

# ICR TREATMENT STUDY ANALYSIS

## Base Analysis and Data Review Comments

<b>Treatment Study ID</b>	1013
<b>Study Protocol</b>	Membrane pilot-scale treatment study
<b>Plant ICR Number</b>	306
<b>PWS Name</b>	Boca Raton Water Treatment Facility
<b>City, State, Zip</b>	Boca Raton, FL 33431

### General Comments:

1. During this pilot-scale study, two membranes were evaluated: the Hydranautics ESNA and the FilmTec NF200. The membranes were evaluated sequentially, first the ESNA between 3/17/98 and 9/15/98 and then the NF200 between 10/6/98 and 4/22/99. This ICR treatment study was part of a larger, on-going membrane pilot project being conducted by the utility.
2. Figure 3 of the Summary Report shows a schematic of a 3-stage pilot system; however, a 2-stage system was used during this study.
3. The Results and Discussion section of the Summary Report contains an abbreviated log of operational events and results from membrane autopsies on both ESNA and NF200 elements.
4. The Summary Report contains a cost estimate for a membrane softening facility.
5. The city has designed a 40 MGD nanofiltration plant, which is expected to be operational by December 2002.

### Water Quality Comments:

1. Thirty-one water quality outliers were identified and removed prior to base analysis.
2. ESNA Membrane: the feed and permeate DBPs for Week 2 are invalid due to a SDS free chlorine residual below the MRL.
3. ESNA Membrane: the SDS incubation time for Week 10 and 10-dup was 29 hours which is 41% below the target value of 41 hours.

**Productivity Comments:**

1. Three productivity outliers were identified and removed prior to base analysis.
2. The membrane cleaning procedure included cleaning with a hydrochloric acid solution (pH = 2) followed by cleaning with a surfactant/sodium hydroxide solution (pH = 12). Additional details about membrane cleaning are given in the Summary Report.

## ICR Information

ID / ICR#: FL4500130 / 306  
 ICR Contact: Dan Bassi  
 Phone No.: 561-338-7328  
 Period: 10/6/98 - 12/16/98 (71 days)

## Membrane Information

Manufacturer: FilmTec Corporation  
 Trade Name: FILMTEC  
 Membrane Model: NF200-4040  
 MWCO: 10 nominal Daltons  
 Element Size: 4" x 40"  
 Element Area: 80.0 ft<sup>2</sup>  
 Design Flux: 27.8 gfd  
 Mfr. NDP: 70.0 psi  
 Mfr. MTC<sub>w</sub>: 0.274 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Maximum Flow: 18.0 gpm  
 Minimum Flow: 4.0 gpm  
 Total Width: 14.0 ft  
 Feed Spacer Thickness: 0.0023 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$700

## Design Parameters

Norm Temp: 25.0 °C  
 Temp Norm MTC-w: 0.274 TavGC  
 Design Recovery: 0.85  
 Avg Sys Flux F<sub>w</sub>: 16.5 gfd  
 # of Elem in P.V.: 7  
 # Pres Ves in Stg 1: 4  
 # Pres Ves in Stg 2: 2  
 Pres Ves in Stg 3: NA  
 Design Flux: 16.5 gfd  
 Recycle Ratio: 0.00  
 Osmotic P Stage 1: 3.7 psi  
 Osmotic P Stage 2: 9.5 psi  
 Osmotic P Stage 3: NA

## Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.4	0.2	5	6.0 - 6.6	6.3	0.3	5	5.8 - 6.5	6.6	0.2	5	6.4 - 6.8
Temp	25.5	0.3	5	25.0 - 25.8	25.5	0.3	5	25.0 - 25.8	25.8	0.5	5	24.8 - 26.0
Alk	121	15	5	98 - 135	78	6	5	70 - 86	304	38	5	260 - 360
TDS	367	4	5	362 - 372	158	5	5	152 - 163	1104	29	5	1060 - 1130
TotHard	252	12	5	236 - 265	101	7	5	94 - 110	1064	65	5	980 - 1140
CaHard	238	9	5	228 - 250	91	8	5	82 - 102	996	72	5	920 - 1100
Turb	1.09	0.7	5	0.17 - 1.72	0.05	0.0	5	0.04 - 0.06	1.78	0.7	5	0.90 - 2.54
Amm	0.67	0.06	5	0.58 - 0.73	0.53	0.05	5	0.47 - 0.62	1.50	0.13	5	1.3 - 1.6
TOC	13.7	1.6	5	12.5 - 16.5	0.3	0.2	5	0.3 - 0.6	84.1	5.1	5	78.6 - 91.9
UV254	0.390	0.1	5	0.186 - 0.448	0.005	0.0	5	0.005 - 0.009	2.654	0.2	5	2.475 - 2.830
SUVA	2.85	0.85	5	1.41 - 3.42	1.75	0.12	5	1.53 - 1.80	3.16	0.24	5	2.80 - 3.36
Bromide	187	9	5	178 - 202	188	3	5	183 - 191				
TOX	1539	88	5	1420 - 1643	13	0	5	13 - 13				
CHCl3	387.3	24.3	5	350.0 - 414.0	0.3	0.7	5	0.0 - 1.5	Mass Balance			
BDCM	66.0	4.0	5	60.6 - 70.6	0.0	0.0	5	0.0 - 0.0	Closure Errors (%)			
DBCM	8.2	0.6	5	7.5 - 9.1	1.3	0.2	5	1.2 - 1.6	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	2.5	0.9	5	1.1 - 3.6	Alk	5	-19	24
THM4	461.4	25.0	5	421.6 - 488.5	4.2	1.3	5	2.7 - 6.3	TDS	5	-38	5
MCAA	12.9	4.2	5	7.4 - 17.4	0.0	0.0	5	0.0 - 0.0	TotHard	5	-2	7
DCAA	107.0	6.4	5	98.5 - 116.0	0.0	0.0	5	0.0 - 0.0	CaHard	5	-5	11
TCAA	131.8	17.4	5	120.0 - 162.0	0.0	0.0	5	0.0 - 0.0	Turb	5	-246	222
MBAA	0.6	0.9	5	0.0 - 1.8	0.0	0.0	5	0.0 - 0.0	Amm	5	7	21
DBAA	1.3	0.1	5	1.2 - 1.3	0.0	0.0	5	0.0 - 0.0	TOC	1	-3	n/a
BCAA	12.5	0.8	5	11.3 - 13.3	0.0	0.0	5	0.0 - 0.0	UV254	2	-9	4
TBAA	NA	NA	0	NA	NA	NA	0	NA	TDS <sub>t</sub>	70	-6	6
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	253.6	24.1	5	234.9 - 295.1	0.0	0.0	5	0.0 - 0.0				
HAA6	266.0	24.7	5	246.2 - 308.4	0.0	0.0	5	0.0 - 0.0	Comments:			
HAA9	NA	NA	0	NA	NA	NA	0	NA				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process	Description						Scale
Res (0)	0.66	0.28	10	0.30 - 1.20	Pressurized Dual Media Filtratio	Silica/Garnet						Pilot-Scale
Temp (°C)	21.8	0.6	10	21.2 - 23.0	Scale Inhibitor Addition	Calgon EL-5600 4.0 mg/l						Pilot-Scale
pH (unit)	8.3	0.1	10	8.2 - 8.5	pH Adjustment	sulfuric acid to pH 6.0 to 6.4						Pilot-Scale
Time (hr)	40.8	0.4	10	40.0 - 41.0	Cartridge Filtration	5 um exclusion size						Pilot-Scale

## Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-1.9%	1.1%	System Inf - Stg 1 Inf	-10.3%	2.5%
Sys Conc - Stg 2 Conc	0.0%	0.4%	Sys Conc - Stg 2 Conc	0.0%	0.2%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	6.2%	2.8%	Stg 1 Conc - Stg 2 Inf	0.0%	0.2%
Sys Perm - Avg Stg Perr	-0.2%	2.1%	Sys Perm - Sum Stg Per	0.5%	0.6%	Sys Perm - Avg Stg Perm	-14.1%	0.6%

## Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.62	0.00	5	0.62 - 0.63					
pH	6.4	6.6	6.3	0.2	5	6.0 - 6.5	6.3	6.3	0.1	4	6.3 - 6.5
Temp	25.5	25.8	25.5	0.3	5	25.0 - 25.8	25.5	25.5	0.3	5	25.0 - 25.8
Alk	121	304	121	12	5	110 - 140	78	64	6	5	54 - 70
TDS	367	1104	367	4	5	362 - 372	158	143	4	5	137 - 148
TotHard	252	1064	262	12	5	246 - 280	101	79	5	5	72 - 84
CaHard	238	996	238	8	5	228 - 250	91	73	6	5	66 - 81
Turb	1.09	1.78	0.95	1	5	0.14 - 1.93	0.05	0.05	0.01	5	0 - 0
TOC	13.7	84.1	13.7	1.7	4	12.5 - 16.2	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.390	2.654	0.453	0.012	5	0.438 - 0.468	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.85	3.16	NA	NA	4	NA	1.75	1.80	0.00	5	1.80 - 1.80

WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.55	0.01	5	0.54 - 0.57					
pH	6.4	6.6	6.5	0.1	4	6.4 - 6.7	6.3	6.6	0.0	4	6.6 - 6.7
Temp	25.5	25.8	25.6	0.4	5	25.0 - 26.0	25.5	25.6	0.4	5	25.0 - 26.0
Alk	121	304	203	19	5	180 - 230	78	128	13	5	110 - 145
TDS	367	1104	655	10	5	638 - 663	158	183	5	5	177 - 188
TotHard	252	1064	534	23	5	510 - 570	101	148	11	5	132 - 163
CaHard	238	996	492	4	5	490 - 500	91	136	11	5	122 - 150
Turb	1.09	1.78	2.01	0	5	1.31 - 2.42	0.05	0.05	0.01	5	0 - 0
TOC	13.7	84.1	33.6	1.7	5	31.3 - 35.9	0.3	0.6	0.1	5	0.6 - 0.7
UV254	0.390	2.654	1.167	0.036	5	1.145 - 1.230	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.85	3.16	3.48	0.20	5.00	3.20 - 3.67	1.75	0.74	0.06	5.00	0.63 - 0.79

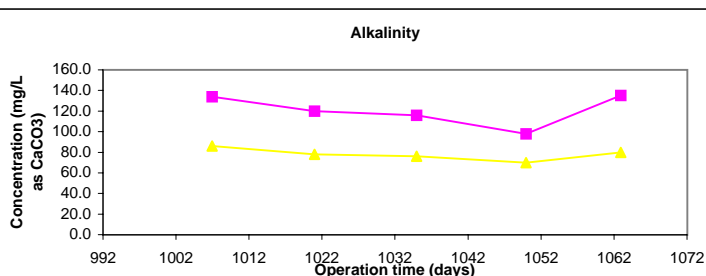
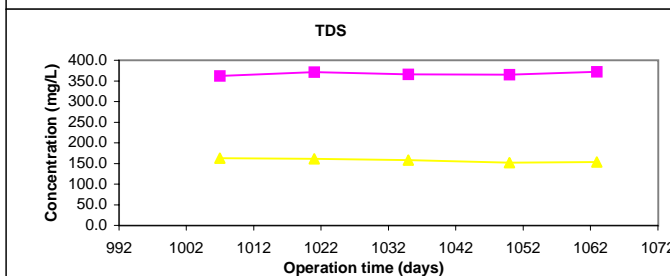
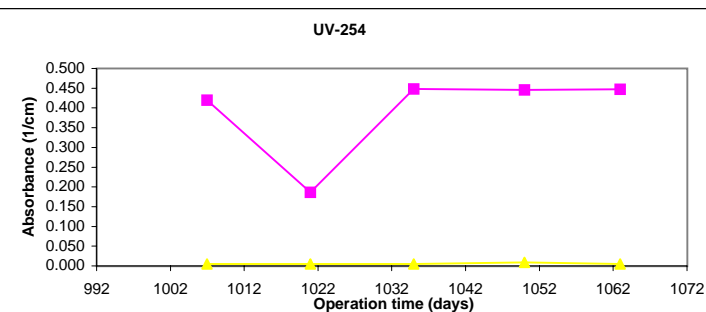
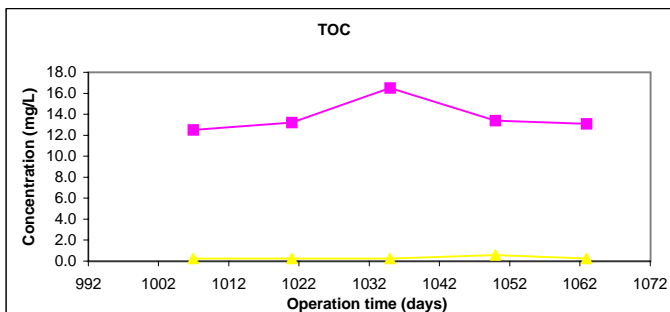
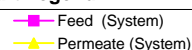
  

WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

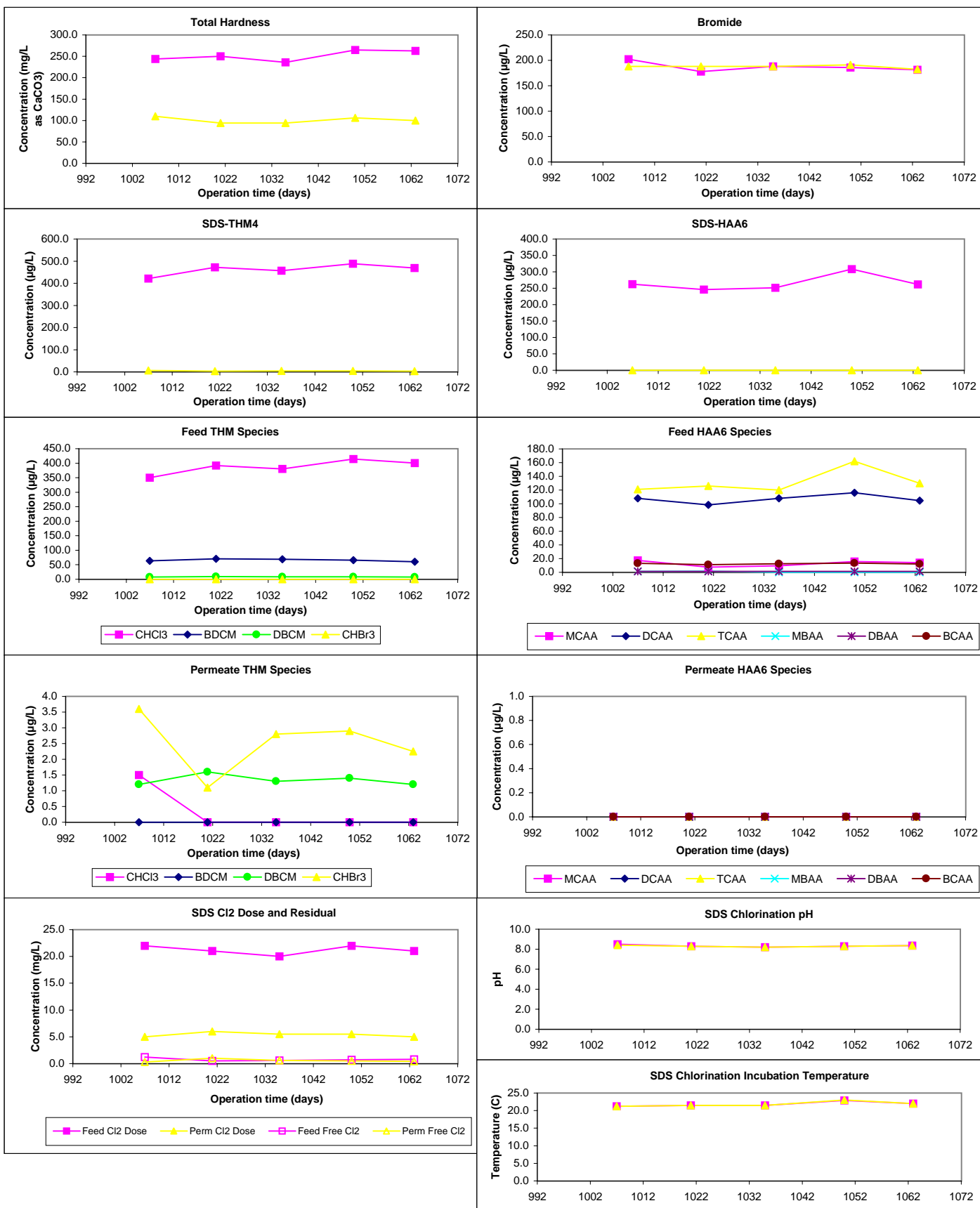
This was only a two stage study.

## Water Quality Parameter Graphs

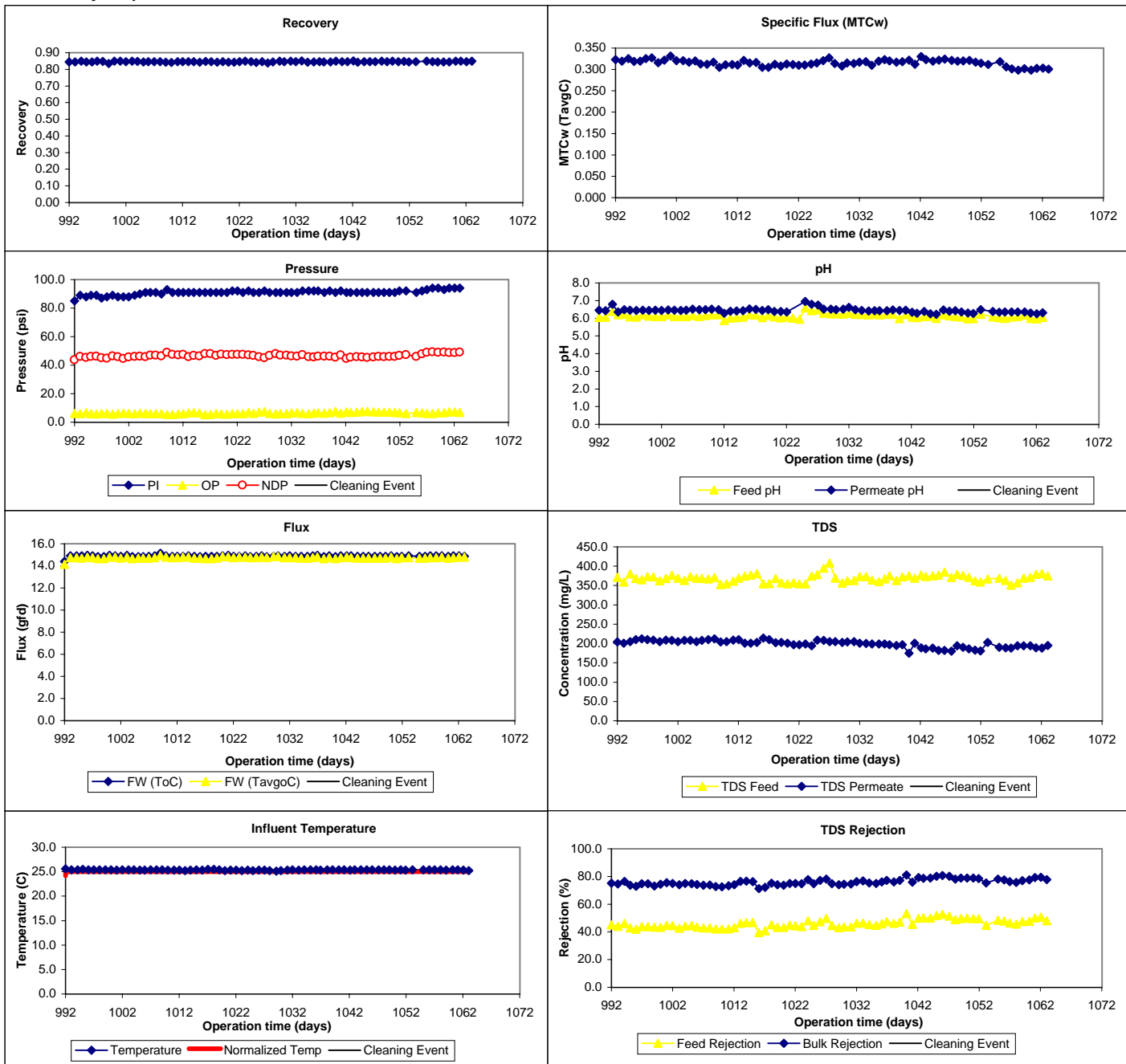
## Chart Legend:



## Water Quality Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: FL4500130 / 306  
 ICR Contact: Dan Bassi  
 Phone No.: 561-338-7328  
 Period: 12/17/98 - 2/28/99 (73 days)

## Membrane Information

Manufacturer: FilmTec Corporation  
 Trade Name: FILMTEC  
 Membrane Model: NF200-4040  
 MWCO: 10 nominal Daltons  
 Element Size: 4" x 40"  
 Element Area: 80.0 ft<sup>2</sup>  
 Design Flux: 27.8 gfd  
 Mfr. NDP: 70.0 psi  
 Mfr. MTC<sub>w</sub>: 0.274 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Maximum Flow: 18.0 gpm  
 Minimum Flow: 4.0 gpm  
 Total Width: 14.0 ft  
 Feed Spacer Thickness: 0.0023 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$700

## Design Parameters

Norm Temp: 25.0 °C  
 Temp Norm MTC-w: 0.274 TavGC  
 Design Recovery: 0.85  
 Avg Sys Flux F<sub>w</sub>: 16.5 gfd  
 # of Elem in P.V.: 7  
 # Pres Ves in Stg 1: 4  
 # Pres Ves in Stg 2: 2  
 Pres Ves in Stg 3: NA  
 Design Flux: 16.5 gfd  
 Recycle Ratio: 0.00  
 Osmotic P Stage 1: 3.7 psi  
 Osmotic P Stage 2: 9.5 psi  
 Osmotic P Stage 3: NA

## Water Quality Summary

Feed (System)					Permeate (System)				Concentrate (System)			
Summary	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.6	0.1	5	6.4 - 6.7	6.5	0.2	5	6.3 - 6.8	6.9	0.2	5	6.6 - 7.1
Temp	25.2	0.5	5	24.3 - 25.5	25.5	0.3	5	25.0 - 25.7	25.6	0.3	5	25.0 - 25.8
Alk	141	21	5	120 - 171	102	25	5	78 - 132	329	38	5	290 - 374
TDS	369	6	5	361 - 376	205	28	5	177 - 240	1017	114	5	872 - 1120
TotHard	270	10	5	260 - 282	120	26	5	94 - 154	954	129	5	800 - 1080
CaHard	237	4	5	230 - 240	110	22	5	90 - 136	858	94	5	760 - 1000
Turb	0.24	0.1	5	0.15 - 0.34	0.05	0.0	5	0.04 - 0.06	1.09	0.6	5	0.59 - 2.11
Amm	0.61	0.08	5	0.49 - 0.68	0.50	0.02	5	0.48 - 0.53	1.33	0.20	5	1.1 - 1.6
TOC	14.3	0.7	5	13.6 - 15.1	0.7	0.2	5	0.5 - 1.0	78.6	2.2	5	76.0 - 81.3
UV254	0.427	0.0	5	0.401 - 0.440	0.005	0.0	5	0.005 - 0.005	2.475	0.2	5	2.220 - 2.634
SUVA	2.99	0.16	5	2.86 - 3.21	0.68	0.14	5	0.46 - 0.83	3.15	0.13	5	2.92 - 3.24
Bromide	171	3	5	166 - 174	172	14	5	149 - 187				
TOX	1447	23	5	1413 - 1475	13	0	5	13 - 13				
CHCl3	425.4	27.4	5	404.0 - 471.0	0.0	0.0	5	0.0 - 0.0	Mass Balance Closure Errors (%)			
BDCM	74.2	8.1	5	66.3 - 83.4	0.0	0.0	5	0.0 - 0.0				
DBCM	9.1	0.9	5	7.7 - 9.9	0.8	0.7	5	0.0 - 1.6	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	2.0	0.8	5	1.2 - 3.3	Alk	5	-4	16
THM4	508.7	33.0	5	480.9 - 563.4	2.8	1.4	5	1.2 - 4.9	TDS	5	-22	7
MCAA	7.9	0.8	5	7.0 - 9.0	0.0	0.0	5	0.0 - 0.0	TotHard	5	-12	10
DCAA	110.2	7.7	5	97.5 - 117.5	0.0	0.0	5	0.0 - 0.0	CaHard	5	-7	3
TCAA	133.9	7.9	5	120.0 - 139.0	0.0	0.0	5	0.0 - 0.0	Turb	5	-23	27
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Amm	5	0	8
DBAA	1.6	0.1	5	1.4 - 1.7	0.0	0.0	5	0.0 - 0.0	TOC	5	-12	5
BCAA	16.6	1.2	5	14.8 - 17.6	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	NA	NA	0	NA	NA	NA	0	NA	TDS <sub>t</sub>	71	4	15
CDBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	253.6	8.5	5	243.9 - 262.6	0.0	0.0	5	0.0 - 0.0				
HAA6	270.2	8.6	5	261.1 - 280.2	0.0	0.0	5	0.0 - 0.0				
HAA9	NA	NA	0	NA	NA	NA	0	NA				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (0)	0.90	0.32	10	0.40 - 1.60	Dual Media Filtration		Silica/Garnet		Pilot-Scale			
Temp (°C)	21.9	0.4	10	21.4 - 22.5	Scale Inhibitor Addition		Calgon EL-5600 4.0 mg/l		Pilot-Scale			
pH (unit)	8.4	0.1	10	8.2 - 8.6	pH Adjustment		sulfuric acid to pH 6.0-6.4		Pilot-Scale			
Time (hr)	41.0	0.0	10	41.0 - 41.0	Cartridge Filtration		5 um exclusion size		Pilot-Scale			

## Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-1.8%	0.6%	System Inf - Stg 1 Inf	-10.2%	1.6%
Sys Conc - Stg 2 Conc	0.0%	0.2%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.3%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	5.1%	1.4%	Stg 1 Conc - Stg 2 Inf	0.0%	0.2%
Sys Perm - Avg Stg Perr	0.4%	1.6%	Sys Perm - Sum Stg Per	0.2%	0.1%	Sys Perm - Avg Stg Perm	-10.3%	8.1%

## Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.61	0.01	5	0.60 - 0.62					
pH	6.6	6.9	6.6	0.2	5	6.3 - 6.7	6.5	6.6	0.2	5	6.3 - 6.8
Temp	25.2	25.6	25.2	0.5	5	24.3 - 25.5	25.5	25.4	0.1	5	25.2 - 25.6
Alk	141	329	143	24	5	118 - 170	102	83	21	5	64 - 110
TDS	369	1017	368	6	5	361 - 375	205	179	29	5	152 - 216
TotHard	270	954	257	10	5	246 - 270	120	99	20	5	78 - 124
CaHard	237	858	240	8	5	230 - 250	110	94	19	5	76 - 116
Turb	0.24	1.09	0.37	0	5	0.16 - 0.88	0.05	0.07	0.01	5	0 - 0
TOC	14.3	78.6	14.1	0.7	5	13.4 - 15.0	0.7	0.6	0.1	5	0.5 - 0.7
UV254	0.427	2.475	0.425	0.023	5	0.388 - 0.447	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.99	3.15	3.02	0.19	5	2.82 - 3.28	0.68	0.79	0.07	5	0.69 - 0.87

WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.56	0.01	5	0.55 - 0.58					
pH	6.6	6.9	6.7	0.2	5	6.5 - 6.9	6.5	6.8	0.1	5	6.6 - 6.9
Temp	25.2	25.6	25.6	0.3	5	25.0 - 25.8	25.5	25.6	0.2	5	25.2 - 25.7
Alk	141	329	231	30	5	200 - 270	102	156	33	5	120 - 192
TDS	369	1017	623	41	5	575 - 664	205	286	31	5	249 - 320
TotHard	270	954	498	37	5	450 - 540	120	171	29	5	142 - 202
CaHard	237	858	462	32	5	420 - 500	110	158	32	5	134 - 194
Turb	0.24	1.09	0.98	1	5	0.31 - 2.08	0.05	0.13	0.18	5	0 - 0
TOC	14.3	78.6	32.7	1.1	5	31.4 - 34.1	0.7	0.8	0.1	5	0.7 - 0.9
UV254	0.427	2.475	1.055	0.052	5	0.995 - 1.139	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	2.99	3.15	3.22	0.12	5.00	3.09 - 3.35	0.68	0.59	0.08	5.00	0.48 - 0.67

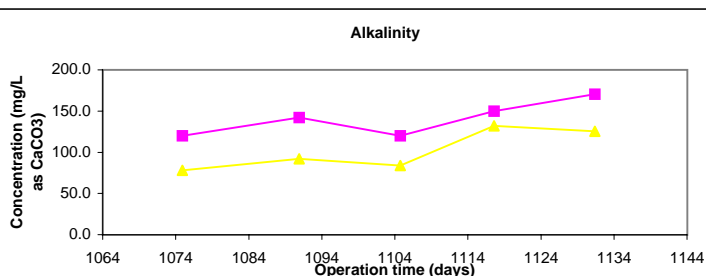
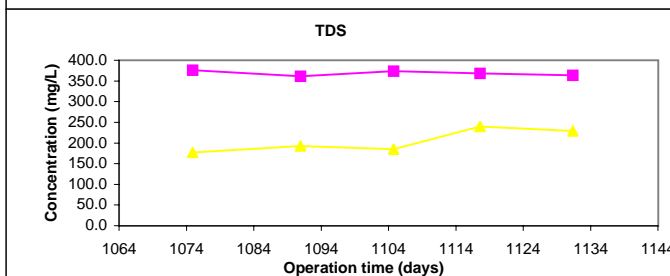
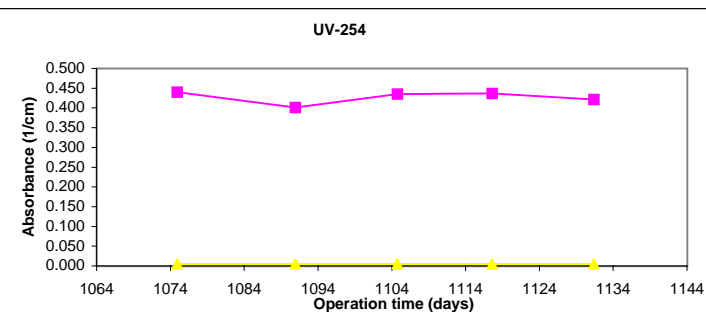
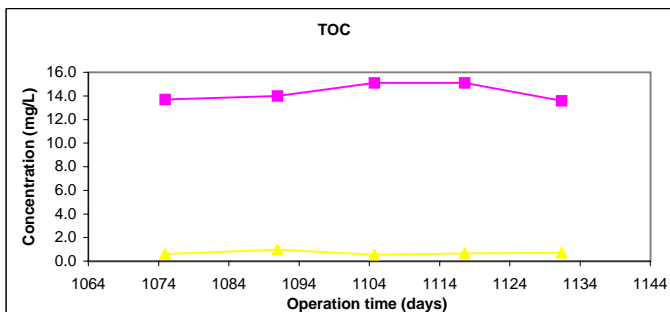
  

WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

## Water Quality Parameter Graphs

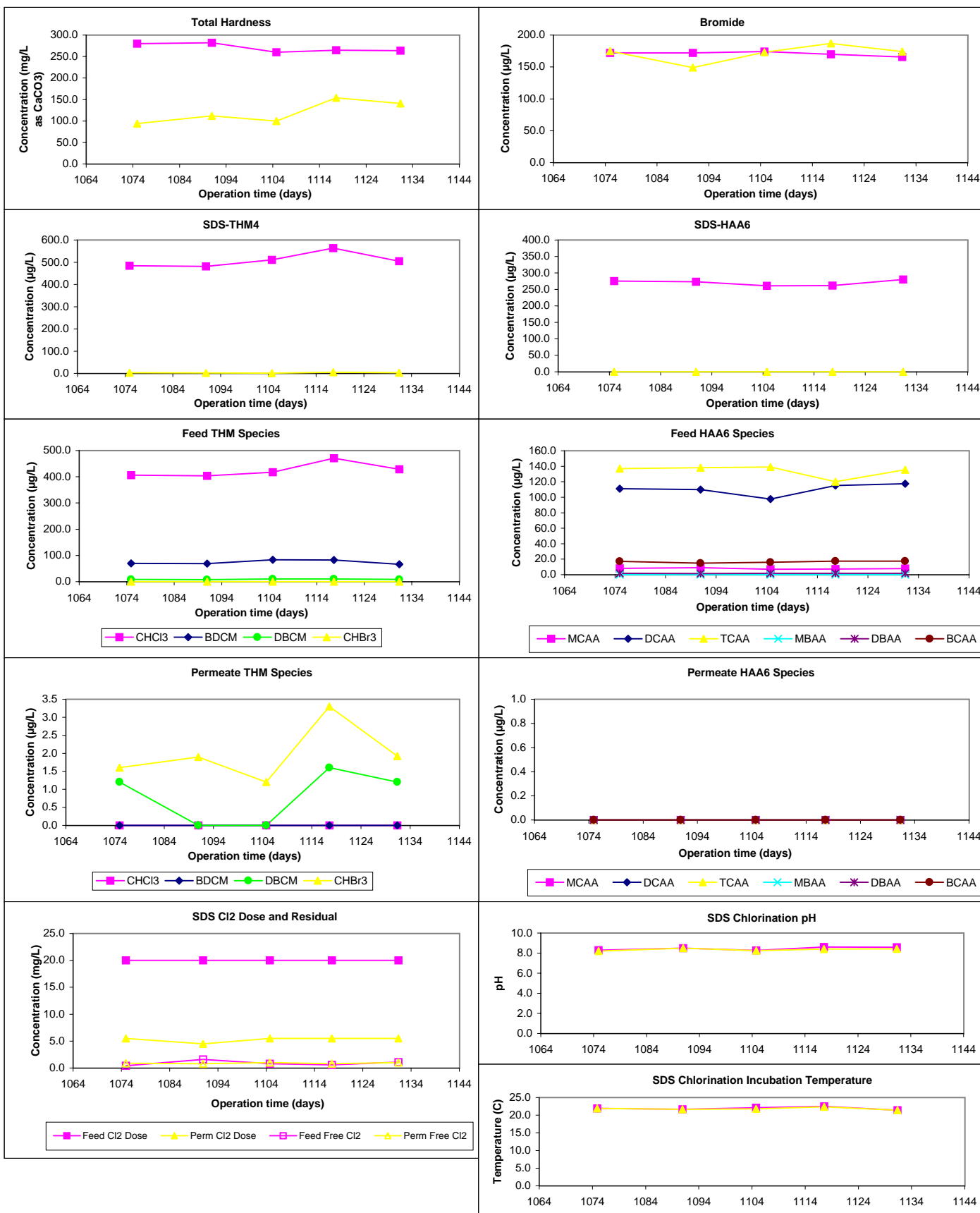
## Chart Legend:

■ Feed (System)  
▲ Permeate (System)

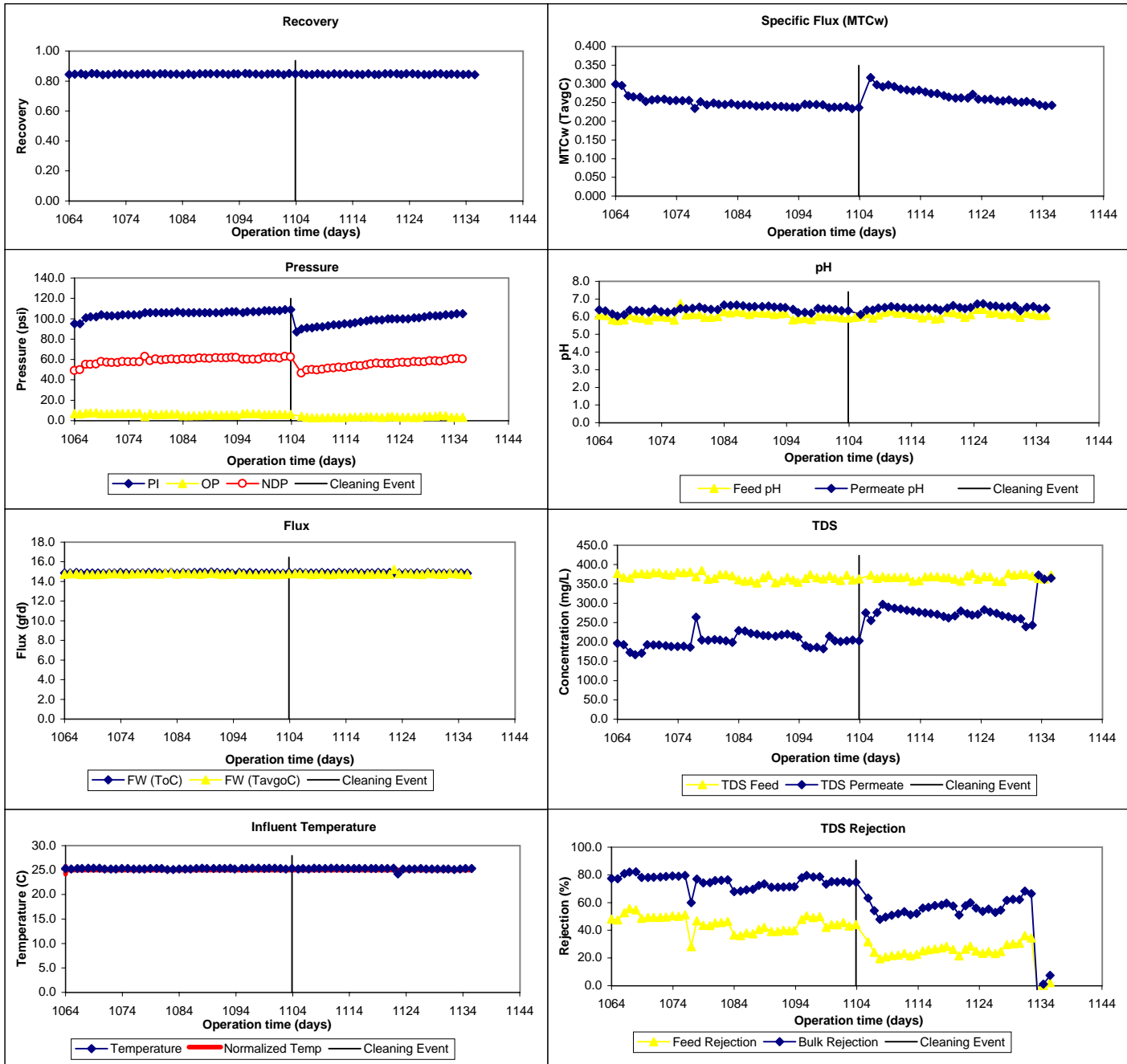




## Water Quality Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: FL4500130 / 306  
 ICR Contact: Dan Bassi  
 Phone No.: 561-338-7328  
 Period: 3/1/99 - 4/22/99 (52 days)

## Membrane Information

Manufacturer: FilmTec Corporation  
 Trade Name: FILMTEC  
 Membrane Model: NF200-4040  
 MWCO: 10 nominal Daltons  
 Element Size: 4" x 40"  
 Element Area: 80.0 ft<sup>2</sup>  
 Design Flux: 27.8 gfd  
 Mfr. NDP: 70.0 psi  
 Mfr. MTC<sub>w</sub>: 0.274 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Maximum Flow: 18.0 gpm  
 Minimum Flow: 4.0 gpm  
 Total Width: 14.0 ft  
 Feed Spacer Thickness: 0.0023 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$700

## Design Parameters

Norm Temp: 25.0 °C  
 Temp Norm MTC-w: 0.274 TavGC  
 Design Recovery: 0.85  
 Avg Sys Flux F<sub>w</sub>: 16.5 gfd  
 # of Elem in P.V.: 7  
 # Pres Ves in Stg 1: 4  
 # Pres Ves in Stg 2: 2  
 Pres Ves in Stg 3: NA  
 Design Flux: 16.5 gfd  
 Recycle Ratio: 0.00  
 Osmotic P Stage 1: 3.7 psi  
 Osmotic P Stage 2: 9.5 psi  
 Osmotic P Stage 3: NA

## Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.4	0.1	3	6.3 - 6.5	6.4	0.1	3	6.3 - 6.5	6.7	0.1	3	6.6 - 6.8
Temp	25.4	0.2	3	25.3 - 25.7	25.6	0.1	3	25.5 - 25.7	25.7	0.3	3	25.5 - 26.0
Alk	118	12	3	110 - 132	95	13	3	88 - 110	229	9	3	222 - 240
TDS	367	4	3	363 - 370	206	16	3	193 - 224	1004	54	3	944 - 1050
TotHard	263	7	3	256 - 270	115	8	3	110 - 124	1012	55	3	960 - 1070
CaHard	227	13	3	218 - 242	106	10	3	96 - 116	865	110	3	740 - 946
Turb	0.31	0.1	3	0.23 - 0.44	0.08	0.0	3	0.05 - 0.13	0.79	0.1	3	0.64 - 0.88
Amm	0.48	0.18	3	0.30 - 0.65	0.46	0.15	3	0.34 - 0.62	1.21	0.41	3	0.8 - 1.7
TOC	14.1	1.3	3	12.8 - 15.4	0.5	0.2	3	0.3 - 0.6	80.4	3.5	3	77.4 - 84.3
UV254	0.449	0.0	3	0.428 - 0.465	0.006	0.0	3	0.005 - 0.010	2.536	0.1	3	2.483 - 2.616
SUVA	3.19	0.22	3	2.94 - 3.34	1.48	0.67	3	0.71 - 1.92	3.16	0.08	3	3.10 - 3.24
Bromide	167	2	3	166 - 170	206	34	3	183 - 245				
TOX	1558	25	3	1535 - 1585	13	0	3	13 - 13				
CHCl3	425.7	39.6	3	385.0 - 464.0	0.0	0.0	3	0.0 - 0.0	Mass Balance			
BDCM	68.5	10.5	3	56.9 - 77.3	0.0	0.0	3	0.0 - 0.0	Closure Errors (%)			
DBCM	7.9	1.0	3	7.1 - 9.0	1.0	0.9	3	0.0 - 1.6	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	3	0.0 - 0.0	2.8	1.1	3	1.6 - 3.8	Alk	3	-4	8
THM4	502.1	48.2	3	449.0 - 543.1	3.8	1.9	3	1.6 - 5.1	TDS	3	-20	3
MCAA	8.8	2.9	3	6.7 - 12.1	0.0	0.0	3	0.0 - 0.0	TotHard	3	-3	9
DCAA	109.2	9.2	3	99.6 - 118.0	0.0	0.0	3	0.0 - 0.0	CaHard	3	0	6
TCAA	151.0	26.5	3	128.0 - 180.0	0.0	0.0	3	0.0 - 0.0	Turb	3	-96	58
MBAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0	Amm	3	52	37
DBAA	5.9	7.5	3	1.5 - 14.6	0.0	0.0	3	0.0 - 0.0	TOC	2	-9	7
BCAA	16.1	1.0	3	15.4 - 17.2	0.0	0.0	3	0.0 - 0.0	UV254	1	-9	n/a
TBAA	NA	NA	0	NA	NA	NA	0	NA	TDSt 51 2 7			
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
HAA5	274.9	32.5	3	252.8 - 312.1	0.0	0.0	3	0.0 - 0.0				
HAA6	291.0	32.2	3	268.2 - 327.8	0.0	0.0	3	0.0 - 0.0				
HAA9	NA	NA	0	NA	NA	NA	0	NA				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (0)	0.68	0.18	6	0.40 - 0.80	Dual Media Filtration		Silica/Garnet		Pilot-Scale			
Temp (°C)	23.6	1.1	6	22.3 - 24.8	Scale Inhibitor Addition		Calgon EL-5600 4.0 mg/l		Pilot-Scale			
pH (unit)	8.3	0.1	6	8.2 - 8.4	pH Adjustment		sulfuric acid to pH 6.0 - 6.4		Pilot-Scale			
Time (hr)	40.7	0.5	6	40.0 - 41.0	Cartridge Filtration		5 um exclusion		Pilot-Scale			

## Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-1.9%	0.9%	System Inf - Stg 1 Inf	-10.8%	1.8%
Sys Conc - Stg 2 Conc	-0.1%	0.5%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.2%	Stg 1 Conc - Stg 2 Inf	5.2%	1.8%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	-0.9%	2.3%	Sys Perm - Sum Stg Per	0.1%	0.4%	Sys Perm - Avg Stg Perm	-10.1%	0.9%

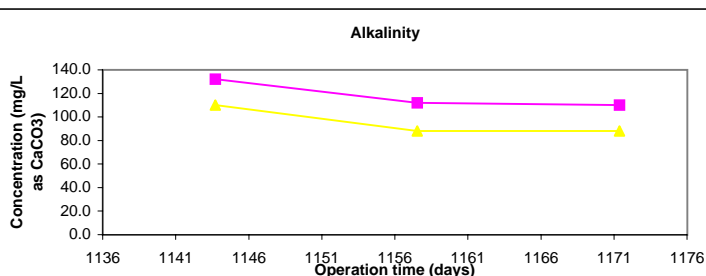
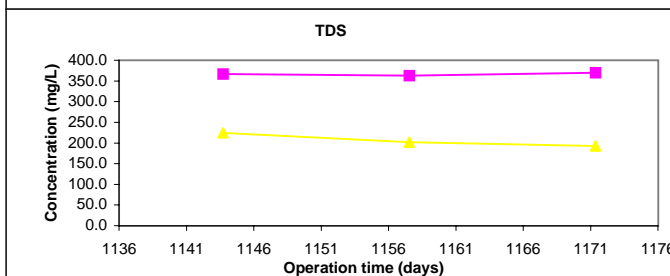
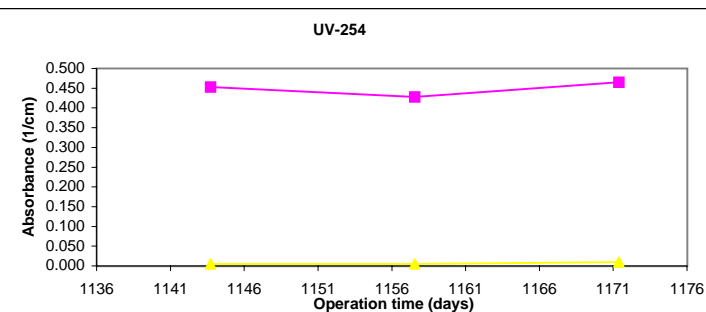
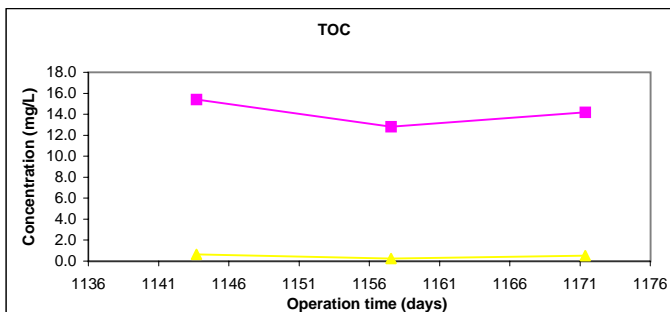
## Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.47	0.31	4	0.00 - 0.63					
pH	6.4	6.7	4.8	3.2	4	0.0 - 6.5	6.4	6.4	0.1	3	6.2 - 6.5
Temp	25.4	25.7	19.1	12.7	4	0.0 - 25.7	25.6	25.6	0.2	3	25.5 - 25.8
Alk	118	229	88	59	4	0 - 126	95	73	17	3	54 - 88
TDS	367	1004	276	184	4	0 - 369	206	190	11	3	180 - 201
TotHard	263	1012	198	134	4	0 - 298	115	99	4	3	94 - 102
CaHard	227	865	170	113	4	0 - 240	106	93	1	3	92 - 94
Turb	0.31	0.79	0.27	0	4	0.00 - 0.43	0.08	0.08	0.04	3	0 - 0
TOC	14.1	80.4	10.0	6.6	4	0.3 - 14.7	0.5	0.5	0.2	3	0.3 - 0.6
UV254	0.449	2.536	0.328	0.216	4	0.005 - 0.455	0.006	0.005	0.000	3	0.005 - 0.005
SUVA	3.19	3.16	2.92	0.80	4	1.80 - 3.58	1.48	1.12	0.59	3	0.73 - 1.80
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.42	0.28	4	0.00 - 0.56					
pH	6.4	6.7	4.9	3.3	4	0.0 - 6.7	6.4	6.7	0.1	3	6.6 - 6.8
Temp	25.4	25.7	19.3	12.9	4	0.0 - 26.0	25.6	25.6	0.2	3	25.5 - 25.8
Alk	118	229	136	91	4	0 - 192	95	136	15	3	126 - 154
TDS	367	1004	455	303	4	0 - 618	206	269	14	3	259 - 285
TotHard	263	1012	364	243	4	0 - 490	115	155	11	3	146 - 168
CaHard	227	865	328	220	4	0 - 462	106	134	9	3	124 - 141
Turb	0.31	0.79	0.34	0	4	0.00 - 0.48	0.08	0.16	0.09	3	0 - 0
TOC	14.1	80.4	24.8	16.4	4	0.3 - 33.9	0.5	0.7	0.2	3	0.6 - 0.9
UV254	0.449	2.536	0.818	0.543	4	0.005 - 1.112	0.006	0.005	0.000	3	0.005 - 0.005
SUVA	3.19	3.16	2.93	0.76	4.00	1.80 - 3.45	1.48	0.65	0.15	3.00	0.50 - 0.79
	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

