

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	1048
Study Protocol	Membrane LTSEBST treatment study
Plant ICR Number	384
PWS Name	Kansas City Board of Public Utilities
City, State, Zip	Kansas City, KS 66102

General Comments:

1. During this long-term, single-element membrane study one membrane, the Fluid Systems TFC-2540 HR, was evaluated over a one year period. The membrane was operated at a recovery of 75% and a flux rate of 10 gfd.
2. A list of study observations is included on page 19 of the Summary Report. This list contains significant operational events that should be considered during data analysis and interpretation.
3. The influent to the study was collected after sedimentation and prior to the addition of chlorine/chlorine dioxide. Pilot scale media-filtration, UV disinfection, cartridge filtration and scale control served as additional pretreatment prior to nanofiltration.
4. The Kansas City BPU is interested in nanofiltration as a process capable of softening as well as reducing distribution system DBP concentrations. The high fouling observed during this study would limit the feasibility of implementing nanofiltration under the pretreatment conditions investigated. However, the utility is in the process of switching from a river intake to a horizontal collector well. This should result in a water with lower pretreatment requirements and longer cleaning intervals. In the Summary Report, the utility indicated that they plan to continue testing nanofiltration on this new source.

Water Quality Comments:

1. 16 water quality outliers were removed from this study.
2. There was some variability in SDS conditions over the course of the study: the pH varied from 6.0 to 8.4; the incubation time varied from 48 to 50 hours; temperature varied from 15 to 32 °C and residual ranged from 0.2 to 1.6 mg/L. SDS-DBP data must be evaluated in light of these changing conditions.

Productivity Comments:

1. 17 productivity outliers were removed from this study.
2. Due to several operational problems that lead to severe fouling events, the first six operational cycles (which were relatively short), were not included in the period of stable performance used to estimate overall productivity. The operational log on page 19 of the report highlight these problems.
3. The productivity analysis conducted by the consultant yielded an average cleaning interval of 28 days which is comparable to the cleaning interval of 24 days generated during the EPA analysis.

ICR Information

ID / ICR#: KS2020906 / 384
 ICR Contact: Mr. Ray Northcutt
 Phone No.: (913) 573-9348
 Period: 4/14/98 - 6/30/98 (77 days)

Membrane Information

Manufacturer: Fluid Systems Mfr. MTC_w: 0.139 (gfd/psi)
 Trade Name: Thin Film Composite Mfr. Temp: 25.0 °C
 Membrane Model: 2540 HR Max Flow: 4.0 gpm
 MWCO: 200-250 Daltons Min Flow: 2.6 gpm
 Element Size: 2.5" x 40" Total Width: 3.0 ft
 Element Area: 27.0 ft² Feed Sp Thickness: 0.0026 ft
 Design Flux: 27.8 gfd 840 Element Area: 365.0 ft²
 Mfr. NDP: 200.0 psi 840 Purchase Price: \$650

Design Parameters

Norm Temp: 17.0 °C Recycle Ratio: 5.20
 Temp Norm MTC-w: 0.110 TavGC Manuf rep Re_{JTDS}: 99%
 Design Recovery: 0.75 TDS_F: 490.0 mg/L
 Design Flux: 10.0 gfd

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	7.0	0.2	5	6.9 - 7.3	6.0	0.2	5	5.8 - 6.2	7.5	0.3	5	7.1 - 7.9
Temp	23.6	4.2	5	20.0 - 30.0	23.4	3.8	5	20.0 - 29.0	23.2	3.4	5	20.0 - 28.0
Alk	134	19	4	110 - 155	8	6	4	0 - 14	426	133	4	260 - 555
TDS	467	58	5	396 - 534	39	33	5	12 - 92	1990	1315	5	1051 - 4309
TotHard	294	65	5	225 - 398	5	7	5	0 - 15	1053	369	5	568 - 1600
CaHard	190	38	5	147 - 250	3	4	5	0 - 10	677	230	5	362 - 999
Turb	0.34	0.22	5	0.18 - 0.71	0.10	0.05	5	0.05 - 0.16	1.18	1.52	5	0.24 - 3.86
Amm	0.0	0.1	5	0.0 - 0.1	0.0	0.0	5	0.0 - 0.1	0.1	0.1	5	0.0 - 0.2
TOC	3.5	0.5	5	2.9 - 4.3	0.3	0.0	5	0.3 - 0.3	14.8	5.3	5	7.8 - 19.6
UV254	0.089	0.0	5	0.071 - 0.111	0.005	0.0	5	0.005 - 0.005	0.358	0.1	5	0.185 - 0.493
SUVA	2.58	0.11	5	2.45 - 2.74	1.80	0.00	5	1.80 - 1.80	2.41	0.13	5	2.24 - 2.58
Bromide	33	14	5	10 - 44	10	0	5	10 - 10				
TOX	442	103	4	330 - 580	20	9	4	13 - 30				
CHCl3	110.1	34.4	5	67.0 - 150.0	2.6	1.9	5	1.2 - 5.8	Mass Balance			
BDCM	27.7	5.1	5	22.0 - 33.0	1.1	1.5	5	0.0 - 2.9	Closure Errors (%)			
DBCM	6.5	2.1	5	4.3 - 10.0	0.5	1.0	5	0.0 - 2.3	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	3	-6	36
THM4	144.3	40.2	5	94.8 - 188.6	4.2	3.7	5	1.2 - 8.4	TDS	5	9	37
MCAA	5.0	1.4	4	3.4 - 6.3	0.0	0.0	5	0.0 - 0.0	TotHard	2	0	27
DCAA	40.1	10.1	4	27.0 - 51.0	0.5	1.1	5	0.0 - 2.6	CaHard	2	1	26
TCAA	42.9	11.8	4	30.0 - 57.0	0.4	0.9	5	0.0 - 2.0	Turb	5	-48	85
MBAA	0.3	0.6	4	0.0 - 1.2	0.0	0.0	5	0.0 - 0.0	Amm	1	40	n/a
DBAA	1.4	0.2	4	1.1 - 1.6	0.0	0.0	5	0.0 - 0.0	TOC	0	n/a	n/a
BCAA	10.7	1.4	4	9.5 - 12.5	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	TDS _t	57	-21	48
CDBAA	2.4	0.5	4	2.0 - 3.2	0.0	0.0	5	0.0 - 0.0	Comments:			
DCBAA	12.6	3.4	4	8.8 - 16.5	0.0	0.0	5	0.0 - 0.0				
HAA5	89.7	20.0	4	61.9 - 109.3	0.9	2.0	5	0.0 - 4.6				
HAA6	100.4	20.4	4	71.4 - 119.1	0.9	2.0	5	0.0 - 4.6				
HAA9	115.4	21.7	4	84.7 - 135.1	0.9	2.0	5	0.0 - 4.6				

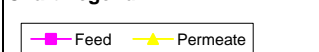
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.62	0.23	10	0.20 - 0.90
Temp (°C)	22.4	2.9	10	18.0 - 25.0
pH (unit)	8.1	0.3	10	7.6 - 8.4
Time (hr)	48.5	0.5	10	47.9 - 49.4

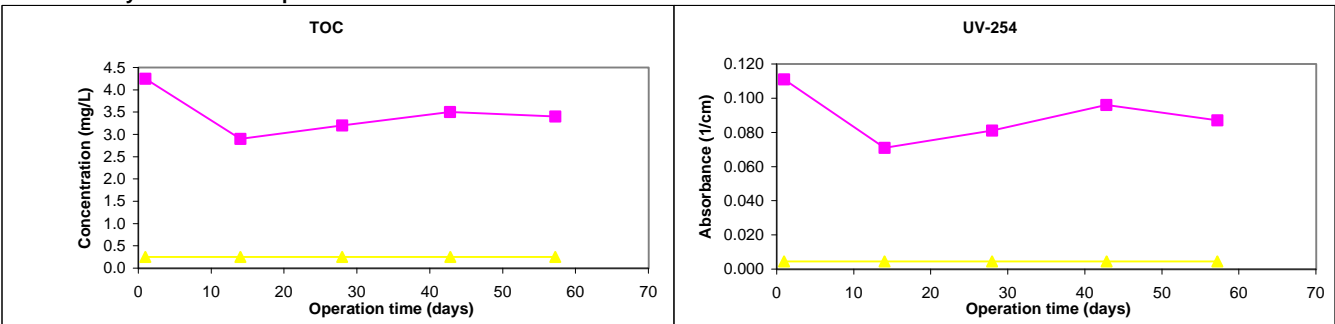
Pretreatment Information

Process	Description	Scale
Sedimentation	Clarification	full-scale
Coagulation	Addition of alum (dose: 12 mg/L, formul: full-scale	
Sedimentation	Clarification (sedimentation time = 10 hr full-scale	
UV-disinfection	Prior to the pilot plant	pilot-scale
Gravity filtration	Used pilot filter - no oxidant present	pilot-scale
	UV-disinfection mbrane unit skid, Ideal Horizons model 5	pilot-scale
Dual media filtration	pre-coated for manganese removal	pilot-scale
	1 micron filter 3-filter, cellulose polyester cartridge mad	pilot-scale

