

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	1004
Study Protocol	Membrane RBSMT treatment study
Plant ICR Number	678
PWS Name	City of Portsmouth, DPU
City, State, Zip	Portsmouth, VA 23705-0490

General Comments:

1. During this bench-scale study, two membranes were evaluated: the Hydranautics NTR7450 and the FilmTec NF45. Each membrane was tested during four quarters over a one-year period. For the NTR7450 membrane, flux was also varied over the four quarters as summarized in Table 5 of the Summary Report.
2. During data analysis, temperatures of 8°C, 19°C, 27°C, and 19°C for Winter, Spring, Summer and Autumn, were used, respectively. This was necessary to estimate the range of pressures required to maintain a constant production rate over the course of a calendar year. The temperatures were estimated using the range of full-scale influent water temperatures reported in the Summary Report. The temperatures reported in the Data Collection Spreadsheets are indicative of lab conditions.
3. No cost information was provided in the Summary Report.

Water Quality Comments:

1. 2 water quality outliers were identified and removed prior to base analysis. These were the feed TOX values for the first quarter for the NF45 membrane. Feed TOX values for the first quarter for the NTR7450 membrane were used for the NF45 membrane since both membranes used the same batch of feed water.
2. SDS conditions are summarized in Table 6 of the Summary Report. The free chlorine residual and pH were held constant over the four quarters, while the incubation temperature varied from 10°C (Winter) to 28°C (Summer) and incubation time was 60 hours in the Winter and Spring and 72 hours in the Summer and Autumn.
3. Ammonia was not measured during this study.

Productivity Comments:

1. No productivity outliers were identified.

ICR Information

ID / ICR#: VA3740600 / 678
ICR Contact: Mr. David Haddaway, Water Quality S
Phone No.: (757) 539-2201
Period: 2/13/97 - 2/18/97 (5 days)

Membrane Information

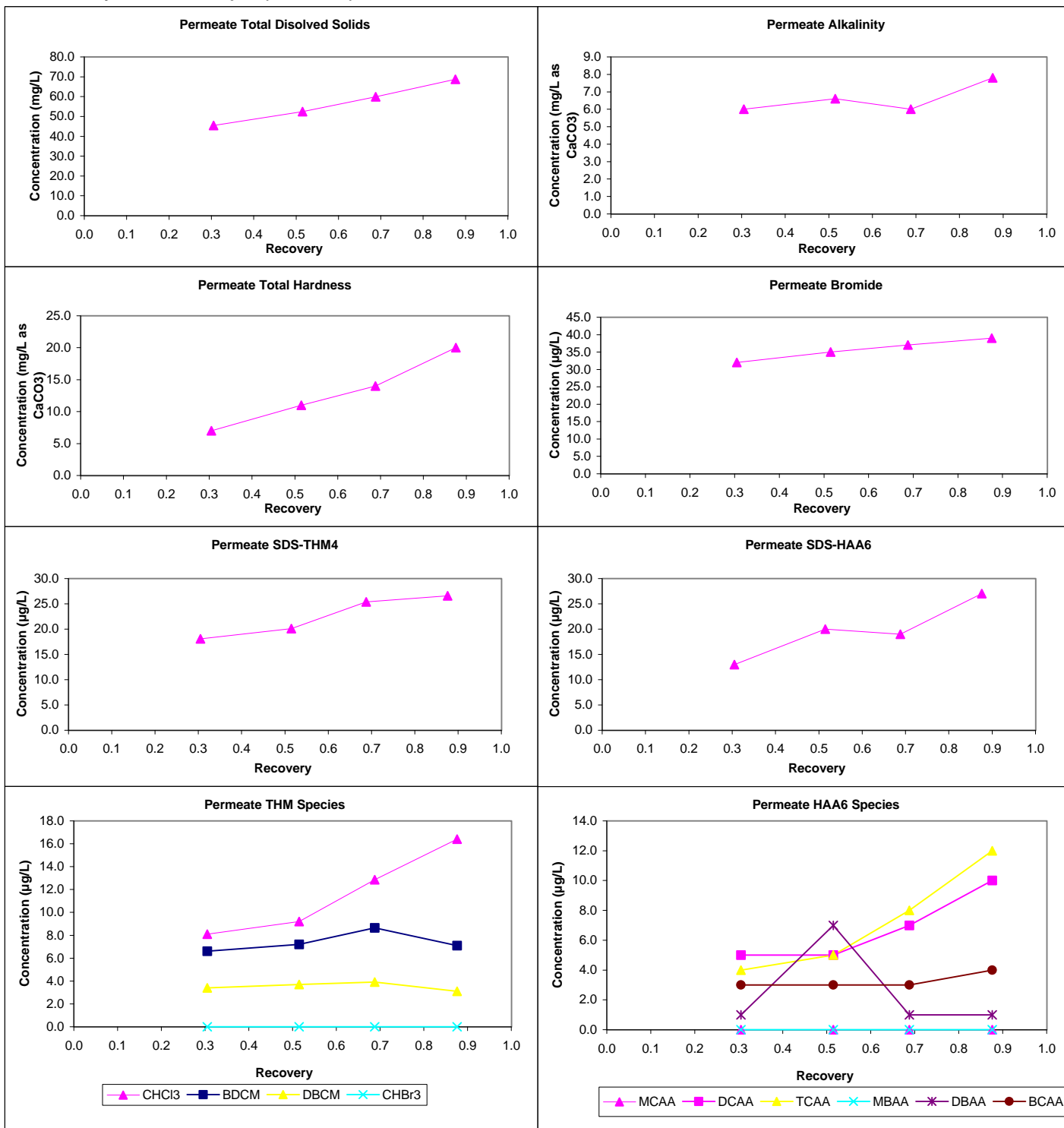
Manufacturer: Hydranautics Corp.
Trade Name: NTR7450
MWCO: 1000 Daltons
Mfr. Flux: 45.0 gfd
Mfr. NDP: 140.0 psi
Mfr. MTCw: 0.320 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 365.0 ft²
840 Purchase Price: \$800
840 Maximum Flow: 75.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 64.0 ft
840 Feed Spacer Thickness: 0.0025 ft