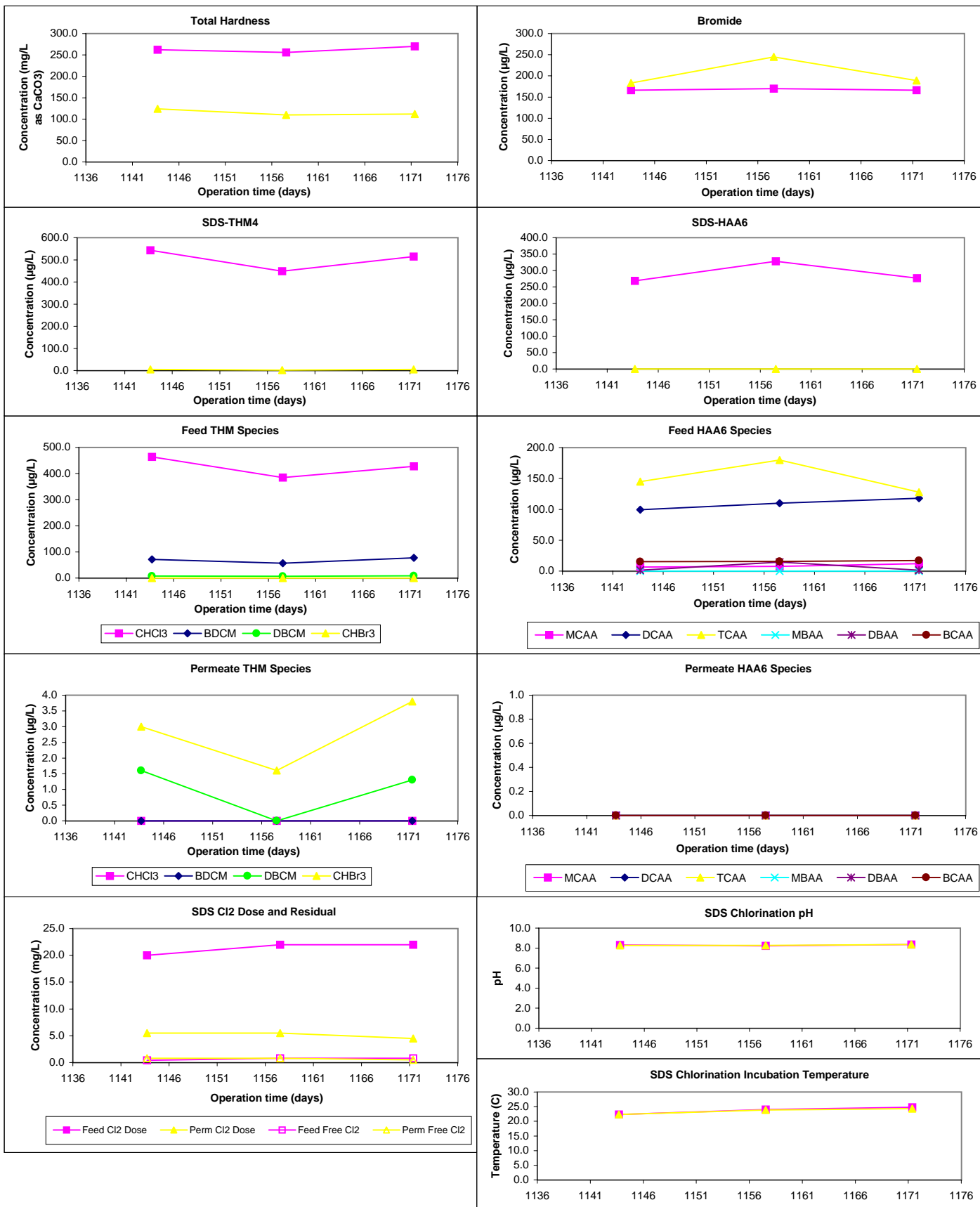
## Water Quality Parameter Graphs

## Chart Legend:

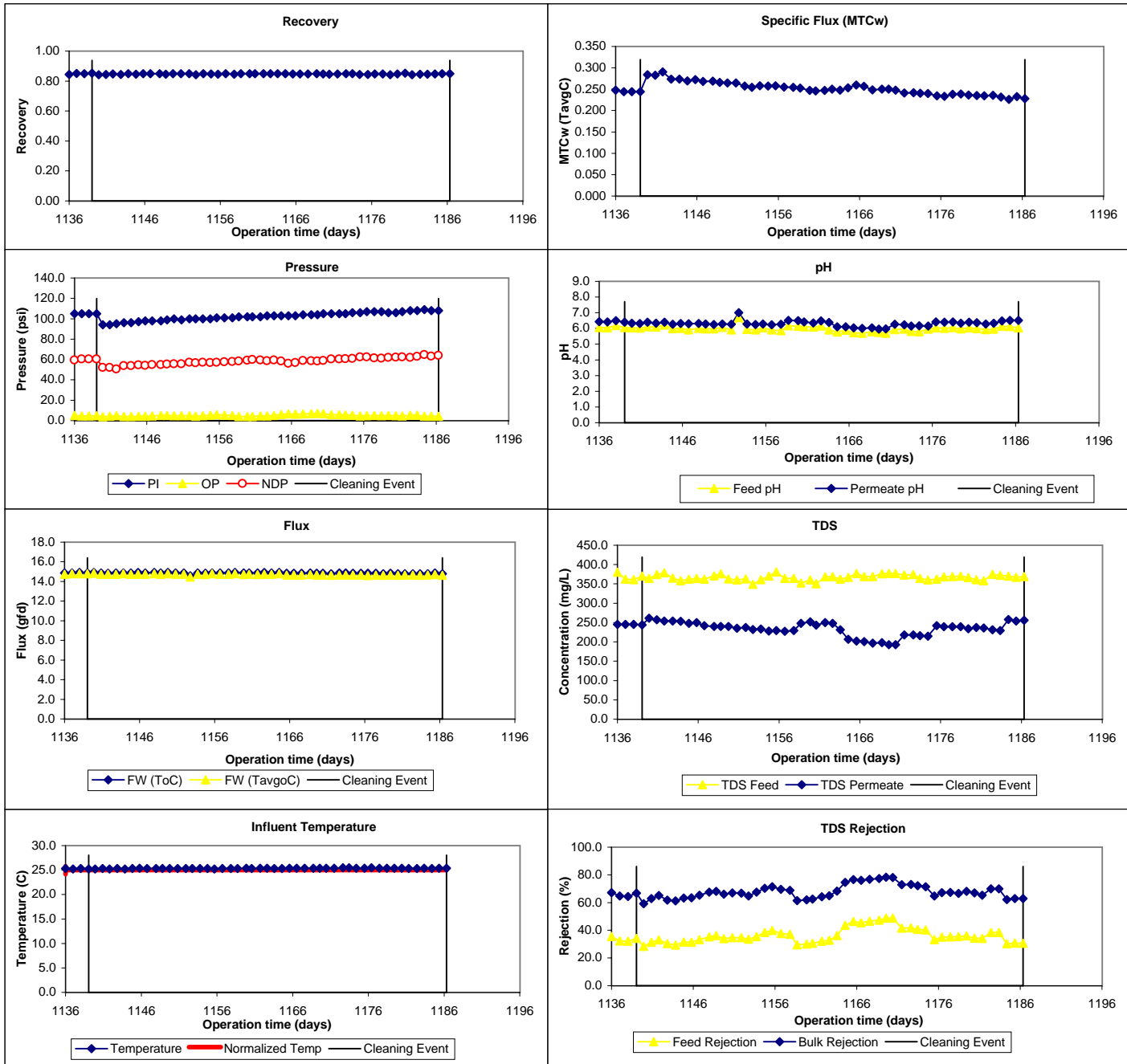
■ Feed (System)  
▲ Permeate (System)



## Water Quality Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: FL4500130 / 306  
 ICR Contact: Dan Bassi  
 Phone No.: 561-338-7328  
 Period: 3/17/98 - 5/31/98 (75 days)

## Membrane Information

Manufacturer: Hydranautics  
 Trade Name: ESNA  
 Membrane Model: 4040-UHA-ESNA  
 MWCO: 100 - 180 Daltons  
 Element Size: 4" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 30.0 gfd  
 Mfr. NDP: 71.0 psi  
 Mfr. MTC<sub>w</sub>: 0.320 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Maximum Flow: 16.0 gpm  
 Minimum Flow: 3.0 gpm  
 Total Width : 15.0 ft  
 Feed Spacer Thickness: 0.0022 ft  
 840 Element Area 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$895 / quantity discount

## Design Parameters

Norm Temp: 25.0 °C  
 Temp Norm MTC-w: 0.320 TavGC  
 Design Recovery: 0.85  
 Avg Sys Flux F<sub>w</sub>: 15.0 gfd  
 # of Elem in P.V.: 7  
 # Pres Ves in Stg 1: 4  
 # Pres Ves in Stg 2: 2  
 Pres Ves in Stg 3: NA  
 Design Flux: 15.0 gfd  
 Recycle Ratio: 0.00  
 Osmotic P Stage 1: 6.8 psi  
 Osmotic P Stage 2: 26.1 psi  
 Osmotic P Stage 3: NA

## Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.6	0.1	5	6.5 - 6.8	5.5	0.1	5	5.3 - 5.6	7.1	0.1	5	7.0 - 7.2
Temp	25.7	0.3	5	25.5 - 26.0	26.0	0.0	5	26.0 - 26.0	26.1	0.2	5	26.0 - 26.5
Alk	123	14	5	106 - 145	15	1	5	14 - 17	694	88	5	604 - 810
TDS	411	12	5	393 - 428	35	7	5	22 - 40	1866	42	5	1824 - 1930
TotHard	253	11	5	240 - 270	13	2	5	12 - 16	1396	139	5	1160 - 1520
CaHard	230	6	5	220 - 237	10	2	5	8 - 12	1302	112	5	1140 - 1400
Turb	0.48	0.2	5	0.21 - 0.60	0.05	0.0	5	0.04 - 0.06	1.18	0.3	5	1.00 - 1.78
Amm	0.48	0.29	5	0.00 - 0.77	0.15	0.09	5	0.00 - 0.21	2.08	1.39	5	0.0 - 3.9
TOC	12.4	0.5	5	11.7 - 12.9	0.3	0.0	5	0.3 - 0.3	75.5	2.3	5	73.7 - 79.4
UV254	0.445	0.0	5	0.418 - 0.470	0.005	0.0	5	0.005 - 0.005	2.626	0.0	5	2.561 - 2.665
SUVA	3.59	0.27	5	3.32 - 4.02	1.80	0.00	5	1.80 - 1.80	3.48	0.10	5	3.33 - 3.58
Bromide	183	5	5	177 - 190	31	9	5	27 - 47	Mass Balance Closure Errors (%)			
TOX	1277	654	5	118 - 1692	13	0	5	13 - 13				
CHCl3	351.6	196.6	5	3.6 - 465.0	0.2	0.4	5	0.0 - 1.0	WQP      Count      Avg      SD/RD			
BDCM	54.2	31.9	5	0.0 - 83.0	0.9	0.8	5	0.0 - 1.8				
DBCM	7.8	5.0	5	0.0 - 13.6	1.0	0.9	5	0.0 - 1.8	Alk	5	-1	10
CHBr3	0.5	0.7	5	0.0 - 1.4	1.1	1.0	5	0.0 - 2.0	TDS	5	-28	6
THM4	414.1	232.7	5	3.6 - 556.0	3.2	2.9	5	0.0 - 6.0	TotHard	5	-9	10
MCAA	9.3	8.9	5	0.0 - 19.6	2.5	5.5	5	0.0 - 12.3	CaHard	5	-7	6
DCAA	98.3	58.2	5	2.3 - 142.0	0.0	0.0	5	0.0 - 0.0	Turb	5	-202	171
TCAA	92.5	55.9	5	0.0 - 137.0	0.0	0.0	5	0.0 - 0.0	Amm	4	-9	9
MBAA	13.7	18.8	5	0.0 - 44.9	1.0	2.3	5	0.0 - 5.2	TOC	0	n/a	n/a
DBAA	1.3	1.4	5	0.0 - 3.5	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
BCAA	19.4	12.3	5	0.0 - 31.0	0.6	0.8	5	0.0 - 1.5	TDS      75      -35      6			
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	215.2	119.0	5	21.9 - 325.4	3.5	5.4	5	0.0 - 12.3				
HAA6	234.6	130.1	5	21.9 - 356.4	4.1	5.3	5	0.0 - 12.3				
HAA9	NA	NA	0	NA	NA	NA	0	NA				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (2)	0.53	0.39	10	0.00 - 1.20	Dual Media Filtration		Silica/Garnet		Pilot-Scale			
Temp (°C)	22.7	0.4	10	22.0 - 23.0	Scale Inhibitor Addition		Calgon EL-5600 4.0 mg/l		Pilot Scale			
pH (unit)	8.4	0.0	10	8.3 - 8.4	pH Adjustment		sulfuric acid to pH 6.0-6.4		Pilot Scale			
Time (hr)	38.8	5.1	10	29.0 - 42.0	Cartridge Filtration		5 um exclusion size		Pilot Scale			

## Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-4.5%	<b>16.7%</b>	System Inf - Stg 1 Inf	1.1%	2.6%
Sys Conc - Stg 2 Conc	-0.1%	0.8%	Sys Conc - Stg 2 Conc	0.6%	1.4%	Sys Conc - Stg 2 Conc	0.0%	0.3%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	7.0%	7.7%	Stg 1 Conc - Stg 2 Inf	0.0%	0.3%
Sys Perm - Avg Stg Perr	-0.3%	1.4%	Sys Perm - Sum Stg Per	-1.7%	<b>17.5%</b>	Sys Perm - Avg Stg Perm	<b>-24.7%</b>	3.7%

## Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.59	0.04	5	0.53 - 0.62					
pH	6.6	7.1	6.6	0.3	5	6.3 - 7.0	5.5	5.5	0.1	5	5.4 - 5.7
Temp	25.7	26.1	25.7	0.3	5	25.5 - 26.0	26.0	25.9	0.2	5	25.5 - 26.0
Alk	123	694	116	17	5	92 - 140	15	12	3	5	8 - 14
TDS	411	1866	414	13	5	394 - 428	35	26	4	5	19 - 30
TotHard	253	1396	271	29	5	250 - 320	13	11	2	5	10 - 14
CaHard	230	1302	243	22	5	220 - 270	10	8	2	5	6 - 10
Turb	0.48	1.18	0.35	0	5	0.22 - 0.60	0.05	0.08	0.07	5	0 - 0
TOC	12.4	75.5	13.0	0.1	5	12.9 - 13.0	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.445	2.626	0.451	0.035	5	0.410 - 0.503	0.005	0.008	0.004	5	0.005 - 0.014
SUVA	3.59	3.48	3.48	0.28	5	3.15 - 3.90	1.80	3.00	1.74	5	1.80 - 5.60

WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.54	0.04	5	0.48 - 0.57					
pH	6.6	7.1	7.0	0.2	5	6.7 - 7.2	5.5	5.9	0.1	5	5.8 - 6.1
Temp	25.7	26.1	26.0	0.1	5	26.0 - 26.2	26.0	26.0	0.0	5	26.0 - 26.0
Alk	123	694	314	89	5	244 - 470	15	22	2	5	19 - 24
TDS	411	1866	912	22	5	897 - 947	35	62	7	5	50 - 69
TotHard	253	1396	663	53	5	580 - 720	13	24	0	5	23 - 24
CaHard	230	1302	546	121	5	344 - 635	10	20	2	5	18 - 22
Turb	0.48	1.18	0.52	0	5	0.29 - 0.88	0.05	0.07	0.03	5	0 - 0
TOC	12.4	75.5	32.5	0.8	5	31.5 - 33.3	0.3	0.3	0.0	5	0.3 - 0.3
UV254	0.445	2.626	1.124	0.157	5	0.923 - 1.363	0.005	0.008	0.005	5	0.005 - 0.016
SUVA	3.59	3.48	3.45	0.45	5.00	2.89 - 4.13	1.80	3.08	2.01	5.00	1.80 - 6.40

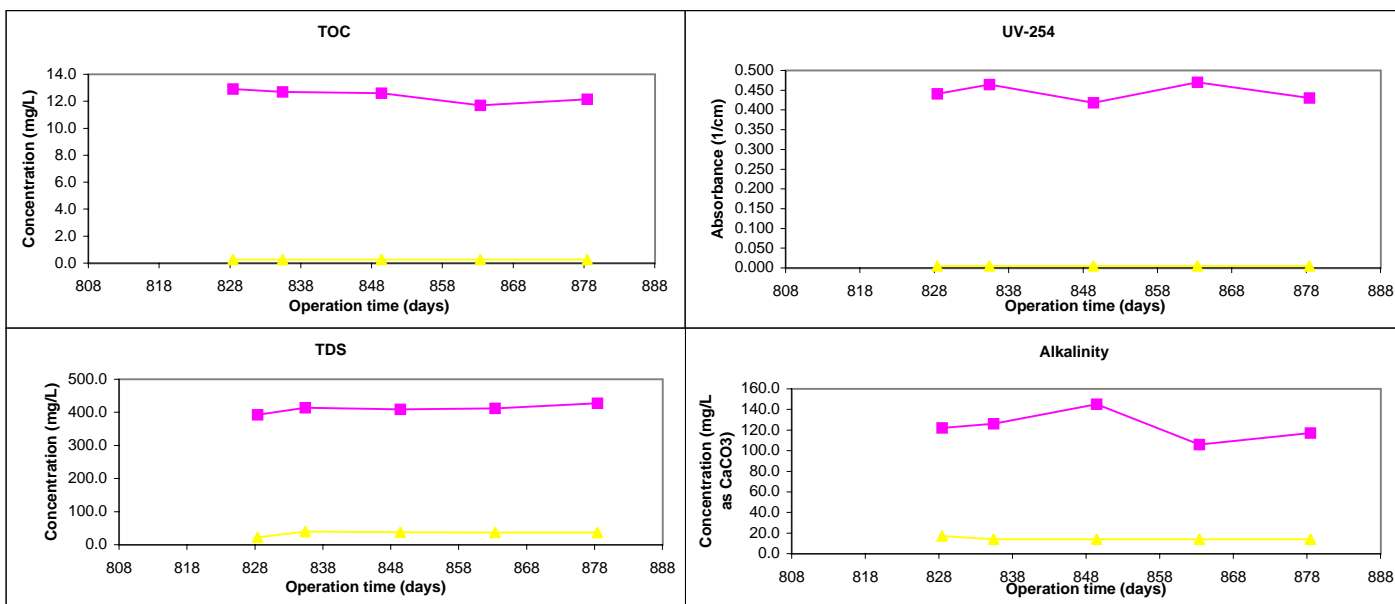
WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

This was only a two stage study.