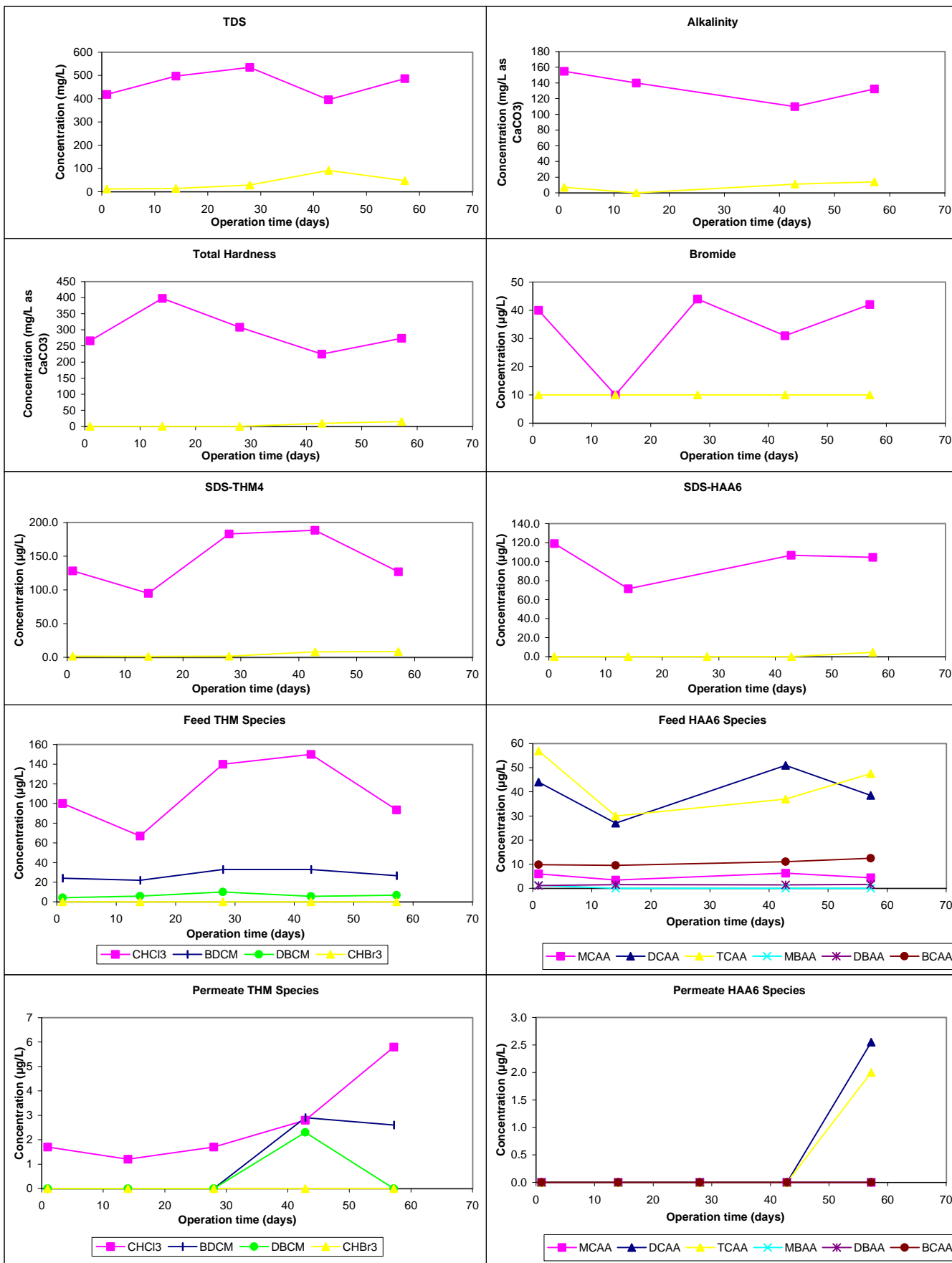
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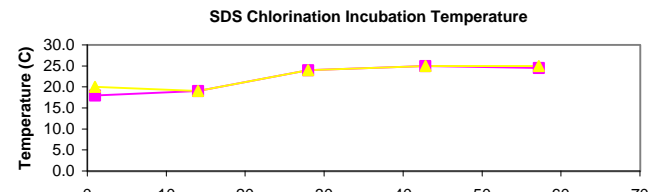
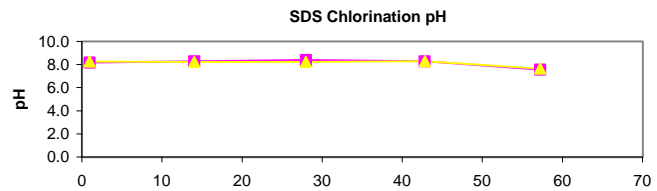
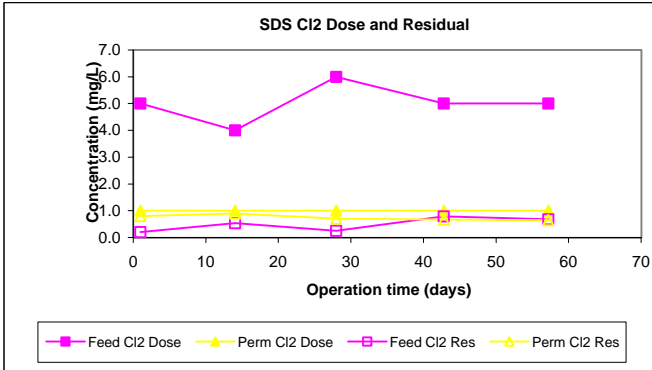
Water Quality Parameter Graphs



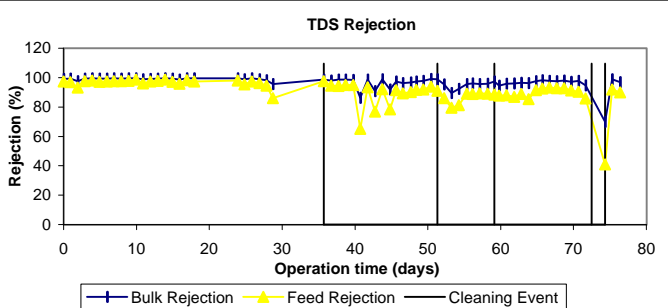
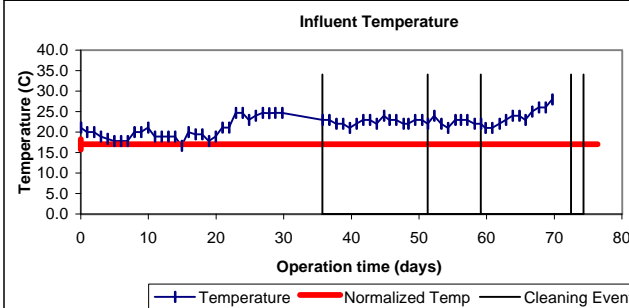
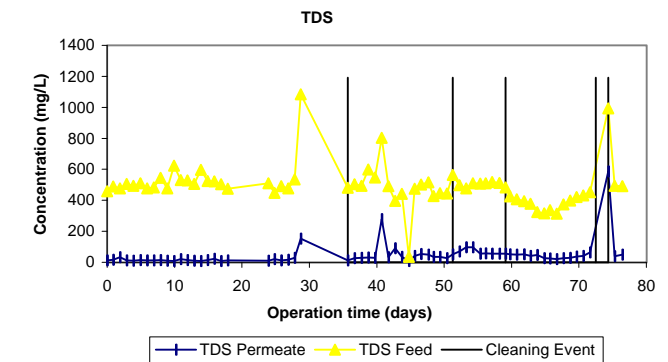
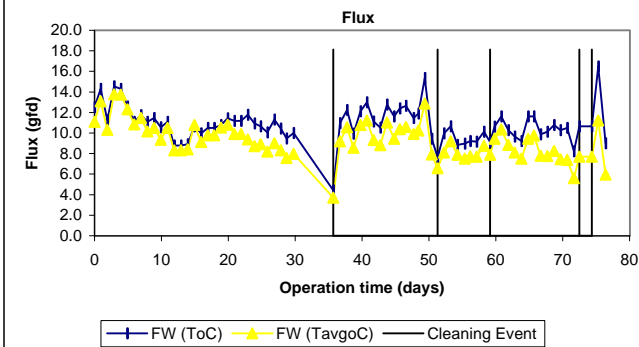
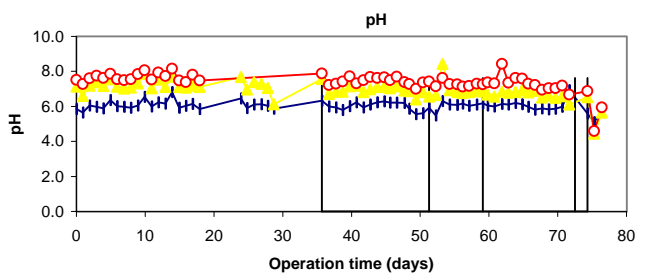
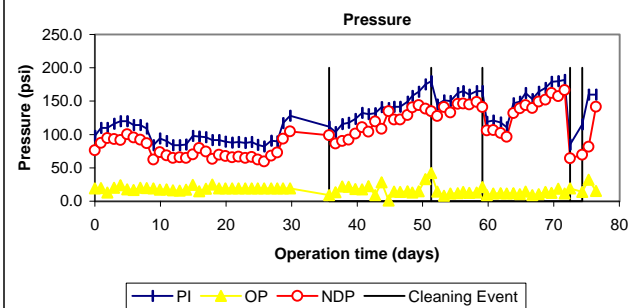
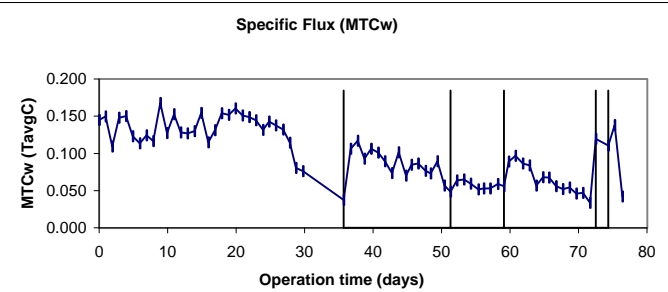
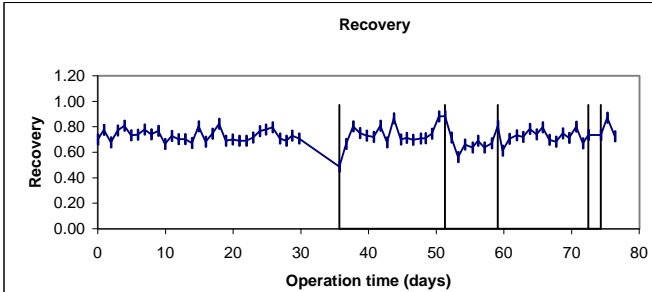
Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: KS2020906 / 384
 ICR Contact: Mr. Ray Northcutt
 Phone No.: (913) 573-9348
 Period: 7/1/98 - 9/14/98 (75 days)

Membrane Information

Manufacturer: Fluid Systems Mfr. MTC_w: 0.139 (gfd/psi)
 Trade Name: Thin Film Composite Mfr. Temp: 25.0 °C
 Membrane Model: 2540 HR Max Flow: 4.0 gpm
 MWCO: 200-250 Daltons Min Flow: 2.6 gpm
 Element Size: 2.5" x 40" Total Width: 3.0 ft
 Element Area: 27.0 ft² Feed Sp Thickness: 0.0026 ft
 Design Flux: 27.8 gfd 840 Element Area: 365.0 ft²
 Mfr. NDP: 200.0 psi 840 Purchase Price: \$650

Design Parameters

Norm Temp: 17.0 °C Recycle Ratio: 5.20
 Temp Norm MTC-w: 0.110 TavGC Manuf rep Rej_{TDS}: 99%
 Design Recovery: 0.75 TDS_F: 490.0 mg/L
 Design Flux: 10.0 gfd