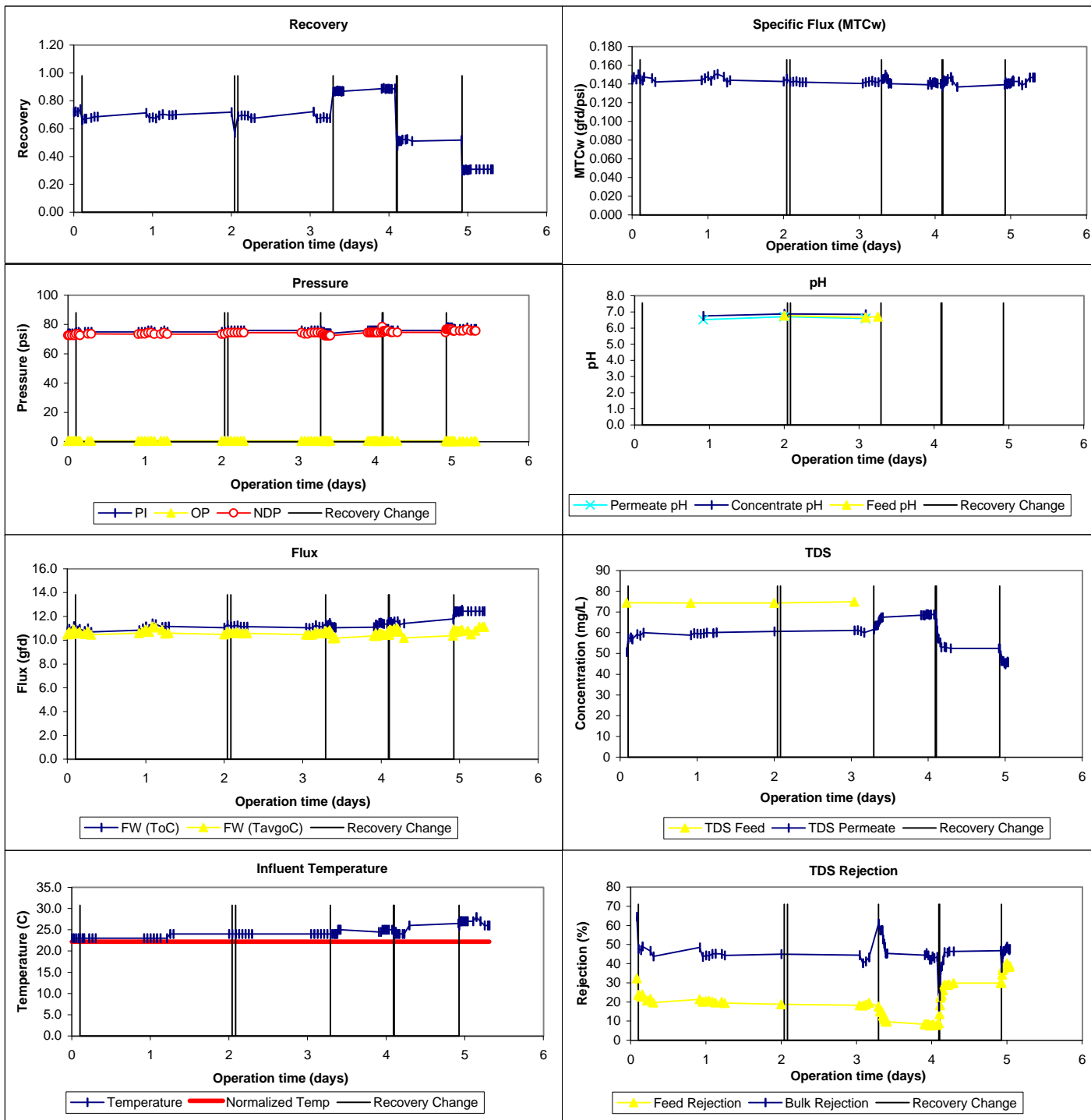
Water Quality Summary

Source ->			Feed				Permeate				Concentrate				Mass Balance Closure Err (%)			
Recovery ->			Avg	Diff	0.31	0.52	0.69	0.88	0.31	0.52	0.69	0.88	WQP	Count	Avg	SD		
pH			6.7	0.1	6.8	6.8	6.8	6.8	7.0	6.9	7.1	7.2	TDS	43	-1	12		
Temp			20.4	1.4	23.4	23.0	23.7	23.5	23.6	23.3	23.7	23.6	Alk	4	40	156		
Alk			6	0	6	7	6	8	8	4	3	4	TDS	4	3	3		
TDS			75	0	46	52	60	69	92	98	111	125	TotHard	4	3	3		
TotHard			24	0	7	11	14	20	32	40	46	56	CaHard	4	2	6		
CaHard			17	1	6	7	10	14	20	27	32	38	Turb	0	n/a	n/a		
Turb			0.14	0.05	NA	NA	NA	NA	NA	NA	NA	NA	Amm	0	n/a	n/a		
Amm			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TOC	4	-22	15		
TOC			3.2	0.0	0.8	1.2	1.8	1.5	3.3	4.3	6.1	10.8	UV254	4	1	4		
UV254			0.051	0.000	0.016	0.019	0.022	0.029	0.068	0.087	0.122	0.196						
SUVA			1.62	0.03	2.00	1.58	1.23	1.93	2.06	2.02	2.00	1.81						
Bromide			39	1	32	35	37	39										
TOX			225	0	87	100	115	145										
CHCl3			30.0	2.1	8.1	9.2	12.9	16.4										
BDCM			11.4	0.8	6.6	7.2	8.7	7.1										
DBCM			2.8	0.2	3.4	3.7	3.9	3.1										
CHBr3			0.0	0.0	0.0	0.0	0.0	0.0										
THM4			44.2	3.0	18.1	20.1	25.4	26.6										
MCAA			3.0	0.0	0.0	0.0	0.0	0.0										
DCAA			15.0	0.0	5.0	5.0	7.0	10.0										
TCAA			24.0	0.0	4.0	5.0	8.0	12.0										
MBAA			0.0	0.0	0.0	0.0	0.0	0.0										
DBAA			1.0	0.0	1.0	7.0	1.0	1.0										
BCAA			4.5	0.5	3.0	3.0	3.0	4.0										
TBAA			0.0	0.0	0.0	0.0	0.0	0.0										
CDBAA			2.0	0.0	2.0	0.0	2.0	3.0										
DCBAA			9.5	0.5	4.0	5.0	5.0	7.0										
HAA5			43.0	0.0	10.0	17.0	16.0	23.0										
HAA6			47.5	0.5	13.0	20.0	19.0	27.0										
HAA9			59.0	1.0	19.0	25.0	26.0	37.0										
SDS Conditions																		
WQP			Avg	SD	Count	Min - Max												
Res (mg/L) (0)			1.15	0.14	6	0.91 - 1.30												
Temp (°C)			10.0	0.0	6	10.0 - 10.0												
pH (unit)			7.4	0.1	6	7.3 - 7.5												
Time (hr)			60.0	0.0	6	60.0 - 60.0												

Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
ICR Contact: Mr. David Haddaway, Water Quality S
Phone No.: (757) 539-2201
Period: 5/26/97 - 6/1/97 (6 days)

Membrane Information

Manufacturer: Hydranautics Corp.
Trade Name: NTR7450
MWCO: 1000 Daltons
Mfr. Flux: 45.0 gfd
Mfr. NDP: 140.0 psi
Mfr. MTCw: 0.320 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 365.0 ft²
840 Purchase Price: \$800
840 Maximum Flow: 75.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 64.0 ft
840 Feed Spacer Thickness: 0.0025 ft