## Chart Legend:

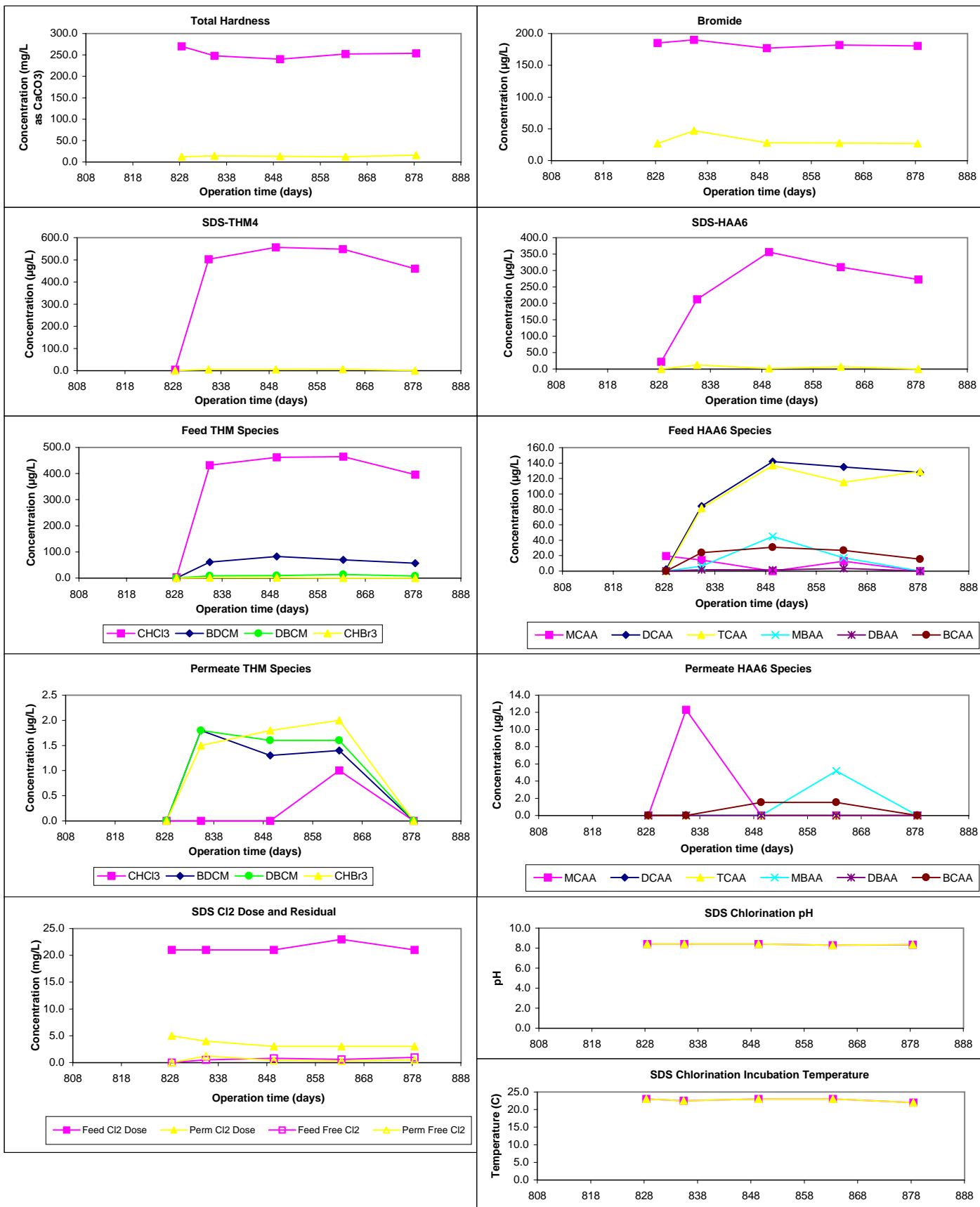
- Feed (System)
- Permeate (System)

## Water Quality Parameter Graphs

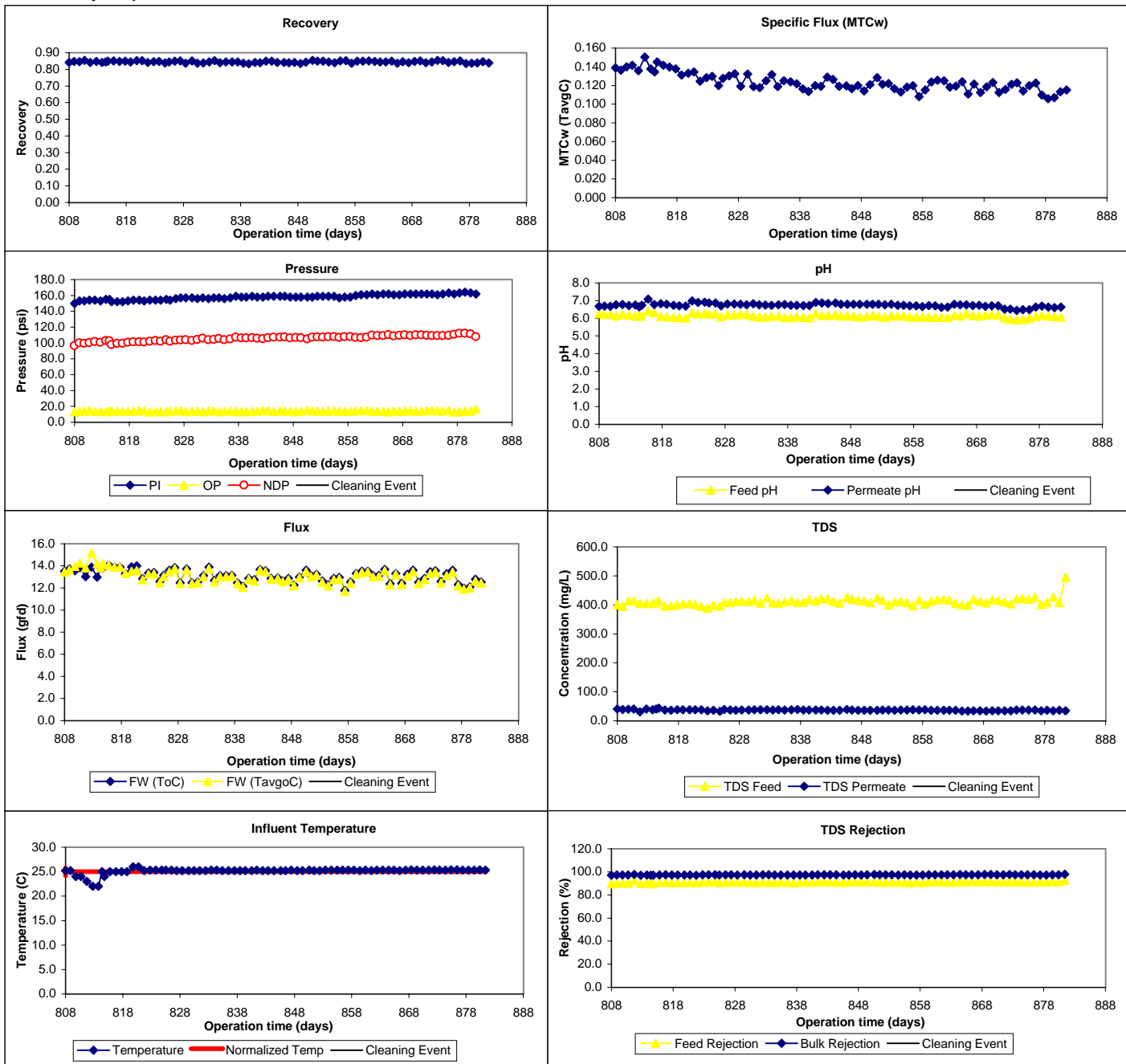




## Water Quality Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: FL4500130 / 306  
 ICR Contact: Dan Bassi  
 Phone No.: 561-338-7328  
 Period: 6/1/98 - 8/11/98 (71 days)

## Membrane Information

Manufacturer: Hydranautics  
 Trade Name: ESNA  
 Membrane Model: 4040-UHA-ESNA  
 MWCO: 100-180 Daltons  
 Element Size: 4" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 30.0 gfd  
 Mfr. NDP: 71.0 psi  
 Mfr. MTC<sub>w</sub>: 0.320 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Maximum Flow: 16.0 gpm  
 Minimum Flow: 3.0 gpm  
 Total Width: 15.0 ft  
 Feed Spacer Thickness: 0.0022 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$895/quantity discount

## Design Parameters

Norm Temp: 25.0 °C  
 Temp Norm MTC-w: 0.320 TavGC  
 Design Recovery: 0.85  
 Avg Sys Flux F<sub>w</sub>: 15.0 gfd  
 # of Elem in P.V.: 7  
 # Pres Ves in Stg 1: 4  
 # Pres Ves in Stg 2: 2  
 Pres Ves in Stg 3: NA  
 Design Flux: 15.0 gfd  
 Recycle Ratio: 0.00  
 Osmotic P Stage 1: 5.7 psi  
 Osmotic P Stage 2: 20.2 psi  
 Osmotic P Stage 3: NA

## Water Quality Summary

Feed (System)					Permeate (System)				Concentrate (System)			
Summary	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.2	0.1	5	6.0 - 6.4	5.4	0.1	5	5.3 - 5.6	6.7	0.1	5	6.6 - 6.9
Temp	26.0	0.0	5	26.0 - 26.0	26.0	0.0	5	26.0 - 26.0	26.5	0.1	5	26.3 - 26.5
Alk	86	14	5	73 - 110	15	1	5	14 - 16	405	63	5	335 - 500
TDS	394	36	5	345 - 427	37	5	5	33 - 44	1638	138	5	1465 - 1835
TotHard	261	11	5	252 - 280	16	2	5	14 - 18	1429	76	5	1370 - 1560
CaHard	237	10	5	230 - 250	13	3	5	8 - 16	1292	76	5	1180 - 1360
Turb	0.44	0.7	5	0.11 - 1.62	0.06	0.0	5	0.03 - 0.08	1.99	1.0	5	0.71 - 3.34
Amm	0.54	0.07	5	0.47 - 0.65	0.17	0.02	5	0.15 - 0.21	2.30	0.32	5	1.9 - 2.8
TOC	13.3	0.7	5	12.4 - 14.3	0.5	0.4	5	0.3 - 1.2	77.2	2.2	5	74.3 - 79.7
UV254	0.422	0.0	5	0.395 - 0.464	0.005	0.0	5	0.005 - 0.009	2.504	0.2	5	2.274 - 2.628
SUVA	3.18	0.25	5	2.85 - 3.43	1.69	1.23	5	0.37 - 3.60	3.24	0.16	5	2.99 - 3.42
Bromide	183	9	5	172 - 196	33	6	5	28 - 44	Mass Balance Closure Errors (%)			
TOX	1523	139	5	1355 - 1725	13	0	5	13 - 13				
CHCl3	454.0	14.6	5	436.0 - 470.0	0.0	0.0	5	0.0 - 0.0	WQP	Count	Avg	SD/RD
BDCM	63.5	11.0	5	47.9 - 76.3	0.4	0.5	5	0.0 - 1.0	Alk	5	8	49
DBCM	8.9	0.5	5	8.3 - 9.6	0.9	0.5	5	0.0 - 1.4	TDS	5	-11	62
CHBr3	0.0	0.0	5	0.0 - 0.0	0.8	0.7	5	0.0 - 1.5	TotHard	5	11	50
THM4	526.5	19.0	5	501.7 - 555.1	2.1	1.3	5	0.0 - 3.6	CaHard	5	13	49
MCAA	5.9	6.9	5	0.0 - 13.7	0.0	0.0	5	0.0 - 0.0	Turb	5	15	120
DCAA	147.4	25.9	5	124.0 - 189.0	0.0	0.0	5	0.0 - 0.0	Amm	5	14	44
TCAA	157.9	52.6	5	114.0 - 234.5	0.3	0.6	5	0.0 - 1.4	TOC	3	27	62
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	UV254	1	-2	n/a
DBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	TDS <sub>t</sub>	70	-35	13
BCAA	20.0	1.4	5	18.5 - 21.8	0.0	0.0	5	0.0 - 0.0	Comments:			
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	311.2	72.6	5	251.7 - 393.0	0.3	0.6	5	0.0 - 1.4				
HAA6	331.2	73.8	5	270.2 - 413.9	0.3	0.6	5	0.0 - 1.4				
HAA9	NA	NA	0	NA	NA	NA	0	NA				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description					Scale
Res (0)	0.68	0.25	10	0.40 - 1.00	Dual Media Filtration		Silica/Garnet					Pilot-Scale
Temp (°C)	21.4	0.6	10	21.0 - 22.2	Scale Inhibitor Addition		Calgon EL-5600 4.0 mg/l					Pilot-Scale
pH (unit)	8.3	0.1	10	8.3 - 8.4	pH Adjustment		sulfuric acid to pH 6.0 - 6.4					Pilot-Scale
Time (hr)	40.8	0.4	10	40.0 - 41.0	Cartridge Filtration		5 um exclusion size					Pilot-Scale

## Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-2.7%	3.5%	System Inf - Stg 1 Inf	-0.7%	8.0%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.4%	2.4%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	7.2%	8.2%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perr	-0.1%	1.2%	Sys Perm - Sum Stg Per	0.3%	0.7%	Sys Perm - Avg Stg Perm	-22.1%	2.1%

