** June 25, 1998
From: Samer Adham, Ph.D.
Prepared by: Lina Boulos **Client:** Hydranautics
Subject: Results of MS2 Challenge Experiments on UF and RO Sheets

INTRODUCTION

On June 6 1998, Montgomery Watson was retained to conduct MS2 virus challenge experiments on two UF membranes, mounted in parallel, three RO modules, mounted in series in a pressure vessel, and three non-contained RO modules, mounted in series. These membranes were operated by Hydranautics, as part of a project funded by the Bureau of Reclamation.

MATERIALS AND METHODS

Membranes

Figure 1 provides a schematic of the treatment train employed.

Two different UF membranes were evaluated in the study: UFA and UFB Both membranes are hollow fiber in configuration with 150,000 molecular weight cut-off (≈ 0.01 to 0.02 micron, pore size range).

Two RO systems were also challenged in the study. The first system consisted of three non-contained RO modules (ROFREE 1, 2, and 3). The second system consisted of a pressure vessel containing three RO elements.

Challenge Microorganism

MS2 bacterial virus was employed as the model virus for the microbial challenge studies. It is recommended by the EPA for such challenge experiments because it is similar in size (0.025 pm), shape (icosahedron) and nucleic acid (RNA) to polio virus and hepatitis. In addition, this virus is not a pathogen which minimizes the risk of infection to system operators and can be safely discharged into the waste stream after chlorination.

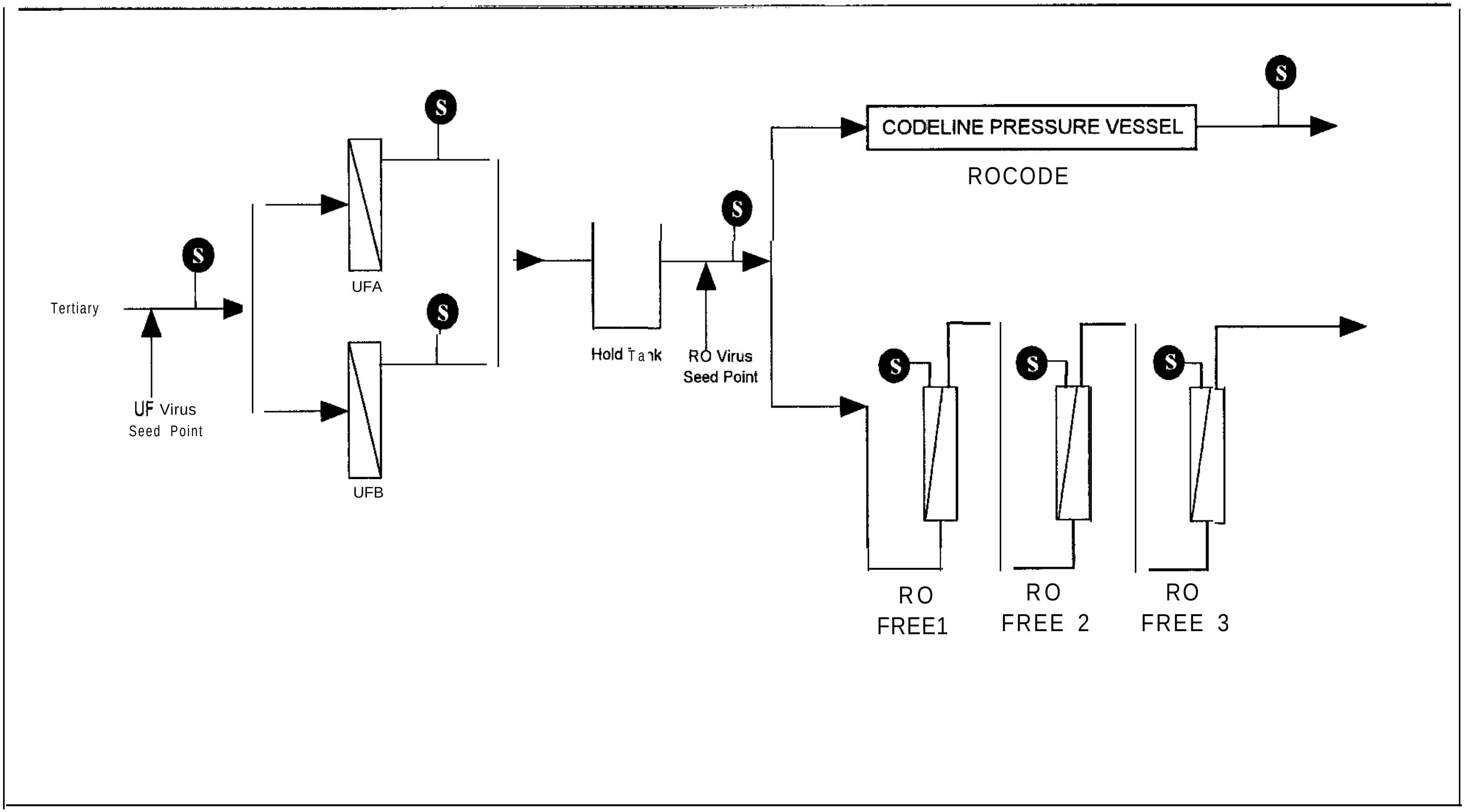


Figure 1: Schematic of Treatment Train

Seeding Protocol

Microbial challenge tests were conducted on each treatment process separately. This was done to allow better evaluation of the log removals achieved by each process. The challenge experiments were conducted in reverse order of the treatment train to avoid potential carry over contamination. Therefore, virus testing was conducted on the RO systems before the UF systems.

For the UF membranes experiments, the MS2 stock seeding solution was initially prepared in a seeding tank using a certain volume of UF permeate. The seed solution was then dosed continuously to the feed of each UF system to get a steady feed concentration. Since the membranes are backwashed every 15 minutes, three samples were collected from the feed line and three samples were collected from the permeate line (beginning, middle, and end of the filtration cycle), that is, after 0.5, 7.5 and 14.5 minutes. The MS2 feed-stock solution concentration was monitored at the start and end of the experiment. All samples were collected as grab samples and assayed by the Applied Research Department Laboratory within 24 hours from the time of sample collection.

For the RO seeding experiments, the MS2 phage seeding solution was initially prepared in a seeding tank using a certain volume of the UF permeate. Seeding experiments were conducted on all of the RO membrane systems connected to the UF units. In these experiments, the seed solution was dosed continuously to the RO influent line (MF or UF permeate) to get a steady concentration. A stabilization period of approximately 10 minutes was allowed, after which sample collection began. Three samples were collected from the RO feed line and three samples were collected from the permeate line of each of the RO systems (after 10, 15 and 20 minutes). The MS2 feed-stock was also monitored at the beginning and the end of the experiment to verify the consistency of the MS2 seed concentration. All samples were collected from each stream at matching time intervals, All samples were collected as grab samples and assayed by the Applied Research Laboratory within 24 hours from the time of sample collection.

Bacterial Virus Assay

MS2 samples were assayed by the agar overlay technique described by Adams' (1959) with some modifications. Host cultures of *E. coli* were grown on the day of the assay in TYE broth at 37°C under aerated conditions for 5 to 6 hours and dispensed in 20 mL aliquots in sterile dropper bottles. Just prior to use, 1.0 mL of 0.1 M sterile $CaCl_2$ solution was added to the dropper bottle. After the MS2 samples were serially diluted in 0.001 M phosphate-saline buffer (PBS), 0.1 mL was added to 2 mL of TYE soft agar, which was maintained at 46 to 48°C. Three to four drops of the host *E. coli* were added, and then the soft agar was mixed gently and poured on a TYE hard agar petri dish. After the soft agar solidified, the petri dishes were incubated at 37°C for 24 hours, after which the plaques, which are clearings in the bacterial lawn, were counted. All dilutions were plated in duplicate. Results were expressed in plaque forming units pfu/mL.

[1] M.H. Adams. Bacteriophages. Interscience Publishers, New-York, 1959

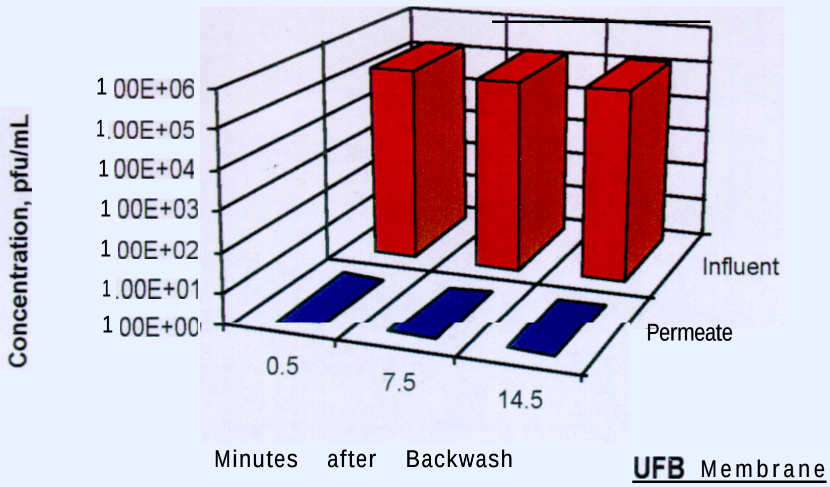


Figure 3 : Results of MS2 Virus Removal by UFB Membrane

Hydranautics RO Membranes

Table 2 summarizes the microbial seeding results from the RO membranes

Table 2: Virus Concentration in Influent and Effluent of the RO Membranes

	Concentration (pfu/mL)			
Minutes after Backwash	Influent	Permeate	Log Removal	Comments
10	3.20E+05	<1	> 5.5	ROCODE
15	1.70E+05	<1	> 5.2	ROCODE
20	2.95E+05	<1	> 5.5	ROCODE
10	3 20E+05	<1	> 5.5	ROFREE 1
15	1.70E+05	<1	> 5.2	ROFREE 1
20	2.95E+05	<1	> 5.5	ROFREE 1
10	3.20E+05	<1	> 5.5	ROFREE 2
15	1 70E+05	<1	> 5.2	ROFREE 2
20	2 95E+05	<1	> 5.5	ROFREE 2
10	3 20E+05	<1	> 5.5	ROFREE 3
15	1.70E+05	<1	> 5.2	ROFREE 3
20	2.95E+05	<1	> 5.5	ROFREE 3

The results are further plotted in Figure 4

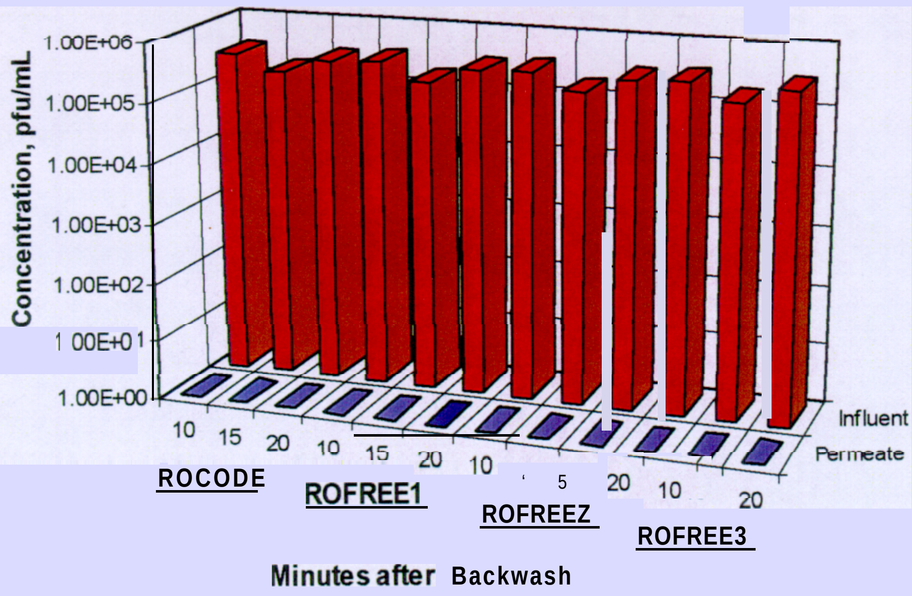


Figure 4: Results of MS2 Virus Removal by the RO Membranes

DISCUSSION AND RECOMMENDATIONS

Results from the UF seeding testing show that one membrane (UFB) achieved complete rejection of MS2 virus (UFB membrane was capable of removing 5.1 logs or more of MS2 virus). This is expected since the UF membrane pore size of 0.01 to 0.02 um is smaller than the MS2 virus size of 0.025 um. On the other hand, UFA membrane achieved only an average of 3.5 logs removal of virus after 7.5 minutes of seeding which demonstrates that some virus was able to pass through the membrane. While this result is surprising, it may be explained by the existence of some compromised fibers in the UFA module. This assumption was reaffirmed with higher particle counts (data not presented) measured in the permeate of the UFA membrane.

Results obtained from the RO seeding testing show that each of the three RO membranes was capable of completely removing the MS2 virus, with a calculated log removal greater than 5.2. This was confirmed by the non-detect results measured in the permeate of each of the 'free" RO modules, and in the permeate of the combined permeate of the three RO modules mounted in the pressure vessel. These results demonstrate that no leaks were present from the membrane nor from the o-ring fittings and glue lines.

TECHNICAL MEMORANDUM

MONTGOMERY WATSON

To:	**Mark Wii** and Steve Ah	**Date:**	October 23, 1998
From:	Samer Adham, Ph.D.		
Prepared by:	Lina Boulos	**Client:**	Hydranautics
Subject:	Results of MS2 Challenge Experiments on UF and RO Sheets		

INTRODUCTION

On October 16 1998, Montgomery Watson was retained to conduct MS2 virus challenge experiments on two UF membranes, mounted in parallel, three RO modules, mounted in series in a pressure vessel, and three non-contained RO modules, mounted in series. These membranes were operated by Hydranautics, as part of a project funded by the Bureau of Reclamation.

MATERIALS AND METHODS

Membranes

Figure 1 provides a schematic of the treatment train employed.

Two different UF membranes were evaluated in the study: UFA and UFB. Both membranes are hollow fiber in configuration with 150,000 molecular weight cut-off (≈ 0.01 to 0.02 micron pore size range).

Two RO systems were also challenged in the study. The first system consisted of three non-contained RO modules (RO-FREE 1, 2, and 3). The second system consisted of a pressure vessel containing three RO elements.

Challenge Microorganism

MS2 bacterial virus was employed as the model virus for the microbial challenge studies. It is recommended by the EPA for such challenge experiments because it is similar in size (0.0’25 pm), shape (icosahedron) and nucleic acid (RNA) to polio virus and hepatitis. In addition, this virus is not a pathogen which minimizes the risk of infection to system operators and can be safely discharged into the waste stream after chlorination.

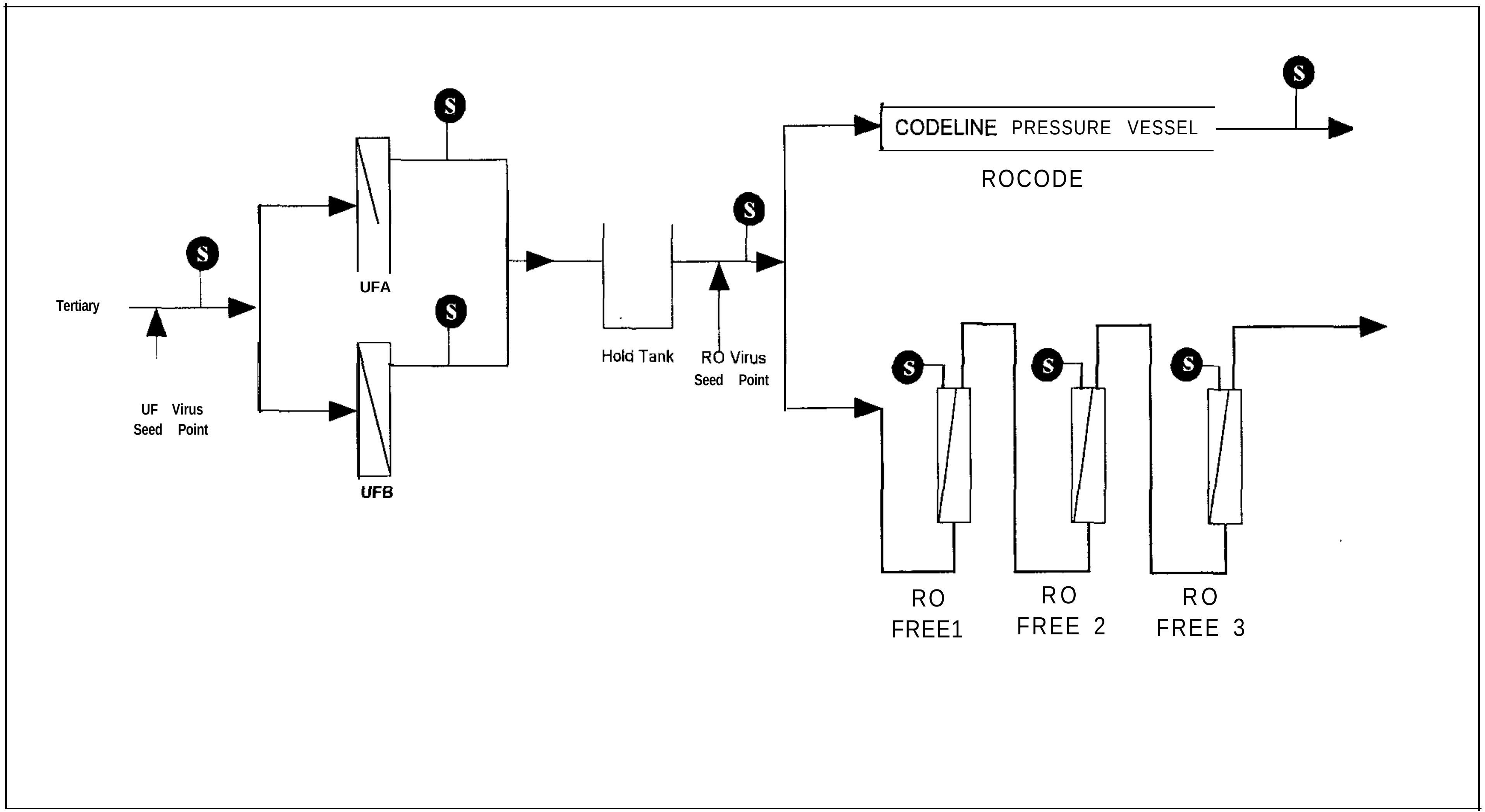


Figure 1: Schematic of Treatment Train

Seeding Protocol

Microbial challenge tests were conducted on each treatment process separately. This was done to allow better evaluation of the log removals achieved by each process. The challenge experiments were conducted in reverse order of the treatment train to avoid potential carry over contamination. Therefore, virus testing was conducted on the RO systems before the UF systems.

For the UF membranes experiments, the MS2 stock seeding solution was initially prepared in a seeding tank using a certain volume of UF permeate. The seed solution was then dosed continuously to the feed of each UF system to get a steady feed concentration. A stabilization period of approximately 15 minutes was allowed, after which sample collection began. Since the membranes are backwashed every 25 minutes, three samples were collected from the feed line and three samples were collected from the permeate line (beginning, middle, and end of the filtration cycle), that is, after 1.0, 13 and 24 minutes. The MS2 feed-stock solution concentration was monitored at the start and end of the experiment. All samples were collected as grab samples and assayed by the Applied Research Department Laboratory within 24 hours from the time of sample collection.

For the RO seeding experiments, the MS2 phage seeding solution was initially prepared in a seeding tank using a certain volume of the UF permeate. Seeding experiments were conducted on all of the RO membrane systems connected to the UF units. In these experiments, the seed solution was dosed continuously to the RO influent line (MF or UF permeate) to get a steady concentration. A stabilization period of approximately 15 minutes was allowed, after which sample collection began. Three samples were collected from the RO feed line and three samples were collected from the permeate line of each of the RO systems (after 5, 10 and 15 minutes). The MS2 feed-stock was also monitored at the beginning and the end of the experiment to verify the consistency of the MS2 seed concentration. All samples were collected from each stream at matching time intervals. All samples were collected as grab samples and assayed by the Applied Research Laboratory within 24 hours from the time of sample collection.

Bacterial Virus Assay

MS2 samples were assayed by the agar overlay technique described by Adams' (1959) with some modifications. Host cultures of *E. coli* were grown on the day of the assay in TYE broth at 37°C under aerated conditions for 5 to 6 hours and dispensed in 20 mL aliquots in sterile dropper bottles. Just prior to use, 1.0 mL of 0.1 M sterile $CaCl_2$ solution was added to the dropper bottle. After the MS2 samples were serially diluted in 0.001 M phosphate-saline buffer (PBS), 0.1 mL was added to 2 mL of TYE soft agar, which was maintained at 46 to 48°C. Three to four drops of the host *E. coli* were added, and then the soft agar was mixed gently and poured on a TYE hard agar petri dish. After the soft agar solidified, the petri dishes were incubated at 37°C for 24 hours, after which the plaques, which are clearings in the bacterial lawn, were counted. All dilutions were plated in duplicate. Results were expressed in plaque forming units pfu/mL.

M.H. Adams. Bacteriophages. Interscience Publishers, New-York, 1959

RESULTS

Hydranautics UFA and UFB Membranes

Table I summarizes the microbial seeding results from the UF membranes.

Table 1: Virus Concentration in Influent and Effluent of UFA and UFB Membranes

	Concentration (pfu/mL)			
Minutes after Backwash	Influent	Permeate	Log Removal	Comments
I	I.46E+06	1.90E+0I	4.88	UFA
13	I.90E+06	0.50E+00	6.58	UFA
24	1.79E+06	<I	>6.25	UFA
I	I.46E+06	1.50E+00	5.99	UFB
13	1.90E+06	I.50E+00	6.10	UFB
24	I.79E+06	0.50E+00	6.55	UFB

The results are further plotted in Figure 2.

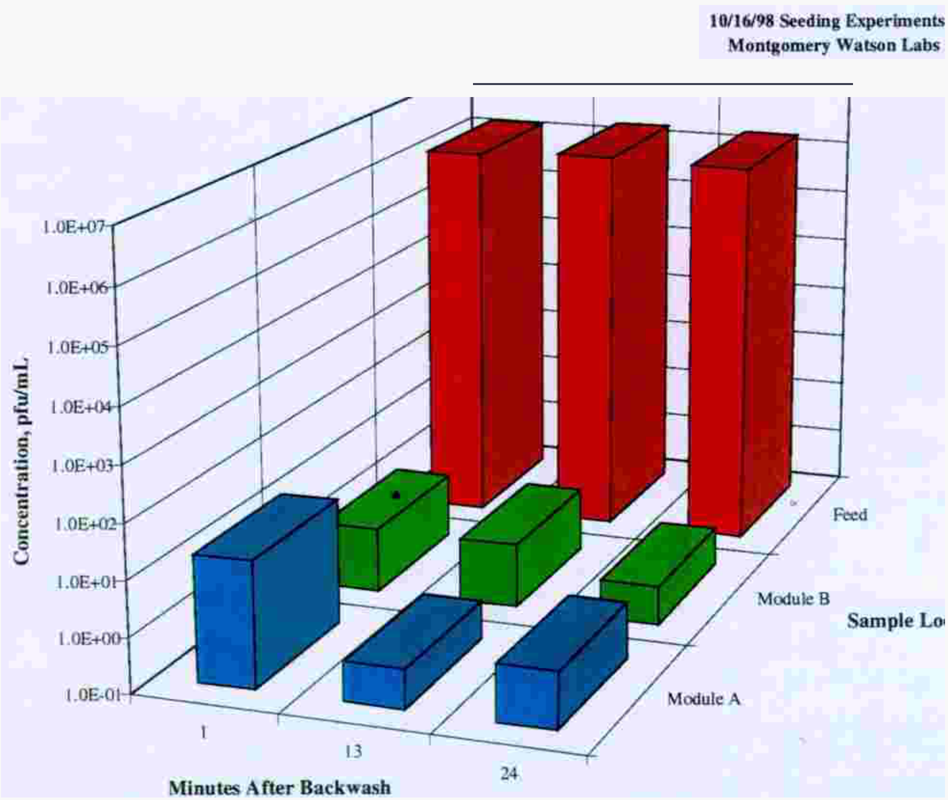


Figure 2: Results of MS2 Virus Removal by UFA and UFB Membranes

RESULTS

Hydranautics UFA and UFB Membranes

Table I summarizes the microbial seeding results from the UF membranes.

Table 1: Virus Concentration in Influent and Effluent of UFA and UFB Membranes

	Concentration (pfu/mL)			
Minutes after Backwash	Influent	Permeate	Log Removal	Comments
l	I.46E+06	1.90E+01	4.88	UFA
13	I.90E+06	0.50E+00	6.58	UFA
24	I.79E+06	<I	>6.25	UFA
l	I.46E+06	1.50E+00	5.99	UFB
13	1.90E+06	1.50E+00	6.10	UFB
24	1.79E+06	0.50E+00	6.55	UFB

The results are further plotted in Figure 2.

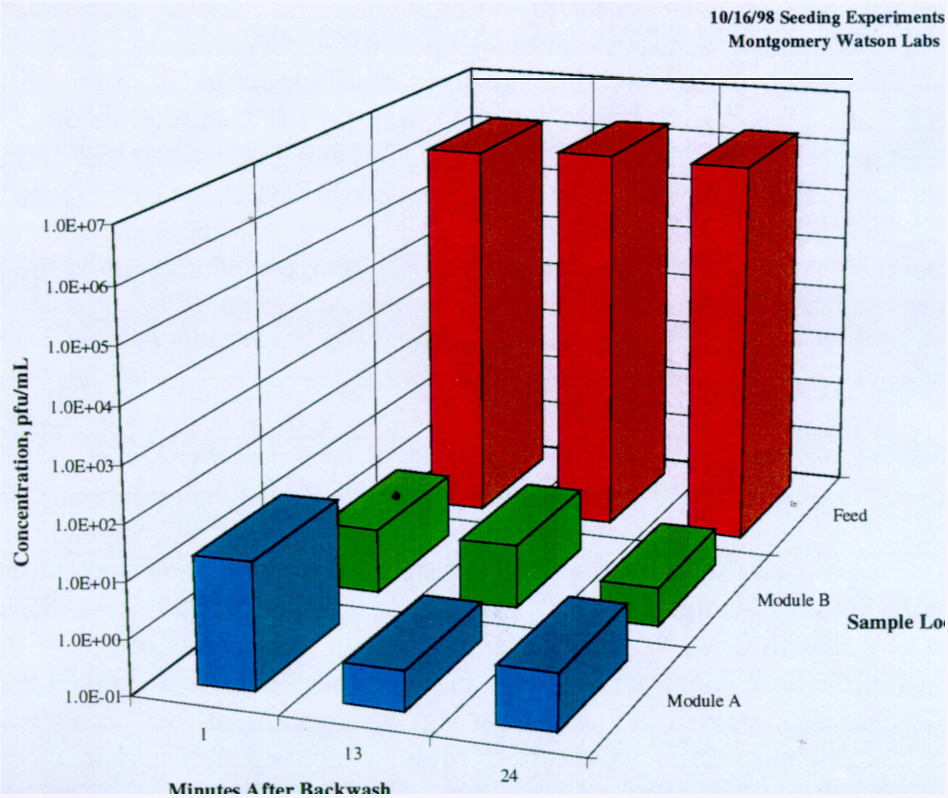


Figure 2: Results of MS2 Virus Removal by UFA and UFB Membranes

Hydranautics RO Membranes

Table 2 summarizes the microbial seeding results from the RO membranes.

Table 2: Virus Concentration in Influent and Effluent of the RO Membranes

	Concentration (pfu/mL)			
Minutes after Backwash	Influent	Permeate	Log Removal	Comments
5	1.51E+07	5.50E+00	6.44	RO-Vessel
10	1.38E+07	1.80E+01	5.88	RO-Vessel
15	1.45E+07	3.45E+01	5.62	RO-Vessel
5	1.51E+07	4.50E+00	6.52	ROFREE 1
10	1.38E+07	1.25E+01	6.04	ROFREE 1
15	1.45E+07	1.55E+01	5.97	ROFREE 1
5	1.51E+07	5.00E+00	6.48	ROFREE 2
10	1.38E+07	1.15E+01	6.08	ROFREE 2
15	1.45E+07	3.00E+00	6.68	ROFREE 2
5	1.51E+07	1.00E+01	6.18	ROFREE 3
10	1.38E+07	9.00E+00	6.18	ROFREE 3
15	1.45E+07	1.20E+01	6.08	ROFREE 3

The results are further plotted in Figure 3.

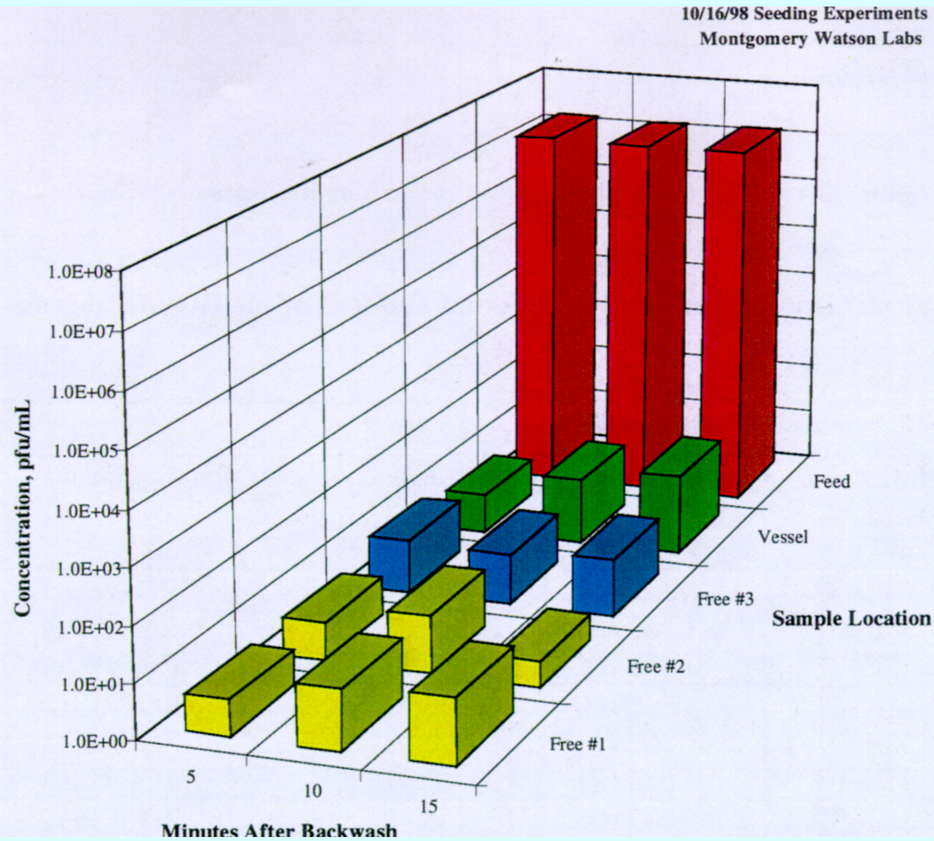


Figure 3: Results of MS2 Virus Removal by the RO Membranes

CONCLUSIONS

Results from the UF seeding testing show that the UF membranes were very effective in removing MS2 virus (4.9 to 6.6 log removal). These results are expected from UF membranes. Some virus was recovered in the permeate which may be due to the pore size distribution of the membrane, which may include few pores that are larger than virus size of 0.025 µm.

Results obtained from the RO seeding testing show significant removal of virus by all RO membranes (5.9 to 6.7 log removal). It appears that the RO Free membranes achieved slightly higher removal of virus as compared to the pressure vessel elements.

BUREC Autopsy Findings
Jan. 22, 1999

LFC1 -FREE's

Serial # X01 185 - Lead element - this element was not cleaned and not dyed

After deshelling the element, it was noticed that a green algae-like growth was present on one side of the unrolled element. It appears that the fiberglass shell is translucent enough to allow sunlight through, and that the side that was exposed to the sun had these algae present. A heavy orange foulant completely covered the membrane surfaces. This foulant was easily wiped away with a wet paper towel. After drying though, this foulant was very hard to remove. The glue lines were very large, which should be expected due to the fact that these elements were manufactured with double glue lines.

The approximate square footage of this element was 73 ft^2. There were some glue drops present on the membrane surface which caused the membrane to delaminate upon unrolling the element. Several creases were found on the element, all of them running parallel to the core tube. There was a thin spattering of glue on one side of the tricot on one of the leaves.

Serial # X01 190 - Middle element - this element was cleaned and not dyed

A heavy orange foulant was covering the membrane surface. This foulant was easily wiped off with DI water and a wet paper towel, but once again was hard to remove after it had dried. One leaf was again found to have glue between the tricot and the back side of the substrate.

Serial # X01 187 - Tail element - this element was cleaned and was dyed

This element was covered with a heavy foulant that had been dyed purple by the dye test. Several creases were observed, some were small and others were larger. A very small amount of dye appeared to penetrate at some of the larger crease points. It was noticed that there was blistering on the side seal glue lines at the brine end of the element, but there was no indication of this blistering on the feed end side seal. In addition, the end seal had more blisters on the brine side with a gradual lessening of blisters toward the feed side. Heavy glue was observed on the back side of the tricot on one leaf.

4040-UHT- LFC1's

Serial # X01 181 - Lead element - this element was not cleaned and not dyed

This element had a light foulant covering the membrane surface. This foulant was easily rinsed away with DI water. One leaf had glue between the tricot and the back of the membrane. All glue lines appeared strong and intact.

Serial # X01 184 - Middle element - this element was cleaned and not dyed

A light foulant was observed in patches on the feed end of the element, but the rest of the membrane appeared very clean. Glue was found between the tricot and the back side of the membrane on one leaf. No creases found on this element. No unusual blistering found.

Serial # X01 183 - Tail element - this element was cleaned and was dyed

Blisters on the brine end side seals were noticed, but there were no blisters on the feed end side seals. The end seals had blisters, but the blisters lessened from the brine end toward the feed end. There were splotches of orange colored foulant present on the brine end of each leaf (see Fig.1). The spacing of these splotches indicate that they might be caused by the element sitting in a solution. These splotches were rinsed off relatively easily with DI water. It appeared that some of this orange colored foulant had passed into the permeate channel of one leaf, but this was determined to just be the same glue that was present in the permeate channels of one leaf in all the elements.

There were several creases present on the convex side of several of the leaves. There was an indication of very slight dye passage at these creases. All glue lines were very strong and intact. One leaf had lots of glue drops present on the membrane surface. This caused the membrane to delaminate as the element was unrolled. The measured membrane area was 76.7 square feet.

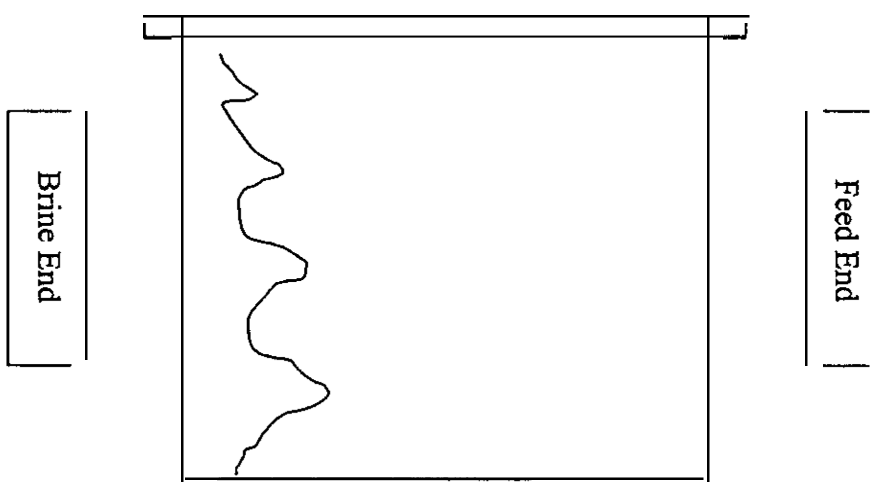


Fig. 1

Summary

After a discussion with the production manager, it was determined that the most likely cause for the glue deposit found between the tricot and the back side of one membrane leaf in each element is that each packet was placed on a table that had not been cleaned of residual glue. This would explain why it was only on one leaf per element, and why it was between the tricot and the back side of the membrane.

Another finding is that it appears that the cleanings performed on the LFC1-FREE modules were not as effective as the cleanings performed on the 4040-UHT-LFC1 elements. This could be partly due to the fact that the inlet piping size for 4040-UHT-LFC1 vessel is 3/4" NPT while the inlet port on the LFC1-FREE module is only 1/2". This could mean that we had higher flow velocities for the 4040-UHT-LFC1 cleanings.

Creases that were found on the different elements were primarily on the convex: side. The blistering that was observed on the elements was most pronounced at the brine end of both tail elements.

The membrane area averaged about 76 square feet due to the fact that these elements were manufactured with double glue lines to prevent the chance of failure.

HYDRANAUTICS
High Performance Membrane Products
A NITTO DENKO CORPORATION

APPENDIX G

February 10, 1999

MEMORANDUM

TO : Mark Wilf

CC : K. Matsumoto. J. Tomaschke

FROM : Chris Gioe

SUBJECT : **BuRec Microbiological Studies**

Six different membrane samples in plastic bags were received on 1/21 and 1/22/99 from Keith Andes. Cultures were taken on each sample and colony counts were performed on the water in each plastic bag.

RODAC™ contact plates were pressed directly onto the surface of each membrane, in several different areas, and Easicult TTC were dipped into the residual water. The Easicult TTCs and the RODAC plates were incubated and checked macroscopically at 24 hours and 48 hours. The organisms on the plates were gram-stained and plated to the appropriate medias, and identification studies were done on each organism isolated. The Easicult colony counts were recorded. Both RODAC plates and Easicult TTCs were held at room temperature for seven days for the possible growth of fungus and/or molds.

The following is a summary of bacteria identified and colony counts

Sample #	Colony Count	RODAC™ Plates
X01181	10^5 organisms/ml.	Heavy growth of: • Psuedomonas cepacia . Alcaligenes denitrificans
X01183	10^2 organisms/ml.	Light growth of: • Pseudomonas putida • Staphylococcus sp. x2
X01184	10^4 organisms/ml.	Light to moderate growth of: • Bacillus sp. • Pseudomonas aeruginosa (classic) . Pseudomonas aeruginosa (mucoid) • Moraxella sp.
X01185	10^5 organisms/ml.	Heavy growth of: • Moraxella sp. • Flavobacterium odoratum
X01187	10^3 organisms/ml.	Light to moderate growth of: • Pseudomonas aeruginosa • Pseudomonas sp.
X01190	10^5 organisms/ml.	Heavy growth of: • Bacillus sp. • Moraxella sp.

10^2 - 1 0^3 = light growth
10^4 = light to moderate growth
10^5 = moderate growth

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE.: 2/1/99

RE: Flat Cell Test Results of HYD-LFC-I-981201-A-VIRGIN-MEMBRANE.

Purpose: To verify membrane performance prior to rolling elements .

Membrane source:Element from customer;part of BUREC grant study (via K. Andes).

Start test (at 150 PSIG). After reading, increase pressure to 225 PSIG and read again.

Flat Cell Test Conditions: 0.15 % NaCl, 150 and 225 psig, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 5 6 cut a cross in the sample).

RESULTS:

(Virgin Memb-LFC-1) 1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	25.2	98.7
2	24.8	98.9
3	22.8	99.0
4	22.0	98.9
5	21.2	99.0
6	21.2	98.8
Avg	22.9	98.9
StD	1.8	0.1

(Virgin Memb-LFC-1) 1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Rej
1	44.2	99.0
2	41.9	99.2
3	37.9	99.3
4	35.1	99.3
5	34.8	99.2
6	34.2	99.1
Avg	38.0	99.2
StD	4.2	0.1

cc: K. Andes, M. Wilf

tt..LFC-I-VIRGIN-MEMBRANE-R # 981201-A\test\990121.wq1 printed/2/1/99

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE: 1/29/99

RE: Flat Cell Test Results of HYD-4040-UHT-LFC-1 -Element # X01 1 81.

Purpose: To verify membrane performance of elements dissected.

Membrane source:Element from customer,part of BUREC grant study (via K. Andes).

Start test (at 150 PSIG). After reading, increase pressure to 225 PSIG and read again.

Flat Cell Test Conditions: 0.15 % NaCl, 150 and 225 psig, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 5 6 cut a cross in the sample).

RESULTS:

(X01 181 -LFC-1) 1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	21 .o	99.4
2	23.7	99.4
3	21.8	99.1
4	20.2	99.6
5	23.3	99.3
6	19.7	99.1
Avg	21.6	99.3
StD	1.6	0.2

(X01 181 -LFC-1) 1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Rej
1	33.4	99.5
2	36.8	99.5
3	34.5	99.3
4	33.4	99.6
5	37.3	99.4
6	31.7	99.3
Avg	34.5	99.4
StD	2.2	0.1

cc: K. Andes, M. Wilf

tt..4040-UHT-LFC-1-S\N X01181\test\990121.wq1 printed/1/29/99

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE:: 1/27/99

RE: Flat Cell Test Results of HYD-4040-UHT-LFC-1 -Element # X01 183.

Purpose: To verify membrane performance of elements dissected .

Membrane source:Element from customer.part of BUREC grant study (via K. Andes).

Start test (at 150 PSIG). After reading, increase pressure to 225 psig and read again.

Flat Cell Test Conditions: 0.15 %NaCl, 150 and 225 psig, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 6 6 cut a cross in the sample).

RESULTS:

(X01183-LFC-1)
1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	23.6	99.4
2	30.6	99.5
3	27.0	99.5
4	27.7	99.3,
5	27.2	99.2
6	22.7	98.6
Avg	26.5	99.2
StD	2.7	0.3

(X01183-LFC-1)
1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Rej
1	33.1	99.5
2	43.1	99.6
3	37.9	99.6
4	37.9	99.4
5	37.9	99.3
6	31.1	99.0
Avg	36.8	99.4
StD	4.2	0.2

cc: K. Andes, M. Wilf

tt..4040-UHT-LFC-1-S\N X01183\test\990121.wq1 printed/1/27/99

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE: 1/29/99

RE: Flat Cell Test Results of HYD-4040-UHT-LFC-1 -Element # X01 184.

Purpose: To verify membrane performance of elements dissected .

Membrane source:Element from customer;part of BUREC grant study (via K. Andes).

Start test (at 150 PSIG). After reading, Increase pressure to 225 PSIG and read again.

Flat Cell Test Conditions: 0.15 % NaCl, 150 and 225 psig, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 5 6 cut a cross in the sample).

RESULTS:

(X01184-LFC-1)
1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	29.5	99.2
2	34.6	99.4
3	30.9	99.5
4	30.9	99.5
5	31.5	99.2
6	28.1	99.2
Avg	30.9	99.4
StD	2.2	0.2

(X01184-LFC-1)
1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Rej
1	42.0	99.3
2	48.7	99.5
3	44.2	99.6
4	43.1	99.5
5	44.6	99.4
6	40.1	99.3
Avg	43.8	99.4
StD	2.9	0.1

cc: K. Andes, M. Wilf

tt..4040-UHT-LFC-1 -S\N X01184\test\99012? ''q1 printed/1/29/99

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE:: 2/1 /99

RE: Flat Cell Test Results of HYD-LFC-1 -FREE-Element # X01 185.

Purpose: To verify membrane performance of elements dissected .

Membrane source:Element from customer;part of BUREC grant study (via K. Andes).

Start test (at 150 PSIG). After reading, increase pressure to 225 PSIG and read again.

Flat Cell Test Conditions: 0.15 % NaCl, 150 and 225 psig, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 5 6 cut a cross in the sample).

RE ;ULTS: (X01185-LFC-1) 1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	26.2	99.2
2	26.2	99.2
3	25.0	99.4
4	23.7	99.3
5	23.3	99.5
A'StD	22.8 24.5 1.5	99.3 99.3 0.1

(X01185-LFC-1) 1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Re
1	42.8	99.3
2	44.3	99.3
3	40.6	99.4
4	37.3	99.4
5	40.3	99.5
6	38.0	99.3
Avg	40.6	99.4
StD	2.7	0.1

cc: K. Andes, M. Wilf

tt..LFC-1 -FREE-S\N X01 185\test\990125.wq1 printed/2/1/99

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE: 2/1 /99

RE: Flat Cell Test Results of HYD-LFC-1 -FREE-Element # X01 187.

Purpose: To verify membrane performance of elements dissected.

Membrane source:Element from customer;part of BUREC grant study (via K. Andes).

Start test (at 150 PSIG). After reading, increase pressure to 225 PSIG and read again.

Flat Cell Test Conditions: 0.15 %NaCl, 150 and 225 psig, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 5 6 cut a cross in the sample).

RESULTS:

(X01187-LFC-1) 1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	25.6	99.6
2	25.6	99.7
3	24.4	99.6
4	23.8	99.6
5	23.8	99.5
6	24.0	99.6
Avg	24.5	99.6
StD	0.9	0.1

(X01187-LFC-1) 1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Rej
1	39.6	99.7
2	40.3	39.8
3	38.0	99.7
4	35.4	39.7
5	37.3	99.6
6	36.9	39.7
Avg	37.9	'99.7
StD	1.8	0.1

cc: K. Andes, M. Wilf

tt..LFC-1-FREE-S\N X01187\test\990125.wq1 printed/2/1/99

MEMORANDUM

TO: D. R. Carlton

FROM: T. Tran

DATE:: 2/1/99

RE: Flat Cell Test Results of HYD-LFC-1 -FREE-Element # X01 190.

Purpose: To verify membrane performance of elements dissected.

Membrane source:Element from customer;part of BUREC grant study (via K. Andes).

Start lest (at 150 PSIG). After reading, increase pressure to 225 PSIG and read again.

Flat Cell Test Conditions: 0.15 % NaCl, 150 and 225 pslg, pH 7 Duration: 45 min.

Flux values are corrected to 75 Deg. F and reported as GFD.

% Rejection is based on ppm NaCl in feed and permeates.

All values are means of 6 coupons (1 2 3 4 5 6 cut a cross in the sample).

RESULTS:

(X01190-LFC-1) 1500ppm-NaCl-150-psig.

Coupon	Flux(GFD)	% Rej
1	31.9	99.0
2	33.7	98.9
3	29.8	99.1
4	26.2	98.8
5	26.5	98.7
6	25.4	99.4
Avg	28.9	99.0
StD	3.4	0.2

(X01190-LFC-1) 1500ppm-NaCl-225-psig.