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	6.8	0.2	5	6.7 - 7.1	5.8	0.4	5	5.2 - 6.2	7.3	0.2	5	7.1 - 7.6
Temp	31.8	2.1	5	29.0 - 34.7	32.3	1.3	5	31.0 - 34.5	32.5	1.2	5	32.0 - 34.6
Alk	119	23	5	80 - 140	12	2	5	10 - 16	383	70	5	265 - 445
TDS	428	112	5	234 - 498	40	11	5	27 - 54	1294	369	5	647 - 1569
TotHard	266	21	5	231 - 286	7	8	5	0 - 19	901	137	5	667 - 1000
CaHard	176	12	5	157 - 187	4	6	5	0 - 13	604	97	5	449 - 699
Turb	0.25	0.08	5	0.15 - 0.36	0.15	0.11	5	0.06 - 0.31	0.45	0.23	5	0.24 - 0.79
Amm	0.0	0.0	5	0.0 - 0.1	0.0	0.0	5	0.0 - 0.1	0.1	0.1	5	0.0 - 0.2
TOC	3.6	0.6	5	3.0 - 4.6	0.3	0.0	5	0.3 - 0.3	14.8	3.7	5	11.5 - 21.0
UV254	0.100	0.0	5	0.080 - 0.133	0.005	0.0	5	0.005 - 0.005	0.358	0.1	5	0.275 - 0.457
SUVA	2.76	0.29	5	2.50 - 3.19	1.80	0.00	5	1.80 - 1.80	2.51	0.67	5	1.49 - 3.19
Bromide	51	23	5	10 - 68	10	0	5	10 - 10				
TOX	487	78	5	413 - 615	45	11	5	30 - 57				
CHCl3	155.2	59.3	5	91.0 - 250.0	7.5	3.4	5	3.3 - 12.0	Mass Balance			
BDCM	30.6	6.7	5	23.0 - 40.0	3.8	1.1	5	2.7 - 5.5	Closure Errors (%)			
DBCM	6.8	2.8	5	3.3 - 10.5	0.8	0.7	5	0.0 - 1.6	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	5	-27	40
THM4	192.6	62.8	5	124.4 - 288.9	12.0	4.9	5	6.2 - 17.4	TDS	5	-39	46
MCAA	5.3	1.7	5	3.0 - 6.9	0.0	0.0	5	0.0 - 0.0	TotHard	3	-17	47
DCAA	46.8	13.7	5	33.0 - 66.0	0.2	0.5	5	0.0 - 1.1	CaHard	2	-42	19
TCAA	33.3	12.2	5	23.0 - 51.0	0.0	0.0	5	0.0 - 0.0	Turb	5	-67	150
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Amm	1	46	n/a
DBAA	1.6	0.4	5	1.1 - 2.0	0.0	0.0	5	0.0 - 0.0	TOC	0	n/a	n/a
BCAA	11.4	1.1	5	10.0 - 13.0	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	4	0.0 - 0.0	TDS	72	-25	24
CDBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Comments:			
DCBAA	7.7	0.5	5	6.8 - 8.2	0.0	0.0	5	0.0 - 0.0				
HAA5	87.0	26.8	5	60.8 - 125.0	0.2	0.5	5	0.0 - 1.1				
HAA6	98.4	27.1	5	70.8 - 137.0	0.2	0.5	5	0.0 - 1.1				
HAA9	101.9	29.6	4	77.6 - 144.9	0.0	0.0	4	0.0 - 0.0				

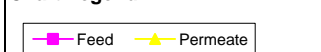
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.56	0.18	10	0.22 - 0.85
Temp (°C)	27.8	1.9	10	25.0 - 31.5
pH (unit)	8.1	0.1	10	8.0 - 8.3
Time (hr)	48.4	0.4	10	47.8 - 48.8

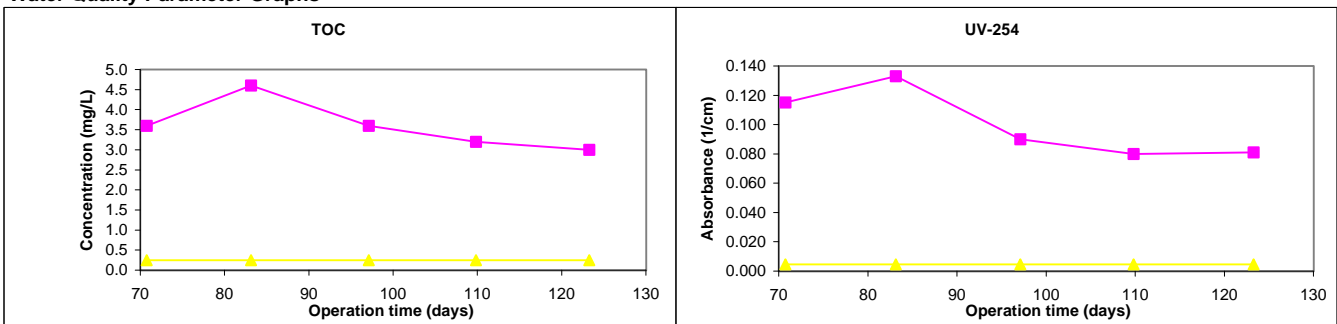
Pretreatment Information

Process	Description	Scale
Sedimentation	Clarification	full-scale
Coagulation	Addition of alum (dose: 12 mg/L, formul: full-scale	
Sedimentation	Clarification (sedimentation time = 10 hr full-scale	
UV-disinfection	Prior to the pilot plant	pilot-scale
Gravity filtration	Used pilot filter - no oxidant present	pilot-scale
	UV-disinfection mbrane unit skid, Ideal Horizons model 5	pilot-scale
	Dual media filtration pre-coated for manganese removal	pilot-scale
	2 micron filter 3-filter, cellulose polyester cartridge mad	pilot-scale

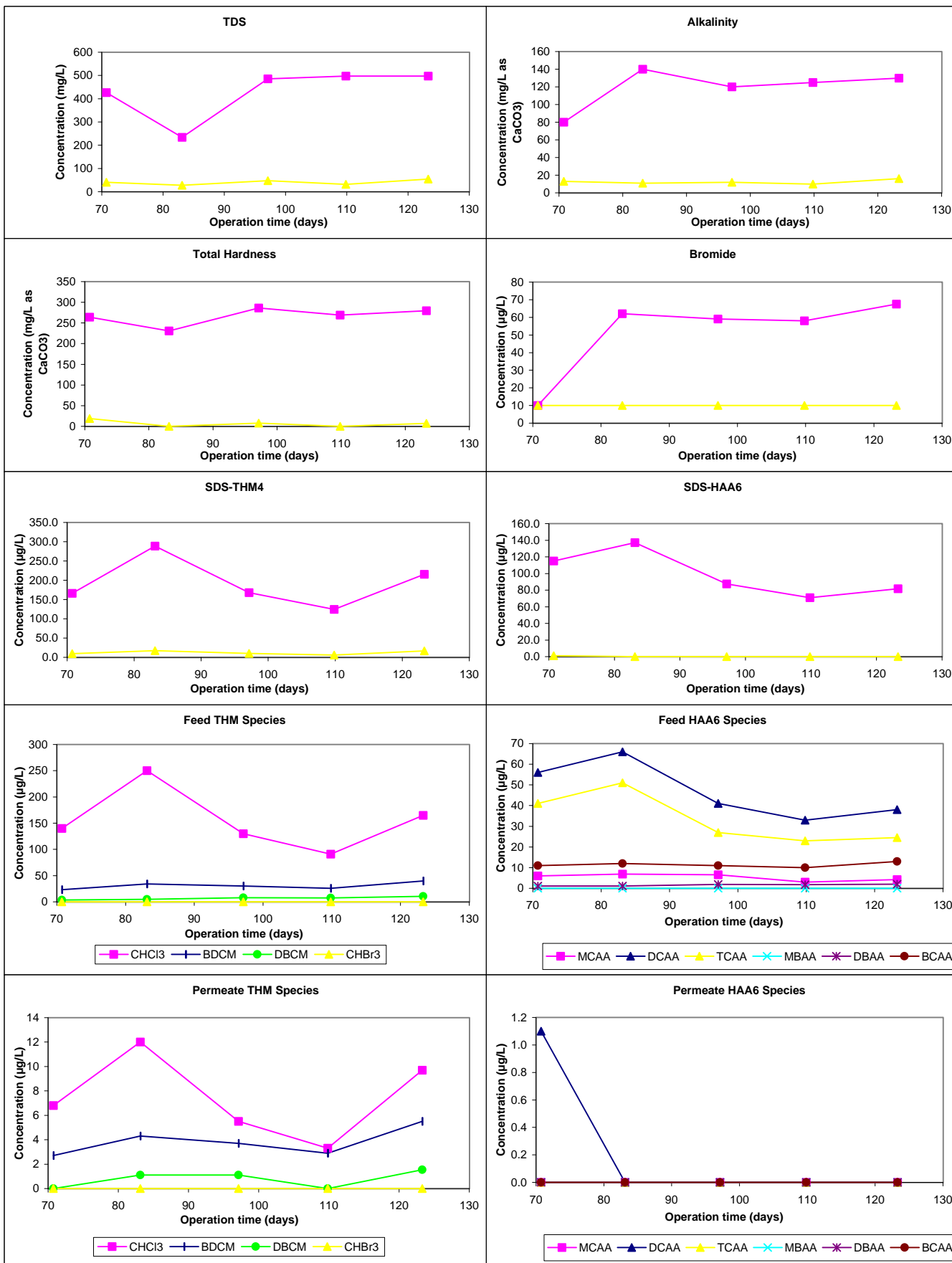
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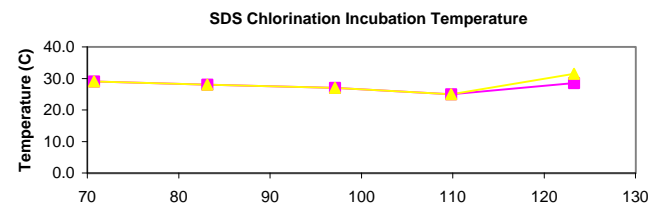
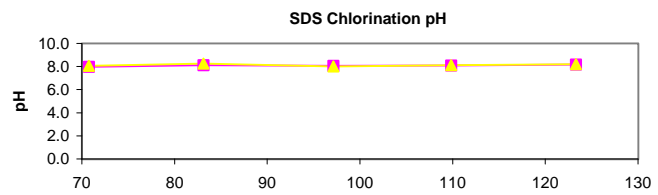
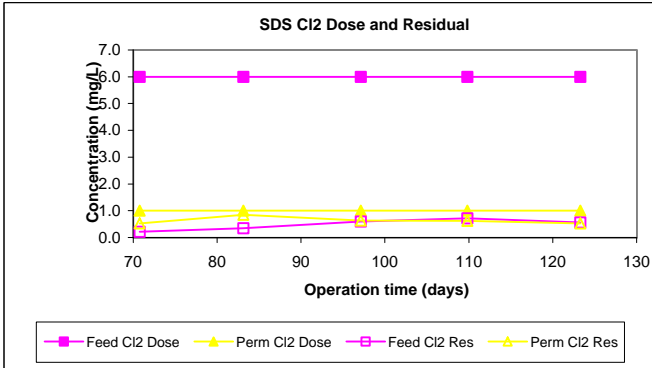
Water Quality Parameter Graphs