Water Quality Summary

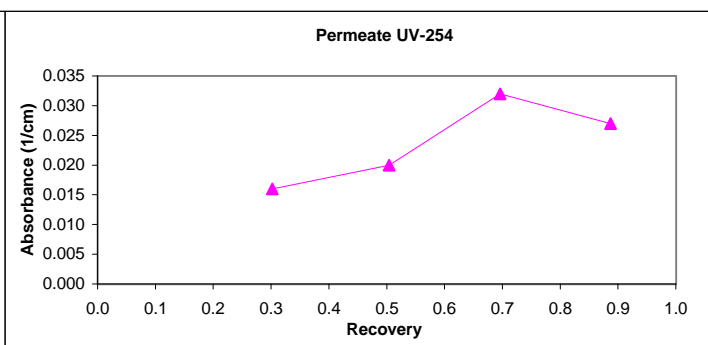
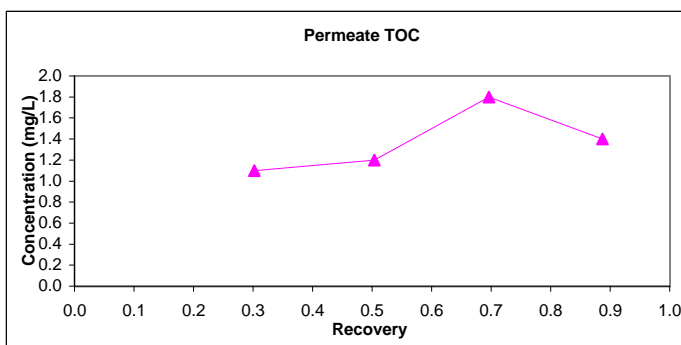
Source ->	Feed		Permeate			
Recovery ->	Avg	Diff	0.30	0.50	0.70	0.89
pH	6.8	0.1	6.9	6.8	6.9	6.9
Temp	21.5	0.3	21.9	22.2	21.5	22.4
Alk	7	0	5	5	5	7
TDS	75	2	43	53	68	69
TotHard	28	0	12	16	24	26
CaHard	20	0	7	10	16	16
Turb	0.09	0.00	0.08	0.07	0.06	0.05
Amm	NA	NA	NA	NA	NA	NA
TOC	3.0	0.0	1.1	1.2	1.8	1.4
UV254	0.051	0.000	0.016	0.020	0.032	0.027
SUVA	1.68	0.02	1.45	1.67	1.78	1.93
Bromide	40	1	33	38	40	41
TOX	264	11	88	102	141	135
CHCl3	48.9	1.1	13.9	16.1	24.2	21.8
BDCM	15.7	0.5	10.0	10.3	13.5	13.2
DBCM	3.5	0.3	4.8	5.0	5.0	5.3
CHBr3	0.0	0.0	0.0	0.0	0.0	0.0
THM4	68.1	1.9	28.7	31.4	42.6	40.3
MCAA	3.0	0.0	0.0	2.0	2.0	2.0
DCAA	23.0	2.0	6.0	7.0	12.0	9.0
TCAA	27.0	3.0	6.0	7.0	13.0	9.0
MBAA	0.0	0.0	0.0	0.0	0.0	0.0
DBAA	1.0	0.0	1.0	1.0	1.0	1.0
BCAA	6.5	0.5	4.0	4.0	5.0	5.0
TBAA	0.0	0.0	0.0	0.0	0.0	0.0
CDBAA	1.5	1.5	3.0	3.0	3.0	3.0
DCBAA	11.5	2.5	5.0	5.0	6.0	6.0
HAA5	54.0	5.0	13.0	17.0	28.0	21.0
HAA6	60.5	5.5	17.0	21.0	33.0	26.0
HAA9	73.5	6.5	25.0	29.0	42.0	35.0
SDS Conditions						
WQP	Avg	SD	Count	Min - Max		
Res (mg/L) (0)	0.79	0.17	6	0.47 - 0.96		
Temp (°C)	18.0	0.0	6	18.0 - 18.0		
pH (unit)	7.3	0.0	6	7.2 - 7.3		
Time (hr)	60.0	0.0	6	60.0 - 60.0		

Mass Balance Closure Err (%)

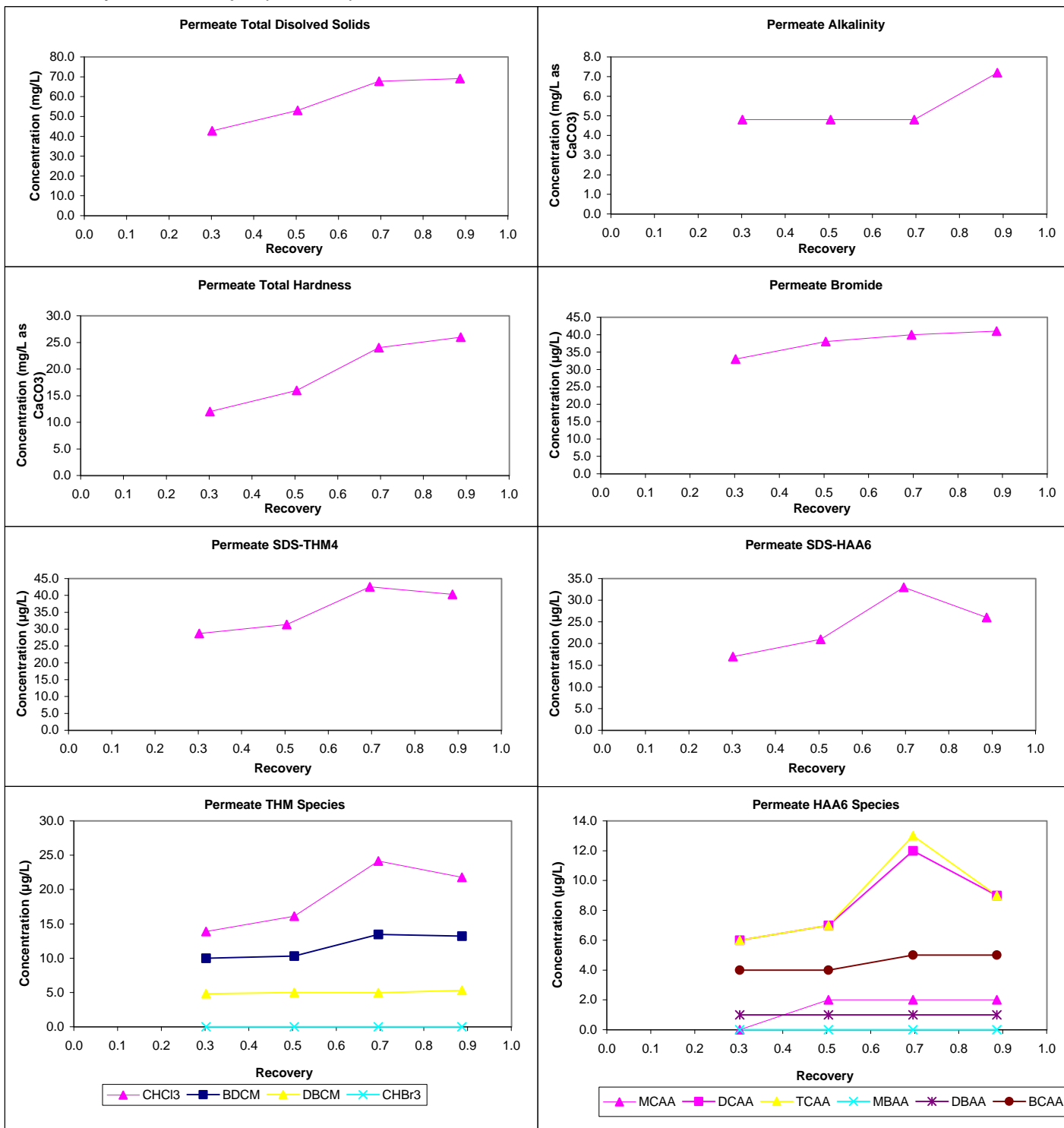
Concentrate				Mass Balance Closure Error (%)			
0.30	0.50	0.70	0.89	WQP	Count	Avg	SD
7.0	7.0	7.1	7.0	TDS	71	-4	59
21.9	21.8	22.6	22.1				
7	7	7	6	Alk	4	-40	36
85	95	95	136	TDS	4	1	6
36	42	38	68	TotHard	4	11	16
24	28	24	50	CaHard	4	-10	8
0.10	0.13	0.14	0.16	Turb	4	-53	99
NA	NA	NA	NA	Amm	0	n/a	n/a
4.0	4.9	4.9	15.2	TOC	4	-3	10
0.062	0.078	0.085	0.247	UV254	4	-4	6
1.55	1.59	1.73	1.63				
Pretreatment Information							
Process		Description		Scale			
Preoxidation		KMnO4 dose = 0.63 mg/L		Full-scale			
PAC addition		PAC dose = 2.1 mg/L		Full-scale			
Coagulation		alum dose = 64 mg/L, pH = 5.8		Full-scale			
Flocculation		One stage, 8 s-1		Full-scale			
Sedimentation		Upflow		Full-scale			
Cartridge Filtration		5 micron nominal rating		Bench-scale			
Plant flow		8.9 mgd		Full-scale			
Design Parameters							
Active memb area:		0.167 ft ²		ID#	Recov (dec.)	F _{W-des}	
Active width:		0.313 ft				(gfd)	
Norm Temp:		22.2 °C		1	0.70	10.0	
Feed TDS:		80.6 mg/L		2	0.90	10.0	
Manuf rep TDS rej:		50%		3	0.50	10.0	
Temp Norm MTC-w:		0.295 gfd/psi		4	0.30	10.0	