Coupon	Flux(GFD)	% Rej
1	51.4	99.0
2	52.9	99.0
3	47.0	99.1
4	41.5	99.0
5	43.3	98.9
6	40.0	99.4
Avg	46.0	99.1
StD	5.3	0.2

cc: K. Andes, M. Wilf

tt..LFC-1-FREE-S\N X01190\test\990125.wq1 printed/2/1/99

Analytical & Testing – Membrane Cell Test Data

Membrane type: LFC1-981201-A-Virgin	SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date: 1-21-99	Feed conductivity (µmho):	3000 NaCl	3000 NaCl
Test loop: 2	pH value:	6.95	6.97
Routine test:	Feed temperature (°C):	22.9	22.5
Non-routine test:	Conversion factor:		
Operator: T.T	Test pressure (psig):	150	225

Test #1 Date: 1-21-99 Time: 13:45 / 14:30 Duration: ___ hrs 45 min Continuing: [X] Yes [ ] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
		1	6.7	6.0	22.56	25.19	43	0.4687	98.67	
		2	6.6	↓	↓	24.82	35	↓	98.92	
		3	6.05	↓	↓	22.75	33	↓	98.98	
		4	5.85	↓	↓	22.00	35	↓	98.92	
		5	5.65	↓	↓	21.24	33	↓	98.98	
		6	5.65	↓	↓	21.24	40	↓	98.76	
					Average ± SD →	22.87		Average ± SD →	98.87	

Further tests (treatments) on these coupons:

(150psig) AFTER READED ON ABOVE INCREASE PRESS. = 1.0 TO ↗
(225 psig) AT 1440 AND READ AGAIN AT 1520

Test #2 Date: 1-21-99 Time: 11:45 / 15:20 Duration: ___ hrs 45 min Continuing: [ ] Yes [X] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
		1	7.75	4.0	22.82	44.21	32	0.4687	99.01	
		2	7.35	↓	↓	41.93	25	↓	99.23	
		3	6.65	↓	↓	37.94	24	↓	99.26	
		4	6.15	↓	↓	35.09	24	↓	99.26	
		5	6.1	↓	↓	34.80	26	↓	99.20	
		6	6.0	↓	↓	34.23	28	↓	99.13	
					Average ± SD →	38.03		Average ± SD →	99.18	

Notes:

AT FM 2121 Rev. B (DCR8261)

Analytical & Testing – Membrane Cell Test Data

Membrane type: 4040-UHT-LFC1 S/N X011181	SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date: 1-21-99	Feed conductivity (µmho):	3000 NaCl	3000 NaCl
Test loop: 2	pH value:	7.02	6.93
Routine test:	Feed temperature (°C):	22.4	22.8
Non-routine test:	Conversion factor:		
Operator: T.T	Test pressure (psig):	150	225

Test #1 Date: 1-21-99 Time: 11:40 / 12:25 Duration: ___ hrs 45 min Continuing: [X] Yes [ ] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.5	6.0	22.79	20.98	20	0.4687	99.38	
	↓	2	6.2	↓	↓	23.65	19	↓	99.41	
		3	5.65			21.55	28		99.13	
		4	5.3			20.22	13		99.60	
		5	6.1			23.27	22		99.32	
	B	6	5.15			19.65	28		99.13	
					Average ± SD →	21.55		Average ± SD →	99.33	

Further tests (treatments) on these coupons:

(150psig) AFTER READED ON ABOVE, INCREASE PRESSURE UP TO
(225psig) AT 1240 AND READ AGAIN AT 1325

Test #2 Date: 1-21-99 Time: 11:40 / 13:25 Duration: ___ hrs 45 min Continuing: [ ] Yes [X] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	ions in Sump
	F	1	5.9	4.0	22.62	33.36	17	0.4687	99.47	
	↓	2	6.5	↓	↓	36.76	17	↓	99.47	
		3	6.1			34.50	24		99.26	
		4	5.9			33.36	12		99.63	
		5	6.6			37.32	20		99.38	
	B	6	5.6			31.67	24		99.26	
					Average ± SD →	34.50		Average ± SD →	99.41	

Notes:

Analytical & Testing – Membrane Cell Test Data

Membrane type: C04C-UFT-LFC1-SNX01183	SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date: 1-21-99	Feed conductivity (μmho):	3000 NaCl	3000 NaCl
Test loop: 1	pH value:	6.97	6.96
Routine test:	Feed temperature (°C):	22.7	22.5
Non-routine test:	Conversion factor:		
Operator: T.T	Test pressure (psig):	150	225

Test #1 Date: 1-21-99 Time: 11:25 12:10 Duration: hrs 45 min Continuing: [X] Yes [ ] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.2	5.0	22.69	23.60	21	0.4687	99.35	
	↓	2	6.75	↓	↓	30.63	17	↓	99.47	
		3	5.95			27.00	17		99.47	
		4	6.1			27.68	24		99.26	
		5	6.0			27.23	27		99.16	
	B	6	5.0			22.69	44		98.64	
					Average ± SD →	26.47		Average ± SD →	99.23	

Further tests (treatments) on these coupons:

(150 psig)
AFTER READED ON ABOVE, INCREASE PRESSURE UP TO ↑ 225 psig AT 1300, AND READ AGAIN AT 1345.

Test #2 Date: 1-21-99 Time: 11:25 13:45 Duration: hrs 45 min Continuing: [ ] Yes [X] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.8	4.0	22.82	33.09	17	0.4687	99.47	
	↓	2	7.55	↓	↓	43.07	14	↓	99.57	
		3	6.65			37.94	14		99.57	
		4	6.65			37.94	19		99.41	
		5	6.65			37.94	23		99.29	
	B	6	5.45			31.09	34		98.95	
					Average ± SD →	36.84		Average ± SD →	99.38	

Notes:

Analytical & Testing – Membrane Cell Test Data

Membrane type: 4040-UHT-LFCL-SN XC1184	SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date: 1-22-99	Feed conductivity (µmho):	3000 NaCl	3000 NaCl
Test loop: 1	pH value:	7.02	6.97
Routine test:	Feed temperature (°C):	23.0	23.0
Non-routine test:	Conversion factor:		
Operator: T.T	Test pressure (psig):	150	225

Test #1 Date: 1-25-99 Time: 7:00 / 7:55 Duration: m hrs 55 n Continuing: Yes ☐ No ☐

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.25	4.0	22.49	29.52	27	0.4687	99.16	
	↓	2	6.15	↓	↓	34.58	18	↓	99.44	
	↓	3	5.5	↓	↓	30.92	15	↓	99.54	
	↓	4	5.5	↓	↓	30.92	17	↓	99.47	
	↓	5	5.6	↓	↓	31.49	25	↓	99.23	
	B	6	5.0	↓	↓	28.11	25	↓	99.23	
					Average ± SD →	30.92		Average ± SD →	99.35	

Further tests (treatments) on these coupons:

(150 psig) AFTER READED ON ABOVE, INCREASE PRESSURE UP ↑ TO (225 psig) AT 8:10. AND READ AGAIN AT 8:55

Test #2 Date: 1-25-99 Time: 7:00 / 8:55 Duration: hrs 45 min Continuing: ☐ Yes ☒ No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.6	3.0	22.49	41.98	24	0.4687	99.26	
	↓	2	6.5	↓	↓	48.73	16	↓	99.51	
	↓	3	5.9	↓	↓	44.23	13	↓	99.60	
	↓	4	5.75	↓	↓	43.11	15	↓	99.54	
	↓	5	5.95	↓	↓	44.61	19	↓	99.41	
	B	6	5.35	↓	↓	40.11	22	↓	99.32	
					Average ± SD →	43.79		Average ± SD →	99.44	

Notes:

Analytical & Testing – Membrane Cell Test Data

Membrane type: ~~4040~~-X01185-LFC1-FREE	SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date: 1-22-99	Feed conductivity (µmho):	3000 NaCl	3000 NaCl
Test loop: 2	pH value:	6.97	6.95
Routine test:	Feed temperature (°C):	23.2	23.5
Non-routine test:	Conversion factor:		
Operator: T.T	Test pressure (psig):	150	225

Test #1 Date: 1-25-99 Time: 7:00 7:55 Duration: ___ hrs 55 min Continuing: [X] Yes [ ] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.85	5.0	22.36	26.16	25	0.4687	99.23	
	↓	2	5.85	↓	↓	26.16	26	↓	99.20	
	↓	3	5.6	↓	↓	25.04	19	↓	99.41	
	↓	4	5.3	↓	↓	23.70	22	↓	99.32	
	↓	5	5.2	↓	↓	23.25	17	↓	99.47	
	B	6	5.1	↓	↓	22.81	24	↓	99.26	
					Average ± SD →	24.52		Average ± SD →	99.31	

Further tests (treatments) on these coupons:

(150 psig) AFTER READED ON ABOVE, INCREASE PRESSURE UP↑ TO (225 psig) AT 8:15. AND READ AGAIN AT 9:00

Test #2 Date: 1-25-99 Time: 7:00 9:00 Duration: ___ hrs 45 min Continuing: [ ] Yes [X] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.8	3.0	22.16	42.84	24	0.4687	99.26	
	↓	2	6.0	↓	↓	44.32	23	↓	99.29	
	↓	3	5.5	↓	↓	40.63	19	↓	99.41	
	↓	4	5.05	↓	↓	37.30	20	↓	99.38	
	↓	5	5.45	↓	↓	40.26	15	↓	99.54	
	B	6	5.15	↓	↓	38.04	22	↓	99.32	
					Average ± SD →	40.57		Average ± SD →	99.37	

Notes:

Analytical & Testing – Membrane Cell Test Data

Membrane type: SINX01187- LFC1-FREE	SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date: 1-22-99	Feed conductivity (µmho):	3000NaCl	3000NaCl
Test loop: 1	pH value:	7.03	7.01
Routine test:	Feed temperature (°C):	22.8	22.5
Non-routine test:	Conversion factor:		
Operator: TT	Test pressure (psig):	150	225

Test #1 Date: 1-25-99 Time: 11:15 12:10 Duration: hrs 45 min Continuing: [X] Yes [ ] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.65	5.0	22.62	25.56	12	0.4687	99.63	
	↓	2	5.65	↓	↓	25.56	11	↓	99.66	
		3	5.4			24.43	13		99.60	
		4	5.25			23.75	12		99.63	
		5	5.25			23.75	16		99.51	
	B	6	5.3			23.98	14		99.57	
					Average ± SD →	24.51		Average ± SD →	99.60	

Further tests (treatments) on these coupons:

(150psig) AFTER READED ON ABOVE, INCREASE PRESSURE UP ↗ TO (225psig) AT 12:10 AND READ AGAIN AT 1255

Test #2 Date: 1-25-99 Time: 11:15 12:55 Duration: hrs 45 min Continuing: [ ] Yes [X] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	5.2	3.0	22.82	39.55	10.0	0.4687	99.69	
	↓	2	5.3	↓	↓	40.32	8	↓	99.75	
		3	5.0			38.03	10		99.69	
		4	4.65			35.37	9		99.72	
		5	4.9			37.27	13		99.60	
	B	6	4.85			36.89	10		99.69	
					Average ± SD →	37.91		Average ± SD →	99.69	

Notes:

Analytical & Testing – Membrane Cell Test Data

Membrane type: S/N X01190-- LFC1 - FREE		SUMP PARAMETERS	TEST #1	TEST #2
Sample arrival date:	1-22-99	Feed conductivity (μmho):	3000NaCl	3000NaCl
Test loop:	2	pH value:	6.96	6.97
Routine test:		Feed temperature (°C):	23.1	23.7
Non-routine test:		Conversion factor:		
Operator:	TT	Test pressure (psig):	150	225

Test #1 Date: -25-99 Time: 11:25 12:15 Duration: ___ hrs 45 min Continuing: [X] Yes [ ] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	7.1	5.0	22.43	31.85	34	0.4687	98.95	
	↓	2	7.5	↓	↓	33.65	36	↓	98.89	
		3	6.65			29.83	30		99.07	
		4	5.85			26.24	39		98.79	
	↓	5	5.9			26.47	42		98.70	
	B	6	5.65	↓	↓	25.35	20	↓	99.38	
					Average ± SD →	28.90		Average ± SD →	98.96	

Further tests (treatments) on these coupons:

(150 psig) AFTER READ ON ABOVE, INCREASE PRESSURE UP ↑ TO (225 psig) AT 12:25 AND READ AGAIN AT 1310.

Test #2 Date: 1-25-99 Time: 11:25 13:10 Duration: ___ hrs 45 min Continuing: [ ] Yes [X] No

Sample ID or Station	Side	Cell #	ml	min	Flux Factor	Flux GFD	Perm. Cond.	Conduct. Conv. Factor	% Rej.	Ions in Sump
	F	1	7.0	3.0	22.03	51.40	34.[illegible]	0.4687	98.95	
	↓	2	7.2	↓	↓	52.87	31	↓	99.04	
		3	6.4			47.00	28		99.13	
		4	5.65			41.49	33		98.98	
	↓	5	5.9			43.33	36		98.89	
	B	6	5.45	↓	↓	40.02	18	↓	99.44	
					Average ± SD →	46.02		Average ± SD →	99.07	

Notes:

REQUEST FOR SEM and EDAX TESTING

Initiator: Please answer the following to ensure a complete report.

Submitted by: KEITH ANDES Date: 1/20/99	LAB USE ONLY
	date received: 1/20/98
Check one: Original photos wanted.* ☒ Copies OK. ☐	
RGA # if applicable:	received by: JR
Who: collected the sample?: KEITH ANDES	
should the report go to?: DR. WILF	nb ref#:
	log #:

What: membrane type?: LFC 1

feed water?: WASTE WATER

When: is the report needed?:

was the membrane or element made?: FEB. 1998

How long was it in use?: 6 MONTHS

Where: Country, Company, City? SAN PASQUAL, CA

Why: What question or problem is being studied?:

PART OF BUREC GRANT STUDY

– 6 SEPERATE SAMPLES –

X01181 X01190

X01183

X01184

X01185

X01187

* High quality scanner photos are provided. If original photos are needed, the film will be charged to your project.

Log 99005

SEM REPORT

To : K. Andes
From : J. Rockoff
CC : D. Canton, K. Matsumoto, M. Wilf
Date : February 16, 1999

SUBJECT : FOULANT ON LFC1 MEMBRANE USED AT THE SAN PASQUAL WASTE WATER PLANT

PURPOSE :
This is part of the Bureau of Reclamation grant study, Fouling on 4040 LFC1 modules is being compared to fouling on 4040 standard elements before and after cleaning.

PROCEDURE:

These samples came from elements installed at the San Pasqual wastewater treatment plant. Standard 4040 elements were in one train in the orderX01181, X01184, and X01183. The LFC1 modules were in a train in the order X01 185, X01 190, and X01 187. The first elements in each train (X01 181 standard, and X01 185 module) were not cleaned prior to dissection. All others were cleaned prior to dissection. The last elements in each train (X01 183 standard, and X01 187 module) were also dye treated before dissection. Pieces were cut from these dissected elements, dried, mounted and gold coated for SEM. A sample of never-used, clean LFC1 was also mounted and gold coated for comparison.

RESULTS :

Part I : Clean LFC1

Photo #	Description
1	LFC1 coating on ESPA membrane is shown at 10,000X.

EDX Scan #　　Description

1 This scan shows the elemental composition of the LFC1 membrane layer, and the polysulfone that is beneath and serves as the control. The sulfur is found only in the polysulfone layer. Scans of samples from previously used elements should be compared to this standard scan when one tries to determine foulant composition.

Part II : Standard 4040 s/n X01181

Photo: #　　Description

1 Bacteria are shown at 7,000X on this fine-grained foulant. Patches of yellow foulant covering a few percent of the surface were seen during dissection. The foulant came in the grid like pattern of the brine spacer. Bacteria were less numerous on most of this foulant.

2 A small piece of membrane taken from the feed side is seen at 10.000x.

3 A small piece of membrane taken from the brine side is shown at 10,000x.

4 Foulant described in photo #1. This piece was tilted to give an edge view of this ridge of foulant rising above the membrane surface.

EDX Scan #　　Description

1 This is a scan of the foulant that is on photos #1 and #4. This foulant was almost entirely composed of carbon and oxygen. The sulfur content is low when compared to clean membrane. This shows that the foulant was thick enough to block some or all of the electron beam from reaching the polysulfone layer. Some of the carbon, oxygen and sulfur may have came from the membrane below the foulant. The iron content is much lower than that seen in foulant from the other five samples.

2 This scan shows membrane taken from the feed side. It has a composition very similar to clean LFC1. This feed side sample was collected in an area where foulant was not seen during dissection.

3 This scan shows membrane taken from the brine side. It has a composition very similar to clean LFC1.

Part III : Module s/n X01 185

Photo # | Description

1 This photo shows the feed side of this sample at 100X. The vertical line on the left side of the photo is thicker foulant collected at a brine spacer line. When examined at higher magnification the LFC1 surface was not seen. The foulant covered the surface. Some bacteria were seen at higher magnification.

2 This photo shows a piece taken from the middle of this sample at 100X. The vertical band on the left side is thicker foulant collected along a brine spacer line. About 20% of the surface had LFC1 visible when examined at higher magnification.

EDX Scan # | Description

1 This scan is of foulant from the feed side of the module which was collected with a scalpel. This technique produces a thicker foulant sample so that the membrane under the foulant is not scanned. This scan is high in iron, oxygen, and carbon. The chromium is notable since it may represent corrosion of steel somewhere in the system. Small amounts of silicon, aluminum, chlorine and sulfur were seen.

2 This is a scan of a spot like that seen on photo #2. The iron, oxygen, and chromium of the foulant are all higher than the clean LFC1. The foulant is thin enough to allow scanning of the polysulfone.

3 This is a scan of a spot from the feed side like that seen on photo #1. This shows more iron, oxygen and chromium foulant than scan #2. Sulfur and carbon from the polysulfone below the foulant are also seen.

Part IV : Standard 4040 s/n X01 184

Photo # | Description

1 An isolated group of bacteria is shown at 7,000X. Bacteria were not easy to locate on this sample. The LFC1 surface is also shown.

2 This is an average looking spot found in the middle of the element. The LFC1 surface is exposed with little or no foulant. The magnification is 10,000X.

Photo #	Description

3 This is a sample of the four-inch feed side strip which appeared fouled during dissection. The LFC1 surface is visible along the bottom of the photo. Thin foulant occurs over most of the photo.

EDX Scan #	Description

1 Feed side foulant was collected with a scalpel to increase sample thickness. This foulant is high in iron and oxygen. The chromium is notable since it may represent corrosion of steel. Small amounts of aluminum, silicon, phosphorous, chlorine, potassium, calcium and copper were seen, The sulfur and carbon values are lower than seen on clean LFC1 It is not known what part of these values came from the foulant, and what part came from the materials below the foulant.

2 The feed side fouled strip was used for this scan. Low magnification was used to scan a larger area. The foulant was thin, so most of the material scanned. was below the foulant. Some iron, calcium, aluminum, and silicon from the foulant were seen.

3 A surface from the middle similar to photo #2 was scanned. This sample had very little foulant. Traces of silicon and aluminum were seen.

Part V : Module s/n X01190

Photo #	Description

1 This sample was taken from the middle of the element. Some LFC1 surface was seen when this sample was examined at higher magnification. More than 80% of the surface appeared covered with foulant when this was examined at higher magnification. The vertical band about a third of the way from the right side is thicker foulant collected along a brine spacer line. Bacteria were not found at higher magnification.

2 This sample was taken from the feed side. The vertical line is heavier foulant associated with a brine spacer mark. The foulant appeared thicker here than the foulant on the middle sample. Most of the LFC1 surface could not be seen due to the foulant coating. LFC1 coating was visible at higher magnification in small patches (<20% of the surface.

EDX Scan #	Description

1 This foulant from the feed side was collected with a scalpel to make it thicker. It is high in iron, oxygen and carbon. The chromium is notable because it could have been produced by corrosion of steel. Small amounts of calcium, aluminum, silicon, phosphorus, and sulfur were seen.

2 This is a scan of a feed side region much like photo #2. The foulant is thin so the scan resembles clean LFC1 except for the iron and extra oxygen.

3 This is a scan of middle area much like photo #1. A little less foulant is seen than scan #2.

Part VI : Standard 4040 s/n X01183

Photo #	Description

1 Mr. Leitz requested that a small black spot of loosely attached foulant be examined. This photo shows a piece of a diatom on this foulant at 6,000X.

2 This element was dye treated. Mr. Leitz suggested this spot of dye uptake be examined to determine the cause. This hole was found.

3 About 5% of this sample had rust colored foulant arranged in the grid pattern of the brine spacer. One of these lines of foulant is shown here at 400X.

4 This sample piece was collected from the middle of the membrane. LFC1 coating is seen. There appears to be little or no foulant.

EDX Scan #	Description

1 This scan closely resembles clean LFC1. It was taken on the middle sample shown in photo #4.

EDX Scan # Description

2 This is a scan of the isolated spot of black foulant seen in photo #1. The foulant is high in iron, and oxygen. The chromium and manganese are notable since they may have come from corrosion of steel. Small amounts of calcium, aluminum, silicon, chlorine and copper were also seen. The sulfur and carbon could have come either from the foulant or the materials under it.

3 This is a scan of the rust colored foulant shown in photo #3. It is high in iron, oxygen, and carbon. Small amounts of silicon, phosphorous, sulfur, chlorine, calcium, chromium and copper were also seen. The chromium is notable since it may show corrosion of steel is occurring.

Part VII : Module s/n X01 187

Photo # Description

1 The feed side and middle samples from this element both appeared very similar under SEM. Only the feed side was photographed. Most of this sample was covered with thin foulant. The magnification is 100X. A band of heavier foulant along the left side of this photo is associated with the brine spacer.

2 This shows some LFC1 surface visible behind the second zero of "Xl 00" on photo #1. The magnification is 1,500X.

EDX Scan # Description

1 This is a scan of foulant collected with a scalpel from the feed side. The foulant is high in iron, oxygen and carbon. The chromium is notable because it may show corrosion of steel occurred. Small amounts of aluminum, silicon, phosphorous and calcium were also seen.

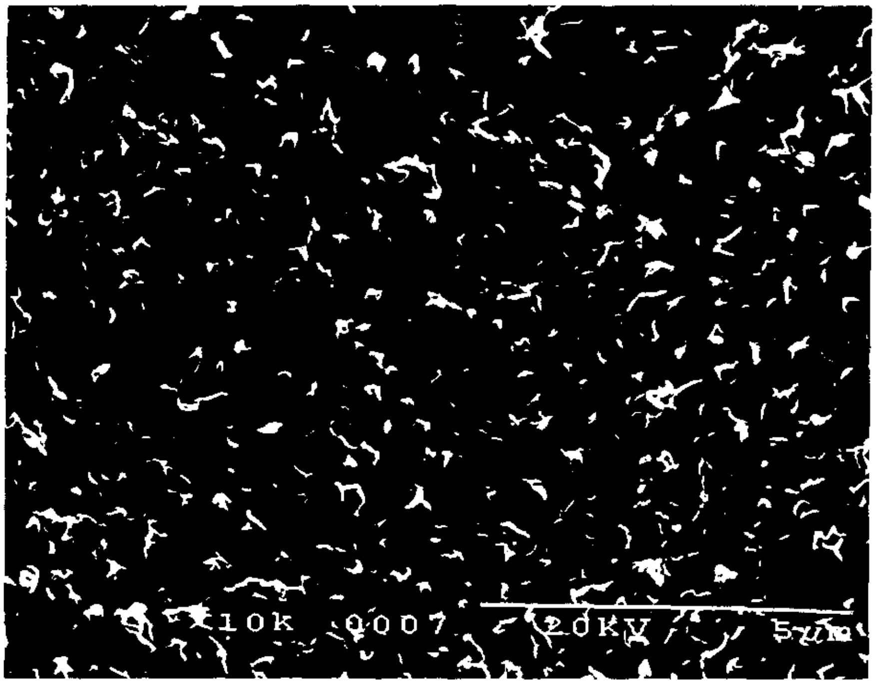
2 This is a scan of feed side foulant like that seen in photo #3. The composition is similar to clean LFC1. Foulant was thin allowing layers below the foulant to be scanned. Iron is the most significant foulant element seen.

3 This is a scan of a sample taken from the middle of the membrane. It is very similar to scan #2 except the iron content is a little lower.

DISCUSSION:

Iron, oxygen and carbon were the main constituents of the foulant. Chromium may indicate corrosion of steel is occurring. The feed side of most of these elements was more fouled than the brine side. This is unusual because solutes usually come out of solution a little more on the brine side where concentrations are higher. The cause of this is unknown. The elements and modules in each train position were compared. The elements all had less foulant than their corresponding module.

LFCl Control 10,000X Photo #1



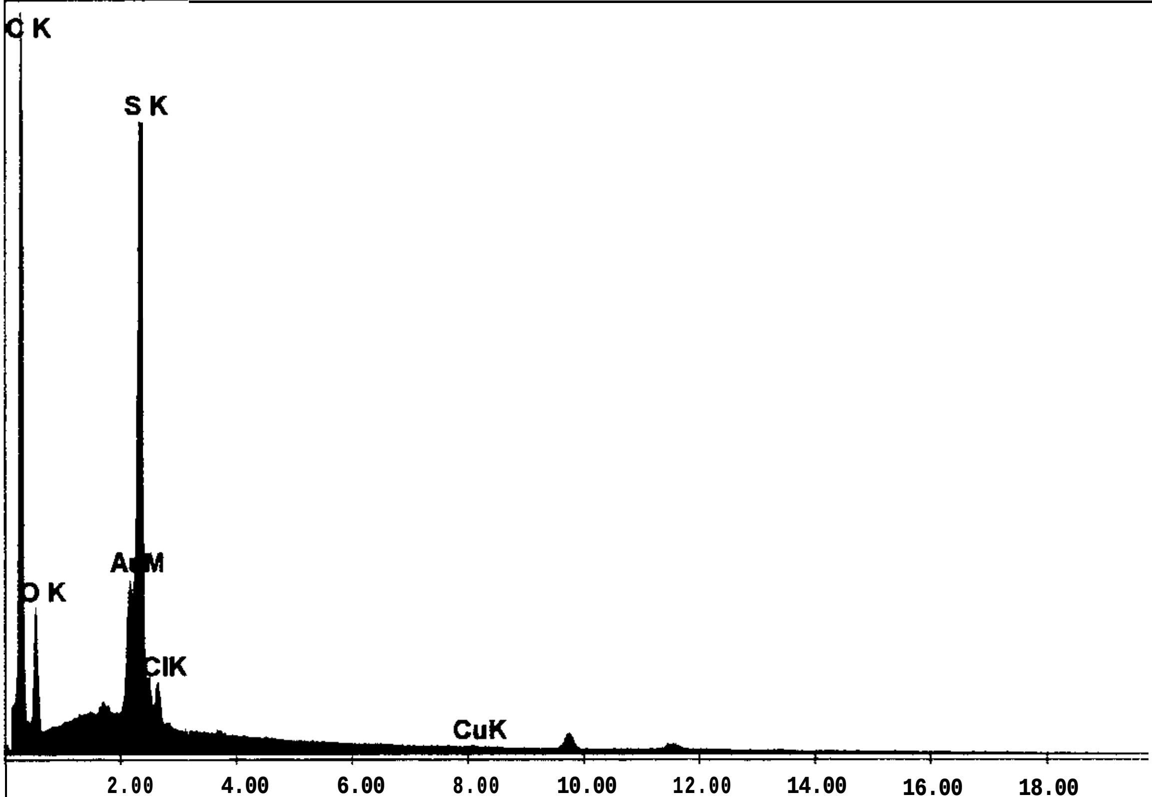
253-75-4

LFCl Control Scan

Untitled:1

Label:

kV:20.0	Tilt:0.0	Take-off:25.0	Det Type:SUTW+	Res:134	Tc:40
FS : 11896	Lsec : 308			21-Jan-99	16:32:57



EDAX ZAF Quantification (Standardless)

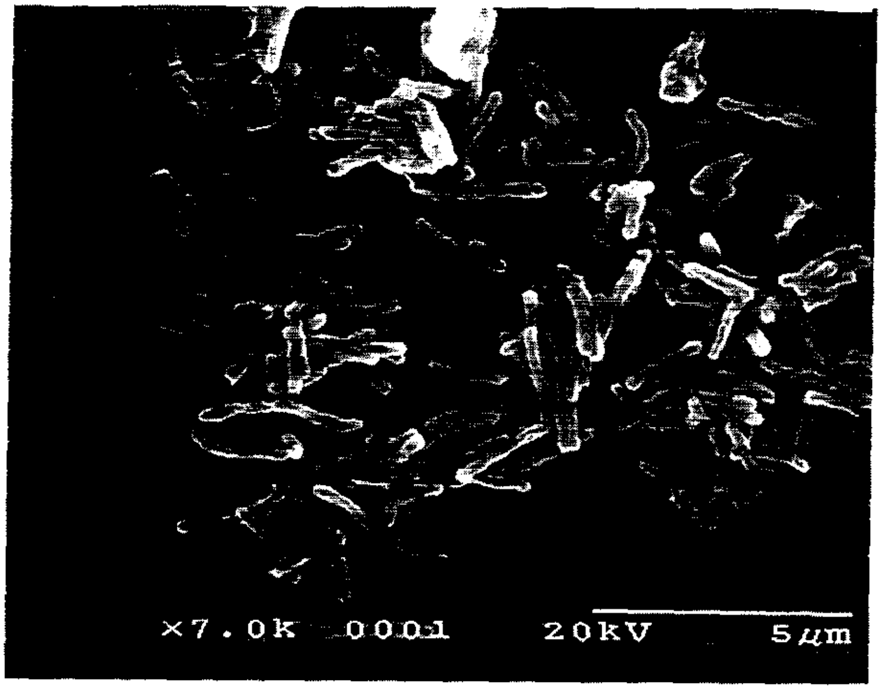
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	62.68	78.18	0.1425	1.0282	0.2210	1.0001
O K	16.18	15.15	0.0234	1.0110	0.1428	1.0001
AuM	7.91	0.60	0.0807	0.6808	1.4964	1.0012
S K	11.92	5.57	0.0967	0.9539	0.8495	1.0008
ClK	1.04	0.44	0.0076	0.9123	0.8014	1.0000
CuK	0.27	0.06	0.0023	0.8264	1.0109	1.0295
Total	100.00	100.00				

LFCl Control

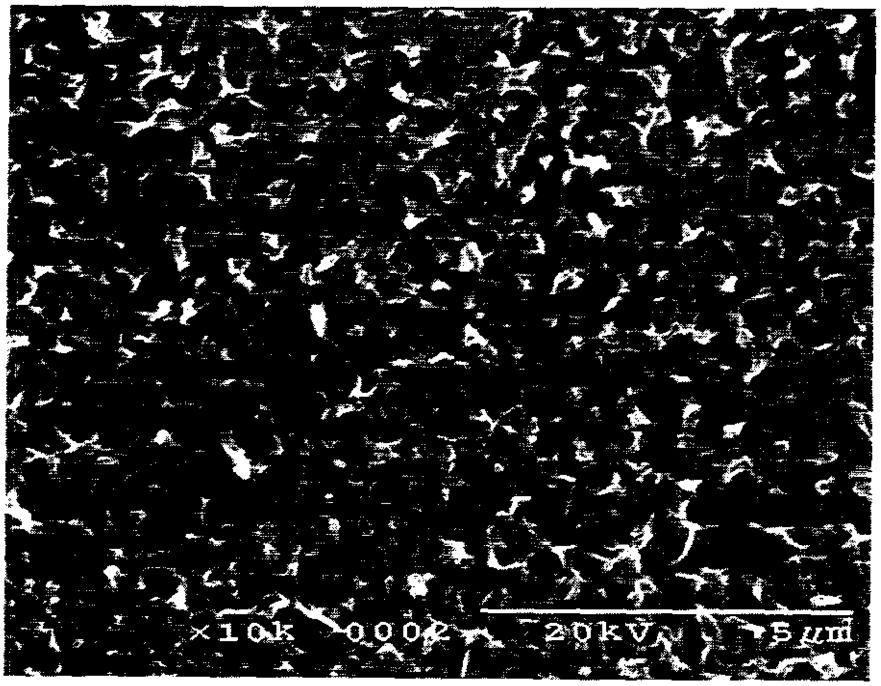
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	218.78	0.64	0.39	343.05
O K	45.21	5.20	0.89	8.70
AuM	59.46	18.79	0.85	3.16
S K	251.76	17.35	0.37	14.51
ClK	18.69	16.26	1.80	1.15
CuK	1.21	5.25	11.94	0.23

On Ridge of Yellow Foulant Photo #1



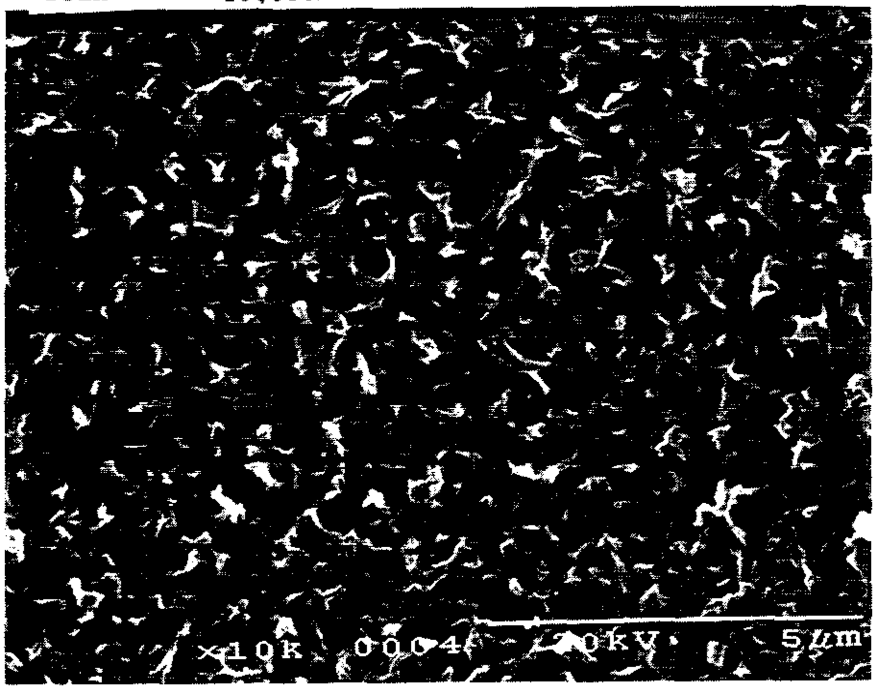
253-75-1 LFC1 Element # X01181

Feed Side 10,000X Photo #2



253-75-2 LFC1 Element # X01181

Brine Side 10,000X Photo #3



253-75-3 LFCI Element # X01181

Foulant on Brine Spacer Tilted for Side View Photo # 4

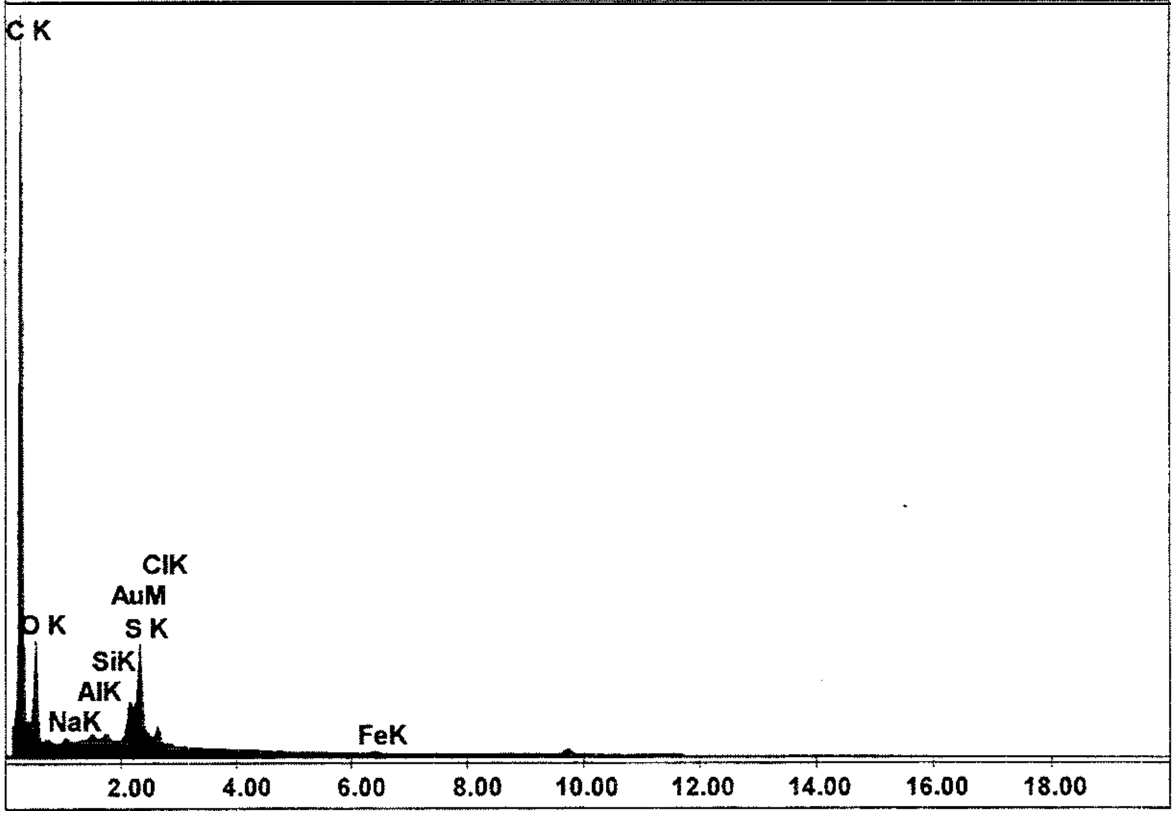
253-75-5 LFCI # X01181

X01181 Scan #1

Untitled:1

Label:

kV:20.0	Tilt:0.0	Take-off:25.0	Det Type:SUTW+	Res:134	Tc:40
FS : 44960	Lsec : 468			21-Jan-99	14:06:45



EDAXZAF Quantification (Standardless)
Element Normalized

Element	Wt %	At %	K-Ratio	Z	A	F
C K	66.40	76.75	0.2521	1.0170	0.3733	1.0002
O K	23.80	20.65	0.0368	1.0000	0.1547	1.0000
NaK	0.40	0.24	0.0014	0.9362	0.3735	1.0003
AlK	0.06	0.03	0.0004	0.9317	0.6845	1.0011
SiK	0.20	0.10	0.0016	0.9590	0.8130	1.0020
AuM	4.52	0.32	0.0453	0.6717	1.4912	1.0034
S K	3.50	1.51	0.0295	0.9405	0.8952	1.0038
ClK	0.79	0.31	0.0065	0.8998	0.9135	1.0001
FeK	0.35	0.09	0.0030	0.8436	1.0208	1.0074
Total	100.00	100.00				

X01181 Scan #1

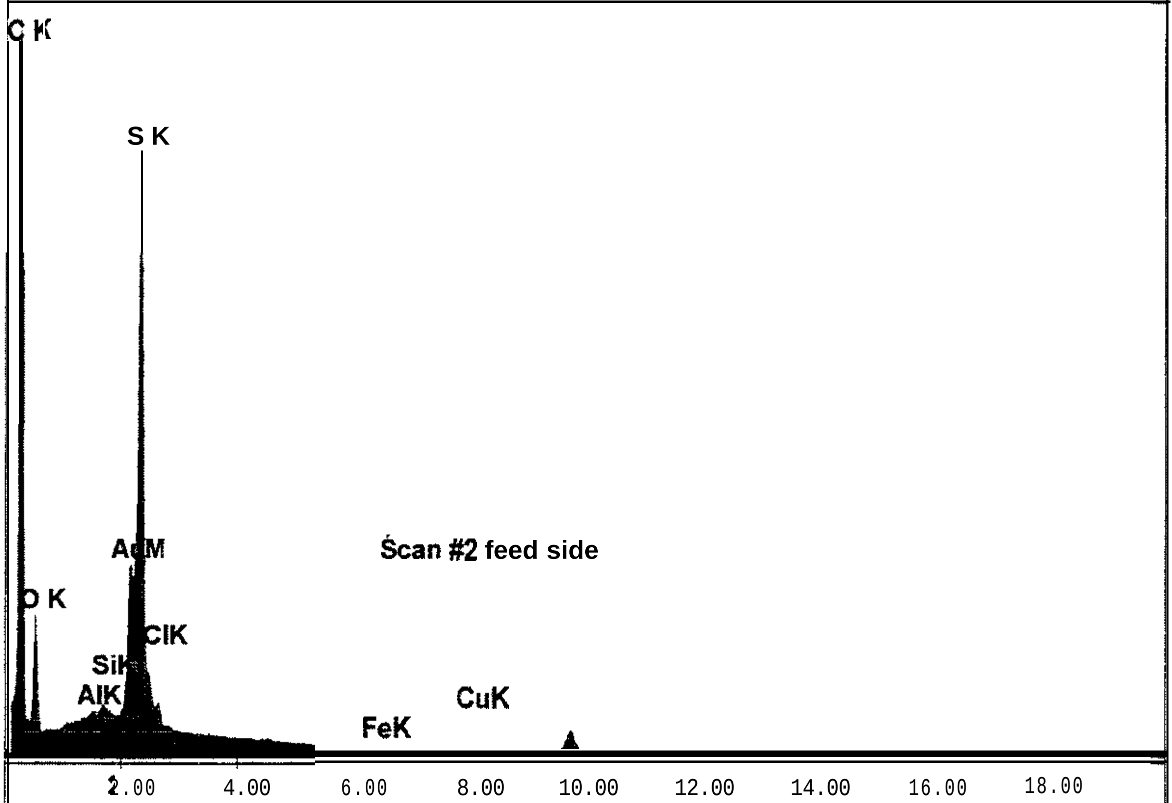
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	524.68	0.48	0.20	1098.08
O K	96.50	4.88	0.48	19.79
NaK	5.66	16.85	3.87	0.34
AlK	1.58	27.86	15.87	0.06
SiK	6.21	20.36	3.84	0.30
AuM	45.20	20.09	0.83	2.25
S K	103.98	18.85	0.49	5.51
ClK	21.53	18.28	1.35	1.18
FeK	3.62	1.12	4.30	0.47

Untitled:1

Label:

kV:20.0 Tilt:0.0 Take-off:25.0 Det Type:SUTW+ Res:134 Tc:40

FS : 19101 Lsec : 381 21-Jan-99 14:25:12



EDAX ZAF Quantification (Standardlees)
Element **Normalized**

Element	Wt %	At%	K-Ratio	Z	A	F
C K	62.15	78.63	0.1420	1.0315	0.2215	1.0001
O K	15.21	i4.46	0.0220	1.0142	0.1426	1.0001
AlK	0.03	0.01	0.0002	0.9447	0.6852	1.0028
SiK	0.11	0.06	0.0008	C.9723	0.8099	1.0052
AuM	9.45	0.73	0.0959	0.6836	1.4831	1.0011
S K	11.86	5.63	0.0936	0.9580	0.8233	1.0005
ClK	0.66	0.29	0.0048	0.9160	0.7848	1.0000
FeK	0.25	0.07	0.0022	3.8586	1.0025	1.0097
CuK	0.29	0.07	0.0025	0.8301	1.0090	1.0321
Total	100.00	100.00				

X01181 scan #2

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	280.18	1.18	0.31	238.19
O K	54.66	13.42	0.76	5.24
AlK	0.65	29.49	43.08	0.02
SiK	3.16	26.05	8.77	0.12
AuM	90.82	25.36	0.61	3.58
S K	313.20	23.68	0.30	13.22
ClK	15.05	22.72	2.09	0.66
FeK	2.52	9.99	7.18	0.25
CuK	1.70	7.83	9.31	0.22

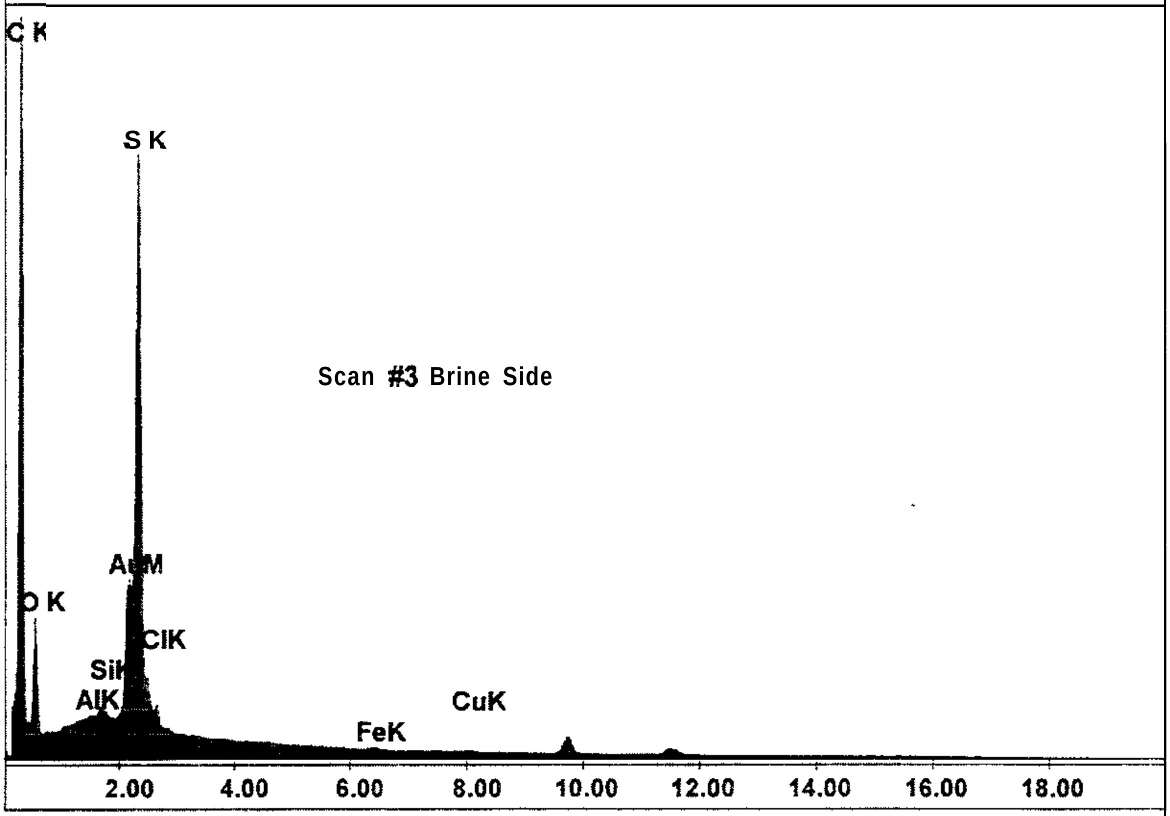
X01181 **Scan #3**

Untitled:1

Label:

kV:20.0 Tilt:0.0 Take-off:25.0 Det Type:SUTW+ Res:134 Tc:40

FS : 19796 Lsec : 393 21-Jan-99 14:48:30



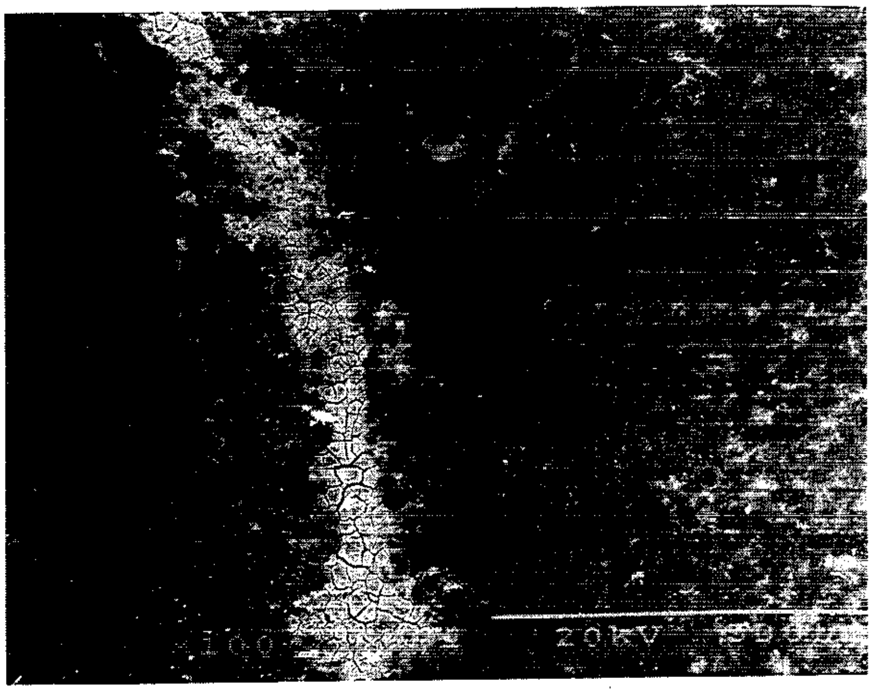
EDAX ZAF Quantification (Standardless)
Element Normaliied