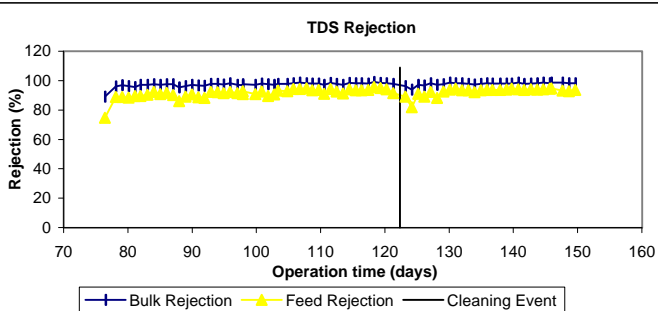
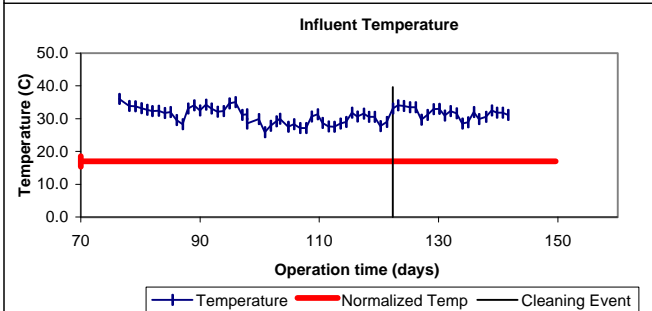
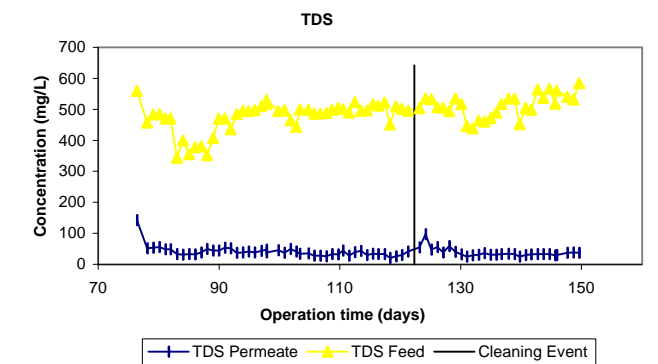
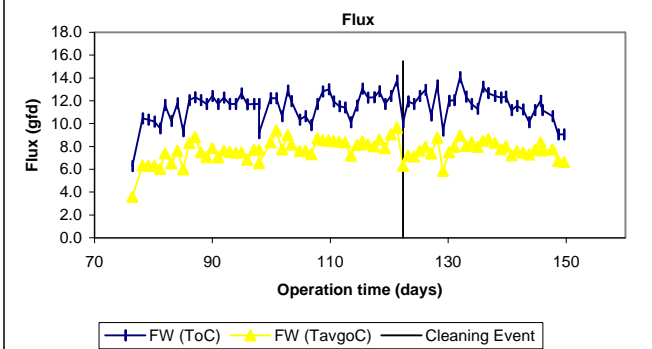
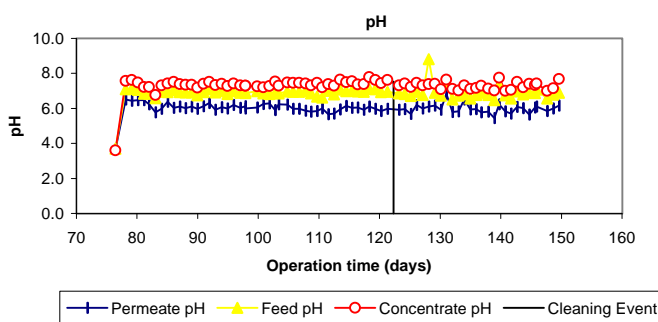
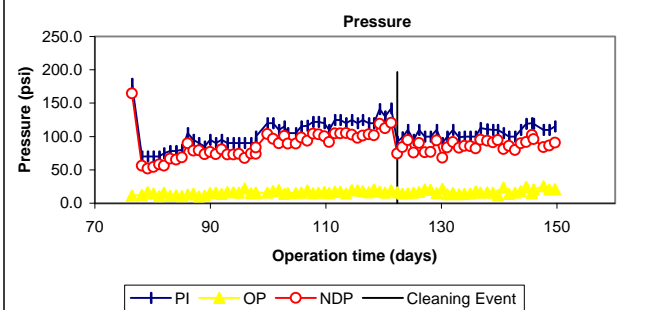
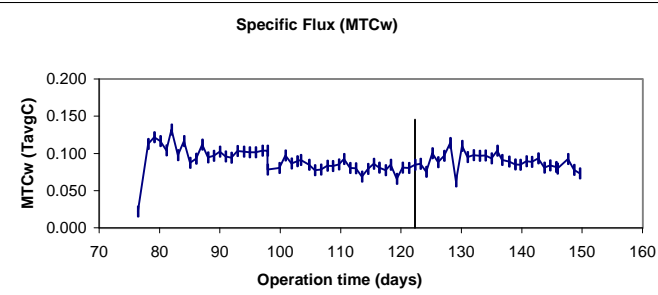
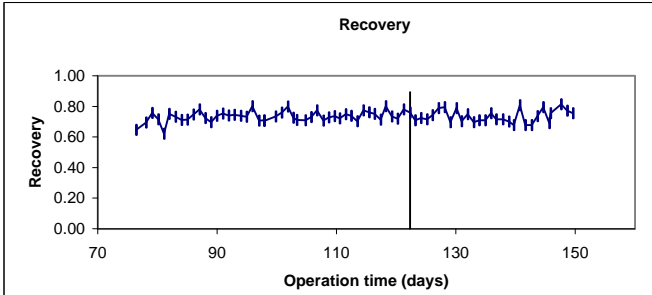
Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: KS2020906 / 384
 ICR Contact: Mr. Ray Northcutt
 Phone No.: (913) 573-9348
 Period: 9/15/98 - 11/19/98 (65 days)

Membrane Information

Manufacturer: Fluid Systems Mfr. MTC_w: 0.139 (gfd/psi)
 Trade Name: Thin Film Composite Mfr. Temp: 25.0 °C
 Membrane Model: 2540 HR Max Flow: 4.0 gpm
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 Design Flux: 10.0 gfd

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	6.8	0.1	5	6.6 - 6.9	5.8	0.2	5	5.4 - 6.0	7.2	0.1	5	7.1 - 7.4
Temp	28.1	3.0	5	24.0 - 31.0	28.6	2.4	5	25.0 - 31.0	28.7	2.4	5	25.0 - 31.0
Alk	121	17	5	95 - 140	8	5	5	0 - 12	370	44	5	310 - 410
TDS	507	14	5	490 - 526	33	7	5	25 - 43	1499	130	5	1364 - 1680
TotHard	263	12	5	250 - 279	0	0	5	0 - 0	906	95	5	785 - 1050
CaHard	171	9	5	160 - 180	0	0	5	0 - 0	590	62	5	502 - 674
Turb	0.28	0.15	5	0.18 - 0.54	0.10	0.05	5	0.06 - 0.16	0.33	0.20	5	0.19 - 0.67
Amm	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0
TOC	3.2	0.3	5	2.8 - 3.5	0.4	0.3	5	0.3 - 0.9	10.9	0.9	5	9.5 - 11.7
UV254	0.070	0.0	5	0.055 - 0.085	0.005	0.0	5	0.005 - 0.005	0.230	0.0	5	0.192 - 0.275
SUVA	2.18	0.20	5	1.96 - 2.50	1.34	0.64	5	0.50 - 1.80	2.10	0.24	5	1.79 - 2.35
Bromide	60	5	5	54 - 65	10	0	5	10 - 10				
TOX	348	61	5	280 - 425	33	12	5	13 - 42				
CHCl3	88.9	19.7	5	70.0 - 120.0	2.7	1.5	5	1.5 - 5.2	Mass Balance			
BDCM	26.2	4.1	5	22.0 - 32.0	2.3	0.6	5	1.8 - 3.1	Closure Errors (%)			
DBCM	8.2	0.7	5	7.6 - 9.0	0.2	0.4	5	0.0 - 1.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	4	-8	18
THM4	123.3	24.4	5	99.6 - 161.0	5.2	2.2	5	3.3 - 8.3	TDS	5	8	58
MCAA	2.5	1.6	5	0.0 - 4.2	0.0	0.0	5	0.0 - 0.0	TotHard	0	n/a	n/a
DCAA	27.0	4.8	5	23.0 - 35.0	0.0	0.0	5	0.0 - 0.0	CaHard	0	n/a	n/a
TCAA	18.8	3.3	5	15.0 - 24.0	0.0	0.0	5	0.0 - 0.0	Turb	5	-53	103
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	2.0	0.1	5	1.8 - 2.0	0.0	0.0	5	0.0 - 0.0	TOC	2	5	8
BCAA	10.3	1.2	5	9.2 - 12.0	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	4	0.0 - 0.0	TDS	53	-26	20
CDBAA	2.0	1.1	5	0.0 - 2.7	0.0	0.0	5	0.0 - 0.0	Comments:			
DCBAA	7.4	1.3	5	6.0 - 9.4	0.0	0.0	5	0.0 - 0.0				
HAA5	50.3	8.7	5	44.7 - 65.2	0.0	0.0	5	0.0 - 0.0				
HAA6	60.5	9.5	5	53.9 - 76.2	0.0	0.0	5	0.0 - 0.0				
HAA9	69.0	13.0	4	59.9 - 88.2	0.0	0.0	4	0.0 - 0.0				

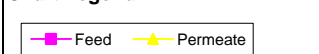
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.90	0.27	10	0.62 - 1.39
Temp (°C)	23.6	2.0	10	22.0 - 27.0
pH (unit)	8.1	0.1	10	8.0 - 8.3
Time (hr)	48.8	0.2	10	48.5 - 49.0

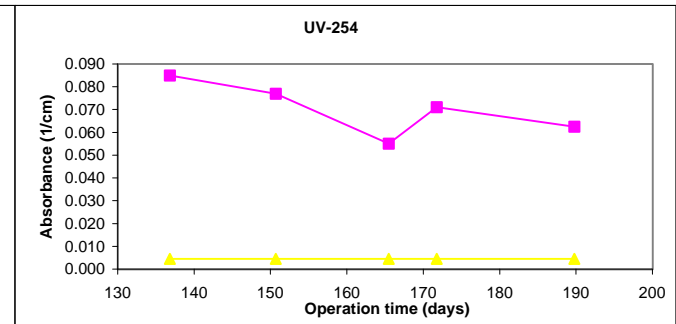
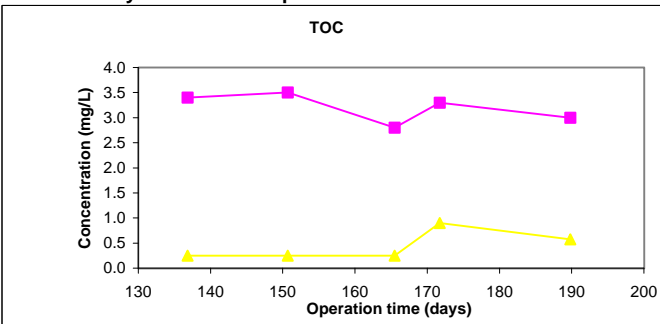
Pretreatment Information