Comments:

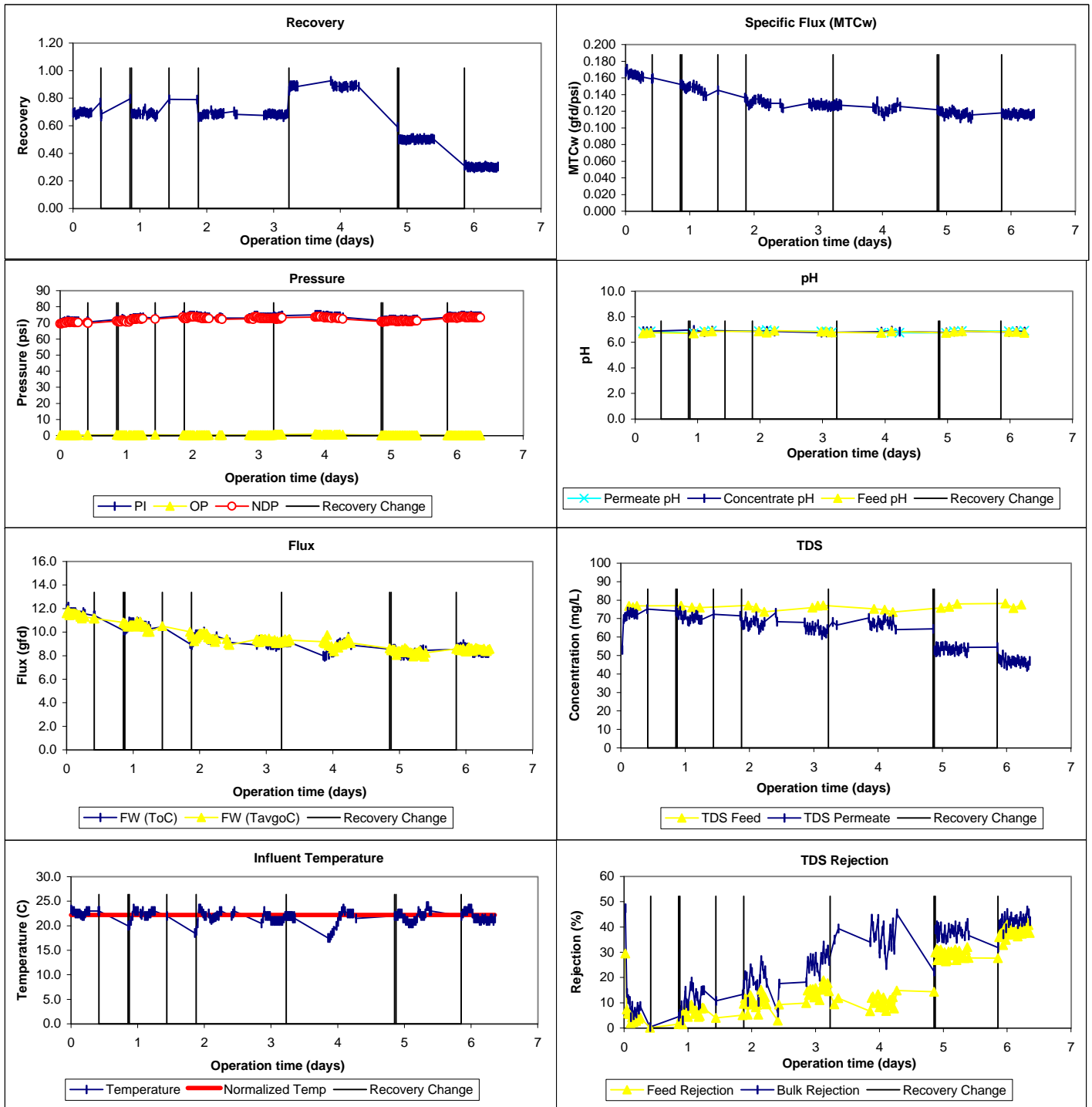
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
 ICR Contact: Mr. David Haddaway, Water Quality S
 Phone No.: (757) 539-2201
 Period: 8/1/97 - 8/8/97 (7 days)

Membrane Information

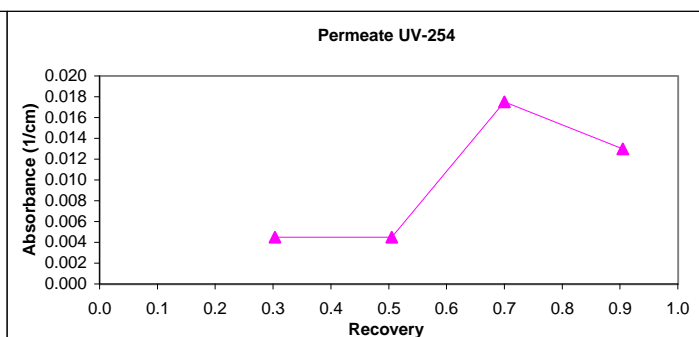
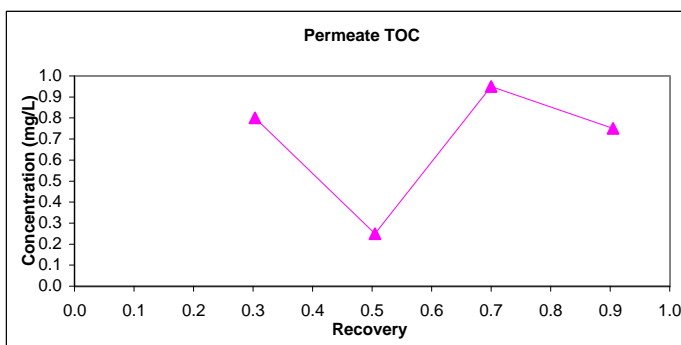
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 Trade Name: NTR7450
 MWCO: 1000 Daltons
 Mfr. Flux: 45.0 gfd
 Mfr. NDP: 140.0 psi
 Mfr. MTCw: 0.320 gfd/psi