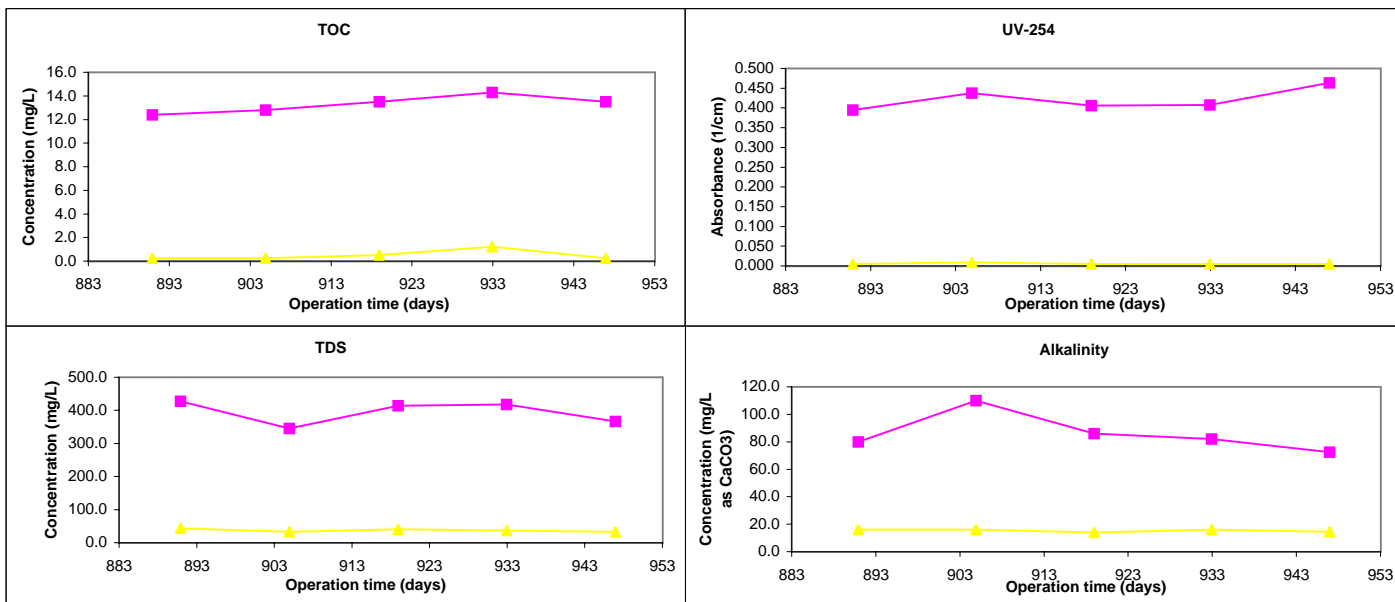
## Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			<b>0.58</b>	<b>0.02</b>	<b>5</b>	<b>0.56 - 0.62</b>					
pH	6.2	6.7	6.2	0.1	5	6.0 - 6.4	5.4	5.4	0.1	5	5.3 - 5.5
Temp	26.0	26.5	26.0	0.0	5	26.0 - 26.0	26.0	26.2	0.4	5	26.0 - 27.0
Alk	86	405	93	10	5	80 - 100	15	14	1	5	12 - 14
<b>TDS</b>	<b>394</b>	<b>1638</b>	405	<b>25</b>	<b>5</b>	<b>368 - 429</b>	<b>37</b>	<b>29</b>	<b>3</b>	<b>5</b>	<b>26 - 33</b>
TotHard	261	1429	270	19	5	250 - 300	16	13	2	5	11 - 14
CaHard	237	1292	241	12	5	230 - 260	13	10	2	5	8 - 12
Turb	0.44	1.99	0.51	1	5	0.14 - 1.90	0.06	0.05	0.01	5	0 - 0
<b>TOC</b>	<b>13.3</b>	<b>77.2</b>	13.7	<b>1.4</b>	<b>5</b>	<b>12.6 - 16.1</b>	<b>0.5</b>	<b>0.7</b>	<b>0.4</b>	<b>5</b>	<b>0.3 - 1.3</b>
UV254	0.422	<b>2.504</b>	<b>0.421</b>	0.030	5	0.377 - 0.458	0.005	0.007	0.003	5	0.005 - 0.012
SUVA	3.18	<b>3.24</b>	<b>3.08</b>	0.18	5	2.84 - 3.29	1.69	1.39	1.33	5	0.34 - 3.60
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			<b>0.52</b>	<b>0.04</b>	<b>5</b>	<b>0.49 - 0.58</b>					
pH	6.2	6.7	6.4	0.1	5	6.2 - 6.6	5.4	5.7	0.1	5	5.5 - 5.8
Temp	26.0	26.5	26.1	0.2	5	26.0 - 26.5	26.0	26.1	0.2	5	26.0 - 26.5
Alk	86	405	204	49	5	155 - 280	15	21	1	5	20 - 22
<b>TDS</b>	<b>394</b>	<b>1638</b>	861	<b>58</b>	<b>5</b>	<b>781 - 907</b>	<b>37</b>	<b>61</b>	<b>8</b>	<b>5</b>	<b>52 - 71</b>
TotHard	261	1429	638	42	5	590 - 700	16	24	2	5	22 - 27
CaHard	237	1292	558	31	5	530 - 610	13	19	2	5	17 - 22
Turb	0.44	1.99	1.10	1	5	0.28 - 2.64	0.06	0.05	0.01	5	0 - 0
<b>TOC</b>	<b>13.3</b>	<b>77.2</b>	31.7	<b>1.1</b>	<b>5</b>	<b>30.0 - 32.7</b>	<b>0.5</b>	<b>0.6</b>	<b>0.4</b>	<b>5</b>	<b>0.3 - 1.1</b>
UV254	0.422	<b>2.504</b>	1.080	0.114	5	0.976 - 1.225	0.005	0.005	0.000	5	0.005 - 0.005
SUVA	3.18	<b>3.24</b>	<b>3.40</b>	0.27	5.00	3.10 - 3.77	1.69	1.06	0.69	5.00	0.40 - 1.80
	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
<b>TDS</b>											
TotHard											
CaHard											
Turb											
<b>TOC</b>											
UV254											
SUVA											

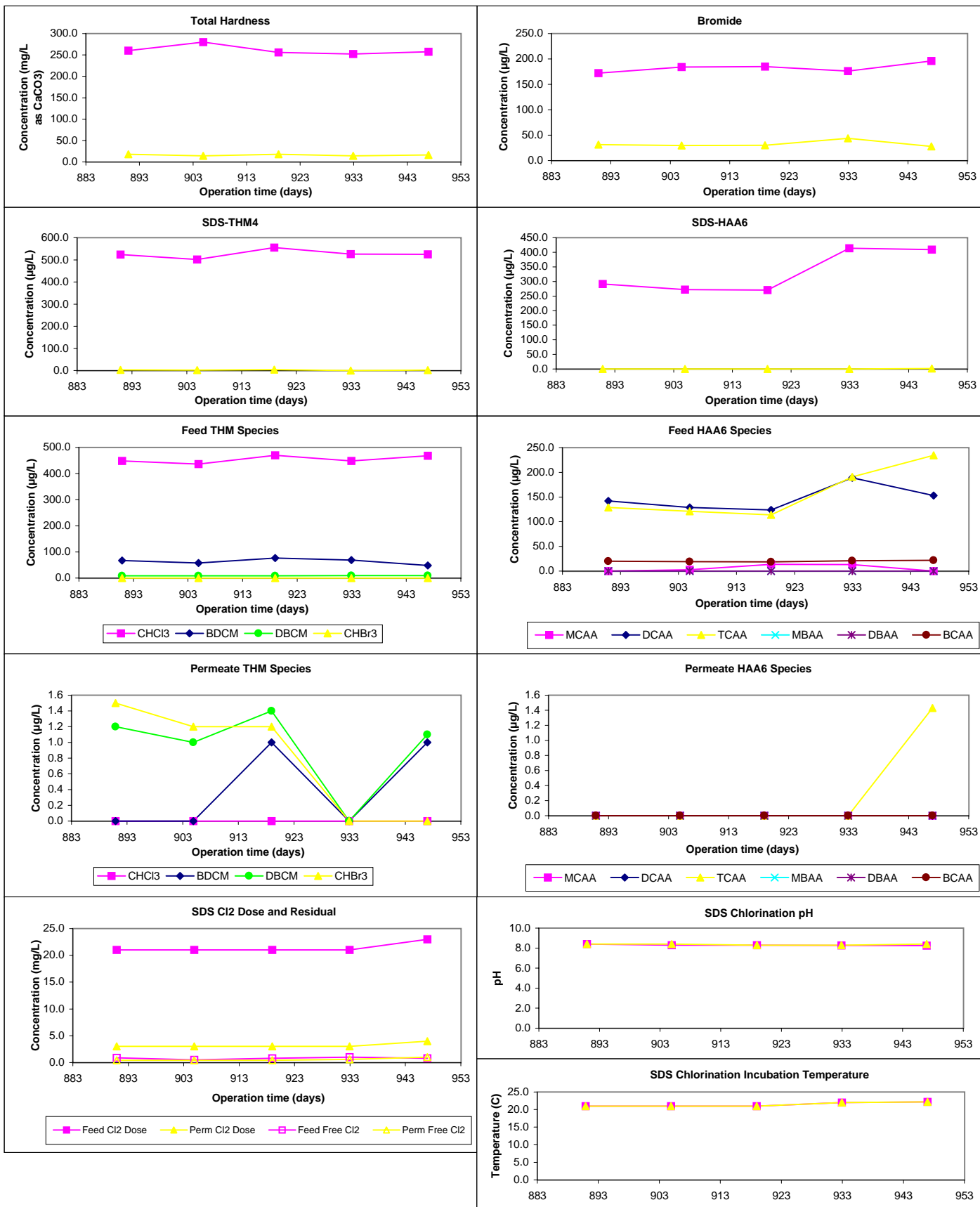
## Water Quality Parameter Graphs

## Chart Legend:

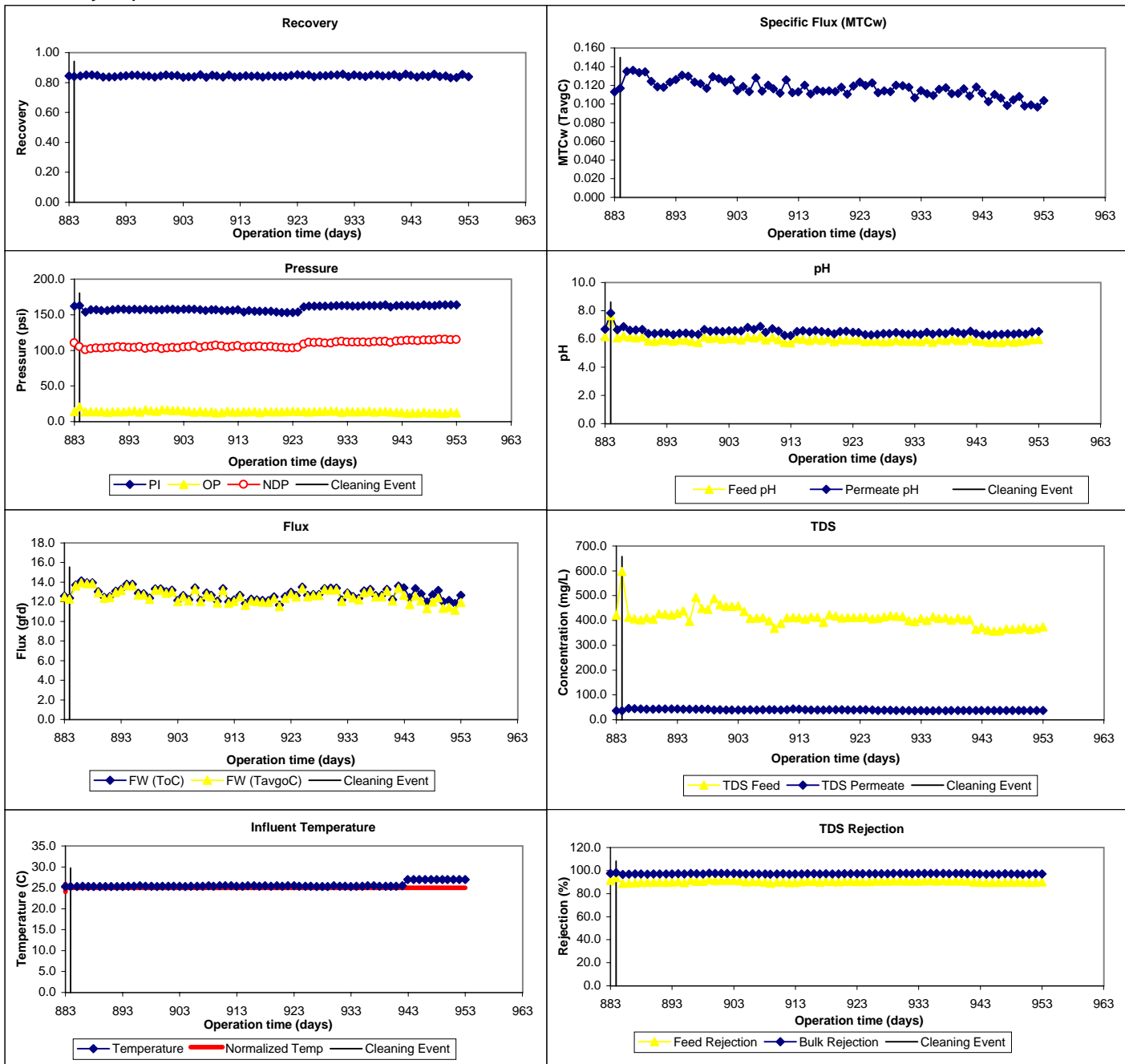
- Feed (System)
- ▲ Permeate (System)



## Water Quality Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: FL4500130 / 306  
 ICR Contact: Dan Bassi  
 Phone No.: 561-338-7328  
 Period: 8/12/98 - 9/15/98 (34 days)

## Membrane Information

Manufacturer: Hydranautics  
 Trade Name: ESNA  
 Membrane Model: 4040-UHA-ESNA  
 MWCO: 100-180 Daltons  
 Element Size: 4" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 30.0 gfd  
 Mfr. NDP: 71.0 psi  
 Mfr. MTC<sub>w</sub>: 0.320 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Maximum Flow: 16.0 gpm  
 Minimum Flow: 3.0 gpm  
 Total Width: 15.0 ft  
 Feed Spacer Thickness: 0.0022 ft  
 840 Element Area 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$895 / quantity discount