Process	Description	Scale
Sedimentation	Clarification	full-scale
Coagulation	Addition of alum (dose: 12 mg/L, formul: full-scale	
Sedimentation	Clarification (sedimentation time = 10 hr full-scale	
UV-disinfection	Prior to the pilot plant	pilot-scale
Gravity filtration	Used pilot filter - no oxidant present	pilot-scale
	UV-disinfection mbrane unit skid, Ideal Horizons model 5	pilot-scale
	Dual media filtration pre-coated for manganese removal	pilot-scale
	2 micron filter 3-filter, cellulose polyester cartridge mad	pilot-scale

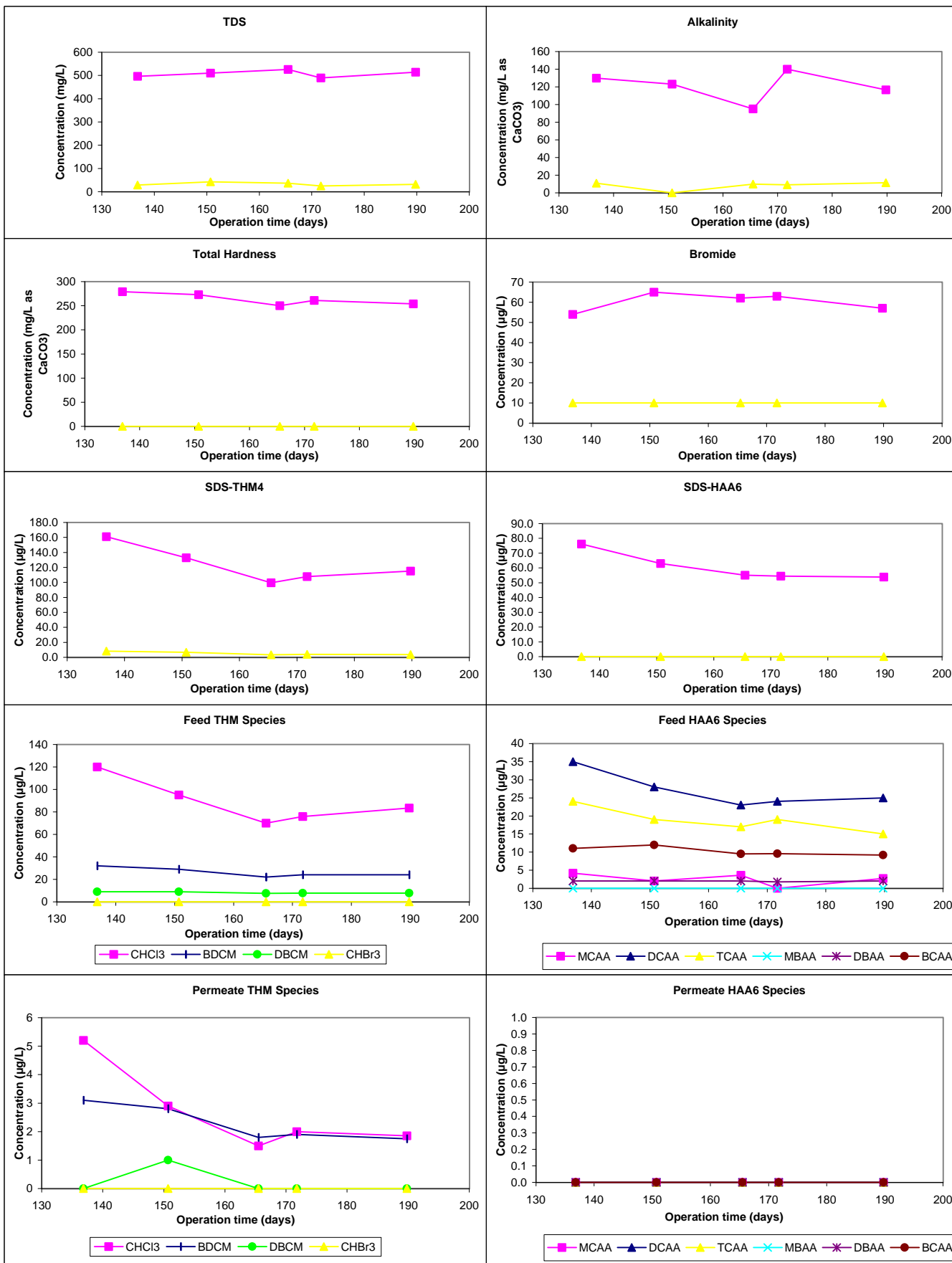
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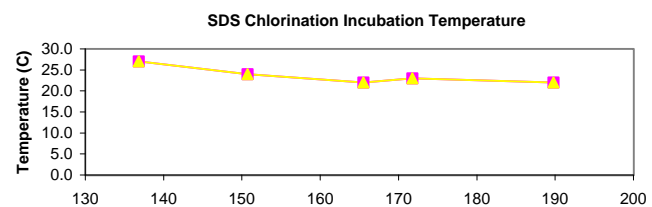
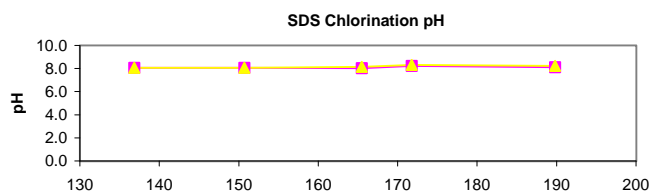
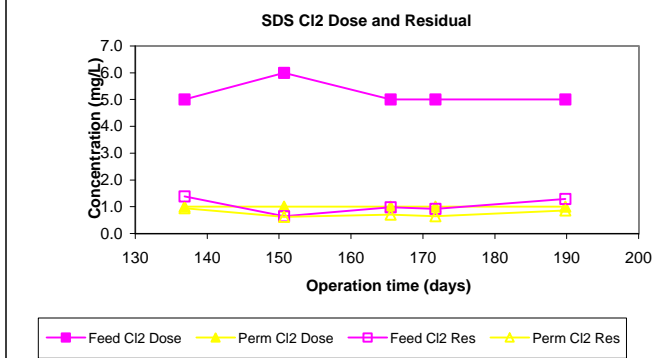
Water Quality Parameter Graphs



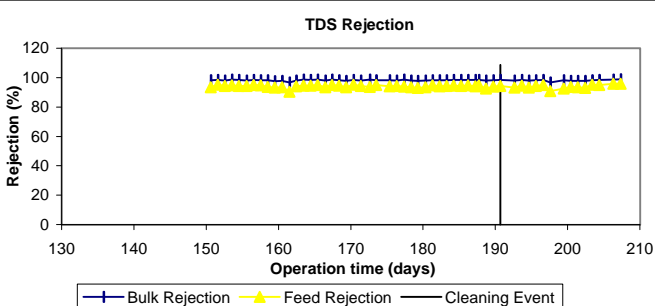
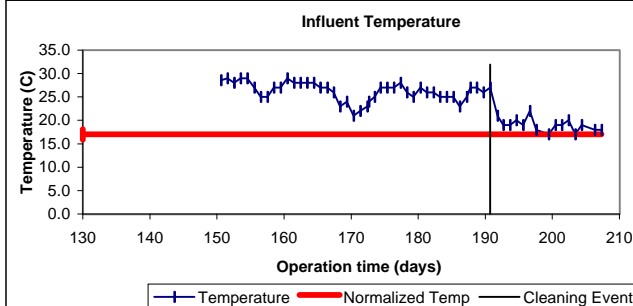
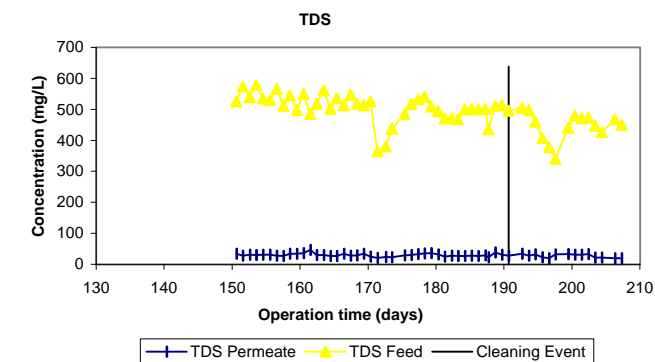
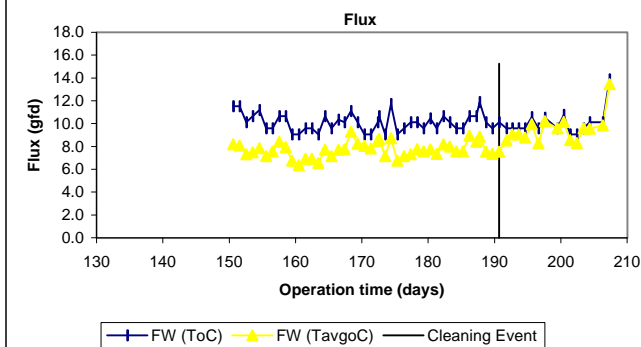
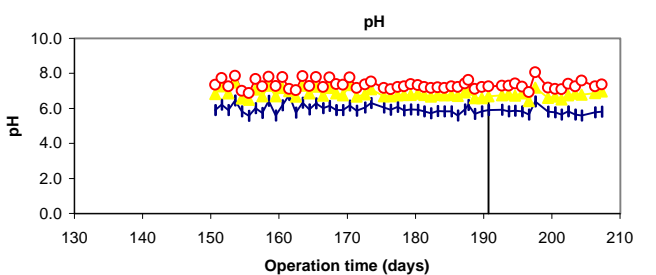
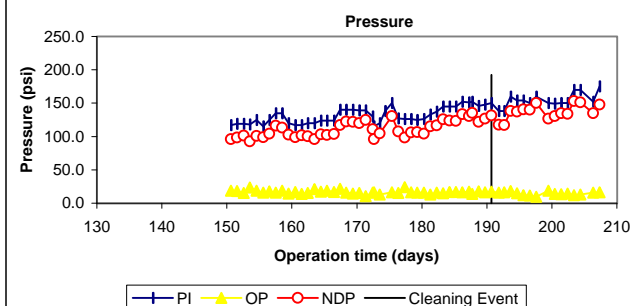
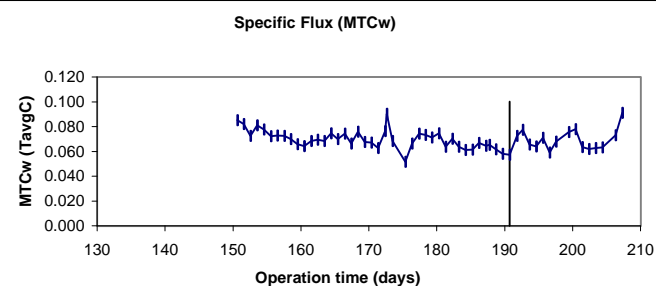
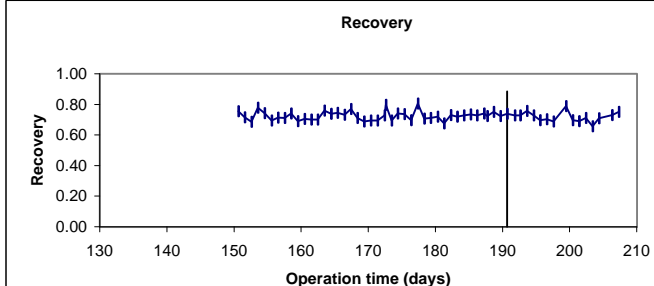
Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: KS2020906 / 384
 ICR Contact: Mr. Ray Northcutt
 Phone No.: (913) 573-9348
 Period: 12/2/98 - 2/28/99 (88 days)