Element	Wt%	At%	K-Ratio	Z	A	F
C K	62.14	78.71	0.1447	1.0297	0.2240	1.0001
O K	15.49	14.59	0.0224	1.0125	0.1426	1.3001
AlK	0.03	0.02	0.0002	0.9431	0.6891	1.0029
SiK	0.12	0.06	0.0009	0.9707	0.8138	1.0053
AuM	8.67	0.66	0.3881	0.6821	1.4881	1.0012
S K	11.80	5.55	0.3943	0.9558	0.8356	1.0005
ClK	0.66	0.28	0.0048	0.9140	0.7934	1.0000
FeK	0.25	0.07	0.0022	0.8567	1.0042	1.0092
CuK	0.24	0.06	0.0021	0.8281	1.0099	1.0308
Total	100.00	**100.00**				

X01181 Scan #3

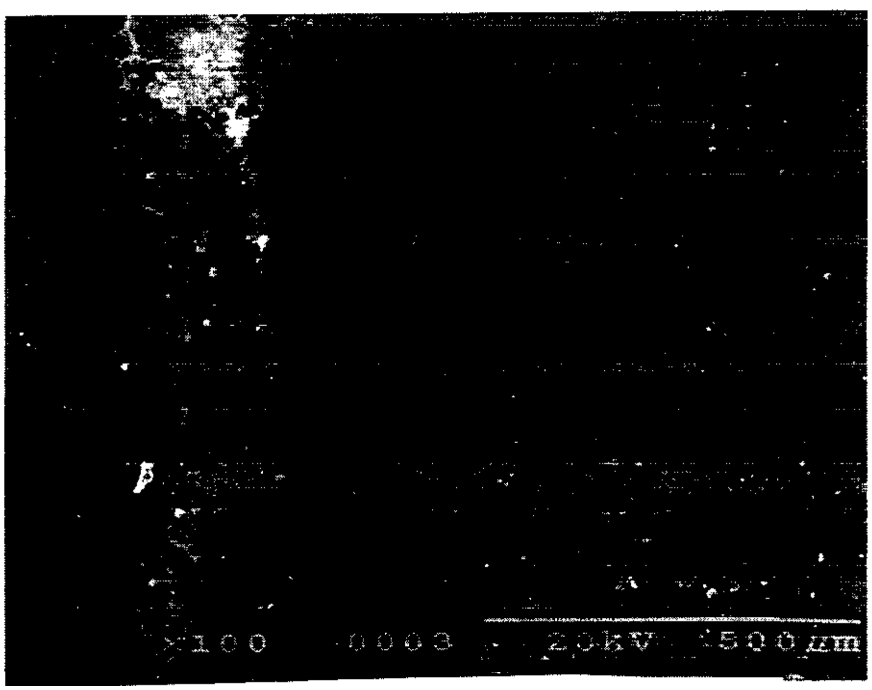
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	**290.88**	1.13	0.30	258.02
O K	56.65	9.85	0.74	5.75
AlK	0.80	29.38	34.92	0.33
SiK	3.64	26.16	7.66	0.14
AuM	85.04	25.82	0.63	3.29
S K	321.50	23.98	0.30	13.41
ClK	15.28	22.17	2.06	0.67
FeK	2.53	9.20	6.91	0.28
CuK	1.46	7.50	10.46	0.19

Photo #1



253-83-1 LFC1 Element X01185 Feed Side

Photo # 2



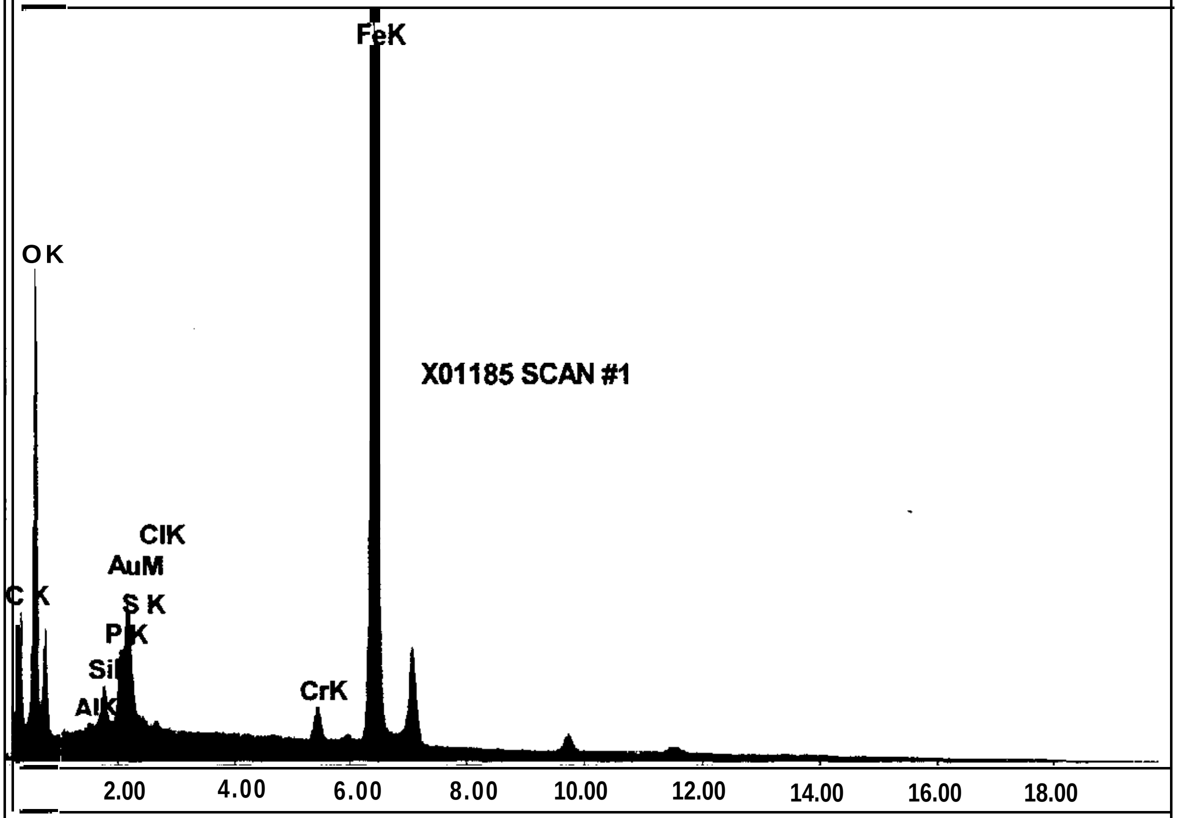
253-83-2 LFC1 Element X01185 Middle

Untitled:1

Label:

kV:20.0 Tilt:0.0 Take-offz25.0 Det Type:SUTW+ Res:138 Tc:40

FS : 15347 Lsec : 326 8-Feb-99 10:43:06



EDAX ZAF Quantification **(Standardless)**
Element **Normalized**

Element	Wt %	At %	K-Ratio	Z	A	F
C K	13.82	31.15	0.0309	1.1138	0.2004	1.0004
O K	23.60	39.93	0.0730	1.0949	0.2821	1.0015
AlK	0.26	0.26	0.0009	1.0186	0.3542	1.0010
SiK	1.16	1.12	0.0058	1.0480	0.4759	1.0014
P K	1.70	1.49	0.0103	1.0188	0.5910	1.0016
AuM	8.67	1.19	0.0658	0.7448	1.0190	1.0000
S K	0.40	0.34	0.0025	1.0467	0.6103	1.0024
ClK	0.15	0.12	0.0011	0.9991	0.7101	1.0042
CrK	1.52	0.79	0.0156	0.9333	0.9779	1.1246
FeK	48.72	23.62	0.4533	0.9348	0.9917	1.0035
Total	100.00	100.00				

X01185 Scan #1

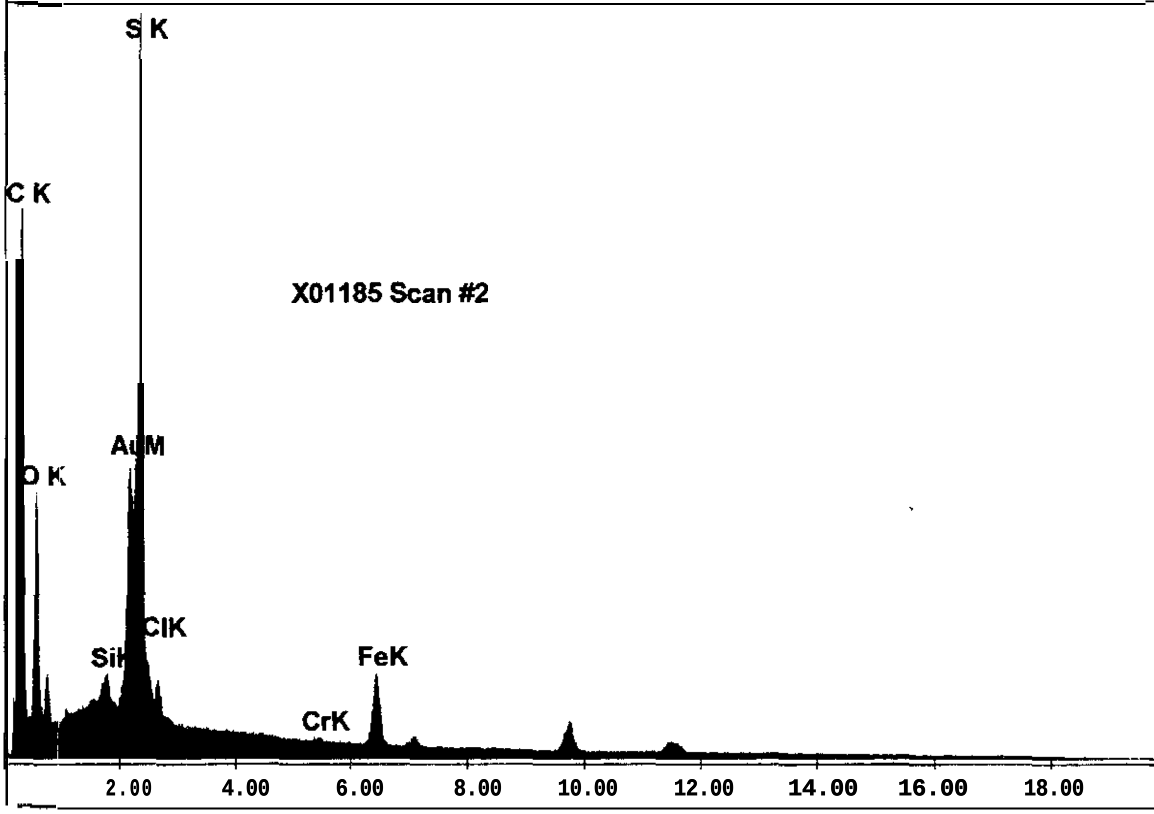
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	64.50	0.53	0.69	120.85
O K	192.32	4.27	0.40	45.07
AlK	4.00	18.99	6.63	0.21
SiK	23.23	20.13	1.57	1.15
P K	37.76	20.84	1.12	1.81
AuM	65.99	21.02	0.78	3.14
S K	9.01	23.34	3.50	0.39
ClK	3.68	22.79	7.74	0.16
CrK	25.43	18.18	1.44	1.40
FeK	548.82	16.98	0.24	32.32

Untitled:1

Label:

kV:20.0 **Tilt:0.0** Take-oW25.0 Det **Type:SUTW+** **Res:138** **Tc:40**

FS : 10139 **Lsec** : 377 **8-Feb-99** **11:01:12**



EDAX ZAF Quantification (Standardless)
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	47.96	67.55	0.0951	1.0459	0.1897	1.0002
O K	21.18	22.40	0.0347	1.0283	0.1591	1.0002
SiK	0.60	0.36	0.0044	0.9855	0.7452	1.0050
AuM	11.75	1.01	0.1139	0.6948	1.3938	1.0010
S K	12.94	6.83	0.0957	0.9744	0.7584	1.0008
ClK	0.90	0.43	0.0062	0.9312	0.7331	1.0004
CrK	0.15	0.05	0.0013	0.8723	0.9758	1.0148
FeK	4.52	1.37	0.0395	0.8726	0.9936	1.0084
Total	100.00	100.00				

X01185 Scan #2

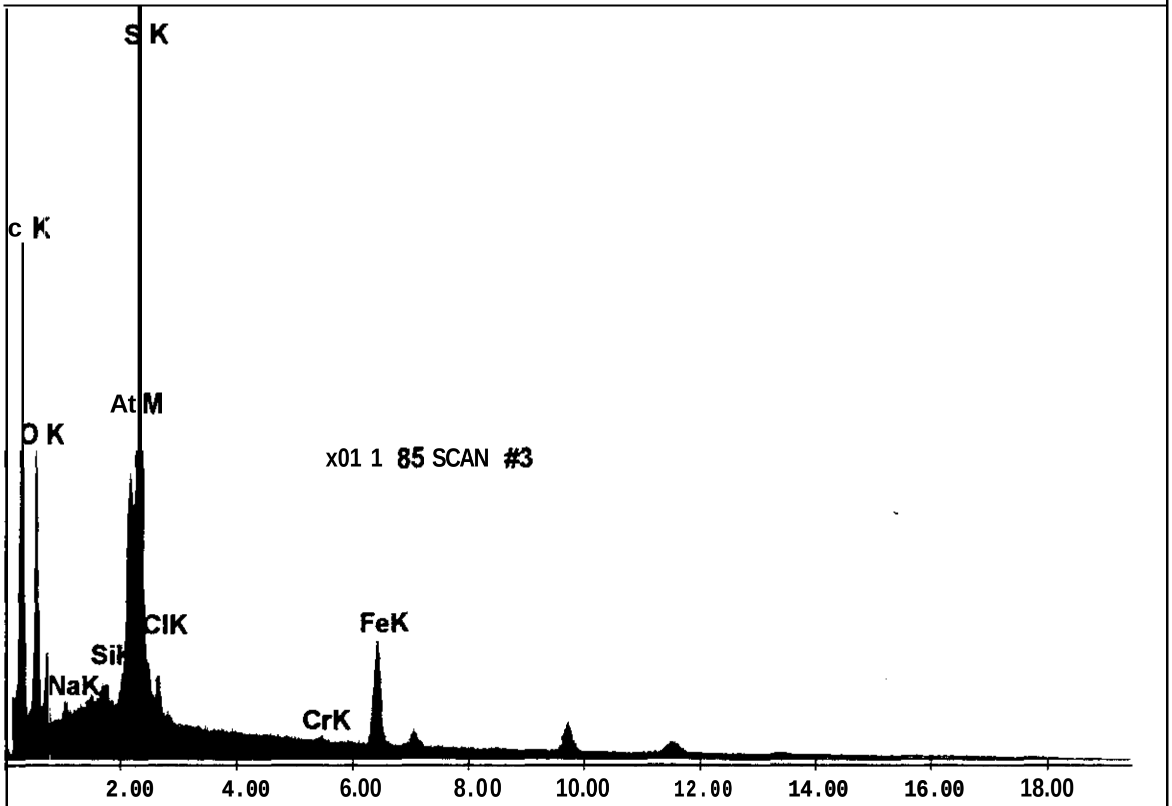
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	126.06	0.41	0.46	309.27
O K	57.86	3.16	0.69	18.29
SiK	11.28	16.92	2.42	0.67
AuM	72.42	15.49	0.67	4.68
S K	214.99	16.11	0.36	13.34
ClK	13.03	14.49	2.07	0.90
CrK	1.36	8.64	11.96	0.16
FeK	30.31	7.02	1.04	4.32

Untitled:1

Label:

kV:20.0 Tilt:0.0 Take-off:25.0 Det Type:SUTW+ Res:138 Tc:40

FS : 9735 Lsec : 390 8-Feb-99 11:18:04



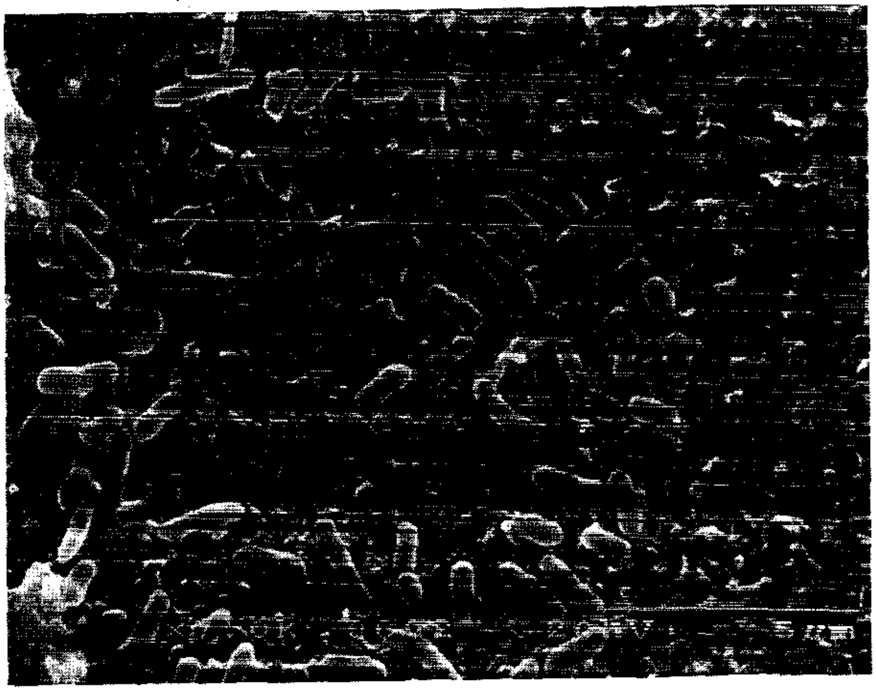
EDAX ZAF Quantification **(Standardless)**
Element Normalized

Element	Wt %	At %	K-Ratio	Z	A	F
C K	43.85	63.34	0.0871	1.0491	0.1894	1.0002
O K	23.82	25.83	0.0412	1.0315	0.1678	1.0002
NaK	0.48	0.36	0.0014	0.9653	0.3093	1.0006
SiK	0.32	0.20	0.0023	0.9885	0.7181	1.0047
AuM	11.40	1.00	0.1087	0.6971	1.3664	1.0010
S K	12.36	6.69	0.0908	0.9777	0.7509	1.0009
ClK	0.92	0.45	0.0063	0.9343	0.7325	1.0006
CrK	0.22	0.07	0.0019	0.8751	0.9763	1.0201
FeK	6.64	2.06	0.0582	0.8755	0.9938	1.0078
Total	100.00	100.00				

X01185 Scan #3

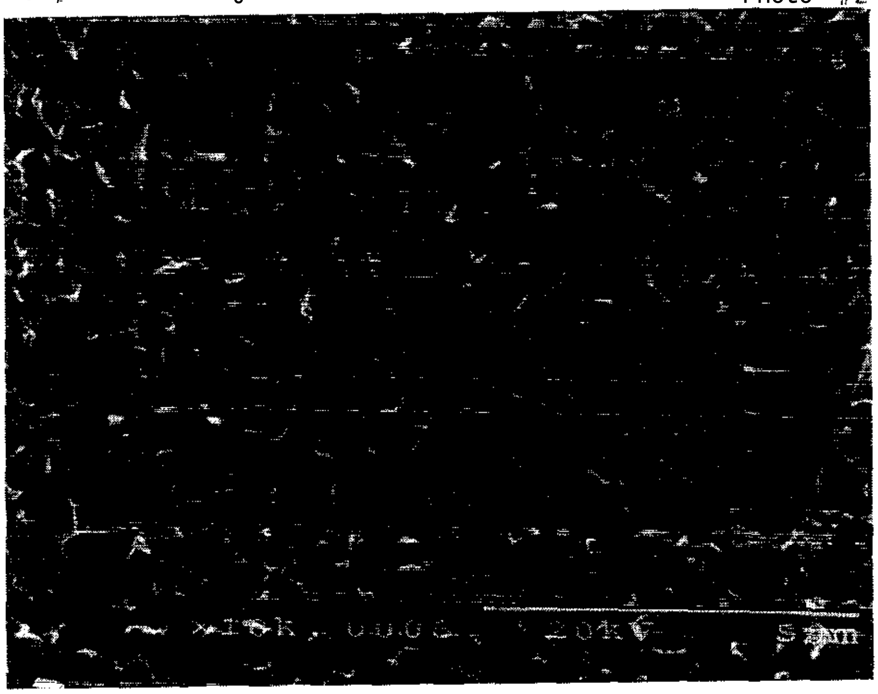
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	122.25	0.26	0.48	465.10
O K	72.91	1.76	0.63	41.43
NaK	3.93	13.70	5.71	0.29
SiK	6.19	20.58	4.41	0.30
AuM	73.20	18.49	0.70	3.96
S K	216.02	19.04	0.38	11.35
ClK	14.08	16.79	2.11	0.84
CrK	2.07	9.17	8.64	0.23
FeK	47.28	8.07	0.84	5.86

Isolated Spot with Bacteria Photo #1



253-82-5 LFCl Element # X01184

10,000X Average Surface Photo #2



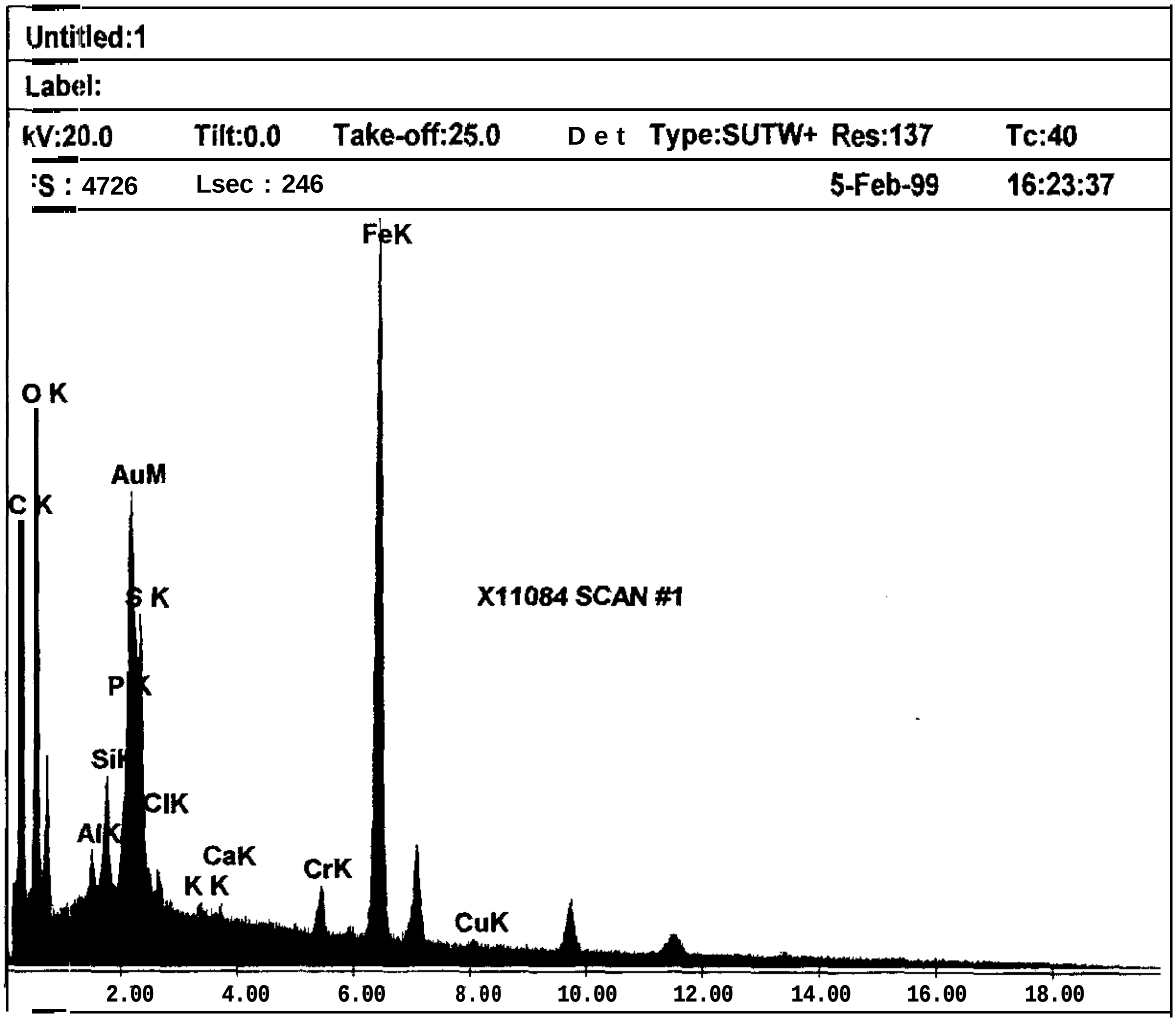
253-82-6 LFCl Element X01184

Fouled Strip Feed Side

Photo #3

253-82-7

LFC1 Element X01184



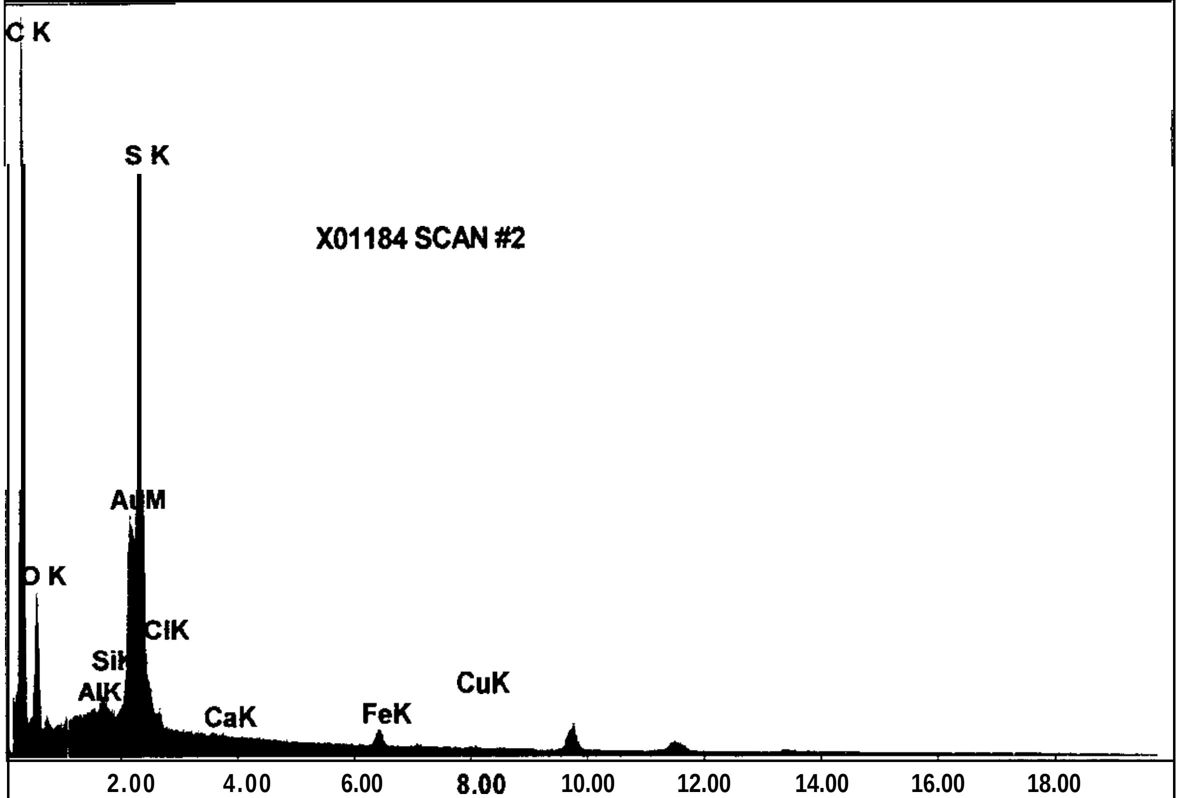
Untitled:1
Label:
kV:20.0 Tilt:0.0 Take-off:25.0 Det Type:SUTW+ Res:137 Tc:40
FS : 4726 Lsec : 246 5-Feb-99 16:23:37
FeK
O K
AuM
C K
S K
X11084 SCAN #1
P K
SiK
ClK
AlK
CaK
K K
CrK
CuK
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00

EDAX ZAF Quantification (Standardless)
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	23.59	46.78	0.0490	1.1002	0.1889	1.0003
O K	21.07	31.38	0.0484	1.0815	0.2122	1.0008
AlK	0.89	0.79	0.0038	1.0062	0.4267	1.0015
SiK	1.71	1.45	0.0097	1.0354	0.5490	1.0020
P K	1.14	0.88	0.0075	1.0068	0.6540	1.0029
AuM	15.83	1.91	0.1300	0.7361	1.1156	1.0003
S K	4.18	3.11	0.0259	1.0345	0.5983	1.0017
ClK	0.58	0.39	0.0039	0.9873	0.6735	1.0024
K K	0.19	0.12	0.0015	0.9886	0.7885	1.0066
CaK	0.19	0.12	0.0017	1.0108	0.8353	1.0104
CrK	1.28	0.59	0.0121	0.9222	0.9579	1.0629
FeK	28.83	12.30	0.2629	0.9242	0.9795	1.0074
CuK	0.51	0.19	0.0044	0.8969	0.9574	1.0167
Total	100.00	100.00				

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	71.44	0.48	0.76	147.57
O K	88.86	3.27	0.69	27.20
AlK	11.38	15.36	2.90	0.74.
SiK	27.30	15.50	1.53	1.76
P K	19.32	15.28	1.94	1.26
AuM	90.96	15.11	0.72	6.02
S K	64.06	16.23	0.89	3.95
ClK	9.00	15.46	3.51	0.58
K K	2.97	14.76	9.04	0.20
CaK	3.01	13.62	8.63	0.22
CrK	13.67	11.17	2.33	1.22
FeK	221.94	10.01	0.44	22.18
CuK	2.23	7.73	9.01	0.29

Untitled:1					
Label:					
kV:20.0	Tilt:0.0	Take-off:25.0	Det Type:SUTW+	Res:137	Tc:40
FS : 8140	Lsec : 231			5-Feb-99	16:53:20



EDAX ZAF Quantification **(Standardless)**
Element **Normalized**

Element	Wt %	At %	K-Ratio	Z	A	F
C K	59.73	77.27	0.1403	1.0355	0.2269	1.0001
O K	16.31	15.84	0.0243	1.0182	0.1461	1.0001
AlK	0.07	0.04	0.0004	0.9483	0.6654	1.0025
SiK	0.17	0.09	0.0013	0.9760	0.7910	1.0045
AuM	10.92	0.86	0.1094	0.6869	1.4582	1.0010
S K	10.99	5.32	0.0841	0.9628	0.7946	1.0003
CaK	0.37 0.04	0.16 0.02	0.0026 0.0003	0.9204 0.9477	0.7729 0.9007	1.0001 1.0006
FeK	1.22	0.34	0.0107	0.8627	1.0000	1.0099
CuK	0.20	0.05	0.0017	0.8344	1.0064	1.0330
Total	100.00	100.00				

X01184 Scan #2

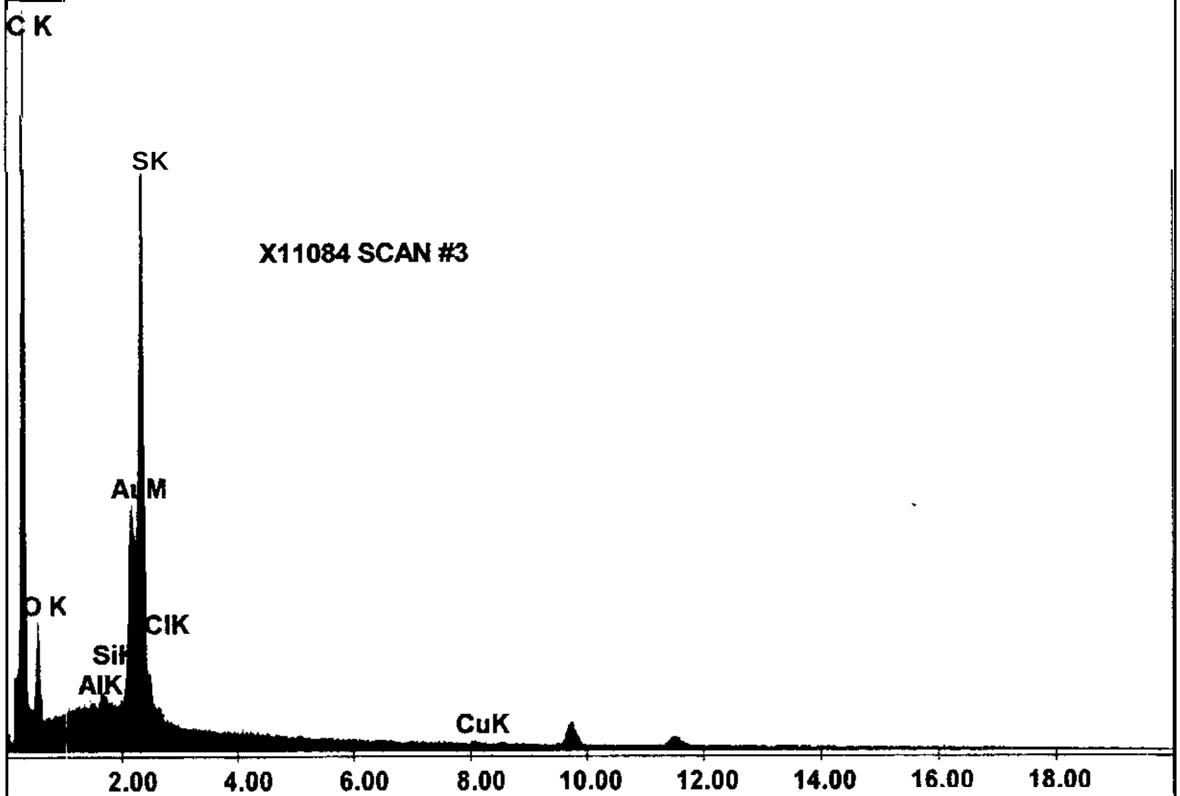
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	218.78	0.72	0.44	303.80
O K	47.66	5.10	1.00	9.35
AlK	1.31	21.03	23.68	0.06
SiK	3.99	19.97	8.06	0.20
AuM	81.88	17.79	0.80	4.60
S K	222.24	18.24	0.46	12.18
ClK	6.49	15.94	4.79	0.41
CaK	0.67	11.29	33.98	0.06
FeK	9.63	6.68	2.75	1.44
CuK	0.91	5.93	18.87	0.15

Untitled:1

Label:

kV:20.0 Tilt:0.0 Take-off:25.0 Det Type:SUTW+ Res:137 Tc:40

FS : 7259 Lsec : 143 5-Feb-99 17:16:25



EDAX ZAF Quantification (Standardless)

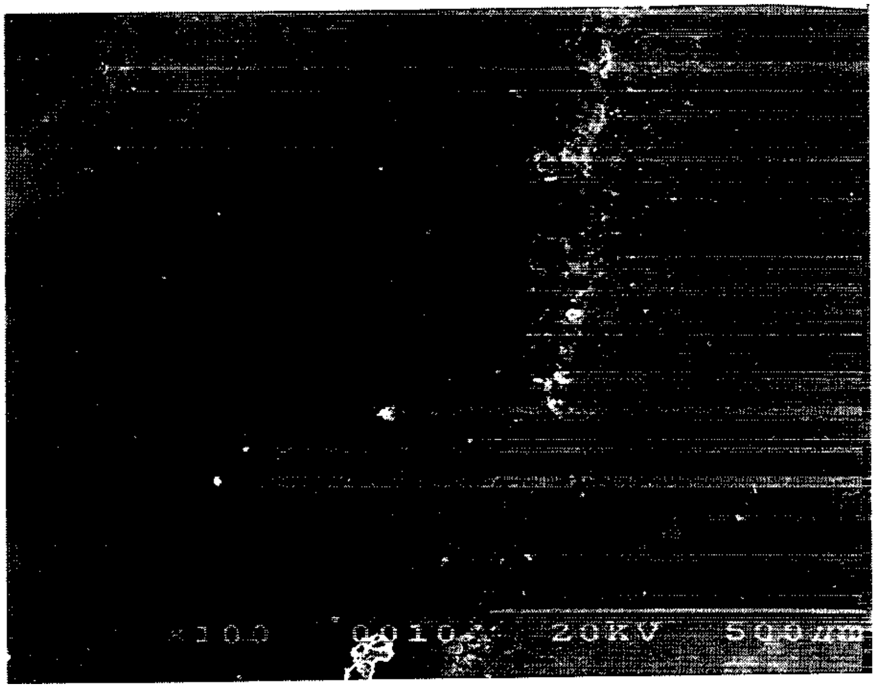
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	63.18	81.13	0.1463	1.0355	0.2236	1.0001
O K	12.39	11.94	0.0176	1.0182	0.1395	1.0001
AlK	0.14	0.08	0.0009	0.9483	0.6842	1.0026
SiK	0.18	0.10	0.0014	0.9760	0.8056	1.0047
AuM	11.74	0.92	0.1190	0.6871	1.4739	1.0010
S K	11.58	5.57	0.0882	0.9631	0.7909	1.0002
ClK	0.36	0.16	0.0026	0.9207	0.7656	1.0000
CuK	0.42	0.10	0.0037	0.8348	1.0073	1.0366
Total	100.00	100.00				

X01184 **Scan #3**

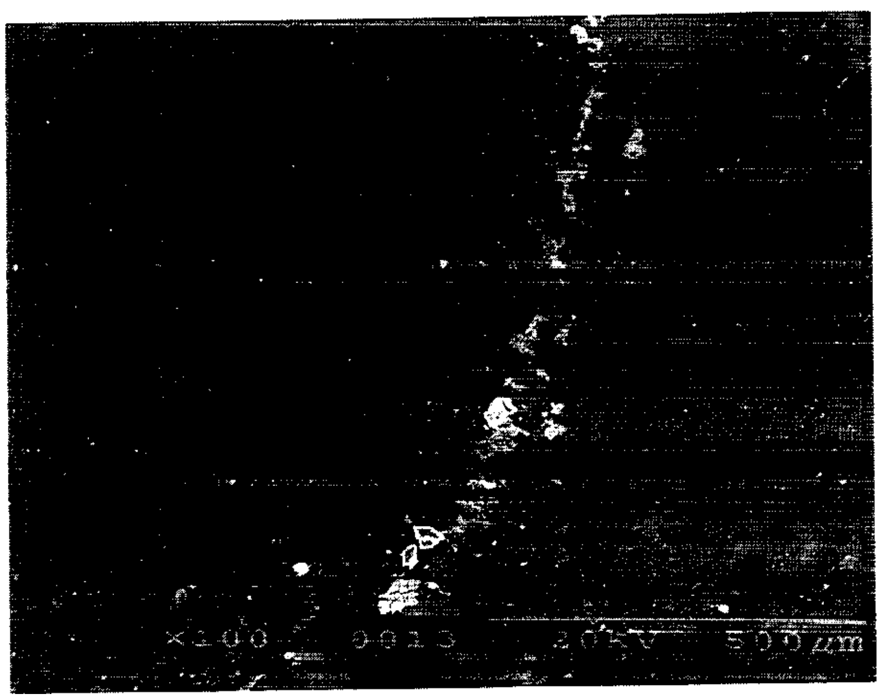
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	313.94	2.09	0.47	149.96
O K	47.53	13.15	1.37	3.62
AlK	3.97	28.79	12.04	0.14
SiK	5.93	27.72	8.17	0.21
AuM	122.56	24.83	0.83	4.94
S K	321.03	25.53	0.48	12.58
ClK	8.75	22.43	5.33	0.39
CuK	2.72	7.02	9.58	0.39

Photo #1



253-84-1 LFC1 Element # X01190 Middle

Photo #2



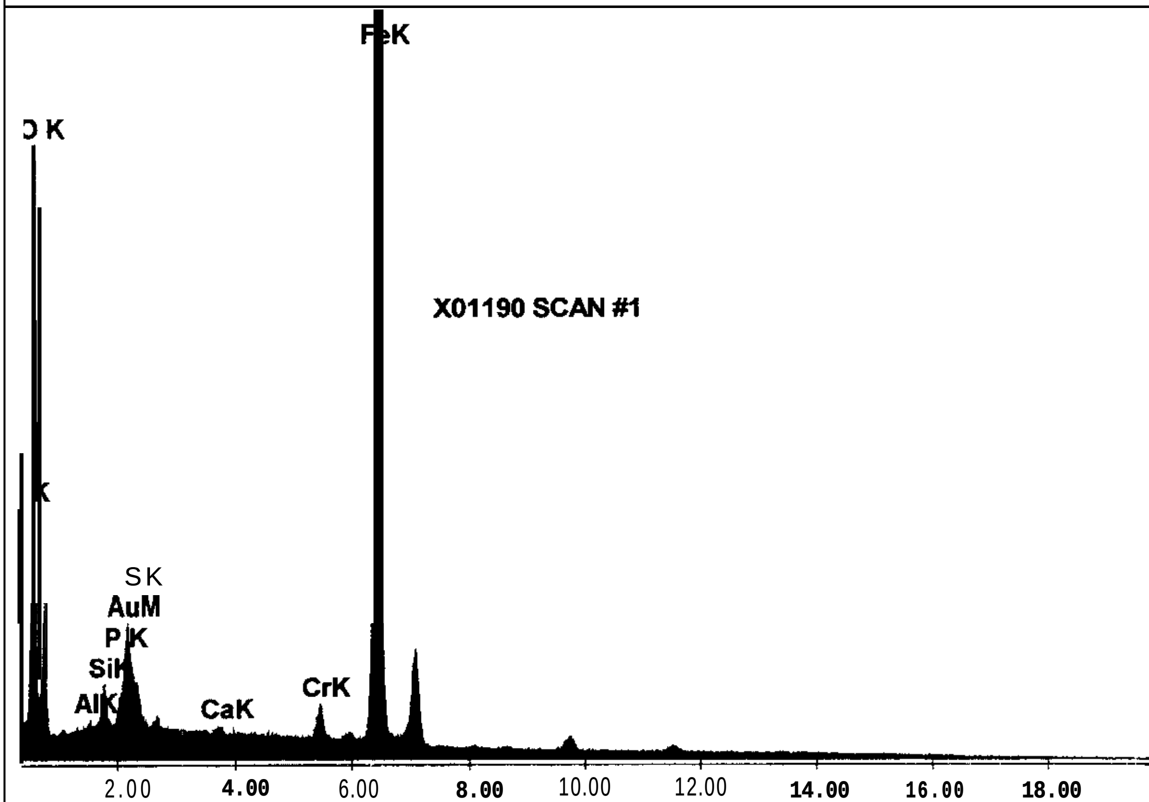
253-84-2 LFC1 Element # X01190 Feed Side

Untitled:1

Label:

kV:20.0 **Tilt:0.0** **Take-off:25.0** Det Type:SUTW+ **Res:138** **Tc:40**

ES : 7909 Lsec : 271 **8-Feb-99** **15:11:26**



EDAX ZAF Quantification (Standardlees)
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	18.31	36.58	0.0441	1.0963	0.2195	1.0004
O K	27.21	40.80	0.0813	1.0777	0.2769	1.0013
AlK	0.23	0.20	0.0009	1.0029	0.3722	1.0008
SiK	0.99	0.85	0.0051	1.0320	0.4976	1.0012
P K	0.57	0.44	0.0035	1.0009	0.6145	1.0018
AuM	6.21	0.76	0.0480	0.7313	1.0563	1.0001
S K	0.99	0.74	0.0067	1.0269	0.6580	1.0024
CaK	0.18	0.11	0.0017	1.0062	0.9064	1.0206
CrK	1.30	0.60	0.0133	0.9170	0.9891	1.1291
FeK	44.01	18.91	0.4049	0.9180	0.9993	1.0028
Total	100.00	100.00				

x01190 Scan #1

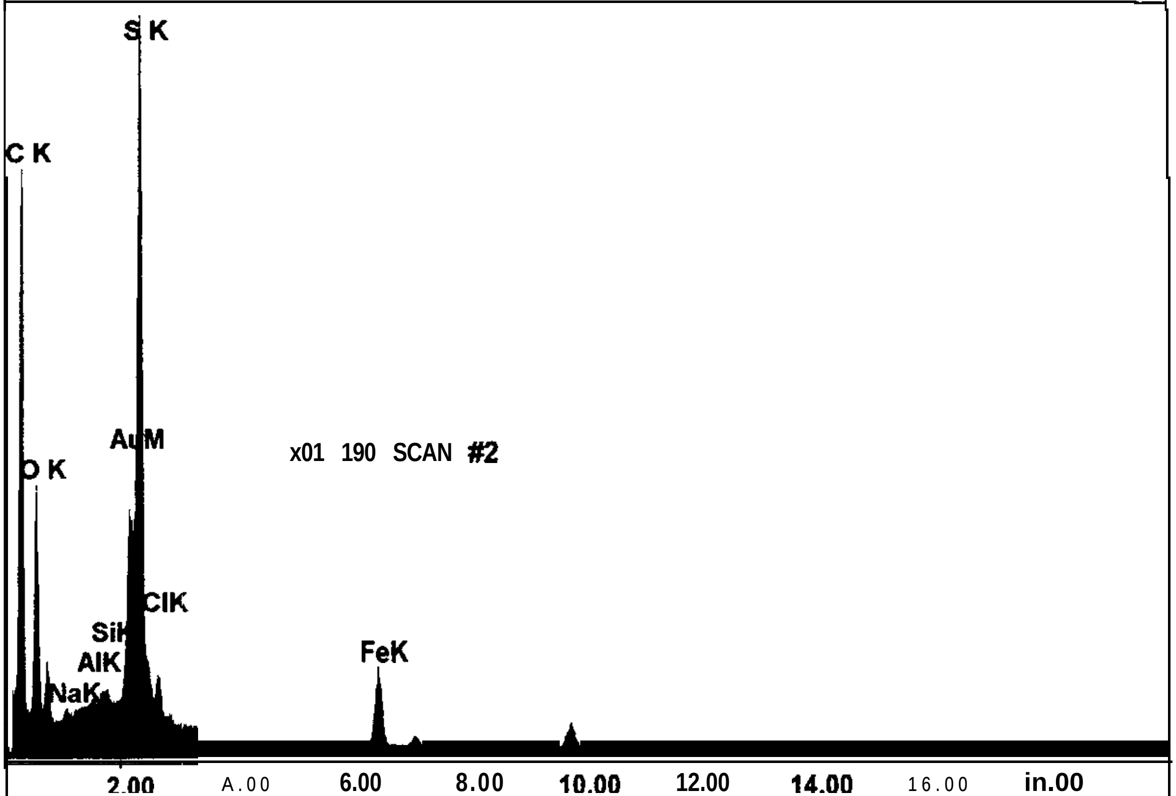
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	62.53	0.38	0.77	166.32
O K	145.28	2.33	0.51	62.46
AlK	2.41	11.87	9.31	0.21
SiK	13.92	12.16	2.23	1.14
P K	8.80	12.16	3.16	0.72
AuM	32.65	12.10	1.24	2.10
S K	16.14	13.14	2.04	1.23
CaK	2.95	11.98	7.96	0.25
CrK	14.63	11.39	2.12	1.28
FeK	332.64	9.83	0.34	33.85