Mfr. Temp: 25.0 °C
 840 Element Area: 365.0 ft²
 840 Purchase Price: \$800
 840 Maximum Flow: 75.0 gpm
 840 Minimum Flow: 25.0 gpm
 840 Total Width: 64.0 ft
 840 Feed Spacer Thickness: 0.0025 ft

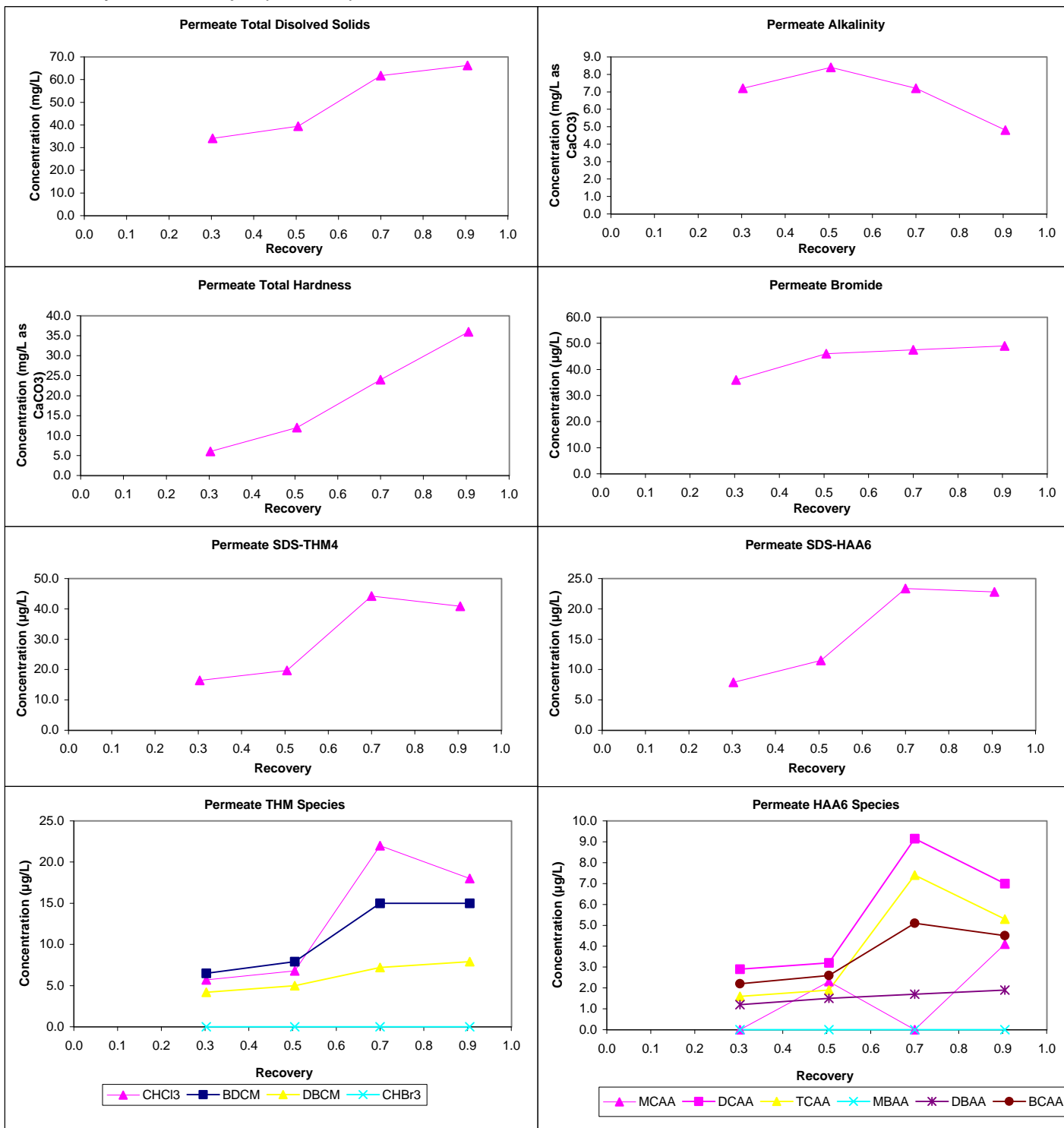
Water Quality Summary

Source ->		Feed		Permeate				Concentrate				Mass Balance Closure Err (%)											
Recovery ->		Avg	Diff	0.30	0.51	0.70	0.91	0.30	0.51	0.70	0.91	WQP	Count	Avg	SD								
pH		6.7	0.1	7.3	7.3	7.3	7.2	6.9	6.9	6.9	6.8	TDS	57	-7	38								
Temp		20.3	0.2	20.2	19.7	21.2	21.4	19.9	19.5	20.7	20.2	Alk	4	-47	140								
Alk		7	0	7	8	7	5	8	8	10	8	TDS	4	-7	5								
TDS		84	0	34	39	62	66	103	126	128	228	TotHard	4	-469	201								
TotHard		44	4	6	12	24	36	14	14	21	14	CaHard	3	-7	6								
CaHard		31	1	0	8	18	22	38	52	54	114	Turb	3	-201	192								
Turb		0.39	0.05	0.00	0.06	0.16	0.14	0.41	0.43	0.44	0.53	Amm	0	n/a	n/a								
Amm		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TOC	3	-3	13								
TOC		3.1	0.0	0.8	0.3	1.0	0.8	4.5	6.1	8.1	21.5	UV254	2	2	5								
UV254		0.047	0.009	0.005	0.005	0.018	0.013	0.076	0.104	0.125	0.362	Pretreatment Information											
SUVA		1.53	0.31	0.56	1.80	1.84	1.73	1.71	1.70	1.54	1.69												
Bromide		48	2	36	46	48	49	ProcessDescriptionScale															
TOX		398	15	47	57	138	115																
CHCl3		96.0	NA	5.7	6.8	22.0	18.0	PreoxidationKMnO4 dose = 1.7 mg/LFull-scale PAC additionPAC dose = 5 mg/LFull-scale Coagulation lum dose = 92 mg/L, pH = 6.3Full-scale FlocculationOne stage, 8 s-1Full-scale SedimentationUpflowFull-scale Cartridge Filtration5 micron nominal ratingBench-scale Plant flow12.3 mgdFull-scale															
BDCM		22.0	NA	6.5	7.9	15.0	15.0																
DBCM		4.1	NA	4.2	5.0	7.2	7.9																
CHBr3		0.0	NA	0.0	0.0	0.0	0.0																
THM4		122.1	NA	16.4	19.7	44.2	40.9																
MCAA		4.1	0.3	0.0	2.3	0.0	4.1																
DCAA		34.0	3.0	2.9	3.2	9.2	7.0																
TCAA		39.5	2.5	1.6	1.9	7.4	5.3	Design Parameters															
MBAA		0.0	0.0	0.0	0.0	0.0	0.0																
DBAA		1.1	0.1	1.2	1.5	1.7	1.9																
BCAA		7.9	0.9	2.2	2.6	5.1	4.5																
TBAA		0.0	NA	NR	NR	0.0	NR																
CDBAA		1.2	1.2	2.3	2.8	3.1	3.4																
DCBAA		13.5	0.5	2.2	2.5	6.8	5.0																
HAA5		78.7	5.7	5.7	8.9	18.3	18.3	Active memb area:0.167 ft² Active width:0.313 ft Norm Temp:22.2 °C Feed TDS:80.6 mg/L Manuf rep TDS rej:50% Temp Norm MTC-w:0.295 gfd/psi															
HAA6		86.6	6.6	7.9	11.5	23.4	22.8																
HAA9		109.5	NA	NR	NR	33.2	NR																
SDS Conditions																ID#Recov (dec.)Fw-des (gfd) 10.7010.0 20.9010.0 30.5010.0 40.3010.0							
WQP		Avg	SD	Count	Min - Max																		
Res (mg/L) (0)		1.39	0.46	6	0.60 - 1.91																		
Temp (°C)		28.0	0.0	6	28.0 - 28.0																		
pH (unit)		7.4	0.1	6	7.3 - 7.4																		
Time (hr)		72.0	0.0	6	72.0 - 72.0	Comments:																	