Membrane Information

Manufacturer: Fluid Systems Mfr. MTC_w: 0.139 (gfd/psi)
 Trade Name: Thin Film Composite Mfr. Temp: 25.0 °C
 Membrane Model: 2540 HR Max Flow: 4.0 gpm
 MWCO: 200-250 Daltons Min Flow: 2.6 gpm
 Element Size: 2.5" x 40" Total Width: 3.0 ft
 Element Area: 27.0 ft² Feed Sp Thickness: 0.0026 ft
 Design Flux: 27.8 gfd 840 Element Area: 365.0 ft²
 Mfr. NDP: 200.0 psi 840 Purchase Price: \$650

Design Parameters

Norm Temp: 17.0 °C Recycle Ratio: 5.20
 Temp Norm MTC-w: 0.110 TavGC Manuf rep Re_{JTDS}: 99%
 Design Recovery: 0.75 TDS_F: 490.0 mg/L
 Design Flux: 10.0 gfd

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Count	Min/Max
pH	6.9	0.4	5	6.6 - 7.4	5.7	0.5	5	5.2 - 6.4	7.4	0.4	5	6.9 - 7.9
Temp	16.8	3.1	5	12.0 - 20.0	19.6	3.0	5	15.0 - 23.0	19.6	2.9	5	15.0 - 22.0
Alk	137	36	5	102 - 187	8	5	5	4 - 16	407	176	5	270 - 709
TDS	504	52	5	418 - 547	32	14	5	18 - 53	1345	266	5	1122 - 1798
TotHard	275	27	5	229 - 301	2	4	5	0 - 9	839	139	5	723 - 1080
CaHard	176	15	5	152 - 193	1	2	5	0 - 5	541	72	5	479 - 664
Turb	0.29	0.14	5	0.18 - 0.54	0.10	0.02	5	0.07 - 0.13	0.43	0.12	5	0.31 - 0.58
Amm	0.1	0.1	5	0.0 - 0.3	0.0	0.0	5	0.0 - 0.1	0.3	0.5	5	0.0 - 1.3
TOC	4.1	0.5	5	3.4 - 4.5	0.8	0.3	5	0.3 - 1.0	10.3	1.8	5	8.6 - 13.3
UV254	0.074	0.0	4	0.068 - 0.084	0.005	0.0	5	0.005 - 0.005	0.227	0.0	4	0.192 - 0.291
SUVA	NA	NA	4	NA	0.76	0.58	5	0.45 - 1.80	NA	NA	4	NA
Bromide	61	25	5	33 - 99	10	0	5	10 - 10				
TOX	322	127	5	150 - 480	25	28	5	13 - 76				
CHCl3	76.4	13.2	4	59.5 - 90.0	0.9	0.6	4	0.0 - 1.4	Mass Balance Closure Errors (%)			
BDCM	23.4	4.2	5	16.0 - 26.0	0.7	0.9	4	0.0 - 1.7				
DBCM	7.4	1.7	5	5.6 - 9.5	0.3	0.5	4	0.0 - 1.0	WQP	Count	Avg	SD/RD
CHBr3	0.3	0.7	5	0.0 - 1.6	0.0	0.0	5	0.0 - 0.0	Alk	5	-9	59
THM4	109.3	11.3	4	94.0 - 119.6	1.9	1.7	4	0.0 - 4.1	TDS	5	-16	59
MCAA	1.1	1.2	4	0.0 - 2.2	0.0	0.0	5	0.0 - 0.0	TotHard	1	56	n/a
DCAA	23.9	4.3	4	19.0 - 29.0	0.0	0.0	5	0.0 - 0.0	CaHard	1	56	n/a
TCAA	20.5	6.6	4	14.0 - 29.0	0.0	0.0	5	0.0 - 0.0	Turb	5	-52	75
MBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Amm	1	66	n/a
DBAA	1.6	0.4	4	1.2 - 1.9	0.0	0.0	5	0.0 - 0.0	TOC	4	-32	50
BCAA	8.8	0.5	4	8.2 - 9.2	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	TDS	57	-44	68
CDBAA	0.0	0.0	4	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Comments:			
DCBAA	6.3	1.6	4	4.4 - 7.8	0.0	0.0	5	0.0 - 0.0				
HAA5	47.1	11.0	4	34.9 - 61.4	0.0	0.0	5	0.0 - 0.0				
HAA6	55.9	11.2	4	43.6 - 70.6	0.0	0.0	5	0.0 - 0.0				
HAA9	62.2	12.4	4	49.2 - 78.4	0.0	0.0	5	0.0 - 0.0				

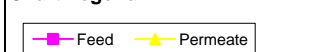
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.93	0.33	10	0.60 - 1.62
Temp (°C)	18.4	1.8	10	15.0 - 20.0
pH (unit)	8.2	0.8	10	6.0 - 8.7
Time (hr)	49.2	0.5	10	48.5 - 50.0

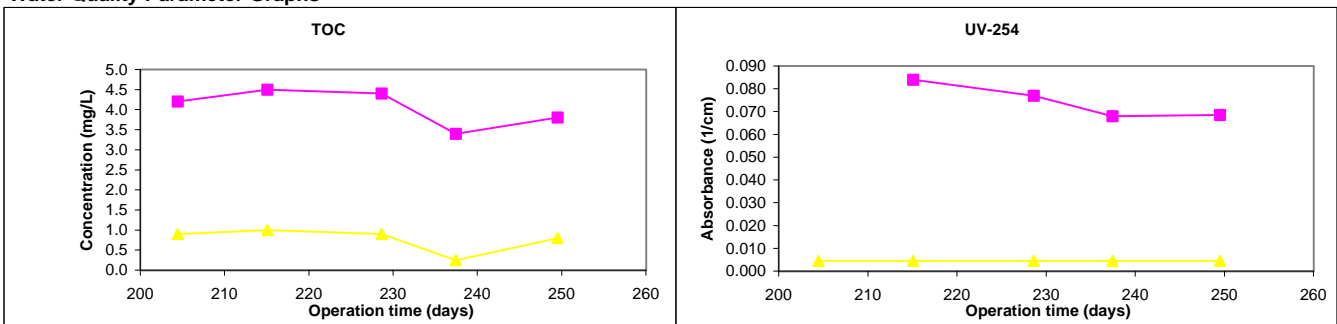
Pretreatment Information

Process	Description	Scale
Sedimentation	Clarification	full-scale
Coagulation	Addition of alum (dose: 12 mg/L, formul: full-scale	
Sedimentation	Clarification (sedimentation time = 10 hr full-scale	
UV-disinfection	Prior to the pilot plant	pilot-scale
Gravity filtration	Used pilot filter - no oxidant present	pilot-scale
	UV-disinfection mbbrane unit skid, Ideal Horizons model 5	pilot-scale
	Dual media filtration pre-coated for manganese removal	pilot-scale
	2 micron filter 3-filter, cellulose polyester cartridge mad	pilot-scale