Untitled:1

Label:

kV:20.0 TWO.0 Take-off:25.0 Det Type:SUTW+ Res:138 Tc:40

FS : 10580 Lsec : 304 8-Feb-99 15:40:04



EDAX ZAF Quantification **(Standardless)**
Element Normalized

Element	Wt %	At%	K-Ratio	Z	A	F
C K	49.65	67.97	0.1015	1.0408	0.1963	1.0002
O K	21.91	22.51	0.0358	1.0234	0.1598	1.0002
NaK	0.34	0.24	0.0011	0.9578	0.3294	1.0007
AlK	0.02	0.02	0.0001	0.9531	0.6170	1.0028
SiK	0.24	0.14	0.0018	0.9809	0.7487	1.0052
AuM	9.43	0.79	0.0917	0.6906	1.4075	1.0011
S K	12.59	6.46	0.0965	0.9681	0.7914	1.0009
ClK	0.95	0.44	0.0067	0.9254	0.7578	1.0004
FeK	4.87	1.43	0.0425	0.8673	0.9992	1.0074
Total	100.00	100.00				

X01190 Scan #2

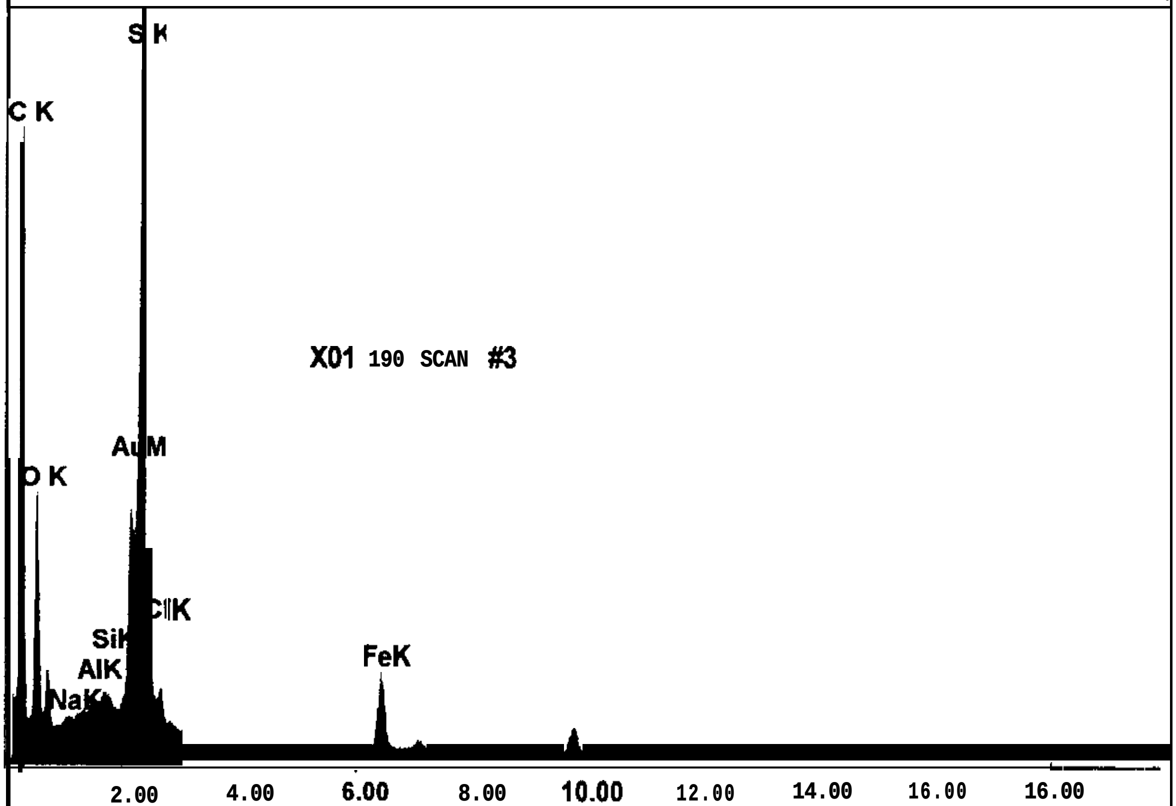
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	173.07	0.54	0.44	319.81
O K	77.03	4.34	0.67	17.74
NaK	3.54	16.30	7.20	0.22
AlK	0.51	26.60	59.03	0.02
SiK	5.75	25.15	5.54	0.23
AuM	75.12	23.19	0.76	3.24
S K	279.25	23.58	0.36	11.84
ClK	18.15	20.28	1.96	0.89
FeK	42.01	8.92	0.97	4.71

Untitled:1

Label:

kV:20.0 Tilt:0.0 Take-offz25.0 Det Type:SUTW+ Res:138 Tc:40

FS : 10545 Lsec : 321 8-Feb-99 15:56:23



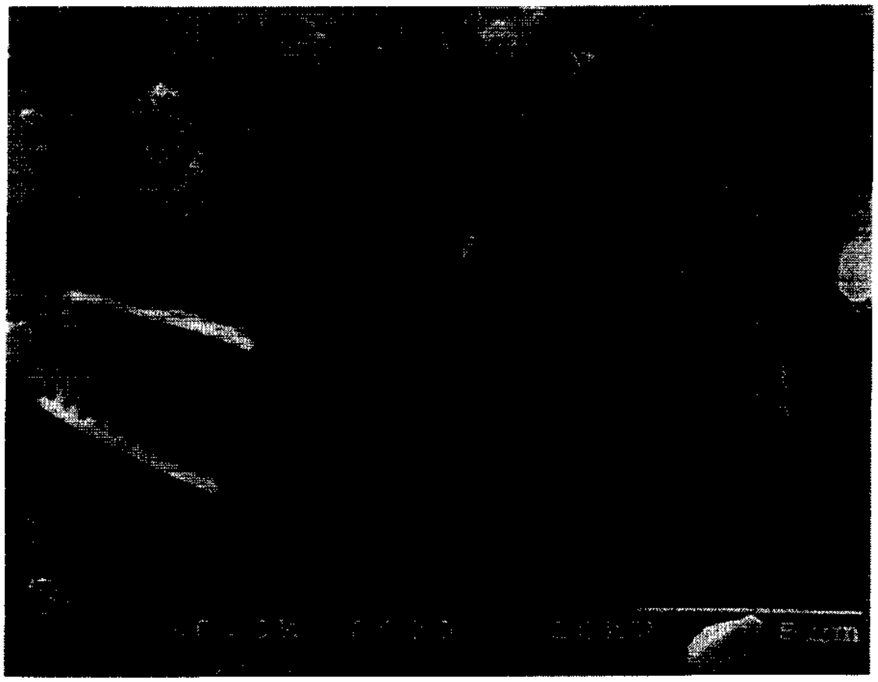
EDAX ZAF Quantification (Standardless)
Element **Normalized**

Element	Wt%	At%	K-Ratio	Z	A	F
C K	**50.90**	69.14	0.1068	1.0401	0.2017	1.0002
O K	**21.52**	21.95	0.0349	1.0227	0.1584	1.0002
NaK	0.07	0.05	0.0002	0.9572	0.3314	1.0006
AlK	0.00	0.00	0.0000	0.9524	**0.6224**	**1.0027**
SiK	0.18	0.10	**0.0013**	0.9802	0.7539	1.0050
AuM	9.66	0.80	0.0944	0.6901	1.4148	1.0011
S K	12.31	**6.26**	0.0943	0.9674	0.7917	1.0008
ClK	0.78	0.36	0.0055	0.9248	0.7603	1.0004
FeK	4.59	1.34	**0.0400**	**0.8667**	0.9994	1.0076
Total	100.00	100.00				

x01190 Scan #3

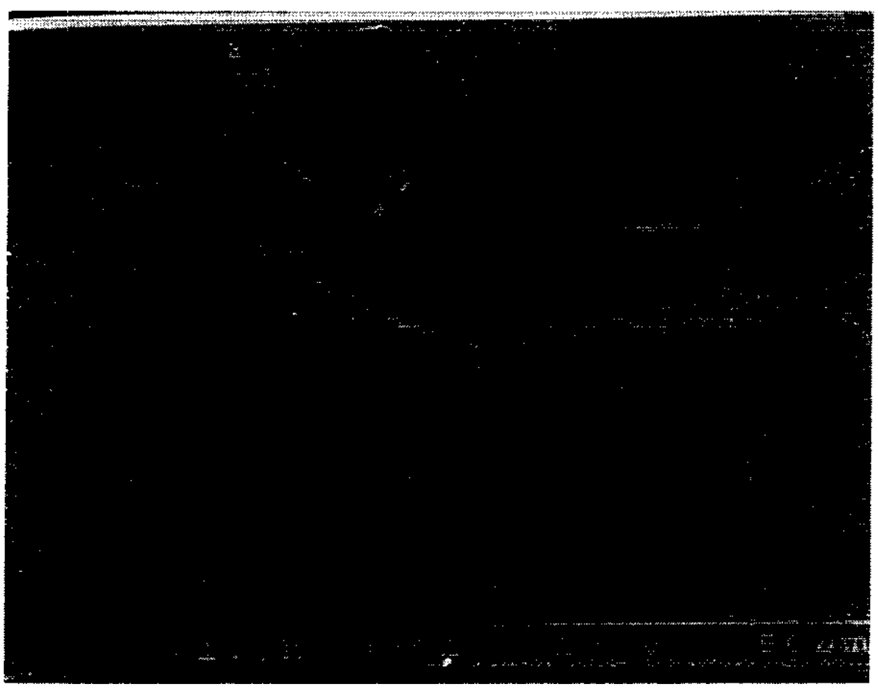
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	174.83	0.44	0.42	400.98
O K	71.93	3.25	0.67	22.10
NaK	0.68	16.83	34.39	0.04
AlK	0.00	26.80	0.00	0.00
SiK	4.21	24.65	7.12	0.17
AuM	74.19	20.97	0.73	3.54
S K	261.78	21.35	0.36	12.26
ClK	14.29	18.42	2.23	0.78
FeK	37.96	8.60	1.00	4.41

Isolated Diatom Piece on Isolated Black Spot of Foulant Photo #1



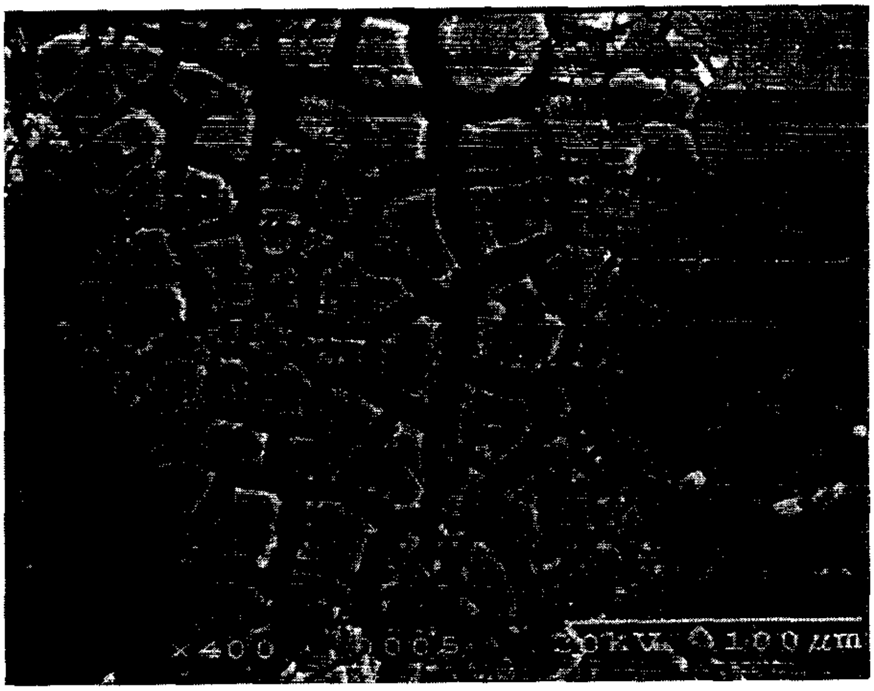
253-82-1 LFCl Element # X01183

Photo #2



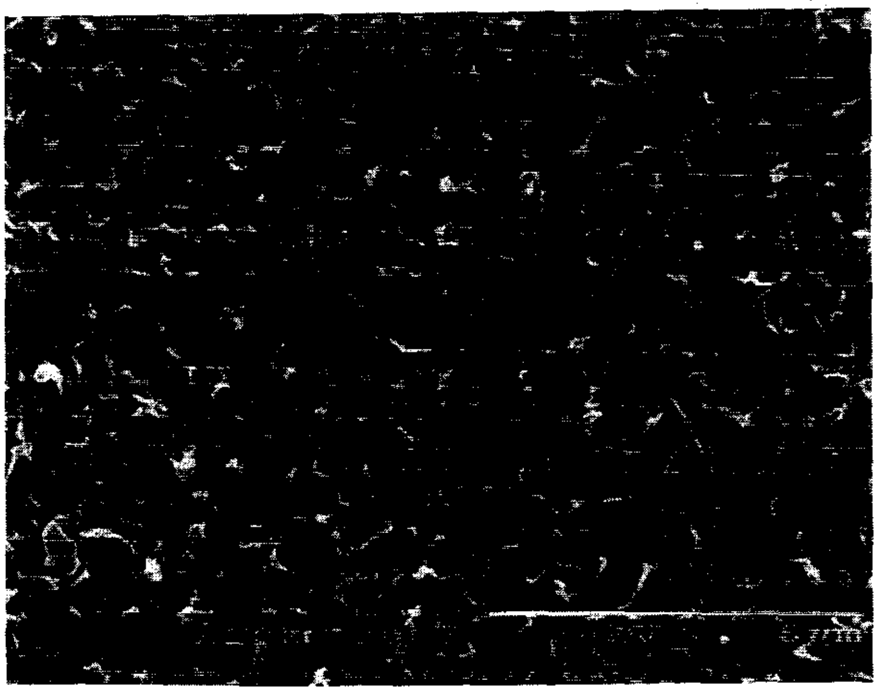
253-82-2 LFCl Element # X01183

Photo #3



253-82-3 LFCl Element # X01183

Photo #4

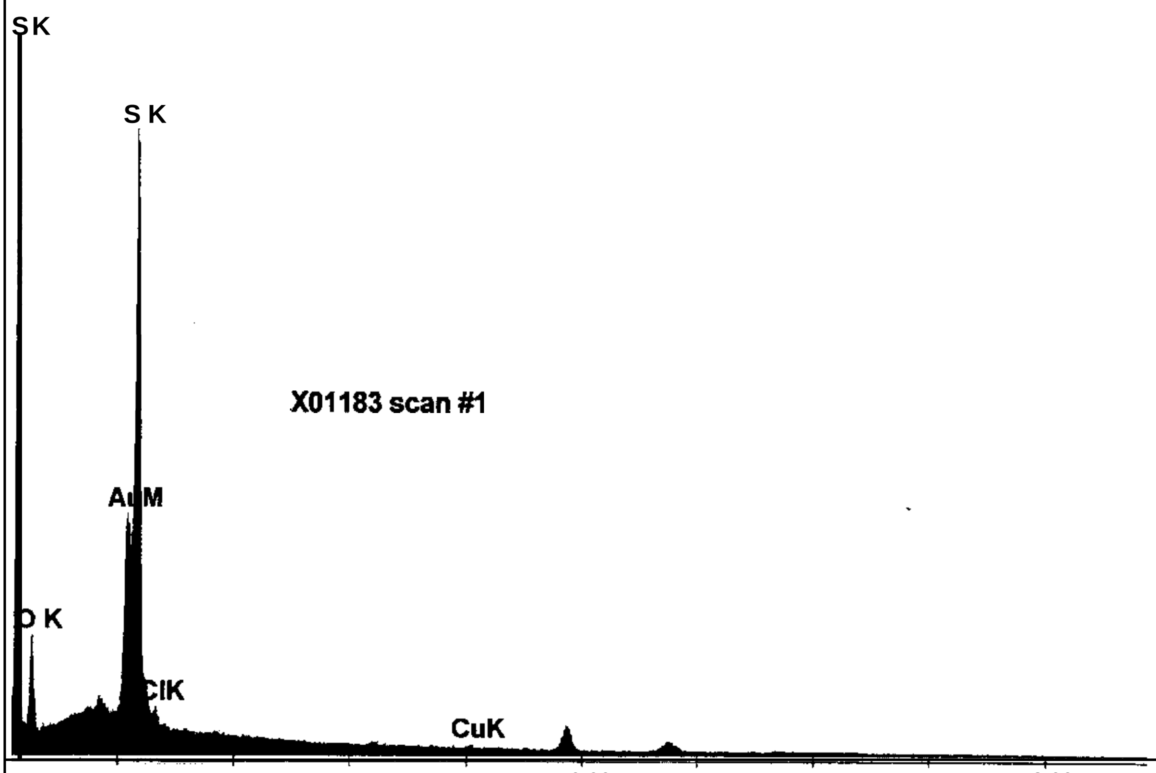


253-82-4 LFCl Element # X01183

Untitled:1

Label:

kV:20.0	Tilt:0.0	Takeoffz25.0	Det Type:SUTW+	Res:137	Tc:40
FS : 7884	Lsec : 305			3-Feb-99	13:12:27

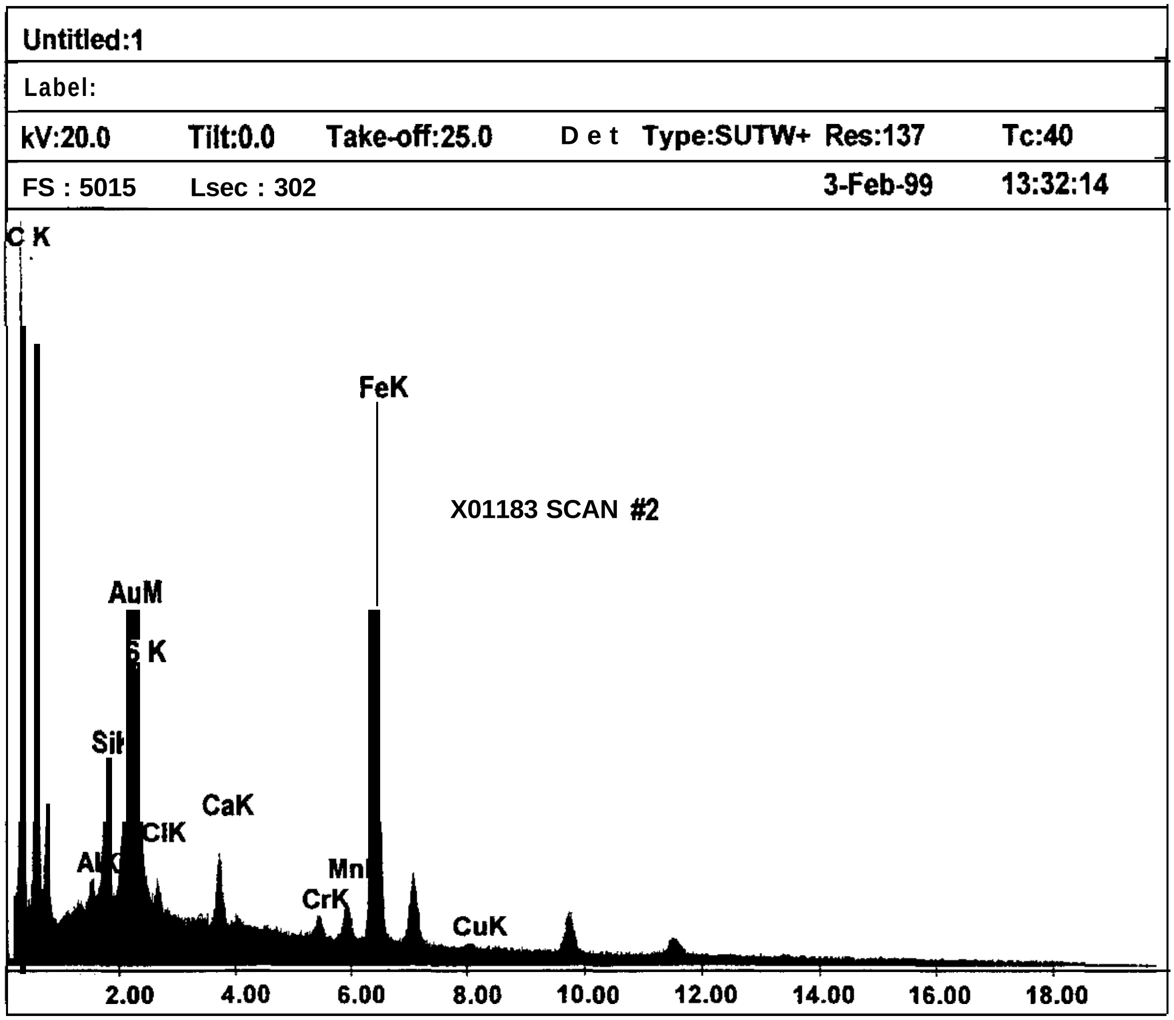


EDAX ZAF Quantification **(Standardless)**
Element **Normalized**

Element	Wt%	At%	K-Ratio	Z	A	F
C K	63.65	El.44	0.1451	1.0348	0.2202	1.0001
O K	12.03	11.56	0.0170	1.0174	0.1386	1.0001
AuM	11.30	0.88	0.1152	0.6864	1.4839	1.0011
S K	12.14	5.82	0.0935	0.9622	0.8004	1.0003
ClK	0.45	0.20	0.0032	0.9198	0.7675	1.0000
CuK	0.43	0.10	0.0037	0.8339	1.0076	1.0356
Total	100.00	100.00				

X01183 Scan #1

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	158.81	0.83	0.46	190.26
O K	23.41	5.01	1.30	4.67
AuM	60.55	12.58	0.81	4.81
S K	173.58	12.69	0.45	13.67
ClK	5.59	10.76	4.14	0.52
CuK	1.41	3.83	9.27	0.37

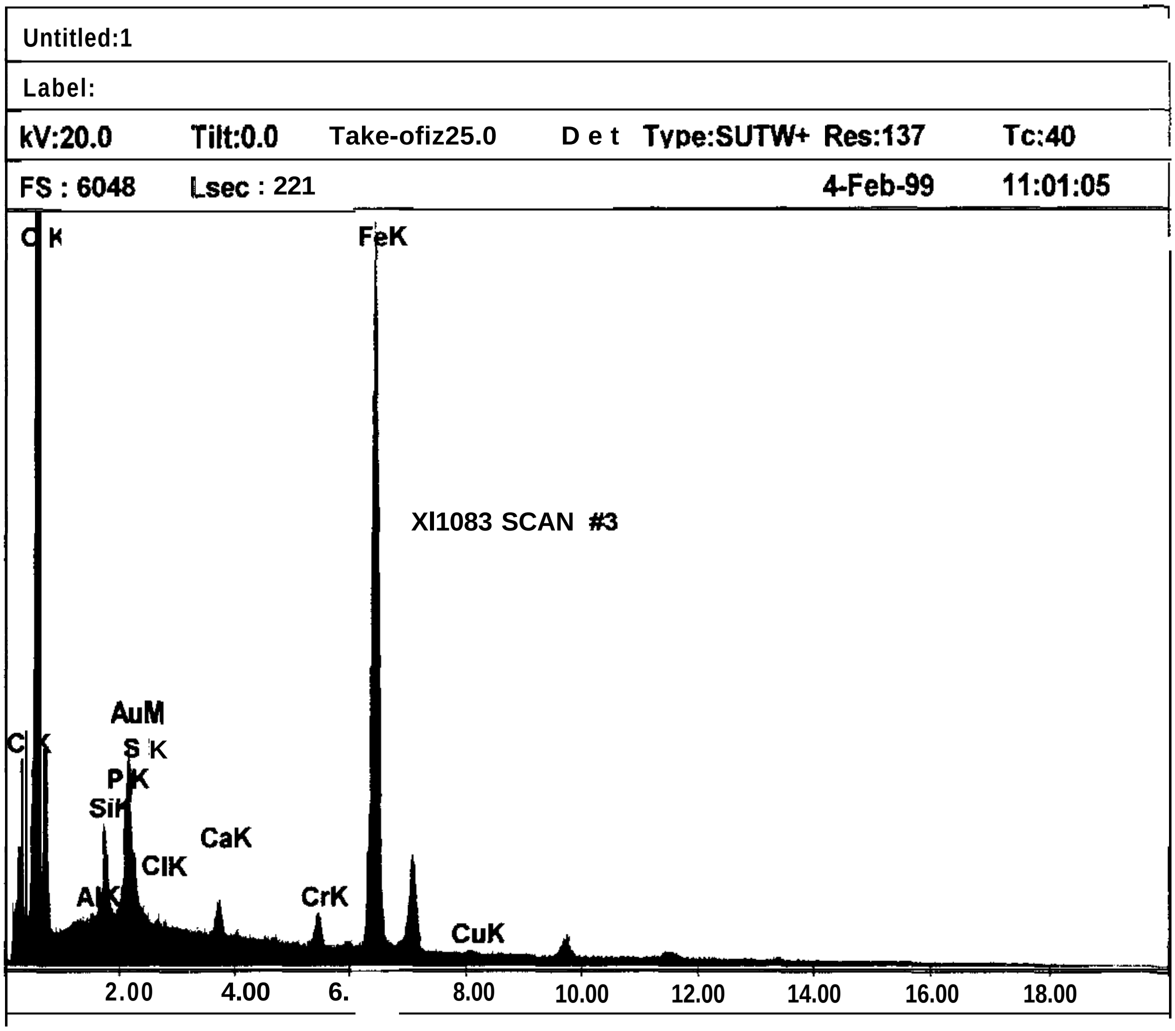


Untitled:1
Label:
kV:20.0 Tilt:0.0 Take-off:25.0 Det Type:SUTW+ Res:137 Tc:40
FS : 5015 Lsec : 302 3-Feb-99 13:32:14
C K
FeK
X01183 SCAN #2
AuM
K
CaK
ClK
MnK
CrK
CuK
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00

EDAX ZAF Quantification (Standardless)
Element Normalized

Element	Wt %	At%	K-Ratio	Z	A	F
C K	33.00	55.12	0.0808	1.0743	0.2278	1.0003
O K	24.44	30.65	0.0518	1.0562	0.2007	1.0006
AlK	0.53	0.39	0.0024	0.9831	0.4682	1.0013
SiK	1.83	1.31	0.0111	1.0117	0.5971	1.0015
AuM	11.83	1.20	0.1002	0.7160	1.1831	1.0003
S K	3.29	2.06	0.0222	1.0051	0.6687	1.0017
ClK	0.47	0.26	0.0033	0.9600	0.7393	1.0025
CaK	1.03	0.52	0.0090	0.9854	0.8827	1.0096
CrK	0.65	0.25	0.0060	0.8981	0.9759	1.0564
MnK	1.22	0.45	0.0107	0.8821	0.9864	1.0045
FeK	21.33	7.66	0.1916	0.8991	0.9924	1.0069
CuK	0.38	0.12	0.0033	0.8710	0.9725	1.0154
Total	100.00	100.00				

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	102.25	0.39	0.57	264.38
O K	82.68	2.50	0.64	33.13
AlK	6.30	11.43	3.84	0.55
SiK	26.99	11.60	1.32	2.33.
AuM	60.89	11.42	0.80	5.33
S K	47.59	12.33	0.94	3.86
ClK	6.74	11.83	3.68	0.57
CaK	14.25	10.68	2.01	1.33
CrK	5.95	8.10	3.62	0.73
MnK	9.12	7.97	2.61	1.14
FeK	140.48	7.30	0.50	19.24
CuK	1.43	5.69	10.74	0.25

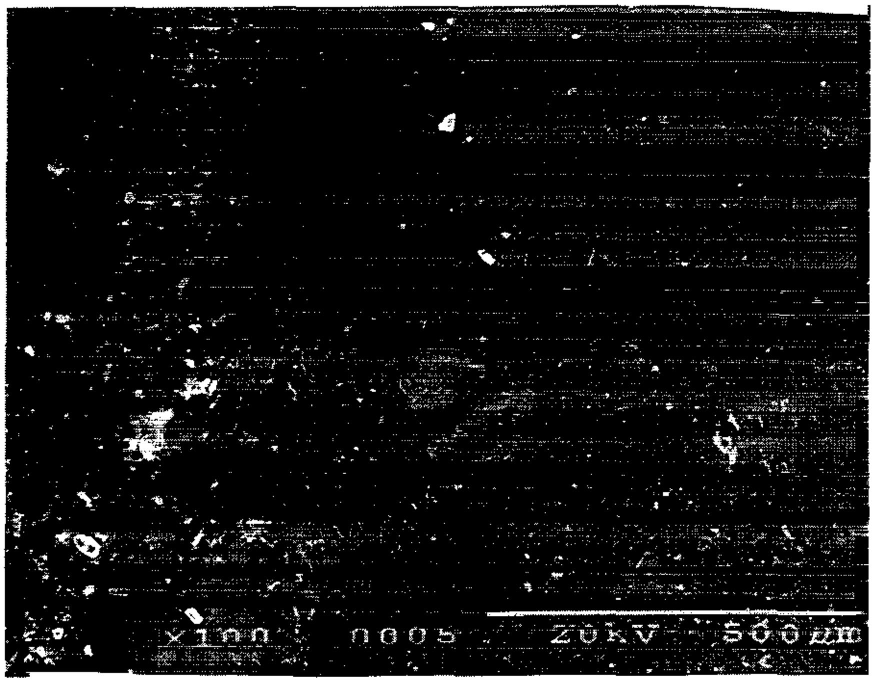

Untitled:1
Label:
kV:20.0 Tilt:0.0 Take-ofiz25.0 Det Type:SUTW+ Res:137 Tc:40
FS : 6048 Lsec : 221 4-Feb-99 11:01:05
FeK
XI1083 SCAN #3
AuM
CaK
ClK
CrK
CuK
2.00
4.00
6.
8.00
10.00
12.00
14.00
16.00
18.00

EDAX ZAF Quantification (Standardless)
Element Normalized

Element	Wt%	At %	K-Ratio	Z	A	F
C K	14.48	30.20	0.0342	1.1023	0.2145	1.0004
O K	29.76	46.61	0.0896	1.0836	0.2774	1.0011
AlK	0.13	0.12	0.0005	1.0082	0.3748	1.0010
SiK	1.91	1.71	0.0099	1.0374	0.5004	1.0010
P K	0.60	0.49	0.0037	1.0077	0.6086	1.0015
AuM	10.06	1.28	0.0775	0.7366	1.0465	1.0001
S K	0.36	0.28	0.0023	1.0348	0.6190	1.0022
ClK	0.09	0.07	0.0007	0.9879	0.7184	1.0038
CaK	0.77	0.48	0.0069	1.0123	0.8793	1.0167
CrK	1.11	0.53	0.0110	0.9231	0.9759	1.1026
FeK	40.34	18.10	0.3716	0.9'246	0.9914	1.0049
CuK	0.39	0.15	0.0034	0.8964	0.9474	1.0095
Total	100.00	100.00				

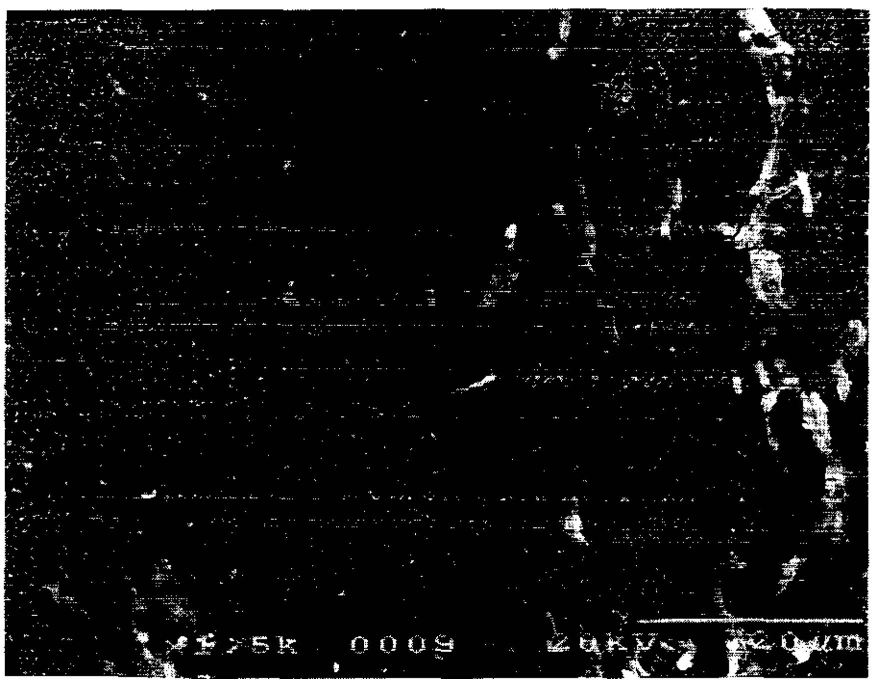
Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	50.22	0.47	0.95	107.85
O K	165.53	2.89	0.53	57.30
AlK	1.43	16.11	19.65	0.09
SiK	27.99	16.16	1.60	1.73
P K	9.57	15.81	3.54	0.60
AuM	54.58	15.60	1.03	3.50
S K	5.71	16.68	5.58	0.34
ClK	1.56	15.75	17.94	0.10
CaK	12.65	12.85	2.68	0.98
CrK	12.51	10.40	2.57	1.20
FeK	315.64	9.58	0.38	32.97
CuK	1.70	6.64	11.45	0.26

Photo #1



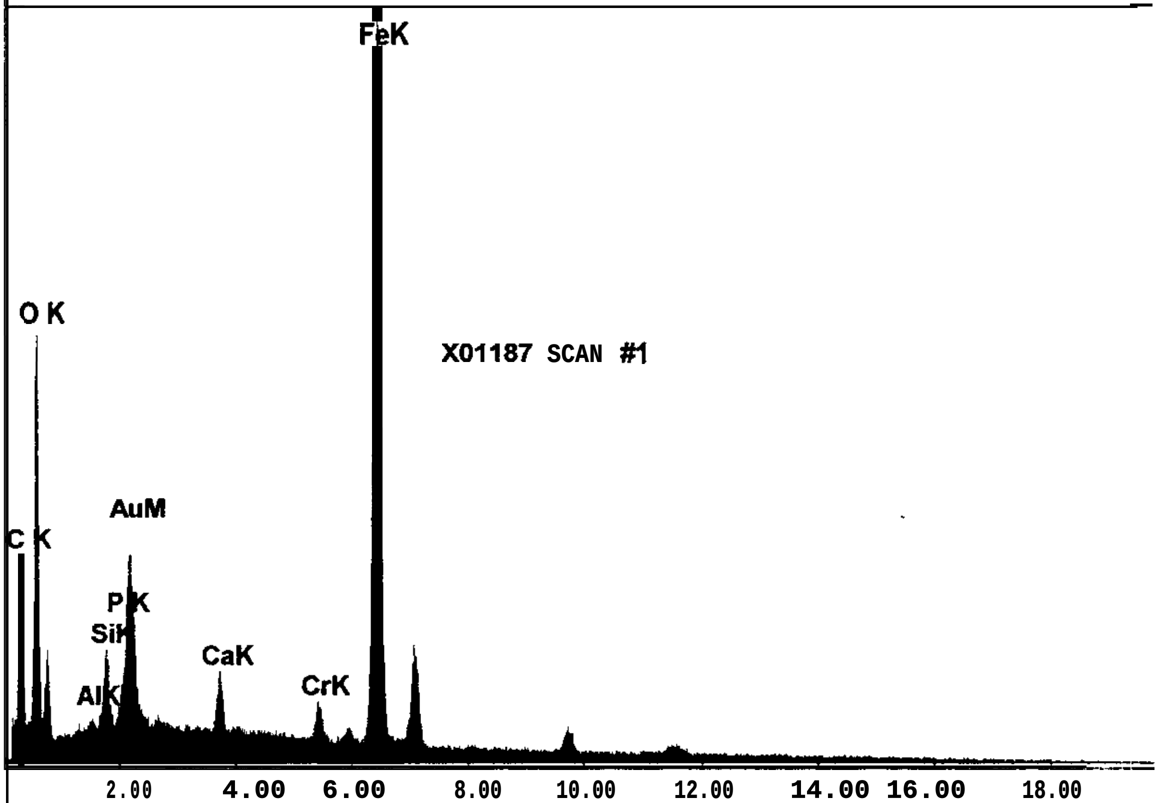
253-83-3 LFC1 Element # X01187 Feed Side

Area Near the Zero of X100 on Photo #3 Photo #2



253-83-4 LFC1 Element # X01187

Untitled:1					
Label:					
kV:20.0	Tilt:0.0	Take-offz25.0	Det Type:SUTW+	Res:138	Tc:40
FS: 3518	Lsec : 129			8-Feb-99	13:06:09



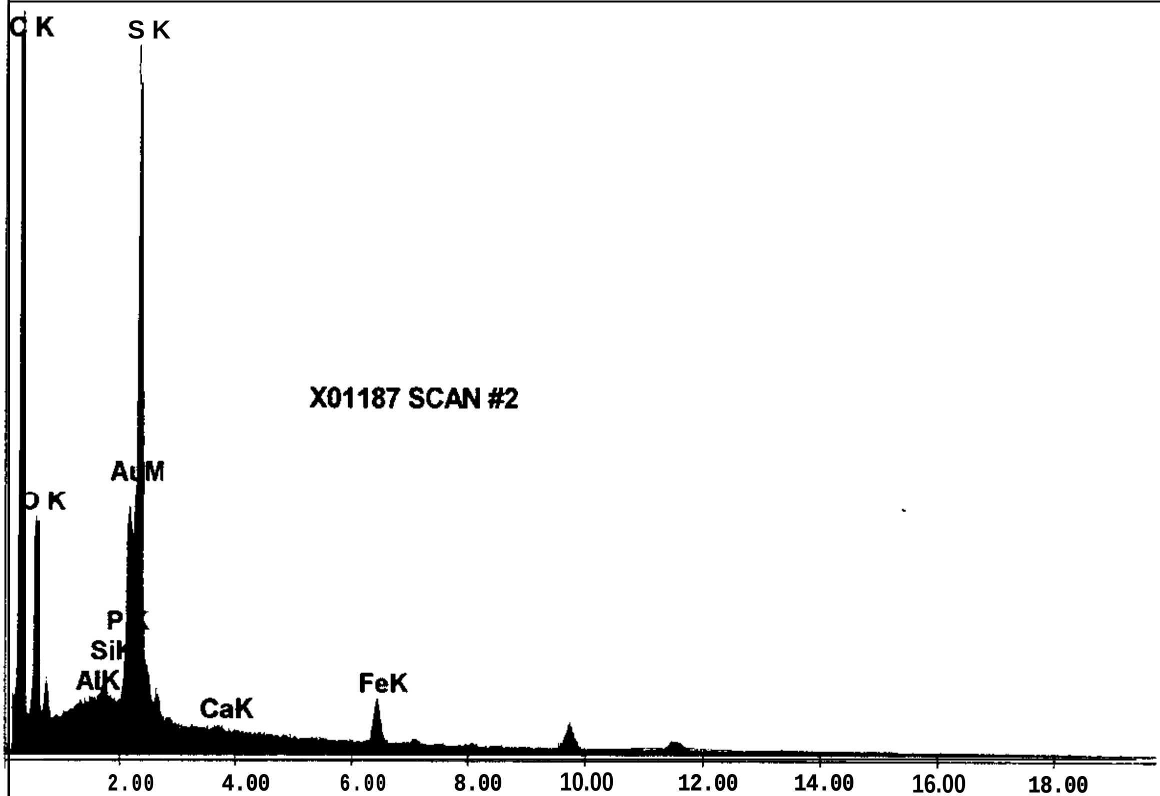
EDAX ZAF Quantification (Standardless)
Element **Normalized**

Element	Wt%	At%	K-Ratio	Z	A	F
C K	16.55	36.94	0.0386	1.1144	0.2095	1.0004
O K	21.00	35.18	0.0581	1.0954	0.2522	1.0014
AlK	0.38	0.38	0.0014	1.0190	0.3643	1.0010
SiK	1.84	1.76	0.0094	1.0484	0.4860	1.0011
P K	0.83	0.72	0.0050	1.0199	0.5949	1.0015
AuM	11.02	1.50	0.0842	0.7458	1.0247	1.0001
CaK	1.39	0.93	0.0126	1.0240	0.8687	1.0179
CrK	1.45	0.75	0.0145	0.9342	0.9697	1.1072
FeK	45.54	21.85	0.4224	0.9361	0.9866	1.0043
Total	100.00	100.00				

X01187 Scan #1

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	49.10	0.52	1.26	94.97
O K	92.99	2.41	0.92	38.63
AlK	3.65	11.49	9.36	0.32
SiK	22.91	12.01	2.27	1.91
P K	11.27	12.27	3.78	0.92
AuM	51.37	12.31	1.36	4.17
CaK	19.87	13.12	2.54	1.51
CrK	14.35	11.17	3.09	1.28
FeK	310.78	9.56	0.51	32.51

Untitled:1					
Label:					
kV:20.0	Tilt:0.0	Take-off:25.0	Det Type:SUTW+	Res:138	Tc:40
FS : 7638	Lsec : 322			8-Feb-99	13:13:24



EDAX ZAF Quantification **(Standardless)**
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	55.81	73.06	0.1267	1.0352	0.2193	1.0001
O K	19.69	19.35	0.0306	1.0179	0.1526	1.0001
AlK	0.11	0.07	0.0007	0.9480	0.6492	1.0027
SiK	0.28	0.16	0.0021	0.9757	0.7768	1.0048
P K	0.08	0.04	0.0007	0.9410	0.8699	1.0086
AuM	9.45	0.75	0.0935	0.6864	1.4406	1.0010
S K	11.76	5.77	0.0911	0.9621	0.8045	1.0002
CaK	0.14	0.06	0.0012	0.9473	0.9069	1.0012
FeK	2.68	0.75	0.0233	0.8621	1.0017	1.0082
Total	100.00	100.00				

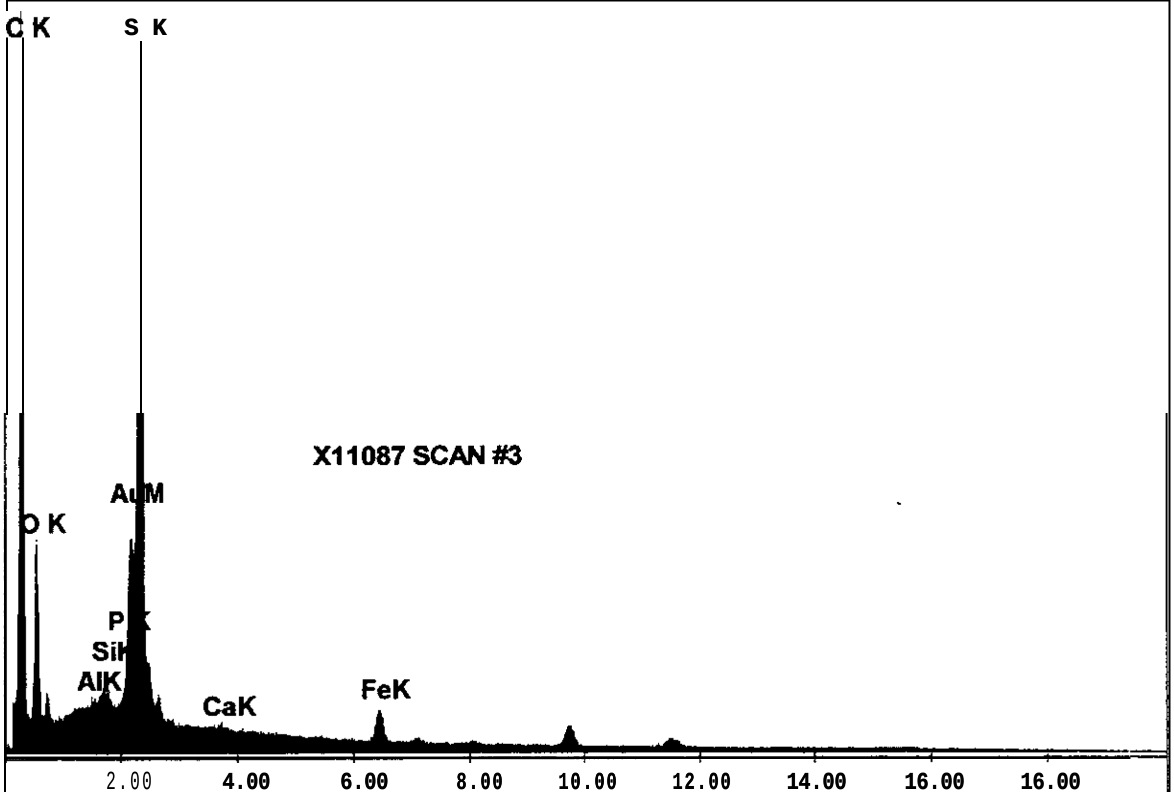
X01187 Scan #2

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	148.65	0.39	0.46	377.71
O K	45.21	2.76	0.85	16.39
AlK	1.65	15.53	13.95	0.11
SiK	4.78	15.91	5.30	0.30
P K	1.40	15.28	16.27	0.09
AuM	52.68	14.60	0.87	3.61
S K	181.18	14.77	0.43	12.27
CaK	1.82	a.77	9.97	0.21
FeK	15.83	5.64	1.63	2.81

Untitled:1

Label:

kV:20.0	Tilt:0.0	Take-offZ25.0	Det Type:SUTW+	Res:138	Tc:40
FS : 7241	Lsec : 299			8-Feb-99	13:28:31



EDAX ZAF Quantification (Standardless)
Element Normalized

Element	Wt%	At%	K-Ratio	Z	A	F
C K	57.35	74.15	0.1283	1.0329	0.2166	1.0001
O K	18.74	18.19	0.0286	1.0157	0.1502	1.0001
AlK	0.14	0.08	0.0009	0.9460	0.6607	1.0030
SiK	0.32	0.18	0.0025	0.9736	0.7872	1.0053
P K	0.22	0.11	0.0019	0.9385	0.8780	1.0092
AuM	8.55	0.67	0.0851	0.6845	1.4526	1.0011
S K	12.26	5.94	0.0964	0.9593	0.8195	1.0002
CaK	0.13	0.05	0.0011	0.9450	0.9123	1.0011
FeK	2.29	0.64	0.0199	0.8597	1.0033	1.0077
Total	100.00	100.00				

X01187 Scan #3

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	148.25	0.50	0.48	298.09
O K	41.62	3.37	0.93	12.36
AlK	2.03	14.43	11.55	0.14
SiK	5.56	13.80	4.57	0.40
P K	3.80	12.77	6.19	0.30
AuM	47.20	12.30	0.94	3.84
S K	188.79	12.61	0.43	14.97
CaK	1.57	8.99	11.99	0.17
FeK	13.29	4.98	1.86	2.67