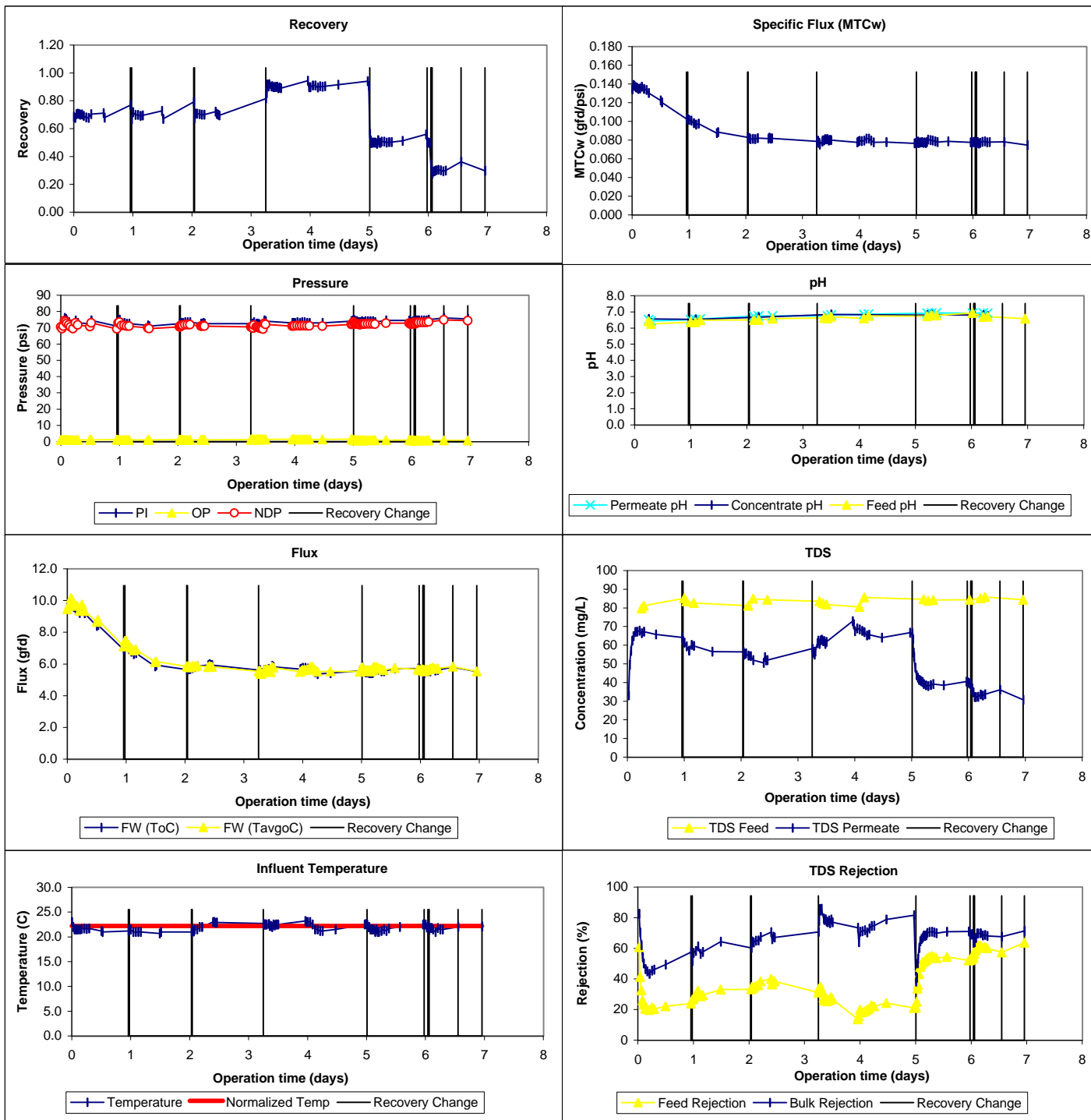
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
ICR Contact: Mr. David Haddaway, Water Quality S
Phone No.: (757) 539-2201
Period: 10/21/97 - 10/27. (6 days)

Membrane Information

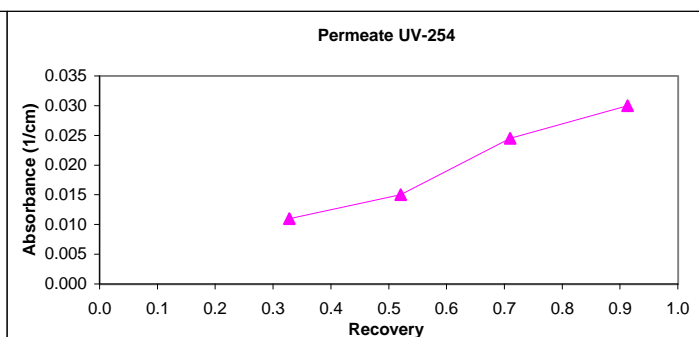
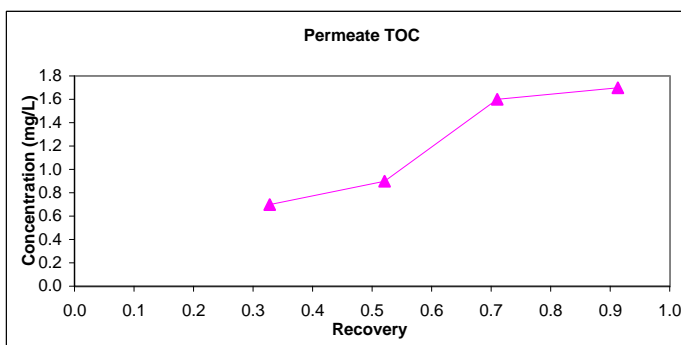
Manufacturer: Hydranautics Corp.
Trade Name: NTR7450
MWCO: 1000 Daltons
Mfr. Flux: 45.0 gfd
Mfr. NDP: 140.0 psi
Mfr. MTCw: 0.320 gfd/psi