## Design Parameters

Norm Temp: 25.0 °C  
 Temp Norm MTC-w: 0.320 TavGC  
 Design Recovery: 0.85  
 Avg Sys Flux F<sub>w</sub>: 15.0 gfd  
 # of Elem in P.V.: 7  
 # Pres Ves in Stg 1: 4  
 # Pres Ves in Stg 2: 2  
 Pres Ves in Stg 3: NA  
 Design Flux: 15.0 gfd  
 Recycle Ratio: 0.00  
 Osmotic P Stage 1: 6.8 psi  
 Osmotic P Stage 2: 26.1 psi  
 Osmotic P Stage 3: NA

## Water Quality Summary

Feed (System)					Permeate (System)				Concentrate (System)			
Summary	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	5.9	0.3	3	5.7 - 6.2	5.4	0.2	3	5.2 - 5.5	6.2	0.4	3	6.0 - 6.6
Temp	26.0	0.2	3	25.8 - 26.2	26.0	0.0	3	26.0 - 26.0	26.4	0.2	3	26.2 - 26.5
Alk	41	19	3	24 - 62	13	1	3	12 - 14	182	110	3	78 - 298
TDS	375	9	3	367 - 384	36	1	3	34 - 37	1495	15	3	1481 - 1510
TotHard	251	8	3	244 - 260	19	1	3	18 - 20	1313	95	3	1240 - 1420
CaHard	233	8	3	224 - 240	13	1	3	12 - 14	1157	166	3	980 - 1310
Turb	0.33	0.4	3	0.10 - 0.75	0.05	0.0	3	0.05 - 0.06	2.88	4.4	3	0.35 - 7.94
Amm	0.49	0.02	3	0.47 - 0.51	0.14	0.01	3	0.13 - 0.14	2.25	0.01	3	2.2 - 2.3
TOC	12.5	1.5	3	11.3 - 14.1	0.3	0.0	3	0.3 - 0.3	72.9	5.4	3	66.7 - 76.6
UV254	0.435	0.0	3	0.431 - 0.442	0.005	0.0	3	0.005 - 0.005	2.511	0.0	3	2.495 - 2.527
SUVA	3.52	0.42	3	3.07 - 3.91	1.80	0.00	3	1.80 - 1.80	3.46	0.29	3	3.28 - 3.79
Bromide	180	5	3	176 - 185	33	4	3	30 - 37				
TOX	1448	169	3	1255 - 1565	13	0	3	13 - 13				
CHCl3	435.3	52.9	3	399.0 - 496.0	0.0	0.0	3	0.0 - 0.0	Mass Balance Closure Errors (%)			
BDCM	70.5	0.4	3	70.1 - 70.9	0.4	0.6	3	0.0 - 1.1				
DBCM	10.0	1.2	3	9.1 - 11.3	1.4	0.2	3	1.2 - 1.6	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	3	0.0 - 0.0	0.8	0.7	3	0.0 - 1.2	Alk	3	-2	9
THM4	515.8	52.3	3	478.6 - 575.6	2.5	1.3	3	1.3 - 3.9	TDS	3	-45	10
MCAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0	TotHard	3	-13	7
DCAA	178.3	35.0	3	138.0 - 200.0	0.0	0.0	3	0.0 - 0.0	CaHard	3	-21	7
TCAA	185.3	34.1	3	153.0 - 221.0	2.0	0.6	3	1.3 - 2.4	Turb	3	-354	691
MBAA	0.4	0.8	3	0.0 - 1.3	0.7	1.2	3	0.0 - 2.0	Amm	3	-6	7
DBAA	0.5	0.8	3	0.0 - 1.4	0.0	0.0	3	0.0 - 0.0	TOC	0	n/a	n/a
BCAA	19.5	6.5	3	13.6 - 26.4	0.0	0.0	3	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	NA	NA	0	NA	NA	NA	0	NA	TDS <sub>t</sub> 34 -21 6			
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA	Comments:			
HAA5	364.6	67.1	3	291.0 - 422.4	2.6	1.6	3	1.3 - 4.4				
HAA6	384.1	66.2	3	309.5 - 436.0	2.6	1.6	3	1.3 - 4.4				
HAA9	NA	NA	0	NA	NA	NA	0	NA				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (0)	0.52	0.13	6	0.40 - 0.70	Dual Media Filtration		Silica/Garnet		Pilot Scale			
Temp (°C)	21.9	0.2	6	21.7 - 22.2	Scale Inhibitor Addition		Calgon EL-5600 4.0 mg/l		Pilot Scale			
pH (unit)	8.3	0.1	6	8.2 - 8.4	pH Adjustment		Sulfuric Acid to pH 6.0-6.4		Pilot Scale			
Time (hr)	41.3	0.5	6	41.0 - 42.0	Cartridge Filtration		5um exclusion size		Pilot Scale			

## Mass Balance Errors

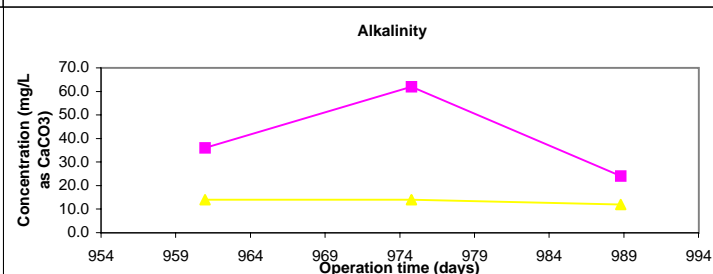
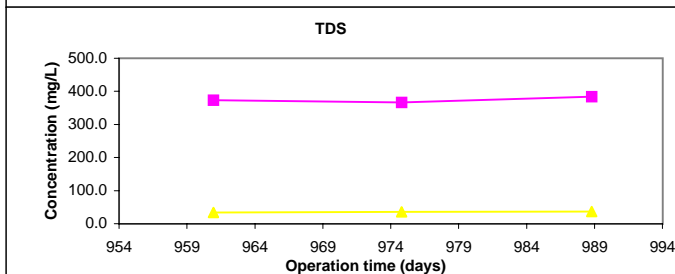
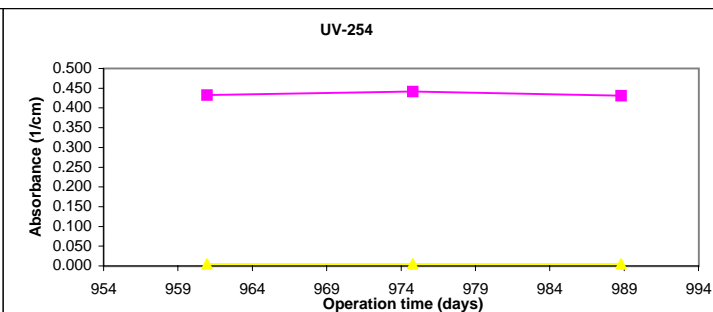
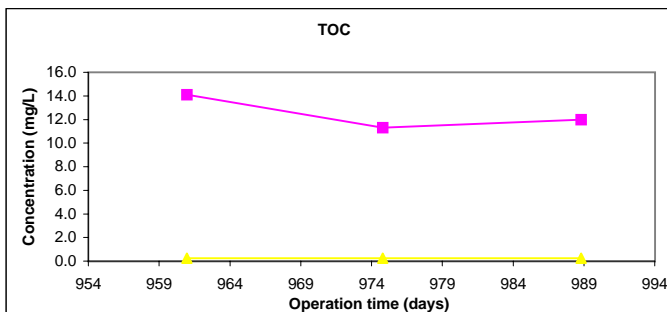
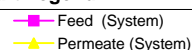
Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-5.5%	4.8%	System Inf - Stg 1 Inf	-10.9%	1.3%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	1.5%	6.3%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	14.0%	10.7%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perm	-0.1%	1.8%	Sys Perm - Sum Stg Per	0.3%	0.4%	Sys Perm - Avg Stg Perm	-19.6%	1.6%

## Stage Summary

	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.44	0.30	4	0.00 - 0.64					
pH	5.9	6.2	4.4	2.9	4	0.0 - 6.2	5.4	5.5	0.1	3	5.4 - 5.5
Temp	26.0	26.4	19.5	13.0	4	0.0 - 26.2	26.0	26.0	0.0	3	26.0 - 26.0
Alk	41	182	30	25	4	0 - 60	13	13	1	3	12 - 14
TDS	375	1495	280	187	4	0 - 383	36	25	6	3	19 - 29
TotHard	251	1313	195	130	4	0 - 270	19	15	1	3	14 - 16
CaHard	233	1157	181	121	4	0 - 260	13	11	1	3	10 - 12
Turb	0.33	2.88	0.09	0	4	0.00 - 0.14	0.05	0.05	0.01	3	0 - 0
TOC	12.5	72.9	9.0	5.9	4	0.3 - 12.2	0.3	0.4	0.2	3	0.3 - 0.6
UV254	0.435	2.511	0.326	0.215	4	0.005 - 0.441	0.005	0.005	0.000	3	0.005 - 0.005
SUVA	3.52	3.46	3.18	0.92	4	1.80 - 3.77	1.80	1.47	0.57	3	0.82 - 1.80
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.42	0.29	4	0.00 - 0.63					
pH	5.9	6.2	4.5	3.0	4	0.0 - 6.3	5.4	5.6	0.1	3	5.5 - 5.7
Temp	26.0	26.4	19.6	13.1	4	0.0 - 26.2	26.0	26.1	0.1	3	26.0 - 26.2
Alk	41	182	58	51	4	0 - 116	13	18	2	3	16 - 20
TDS	375	1495	587	391	4	0 - 785	36	54	2	3	53 - 56
TotHard	251	1313	460	307	4	0 - 620	19	23	1	3	22 - 24
CaHard	233	1157	400	267	4	0 - 560	13	19	1	3	18 - 20
Turb	0.33	2.88	0.25	0	4	0.00 - 0.54	0.05	0.06	0.01	3	0 - 0
TOC	12.5	72.9	21.3	14.1	4	0.3 - 29.1	0.3	0.5	0.2	3	0.3 - 0.6
UV254	0.435	2.511	0.765	0.507	4	0.005 - 1.040	0.005	0.005	0.000	3	0.005 - 0.005
SUVA	3.52	3.46	3.15	0.91	4.00	1.80 - 3.77	1.80	1.12	0.59	3.00	0.76 - 1.80
	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

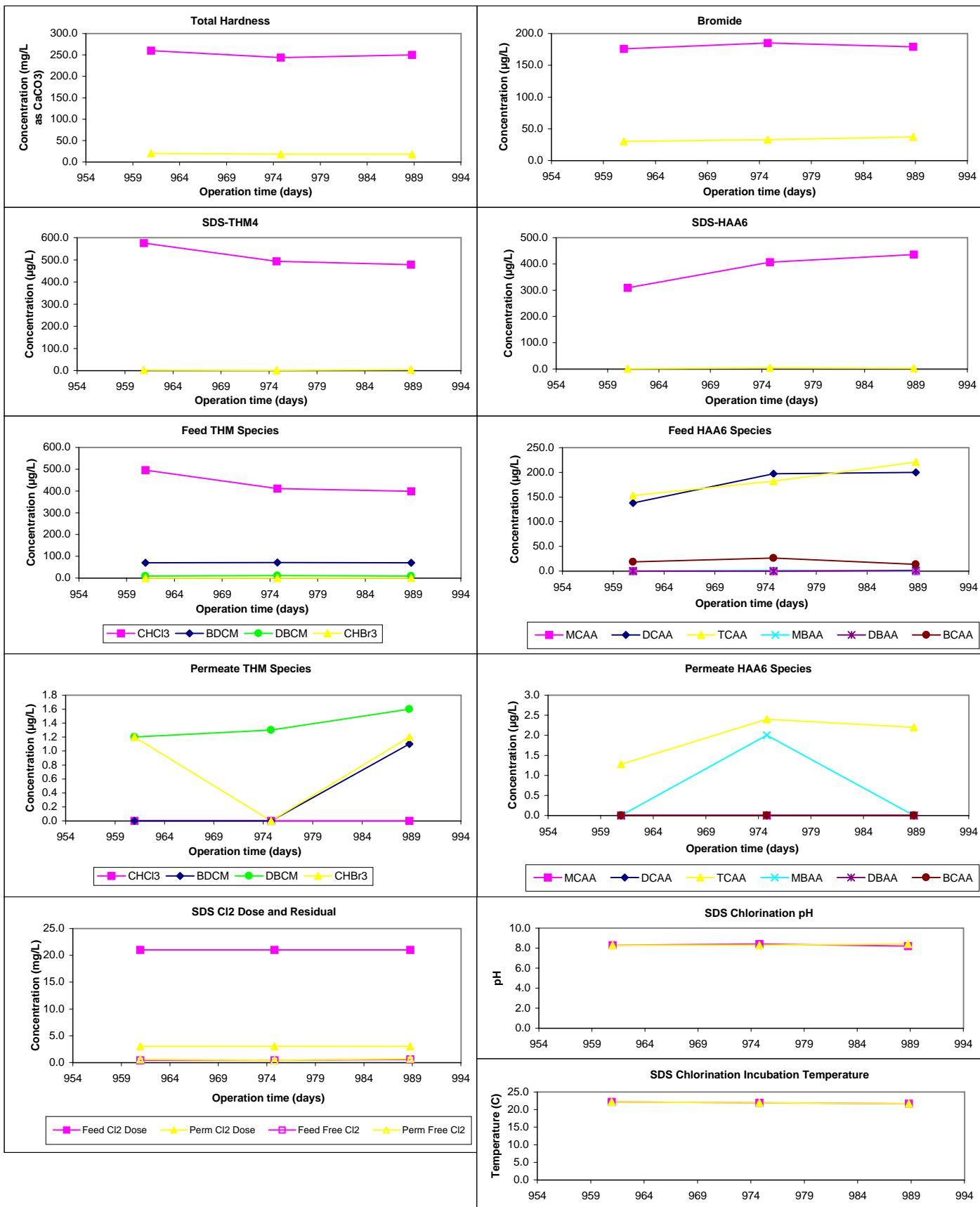
## Water Quality Parameter Graphs

## Chart Legend:





## Water Quality Graphs (Continued)



## Productivity Graphs