APPENDIX J

San Pasqual Wastewater IMS Raw Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
5	19-Feb-98	87.4	0	18.8	18.1	12.2	6.25	10	53.333333	13.762948	19.8	19	13	6.4	10	53.33333333	13.44037903		
6		88.8	0	19.1	18.3	12.4	6.3	10	53.333333	13.653718	19.8	19.1	13.4	6.05	10	53.33333333	14.21792162		
7		92.2	0	19.8	19.1	14.2	5.25	8	42.666667	13.10757	20.2	19.8	15.2	4.8	8	42.66666667	14.3364043		
8	20-Feb-98	102	0	20	19.7	16.1	3.75	6	32	13.762948	21.1	19.3	16.8	3.4	6	32	15.1797222		
9		103.3	0	20.2	18.3	12.2	6.5	10	53.333333	13.233604	20	19.2	13.2	6.4	10	53.33333333	13.44037903		
10		104.6	0	20.4	18.6	11.7	7.2	10	53.333333	11.947004	20.1	19.5	12.8	7	10	53.33333333	12.28834654		
11	23-Feb-98	111.5	0	20.6	18.9	11.6	7.1	10	53.333333	12.115271	19.8	19	12.5	6.9	10	53.33333333	12.46643852		
12		112.7	0	20.8	19.2	11.5	7.55	10	53.333333	11.393169	19.5	18.7	11.7	7.4	10	53.33333333	11.62411159		
13		113.9	0	21	19.5	11.4	4.7	8	42.666667	14.641434	20.5	19.9	14.8	5.4	8	42.66666667	12.74347049		
14		115.1	0	19.1	19.8	11.3	8.05	8	42.666667	8.548415	19.5	18.8	11.8	7.35	8	42.66666667	9.362549745		
15		116.3	0	19.2	20.1	11.2	4.5	8	42.666667	15.292165	19.9	19.7	14.8	5	8	42.66666667	13.76294812		
16	24-Feb-98	117.5	0	19	18.2	11.5	7.35	8	42.666667	9.3625497	20.3	19.8	14.7	5.35	8	42.66666667	12.86256834		
17		118.7	0	18.9	17.9	10.4	8	8	42.666667	8.6018426	20.2	19.9	14.2	5.85	8	42.66666667	11.76320353		
18		120.3	0	19.5	18.9	14.5	4.7	8	42.666667	14.641434	21.5	20.1	13.9	6.9	8	42.66666667	9.973150815		
19		122.1	0	18.9	18.1	13.5	5	8	42.666667	13.762948	20.5	19.9	14.6	5.6	8	42.66666667	12.28834654		
20	25-Feb-98	125.1	0	19.1	18.9	14.5	4.5	8	42.666667	15.292165	20.2	19.8	14.8	5.2	8	42.66666667	13.23360397		
21		136		19.5	18.8	14.9	4.25	8	42.666667	16.191704	21	20.1	15.2	5.35	8	42.66666667	12.86256834		
22		138.1	0	19.1	18.9	12.9	6.1	8	42.666667	11.281105	20.5	20	13.8	6.45	8	42.66666667	10.66895203		
23		144.6	0	19.5	18.7	12.9	6.2	8	42.666667	11.099152	20	19.3	14.4	5.25	8	42.66666667	13.10756964		
24	26-Feb-98	148.2	0	19.4	18.9	13.7	5.45	8	42.666667	12.626558	20.1	19.9	14.6	5.4	8	42.66666667	12.74347049		
25		161.2	0	19.2	18.9	13.8	5.25	8	42.666667	13.10757	20.9	20.1	14.2	6.3	8	42.66666667	10.9229747		
26		164.6	0	19.9	19.1	13.9	5.6	8	42.666667	12.288347	20.9	20.2	13.6	6.95	8	42.66666667	9.901401529		
27	27-Feb-98	167.8	0	19.7	19	13.2	6.15	8	42.666667	11.189389	20	19.5	13.5	6.25	8	42.66666667	11.0103585		
28		172.9	0	19	18.4	13.2	5.5	8	42.666667	12.511771	20.9	20.1	14.1	6.4	8	42.66666667	10.75230322		
29		183	0	19.5	18.9	14	5.2	8	42.666667	13.233604	21.1	20.2	14.5	6.15	8	42.66666667	11.18938872		Sy
30		192.4	0	19.9	19.1	13.1	6.4	8	42.666667	10.752303	20	19.3	13.5	6.15	8	42.66666667	11.18938872		
31		196.3	0	19.9	19.2	12.5	7.05	8	42.666667	9.7609561	20.5	20	14	6.25	8	42.66666667	11.0103585		
32	3-Mar-98	206.3	0	19.5	18.9	12.2	7	8	42.666667	#VALUE!	19.9	19.1	14.1	5.4	8	42.66666667	#VALUE!		Unit Shutd
33		212.7	0	19.9	19.2	12.2	7.35	8	42.666667	9.3625497	20.5	20.1	14.8	5.5	8	42.66666667	12.51177102		
34		217.2	0	20.1	19.1	12.8	6.8	8	42.666667	10.119815	20.1	19.9	14.2	5.8	8	42.66666667	11.86461045		
35		221.1	0	19	18.2	12.8	5.8	8	42.666667	11.86461	19.9	19.1	13.3	6.2	8	42.66666667	11.09915171		
36	4-Mar-98	232.3	0	19.9	19.1	12.6	6.9	8	42.666667	9.9731508	19.9	19.1	13.8	5.7	8	42.66666667	12.07276151		
37		240.2	0	19	18.5	13.5	5.25	8	42.666667	13.10757	20.2	19.8	13.8	6.2	8	42.66666667	11.09915171		
38		245.9	0	19.8	18.9	13.1	6.25	8	42.666667	11.010358	20.3	19.9	12.9	7.2	8	42.66666667	9.557602864		
39		249.8	0	19.1	18.8	12.2	6.75	8	42.666667	10.194776	20	19	12.6	6.9	8	42.66666667	9.973150815		
40	5-Mar-98	256.2	0	19.1	18.3	12	6.7	8	42.666667	10.270857	20	19.3	13.1	6.55	8	42.66666667	10.50606727		
41		264.6	0	18.9	18.2	12.2	6.35	8	42.666667	10.836967	20.2	20	13.9	6.2	8	42.66666667	11.09915171		
42		269.8	0	19.1	18.4	12.5	6.25	8	42.666667	11.010358	21.1	20.1	12	8.6	8	42.66666667	8.001714026		
43		274.3	0	19.1	18.9	11	8	8	42.666667	8.6018426	19.9	19.2	12.5	7.05	8	42.66666667	9.760956117		
44	6-Mar-98	278.2	0	19	18.4	10.4	8.3	8	42.666667	8.2909326	20.1	19.9	10.9	9.1	8	42.66666667	7.562059409		
45		288.6	0	19.2	18.6	10.5	8.5	8	42.666667	8.0958518	20.1	19.9	10.9	9.1	8	42.66666667	7.562059409		
46	9-Mar-98	295.9	0	19.5	18.9	11.2	8	8	42.666667	8.6018426	20.5	19.5	8.8	11.2	8	42.66666667	6.14417327		
47		299.9	0	20	19.1	10.2	9.35	8	42.666667	7.3598653	19.9	19.5	8.3	11.4	8	42.66666667	6.036380757		
48		303.5	0	19	18.3	9.5	9.15	8	42.666667	7.5207367	19.9	19.1	12	7.5	8	42.66666667	9.17529875		
49	10-Mar-98	312.6	0	19.2	18.8	9.3	9.7	8	42.666667	7.0943032	20.5	20	11.5	8.75	8	42.66666667	7.864541786		
50		317.4	0	19.5	18.9	9.6	9.6	8	42.666667	#VALUE!	20.4	20.1	6.5	13.75	8	42.66666667	#VALUE!		
51	11-Mar-98	321.5	0	19.2	18.9	8.1	10.95	8	42.666667	6.2844512	20.1	19.9	11.9	8.1	8	42.66666667	8.495646991		
52		325.7	0	19.1	18.8	8.9	10.05	8	42.666667	6.8472379	20.1	20	10	10.05	8	42.66666667	6.847237873		
53		334.6	0	18.9	18.2	10.2	8.35	8	42.666667	8.2412863	21.5	20.7	3	18.1	8	42.66666667	3.801919372		
54		341.6	0	19.5	19.1	9.5	9.8	8	42.666667	7.0219123	19.6	19.3	3.5	16.05	5	26.66666667	2.679701738		
55		343	0	19.8	19.4	8	11.6	6	32	4.4492289	20.2	19.7	7.7	12.25	4	21.33333333	2.808764923		
56		351.7	0	19.5	19	13.1	6.15	4	21.333333	5.5946944	20.4	19.9	11.3	8.85	3	16	2.91587884		
57		352.2	0	19.2	18.9	10.3	8.75	8	42.666667	7.8645418	19.2	18.7	5	13.95	8	42.66666667	4.932956317		
58		352.7	0	20.2	19.4	10.4	9.4	6	32	5.4905378	20.1	19.6	12.2	7.65	5	26.66666667	5.622119332		
59		353.2	0	19	18.5	9	9.75	4	21.333333	3.5289611	20.1	19.6	14.5	5.35	4	21.33333333	6.431284171		
60		353.7	0	19	18.5	12.2	6.55	8	42.666667	10.506067	20.1	19.6	16	3.85	3	16	6.702734476		R
61		354.2	0	19.2	18.7	15	3.95	6	32	13.06609	20.5	20	6.5	13.75	6	32	3.753531307		
62		354.7	0	18.2	17.7	12.5	5.45	4	21.333333	6.313279	21	20.5	11.1	9.65	5	26.66666667	4.456913253		
63		355.2	0	19.1	18.6	14.7	4.15	8	42.666667	16.581865	21	20.5	14.2	6.55	4	21.33333333	5.253033635		
64		355.7	0	19.5	19	16.7	2.55	6	32	#VALUE!	21.5	21	16.5	4.75	3	16	#VALUE!		After 0.25%
65	19-Mar-98	356.2	0	20	19.5	13.7	6.05	4	21.333333	5.6871686	20	19	12.8	6.7	8	42.66666667	10.27085681		
66	19-Mar-98	356.7	2	20	19.5	15.5	4.25	8	42.666667	16.191704	20.5	20	15.2	5.05	6	32	10.22001098		

San Pasqual Wastewater IMS Raw Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
67		357.2	2	20	19.5	17.4	2.35	6	32	21.962151	20.5	20	16.2	4.05	5	26.66666667	10.61955874		Re
68	20-Mar-98	357.7	2	19.1	18.6	13.3	5.55	6	32	9.2992893	21.1	20.6	17.8	3.05	4	21.33333333	11.28110502		
69		358.2	2	19.2	18.7	15.2	3.75	6	32	13.762948	21	20.5	18.2	2.55	3	16	10.1198148		
70		360.9	2	19.7	19.2	17.2	2.25	6	32	22.938247	19.9	19.5	14.8	4.9	8	42.66666667	14.04382462		
71		361.9	2	19	18.5	14.4	4.35	6	32	#VALUE!	19.8	19.2	16	3.5	6	32	#VALUE!		Shut D
72	21-Mar-98	365.4	2	19	18.2	15.8	2.8	6	32	18.43252	20.5	19.9	16.2	4	6	32	12.90276387		
73		375.4	2	19.8	18.9	15.9	3.45	6	32	#VALUE!	21	20	15.8	4.7	6	32	#VALUE!		Shut
74		380.2	2	19.9	19.2	15.8	3.75	6	32	#VALUE!	20	19.5	15.5	4.25	6	32	#VALUE!		replace 50u
75		384.4	2	18.9	18.2	15	3.55	6	32	14.538325	20.1	19.9	15.5	4.5	6	32	11.46912344		
76		389.3	2	19.1	18.8	15.5	3.45	6	32	14.959726	20.2	20	15	5.1	6	32	10.1198148		
77	25-Mar-98	399.7	2	19.5	18.5	15.7	3.3	6	32	15.639714	20.8	20.1	13.2	7.25	6	32	7.118766271		
78		404.5	2	19.2	19	15.8	3.3	6	32	15.639714	20	19.3	15.2	4.45	6	32	11.59798999		
79	tart @ 439.4	409	2	18.8	18.1	15	3.45	6	32	14.959726	20.2	19.4	14.2	5.6	6	32	9.216259905		U
80		415.4	2	19	18.2	15.2	3.4	6	32	#VALUE!	20.6	20	12.9	7.4	6	32	#VALUE!		by ph 11.7 recirc fo
81	31-Mar-98	422	2	19.7	19.1	15.5	3.9	6	32	13.233604	20.5	20	12	15?	6	32	#VALUE!		
82		430.3	2	19.5	18.5	16.5	2.5	6	32	20.644422	20.2	19.8	4	8.25	6	32	6.255885511		
83		433.5	2	19.9	18.9	15.3	4.1	6	32	12.588062	20.2	19.8	16.5	16	6	32	3.225690967		
84	1-Apr-98	439.8	2	19.2	19	16.8	2.3	6	32	22.439589	20.6	20	16.2	3.5	6	32	14.74601585		
85		441.7	2	19.5	19	16.8	2.45	6	32	21.065737	20.9	20.2	16.5	4.1	6	32	12.58806231		Pr
86		447.6	2	20	19.5	16.9	2.85	6	32	18.109142	21	20.2	15.8	4.05	6	32	12.74347049		
87		458.3	2	19.8	19.2	16.2	3.3	7	37.333333	18.246333	21.2	20.8	15.8	4.8	6	32	10.75230322		1-
88		459.1	2	19.4	18.9	16.2	2.95	7	37.333333	#VALUE!	21	20.2	15.6	#REF!	6	32	#VALUE!		Unit S
89		465.5	2	20	19.2	16	3.6	7	37.333333	#VALUE!	20	19.8	15.5	5.2	6	32	#VALUE!		Cast Iron p
90	2-Apr-98	474.2	2	20.1	19	16.1	3.45	7	37.333333	#VALUE!	20.9	20.2	16	5	6	32	#VALUE!		New Cl
91		483.2	2	19.1	18.5	16.1	2.7	7	37.333333	22.301073	21	20	15.8	4.4	6	32	11.72978533		
92		489.6	2	19.8	19.1	16.3	3.15	7	37.333333	19.115206	20.1	19.5	14.8	4.55	6	32	11.34308911		
93	3-Apr-98	499.5	2	19.9	19.1	16.3	3.2	7	37.333333	18.816531	20.1	19.1	14.3	4.7	6	32	10.98107563		
94		503.4	2	18.9	18.2	15	3.55	7	37.333333	16.96138	20	19.3	14.7	5	6	32	10.32221109		
95		508	2	19	18.2	15	3.6	7	37.333333	16.725805	18.9	18.2	14.8	5.3	7	37.33333333	11.36092416		
96		522.6	2	19	19.2	15.1	4	7	37.333333	15.053225	20.8	20.2	14.5	4.95	7	37.33333333	12.16422183		
97		526.5	2	20	19.7	14.2	5.65	7	37.333333	10.65715	21	20.1	14.8	3.75	7	37.33333333	16.05677281		
98		531.6	2	19.8	19.1	15.2	4.25	7	37.333333	14.167741	19.8	19.2	14.6	6	7	37.33333333	10.03548301		
99	5-Apr-98	538.9	2	19.8	19.1	14.8	4.65	7	37.333333	12.94901	20.8	20	14.4	5.75	7	37.33333333	10.47180836		
100		546.7	2	18.9	18.2	14.5	4.05	7	37.333333	14.867382	20.9	20.1	13.8	4.9	7	37.33333333	12.28834654		
101		553.5	2	19.2	18.9	15.2	3.85	7	37.333333	15.639714	20	19.4	13.4	6	7	37.33333333	10.03548301		
102	6-Apr-98	562.6	2	19.5	19	15.1	4.15	7	37.333333	14.509132	20.1	19.8	13.9	6.7	7	37.33333333	8.986999708		
103		568.4	2	19.2	18.6	14.9	4	7	37.333333	15.053225	21	20.1	15	6.3	7	37.33333333	9.557602864		
104		576.3	2	19.5	18.8	15.1	4.05	7	37.333333	14.867382	20.1	19.4	13.8	6.05	7	37.33333333	9.952545132		
105	7-Apr-98	585.9	2	19.9	19.2	15.3	4.25	7	37.333333	14.167741	20.1	19.5	13.8	5.55	7	37.33333333	10.84917082		
106		592.8	2	19.1	18.2	14.5	4.15	7	37.333333	14.509132	21	20.5	14	5.95	7	37.33333333	10.1198148		
107		596	2	19	18.2	14.8	3.8	7	37.333333	15.845499	20	19.2	13.8	6	7	37.33333333	10.03548301		
108	8-Apr-98	598.9	2	19.5	19	15	4.25	7	37.333333	14.167741	20.5	19.9	14.2	6.75	7	37.33333333	8.92042934		
109		607.3	2	18.9	18.1	14.9	3.6	7	37.333333	16.725805	20.5	20	14.2	5.8	7	37.33333333	10.38153415		
110		612.3	2	19.9	19.1	15.5	4	7	37.333333	15.053225	19.9	19.1	13	6	7	37.33333333	10.03548301		
111	9-Apr-98	621	2	19.8	18.9	15.2	4.15	7	37.333333	14.509132	20.1	19.8	13.8	6.05	7	37.33333333	9.952545132		
112		630.4	2	18.6	17.9	14	4.25	7	37.333333	14.167741	20.9	20.2	14.5	6.5	7	37.33333333	9.263522776		
113		635.1	2	19.3	19	15	4.15	7	37.333333	14.509132	20	19.3	13.3	6.15	7	37.33333333	9.790715129		
114	10-Apr-98	644.3	2	19.8	19.1	15.1	4.35	7	37.333333	13.842046	19.8	19.2	12.9	6.05	7	37.33333333	9.952545132		
115		650.6	2	18.2	17.8	14.3	3.7	7	37.333333	16.273756	20.2	20	14	6.35	7	37.33333333	9.482346149		
116		654.6	2	18.9	18	13.9	4.55	7	37.333333	13.233604	20.3	20	13.6	6.6	7	37.33333333	9.123166371		
117		659.9	2	19.1	18.8	14.9	4.05	7	37.333333	14.867382	20	19.3	12.9	6.1	7	37.33333333	9.870966893		
118	11-Apr-98	668.3	2	19.5	18.9	14.7	4.5	7	37.333333	13.360644	20	19.4	12.5	6.55	7	37.33333333	9.192808862		
119		674.6	2	18.9	18.1	14.1	4.4	7	37.333333	13.68475	20.5	19.9	12.1	6.75	7	37.33333333	8.92042934		
120		678.5	2	19.1	18.5	13.8	5	7	37.333333	12.04258	20.3	19.9	13	7.2	7	37.33333333	8.362902506		
121		683.9	2	19.1	18.8	13.8	5.15	7	37.333333	11.691825	20	19.4	12.6	8.1	7	37.33333333	7.433691117		
122	12-Apr-98	692.5	2	19.3	18.8	14.2	4.85	7	37.333333	12.415031	20.1	19.5	12.8	7.1	7	37.33333333	8.480689866		
123		696.3	2	19.2	18.4	14.1	4.7	7	37.333333	12.811255	20.1	19.8	12.5	7.1	7	37.33333333	8.480689866		
124		702.3	2	19	18.4	13.8	4.9	7	37.333333	12.288347	19.9	19.1	12.5	7	7	37.33333333	8.601842578		
125		707.8	2	19.2	18.8	14.4	4.6	7	37.333333	13.08976	19.9	19.1	11.9	7.45	7	37.33333333	8.082268194		
126	13-Apr-98	716.5	2	19.9	19.1	14.1	5.4	7	37.333333	11.150537	20	19.5	11.8	7	7	37.33333333	8.601842578		
127		723.6	2	18.9	18.1	13	5.5	7	37.333333	10.9478	20.8	20	12.2	7.6	7	37.33333333	7.922749743		
128		727.1	2	19.2	18.5	13.4	5.45	7	37.333333	11.048238	20.1	19.5	12.1	7.95	7	37.33333333	7.57394944		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
129	14-Apr-98	740.2	2	19.5	18.8	13	6.15	7	37.333333	9.7907151	20	19.2	11.2	8.2	7	37.33333333	7.343036347		
130		746.1	2	18.9	18.1	12.2	6.3	7	37.333333	#VALUE!	20.8	20	11.8	7.7	7	37.33333333	#VALUE!		Shut Dow
131		751.8	2	19.2	18.5	12.4	6.45	7	37.333333	9.335333	20.1	19.5	11.5	8.4	7	37.33333333	7.168202148		
132	15-Apr-98	763.4	2	19.8	18.9	12.1	7.25	7	37.333333	8.3052273	20	19.3	11.3	8.6	7	37.33333333	7.001499773		
133		769.3	2	19.1	18.5	11.5	7.3	7	37.333333	8.2483422	20.8	20	12	8.3	7	37.33333333	7.25456603		
134		774.6	2	19.1	18.3	11.2	7.5	7	37.333333	8.0283864	21	20.5	9.7	8.35	7	37.33333333	7.211125515		
135		778.8	2	19.8	19	11.9	7.5	7	37.333333	8.0283864	19.9	19.1	8.3	8.4	7	37.33333333	7.168202148		
136	16-Apr-98	787.5	2	19.8	19.2	10.8	8.7	7	37.333333	6.9210228	20.5	20	11.5	11.05	7	37.33333333	5.449131045		
137		798.3	2	18.9	18.1	10.5	8	7	37.333333	7.5266123	21	20.2	12	11.2	7	37.33333333	5.376151611		
138		803.9	2	19.8	19	10.9	8.5	7	37.333333	7.0838704	19.8	18	9	8.75	7	37.33333333	6.881474062		
139	17-Apr-98	812.4	2	19.9	19.2	10	9.55	7	37.333333	6.3050155	19.9	19.2	8.2	8.6	7	37.33333333	7.001499773		
140		821.1	2	18.5	17.5	5.8	12.2	7	37.333333	4.9354834	20.5	20.2	16.2	9.9	7	37.33333333	6.082110914		
141		822.9	2	18.5	17.9	4.9	13.3	7	37.333333	4.5272856	20.6	20	14.6	11.35	7	37.33333333	5.305101149		
142		827.8	2	19.8	19.1	16.2	3.25	7	37.333333	18.527046	19.7	18.9	11.5	4.15	7	37.33333333	14.50913206		
143	18-Apr-98	835.5	2	19.7	18.9	15	4.3	7	37.333333	14.003	19.5	19	11.5	5.7	7	37.33333333	10.56366632		
144		841	2	18.2	17.5	13.5	4.35	7	37.333333	13.842046	20.6	19.9	11	7.8	7	37.33333333	7.719602314		
145		846.9	2	18.2	17.5	14	3.85	7	37.333333	15.639714	19.8	18.9	9	7.75	7	37.33333333	7.7694062		
146	19-Apr-98	858.2	0	19.8	19.1	14.7	4.75	7	37.333333	12.6764	19.5	18.9	9.5	9.25	7	37.33333333	6.509502491		
147		865.4	0	18.2	17.3	12.9	4.85	7	37.333333	12.415031	20.2	19.5	9.8	10.35	7	37.33333333	5.817671309		
148		869.4	0	18.1	17.5	13.5	4.3	7	37.333333	14.003	20	19.2	6.5	9.7	7	37.33333333	6.207515263		
149		874.8	0	19	18.5	14.1	4.65	7	37.333333	12.94901	19.2	18.6	14.2	10.05	7	37.33333333	5.991333139		
150	20-Apr-98	885.3	0	18.5	18	13.5	4.75	7	37.333333	12.6764	20.5	20	15.9	13.1	7	37.33333333	4.596404431		
151	21-Apr-98	894.9	0	18.2	17.6	14.6	3.3	7	37.333333	18.246333	20.6	20.1	15.5	4.7	7	37.33333333	12.8112549		
152		898.8	0	19.5	19.5	16.2	3.3	7	37.333333	18.246333	20	19.5	15	4.35	7	37.33333333	13.84204553		
153	24-Apr-98	908.7	0	19.8	19.8	16.2	3.6	7	37.333333	16.725805	20	19.5	14.5	4.85	7	37.33333333	12.41503053		
154		915.2	0	18.5	18.5	15.1	3.4	7	37.333333	17.709676	20.9	20.1	15	4.75	7	37.33333333	12.67639959		
155		919.5	0	19	19	15.1	3.9	7	37.333333	15.439205	20.4	20	15.1	5.25	7	37.33333333	11.46912344	0.8	
156		924.6	0	19.2	19.2	15.9	3.3	7	37.333333	18.246333	20	19.9	14.8	5.5	7	37.33333333	10.94779964	2	
157	25-Apr-98	930.2	0	19.1	19.1	15.3	3.8	7	37.333333	15.845499	20.9	20.2	15.2	5.1	7	37.33333333	11.8064506	3.7	
158		936.1	0	19.1	19.1	15.1	4	7	37.333333	15.053225	21	20.2	15	5.15	7	37.33333333	11.69182486	10.8	
159		941.4	0	19.2	19.2	15.1	4.1	7	37.333333	9.9713862	19.9	19.3	14.9	5.35	7	37.33333333	7.64162305	25.7	
160	26-Apr-98	949.7	0	19.9	19.9	15.7	4.2	7	37.333333	9.6875549	20	19.5	14.2	5.6	7	37.33333333	7.265666143	26.3	
161		955.9	0	19.2	19.2	14.9	4.3	7	37.333333	9.5076008	20.5	20	14	4.7	7	37.33333333	8.698443259	30.5	
162		959.1	0	18.8	18.8	14.8	4	7	37.333333	9.6971519	20.8	20.1	15.1	5.55	7	37.33333333	6.98893829	34.5	
163		965.2	0	19.1	19.1	14.8	4.3	7	37.333333	9.5076008	19.9	19.1	12.2	6.25	7	37.33333333	6.541229331	39.8	45.2
164	27-Apr-98	972.2	0	19.5	19.5	15.5	4	7	37.333333	10.171933	19.9	19.3	14.4	5.35	7	37.33333333	7.605183252	48.2	45.4
165		978.1	0	18.1	18.1	13.9	4.2	7	37.333333	9.3240964	20.2	20	14.4	7.3	7	37.33333333	5.364548599	54.5	40.6
166		982.3	0	18.8	18.5	14.5	4.15	7	37.333333	9.1477528	20.9	20.1	15.1	5.2	7	37.33333333	7.30061037	58.5	40.2
167		987.4	0	19.6	19.4	15.3	4.2	7	37.333333	9.4361877	19.8	19	13	5.7	7	37.33333333	6.952980439	72.5	37.4
168	28-Apr-98	994.9	0	19.9	19.9	15.9	4	7	37.333333	10.027106	19.7	19.1	13.4	5.4	7	37.33333333	7.427487378	78.2	36.4
169		1000.7	0	18.5	18.5	14.2	4.3	7	37.333333	9.1727906	20.2	20	14.9	6.4	7	37.33333333	6.162968694	87.7	36.4
170		1006.2	0	18.9	18.8	14.4	4.45	7	37.333333	8.9060646	20.5	20.2	14.8	6	7	37.33333333	6.605331417	97.7	36.4
171		1012.1	0	19.6	19.4	15.7	3.8	7	37.333333	10.681738	20.1	19.9	14.9	5.2	7	37.33333333	7.805885161	106.7	36.4
172	29-Apr-98	1018.5	0	19.8	19.8	15.5	4.3	7	37.333333	9.1727906	20.2	20	13.9	5.55	7	37.33333333	7.106846782	131.4	36.6
173		1019.5	0	19.1	19.1	15	4.1	7	37.333333	9.6894688	20	19.8	13.5	5.1	7	37.33333333	7.789572987	143.2	36.4
174	30-Apr-98	1029.2	0	19.5	18.9	13.5	5.7	7	37.333333	7.1041591	20.1	19.9	14.2	6.2	7	37.33333333	6.531243086	154.5	36.4
175		1034.2	0	18.9	18.9	13.2	5.7	7	37.333333	6.6539862	20.1	19.9	14.9	6.4	7	37.33333333	6.104331446	167.2	36.4
176		1038.3	0	19.2	19.2	15	4.2	7	37.333333	9.1694019	20.1	19.9	14.8	5.8	7	37.33333333	6.639911699	178.7	36.7
177		1044.8	0	19.5	19.5	15.3	4.2	7	37.333333	9.6875549	21.2	20.9	14.9	5.1	7	37.33333333	7.977986353	192.2	36.6
178	1-May-98	1052.7	0	19.2	19.2	15	4.2	7	37.333333	9.1475132	20.1	19.8	15.5	5.2	7	37.33333333	7.38837602	201	36.6
179		1060	0	19.1	19.1	14.2	4.9	7	37.333333	8.3434048	20.2	20	15.5	6.15	7	37.33333333	6.647590783	19	36.4
180		1064.6	0	19.1	19	15.2	3.85	7	37.333333	1.7350104	19.2	18.9	14.1	4.45	7	37.33333333	1.501076454	16.1	36.4
181	2-May-98	1075.1	0	20	20	16.5	3.5	7	37.333333	11.13556	21.2	20.9	14.8	4.8	7	37.33333333	8.472708889	211.3	36.4
182		1077.4	0	18	17.9	14.8	3.15	7	37.333333	1.9738464	20	19.6	14.3	4.95	7	37.33333333	1.256084077	216.9	35.8
183	3-May-98	1084	0	19	19	15.2	3.8	7	37.333333	1.800358	19.1	18.7	13.6	6.25	7	37.33333333	1.094617644	222.7	36.4
184		1087.7	0	19.9	19.9	15	4.9	7	37.333333	8.3633693	20.1	19.9	14.8	5.5	7	37.33333333	7.451001779	233.9	35.8
185		1092	0	17.9	17.9	14.1	3.8	7	37.333333	10.256437	20.2	19.9	14.4	5.3	7	37.33333333	7.353671866	241.2	36.5
186		1097.9	0	20	20	16.1	3.9	7	37.333333	9.6646029	20.8	20	13.9	5.2	7	37.33333333	7.248452204	250.1	36.4
187	4-May-98	1106.2	0	20.1	20	15.8	4.25	7	37.333333	9.665546	22	21.8	16.9	5.65	7	37.33333333	7.270543423	261.2	36.3
188		1113.1	0	19.7	19.5	15.5	4.1	7	37.333333	9.460636	22.2	22	17	6.5	7	37.33333333	5.967478078	264	36.4
189		1117.3	0	21	21	17.2	3.8	7	37.333333	10.280979	22.6	22.2	17.8	5	7	37.33333333	7.81354425	273.1	36.4
190		1121.4	0	21.2	21.2	17.2	4	7	37.333333	9.9792928	21.3	21	15.7	5.1	7	37.33333333	7.826896278	280.1	36.4

San Pasqual Wastewater IMS Raw Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
191	5-May-98	1129.7	0	21.2	21.2	17.5	3.7	7	37.333333	9.9940884	20.3	19.9	15.5	4.6	7	37.33333333	8.038723317	284.5	36.7
192		1136.9	0	19.2	19.2	15.2	4	7	37.333333	9.4229879	20	19.3	14.5	5.45	7	37.33333333	6.915954397	289.6	36.6
193		1140.3	0	20	20	16.1	3.9	7	37.333333	9.3913592	20.1	19.9	14.9	4.6	7	37.33333333	7.962239298	290.9	36.4
194		1145.4	0	18.9	18.9	15	3.9	7	37.333333	9.3020056	20.2	20	14.3	5.15	7	37.33333333	7.044237227	300.6	36.4
195	6-May-98	1147.8	0	19.1	19.1	15	4.1	7	37.333333	9.1274797	21	20.2	15.5	5.1	7	37.33333333	7.337777786	306	36.8
196		1157.3	0	18.8	18.8	14.3	4.5	7	37.333333	8.4362609	21.1	20.8	15.5	5.8	7	37.33333333	6.545374815	314.3	36.4
197		1163.7	0	19.9	19.9	15.8	4.1	7	37.333333	9.0190554	21.1	20.9	15.8	5.1	7	37.33333333	7.250613188	321.1	37.1
198	7-May-98	1173.7	0	20	20	15.5	4.5	7	37.333333	8.3960318	21.3	21	15.9	5.45	7	37.33333333	6.932503296	328.4	36.4
199		1177.8	0	20	20	15.9	4.1	7	37.333333	9.4832739	23	22.3	17.1	5.2	7	37.33333333	7.47719676	338.5	36.4
200		1182.8	0	20.2	20.2	16.1	4.1	7	37.333333	9.1493205	21.2	20.8	16.8	5.25	7	37.33333333	7.145183591	342.6	37.2
201		1188.5	0	20.8	20.8	16.7	4.1	7	37.333333	9.4832739	20.8	20.1	14.9	5.55	7	37.33333333	7.005661829	350.1	36.7
202	8-May-98	1194.9	0	20.1	20	16.2	3.85	7	37.333333	9.2664786	20.1	19.9	15	4.2	7	37.33333333	8.494272028	360	36.4
203		1200.3	0	19.5	19.5	15.2	4.3	7	37.333333	8.6407688	21.5	21.2	16.2	5.55	7	37.33333333	6.694649698	366	36.7
204		1207	0	19.1	19.1	15	4.1	7	37.333333	9.3930458	20.9	20.3	15.5	5	7	37.33333333	7.702297571	372.5	36.4
205	9-May-98	1218.9	0	20.5	20.4	16.5	3.95	7	37.333333	8.9032912	22	21.5	16	5.15	7	37.33333333	6.828737894	373.4	36.4
206		1230.2	0	19.9	19.9	15.6	4.3	7	37.333333	8.5995645	20.5	20	14.8	5.1	7	37.33333333	7.250613188	383.1	36.4
207		1232.8	0	20.9	20.9	16.1	4.8	7	37.333333	7.9089946	22	21.5	16.1	5.75	7	37.33333333	6.602291118	388.1	36.4
208		1235.3	0	19.2	19.2	15	4.2	7	37.333333	8.353345	21.5	21.2	15.8	5.45	7	37.33333333	6.437440183	392.2	36.4
209	10-May-98	1243	0	21	21	16.2	4.8	7	37.333333	7.7963889	21.8	21.2	16.1	5.65	7	37.33333333	6.623480834	406.7	36.4
210		1247.7	0	20.5	20.5	16	4.5	7	37.333333	8.0617382	21	20.5	15.6	5.55	7	37.33333333	6.536544454	413.1	36.4
211		1254	0	19.4	19.4	15.1	4.3	7	37.333333	8.2967308	21.2	20.8	15.4	5.4	7	37.33333333	6.606656022	418.4	37.1
212		1258.5	0	20.9	20.9	16.8	4.1	7	37.333333	9.1274797	21.2	20.8	15.4	5.15	7	37.33333333	7.266537225	429.5	36.3
213	11-May-98	1269.3	0	20.1	20.1	15.6	4.5	7	37.333333	8.0041422	21.2	20.9	15.4	5.6	7	37.33333333	6.431900003	431.5	37.1
214		1273.7	0	20.1	20.1	15.6	4.5	7	37.333333	8.023295	20.9	20.2	14.2	5.6	7	37.33333333	6.447290628	438.3	36.4
215		1275.8	0	19.2	19.2	13.9	5.3	7	37.333333	7.162863	20.9	20.2	14.9	5.65	7	37.33333333	6.719145828	442	36.4
216		1279.3	0	20.5	20.5	12.2	8.3	7	37.333333	4.4233665	19.9	19.2	14.4	6.35	7	37.33333333	5.7817232	446.3	36.4
217		1283.4	0	20.6	20.6	13.3	7.3	7	37.333333	4.993376	19.9	19.3	14.3	5.65	7	37.33333333	6.451618551	452.2	36.7
218	12-May-98	1293.5	0	18.8	18.8	13.7	5.1	7	37.333333	7.0456193	20.9	20	14.9	5.15	7	37.33333333	6.977215195	460.5	36.2
219		1295.8	0	18.9	18.9	13.7	5.2	7	37.333333	6.763077	20.8	20.1	15.1	5.3	7	37.33333333	6.635471727	467.6	36.4
220		1299.3	0	19.5	19.5	14.1	5.4	7	37.333333	6.7664571	20.1	19.9	14.4	5.55	7	37.33333333	6.583579898	471.8	36.4
221		1303.8	0	20.5	20.5	15.5	5	7	37.333333	7.3956255	19.1	18.5	13.5	5.35	7	37.33333333	6.911799487	475.9	37.0
222	13-May-98	1312.8	0	20	20	15	5	7	37.333333	7.152262	20	19.5	14.3	5.6	7	37.33333333	6.385948214	484.4	36.6
223		1322.2	0	18.9	18.9	14	4.9	7	37.333333	7.3156902	20.1	19.9	14.3	5.3	7	37.33333333	6.763562593	491.3	36.4
224		1328.3	0	19	19	14	5	7	37.333333	7.290329	21.5	20.9	16.2	5.45	7	37.33333333	6.688375195	494.8	36.4
225		1336.7	0	19.1	19.1	14.2	4.9	7	37.333333	7.5465566	21.8	21.3	15.8	5.7	7	37.33333333	6.487390747	500	36.4
226	14-May-98	1341.3	0	21.1	21.1	16.1	5	7	37.333333	7.3252602	22	21.6	15.9	5	7	37.33333333	7.325260154	502	37.1
227		1342.2	0	21.3	21.3	15.8	5.5	7	37.333333	6.6434306	22.8	22.2	17.3	5.75	7	37.33333333	6.354585815	511.7	36.6
228		1343	0	21.8	21.8	15.7	6.1	7	37.333333	6.0764936	22	21.5	17.2	5.9	7	37.33333333	6.282476386	518.7	36.6
229		1350	0	21.8	21.8	17.2	4.6	7	37.333333	8.1939025	22.9	22.2	17.2	5.2	7	37.33333333	7.248452204	528.3	36.6
230	15-May-98	1359.1	0	21.8	21.8	17	4.8	7	37.333333	7.5218391	22.2	21.9	16.2	4.55	7	37.33333333	7.935126927	533.5	37.4
231		1362.6	0	21.3	21.2	16.2	5.05	7	37.333333	7.3224014	21	20.2	15.5	5.35	7	37.33333333	6.911799487	537.4	37.1
232		1364.3	0	21.1	21.1	13.4	7.7	7	37.333333	4.8600866	21.7	21.2	15.5	5.85	7	37.33333333	6.397037045	543.1	36.6
233		1371	0	19.9	19.9	15	4.9	7	37.333333	7.5105701	21.3	21	16	5.1	7	37.33333333	7.216037957	549.6	36.7
234	16-May-98	1382.3	0	20.5	20.4	14.8	5.65	7	37.333333	6.4825311	22.2	21.9	16.9	5.95	7	37.33333333	6.155680802	555.1	36.8
235		1387.6	0	20.2	20.2	16	4.2	7	37.333333	8.9314795	23.1	22.9	17.5	5.15	7	37.33333333	7.28392502	561	36.6
236		1392.1	0	21	21	16.7	4.3	7	37.333333	8.8286451	22.2	21.8	16.2	5.15	7	37.33333333	7.371490083	573.6	36.6
237	17-May-98	1399.7	0	21.9	21.9	17	4.9	7	37.333333	7.5827155	21	20.6	15.9	5.5	7	37.33333333	6.75551015	584.9	36.7
238		1404	0	21.1	21	16.1	4.95	7	37.333333	7.5601347	22.5	22	16.9	5.8	7	37.33333333	6.452183916	590	36.6
239		1408.3	0	19.9	19.9	15.8	4.1	7	37.333333	9.2372074	22.3	22	17	4.9	7	37.33333333	7.729091894	597.7	36.6
240		1413.2	0	22.1	22.1	17.5	4.6	7	37.333333	8.1548291	18.6	18.1	13	5.35	7	37.33333333	7.011628757	608.8	38.3
241	18-May-98	1420.7	0	21.1	21.1	16.8	4.3	7	37.333333	8.7237707	21.3	20.9	15.8	5.15	7	37.33333333	7.28392502	613.3	36.6
242		1425.5	0	17.2	17.2	12.5	4.7	7	37.333333	8.15486	21.5	21.2	16.2	5.35	7	37.33333333	7.164082655	624.1	36.6
243		1429.6	0	19	19	14.9	4.1	7	37.333333	8.9119191	21.5	21.1	15.8	5.3	7	37.33333333	6.89412612	628.5	36.6
244		1434.1	0	20	20	15.5	4.5	7	37.333333	8.3559945	20.4	20	15.2	5.15	7	37.33333333	7.30135442	634.1	36.6
245	19-May-98	1441.4	0	19.5	19.5	14.9	4.6	7	37.333333	8.3122496	23.5	23.2	17.9	5.5	7	37.33333333	6.95206328	638.1	36.4
246		1447.8	0	20.2	20.2	15.9	4.3	7	37.333333	8.7655701	22.5	22.2	16.1	5	7	37.33333333	7.538390293	643.7	36.6
247		1454.8	0	22.2	22.2	18	4.2	7	37.333333	8.9742742	20.6	20	15	5.45	7	37.33333333	6.915954397	649.7	36.6
248	20-May-98	1462.1	0	21.2	21.2	16.5	4.7	7	37.333333	8.1159728	21.2	20.7	15.3	6.25	7	37.33333333	6.103211566	654.1	36.6
249		1467.9	0	20	20	15.1	4.9	7	37.333333	7.8594873	20.2	20	15.2	5.3	7	37.33333333	7.266318463	663	36.6
250		1469.2	0	19	19	14	5	7	37.333333	7.6839111	21.5	20.9	15.1	5.65	7	37.33333333	6.799921292	672.5	36.4
251		1475.9	0	19.1	19.1	14.8	4.3	7	37.333333	9.0855166	20.7	20.1	15.3	4.9	7	37.33333333	7.973004337	678.6	36.4
252	21-May-98	1485.7	0	19.1	19.1	14.8	4.3	7	37.333333	9.1947398	21.2	20.9	16.2	6.1	7	37.33333333	6.481537893	687.2	36.7

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
253		1491	0	19.4	19.4	14.3	5.1	7	37.333333	7.5332461	22.5	22	17.1	5.1	7	37.33333333	7.533246138		36.7
254		1496.1	0	20	20	15.8	4.2	7	37.333333	9.3240964	20.9	20.2	15.9	4.85	7	37.33333333	8.074475211	693.4	36.7
255	22-May-98	1504	0	20.2	20.2	15.8	4.4	7	37.333333	9.0072701	22.8	22	17.2	5.15	7	37.33333333	7.695531748		36.7
256		1513.7	0	19.9	19.9	15.8	4.1	7	37.333333	9.3259385	21.9	21.2	16	4.65	7	37.33333333	8.222870547	701	36.8
257	23-May-98	1524.2	0	21.2	21.1	16.9	4.25	7	37.333333	9.1485702	20.9	20.1	15.8	5.2	7	37.33333333	7.47719676	709.7	36.6
258		1530.2	0	20.5	20.4	15.8	4.65	7	37.333333	8.5230083	21.8	21.1	16.5	5.55	7	37.33333333	7.140898829	714.8	36.6
259		1535.2	0	19.5	19.5	15	4.5	7	37.333333	8.4362609	22	21.5	16.5	4.7	7	37.33333333	8.077271048	722.5	36.8
260		1538	0	21.1	21.1	16.8	4.3	7	37.333333	8.7865449	20.5	20	15.5	4.95	7	37.33333333	7.632756154	735.4	36.3
261	24-May-98	1545.4	0	21	21	16.2	4.8	7	37.333333	7.9849671	21.8	21.1	16.5	5.25	7	37.33333333	7.300541373	742.2	36.0
262		1551.2	0	19.2	19.1	14.2	4.95	7	37.333333	7.2939045	22	21.3	16.3	4.75	7	37.33333333	7.601016319	747	36.6
263		1554.2	0	20.1	20.1	15.1	5	7	37.333333	7.5745101	21.2	20.9	15.9	4.95	7	37.33333333	7.651020258	755.9	36.4
264		1560.1	0	19.9	19.9	14.9	5	7	37.333333	7.7948922	20	19.8	15	5.35	7	37.33333333	7.284945961	760.7	36.4
265	25-May-98	1566.9	0	20.1	20.1	14.6	5.5	7	37.333333	6.7716751	22	21.6	16.2	5.15	7	37.33333333	7.23188606	765.6	36.8
266		1574	0	18.9	18.8	14.3	4.55	7	37.333333	7.9351269	21.9	21.1	15.9	4.9	7	37.33333333	7.368332146	779.7	36.4
267		1577	0	20.9	20.9	14.5	6.4	7	37.333333	6.0318188	20	19.4	14.3	5.6	7	37.33333333	6.893507212	785.2	36.4
268		1581	0	20.2	20.2	14.2	6	7	37.333333	6.1336323	20.5	20	14.9	5.6	7	37.33333333	6.571748854	789.9	36.8
269	26-May-98	1591.9	0	18.9	18.8	12.8	6.05	7	37.333333	5.9534942	21	20.5	15.5	5.4	7	37.33333333	6.670118521	803.4	36.8
270		1598	0	19.2	19.2	12.9	6.3	7	37.333333	6.0837845	21.1	20.8	15.5	5.35	7	37.33333333	7.164082655	810.5	36.4
271		1602.1	0	19.9	19.9	13.9	6	7	37.333333	6.1043835	19.9	19.2	14.1	5.25	7	37.33333333	6.976438242	818.5	36.6
272	27-May-98	1609.3	0	19.1	19.1	13	6.1	7	37.333333	6.1056087	19.5	19.3	14.5	5.45	7	37.33333333	6.833800589	826.8	37.2
273		1614.8	0	19.2	19.2	13	6.2	7	37.333333	6.1230926	20.2	20	15.2	5.45	7	37.33333333	6.965719986	833.5	36.3
274		1618.8	0	18.5	18.5	12.5	6	7	37.333333	6.1189904	21.9	21.2	16.2	4.9	7	37.33333333	7.49264129	842.5	36.7
275		1622.3	0	19.2	19.2	13.2	6	7	37.333333	6.192551	21.2	20.2	15	4.9	7	37.33333333	7.582715474	853.9	36.6
276	28-May-98	1631	0	21.5	21.5	15.1	6.4	7	37.333333	5.8472917	21.9	21.1	15.2	5.35	7	37.33333333	6.994890974	856.6	36.6
277		1635.7	0	20	20	13.2	6.8	7	37.333333	5.3477396	22	21.8	16.9	5.7	7	37.33333333	6.379759545	874.2	36.4
278		1638.2	0	19.6	19.6	13.2	6.4	7	37.333333	5.8333333	12.2	11.9	6.9	6.3	7	37.33333333	5.925925926	886.5	36.4
279		1644.8	0	21.1	21.1	15	6.1	7	37.333333	5.8625098	17.7	17.1	12.5	5	7	37.33333333	7.152261999	898.3	36.4
280	29-May-98	1652.3	0	11.5	11.5	5	6.5	7	37.333333	5.7849193	20	19.5	13.9	5.15	7	37.33333333	7.30135442	910.8	36.4
281		1652.8	0	16.9	16.9	10.5	6.4	7	37.333333	5.574366	19.9	19.1	14.1	4.9	7	37.33333333	7.280804596	922.5	36.4
282		1659.7	0	19.5	19.5	11.8	7.7	7	37.333333	4.8369108	21.2	20.9	15.6	5.85	7	37.33333333	6.366532172	932.5	36.4
283		1662.3	0	19.1	19.1	12.2	6.9	7	37.333333	5.1627986	19.2	18.9	13.6	5.4	7	37.33333333	6.622464814	946.9	36.4
284	30-May-98	1672.3	0	19.2	19.2	12.5	6.7	7	37.333333	5.53233	20.2	20	15.5	5.45	7	37.33333333	6.801212968	954.9	37.1
285		1677.9	0	18.1	18	11.5	6.55	7	37.333333	5.5784532	21.3	21.1	15.6	5.45	7	37.33333333	6.704379529	958.5	36.4
286	31-May-98	1695.6	0	20	20	13	7	7	37.333333	5.2198383	21.8	21.2	16.2	4.6	7	37.33333333	7.943232268	975.3	36.6
287	1-Jun-98	1716	0	20.1	20.1	13	7.1	7	37.333333	5.2707981	21	20.2	15.3	5.6	7	37.33333333	6.682619056	982.3	36.6
288	2-Jun-98	1735.1	0	20.5	20.5	14.8	5.7	7	37.333333	6.4673907	20.9	20.1	15.3	5.3	7	37.33333333	6.977005143	995.2	36.6
289		1743.6	0	19.6	19.4	13.6	5.9	7	37.333333	6.511789	20	20	15.2	5.3	7	37.33333333	7.248972699	1005.8	36.8
290		1748	0	19.7	19.7	14	5.7	7	37.333333	6.3645301	21	20.3	15.4	5.2	7	37.33333333	6.976504177	1010	36.6
291	3-Jun-98	1758	0	19.5	19.5	13.9	5.6	7	37.333333	6.6507524	20.9	20.1	15.1	4.8	7	37.33333333	7.759211085	1020	37.0
292		1765.5	0	19.5	19.4	12.5	6.95	7	37.333333	5.5016328	21.5	21	16	5.25	7	37.33333333	7.283113913	1027.9	36.4
293	4-Jun-98	1778	0	19.9	19.9	13.1	6.8	7	37.333333	5.3222384	21	20.8	15.6	5.4	7	37.33333333	6.70207801	1035.4	36.7
294		1783.1	0	20.1	20.1	13.5	6.6	7	37.333333	5.6565657	21.1	20.7	15.3	5.25	7	37.33333333	7.111111111	1043.9	36.7
295	5-Jun-98	1794.1	0	19.8	19.8	13.9	5.9	7	37.333333	6.4190763	22	21.5	16.8	5.3	7	37.33333333	7.145764204	1050.5	36.4
296		1799.6	0	19.8	19.8	13.1	6.7	7	37.333333	5.337509	20.7	20.3	15.6	5.6	7	37.33333333	6.385948214	1065	36.7
297		1805.2	0	20.8	20.6	14.5	6.2	7	37.333333	6.1230926	20.9	20.3	14.9	4.95	7	37.33333333	7.869328066	1071.2	36.7
298	6-Jun-98	1814.5	0	19.2	19.1	14.9	4.25	7	37.333333	8.6179531	20.8	20.2	15.3	4.9	7	37.33333333	7.474755259	1091.5	36.8
299		1819.7	0	19.5	19.3	13.2	6.2	7	37.333333	6.0503571	21.2	21.1	16.2	5.7	7	37.33333333	6.581090149	1114.5	37.1
300	7-Jun-98	1834.9	0	19.5	19.5	14	5.5	7	37.333333	6.7232959	21	20.3	15.3	5.2	7	37.33333333	7.111178319	1136.4	36.7
301		1840.8	0	20	19.9	14.3	5.65	7	37.333333	6.6234608	21.1	21	15.8	4.95	7	37.33333333	7.560134689	1145	36.7
302	8-Jun-98	1858.7	0	19.8	19.5	14.8	4.85	7	37.333333	7.3383049	21	21	15.6	5.35	7	37.33333333	6.652482024	1150.9	36.4
303		1861.9	0	19.9	19.8	13.9	5.95	7	37.333333	6.024686	20.8	20.4	15.4	5.25	7	37.33333333	6.827977475	1160	36.7
304	9-Jun-98	1876.8	0	19.5	19.5	13.8	5.7	7	37.333333	6.4256668	20	19.8	14.4	5.4	7	37.33333333	6.782648291	1170.9	36.3
305		1881.3	0	19.2	19.1	13.8	5.35	7	37.333333	6.5421118	20.1	20	15	5.2	7	37.33333333	6.730826585	1185.2	36.7
306		1885.5	0	18.8	18.6	13.2	5.5	7	37.333333	6.6752622	19.9	19.7	14	5.5	7	37.33333333	6.67526224	1189.5	36.6
307		1889	0	19.1	19	13.3	5.75	7	37.333333	6.1454792	21	20.8	14.5	5.05	7	37.33333333	6.997327842	1202.5	36.7
308	10-Jun-98	1896.7	0	18.5	18.4	12.2	6.25	7	37.333333	5.9306577	20.1	20	14.5	5.8	7	37.33333333	6.390794944	1208	36.6
309		1901.9	0	19.8	19.5	14.5	5.15	7	37.333333	6.8778759	20.1	20	14.5	6.4	7	37.33333333	5.534540759	1225	36.6
310		1904.8	0	19.1	19	14.6	4.45	7	37.333333	8.0940764	20.9	20.5	15.7	5.55	7	37.33333333	6.489845048	1231.1	36.7
311	11-Jun-98	1912.5	0	19	18.9	13	5.95	7	37.333333	5.9816435	19.2	19	13.9	5.55	7	37.33333333	6.412752942	1248.1	36.4
312		1919.2	0	19.6	19.5	13.7	5.85	7	37.333333	6.3059581	20.2	20.1	13.8	5	7	37.33333333	7.377971012	1254.7	36.6
313	12-Jun-98	1920	0	19.1	19.1	14	5.1	7	37.333333	7.0963179	20.2	20.1	14.5	5.2	7	37.33333333	6.959850241	1275.1	36.3
314		1925.1	0	19	18.9	11	7.95	7	37.333333	4.6402333	20.9	20.2	14.8	6.35	7	37.33333333	5.809425994	1279	36.8