Mfr. Temp: 25.0 °C
840 Element Area: 365.0 ft²
840 Purchase Price: \$800
840 Maximum Flow: 75.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 64.0 ft
840 Feed Spacer Thickness: 0.0025 ft

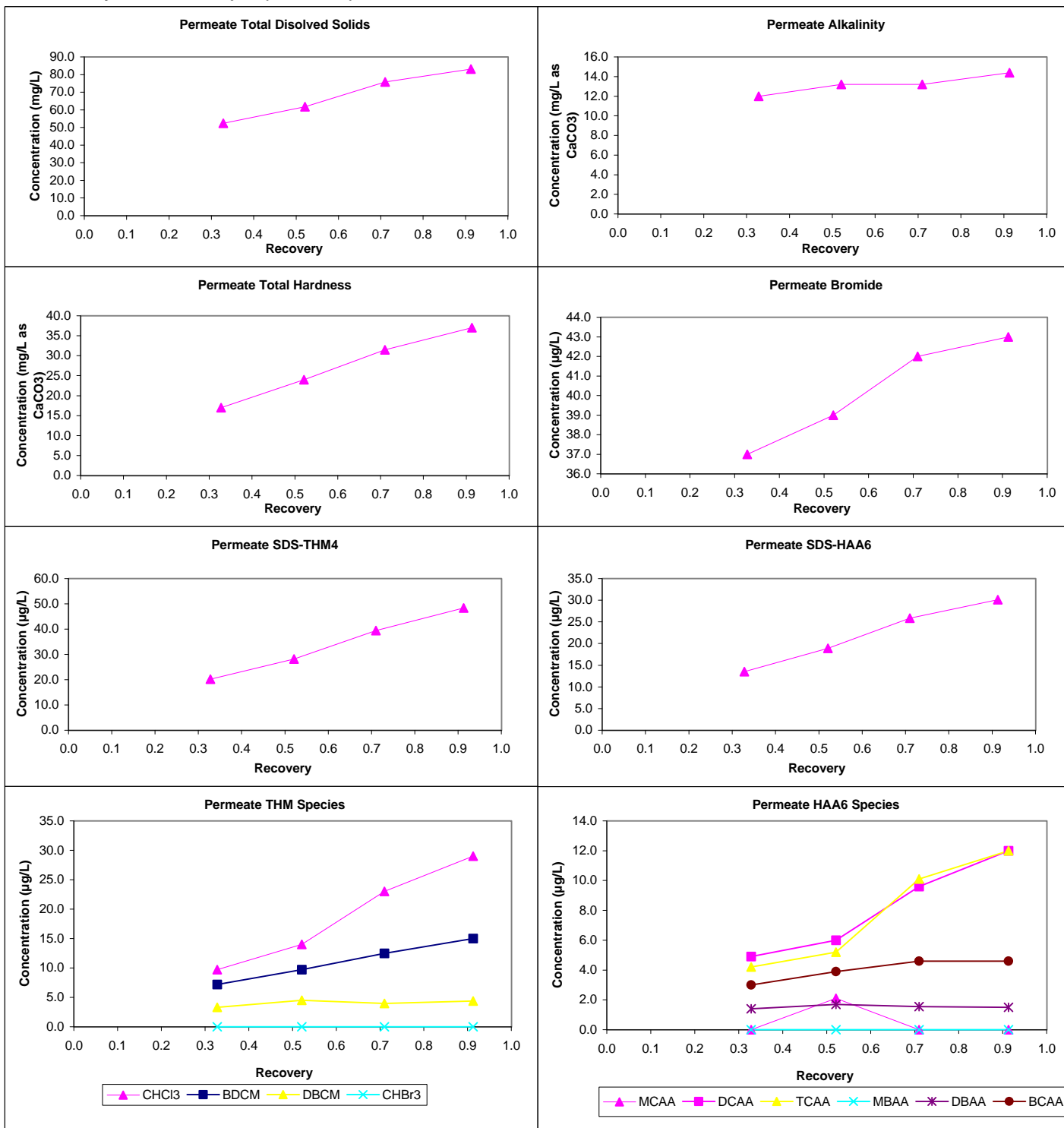
Water Quality Summary

Source ->		Feed		Permeate				Concentrate				Mass Balance Closure Err (%)				
Recovery ->		Avg	Diff	0.33	0.52	0.71	0.91	0.33	0.52	0.71	0.91	WQP	Count	Avg	SD	
pH		7.1	0.0	7.3	7.5	7.5	7.4	7.5	7.5	7.6	7.5	TDS	55	-10	48	
Temp		19.0	0.0	24.5	24.8	25.0	25.5	25.0	25.4	24.0	25.0	Alk	4	5	19	
Alk		15	0	12	13	13	14	18	17	17	30	TDS	4	-3	1	
TDS		89	0	52	62	76	83	102	115	116	144	TotHard	4	-1	3	
TotHard		41	1	17	24	32	37	51	61	62	82	CaHard	4	2	5	
CaHard		29	1	12	16	22	26	36	42	45	60	Turb	4	29	79	
Turb		0.10	0.00	0.08	0.22	0.11	0.06	0.15	0.22	0.23	0.30	Amm	0	n/a	n/a	
Amm		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TOC	4	-5	6	
TOC		3.0	0.1	0.7	0.9	1.6	1.7	3.7	5.0	6.4	14.5	UV254	4	-9	6	
UV254		0.053	0.000	0.011	0.015	0.025	0.030	0.069	0.091	0.112	0.252					
SUVA		1.80	0.09	1.57	1.67	1.53	1.76	1.86	1.82	1.75	1.74					
Bromide		42	0	37	39	42	43									
TOX		233	43	77	88	135	170									
CHCl3		48.0	2.0	9.7	14.0	23.0	29.0									
BDCM		16.0	1.0	7.2	9.7	12.5	15.0									
DBCM		2.8	0.2	3.3	4.5	4.0	4.4									
CHBr3		0.0	0.0	0.0	0.0	0.0	0.0									
THM4		66.8	3.2	20.2	28.2	39.5	48.4									