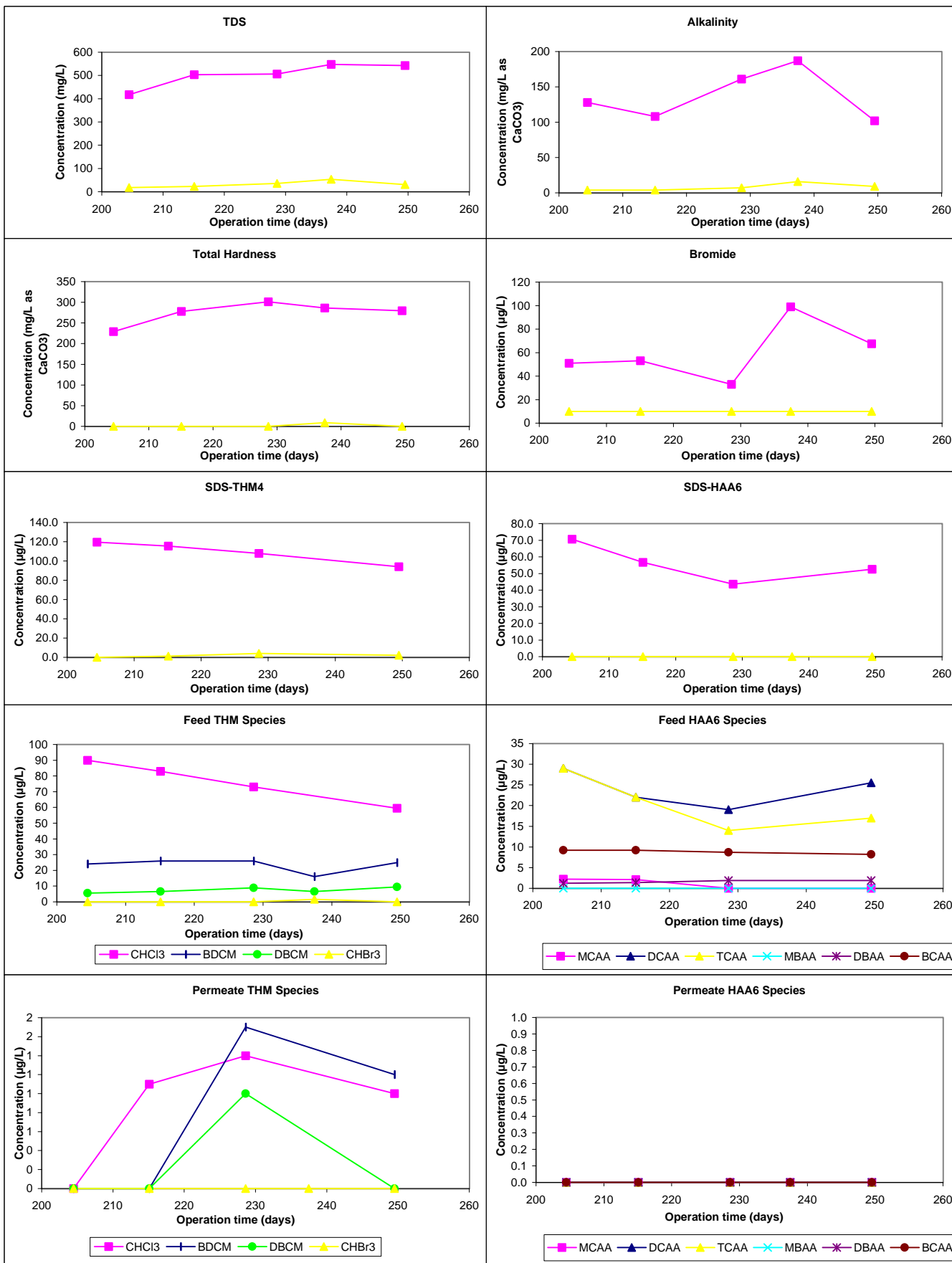
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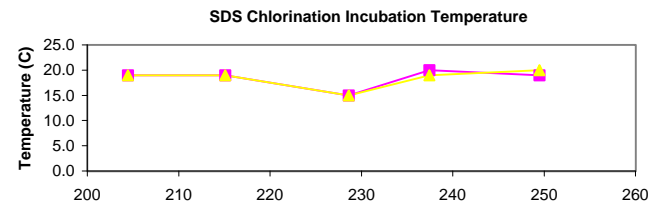
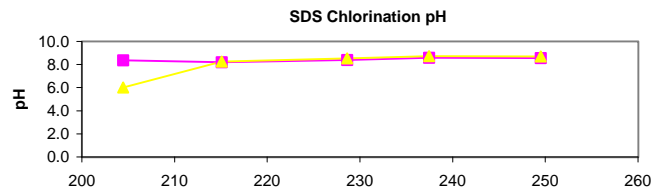
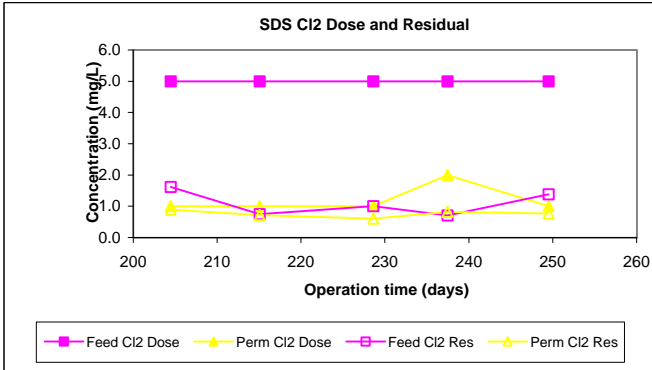
Water Quality Parameter Graphs



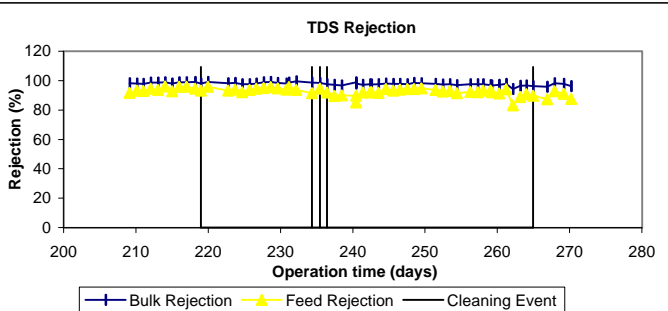
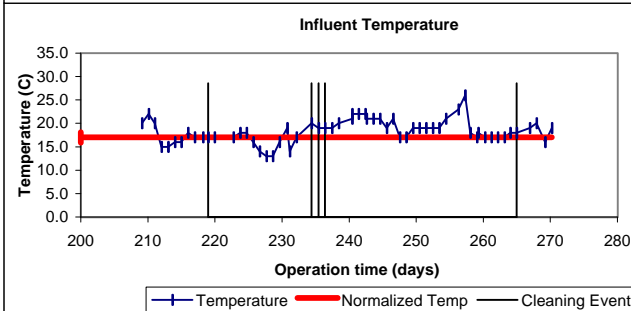
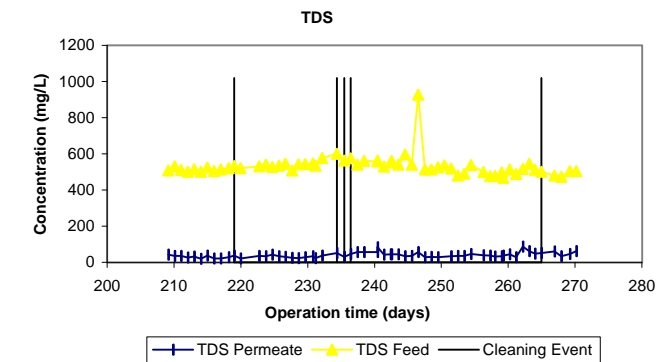
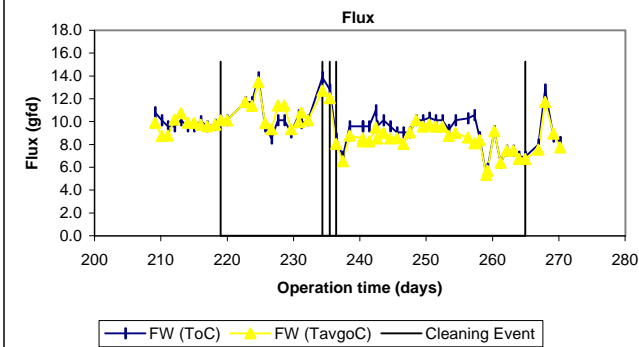
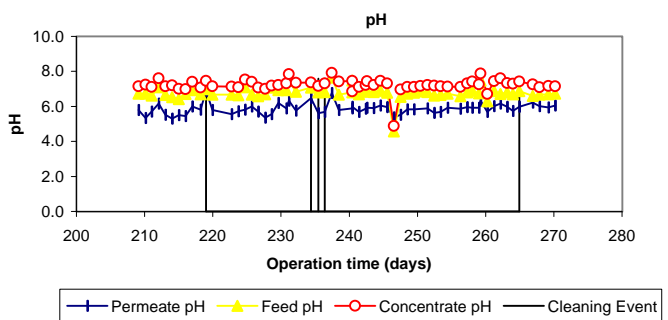
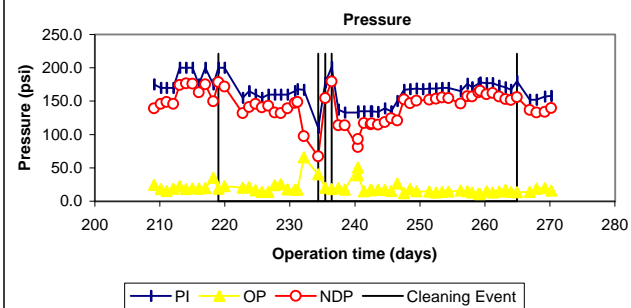
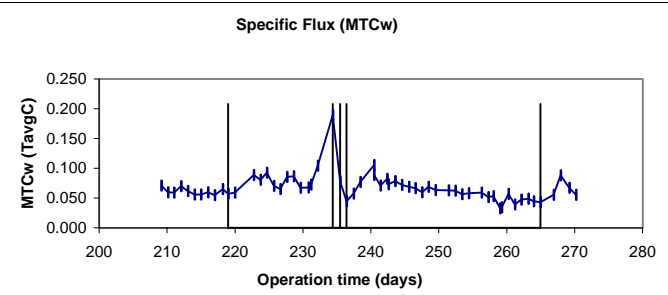
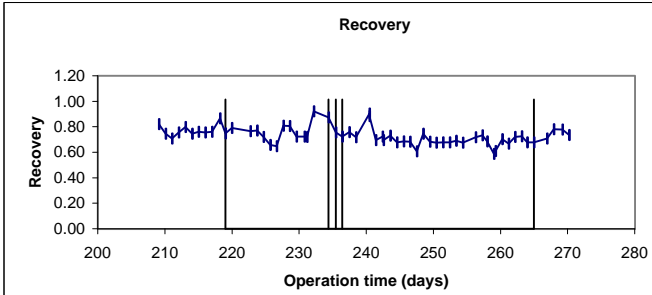
Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: KS2020906 / 384
 ICR Contact: Mr. Ray Northcutt
 Phone No.: (913) 573-9348
 Period: 3/1/99 - 4/13/99 (43 days)

Membrane Information

Manufacturer: Fluid Systems Mfr. MTC_w: 0.139 (gfd/psi)
 Trade Name: Thin Film Composite Mfr. Temp: 25.0 °C
 Membrane Model: 2540 HR Max Flow: 4.0 gpm
 MWCO: 200-250 Daltons Min Flow: 2.6 gpm
 Element Size: 2.5" x 40" Total Width: 3.0 ft
 Element Area: 27.0 ft² Feed Sp Thickness: 0.0026 ft
 Design Flux: 27.8 gfd 840 Element Area: 365.0 ft²
 Mfr. NDP: 200.0 psi 840 Purchase Price: \$650

Design Parameters

Norm Temp: 17.0 °C Recycle Ratio: 5.20
 Temp Norm MTC-w: 0.110 TavGC Manuf rep Re_{JTDS}: 99%
 Design Recovery: 0.75 TDS_F: 490.0 mg/L
 Design Flux: 10.0 gfd