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
315		1927.4	0	19.1	19	12.2	6.85	7	37.333333	5.2960324	18.5	18	13	5.65	7	37.33333333	6.420853402	1296	36.3
316	13-Jun-98	1935.7	0	19.5	19.5	13.5	6	7	37.333333	6.1483092	20.2	20	14.5	5.75	7	37.33333333	6.415626967	1301	36.4
317		1942.7	0	17.1	17.1	12.5	4.6	7	37.333333	7.9053542	20	19.4	12.8	5.25	7	37.33333333	6.926596078	1305.9	36.3
318	14-Jun-98	1957	0	19.2	19.2	13.8	5.4	7	37.333333	6.606656	20	19.5	14.1	5.6	7	37.33333333	6.370704021	1309.9	36.3
319		1962.9	0	18.5	18.5	11	7.5	7	37.333333	4.9069058	20.5	20.5	14.5	6.9	7	37.33333333	5.333593273	1316.7	36.4
320	15-Jun-98	1980.1	0	18.5	18.5	13.5	5	7	37.333333	7.4488426	20.5	20.1	14	5.65	7	37.33333333	6.591896143	1325	36.6
321		1986	0	19.5	19.5	13.5	6	7	37.333333	6.1189904	20.1	20	13.9	6	7	37.33333333	6.118990387	1328.1	36.6
322	16-Jun-98	2001.6	0	18.1	18.1	12.7	5.4	7	37.333333	6.7988782	21	20.1	14.2	6.3	7	37.33333333	5.827609892	1336.9	36.4
323		2006.3	0	18.9	18.9	13.2	5.7	7	37.333333	6.5653801	22	21.5	15.2	6.15	7	37.33333333	6.084986457	1344.2	36.7
324		2011.7	0	19.9	19.9	14.2	5.7	7	37.333333	6.4873907	21.3	21	15.1	6.35	7	37.33333333	5.823327127	1345.6	36.4
325	17-Jun-98	2023.6	0	20.8	20.5	14	6.65	7	37.333333	5.7773767	22	21.2	15	6.55	7	37.33333333	5.865580962	1351.4	36.3
326		2029.1	0	20	19.9	14.5	5.45	7	37.333333	6.7365032	21.8	21.5	15.4	6.05	7	37.33333333	6.068420218	1351.4	36.4
327	18-Jun-98	2042.5	0	20.9	20.9	15.5	5.4	7	37.333333	7.0808052	22	21.5	16	6.6	7	37.33333333	5.793386067	1363.4	36.2
328		2048	0	20.2	20.1	14.8	5.35	7	37.333333	7.0284066	21.8	21.2	16.2	6.25	7	37.33333333	6.016316042	1387.6	36.6
329		2054.2	0	20.8	20.4	15.2	5.4	7	37.333333	6.6383114	20.5	20.1	14.1	5.75	7	37.33333333	6.234240303	1394.2	36.6
330	19-Jun-98	2063.9	0	21.1	21.1	15.7	5.4	7	37.333333	6.7181151	23	22.6	16.5	5.3	7	37.33333333	6.844872022	1418.9	36.6
331		2070.7	0	19.2	19.1	14	5.15	7	37.333333	6.7637662	22	21.8	16.5	6.2	7	37.33333333	5.618289682	1420.8	36.6
332		2075.4	0	21.5	21.3	16	5.4	7	37.333333	6.6860792	22.1	22	16.8	6.3	7	37.33333333	5.730925003	1437.7	36.6
333	20-Jun-98	2083.9	0	20.6	20.4	15.3	5.2	7	37.333333	6.8936311	22.3	22.2	16.7	5.4	7	37.33333333	6.638311434	1449.7	36.4
334	21-Jun-98	2106.1	0	20.8	20.6	15.8	4.9	7	37.333333	7.4036371	21.1	21	15.3	5.25	7	37.33333333	6.91006128	1463.2	36.4
335	22-Jun-98	2129.1	0	21	20.9	15.7	5.25	7	37.333333	6.6349326	21.8	21.5	15.8	5.55	7	37.33333333	6.276287573	1469.4	36.8
336	23-Jun-98	2146.2	0	20	19.9	15	4.95	7	37.333333	7.3992527	21	21	14.2	5.75	7	37.33333333	6.369791438	1484.7	36.3
337		2155.5	0	20.1	20	15.1	4.95	7	37.333333	7.0876867	19.5	19.1	13.1	5.85	7	37.33333333	5.997273333	1491	36.6
338	24-Jun-98	2169.7	0	19.5	19.5	13.8	5.7	7	37.333333	6.1404032	16.9	16.5	10.4	6.8	7	37.33333333	5.147102683	1498	36.7
339		2179	0	19.1	19	13	6.05	7	37.333333	5.9534942	20.2	20.1	13.8	6.2	7	37.33333333	5.809458067	1509	36.4
340	25-Jun-98	2189.6	0	15.9	15.8	10.7	5.15	7	37.333333	6.6674659	19.5	19.1	12.2	6.3	7	37.33333333	5.45038882	1517	36.8
341		2195.3	0	19	19.8	13.5	5.9	7	37.333333	5.9039654	18.1	17.9	11.2	6.35	7	37.33333333	5.485574178	1522.1	36.8
342		2200	0	18	17.9	12.2	5.75	7	37.333333	6.2193583	19.9	19.5	12.2	7.1	7	37.33333333	5.036804225	1531.8	36.4
343	26-Jun-98	2213.9	0	16.9	16.8	10.8	6.05	7	37.333333	5.8547208	20.1	19.9	12.8	6.8	7	37.33333333	5.208979537	1557	37.2
344	27-Jun-98	2227.2	0	18.5	18.2	12.2	6.15	7	37.333333	5.8148472	19.8	19.2	13	7.5	7	37.33333333	4.768174666	1583.1	37.2
345		2232.6	0	18.9	18.7	12.7	6.1	7	37.333333	6.1056087	20.1	20	13.4	7.2	7	37.33333333	5.17280739	1602.6	36.4
346	28-Jun-98	2249.7	0	18.2	18.1	13.1	5.05	7	37.333333	6.7348015	20.9	20.5	13.2	6.5	7	37.33333333	5.232422719	1613.1	36.4
347		2253.6	0	18.8	18.7	13.5	5.25	7	37.333333	6.779196	19.5	19	11	6.65	7	37.33333333	5.351996816	1629.4	36.4
348	29-Jun-98	2271.1	0	19.5	19.3	13	6.4	7	37.333333	5.3141793	20.9	20.5	13	7.5	7	37.33333333	4.534766356	1636.3	36.8
349		2274.8	0	18	17.8	11.5	6.4	7	37.333333	5.6010753	22.5	22.2	15	8.25	7	37.33333333	4.345076575	1652	36.4
350	30-Jun-98	2291.8	0	19.6	19.3	13.2	6.25	7	37.333333	5.4939919	22.2	22	13.2	7.7	7	37.33333333	4.459409034	1658.8	36.6
351	1-Jul-98	2312.7	0	21.1	21	15.9	5.15	7	37.333333	6.6674659	22.8	22.2	14.2	7.35	7	37.33333333	4.671761846	1664.8	37.1
352	2-Jul-98	2332.1	0	21	20.9	14.9	6.05	7	37.333333	5.594804	21.1	20.9	13.4	8.9	7	37.33333333	3.803209463	1679.7	36.4
353		2341	0	21.1	21	16.2	4.85	7	37.333333	7.2165563	22.5	22	13.1	8.3	7	37.33333333	4.216903403	1694	36.2
354		2344.7	0	20	19.9	15	4.95	7	37.333333	6.8872991	22.2	22	13	7.6	7	37.33333333	4.485806654	1701	36.3
355	3-Jul-98	2354.4	0	20	20	14.9	5.1	7	37.333333	6.8464211	18.9	18.5	10.9	9.15	7	37.33333333	3.816037968	1720.5	36.7
356		2358.7	0	21	20.9	15.5	5.45	7	37.333333	6.2405042	19	18.8	11.2	9.1	7	37.33333333	3.737444799	1724.4	36.6
357		2362.7	0	17.5	17.3	12.2	5.2	7	37.333333	6.7147591	19.8	19.4	11	7.8	7	37.33333333	4.476506078	1744.8	36.8
358		2365.4	0	18	17.9	12.8	5.15	7	37.333333	6.5255802	22.8	22.4	13.8	7.7	7	37.33333333	4.364511429	1749	36.7
359	4-Jul-98	2377.4	0	18.2	18.1	12.8	5.35	7	37.333333	6.5109151	22	21.5	12.2	8.6	7	37.33333333	4.050394887	1768.4	37.0
360	5-Jul-98	2396.2	0	21.2	21.1	15.9	5.25	7	37.333333	6.619094	20.3	20.1	11.2	8.8	7	37.33333333	3.94889132	1792	36.6
361		2399.8	0	20.5	20.4	14.8	5.65	7	37.333333	6.239319	21.5	21.2	12.9	9.55	7	37.33333333	3.691324837	1814	37.1
362	6-Jul-98	2417.9	0	19	18.9	13.4	5.55	7	37.333333	6.0552681	21.9	21.6	12.8	9	7	37.33333333	3.734082	1824.3	36.4
363	7-Jul-98	2420	0	19.1	19	13.5	5.55	7	37.333333	6.3365766	22	21.8	13.8	8.45	7	37.33333333	4.161893509	1839.6	36.4
364		2425.2	0	20.9	20.8	14	6.85	7	37.333333	5.0851673	21	21	13.5	8.95	7	37.33333333	3.891999556	1844.2	36.7
365		2428.2	0	21	20.9	15.2	5.75	7	37.333333	6.1454792	20.8	20.3	12.3	8.1	7	37.33333333	4.362531556	1866.3	36.4
366	8-Jul-98	2441.4	0	19.5	19.5	15	4.5	7	37.333333	7.8901819	20.1	20	12.1	7.5	7	37.33333333	4.734109125	1887.8	36.4
367		2444.3	0	19.1	19	13.3	5.75	7	37.333333	5.957475	19.2	19	11.2	8.25	7	37.33333333	4.152179521	1891.4	36.4
368	9-Jul-98	2467	0	18.1	18	13.2	4.85	7	37.333333	7.1649987	23.2	23.1	13.4	7.95	7	37.33333333	4.371099826	1912.5	36.4
369		2470.8	0	17.2	17.1	12.2	4.95	7	37.333333	6.8054857	23.6	23.2	14.2	7.9	7	37.33333333	4.26419673	1915	36.7
370	10-Jul-98	2481.4	0	23	22.8	15.5	7.4	7	37.333333	4.4236121	23.1	22.9	15.8	9.75	7	37.33333333	3.357408168	1920.9	36.7
371		2485	0	22.2	22	16.3	5.8	7	37.333333	5.6981335	24.8	24.5	15.8	9.2	7	37.33333333	3.592301554	1924.5	36.7
372		2489	0	22.9	22.8	17.1	5.75	7	37.333333	5.7614359	25.9	25.3	16.3	7.2	7	37.33333333	4.601146707	1939.5	36.3
373		2491.3	0	23.2	23.1	18.2	4.95	7	37.333333	6.5501569	26	25.5	15.5	8.85	7	37.33333333	3.663647089	1942.8	37.0
374	11-Jul-98	2500	0	24.1	24	19	5.05	7	37.333333	6.3898343	24.8	24.2	13.2	9.3	7	37.33333333	3.469748741	1968.4	38.1
375	12-Jul-98	2519.5	0	24.8	24.5	18.8	5.85	7	37.333333	5.6494315	26.1	25.8	15.5	10.25	7	37.33333333	3.224309688	1972.6	38.0
376		2524.6	0	23.2	23	16.2	6.9	7	37.333333	4.8821963	20	19.5	9.5	11.3	7	37.33333333	2.981164085	1985	36.4

San Pasqual Wastewater IMS Raw Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
377	13-Jul-98	2539.4	0	24.9	24.7	19	5.8	7	37.333333	5.6439189	17.2	17	8.1	10.45	7	37.33333333	3.132510013	1989	37.4
378	14-Jul-98	2563.1	0	17.9	17.5	12.1	5.6	7	37.333333	5.7210937	20	19.9	9.1	10.25	7	37.33333333	3.125670678	1993.3	36.8
379		2571.6	0	16.1	16	11.2	4.85	7	37.333333	7.0629858	20.8	20.2	11.2	9	7	37.33333333	3.806164561	2006	37.4
380	15-Jul-98	2579.8	0	19.9	19.5	13.2	6.5	7	37.333333	5.3079962	20	20	9.1	10.85	7	37.33333333	3.179905574	2027.4	37.0
381	16-Jul-98	2577	0	19.5	19.2	13.9	5.45	7	37.333333	6.3155255	20.7	20.1	9.2	9.3	7	37.33333333	3.701033787	2050.5	37.4
382	17-Jul-98	2593	0	19	19	12.9	6.1	7	37.333333	5.6022472	21.5	21.2	11.3	10.9	7	37.33333333	3.135202588	2077.6	37.6
383		2600.5	0	19.5	19.2	13.2	6.15	7	37.333333	5.3867083	21.8	21.5	8	11.2	7	37.33333333	2.957880026	2087.4	37.0
384	18-Jul-98	2611.7	0	20.9	20.7	13.2	7.6	7	37.333333	4.5505966	21.1	20.9	7	10.05	7	37.33333333	3.441247146	2096.6	37.4
385	19-Jul-98	2632.8	0	21	20.9	14.5	6.45	7	37.333333	4.8730813	20	19.8	14.8	13.65	7	37.33333333	2.3026648	2099	37.2
386		2638.4	0	20	19.9	13.9	6.05	7	37.333333	5.3848977	23.4	23.2	20.8	14	7	37.33333333	2.327045071	2112	36.7
387	21-Jul-98	2647.5	0	18.8	18.5	14.7	3.95	7	37.333333	7.8066115	20.2	20.1	16.2	5.1	7	37.33333333	6.046297147	2120.4	37.5
388		2653.1	0	24.9	24.8	21.1	3.75	7	37.333333	8.7292612	20.2	20.2	16.2	2.5	7	37.33333333	13.09389185	2133.1	36.6
389	22-Jul-98	2665.5	0	19.2	19	16.2	2.9	7	37.333333	11.341923	23	23	19.1	3.95	7	37.33333333	8.326981318	2157.1	36.4
390		2668.1	0	19.1	19.1	16.5	2.6	7	37.333333	12.263595	20	19.9	15.8	4	7	37.33333333	7.97133691	2163.5	36.4
391		2672.8	0	21.9	21.9	18.7	3.2	7	37.333333	10.059885	19.2	19.1	15.1	3.9	7	37.33333333	8.254264942	2171	37.0
392	23-Jul-98	2683.6	0	17.3	17.2	15.5	1.75	7	37.333333	18.527587	19.2	19.1	15.2	4.15	7	37.33333333	7.812837768	2175	35.6
393		2687.8	0	18	17.9	14.5	3.45	7	37.333333	9.6023931	18.1	18	14.5	4.05	7	37.33333333	8.179816368	2189.1	37.1
394		2691.5	0	18	17.9	15	2.95	7	37.333333	11.123071	19.6	19.4	15.6	3.95	7	37.33333333	8.307103596	2191.9	37.5
395		2694.7	0	17	16.9	13.8	3.15	7	37.333333	10.36717	19.7	19.5	15.4	3.55	7	37.33333333	9.199038605	2196.5	37.4
396	24-Jul-98	2705.5	0	18.2	18.1	15	3.15	7	37.333333	10.592584	20	19.9	16	3.9	7	37.33333333	8.555548583	2208.6	37.8
397		2708.8	0	18.2	18.1	15	3.15	7	37.333333	10.391978	20.1	20	16.1	4.2	7	37.33333333	7.793983246	2213.3	37.2
398		2713	0	18.6	18.5	15.1	3.45	7	37.333333	9.4883274	20.2	20.1	16.3	3.95	7	37.33333333	8.287273325	2213.3	37.2
399	25-Jul-98	2715.3	0	18.9	18.8	15.6	3.25	7	37.333333	10.096326	19.5	19.2	15.1	3.95	7	37.33333333	8.307103596	2221.7	37.8
400		2725	0	19.1	19	15.6	3.45	7	37.333333	9.7410835	20.6	20.5	16.2	3.85	7	37.33333333	8.729022858	2233.4	37.2
401		2729	0	18.1	18	14.5	3.55	7	37.333333	9.1990386	19.1	19	15	4.25	7	37.33333333	7.683902835	2237.2	37.4
402	26-Jul-98	2747.2	0	19.1	19.1	15.6	3.5	7	37.333333	9.2637934	20.1	20	15.4	4.35	7	37.33333333	7.453626836	2242	37.4
403		2750.8	0	17.7	17.6	14.5	3.15	7	37.333333	10.293104	19.6	19.5	15.2	4.05	7	37.33333333	8.005747342	2242	37.1
404	27-Jun-98	2768	0	18.9	18.8	14.9	3.95	7	37.333333	8.5488007	20.3	20.2	16.9	4.65	7	37.33333333	7.261884463	2255.6	37.1
405		2772	0	18.1	18	14.2	3.85	8	42.666667	10.023826	20.1	20	16.4	4.35	7	37.33333333	7.762704081	2255.6	37.4
406	28-Jul-98	2781.5	0	19.3	19.2	15.6	3.65	8	42.666667	10.44748	19.9	20	16.4	3.35	7	37.33333333	9.960190887	2280	37.0
407		2782.4	0	19	18.9	15.1	3.85	8	42.666667	9.9047538	19.7	20	16.4	3.65	7	37.33333333	9.141545061	2280	37.0
408	29-Jul-98	2793.2	0	18.9	18.8	14.8	4.05	8	42.666667	9.4156302	20.1	20	16.3	3.75	7	37.33333333	8.897770526	2280	37.2
409		2797.4	0	18.1	18	14.2	3.85	7.5	40	9.2857067	19.5	19.2	15.2	4.15	7	37.33333333	8.04015409	2280	37.4
410		2801.9	0	18.1	18	13.9	4.15	7	37.333333	7.4126518	19.2	19.1	15.2	3.95	7	37.33333333	7.787975983	2300.2	37.6
411	30-Jul-98	2813.6	0	18.8	18.6	14.2	4.5	7	37.333333	6.8853033	19.9	19.8	15.5	4.35	7	37.33333333	7.122727568	2321.3	37.5
412	31-Jul-98	2834.1	0	19	18.5	14.8	3.95	7	37.333333	8.3269813	20	19.5	14.4	5.35	7	37.33333333	6.147958169	2333.6	37.5
413		2836.2	0	19.2	18.8	14.5	4.5	7	37.333333	7.1708141	20.1	19.8	15	4.95	8	42.66666667	7.450196431	2338.1	37.5
414	1-Aug-98	2846.3	0	22	21.5	15.2	6.55	7	37.333333	4.787228	23	22.5	17.1	5.65	8	42.66666667	6.342623157	2343.6	37.5
415		2850.4	0	20.8	20	10.1	10.3	7	37.333333	3.2240318	21.9	21.2	14.2	7.35	8	42.66666667	5.163463948	2356.8	37.1
416	2-Aug-98	2864.7	0	22.2	22	2	20.1	7	37.333333	1.5787711	23.5	23	12	11.25	8	42.66666667	3.223700253	2380	37.2
417	3-Aug-98	2872	0	19.5	19	15	4.25	7	37.333333	7.6839028	20.5	20	16.8	3.45	8	42.66666667	10.81791703	2382.3	37.2
418	4-Aug-98	2887.7	0	19.1	18.5	13.3	5.5	7	37.333333	6.1985692	20.1	19.8	14.4	5.55	7	37.33333333	6.142726229	2393.3	37.1
419		2892.5	0	19.5	19	14	5.25	7	37.333333	6.2351866	20.8	20.1	15.3	5.15	7	37.33333333	6.356258181	2397.8	36.6
420	5-Aug-98	2909.8	0	20	19.7	15.9	3.95	7	37.333333	8.8820377	21.2	20.9	16.7	4.35	7	37.33333333	8.06529862	2414.1	36.4
421		2915.4	0	18.2	17.8	13.2	4.8	7	37.333333	5.9654272	19.2	18.8	14.5	4.5	7	37.33333333	6.363122308	2416	37.0
422	6-Aug-98	2929	0	14	13.5	8.1	5.65	7	37.333333	5.8076211	15	14.5	9.5	5.25	7	37.33333333	6.250106515	2433.5	37.0
423		2935.3	0	19.8	19.2	14.2	5.3	7	37.333333	5.9586634	21	20.2	15.2	5.4	7	37.33333333	5.8485141	2438.5	37.1
424	7-Aug-98	2951.3	0	19.9	19.2	14.9	4.65	7	37.333333	7.1243562	21	20.5	16	4.75	7	37.33333333	6.974369746	2457.3	37.0
425	8-Aug-98	2973.5	0	19.5	19.1	14.2	5.1	7	37.333333	6.2371044	20.5	20.1	15.2	5.1	7	37.33333333	6.237104442	2463.4	37.5
426	9-Aug-98	2991.3	0	19.5	19	15.1	4.15	7	37.333333	8.059393	20.6	20.1	15.8	4.55	7	37.33333333	7.35087497	2478.4	37.2
427	10-Aug-98	3013	0	16.5	16	12.1	4.15	7	37.333333	7.7941874	17.1	17	13	4.05	7	37.33333333	7.986636453	2485	36.8
428		3016.7	0	19	18.5	15	3.75	7	37.333333	8.9404037	20	19.9	15.5	4.45	7	37.33333333	7.534048046	2502.3	36.4
429	11-Aug-98	3032.8	0	20.4	20	16.8	3.4	7	37.333333	9.9079865	21.8	21.2	17.2	4.3	7	37.33333333	7.834221899	2528.2	36.8
430		3044.2	0	19.9	19.2	15.9	3.65	7	37.333333	9.0545683	20.9	20.2	16.5	4.05	7	37.33333333	8.160289951	2546.3	37.1
431	12-Aug-98	3062.5	0	19.7	19.1	15.8	3.6	7	37.333333	9.0929805	20.6	20.1	16.1	4.25	7	37.33333333	7.702289326	2569.7	37.6
432		3065.9	0	19.6	19.1	15.6	3.65	7	37.333333	8.6319412	20.6	20.1	16.1	4.35	7	37.33333333	7.242893163	2573.6	37.0
433		3068.2	0	19.9	19.3	15.8	3.8	7	37.333333	8.5120731	21	20.5	16.9	3.85	7	37.33333333	8.401526658	2591.2	37.2
434	13-Aug-98	3077.2	0	20.5	20	16	4.25	7	37.333333	7.2037203	21.5	21.1	16.1	5.2	7	37.33333333	5.887656007	2603.7	37.1
435	14-Aug-98	3100.8	0	20.1	19.8	15.8	4.15	7	37.333333	7.3773039	21.2	20.9	15.8	5.25	7	37.33333333	5.831583093	2623.8	37.1
436	15-Aug-98	3121.3	0	20.8	20	16.5	3.9	7	37.333333	7.850208	21.9	21.2	16.5	5.05	7	37.33333333	6.062536879	2627.4	36.8
437		3126.3	0	19.9	19.1	15.1	4.4	7	37.333333	7.0249777	21	20.2	15.6	5	7	37.33333333	6.181980381	2629.7	37.1
438	16-Aug-98	3144.1	0	20.5	20	16.2	4.05	7	37.333333	7.9675712	21.8	21.1	16.6	4.85	7	37.33333333	6.653332638	2639.4	37.1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
439		3149.8	0	20	19.2	15.8	3.8	7	37.333333	8.4917535	21	20.5	15.9	4.85	7	37.33333333	6.653332638	2639.4	36.8
440	17-Aug-98	3163.9	0	19.9	19.1	15.8	3.7	7	37.333333	8.6683944	21	20.2	15.9	4.7	7	37.33333333	6.981501958	2687.3	37.1
441		3169.7	0	20	19.2	15.8	3.8	7	37.333333	8.6971511	21.1	20.5	15.8	5	7	37.33333333	6.60983486	2692.1	36.8
442	18-Aug-98	3185.6	0	20	19.2	15	4.6	7	37.333333	7.3232944	21	20.5	15.2	5.55	7	37.33333333	6.069757507	2711.8	36.8
443	19-Aug-98	3206.3	0	20.8	20	16.3	4.1	7	37.333333	8.0031852	22	21.3	15.9	5.75	7	37.33333333	5.706618992	2717.5	36.7
444		3215.6	0	19.9	19.5	16.3	3.4	7	37.333333	9.9079865	20.8	20.2	15.2	5.3	7	37.33333333	6.356066823	2733.6	36.7
445	20-Aug-98	3228.4	0	20.1	19.9	15.9	4.1	7	37.333333	8.0223357	21.5	21	15.5	5.75	7	37.33333333	5.720274123	2740	36.4
446	21-Aug-98	3249.7	0	20.2	20	15.8	4.3	7	37.333333	7.9094762	21.5	21.1	15.2	6.1	7	37.33333333	5.575532405	2757.1	36.7
447	22-Aug-98	3273.6	0	19.9	19.2	15.8	3.75	7	37.333333	9.1566532	21.1	20.7	14.8	6.1	7	37.33333333	5.629090093	2779.7	36.7
448	23-Aug-98	3288.6	0	20	19.2	14.2	5.4	7	37.333333	6.061987	21.2	20.9	13.9	7.15	7	37.33333333	4.578283865	2789.8	36.4
449	24-Aug-98	3305.2	0	22	21.4	17.5	4.2	7	37.333333	8.3135113	23.2	22.9	16.9	6.15	7	37.33333333	5.677519904	2803.7	50.5
450	25-Aug-98	3327.4	0	20.1	20	15.8	4.25	7	37.333333	8.1960932	21.8	21.2	15.2	6.3	7	37.33333333	5.529110481	2826.7	50.5
451		333.5	0	19.9	19.2	15.1	4.45	7	37.333333	7.6611529	21.2	20.8	14.9	6.1	7	37.33333333	5.588873864	2852.6	50.1
452	26-Aug-98	3349.7	0	20.1	19.9	15.8	4.2	7	37.333333	7.6830151	21.5	21.1	15.1	6.2	7	37.33333333	5.204623112	2869.2	50.1
453		3355.1	0	21.1	20.2	15.1	5.55	7	37.333333	6.0552681	22.1	21.9	15	7	7	37.33333333	4.800962572	2887.4	50.6
454	27-Aug-98	3371.2	0	19.5	19	11.5	7.75	7	37.333333	4.315675	21	20.5	11.9	8.85	7	37.33333333	3.779263403	2911.4	50.5
455	28-Aug-98	3394.4	0	19.2	18.8	11.9	7.1	7	37.333333	4.5775861	20.2	20	11.2	8.9	7	37.33333333	3.65178214	2918.1	50.5
456	29-Aug-98	3416.3	0	21.1	20.5	14.3	6.5	7	37.333333	5.1456125	22.3	21.9	13	9.1	7	37.33333333	3.675437485	2935.6	50.5
457	30-Aug-98	3422	0	20.2	19.9	14.8	5.25	7	37.333333	6.1758622	21.8	21.2	13	8.5	7	37.33333333	3.814503145	2941.5	50.5
458	31-Aug-98	3442.9	0	20	19.2	7.6	12	7	37.333333	2.8139802	21.3	20.9	8.6	12.5	7	37.33333333	2.70142102	2958.8	49.2
459	1-Sep-98	3454.1	0	19.9	19.3	16.6	3	7	37.333333	11.309853	21.1	20.7	16.1	4.8	7	37.33333333	7.068658134	2984.1	50.1
460	2-Sep-98	3465.2	0	20.5	20	16.9	3.35	7	37.333333	9.8890317	22	21.2	16.8	4.8	7	37.33333333	6.901720061	3007.7	50.4
461	3-Sep-98	3487.7	0	20	19.5	16.5	3.25	7	37.333333	9.2197838	21.2	21	16.8	4.3	7	37.33333333	6.96844123	3014.6	50.5
462	4-Sep-98	3504.4	0	21	19.8	16	4.4	7	37.333333	7.1605876	21	20.8	16.2	4.7	7	37.33333333	6.703528797	3037	49.9
463	5-Sep-98	3526.4	0	19.9	19.2	15.9	3.65	7	37.333333	8.2882547	20.9	20.3	15.8	4.8	7	37.33333333	6.302527004	3042.8	48.8
464	6-Sep-98	3550.6	0	19.3	19	15.6	3.55	4	21.333333	5.1693822	20.8	20.2	15.5	5	7	37.33333333	6.422957428	3054.8	50.5
465	7-Sep-98	3571.1	0	20	19.8	16.6	3.3	7	37.333333	9.6853469	21.2	20.9	15.9	5.15	7	37.33333333	6.206144613	3079.1	50.5
466	8-Sep-98	3591.7	0	20.2	20	16.2	3.9	7	37.333333	8.2345608	21.5	21.1	15.8	5.5	7	37.33333333	5.839052207	3082.8	49.2
467	9-Sep-98	3615.1	0	22	21.5	14.5	7.25	5	26.666667	3.2716776	23.1	23	14.5	8.55	7	37.33333333	3.883921347	3106.6	50.3
468	10-Sep-98	3638.3	0	18.5	18	12.6	5.65	7	37.333333	5.8215179	19.8	19.1	12.8	6.65	7	37.33333333	4.946101685	3132.8	49.7
469	11-Sep-98	3657.1	0	19	18.5	12	6.75	4.8	25.6	3.3493619	20	19.5	13.5	6.25	7	37.33333333	5.275244974	3155.1	49.7
470	12-Sep-98	3676.1	0	20	19.5	13.2	6.55	7	37.333333	5.081983	21.1	20.8	13.6	7.35	7	37.33333333	4.528841963	3177.3	49.2
471	13-Sep-98	3697.1	0	25.2	25.1	5.8	19.35	7	37.333333	1.7202578	27.3	27.1	7.2	20	7	37.33333333	1.664349421	3202.7	50.3
472		3712.7	0	20.2	20	14.9	5.2	7	37.333333	6.4320156	21.3	21	15.7	5.45	5	26.66666667	4.383549294	3228.1	50.5
473	14-Sep-98	3724.8	0	21	20.5	11.5	9.25	7	37.333333	3.6856357	21	20.5	9.5	11.25	7	37.33333333	3.030411606	3248.5	50.6
474	15-Sep-98	3737.5	0	20	19.9	1	18.95	7	37.333333	1.8381739	21.5	21.2	2	19.35	7	37.33333333	1.800175505	3268.2	49.9
475	16-Sep-98	3744.1	0	19.9	19.4	11.5	8.15	7	37.333333	4.3047913	21	20.5	11	9.75	5	26.66666667	2.57026	3289.2	50.3
476	17-Sep-98	3758.1	0	20	19.9	1	18.95	7	37.333333	1.8558311	21.2	21.1	1	20.15	7	37.33333333	1.745310181	3291.4	50.8
477	21-Sep-98	3764.3	0	19.8	19.4	15.2	4.4	7	37.333333	7.4219516	21	20.5	12.8	7.95	5.2	27.73333333	3.05146905	3307.7	50.3
478	21-Sep-98	3771.4	0	19	18.2	9.2	9.4	7	37.333333	3.723436	20	19.8	5.5	14.4	7	37.33333333	2.430576267	3320.7	49.2
479	22-Sep-98	3765.4	0	23.5	23.1	5	18.3	7	37.333333	1.908019	25	24.5	1.9	22.85	7	37.33333333	1.528085226	3356.6	50.4
480	22-Sep-98	3792.3	0	20	19.8	14.3	5.6	7	37.333333	6.2202493	21.1	20.9	12.9	8.1	7	37.33333333	4.300419263	3336.5	50.4
481	22-Sep-98	3795	0	19.8	19.1	9.8	9.65	7	37.333333	3.5838895	20.9	20.2	9.2	11.35	7	37.33333333	3.047095491	3344.2	50.3
482	23-Sep-98	3804.2	0	26.8	26.2	1.7	24.8	7	37.333333	1.4454388	28.1	27.8	5	22.95	7	37.33333333	1.561955632	3359.4	50.3
483	24-Sep-98	3810.4	0	21.1	20.8	16.2	4.75	7	37.333333	7.3684838	22.5	22	16.6	5.65	7	37.33333333	6.194743052	3361.3	50.5
484	24-Sep-98	3816.5	0	21	20.5	13	7.75	7	37.333333	4.6475665	22.1	21.9	13.7	8.3	7	37.33333333	4.339595182	3374.2	50.5
485	25-Sep-98	3830.8	0	21.1	20.8	4.3	16.65	7	37.333333	2.189288	22.2	22	6.5	15.6	7	37.33333333	2.336643898	3375	50.5
486	28-Sep-98	3833.7	0	19.7	19.2	13.9	5.55	7	37.333333	6.5365445	20.8	20.1	15.9	4.55	7	37.33333333	7.973147631	3397	50.3
487	29-Sep-98	3842.3	0	19.1	18.5	7.8	11	7	37.333333	3.2979838	20.1	19.9	14.8	5.2	7	37.33333333	6.976504177	3400	50.6
488	30-Sep-98	3852.9	0	19.1	18.9	4.3	14.7	7	37.333333	2.467879	20.2	20	15.1	5	7	37.33333333	7.255564344	3409.6	50.5
489	1-Oct-98	3857.9	0	20.6	20.1	16.9	3.45	7	37.333333	10.667167	21.6	21.1	16.2	5.15	7	37.33333333	7.145979336	3421.1	50.3
490	1-Oct-98	3858.7	0	19.8	19.4	15.9	3.7	7	37.333333	9.2803918	20.6	20.1	15.2	5.15	7	37.33333333	6.667465935	3423.2	60.1
491	2-Oct-98	3873.2	0	21.2	21	17	4.1	7	37.333333	8.4959503	22.5	22	16.8	5.45	7	37.33333333	6.391448813	3423.9	59.6
492	2-Oct-98	3878.7	0	21.1	20.9	16.6	4.4	7	37.333333	8.2449595	22.5	22.1	16.5	5.8	7	37.33333333	6.254796848	3439.8	59.8
493	3-Oct-98	3895.7	0	19.1	18.9	14.1	4.9	7	37.333333	7.1258668	20.2	20	14.2	5.9	7	37.33333333	5.918092782	3445.7	59.6
494	3-Oct-98	3899	0	19.1	18.9	14	5	7	37.333333	7.203728	20.1	19.9	14.1	5.9	7	37.33333333	6.10465424	3464.1	59.8
495	4-Oct-98	3916.1	0	19.1	18.9	13.9	5.1	7	37.333333	6.8464211	20.1	19.9	13.2	6.8	7	37.33333333	5.134815796	3467.7	59.8
496	4-Oct-98	3920.4	0	19.1	18.9	12.4	6.6	7	37.333333	5.3668274	20.1	19.9	12.2	7.8	7	37.33333333	4.541161648	3491.3	59.5
497	5-Oct-98	3937.2	0	18.9	18.2	11.2	7.35	7	37.333333	5.0430763	19.9	19.2	12	7.55	7	37.33333333	4.909484858	3508.9	59.5
498	5-Oct-98	3942.2	0	19	18.5	12.5	6.25	7	37.333333	5.6403444	20	19.9	12.9	7.05	7	37.33333333	5.000305276	3514.9	60.1
499	6-Oct-98	3966.4	0	18.6	18.1	12.9	5.45	7	37.333333	6.4528441	19.9	19.2	13.3	6.25	7	37.33333333	5.626880025	3540.8	59.6
500	6-Oct-98	3972.2	0	19.2	19	13.5	5.6	7	37.333333	6.4472906	20.2	20	14	6.1	7	37.33333333	5.918824183	3547	59.6

San Pasqual Wastewater IMS Raw Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
501	7-Oct-98	3981.8	0	19.8	19.2	13.2	6.3	7	37.333333	6.0692616	20.8	20.1	13.8	6.65	7	37.33333333	5.749826773	3557.5	58.5
502	7-Oct-98	3991.8	0	18.9	18.3	12.2	6.4	7	37.333333	5.5877047	20	19.8	13	6.9	7	37.33333333	5.18279855	3568	55.3
503	8-Oct-98	4006	0	18.2	18	11.2	6.9	7	37.333333	5.5282713	18.9	18.5	12.5	6.2	7	37.33333333	6.152431014	3583.6	58.1
504	8-Oct-98	4011.8	0	19.5	19	13	6.25	7	37.333333	5.7218096	20.9	20.1	13.9	6.8	7	37.33333333	5.418380302	3589.9	59.6
505	9-Oct-98	4027.4	0	19.5	19.1	11.5	7.8	7	37.333333	4.925584	21	20.5	13	7.75	7	37.33333333	4.957361974	3606.8	59.8
506	10-Oct-98	4051.7	0	21	20.5	14.1	6.65	7	37.333333	5.5077144	22.5	22	15.1	7.15	7	37.33333333	5.122559548	3633.1	61.7
507	11-Oct-98	4072.7	0	20	19.5	11.1	8.65	7	37.333333	4.3263199	21.1	20.5	12.5	8.3	7	37.33333333	4.508755025	3655.7	58.1
508	12-Oct-98	4093.8	0	20	19.5	12	7.75	7	37.333333	4.8287312	21.1	20.8	12.2	8.75	7	37.33333333	4.276876196	3678.7	58.1
509	13-Oct-98	4116.1	0	21	20.5	13.6	7.15	7	37.333333	5.1348171	22.2	21.9	14.3	7.75	7	37.33333333	4.73726288	3702.8	58.6
510	13-Oct-98	4127.4	0	20.1	19.9	12.1	7.9	7	37.333333	4.5811672	21.2	21	13.1	8	7	37.33333333	4.523902657	3715	58.5
511	14-Oct-98	4138.5	0	20.1	19.9	12.1	7.9	7	37.333333	4.6807756	21.5	21	13.1	8.15	7	37.33333333	4.537193528	3727.1	58.9
512	14-Oct-98	4148.5	0	19.9	19.3	9.2	10.4	7	37.333333	3.4799251	21	20.2	11	9.6	7	37.33333333	3.769918881	3737.8	58.3
513	15-Oct-98	4161.4	0	20	19.8	12	7.9	7	37.333333	4.6696019	21.2	20.9	13.1	7.95	7	37.33333333	4.640233341	3751.8	58.1
514	15-Oct-98	4167.2	0	19.5	19	12	7.25	7	37.333333	4.9918926	20.8	20.1	13.5	6.95	7	37.33333333	5.207369965	3758	58.3
515	16-Oct-98	4182.7	0	18.2	17.9	8.9	9.15	7	37.333333	4.1095055	19.5	19	11	8.25	7	37.33333333	4.557815183	3775.1	60.0
516	16-Oct-98	4188.5	0	19.1	18.9	8.9	10.1	7	37.333333	3.5322715	20.5	20	11.9	8.35	7	37.33333333	4.272567966	3781.3	60.0
517	17-Oct-98	4209.4	0	16.9	16.2	7.9	8.65	7	37.333333	4.3159923	18	17.5	10	7.75	7	37.33333333	4.817204301	3799.6	60.0
518	17-Oct-98	4205.7	0	18.5	18	8	10.25	7	37.333333	3.5224222	19.9	19.2	11.2	8.35	7	37.33333333	4.323931439	3803.3	60.7
519	18-Oct-98	4227.4	0	20	19.5	9	10.75	7	37.333333	3.6603575	21.2	21	13	8.1	7	37.33333333	4.857881905	3823.5	59.9
520	18-Oct-98	4229.4	0	18.9	18.2	4	14.55	7	37.333333	2.6091528	20.5	20	11	9.25	7	37.33333333	4.104126911	3825.6	60.0
521	19-Oct-98	4247.6	0	20.1	20	7.1	12.95	7	37.333333	3.0750489	21.8	21.1	12.5	8.95	7	37.33333333	4.44937239	3845.3	59.9
522	19-Oct-98	4255.2	0	20	19.5	13.8	5.95	7	37.333333	6.1704105	21.2	20.8	14.8	6.2	7	37.33333333	5.9216036	3849.1	59.9
523	20-Oct-98	4269.1	0	21.2	20.9	14.8	7.3	7	37.333333	5.4290395	22.7	22.2	15.8	6.7	7	37.33333333	5.915222164	3864	60.1
524	20-Oct-98	4278.6	0	18.8	18.1	12.5	5.9	7	37.333333	6.3732161	20	19.9	13.8	6.1	7	37.33333333	6.16425824	3874.4	60.4
525	21-Oct-98	4292.1	0	19.5	19.1	12.9	6.4	7	37.333333	6.13358	21	20.2	14	6.6	7	37.33333333	5.947713938	3889.1	60.4
526	21-Oct-98	4299.9	0	18.8	18.2	12.5	6	7	37.333333	6.192551	20	19.9	13.8	6.1	7	37.33333333	6.091033742	3898	60.7
527	22-Oct-98	4312.1	0	19.8	19.2	12.9	6.6	7	37.333333	5.9335159	21	20.4	414.2	6.5	7	37.33333333	6.024800735	3912	60.1
528	22-Oct-98	4318	0	18.9	18.3	12.2	6.4	7	37.333333	5.9744294	20	19.5	13.5	6.3	7	37.33333333	6.069261594	3917.9	59.9
529	23-Oct-98	4334	0	20	19.5	13.9	5.9	7	37.333333	6.480737	21.1	20.5	14.5	6.3	7	37.33333333	6.069261594	3936.9	59.9
530	23-Oct-98	4340.7	0	18.3	18	11.9	6.3	7	37.333333	5.662848	19.9	19.2	13.2	6.4	7	37.33333333	5.574366019	3944.9	60.7
531	24-Oct-98	4355.2	0	19.5	19.1	12.9	6.4	7	37.333333	5.8893674	20.9	20.2	14.1	6.4	7	37.33333333	5.889367416	3960.9	60.4
532	24-Oct-98	4358.8	0	18.5	18.1	12	6.3	7	37.333333	5.7035965	19.9	19.2	13.1	6.4	7	37.33333333	5.614477852	3965	60.0
533	25-Oct-98	4376	0	18.4	18	12	6.2	7	37.333333	6.035914	19.9	19.2	13.1	6.4	7	37.33333333	5.847291674	3984.3	59.9
534	25-Oct-98	4381	0	19	18.5	128	6	7	37.333333	6.1043835	20.1	19.9	13.9	6.1	7	37.33333333	6.004311602	3990.5	60.4
535	26-Oct-26	4396.6	0	19.5	19	13.1	6.2	7	37.333333	6.1084759	2.8	20.2	14.1	6.4	7	37.33333333	5.917585981	4008.1	59.9
536	26-Oct-98	4403	0	18.6	18.1	12.5	5.9	7	37.333333	6.1634965	19.9	9.2	13.9	5.7	7	37.33333333	6.379759545	4015.6	60.5
537	27-Oct-98	4418.7	0	20.3	20	13.3	6.9	7	37.333333	5.5019093	22	21.5	14.6	7.2	7	37.33333333	5.272663045	4033.2	60.1
538	27-Oct-98	4428.8	0	20	19.9	13.8	6.2	7	37.333333	5.9784856	21.2	20.9	14.6	6.5	7	37.33333333	5.702555489	4044.7	60.0
539	28-Oct-98	4439	0	19.9	19.4	13.2	6.5	7	37.333333	5.8126374	21.2	20.8	14.6	6.4	7	37.33333333	5.903459838	4056.4	60.1
540	28-Oct-98	4448	0	19.5	19.1	13.2	6.1	7	37.333333	5.9614147	21	20.2	14.8	5.8	7	37.33333333	6.269763691	4066.7	53.6
541	29-Oct-98	4461.7	0	20	19.7	13.4	6.5	7	37.333333	5.7987618	21.2	20.8	14.2	6.8	7	37.33333333	5.542934039	4082.2	60.1
542	29-Oct-98	4467	0	19.2	19	12.7	6.4	7	37.333333	5.7365535	20.4	20.1	14.1	6.2	7	37.33333333	5.9216036	4088.2	60.6
543	3-Nov-98	4565.9	0	20.5	20	10.3	9.95	7	37.333333	3.9831144	21.8	21.2	13.5	8	7	37.33333333	4.953998563	4200.9	59.9
544	3-Nov-98	4578	0	20.5	20	11	9.3	7	37.333333	4.1016207	21.5	21	14.3	7	7	37.33333333	5.449296041	4211.3	60.0
545	4-Nov-98	4586	0	19.1	18.7	9.7	9.2	7	37.333333	4.3181329	20.1	19.8	12.7	7.2	7	37.33333333	5.517614199	4223.6	59.6
546	5-Nov-98	4598	0	19.1	18.7	9.8	9.1	7	37.333333	4.2219292	20	19.8	12.8	7.1	7	37.33333333	5.411204972	4237.7	59.9
547	6-Nov-98	4251.9	0	19.3	18.8	10.2	8.8	7	37.333333	4.4395138	20.2	19.9	13	7.1	7	37.33333333	5.502495951	4251.9	71.4
548	7-Nov-98	4631.2	0	18.9	18.4	11.2	7.5	7	37.333333	5.3222895	20	19.8	12.5	7.4	7	37.33333333	5.3942123	4275.2	71.8
549	7-Nov-98	4635.8	0	19.9	19.2	12.8	6.8	7	37.333333	5.5961786	21.1	20.6	14.1	6.8	7	37.33333333	5.596178592	4280.6	72.6
550	8-Nov-98	4651	0	19.8	19	12	7.3	7	37.333333	5.4031506	20.8	20.1	13.2	7.3	7	37.33333333	5.403150636	4297.9	72.6
551	8-Nov-98	4658.1	0	20	19.8	12.8	7.1	7	37.333333	5.5553521	21.1	20.8	13.9	7.1	7	37.33333333	5.555352062	4304.8	71.8
552	9-Nov-98	4664.6	0	19.1	18.9	11.2	7.8	7	37.333333	5.1298317	20.2	20	13	7.1	7	37.33333333	5.63558974	4314.8	70.9
553	9-Nov-98	4669.4	0	19.1	18.9	11.1	7.9	7	37.333333	4.8400441	20.2	20	13.5	6.6	7	37.33333333	5.793386067	4319.8	72.6
554	10-Nov-98	4686.1	0	22	21.7	13.8	8.1	7	37.333333	5.0472449	23.2	22.9	15.3	7.8	7	37.33333333	5.241369656	4338.8	70.9
555	10-Nov-98	4695.5	0	19.9	19.1	11.1	8.4	7	37.333333	4.5519462	21	20.2	13.4	7.5	7	37.33333333	5.098179739	4349.6	70.9
556	11-Nov-98	4706	0	19.9	19.2	11.9	7.7	7	37.333333	5.1224675	21	20.2	13.1	7.5	7	37.33333333	5.259066619	4361.5	70.4
557	13-Nov-98	4744.8	0	19.1	18.5	10.7	8.1	7	37.333333	5.0231766	20.2	19.8	12.2	7.8	7	37.33333333	5.216375692	4411.4	71.4
558	14-Nov-98	4768.3	0	18.8	18.2	10.4	8.1	7	37.333333	5.0351963	19.9	19.1	11.6	7.9	7	37.33333333	5.162669668	4434.9	71.3
559	15-Nov-98	4792.8	0	19.2	18.7	10.2	8.8	7	37.333333	4.6457595	20.3	19.9	11.2	8.9	7	37.33333333	4.593559923	4460.4	71.3
560	15-Nov-98	4795.5	0	18	17.4	9.5	8.2	7	37.333333	4.6853116	19.4	18.6	10.8	8.3	7	37.33333333	4.628862085	4463.6	71.8
561	16-Nov-98	4812	0	19.5	19	10.8	8.5	7	37.333333	4.8212364	20.6	20	12.7	11.6	7	37.33333333	3.532802568	4482.3	71.0
562	16-Nov-98	4821.5	0	20.1	19.7	11.4	8.5	7	37.333333	4.6292757	21.2	20.7	12.9	8.1	7	37.33333333	4.857881905	4490	68.8