Water Quality Summary

	Mean	SD	Feed Count	Min/Max	Mean	SD	Permeate Count	Min/Max	Mean	SD	Concentrate Count	Min/Max
pH	7.0	0.5	5	6.6 - 7.9	6.2	0.5	5	5.9 - 7.0	7.4	0.5	5	6.9 - 8.2
Temp	21.2	1.8	5	19.0 - 23.0	24.4	2.1	5	22.0 - 27.0	19.7	10.9	5	0.4 - 26.0
Alk	154	29	5	124 - 189	12	2	5	10 - 15	443	169	5	227 - 624
TDS	486	15	5	465 - 505	37	5	5	30 - 43	1376	274	5	929 - 1612
TotHard	276	20	5	244 - 296	2	4	5	0 - 9	911	205	5	573 - 1060
CaHard	179	16	5	153 - 192	1	2	5	0 - 5	590	123	5	382 - 669
Turb	0.41	0.08	5	0.34 - 0.53	0.08	0.01	5	0.06 - 0.09	1.21	1.37	5	0.39 - 3.62
Amm	0.0	0.1	5	0.0 - 0.1	0.0	0.0	5	0.0 - 0.1	0.1	0.1	5	0.0 - 0.2
TOC	3.4	0.3	4	3.1 - 3.8	0.6	0.5	5	0.3 - 1.2	10.2	2.9	4	6.8 - 13.7
UV254	0.093	0.0	5	0.070 - 0.164	0.005	0.0	5	0.005 - 0.005	0.276	0.1	5	0.142 - 0.471
SUVA	NA	NA	4	NA	1.23	0.78	5	0.38 - 1.80	NA	NA	4	NA
Bromide	65	15	5	55 - 92	10	0	5	10 - 10				
TOX	526	293	5	280 - 920	18	13	5	13 - 41				
CHCl3	96.0	33.1	5	63.0 - 130.0	3.0	1.5	5	1.8 - 5.3	Mass Balance			
BDCM	26.8	4.1	5	23.0 - 32.0	2.0	1.0	5	1.3 - 3.7	Closure Errors (%)			
DBCM	7.9	1.5	5	5.4 - 9.5	0.4	0.8	5	0.0 - 1.8	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	3	-50	110
THM4	130.7	36.7	5	94.0 - 171.5	5.4	2.7	5	3.2 - 9.1	TDS	3	-37	81
MCAA	1.5	2.2	5	0.0 - 4.9	0.0	0.0	5	0.0 - 0.0	TotHard	0	n/a	n/a
DCAA	26.4	8.4	5	18.0 - 39.0	0.2	0.4	5	0.0 - 1.0	CaHard	0	n/a	n/a
TCAA	18.9	8.9	5	12.0 - 34.5	0.0	0.0	5	0.0 - 0.0	Turb	3	-123	95
MBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Amm	0	n/a	n/a
DBAA	1.5	0.8	5	0.0 - 1.9	0.0	0.0	5	0.0 - 0.0	TOC	1	53	n/a
BCAA	9.3	0.7	5	8.4 - 10.0	0.0	0.0	5	0.0 - 0.0	UV254	0	n/a	n/a
TBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	TDS _t	8	-147	188
CDBAA	0.9	1.3	5	0.0 - 2.4	0.0	0.0	5	0.0 - 0.0	Comments:			
DCBAA	5.8	0.8	5	5.0 - 7.3	0.0	0.0	5	0.0 - 0.0				
HAA5	48.3	18.4	5	31.7 - 78.4	0.2	0.4	5	0.0 - 1.0				
HAA6	57.6	18.5	5	40.7 - 87.5	0.2	0.4	5	0.0 - 1.0				
HAA9	64.3	19.4	5	45.7 - 94.8	0.2	0.4	5	0.0 - 1.0				

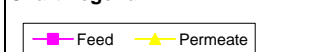
SDS Conditions

WQP	Avg	SD	Count	Min - Max
Res (0)	0.89	0.24	10	0.63 - 1.45
Temp (°C)	19.9	1.8	10	18.0 - 23.0
pH (unit)	8.4	0.5	10	7.1 - 8.7
Time (hr)	48.8	0.7	10	48.0 - 50.0

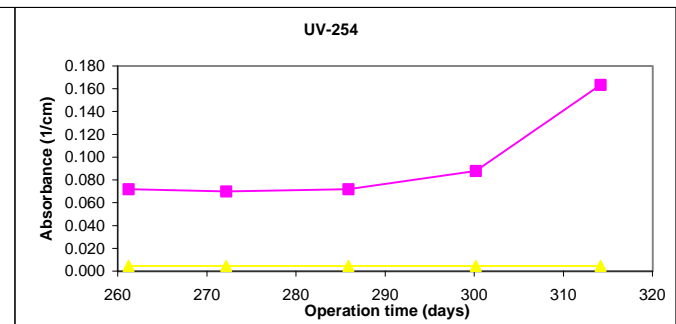
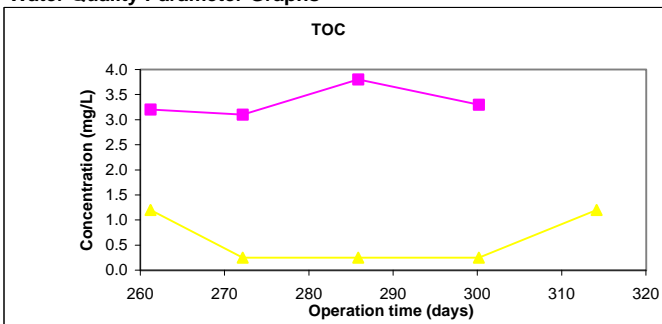
Pretreatment Information

Process	Description	Scale
Sedimentation	Clarification	full-scale
Coagulation	Addition of alum (dose: 12 mg/L, formul: full-scale	
Sedimentation	Clarification (sedimentation time = 10 hr full-scale	
UV-disinfection	Prior to the pilot plant	pilot-scale
Gravity filtration	Used pilot filter - no oxidant present	pilot-scale
	UV-disinfection mbrane unit skid, Ideal Horizons model 5	pilot-scale
	Dual media filtration pre-coated for manganese removal	pilot-scale
	2 micron filter 3-filter, cellulose polyester cartridge mad	pilot-scale

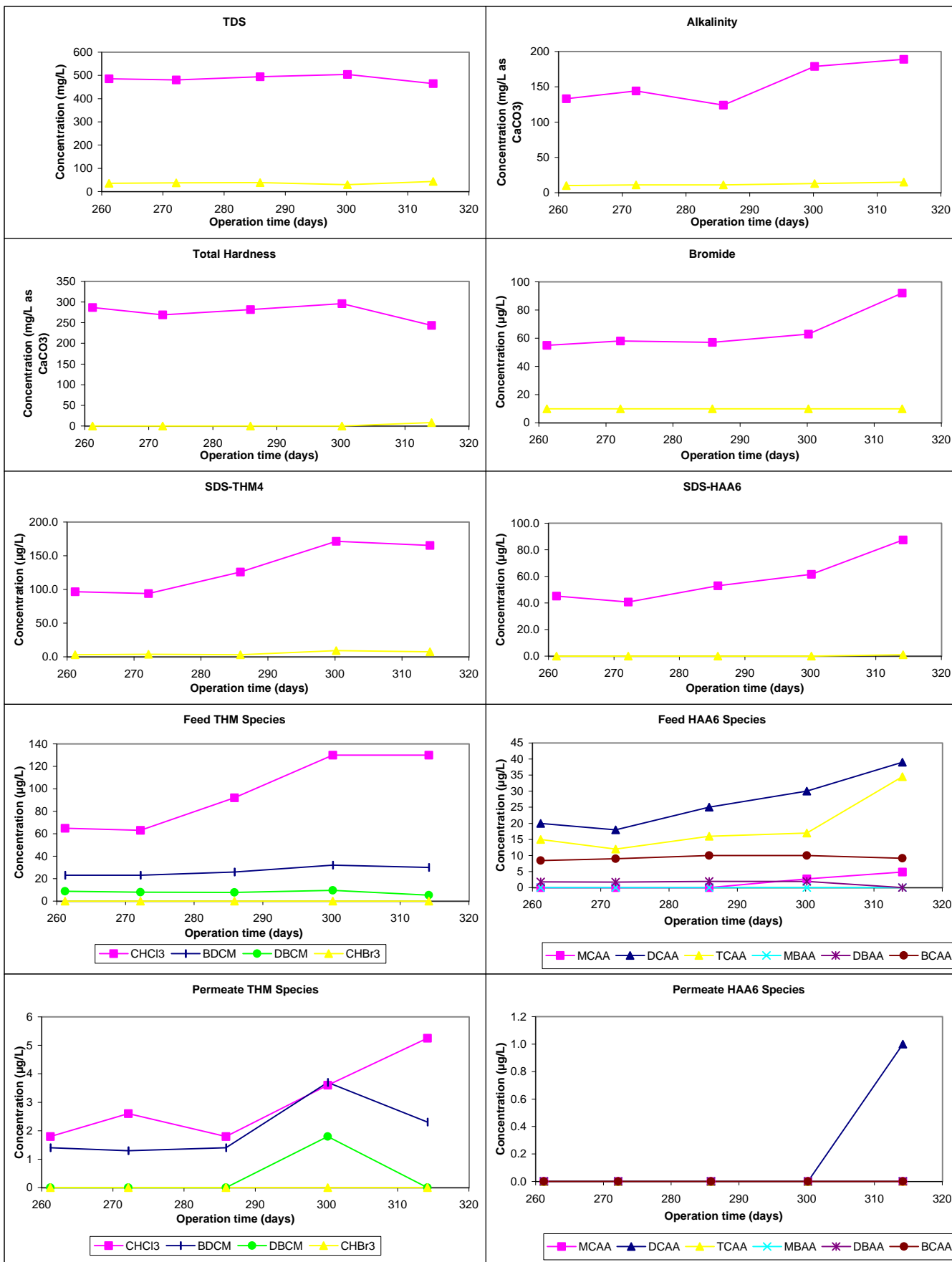
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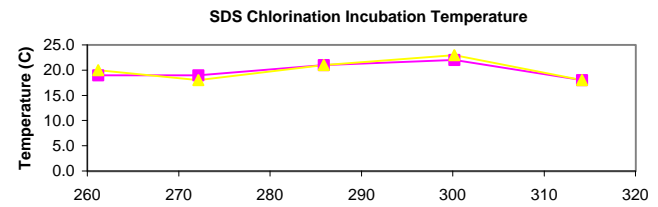
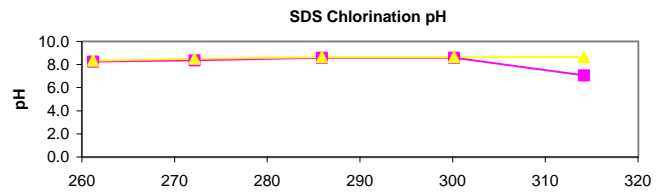
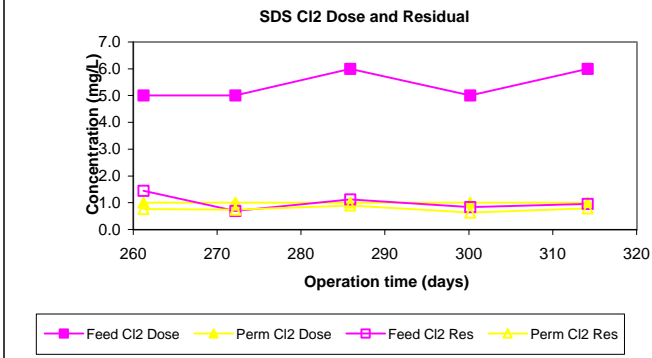
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Water Quality Parameter Graphs (Continued)



Productivity Graphs