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	Date	Hour	Conc Flow	Element A Feed Psi	A Top psi	Filtrate psi-A	A TMP	A Filt GPM	GFD	A GFD/psi	B Feed psi	B Top psi	Filtrate psi-B	B TMP	B filt Gpm		B GFD/psi	RO Hour	
563	17-Nov-98	4832.7	0	19.2	18.9	10.8	8.3	7	37.333333	4.7749384	20.2	19.9	12.2	7.9	7	37.33333333	5.016707405	4502.7	61.5
564	17-Nov-98	4839.3	0	20.1	19.9	11.3	8.7	7	37.333333	4.6101646	21.7	21.1	13.7	7.7	7	37.33333333	5.208887252	4510.2	62.7
565	18-Nov-98	4853.9	0	21	20.5	12.4	8.4	7	37.333333	4.7634151	22.1	21.9	14.1	7.9	7	37.33333333	5.064897108	4527	64.3
566	18-Nov-98	4860.1	0	20.1	19.9	12	8	7	37.333333	4.9186054	21.5	21	13.6	7.7	7	37.33333333	5.110239407	4533.9	62.7
567	19-Nov-98	4877.5	0	20.1	19.9	11.5	8.5	7	37.333333	4.8559289	21.8	21.1	13.2	8.3	7	37.33333333	4.972939271	4553.8	63.6
568	20-Nov-98	4900.3	0	19.8	19.1	11.1	8.4	7	37.333333	4.7748133	21	20.1	12.5	8.1	7	37.33333333	4.951658252	4579.7	62.3
569	20-Nov-98	4903.1	0	19.9	19.2	11.9	7.7	7	37.333333	5.1347248	21.1	20.5	13.2	7.6	7	37.33333333	5.202286993	4582.9	62.4
570	21-Nov-98	4919.8	0	21.3	20.9	12.2	8.9	7	37.333333	4.6710566	22.9	22.3	14	8.6	7	37.33333333	4.834000469	4601.9	62.7
571	22-Nov-98	4938.2	0	23	22.2	13.7	8.9	7	37.333333	4.6647499	24.2	23.7	15.3	8.7	7	37.33333333	4.976583229	4622.9	63.6
572	23-Nov-98	4959.9	0	23.3	22.2	13.7	8.9	7	37.333333	4.853137	24.8	24.1	15.3	9.2	7	37.33333333	4.69488256	4647.4	62.7
573	23-Nov-98	4966.3	0	21.6	21.1	12.5	8.9	7	37.333333	4.5716551	23.2	22.5	14.1	8.8	7	37.33333333	4.623605727	4654.3	62.7
574	24-Nov-98	4981	0	20.8	20.1	11.7	8.8	7	37.333333	4.7809289	22.1	21.5	13.2	8.6	7	37.33333333	4.892113308	4671.4	62.3
575	24-Nov-98	4985.5	0	19.9	19.2	10.8	8.8	7	37.333333	4.4607855	21.2	20.8	12.5	8.5	7	37.33333333	4.61822494	4676.7	59.9
576	27-Nov-98	5042.9	0	21	20.5	11.2	9.6	7	37.333333	4.3201213	22.1	20.8	13.4	8.1	7	37.33333333	5.120143781	4742	59.6
577	27-Nov-98	5048.9	0	20	19.5	10.1	9.7	7	37.333333	4.154702	21.2	20.9	12.5	8.6	7	37.33333333	4.686117336	4748.8	59.9

San Pasqual Wastewater IMS Raw Data

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Inrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
5	19-Feb-98																	
6																		
7																		
8	20-Feb-98																	
9																		
10																		
11	23-Feb-98																	
12																		
13		System shutdown w/chlorine in element B from 2/20 5pm to 2/23 8am																
14																		
15																		
16	24-Feb-98																	
17																		
18																		
19																		
20	25-Feb-98																	
21																		
22		System Shutdown to upload Hydra4c-Cl2 in element B correction																
23																		
24	26-Feb-98																	
25																		
26																		
27	27-Feb-98																	
28																		
29		tem Shutdown to Redo inlet plumbing hose, replace PIT hose, replumb backwash feed to hose (RO)																
30																		
31																		
32	3-Mar-98	wn to collapsed feed hose				Unit Shutdown and 300um strainer removed												
33																		
34																		
35																		
36	4-Mar-98																	
37																		
38																		
39																		
40	5-Mar-98																	
41																		
42																		
43																		
44	6-Mar-98																	
45																		
46	9-Mar-98																	
47		Unit Shutdown to install 1-1/2" 300um filter																
48																		
49	10-Mar-98																	
50			leaned thru Backwash 1/2 soak 0.5% NaOH, 1% Citric, 100ppm NaOCL															
51	11-Mar-98		Shut Unit down for cleaning															
52		Cleaning consists again of cleaning through backwash line																
53			Initial Data prior to clean:															
54																		
55																		
56		After 1 hour 2% Circt Acid Soak pH 2.06:																
57																		
58																		
59																		
60		system to check backwash from the fee																
61		Initial Parameters prior to High pH clean																
62																		
63																		
64		aOH 1 hour soak pH 12.3																
65	19-Mar-98																	
66	19-Mar-98																	

San Pasqual Wastewater IMS Raw Data

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Itrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
67		lumbed System and performed recirculation cleaning one element at a time																
68	20-Mar-98	1 hour 4gpm concentrate only, then 15-30min with 3 gpm permeate flow																
69		Backwash after recirc once then 3-4 with RO water																
70																		
71		wn for Koch plumbing																
72	21-Mar-98																	
73		wn-pump cavitating																
74		screen with 150um screen																
75																		
76																		
77	25-Mar-98																	
78		Unit Shutdown due to fouling element B																
79	tart @ 439.4	it Cleaned by Dan Smith ph2.1 recirc followed																
80		2hrs each element (no backwash)																
81	31-Mar-98																	
82																		
83		nit cleaned and element location switched																
84	1-Apr-98		A=X B=K															
85		lem with backwashing element B valve sticking																
86		Upped air pressure to 78psi (from 60)																
87		/2hr recirc individually ph2 followed by pH 11.7																
88		utdown at 459 hours																
89		mps removed, SS inserted																
90	2-Apr-98	injection valve/tubing																
91																		
92																		
93	3-Apr-98																	
94																		
95																		
96																		
97																		
98																		
99	5-Apr-98																	
100																		
101																		
102	6-Apr-98																	
103																		
104																		
105	7-Apr-98																	
106																		
107																		
108	8-Apr-98																	
109																		
110																		
111	9-Apr-98																	
112																		
113																		
114	10-Apr-98																	
115																		
116																		
117																		
118	11-Apr-98																	
119																		
120																		
121																		
122	12-Apr-98																	
123																		Cha
124																		
125																		
126	13-Apr-98																	
127																		
128																		

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	IIrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
129	14-Apr-98																	
130		to replumb drain/fix leaks																
131																		
132	15-Apr-98																	
133																		
134																		
135																		
136	16-Apr-98																	
137																		
138																		
139	17-Apr-98																	
140																		
141																		
142																		
143	18-Apr-98																	
144																		
145																		
146	19-Apr-98																	
149																		
150	20-Apr-98																	
151	21-Apr-98																	
152																		
153	24-Apr-98																	
154																		
155																		
156															2.7		2.7	50.0
157	25-Apr-98														3		2	60.0
158															2.2		3	42.3
159		16.2													2.2		3	42.3
160	26-Apr-98	16.4													2		2.8	41.7
161		16.2													1.9		3	38.8
162		18.4													1.8		3	37.5
163		16.2	135	132	130	128	0.85	0.83	0.79	2.47	15.808	3	130	126	1.8	10.16470588	3	37.5
164	27-Apr-98	16.4	135	131	129	128	0.85	0.84	0.8	2.49	15.936	3	149	145	1.8	10.16470588	3	37.5
165		18	110	106	104	103	0.7	0.7	0.65	2.05	13.12	3	104	100	1.9	10.72941176	3	38.8
166		19.3	108	105	103	102	0.7	0.67	0.65	2.02	12.928	3	102	98	1.8	10.16470588	3	37.5
167		17.5	97	95	93	92	0.62	0.6	0.57	1.79	11.456	3	94	90	1.8	10.16470588	3	37.5
168	28-Apr-98	17	94	91	89	87	0.6	0.57	0.55	1.72	11.008	3	89	85	1.9	10.72941176	3	38.8
169		17.7	92	89	87	86	0.6	0.57	0.55	1.72	11.008	3	82	78	1.9	10.72941176	3	38.8
170		17.5	87	84	83	81	0.6	0.57	0.55	1.72	11.008	3	81	76	1.8	10.16470588	3	37.5
171		16.5	88	85	84	83	0.6	0.57	0.55	1.72	11.008	3	84	80	1.8	10.16470588	3	37.5
172	29-Apr-98	17.7	93	91	89	87	0.6	0.58	0.55	1.73	11.072	3	89	85	1.9	10.72941176	3	38.8
173		17.4	90	87	86	84	0.6	0.57	0.55	1.72	11.008	3	84	80	1.9	10.72941176	3	38.8
174	30-Apr-98	16.6	88	86	84	83	0.6	0.57	0.55	1.72	11.008	3	84	79	1.9	10.72941176	3	38.8
175		18.1	93	90	88	87	0.6	0.57	0.55	1.72	11.008	3	89	85	1.9	10.72941176	3	38.8
176		18.7	92	89	87	86	0.61	0.58	0.55	1.74	11.136	3	86	82	1.9	10.72941176	3	38.8
177		16.4	91	89	86	85	0.6	0.58	0.55	1.73	11.072	3	87	84	1.9	10.72941176	3	38.8
178	1-May-98	18.8	94	92	90	89	0.6	0.58	0.55	1.73	11.072	3	90	86	1.9	10.72941176	3	38.8
179		16.2	88	86	84	82	0.6	0.57	0.55	1.72	11.008	3	88	84	1.9	10.72941176	3	38.8
180		92	87	85	83	82	0.6	0.57	0.55	1.72	11.008	3	86	82	1.9	10.72941176	3	38.8
181	2-May-98	18.2	90	87	85	84	0.6	0.57	0.55	1.72	11.008	3	86	82	1.9	10.72941176	3	38.8
182		95	90	85	84	0.6	0.57	0.55	0.55	1.67	10.688	3	82	82	1.9	10.72941176	3	38.8
183	3-May-98	91	87	90	87	86	0.6	0.57	0.55	1.72	11.008	3	87	82	1.9	10.72941176	3	38.8
184		16.1	90	85	83	0.6	0.57	0.55	0.55	1.67	10.688	3	87	82	1.9	10.72941176	3	38.8
185		18.2	87	90	89	0.6	0.57	0.55	0.55	1.67	10.688	2.9	92	89	1.9	10.72941176	3	38.8
186		19.6	93	89	87	85	0.65	0.62	0.6	1.87	11.968	3	86	81	1.9	10.72941176	3	38.8
187	4-May-98	16	92	89	87	86	0.6	0.57	0.54	1.71	10.944	3	96	93	1.9	10.72941176	3	38.8
188		18.4	90	87	85	83	0.6	0.57	0.55	1.72	11.008	3	85	81	1.9	10.72941176	3	38.8
189		18.1	84	82	80	78	0.6	0.57	0.55	1.72	11.008	3	78	74	1.9	10.72941176	3	38.8
190		17.2	94	92	89	87	0.6	0.57	0.55	1.72	11.008	3	91	87	1.9	10.72941176	3	38.8

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	lnrstg 1 psi	ltrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
191	5-May-98	20.4	88	86	83	82	0.61	0.58	0.55	1.74	11.136	3	86	81	1.9	10.72941176	3	38.8
192		19.6	86	84	81	80	0.6	0.58	0.55	1.73	11.072	3	86	82	1.9	10.72941176	3	38.8
193		20.8	87	84	83	81	0.6	0.57	0.55	1.72	11.008	3	87	83	1.9	10.72941176	3	38.8
194		21.2	82	80	77	76	0.6	0.57	0.55	1.72	11.008	3	83	78	1.9	10.72941176	3	38.8
195	6-May-98	19.9	87	84	83	81	0.6	0.58	0.55	1.73	11.072	3	86	82	1.9	10.72941176	3	38.8
196		19.3	84	81	79	78	0.6	0.57	0.55	1.72	11.008	3	84	79	1.9	10.72941176	3	38.8
197		20.4	83	80	78	76	0.62	0.6	0.55	1.77	11.328	3	84	79	1.9	10.72941176	3	38.8
198	7-May-98	19.5	84	82	80	78	0.6	0.57	0.55	1.72	11.008	3	85	80	1.9	10.72941176	3	38.8
199		18.3	87	85	83	82	0.6	0.57	0.55	1.72	11.008	3	86	82	1.9	10.72941176	3	38.8
200		19.8	89	86	84	83	0.62	0.6	0.56	1.78	11.392	3	86	82	1.9	10.72941176	3	38.8
201		18.3	87	85	83	81	0.6	0.59	0.55	1.74	11.136	3	86	81	1.9	10.72941176	3	38.8
202	8-May-98	21.9	89	86	84	83	0.6	0.57	0.55	1.72	11.008	3	90	86	1.9	10.72941176	3	38.8
203		20.2	86	84	83	81	0.6	0.59	0.55	1.74	11.136	3	87	84	1.9	10.72941176	3	38.8
204		18.7	88	86	84	82	0.6	0.57	0.55	1.72	11.008	3	91	87	1.9	10.72941176	3	38.8
205	9-May-98	22.5	84	81	79	77	0.6	0.57	0.55	1.72	11.008	3	84	79	1.9	10.72941176	3	38.8
206		20.4	86	84	81	80	0.6	0.57	0.55	1.72	11.008	3	87	82	1.9	10.72941176	3	38.8
207		19.3	88	86	84	82	0.6	0.57	0.55	1.72	11.008	3	90	86	1.9	10.72941176	3	38.8
208		22.6	75	73	71	69	0.6	0.57	0.55	1.72	11.008	3	82	77	1.9	10.72941176	3	38.8
209	10-May-98	19.9	88	86	85	83	0.6	0.57	0.55	1.72	11.008	3	87	84	1.9	10.72941176	3	38.8
210		21.2	90	87	85	84	0.6	0.57	0.55	1.72	11.008	3	90	86	1.9	10.72941176	3	38.8
211		21.9	82	80	77	76	0.62	0.6	0.55	1.77	11.328	3	80	76	1.9	10.72941176	3	38.8
212		19.9	87	85	83	82	0.6	0.57	0.54	1.71	10.944	3	88	84	1.9	10.72941176	3	38.8
213	11-May-98	21.5	85	83	80	79	0.62	0.6	0.55	1.77	11.328	3	84	79	1.9	10.72941176	3	38.8
214		21.4	86	83	81	80	0.6	0.57	0.55	1.72	11.008	3	84	80	1.9	10.72941176	3	38.8
215		19.3	90	87	85	84	0.6	0.57	0.55	1.72	11.008	3	91	87	1.9	10.72941176	3	38.8
216		20.7	89	87	84	83	0.6	0.57	0.55	1.72	11.008	3	89	84	1.9	10.72941176	3	38.8
217		21	90	87	85	84	0.6	0.59	0.55	1.74	11.136	3	91	86	1.9	10.72941176	3	38.8
218	12-May-98	21.6	91	90	87	85	0.6	0.55	0.55	1.7	10.88	3	94	90	1.9	10.72941176	3	38.8
219		22.5	91	89	86	86	0.6	0.57	0.55	1.72	11.008	3	90	86	1.9	10.72941176	3	38.8
220		20.9	89	86	84	84	0.6	0.57	0.55	1.72	11.008	3	91	87	1.9	10.72941176	3	38.8
221		20.4	86	85	83	83	0.61	0.6	0.55	1.76	11.264	3	89	85	1.9	10.72941176	3	38.8
222	13-May-98	21.8	85	83	81	81	0.6	0.58	0.55	1.73	11.072	3	84	80	1.9	10.72941176	3	38.8
223		21.7	86	84	82	80	0.6	0.57	0.55	1.72	11.008	3	87	83	1.9	10.72941176	3	38.8
224		21	90	87	85	84	0.6	0.57	0.55	1.72	11.008	3	90	86	1.9	10.72941176	3	38.8
225		20.4	87	85	83	82	0.6	0.57	0.55	1.72	11.008	3	86	87	1.9	10.72941176	3	38.8
226	14-May-98	20.8	86	84	83	80	0.61	0.6	0.56	1.77	11.328	3	86	83	1.9	10.72941176	3	38.8
227		20.9	86	85	83	82	0.6	0.58	0.55	1.73	11.072	3	89	84	1.9	10.72941176	3	38.8
228		20.3	90	87	86	84	0.6	0.58	0.55	1.73	11.072	3	90	86	1.9	10.72941176	3	38.8
229		19.6	90	87	85	84	0.6	0.58	0.55	1.73	11.072	3	89	85	1.9	10.72941176	3	38.8
230	15-May-98	21.4	90	86	85	85	0.62	0.6	0.57	1.79	11.456	3	89	85	1.9	10.72941176	3	38.8
231		20.4	90	87	85	85	0.61	0.6	0.56	1.77	11.328	3	90	87	1.9	10.72941176	3	38.8
232		19.9	94	92	90	90	0.6	0.58	0.55	1.73	11.072	3	95	91	1.9	10.72941176	3	38.8
233		20.6	91	88	86	86	0.61	0.58	0.55	1.74	11.136	3	89	86	1.9	10.72941176	3	38.8
234	16-May-98	20.8	93	91	89	89	0.61	0.59	0.55	1.75	11.2	3	94	90	1.9	10.72941176	3	38.8
235		19.8	94	91	89	88	0.6	0.58	0.55	1.73	11.072	3	94	90	1.9	10.72941176	3	38.8
236		19.3	92	90	87	85	0.6	0.58	0.55	1.73	11.072	3	92	89	1.9	10.72941176	3	38.8
237	17-May-98	20.2	92	90	88	87	0.61	0.58	0.55	1.74	11.136	3	92	89	1.9	10.72941176	3	38.8
238		19.9	94	92	89	88	0.6	0.58	0.55	1.73	11.072	3	94	90	1.9	10.72941176	3	38.8
239		19.4	94	91	89	88	0.6	0.58	0.55	1.73	11.072	3	95	91	1.9	10.72941176	3	38.8
240		19.8	90	88	86	84	0.65	0.62	0.59	1.86	11.904	3	90	86	1.9	10.72941176	3	38.8
241	18-May-98	19.8	92	89	88	85	0.6	0.58	0.55	1.73	11.072	3	94	90	1.9	10.72941176	3	38.8
242		18.9	91	89	87	85	0.6	0.58	0.55	1.73	11.072	3	93	90	1.9	10.72941176	3	38.8
243		20.9	91	88	86	84	0.6	0.58	0.55	1.73	11.072	3	92	89	1.9	10.72941176	3	38.8
244		19.7	93	90	88	86	0.6	0.58	0.55	1.73	11.072	3	94	90	1.8	10.16470588	3	37.5
245	19-May-98	19	93	90	89	86	0.6	0.57	0.55	1.72	11.008	3	94	91	1.9	10.72941176	3	38.8
246		19.6	89	86	85	83	0.6	0.58	0.55	1.73	11.072	3	90	87	1.9	10.72941176	3	38.8
247		19.6	92	90	88	86	0.6	0.58	0.55	1.73	11.072	3	93	90	1.9	10.72941176	3	38.8
248	20-May-98	19.1	94	92	90	88	0.6	0.58	0.55	1.73	11.072	3	93	90	1.9	10.72941176	3	38.8
249		18.7	93	91	88	86	0.6	0.58	0.55	1.73	11.072	3	92	88	1.9	10.72941176	3	38.8
250		18.8	94	92	90	89	0.6	0.57	0.55	1.72	11.008	3	94	90	1.9	10.72941176	3	38.8
251		18.1	95	93	90	89	0.6	0.57	0.55	1.72	11.008	3	95	92	1.9	10.72941176	3	38.8
252	21-May-98	17.6	100	98	96	94	0.61	0.58	0.55	1.74	11.136	3	97	94	1.9	10.72941176	3	38.8

San Pasqual Wastewater IMS Raw Data

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Itrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
253		18.8	100	98	96	95	0.6	0.59	0.55	1.74	11.136	3	97	94	1.9	10.72941176	3	38.8
254		18	101	98	96	96	0.6	0.59	0.55	1.74	11.136	3	99	96	1.9	10.72941176	3	38.8
255	22-May-98	17.5	104	101	100	100	0.6	0.59	0.55	1.74	11.136	3	100	97	1.9	10.72941176	3	38.8
256		19	101	98	96	96	0.61	0.59	0.55	1.75	11.2	3	97	94	1.9	10.72941176	3	38.8
257	23-May-98	18.3	103	101	99	99	0.6	0.58	0.55	1.73	11.072	3	100	97	1.9	10.72941176	3	38.8
258		17.5	104	101	99	99	0.6	0.58	0.55	1.73	11.072	3	100	98	1.9	10.72941176	3	38.8
259		19.3	91	88	86	85	0.61	0.59	0.55	1.75	11.2	3	91	87	1.9	10.72941176	3	38.8
260		19.5	97	95	92	91	0.59	0.58	0.54	1.71	10.944	3	99	95	1.9	10.72941176	3	38.8
261	24-May-98	18.9	98	96	94	92	0.59	0.56	0.54	1.69	10.816	3	100	97	1.9	10.72941176	3	38.8
262		21.4	96	94	91	90	0.6	0.58	0.55	1.73	11.072	3	96	92	1.9	10.72941176	3	38.8
263		19.4	95	92	90	89	0.6	0.57	0.55	1.72	11.008	3	96	93	1.9	10.72941176	3	38.8
264		18.2	95	93	91	89	0.59	0.58	0.55	1.72	11.008	3	96	92	1.9	10.72941176	3	38.8
265	25-May-98	20.1	93	90	88	87	0.61	0.59	0.55	1.75	11.2	3	91	88	1.9	10.72941176	3	38.8
266		21.4	97	94	92	90	0.6	0.57	0.55	1.72	11.008	3	95	92	1.9	10.72941176	3	38.8
267		18.6	97	94	93	91	0.6	0.57	0.55	1.72	11.008	3	97	94	1.9	10.72941176	3	38.8
268		20.6	96	94	91	90	0.61	0.59	0.55	1.75	11.2	3	94	89	1.9	10.72941176	3	38.8
269	26-May-98	21.5	91	89	87	85	0.61	0.59	0.55	1.75	11.2	3	90	86	1.9	10.72941176	3	38.8
270		18.9	98	95	93	91	0.6	0.57	0.55	1.72	11.008	3	97	94	1.9	10.72941176	3	38.8
271		20.8	95	93	90	88	0.6	0.58	0.55	1.73	11.072	3	91	87	1.9	10.72941176	3	38.8
272	27-May-98	20.1	94	91	89	87	0.62	0.6	0.56	1.78	11.392	3	90	86	1.9	10.72941176	3	38.8
273		19.3	97	94	92	90	0.6	0.57	0.54	1.71	10.944	3	96	92	1.9	10.72941176	3	38.8
274		20.7	94	92	90	88	0.61	0.58	0.55	1.74	11.136	3	91	87	1.9	10.72941176	3	38.8
275		20.2	95	93	90	89	0.6	0.58	0.55	1.73	11.072	3	94	90	1.9	10.72941176	3	38.8
276	28-May-98	19.9	97	95	93	91	0.6	0.58	0.55	1.73	11.072	3	96	93	1.9	10.72941176	3	38.8
277		21.1	94	91	89	87	0.6	0.57	0.55	1.72	11.008	3	93	90	1.9	10.72941176	3	38.8
278		20	94	92	90	88	0.6	0.57	0.55	1.72	11.008	3	94	90	1.9	10.72941176	3	38.8
279		21.8	96	93	90	89	0.6	0.57	0.55	1.72	11.008	3	94	90	1.9	10.72941176	3	38.8
280	29-May-98	19.7	94	92	90	88	0.6	0.57	0.55	1.72	11.008	3	92	90	1.9	10.72941176	3	38.8
281		21.9	95	93	90	89	0.6	0.57	0.55	1.72	11.008	3	94	91	1.9	10.72941176	3	38.8
282		20.1	92	89	87	85	0.6	0.57	0.55	1.72	11.008	3	90	87	1.9	10.72941176	3	38.8
283		21.8	94	91	89	87	0.6	0.57	0.55	1.72	11.008	3	95	92	1.9	10.72941176	3	38.8
284	30-May-98	20.3	92	90	87	85	0.62	0.6	0.55	1.77	11.328	3	90	87	1.9	10.72941176	3	38.8
285		20.9	93	90	89	86	0.6	0.57	0.55	1.72	11.008	3	94	90	1.9	10.72941176	3	38.8
286	31-May-98	20.9	92	89	86	85	0.6	0.58	0.55	1.73	11.072	3	90	87	1.9	10.72941176	3	38.8
287	1-Jun-98	19.9	94	92	90	88	0.6	0.58	0.55	1.73	11.072	3	93	90	1.9	10.72941176	3	38.8
288	2-Jun-98	20.4	94	92	89	87	0.6	0.58	0.55	1.73	11.072	3	92	89	1.9	10.72941176	3	38.8
289		18.8	94	91	89	87	0.61	0.59	0.55	1.75	11.2	3	92	89	1.9	10.72941176	3	38.8
290		21.2	95	93	90	88	0.6	0.58	0.55	1.73	11.072	3	94	91	1.9	10.72941176	3	38.8
291	3-Jun-98	20.1	94	91	89	86	0.61	0.6	0.55	1.76	11.264	3	93	90	1.9	10.72941176	3	38.8
292		19	98	95	93	91	0.6	0.57	0.55	1.72	11.008	3	99	95	1.9	10.72941176	3	38.8
293	4-Jun-98	21.3	95	92	89	88	0.61	0.58	0.55	1.74	11.136	3	91	88	1.9	10.72941176	3	38.8
294		20	97	93	90	89	0.61	0.58	0.55	1.74	11.136	3	95	91	1.9	10.72941176	3	38.8
295	5-Jun-98	19.4	94	95	92	90	0.6	0.57	0.55	1.72	11.008	3	97	93	1.9	10.72941176	3	38.8
296		21.8	95	91	89	88	0.61	0.58	0.55	1.74	11.136	3	91	88	1.9	10.72941176	3	38.8
297		19.3	96	93	91	90	0.6	0.59	0.55	1.74	11.136	, 3	94	91	1.9	10.72941176	3	38.8
298	6-Jun-98	20.8	92	94	91	90	0.61	0.59	0.55	1.75	11.2	3	95	92	1.9	10.72941176	3	38.8
299		19.8	97	90	88	86	0.62	0.6	0.55	1.77	11.328	3	90	87	1.9	10.72941176	3	38.8
300	7-Jun-98	20.4	96	94	92	90	0.6	0.59	0.55	1.74	11.136	3	96	93	1.9	10.72941176	3	38.8
301		19.9	96	93	91	89	0.6	0.59	0.55	1.74	11.136	3	92	89	1.9	10.72941176	3	38.8
302	8-Jun-98	22	96	94	92	90	0.6	0.57	0.55	1.72	11.008	3	94	90	1.9	10.72941176	3	38.8
303		21.7	91	93	92	90	0.61	0.58	0.55	1.74	11.136	3	94	91	1.9	10.72941176	3	38.8
304	9-Jun-98	20.8	90	89	86	90	0.6	0.57	0.54	1.71	10.944	3	91	89	1.9	10.72941176	3	38.8
305		22.7	90	87	85	83	0.61	0.58	0.55	1.74	11.136	3	87	84	1.9	10.72941176	3	38.8
306		20.7	91	88	86	85	0.6	0.58	0.55	1.73	11.072	3	90	87	1.9	10.72941176	3	38.8
307		22.3	88	89	86	85	0.6	0.59	0.55	1.74	11.136	3	90	88	1.9	10.72941176	3	38.8
308	10-Jun-98	20.3	94	86	84	83	0.6	0.58	0.55	1.73	11.072	3	87	84	1.9	10.72941176	3	38.8
309		22.2	92	91	90	88	0.6	0.58	0.55	1.73	11.072	3	91	89	1.9	10.72941176	3	38.8
310		21.5	93	90	88	86	0.61	0.58	0.55	1.74	11.136	3	89	86	1.9	10.72941176	3	38.8
311	11-Jun-98	22	91	90	88	86	0.6	0.57	0.55	1.72	11.008	3	91	89	1.9	10.72941176	3	38.8
312		20.5	90	89	86	85	0.6	0.58	0.55	1.73	11.072	3	89	85	1.9	10.72941176	3	38.8
313	12-Jun-98	21.3	91	88	86	85	0.6	0.57	0.54	1.71	10.944	3	91	88	1.9	10.72941176	3	38.8
314		20.5	92	88	86	85	0.61	0.59	0.55	1.75	11.2	3	89	86	1.9	10.72941176	3	38.8

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Itrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
315		21.2	92	89	87	86	0.6	0.57	0.54	1.71	10.944	3	92	89	1.9	10.72941176	3	38.8
316	13-Jun-98	20.5	92	89	87	86	0.6	0.58	0.54	1.72	11.008	3	90	87	1.9	10.72941176	3	38.8
317		21.1	92	90	88	86	0.6	0.57	0.54	1.71	10.944	3	93	90	1.9	10.72941176	3	38.8
318	14-Jun-98	21.9	92	89	87	86	0.6	0.57	0.54	1.71	10.944	3	92	89	1.9	10.72941176	3	38.8
319		20.6	92	90	88	86	0.6	0.57	0.55	1.72	11.008	3	94	91	1.9	10.72941176	3	38.8
320	15-Jun-98	20.1	91	90	87	86	0.6	0.58	0.55	1.73	11.072	3	93	89	1.9	10.72941176	3	38.8
321		20.7	91	88	86	85	0.6	0.58	0.55	1.73	11.072	3	91	88	1.9	10.72941176	3	38.8
322	16-Jun-98	20.7	92	89	86	85	0.6	0.57	0.55	1.72	11.008	3	93	90	1.9	10.72941176	3	38.8
323		19.9	91	90	87	86	0.6	0.59	0.55	1.74	11.136	3	94	90	1.9	10.72941176	3	38.8
324		20.4	90	89	86	85	0.6	0.58	0.54	1.72	11.008	3	92	89	1.9	10.72941176	3	38.8
325	17-Jun-98	18.8	91	88	86	84	0.6	0.57	0.54	1.71	10.944	3	91	89	1.9	10.72941176	3	38.8
326		20.7	90	88	86	85	0.6	0.57	0.55	1.72	11.008	3	92	89	1.9	10.72941176	3	38.8
327	18-Jun-98	19	97	88	86	84	0.6	0.56	0.54	1.7	10.88	3	91	88	1.9	10.72941176	3	38.8
328		19.7	94	95	93	91	0.6	0.58	0.55	1.73	11.072	3	94	91	1.9	10.72941176	3	38.8
329		21.7	94	91	90	89	0.6	0.58	0.55	1.73	11.072	3	91	89	1.9	10.72941176	3	38.8
330	19-Jun-98	21.2	92	90	88	86	0.6	0.58	0.55	1.73	11.072	3	94	91	1.9	10.72941176	3	38.8
331		22.9	94	93	90	89	0.6	0.58	0.55	1.73	11.072	3	94	91	1.9	10.72941176	3	38.8
332		21.4	94	91	84	87	0.6	0.58	0.55	1.73	11.072	3	89	85	1.9	10.72941176	3	38.8
333	20-Jun-98	21.7	90	88	85	84	0.6	0.57	0.55	1.72	11.008	3	91	88	1.9	10.72941176	3	38.8
334	21-Jun-98	21.2	89	88	84	83	0.6	0.57	0.55	1.72	11.008	3	87	84	1.9	10.72941176	3	38.8
335	22-Jun-98	22.9	105	103	100	99	0.61	0.59	0.55	1.75	11.2	3	87	84	1.9	10.72941176	3	38.8
336	23-Jun-98	20.8	88	86	84	83	0.6	0.57	0.54	1.71	10.944	3	90	86	1.9	10.72941176	3	38.8
337		22.6	89	86	84	83	0.6	0.58	0.55	1.73	11.072	3	90	86	1.9	10.72941176	3	38.8
338	24-Jun-98	22.7	88	85	83	82	0.61	0.58	0.55	1.74	11.136	3	86	83	1.9	10.72941176	3	38.8
339		21.5	91	89	86	85	0.6	0.57	0.55	1.72	11.008	3	92	89	1.9	10.72941176	3	38.8
340	25-Jun-98	23.5	89	87	84	84	0.61	0.59	0.55	1.75	11.2	3	94	83	1.9	10.72941176	3	38.8
341		22.9	87	84	83	81	0.61	0.59	0.55	1.75	11.2	3	88	84	1.9	10.72941176	3	38.8
342		21.8	88	86	84	82	0.6	0.57	0.55	1.72	11.008	3	90	86	1.9	10.72941176	3	38.8
343	26-Jun-98	22.2	87	84	83	81	0.62	0.6	0.56	1.78	11.392	3	86	81	1.9	10.72941176	3	38.8
344	27-Jun-98	21.8	86	84	82	81	0.62	0.6	0.56	1.78	11.392	3	88	84	1.9	10.72941176	3	38.8
345		20.1	88	85	83	82	0.6	0.58	0.54	1.72	11.008	3	89	85	1.9	10.72941176	3	38.8
346	28-Jun-98	23.9	88	86	83	82	0.6	0.58	0.54	1.72	11.008	3	88	85	1.9	10.72941176	3	38.8
347		22	88	85	83	82	0.6	0.58	0.54	1.72	11.008	3	88	85	1.9	10.72941176	3	38.8
348	29-Jun-98	23.9	88	84	83	81	0.61	0.59	0.55	1.75	11.2	3	91	87	1.9	10.72941176	3	38.8
349		21.7	83	81	79	77	0.61	0.57	0.54	1.72	11.008	3	87	80	1.9	10.72941176	3	38.8
350	30-Jun-98	23.5	85	83	80	79	0.61	0.57	0.55	1.73	11.072	3	86	82	1.9	10.72941176	3	38.8
351	1-Jul-98	23.5	86	83	81	80	0.63	0.59	0.55	1.77	11.328	3	83	79	1.9	10.72941176	3	38.8
352	2-Jul-98	24.1	87	85	83	81	0.6	0.57	0.55	1.72	11.008	3	87	84	1.9	10.72941176	3	38.8
353		22.7	86	84	81	80	0.6	0.56	0.54	1.7	10.88	3	84	80	1.9	10.72941176	3	38.8
354		23.8	81	80	77	76	0.6	0.56	0.55	1.71	10.944	3	85	81	1.9	10.72941176	3	38.8
355	3-Jul-98	22.8	82	80	78	76	0.6	0.59	0.55	1.74	11.136	3	84	79	1.9	10.72941176	3	38.8
356		23.9	85	83	81	80	0.6	0.58	0.55	1.73	11.072	3	88	84	1.9	10.72941176	3	38.8
357		22.8	84	83	80	79	0.61	0.59	0.55	1.75	11.2	3	84	79	1.9	10.72941176	3	38.8
358		24.4	85	83	80	79	0.6	0.59	0.55	1.74	11.136	3	86	82	1.9	10.72941176	3	38.8
359	4-Jul-98	22.9	89	86	84	83	0.62	0.59	0.55	1.76	11.264	3	84	79	1.9	10.72941176	3	38.8
360	5-Jul-98	23	85	83	80	78	0.6	0.58	0.55	1.73	11.072	3	86	82	1.9	10.72941176	3	38.8
361		22.4	84	81	80	78	0.62	0.6	0.55	1.77	11.328	3	83	78	1.9	10.72941176	3	38.8
362	6-Jul-98	24.4	85	82	80	79	0.6	0.57	0.55	1.72	11.008	3	86	83	1.9	10.72941176	3	38.8
363	7-Jul-98	22.5	85	83	80	79	0.6	0.57	0.55	1.72	11.008	3	86	83	1.9	10.72941176	3	38.8
364		22.9	85	82	80	78	0.6	0.59	0.55	1.74	11.136	3	86	83	1.9	10.72941176	3	38.8
365		22.3	84	81	79	77	0.6	0.57	0.55	1.72	11.008	3	83	79	1.9	10.72941176	3	38.8
366	8-Jul-98	22.1	84	81	79	77	0.6	0.57	0.55	1.72	11.008	3	83	79	1.9	10.72941176	3	38.8
367		23.6	85	82	80	79	0.6	0.57	0.55	1.72	11.008	3	86	82	1.9	10.72941176	3	38.8
368	9-Jul-98	23	85	82	80	79	0.6	0.57	0.55	1.72	11.008	3	85	81	1.9	10.72941176	3	38.8
369		24.3	85	83	80	80	0.6	0.59	0.55	1.74	11.136	3	86	82	1.9	10.72941176	3	38.8
370	10-Jul-98	25.5	85	83	80	79	0.6	0.59	0.55	1.74	11.136	3	86	84	1.9	10.72941176	3	38.8
371		25.1	84	81	80	78	0.6	0.59	0.55	1.74	11.136	3	84	79	1.9	10.72941176	3	38.8
372		25	84	82	80	79	0.6	0.57	0.54	1.71	10.944	3	84	79	1.9	10.72941176	3	38.8
373		25.9	84	81	79	77	0.62	0.59	0.55	1.76	11.264	3	81	76	1.9	10.72941176	3	38.8
374	11-Jul-98	26.1	83	80	78	76	0.65	0.62	0.58	1.85	11.84	3	80	75	1.9	10.72941176	3	38.8
375	12-Jul-98	25.1	83	80	78	77	0.65	0.61	0.58	1.84	11.776	3	82	77	1.9	10.72941176	3	38.8
376		24.3	81	78	76	75	0.6	0.57	0.55	1.72	11.008	3	81	76	1.9	10.72941176	3	38.8

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Itrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
377	13-Jul-98	25.5	81	78	76	75	0.64	0.6	0.55	1.79	11.456	3	81	76	1.9	10.72941176	3	38.8
378	14-Jul-98	26.4	80	77	75	73	0.62	0.58	0.55	1.75	11.2	3	79	74	1.9	10.72941176	3	38.8
379		23.6	83	80	79	77	0.62	0.6	0.57	1.79	11.456	3	80	76	1.9	10.72941176	3	38.8
380	15-Jul-98	23.3	84	82	80	78	0.62	0.59	0.55	1.76	11.264	3	84	80	1.9	10.72941176	3	38.8
381	16-Jul-98	23.4	84	81	79	78	0.63	0.6	0.56	1.79	11.456	3	81	78	1.9	10.72941176	3	38.8
382	17-Jul-98	23.7	81	79	77	76	0.64	0.61	0.56	1.81	11.584	3	80	75	1.9	10.72941176	3	38.8
383		25	84	81	79	78	0.62	0.59	0.55	1.76	11.264	3	86	81	1.9	10.72941176	3	38.8
384	18-Jul-98	23.2	86	84	81	80	0.63	0.6	0.56	1.79	11.456	3	86	81	1.9	10.72941176	3	38.8
385	19-Jul-98	27.2	86	84	82	80	0.63	0.6	0.55	1.78	11.392	3	86	82	1.9	10.72941176	3	38.8
386		25.7	85	82	80	79	0.61	0.58	0.55	1.74	11.136	3	85	80	1.9	10.72941176	3	38.8
387	21-Jul-98	28	84	81	79	78	0.64	0.6	0.56	1.8	11.52	3	84	79	1.9	10.72941176	3	38.8
388		25.5	85	83	81	79	0.6	0.58	0.55	1.73	11.072	3	87	84	1.9	10.72941176	3	38.8
389	22-Jul-98	25.3	79	76	73	71	0.6	0.57	0.55	1.72	11.008	3	80	73	1.9	10.72941176	3	38.8
390		26.6	79	76	74	72	0.6	0.57	0.55	1.72	11.008	3	80	74	1.9	10.72941176	3	38.8
391		26.2	78	76	74	72	0.62	0.59	0.55	1.76	11.264	3	77	70	1.9	10.72941176	3	38.8
392	23-Jul-98	25.9	80	77	74	73	0.6	0.57	0.54	1.71	10.944	3.1	86	81	1.9	10.72941176	3	38.8
393		25	84	81	79	77	0.63	0.59	0.55	1.77,	11.328	3	88	81	1.8	10.16470588	3	37.5
394		25.4	83	80	78	76	0.64	0.6	0.56	1.8	11.52	3	84	77	1.9	10.72941176	3	38.8
395		25.6	80	76	74	72	0.64	0.6	0.55	1.79	11.456	3	83	76	1.9	10.72941176	3	38.8
396	24-Jul-98	24.7	80	78	75	74	0.65	0.61	0.56	1.82	11.648	3	85	78	1.9	10.72941176	3	38.8
397		25.5	82	79	77	75	0.63	0.6	0.55	1.78	11.392	3	80	75	1.9	10.72941176	3	38.8
398		25.5	82	79	77	76	0.63	0.6	0.55	1.78	11.392	3	80	74	1.9	10.72941176	3	38.8
399	25-Jul-98	25.4	81	78	76	75	0.65	0.61	0.56	1.82	11.648	3	80	75	1.9	10.72941176	3	38.8
400		24.4	82	79	77	76	0.63	0.6	0.55	1.78	11.392	3	82	77	1.9	10.72941176	3	38.8
401		25.6	81	79	76	75	0.64	0.6	0.55	1.79	11.456	3	80	75	1.9	10.72941176	3	38.8
402	26-Jul-98	25.9	81	78	76	75	0.64	0.6	0.55	1.79	11.456	3	81	76	1.9	10.72941176	3	38.8
403		25.9	82	78	76	75	0.63	0.59	0.55	1.77	11.328	3	82	77	1.9	10.72941176	3	38.8
404	27-Jun-98	24.2	80	78	75	74	0.63	0.59	0.55	1.77	11.328	3	80	74	1.9	10.72941176	3	38.8
405		24.2	80	77	75	74	0.64	0.6	0.55	1.79	11.456	3	80	74	1.9	10.72941176	3	38.8
406	28-Jul-98	24.7	81	79	77	76	0.62	0.59	0.55	1.76	11.264	3	82	77	1.9	10.72941176	3	38.8
407		24.7	81	79	77	75	0.62	0.59	0.55	1.76	11.264	3	81	75	1.9	10.72941176	3	38.8
408	29-Jul-98	24.7	81	79	76	75	0.63	0.6	0.55	1.78	11.392	3	80	75	1.9	10.72941176	3	38.8
409		24.7	75	72	70	68	0.64	0.6	0.55	1.79	11.456	3	74	67	1.9	10.72941176	3	38.8
410		28.1	76	74	71	70	0.65	0.6	0.56	1.81	11.584	3	75	69	1.9	10.72941176	3	38.8
411	30-Jul-98	27.8	78	75	73	72	0.62	0.58	0.54	1.74	11.136	2.9	80	76	1.9	10.72941176	3	38.8
412	31-Jul-98	25.3	81	78	76	75	0.64	0.6	0.56	1.8	11.52	3	78	71	1.9	10.72941176	3	38.8
413		26.1	77	74	72	70	0.65	0.6	0.55	1.8	11.52	3	76	70	1.9	10.72941176	3	38.8
414	1-Aug-98	27.3	78	76	74	72	0.64	0.6	0.56	1.8	11.52	3	80	76	1.9	10.72941176	3	38.8
415		24.9	76	74	72	70	0.63	0.59	0.55	1.77	11.328	3	76	69	1.9	10.72941176	3	38.8
416	2-Aug-98	26.8	79	76	74	73	0.63	0.6	0.55	1.78	11.392	3	78	74	1.9	10.72941176	3	38.8
417	3-Aug-98	25.6	81	79	76	75	0.63	0.6	0.55	1.78	11.392	3	80	76	1.9	10.72941176	3	38.8
418	4-Aug-98	23.8	80	77	75	74	0.63	0.59	0.55	1.77	11.328	3	76	70	1.9	10.72941176	3	38.8
419		25.5	82	80	77	76	0.61	0.58	0.54	1.73	11.072	3	82	78	1.9	10.72941176	3	38.8
420	5-Aug-98	22.6	66	63	61	60	0.6	0.57	0.55	1.72	11.008	3	66	57	1.9	10.72941176	3	38.8
421		31.1	75	72	70	68	0.63	0.58	0.55	1.76	11.264	3	75	69	1.9	10.72941176	3	38.8
422	6-Aug-98	25.4	73	70	68	66	0.62	0.59	0.55	1.76	11.264	3	71	64	1.9	10.72941176	3	38.8
423		27	76	73	71	69	0.63	0.59	0.55	1.77	11.328	3	76	71	1.9	10.72941176	3	38.8
424	7-Aug-98	25	73	70	78	67	0.63	0.58	0.55	1.76	11.264	3	72	66	1.9	10.72941176	3	38.8
425	8-Aug-98	26.7	75	73	70	68	0.64	0.6	0.56	1.8	11.52	3	76	71	1.9	10.72941176	3	38.8
426	9-Aug-98	24.6	78	75	73	71	0.64	0.59	0.55	1.78	11.392	3	74	69	1.9	10.72941176	3	38.8
427	10-Aug-98	26	76	74	71	70	0.61	0.59	0.55	1.75	11.2	3	78	73	1.9	10.72941176	3	38.8
428		24.5	76	74	72	70	0.6	0.57	0.55	1.72	11.008	3	78	73	1.9	10.72941176	3	38.8
429	11-Aug-98	24.3	77	74	72	71	0.62	0.58	0.55	1.75	11.2	3	77	71	1.9	10.72941176	3	38.8
430		25.1	77	75	70	71	0.63	0.59	0.55	1.77	11.328	3	76	71	1.9	10.72941176	3	38.8
431	12-Aug-98	25.5	76	74	71	70	0.64	0.6	0.57	1.81	11.584	3	74	66	1.8	10.16470588	3	37.5
432		27.1	76	74	71	69	0.63	0.58	0.55	1.76	11.264	3	77	70	1.8	10.16470588	3	37.5
433		26	73	70	68	66	0.64	0.59	0.55	1.78	11.392	3	73	65	1.9	10.72941176	3	38.8
434	13-Aug-98	28.3	73	70	68	67	0.63	0.59	0.55	1.77	11.328	3	70	62	1.9	10.72941176	3	38.8
435	14-Aug-98	28.3	72	70	67	66	0.63	0.59	0.55	1.77	11.328	3	70	62	1.9	10.72941176	3	38.8
436	15-Aug-98	28.3	73	70	67	66	0.62	0.58	0.55	1.75	11.2	3	72	65	1.9	10.72941176	3	38.8
437		27.9	74	72	69	67	0.62	0.6	0.55	1.77	11.328	3	75	69	1.9	10.72941176	3	38.8
438	16-Aug-98	26.1	76	74	73	71	0.63	0.59	0.55	1.77	11.328	3	76	70	1.9	10.72941176	3	38.8

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Ilrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
439		26.1	78	76	73	71	0.62	0.58	0.55	1.75	11.2	3	78	72	1.9	10.72941176	1.9	50.0
440	17-Aug-98	25.4	76	74	72	70	0.63	0.59	0.55	1.77	11.328	3	76	69	1.9	10.72941176	1.9	50.0
441		25.1	77	75	73	71	0.62	0.58	0.55	1.75	11.2	3	77	71	1.9	10.72941176	1.9	50.0
442	18-Aug-98	24.3	77	74	72	70	0.62	0.58	0.55	1.75	11.2	3	76	69	1.9	10.72941176	1.9	50.0
443	19-Aug-98	25.4	77	75	73	71	0.61	0.58	0.55	1.74	11.136	3	78	72	1.9	10.72941176	1.9	50.0
444		24.3	76	74	72	70	0.61	0.58	0.55	1.74	11.136	3	76	69	1.9	10.72941176	1.9	50.0
445	20-Aug-98	25.3	78	76	74	72	0.6	0.57	0.55	1.72	11.008	3	79	74	1.9	10.72941176	1.9	50.0
446	21-Aug-98	23.9	79	77	75	74	0.61	0.58	0.55	1.74	11.136	3	81	76	1.9	10.72941176	1.9	50.0
447	22-Aug-98	23.5	76	73	70	69	0.61	0.58	0.55	1.74	11.136	3	76	70	1.9	10.72941176	1.9	50.0
448	23-Aug-98	25.5	80	78	76	75	0.6	0.57	0.55	1.72	11.008	3	81	76	1.9	10.72941176	1.9	50.0
449	24-Aug-98	22.8	88	86	85	85	0.69	0.65	0.6	1.94	12.416	1.9	84	79	1.9	10.72941176	1.9	50.0
450	25-Aug-98	22.9	87	85	83	82	0.69	0.65	0.6	1.94	12.416	1.9	81	77	1.9	10.72941176	1.9	50.0
451		23.8	83	82	80	79	0.68	0.64	0.59	1.91	12.224	1.9	74	69	1.9	10.72941176	1.9	50.0
452	26-Aug-98	26.1	85	83	81	80	0.68	0.64	0.59	1.91	12.224	1.9	80	77	1.9	10.72941176	1.9	50.0
453		24.4	88	86	85	84	0.69	0.65	0.61	1.95	12.48	1.9	80	77	1.9	10.72941176	1.9	50.0
454	27-Aug-98	24.6	83	81	80	79	0.69	0.65	0.6	1.94.	12.416	1.9	76	71	1.9	10.72941176	1.9	50.0
455	28-Aug-98	25.8	85	83	81	80	0.69	0.65	0.6	1.94	12.416	1.9	80	77	1.9	10.72941176	1.9	50.0
456	29-Aug-98	24.6	85	83	82	80	0.69	0.65	0.6	1.94	12.416	1.9	77	74	1.9	10.72941176	1.9	50.0
457	30-Aug-98	25.9	86	85	84	82	0.69	0.65	0.6	1.94	12.416	1.9	82	80	1.9	10.72941176	1.9	50.0
458	31-Aug-98	24.2	88	86	85	84	0.69	0.65	0.6	1.94	12.416	2	82	79	1.9	10.72941176	1.9	50.0
459	1-Sep-98	24	88	86	85	84	0.68	0.64	0.59	1.91	12.224	1.9	82	78	1.9	10.72941176	1.9	50.0
460	2-Sep-98	25	84	83	81	80	0.69	0.64	0.6	1.93	12.352	1.9	76	69	1.9	10.72941176	1.9	50.0
461	3-Sep-98	29.2	88	87	85	84	0.69	0.65	0.6	1.94	12.416	1.9	79	74	1.9	10.72941176	1.9	50.0
462	4-Sep-98	27.1	79	77	76	75	0.68	0.63	0.58	1.89	12.096	1.9	72	67	1.9	10.72941176	1.9	50.0
463	5-Sep-98	28.8	81	80	78	78	0.65	0.6	0.56	1.81	11.584	1.9	77	73	1.9	10.72941176	1.9	50.0
464	6-Sep-98	26.3	82	80	79	78	0.69	0.65	0.6	1.94	12.416	1.9	82	78	1.8	10.16470588	1.9	48.6
465	7-Sep-98	26.5	84	82	81	80	0.69	0.65	0.6	1.94	12.416	1.9	86	82	1.8	10.16470588	1.9	48.6
466	8-Sep-98	26.3	86	85	83	82	0.65	0.62	0.57	1.84	11.776	1.9	88	83	1.9	10.72941176	1.9	50.0
467	9-Sep-98	24.9	86	84	83	82	0.68	0.64	0.6	1.92	12.288	1.9	80	76	1.9	10.72941176	1.9	50.0
468	10-Sep-98	25.3	88	87	85	84	0.67	0.63	0.58	1.88	12.032	1.9	82	78	1.9	10.72941176	1.9	50.0
469	11-Sep-98	25.2	87	86	84	83	0.66	0.63	0.59	1.88	12.032	1.9	81	77	1.9	10.72941176	1.9	50.0
470	12-Sep-98	24.8	88	86	85	84	0.65	0.61	0.58	1.84	11.776	1.9	84	79	1.9	10.72941176	1.9	50.0
471	13-Sep-98	24.8	92	90	89	88	0.68	0.64	0.6	1.92	12.288	1.9	84	80	1.8	10.16470588	1.9	48.6
472		24.6	92	90	88	87	0.69	0.65	0.6	1.94	12.416	1.9	84	80	1.7	9.6	1.9	47.2
473	14-Sep-98	23.8	97	95	94	93	0.69	0.65	0.61	1.95	12.48	1.9	89	86	1.9	10.72941176	1.9	50.0
474	15-Sep-98	22.9	98	96	95	94	0.67	0.63	0.59	1.89	12.096	1.9	90	87	1.9	10.72941176	1.9	50.0
475	16-Sep-98	22.6	98	96	94	93	0.68	0.64	0.6	1.92	12.288	1.9	89	86	1.9	10.72941176	1.9	50.0
476	17-Sep-98	22.5	96	94	92	91	0.69	0.65	0.62	1.96	12.544	1.9	86	82	1.9	10.72941176	1.9	50.0
477	21-Sep-98	25.6	98	96	94	94	0.68	0.64	0.6	1.92	12.288	1.9	89	86	1.9	10.72941176	1.9	50.0
478	21-Sep-98	22.7	93	91	90	89	0.63	0.62	0.59	1.84	11.776	1.9	81	78	1.9	10.72941176	1.9	50.0
479	22-Sep-98	22.8	92	90	88	87	0.69	0.64	0.6	1.93	12.352	1.9	86	83	1.9	10.72941176	1.9	50.0
480	22-Sep-98	22.9	93	91	90	89	0.69	0.64	0.6	1.93	12.352	1.9	85	82	1.8	10.16470588	1.3	58.1
481	22-Sep-98	23.2	95	93	92	91	0.68	0.64	0.6	1.92	12.288	1.9	88	85	1.9	10.72941176	1.3	59.4
482	23-Sep-98	21.7	95	93	91	91	0.68	0.64	0.6	1.92	12.288	1.9	89	86	1.9	10.72941176	1.3	59.4
483	24-Sep-98	22.7	101	99	98	97	0.69	0.65	0.6	1.94	12.416	1.9	92	89	1.9	10.72941176	1.3	59.4
484	24-Sep-98	21.5	96	94	93	92	0.69	0.65	0.6	1.94	12.416	1.9	80	78	1.8	10.16470588	1.3	58.1
485	25-Sep-98	21	96	94	93	92	0.69	0.65	0.6	1.94	12.416	1.9	91	89	1.9	10.72941176	1.3	59.4
486	28-Sep-98	21.2	101	99	97	96	0.68	0.64	0.6	1.92	12.288	1.9	89	86	1.9	10.72941176	1.3	59.4
487	29-Sep-98	21.2	100	98	96	95	0.69	0.65	0.61	1.95	12.48	1.9	88	86	1.9	10.72941176	1.2	61.3
488	30-Sep-98	21.2	100	99	97	96	0.69	0.65	0.6	1.94	12.416	1.9	89	86	1.9	10.72941176	1.2	61.3
489	1-Oct-98	20.6	92	89	88	87	0.68	0.64	0.6	1.92	12.288	1.9	83	81	1.8	10.16470588	1.3	58.1
490	1-Oct-98	23.5	96	95	94	93	0.7	0.66	0.6	1.96	12.544	1.3	81	79	1.8	10.16470588	1.3	58.1
491	2-Oct-98	22.9	98	96	95	94	0.69	0.65	0.58	1.92	12.288	1.3	84	82	1.9	10.72941176	1.3	59.4
492	2-Oct-98	21.2	95	93	92	91	0.69	0.65	0.59	1.93	12.352	1.3	80	79	1.9	10.72941176	1.3	59.4
493	3-Oct-98	22.8	98	96	95	94	0.68	0.65	0.59	1.92	12.288	1.3	84	82	1.9	10.72941176	1.3	59.4
494	3-Oct-98	21.5	97	95	94	93	0.69	0.65	0.59	1.93	12.352	1.3	82	80	1.9	10.72941176	1.3	59.4
495	4-Oct-98	22.8	101	100	99	98	0.69	0.65	0.59	1.93	12.352	1.3	88	86	1.9	10.72941176	1.3	59.4
496	4-Oct-98	22.2	100	99	98	96	0.69	0.64	0.58	1.91	12.224	1.3	84	81	1.6	9.035294118	1.3	55.2
497	5-Oct-98	20.3	103	102	101	101	0.68	0.64	0.59	1.91	12.224	1.3	89	89	1.9	10.72941176	1.3	59.4
498	5-Oct-98	22.4	101	100	99	98	0.69	0.64	0.63	1.96	12.544	1.3	88	86	1.9	10.72941176	1.3	59.4
499	6-Oct-98	22.5	99	97	96	95	0.69	0.64	0.59	1.92	12.288	1.3	86	82	1.9	10.72941176	1.3	59.4
500	6-Oct-98	21.4	99	98	94	92	0.69	0.64	0.59	1.92	12.288	1.3	89	88	1.9	10.72941176	1.3	59.4

San Pasqual Wastewater IMS Raw Data

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Itrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
501	7-Oct-98	19	104	103	102	101	0.65	0.62	0.56	1.83	11.712	1.3	95	94	1.8	10.16470588	1.3	58.1
502	7-Oct-98	21.8	99	95	92	91	0.6	0.54	0.47	1.61	10.304	1.3	88	84	1.8	10.16470588	1.3	58.1
503	8-Oct-98	19.1	102	101	100	99	0.65	0.6	0.55	1.8	11.52	1.3	92	91	1.9	10.72941176	1.3	59.4
504	8-Oct-98	21.8	100	99	98	97	0.69	0.64	0.59	1.92	12.288	1.3	86	84	1.8	10.16470588	1.3	58.1
505	9-Oct-98	18.8	106	104	101	100	0.69	0.65	0.59	1.93	12.352	1.3	94	92	1.8	10.16470588	1.3	58.1
506	10-Oct-98	20.8	103	102	101	100	0.69	0.65	0.59	1.93	12.352	1.2	89	87	1.8	10.16470588	1.3	58.1
507	11-Oct-98	19.9	104	103	102	101	0.65	0.6	0.55	1.8	11.52	1.3	81	80	1.8	10.16470588	1.3	58.1
508	12-Oct-98	19.9	108	106	106	105	0.65	0.6	0.55	1.8	11.52	1.3	82	91	1.8	10.16470588	1.3	58.1
509	13-Oct-98	20.7	102	100	99	98	0.65	0.62	0.57	1.84	11.776	1.3	90	89	1.9	10.72941176	1.3	59.4
510	13-Oct-98	21.3	105	104	103	102	0.65	0.62	0.56	1.83	11.712	1.3	89	88	1.9	10.72941176	1.3	59.4
511	14-Oct-98	20.4	104	102	101	100	0.66	0.62	0.58	1.86	11.904	1.3	91	90	1.9	10.72941176	1.3	59.4
512	14-Oct-98	21.3	102	101	100	100	0.65	0.61	0.56	1.82	11.648	1.3	89	86	1.9	10.72941176	1.3	59.4
513	15-Oct-98	20.5	101	99	98	97	0.65	0.6	0.55	1.8	11.52	1.3	89	88	1.9	10.72941176	1.3	59.4
514	15-Oct-98	21.3	101	99	98	97	0.65	0.62	0.55	1.82	11.648	1.3	87	86	1.9	10.72941176	1.3	59.4
515	16-Oct-98	19.7	111	109	108	107	0.7	0.65	0.6	1.95	12.48	1.3	100	99	1.9	10.72941176	1.3	59.4
516	16-Oct-98	21.9	106	105	104	103	0.7	0.65	0.6	1.95	12.48	1.3	94	91	1.9	10.72941176	1.3	59.4
517	17-Oct-98	20	111	110	109	108	0.7	0.65	0.6	1.95	12.48	1.3	96	95	1.9	10.72941176	1.3	59.4
518	17-Oct-98	21.4	110	108	107	106	0.72	0.67	0.62	2.01	12.864	1.3	93	90	1.9	10.72941176	1.3	59.4
519	18-Oct-98	17.8	115	114	113	112	0.69	0.65	0.6	1.94	12.416	1.3	101	100	1.9	10.72941176	1.3	59.4
520	18-Oct-98	19.3	114	112	111	110	0.7	0.65	0.6	1.95	12.48	1.3	96	95	1.9	10.72941176	1.3	59.4
521	19-Oct-98	17.3	117	115	115	114	0.69	0.65	0.6	1.94	12.416	1.3	104	103	1.9	10.72941176	1.3	59.4
522	19-Oct-98	20.7	107	106	105	105	0.69	0.65	0.6	1.94	12.416	1.3	94	92	1.9	10.72941176	1.3	59.4
523	20-Oct-98	17.5	121	119	118	118	0.7	0.66	0.6	1.96	12.544	1.3	105	104	1.9	10.72941176	1.3	59.4
524	20-Oct-98	19.7	115	113	112	111	0.7	0.66	0.62	1.98	12.672	1.3	96	95	1.9	10.72941176	1.3	59.4
525	21-Oct-98	17.9	118	116	115	115	0.7	0.66	0.62	1.98	12.672	1.3	102	101	1.9	10.72941176	1.3	59.4
526	21-Oct-98	20.2	113	111	110	109	0.72	0.67	0.62	2.01	12.864	1.3	96	95	1.9	10.72941176	1.3	59.4
527	22-Oct-98	18	118	116	115	115	0.7	0.65	0.61	1.96	12.544	1.3	103	102	1.9	10.72941176	1.3	59.4
528	22-Oct-98	19	120	118	117	116	0.69	0.65	0.6	1.94	12.416	1.3	97	95	1.9	10.72941176	1.3	59.4
529	23-Oct-98	19	120	118	117	116	0.69	0.65	0.6	1.94	12.416	1.3	97	95	1.9	10.72941176	1.3	59.4
530	23-Oct-98	21.9	107	105	104	104	0.72	0.66	0.63	2.01	12.864	1.3	94	92	1.9	10.72941176	1.3	59.4
531	24-Oct-98	19.6	113	111	110	109	0.7	0.66	0.62	1.98	12.672	1.3	101	100	1.9	10.72941176	1.3	59.4
532	24-Oct-98	21.6	106	104	103	102	0.7	0.65	0.6	1.95	12.48	1.3	96	94	1.9	10.72941176	1.3	59.4
533	25-Oct-98	19.9	110	108	107	106	0.69	0.65	0.6	1.94	12.416	1.3	100	99	1.9	10.72941176	1.3	59.4
534	25-Oct-98	20.8	109	107	106	105	0.7	0.66	0.62	1.98	12.672	1.3	99	97	1.9	10.72941176	1.3	59.4
535	26-Oct-26	19.4	111	110	109	108	0.69	0.65	0.6	1.94	12.416	1.3	104	102	1.9	10.72941176	1.3	59.4
536	26-Oct-98	21.1	109	107	106	105	0.68	0.68	0.63	1.99	12.736	1.3	100	98	1.9	10.72941176	1.3	59.4
537	27-Oct-98	19.3	113	111	110	109	0.7	0.65	0.61	1.96	12.544	1.3	103	101	1.9	10.72941176	1.3	59.4
538	27-Oct-98	20.3	110	108	107	106	0.7	0.65	0.6	1.95	12.48	1.3	100	99	1.9	10.72941176	1.3	59.4
539	28-Oct-98	19.5	112	111	110	109	0.7	0.65	0.61	1.96	12.544	1.3	101	100	1.9	10.72941176	1.3	59.4
540	28-Oct-98	21.1	110	108	107	106	0.2	0.68	0.62	1.5	9.6	1.3	98	96	1.9	10.72941176	1.3	59.4
541	29-Oct-98	19.6	112	110	109	108	0.7	0.66	0.6	1.96	12.544	1.3	103	101	1.9	10.72941176	1.3	59.4
542	29-Oct-98	20.7	111	109	108	107	0.71	0.66	0.63	2	12.8	1.3	100	99	1.9	10.72941176	1.3	59.4
543	3-Nov-98	17.5	118	117	116	115	0.69	0.65	0.6	1.94	12.416	1.3	110	108	1.9	10.72941176	1.3	59.4
544	3-Nov-98	19.1	115	113	112	111	0.7	0.65	0.6	1.95	12.48	1.3	103	101	1.9	10.72941176	1.3	59.4
545	4-Nov-98	17.4	118	117	116	115	0.68	0.64	0.6	1.92	12.288	1.3	109	107	1.9	10.72941176	1.3	59.4
546	5-Nov-98	18.8	114	111	110	109	0.69	0.65	0.6	1.94	12.416	1.3	107	105	1.9	10.72941176	1.3	59.4
547	6-Nov-98	18.1	183	181	180	179	1.05	1	0.94	2.99	19.136	1.2	160	158	2.8	15.81176471	1.4	66.7
548	7-Nov-98	17.2	190	187	186	185	1.4	0.99	0.92	3.31	21.184	1.3	166	164	2.8	15.81176471	1.3	68.3
549	7-Nov-98	19.2	183	180	179	178	1.5	1	0.94	3.44	22.016	1.3	160	157	2.8	15.81176471	1.3	68.3
550	8-Nov-98	17.7	189	186	185	184	1.5	1	0.94	3.44	22.016	1.3	165	163	2.8	15.81176471	1.3	68.3
551	8-Nov-98	17.7	187	185	184	183	1.4	0.99	0.92	3.31	21.184	1.3	165	163	2.8	15.81176471	1.3	68.3
552	9-Nov-98	17.1	187	184	183	182	1.3	0.97	0.9	3.17	20.288	1.3	167	165	2.8	15.81176471	1.3	68.3
553	9-Nov-98	19	183	180	178	177	1.5	1	0.94	3.44	22.016	1.3	160	158	2.8	15.81176471	1.3	68.3
554	10-Nov-98	16.2	190	188	186	185	1.03	0.98	0.92	2.93	18.752	1.2	171	170	2.8	15.81176471	1.3	68.3
555	10-Nov-98	19	186	184	182	181	1.3	0.97	0.9	3.17	20.288	1.3	167	166	2.8	15.81176471	1.3	68.3
556	11-Nov-98	17.7	189	187	185	184	1	0.95	0.9	2.85	18.24	1.2	171	170	2.8	15.81176471	1.3	68.3
557	13-Nov-98	16.4	216	213	212	211	1.05	1	0.94	2.99	19.136	1.2	180	179	2.8	15.81176471	1.3	68.3
558	14-Nov-98	16.3	216	213	121	211	1.05	1	0.93	2.98	19.072	1.2	179	177	2.8	15.81176471	1.3	68.3
559	15-Nov-98	16.2	216	213	212	211	1.06	1	0.92	2.98	19.072	1.2	178	176	2.8	15.81176471	1.3	68.3
560	15-Nov-98	18.8	213	209	208	207	1.08	1.02	0.96	3.06	19.584	1.2	170	168	2.8	15.81176471	1.3	68.3
561	16-Nov-98	16.1	218	215	214	213	1.05	0.99	0.9	2.94	18.816	1.2	181	180	2.8	15.81176471	1.3	68.3
562	16-Nov-98	17.8	195	191	189	187	1	0.95	0.91	2.86	18.304	1.3	177	175	2.8	15.81176471	1.2	70.0

San Pasqual Wastewater IMS Raw Data

	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
4	Date	RO Fd C	Free Feed psi	Inrstg 1 psi	Itrstg 2 psi	Free Rej psi	A Perm gpm	B Perm gpm	C Perm gpm	Total Flow		Free Rej gpm	Std Feed psi	Std Rej psi	Std Perm gpm		Std rej gpm	
563	17-Nov-98	17.5	195	191	189	188	1	0.95	0.92	2.87	18.368	1.8	175	173	2.8	15.81176471	1.3	68.3
564	17-Nov-98	17	200	197	194	193	1.05	1	0.97	3.02	19.328	1.8	170	167	2.8	15.81176471	1.3	68.3
565	18-Nov-98	17.1	205	202	200	199	1.3	0.99	0.95	3.24	20.736	1.8	176	175	2.8	15.81176471	1.3	68.3
566	18-Nov-98	17.8	200	197	193	192	1.05	1	0.97	3.02	19.328	1.8	169	167	2.8	15.81176471	1.3	68.3
567	19-Nov-98	15.8	204	200	198	196	1.2	0.99	0.95	3.14	20.096	1.8	175	173	2.8	15.81176471	1.3	68.3
568	20-Nov-98	17	201	197	195	193	1.04	0.99	0.95	2.98	19.072	1.8	171	169	2.8	15.81176471	1.3	68.3
569	20-Nov-98	17.6	200	196	193	192	1.04	1	0.95	2.99	19.136	1.8	171	169	2.8	15.81176471	1.3	68.3
570	21-Nov-98	15.5	217	213	211	109	1.05	1	0.98	3.03	19.392	1.8	177	176	2.8	15.81176471	1.3	68.3
571	22-Nov-98	13.8	237	233	230	229	1.05	1.1	0.99	3.14	20.096	1.8	197	196	2.8	15.81176471	1.3	68.3
572	23-Nov-98	13.9	235	232	229	228	1.05	1	0.98	3.03	19.392	1.8	200	197	2.8	15.81176471	1.3	68.3
573	23-Nov-98	16.4	219	215	213	212	1.05	1	0.98	3.03	19.392	1.8	187	185	2.8	15.81176471	1.3	68.3
574	24-Nov-98	15	221	218	215	214	1.03	0.99	0.96	2.98	19.072	1.8	192	190	2.8	15.81176471	1.3	68.3
575	24-Nov-98	17.9	130	128	127	126	0.69	0.65	0.6	1.94	12.416	1.3	170	168	2.8	15.81176471	1.3	68.3
576	27-Nov-98	15.6	133	131	130	129	0.68	0.64	0.6	1.92	12.288	1.3	180	178	2.8	15.81176471	1.3	68.3
577	27-Nov-98	16.8	132	130	129	128	0.69	0.65	0.6	1.94	12.416	1.3	177	175	2.8	15.81176471	1.3	68.3

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
5	19-Feb-98	15min cl2every, soak every2, Cl2pmp 30%			1.74
6					1.74
7					
8	20-Feb-98				
9					1.66
10					1.51
11	23-Feb-98	Increased Cl2 pump to 50%			1.52
12		0.6ppm Cl2 in permeate tank			1.87
13					
14		cl2 dose to 40% backwash soak to 17sec			1.33
15					1.4
16	24-Feb-98				1.78
17					1.78
18					1.66
19				7.56	1.57
20	25-Feb-98				1.67
21					1.92
[illegible]					
24	26-Feb-98				
25					1.82
26				7.64	1.78
27	27-Feb-98				2
28		Changed Cl2 to 50%		7.6	1.92
[illegible]					[illegible]
31				7.61	2.11
[illegible]	[illegible]				
34					2.06
35				7.6	1.8
36	4-Mar-98				
37					2.37
38					
39					2.16
40	5-Mar-98	Feed Cl2 66ppm Filtrate collection freecl2=0.4ppm		7.64	2.02
41					2.23
42					2.16
43					2.23
44	6-Mar-98			7.64	2.15
45					2.36
46	9-Mar-98				2.28
47					2.33
48				7.6	2.07
49	10-Mar-98				2.08
50					2.09
51	11-Mar-98				2.1
52		Feed cl2>50ppm post filters 42ppm		7.47	2.21
53		filtrate tank 0.15ppm			2.21
54		cl2 dose to 40%			
55					2.06
56					2.21
57					1.9
58					
59					2.1
60					2.1
61					2.04
62					
63					
64					
65	19-Mar-98				
66	19-Mar-98				

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
67					
68	20-Mar-98				
69					
70					
71					
72	21-Mar-98				
73					
74					
75					
76					
77	25-Mar-98				
78					
79	tart @ 439.4				
80					
81	31-Mar-98				
82					
83					
84	1-Apr-98				
85					
86					1.78
87					
88					2.17
89					2.4
90	2-Apr-98				
91					
92				7.53	2.08
93	3-Apr-98				1.82
94					1.54
95					1.45
96				7.56	1.31
97					1.53
98					1.91
99	5-Apr-98				2.14
100					
101					
102	6-Apr-98				
103					1.8
104					1.93
105	7-Apr-98				
106					
107					
108	8-Apr-98				
109					
110					1.74
111	9-Apr-98				1.7
112					1.62
113				7.4	1.07
114	10-Apr-98				
115					
116					
117					1.27
118	11-Apr-98			7.25	2.1
119		Cl2 pump at 40% Feed =36ppm cl2		7.48	2.31
120		effluent =8ppm?		7.25	0.92
121		tank=0.35ppmfree, 5.5 ppm total?			1.49
122	12-Apr-98				1.54
123		ged backwash Sequence to decrease cl2 in the filtrate collection tank			1.68
124		sequence now 5,7,7,~~12~~-10,~~17~~-15,~~12~~-16		7.61	1.63
125		fast flush, btm,top,both,soak,rinse		7.34	2.04
126	13-Apr-98				
127					1.85
128					1.85

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
129	14-Apr-98	Debris found in 150um strainer include worms			1.87
130				7.51	1.66
131					1.57
132	15-Apr-98				
133					Powe
134			Shut Down to Replumb Cl2 dosing to		
135					1.61
136	16-Apr-98	bkwsh tnk free cl2=0.21, tot=3.26		7.49	1.15
137		filtrate coll tank free cl2=0.24 tot=5.2			1.06
138					1.54
139	17-Apr-98	bkwsh tnk free cl2=0.20 tot=2.3			
140		filtrate col tank free cl2=0.15 tot=4.0			1.78
141					
142		checked cl2 dos 55ml/24sec 138ppm!		7.45	1
143	18-Apr-98	decrease cl2 from 48% to 40%			1
144					1.49
145				7.37	2.25
146	19-Apr-98				1.84
147				7.52	1.32
148		Noticed that Conc flowmeter and check valve			1.64
149		in K elemnt conc turning brown, but not			
150	20-Apr-98	other check valve			
151	21-Apr-98				2.41
152					2.33
153	24-Apr-98				1.81
154					1.77
155				7.57	1.8
156					1.98
157	25-Apr-98				2.02
158					2.1
159				7.61	2.69
160	26-Apr-98				1.89
161				7.36	1.85
162		Particle Monitoring Data Indicating		7.57	1.85
163		B (K) element is leaking			2
164	27-Apr-98			7.52	1.78
165				7.36	1.87
166					1.81
167			Unit Shutdown and Cleaned		1.99
168	28-Apr-98				2.26
169				7.41	1.65
170					1.7
171				1.71	
172	29-Apr-98		7.51	1.51	
173				1.99	
174	30-Apr-98	a 124ppm totcl2 in, 36ppm out			2.08
175		b 96ppm in, 3ppm out			
176		During backwash, other ele		1.97	
177			7.57	1.85	
178	1-May-98	rises as if water is flowing			2
179		Cl2 injection valve is not working			1.99
180		Changed Backwash cl2 pump from 40 to 33%		7.52	2.16
181	2-May-98	Verified that bkwsh fd valves closing totally			Unit Shutdown
182		bkwsh a fd p=25psi, 29gpm			New K elemen
183	3-May-98	bkwsh b fd p=32psi, 20gpm			Element location sw
184		DID NOT PLUG BYPASS TUBES IN K-Fast Flush			A=K B=X
185		system bkwsh flow=32gpm, 19-22psi w/BLANKS	Unit Shutdown and		
186		bkwsh 29gpm, 23psi upon startup			
187	4-May-98	Decreased cl2 to 13% ~25ppm			
188		BKWH now 5 9,7,7,10,15,1612			
189		Particle count showing good integrity both			
190		Removed globe valve in bkwsh fd 34 gpm, 30?psi			

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
191	5-May-98	confirmed bkwsh cl2 28ppm free		7.54	1.76
192					
193			Unit shutdown and bkwsh glob		
194					
195	6-May-98				
196					
197		Tertiary Filter and Storage Tank			
198	7-May-98	cleaned/chlorinated somewhere in here		7.38	2.21
199					
200		1st mnl lowpH bkwsh			
201		Atmp= 5.5-4.9 Btmp=6.6-6.5		7.57	2
202	8-May-98				
203					
204		2nd manual low pH bkwsh			
205	9-May-98	A tmp= 4.6-4.8 B tmp=5.9-5.5		7.58	2.03
206					
207					
208		3rd manual low pH bkwsh			
209	10-May-98	A tmp= 4.2-4.0 B tmp=5.8-4.8		7.53	1.66
210					
211		4th manual low pH bkwsh			
212					
213	11-May-98				
214		5th manual low pH bkwsh			
215				7.47	2.49
216		system ERROR-PLC no longer controlling fd pressure			
217					
218	12-May-98				
219				7.51	1.8
220					
221					
222	13-May-98			7.36	1.7
223					
224				7.41	1.92
225					
226	14-May-98				
227					
228				7.34	2.01
229					
230	15-May-98	Any of the following leading to longer run			
231		low pH Backwash			
232		tank/teriary filters cleaned week of 4/27-5/1		7.6	2.18
233		lower cl2 dose			
234	16-May-98				
235		Another low pH backwash			
236				7.55	1.99
237	17-May-98				
238					
239		Low pH backwash			
240		tmp a 4.3-4.2 b 5.6 5.0		7.54	1.75
241	18-May-98	LOST TOUCHPANEl			
242					
243		Low pH bkwsh		7.37	1.95
244		tmp a 4.8 3.9 b 5.8 5.0			
245	19-May-98				
246		Low pH bkwsh		7.32	1.03
247		tmp a 4.5 4.3 b 5.5 5.3			
248	20-May-98				
249					
250				7.36	1.5
251		Low ph backwash			
252	21-May-98	tmp a 5.3-5.0 b 6.3-6.2			

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
253					
254		Reloaded MT200 software		7.46	1.25
255	22-May-98	low ph a 5.2 5.4 b 5.3 6			
256		RO shutdown-broken valve			
257	23-May-98				
258					
259				7.52	2.38
260					
261	24-May-98				
262		System run for 3.5hours w/o any backwash RO			
263				7.45	
264		Low pH Backwash			
265	25-May-98	tmp a 5.5-6.1 b 5.8-5.9			
266					
267				7.47	
268		FIXED BACKWASH BOTH ELEMENTS			
269	26-May-98	NOW EQUAL			
270		Low pH backwash			
271		tmp a 5.6-4.6 b 6.0-5.0		7.3	1.94
272	27-May-98	TOUCHPANEL DOWN AGAIN			
273		Low ph backwash			
274		tmp a 4.9-4.5 5.5-5.2			
275				7.26	1.6
276	28-May-98				
277					
278		Low pH backwash		7.26	1.59
279		a tmp 4.7-5.1 b 5.4-5.0			
280	29-May-98				
281					
282				7.47	1.6
283					
284	30-May-98				
285					
286	31-May-98	Low pH backwash		7.42	1.97
287	1-Jun-98	a tmp5-4.8 b 4.7-4.8			
288	2-Jun-98				
289		Low pH backwash		7.4	1.8
290		a tmp 5.1-4.8 b 5.1-5.1			
291	3-Jun-98	Reloaded MT200 Software Again			
292		Added Second Dosing Pump to System			
293	4-Jun-98	Low pH backwash once per day pH ~2.7		7.41	2.15
294		0.1% Citric Acid pumped in			
295	5-Jun-98	Cl2 now w/LMI 25-30ppm free in feed			
296				7.3	1.86
297					
298	6-Jun-98			7.32	2.42
299					
300	7-Jun-98				
301					
302	8-Jun-98			7.32	1.74
303		Verified Cl2 in bkwsh feed =30ppm			
304	9-Jun-98	max stroke and frequency			
305					
306				7.47	1.57
307					
308	10-Jun-98				
309					
310				7.57	1.97
311	11-Jun-98				
312					
313	12-Jun-98			7.7	1.72
314					

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
315					
316	13-Jun-98	Feed Pump VFD low?			
317		Manual low pH backwash		7.57	1.78
318	14-Jun-98	a tmp 7-6 b 6.05-5.2			
319					
320	15-Jun-98				
321				7.49	1.98
322	16-Jun-98				
323		Checked bwash,cl2 ok			
324					
325	17-Jun-98			7.51	1.48
326					
327	18-Jun-98			7.54	2.55
328				7.57	1.75
329				7.67	2.15
330	19-Jun-98				
331					
332				7.44	1.89
333	20-Jun-98				
334	21-Jun-98			7.6	2.1
335	22-Jun-98				
336	23-Jun-98			7.39	2.01
337					
338	24-Jun-98				
339				7.41	2.68
340	25-Jun-98				
341				7.47	2.55
342					
343	26-Jun-98			7.48	2.59
344	27-Jun-98	Check Integrity Particle Counts look good			
345		Moved RO sample locations		7.26	2.54
346	28-Jun-98	Probing Study on LFC1 3M looks uniform			
347		Virus Challenge-UF and RO			
348	29-Jun-98	Overnite, K (A) membrane increase in particle			
349				7.36	2.43
350	30-Jun-98				
351	1-Jul-98				
352	2-Jul-98	Removed membranes-K 2 leaks, X good			
353				Unit Shutdown to Integrity te	
354					
355	3-Jul-98			7.44	2.05
356					
357					
358				7.4	2.3
359	4-Jul-98				
360	5-Jul-98			7.26	2.35
361					
362	6-Jul-98				
363	7-Jul-98				
364				7.36	2.41
365					
366	8-Jul-98				
367				7.26	1.93
368	9-Jul-98				
369				7.49	1.97
370	10-Jul-98				
371					
372				7.3	1.99
373					
374	11-Jul-98				
375	12-Jul-98			7.47	2.84
376				7.45	2.4

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
377	13-Jul-98			7.48	2.07
378	14-Jul-98	Switched from Citric Acid to HCl in BW		7.3	1.83
379		pH 2.7			
380	15-Jul-98			7.61	2.37
381	16-Jul-98				
382	17-Jul-98			7.44	2.28
383					
384	18-Jul-98				
385	19-Jul-98	B membrane failed coliform challenge?		7.36	2.04
386				7.34	2.3
387	21-Jul-98				
388				7.33	2
389	22-Jul-98				
390				7.32	1.84
391					
392	23-Jul-98			7.39	1.4
393				7.37	1.5
394				7.46	1.88
395					
396	24-Jul-98	Removed membranes, neither had leaks,			
397				7.49	2.31
398					
399	25-Jul-98				
400					
401				7.4	2.21
402	26-Jul-98	but neither held va		7.38	2.4
403					
404	27-Jun-98		Shut Down to Integrity Test Modules-no le		
405				7.47	2.5
406	28-Jul-98				
407					
408	29-Jul-98				
409				7.41	1.89
410					
411	30-Jul-98			7.61	2.6
412	31-Jul-98	Both membranes failed coliform challenge			
413				7.64	2.6
414	1-Aug-98				
415					
416	2-Aug-98				
417	3-Aug-98			7.37	2.64
418	4-Aug-98			7.38	2.53
419				7.36	2.88
420	5-Aug-98	System Cleaned		7.47	2.99
421					
422	6-Aug-98				
423					
424	7-Aug-98		Shut Down and Cleaned		
425	8-Aug-98				
426	9-Aug-98			6.79	1.86
427	10-Aug-98				2.3
428					
429	11-Aug-98				
430					
431	12-Aug-98			7.21	1.95
432					
433				7.4	1.55
434	13-Aug-98				
435	14-Aug-98				
436	15-Aug-98			7.41	1.94
437					
438	16-Aug-98				

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
439					
440	17-Aug-98			7.51	1.94
441					
442	18-Aug-98				
443	19-Aug-98			7.37	1.59
444		Replaced Solenoid, ycheck on B			
445	20-Aug-98	Removed membranes			
446	21-Aug-98	A >4leaks, replaced		7.41	1.82
447	22-Aug-98	B 2 leaks repaired			
448	23-Aug-98	BW every 25 min 9,7,7,10,15,10		7.46	1.87
449	24-Aug-98	Increased flow to 8gpm			
450	25-Aug-98	restarted BW evey 25 min (same)		7.37	1.57
451		7gpm/membrane			
452	26-Aug-98			7.42	1.78
453					
454	27-Aug-98				
455	28-Aug-98			7.49	1.61
456	29-Aug-98			7.5	1.22
457	30-Aug-98				
458	31-Aug-98			7.49	1.86
459	1-Sep-98				
460	2-Sep-98			Shut Down and Cleaned	
461	3-Sep-98				
462	4-Sep-98			7.49	1.99
463	5-Sep-98				
464	6-Sep-98			7.48	2.14
465	7-Sep-98				
466	8-Sep-98			7.45	2.72
467	9-Sep-98				
468	10-Sep-98			7.46	2.62
469	11-Sep-98			7.42	2.81
470	12-Sep-98			7.31	1.73
471	13-Sep-98			7.49	1.96
472					
473	14-Sep-98			7.42	1.42
474	15-Sep-98				
475	16-Sep-98	Free cl2 in RO feed ~0.3ppm (chloramines?)		7.57	1.69
476	17-Sep-98	Free cl2 in backwash feed 17ppm			
477	21-Sep-98	shut down at 1100 to repair UF leak			
478	21-Sep-98			7.33	2.31
479	22-Sep-98	RO FROM 40 TO 50% RECOVERY		7.57	2.29
480	22-Sep-98			7.49	2.51
481	22-Sep-98				
482	23-Sep-98			7.39	2.17
483	24-Sep-98				
484	24-Sep-98			7.45	1.86
485	25-Sep-98	USING UF FILTRATE IN THE BACKWASH			
486	28-Sep-98			7.43	1.97
487	29-Sep-98			7.32	1.89
488	30-Sep-98				
489	1-Oct-98			7.33	1.89
490	1-Oct-98	Power out		7.32	1.89
491	2-Oct-98			7.32	1.7
492	2-Oct-98	Restarted with UF Filtrate ~8ppm free cl2 in BW		7.44	2.01
493	3-Oct-98	cl2 evert BW		7.42	2.02
494	3-Oct-98			7.41	2.38
495	4-Oct-98				
496	4-Oct-98			7.4	2.49
497	5-Oct-98		Shut Down and Cleaned		
498	5-Oct-98			7.26	2.19
499	6-Oct-98			7.45	2.34
500	6-Oct-98	Low pH BW left on-No HCl		7.4	2.04

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
501	7-Oct-98			7.28	1.9
502	7-Oct-98	Periodic Citric BW			2.54
503	8-Oct-98	in		7.5	2.46
504	8-Oct-98	here		7.29	2.71
505	9-Oct-98			7.3	2.37
506	10-Oct-98			7.33	1.76
507	11-Oct-98	Restarted with 8ppm Free cl2 in BW every 9bw		7.46	1.95
508	12-Oct-98	Post Citric BW flow 39gpm, FF flow 38gpm		7.42	1.79
509	13-Oct-98	High pH solution turned brown		7.52	2.21
510	13-Oct-98	2 day soak with ~40ppm NaOCl		7.42	1.74
511	14-Oct-98	Backwash with RO permeate, cl2~8ppm every BW		7.44	1.67
512	14-Oct-98		Shut Down and Cl	7.52	1.37
513	15-Oct-98			7.33	1.6
514	15-Oct-98			7.46	1.34
515	16-Oct-98			Shut Down and Cleaned	
516	16-Oct-98	7-8ppm total Cl2 in BW			
517	17-Oct-98				
518	17-Oct-98	Replaced old style B membrane with bypass			
519	18-Oct-98		Shut Down and Cleaned		
520	18-Oct-98			Shut Down and Cleaned	
521	19-Oct-98		Shut Down and Cl	restored-2day soak in cl2	
522	19-Oct-98	Now both A and B new bypass membranes			
523	20-Oct-98	INCREASED RO RECOVERY TO 60%	d, Replaced B membrane (leaking)		
524	20-Oct-98	BW every 25min 9,7,7,10,15,12 SAME			
525	21-Oct-98	~25ppm cl2 every BW			
526	21-Oct-98	Shut Down and Cleaned, Replaced A membrane			
527	22-Oct-98				
528	22-Oct-98				
529	23-Oct-98				
530	23-Oct-98				
531	24-Oct-98				
532	24-Oct-98				
533	25-Oct-98				
534	25-Oct-98				
535	26-Oct-26				
536	26-Oct-98			7.47	
537	27-Oct-98				1.6
538	27-Oct-98			7.44	
539	28-Oct-98				2.03
540	28-Oct-98	Acid Pump left on again			
541	29-Oct-98	Low pH backwash pH 2.6-increased acid			
542	29-Oct-98			7.43	
543	3-Nov-98	Lowered low pH backwash to 2.1			1.6
544	3-Nov-98			7.35	
545	4-Nov-98				1.59
546	5-Nov-98			7.37	
547	6-Nov-98	increased recovery on RO			1.53
548	7-Nov-98	VIRUS CHALLENGE#2		7.4	
549	7-Nov-98	No Cl2 on UF			1.24
550	8-Nov-98			7.4	
551	8-Nov-98			7.35	1.14
552	9-Nov-98			7.36	1.51
553	9-Nov-98			7.35	1.72
554	10-Nov-98			7.32	1.7
555	10-Nov-98	Unit Cleaned			1.89
556	11-Nov-98			7.4	
557	13-Nov-98				1.78
558	14-Nov-98			7.37	
559	15-Nov-98				1.68
560	15-Nov-98			7.36	
561	16-Nov-98				1.68
562	16-Nov-98	Inreased free conc flow from 1.2 to 1.8 GPM		7.34	

	A	AK	AL	AM	AN
4	Date	Comments		UF Feed pH	UF Feed NTU
563	17-Nov-98				1.5
564	17-Nov-98			7.37	
565	18-Nov-98				1.61
566	18-Nov-98				
567	19-Nov-98				
568	20-Nov-98				
569	20-Nov-98				
570	21-Nov-98				
571	22-Nov-98				
572	23-Nov-98				
573	23-Nov-98				
574	24-Nov-98				
575	24-Nov-98				
576	27-Nov-98				
577	27-Nov-98				