MCAA		2.7	0.5	0.0	2.1	0.0	0.0									
DCAA		21.0	0.0	4.9	6.0	9.6	12.0									
TCAA		30.5	0.5	4.2	5.2	10.1	12.0									
MBAA		0.0	0.0	0.0	0.0	0.0	0.0									
DBAA		1.2	0.2	1.4	1.7	1.6	1.5									
BCAA		5.9	0.2	3.0	3.9	4.6	4.6									
TBAA		NA	NA	NR	NR	NA	NR									
CDBAA		2.1	NA	NR	NR	NA	NR									
DCBAA		11.0	1.0	4.0	4.4	6.0	6.5									
HAA5		55.3	0.8	10.5	15.0	21.3	25.5									
HAA6		61.2	1.0	13.5	18.9	25.9	30.1									
HAA9		NA	NA	NR	NR	NA	NR									
SDS Conditions																
WQP	Avg	SD	Count	Min - Max												
Res (mg/L) (0)	1.21	0.19	6	0.97 - 1.49												
Temp (°C)	15.5	0.0	6	15.5 - 15.5												
pH (unit)	7.3	0.1	6	7.3 - 7.5												
Time (hr)	72.0	0.0	6	72.0 - 72.0												
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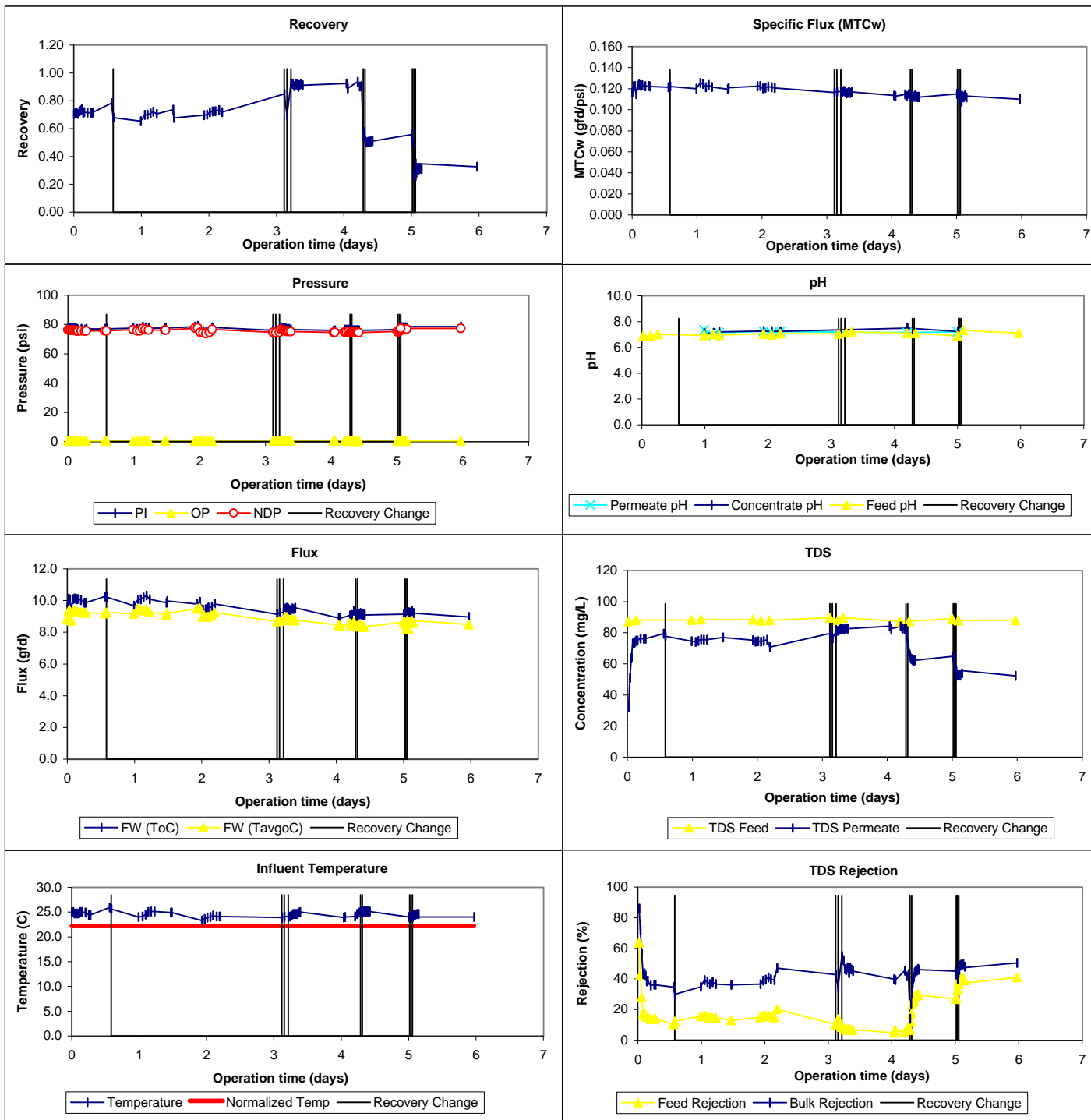
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
 ICR Contact: Mr. David Haddaway, Water Quality S
 Phone No.: (757) 539-2201
 Period: 2/5/97 - 2/10/97 (5 days)

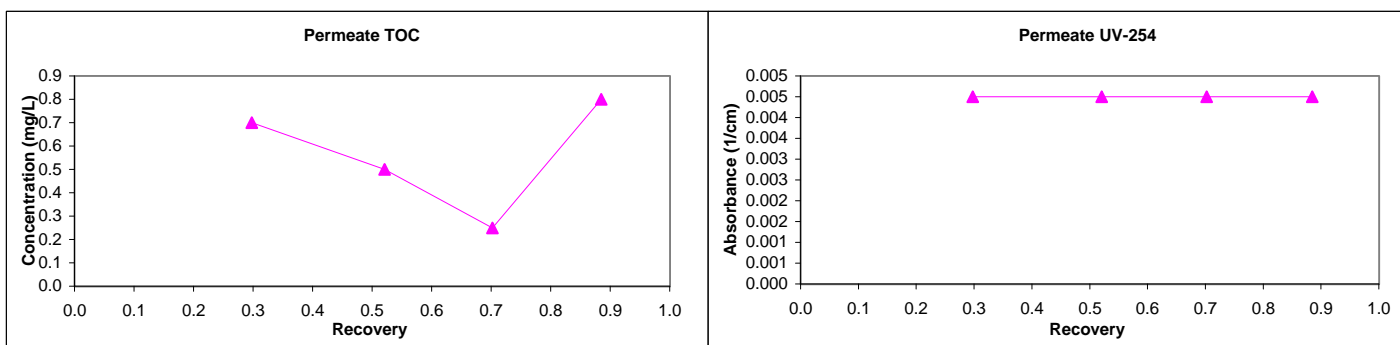
Membrane Information

Manufacturer: Dow Chemical Co. Mfr. Temp: 25.0 °C
 Trade Name: FilmTec NF45 840 Element Area: 390.0 ft²
 MWCO: 200 Daltons 840 Purchase Price: \$600
 Mfr. Flux: 28.0 gfd 840 Maximum Flow: 60.0 gpm
 Mfr. NDP: 120.0 psi 840 Minimum Flow: 25.0 gpm
 Mfr. MTCw: 0.230 gfd/psi 840 Total Width: 69.0 ft
 840 Feed Spacer Thickness: 0.0025 ft

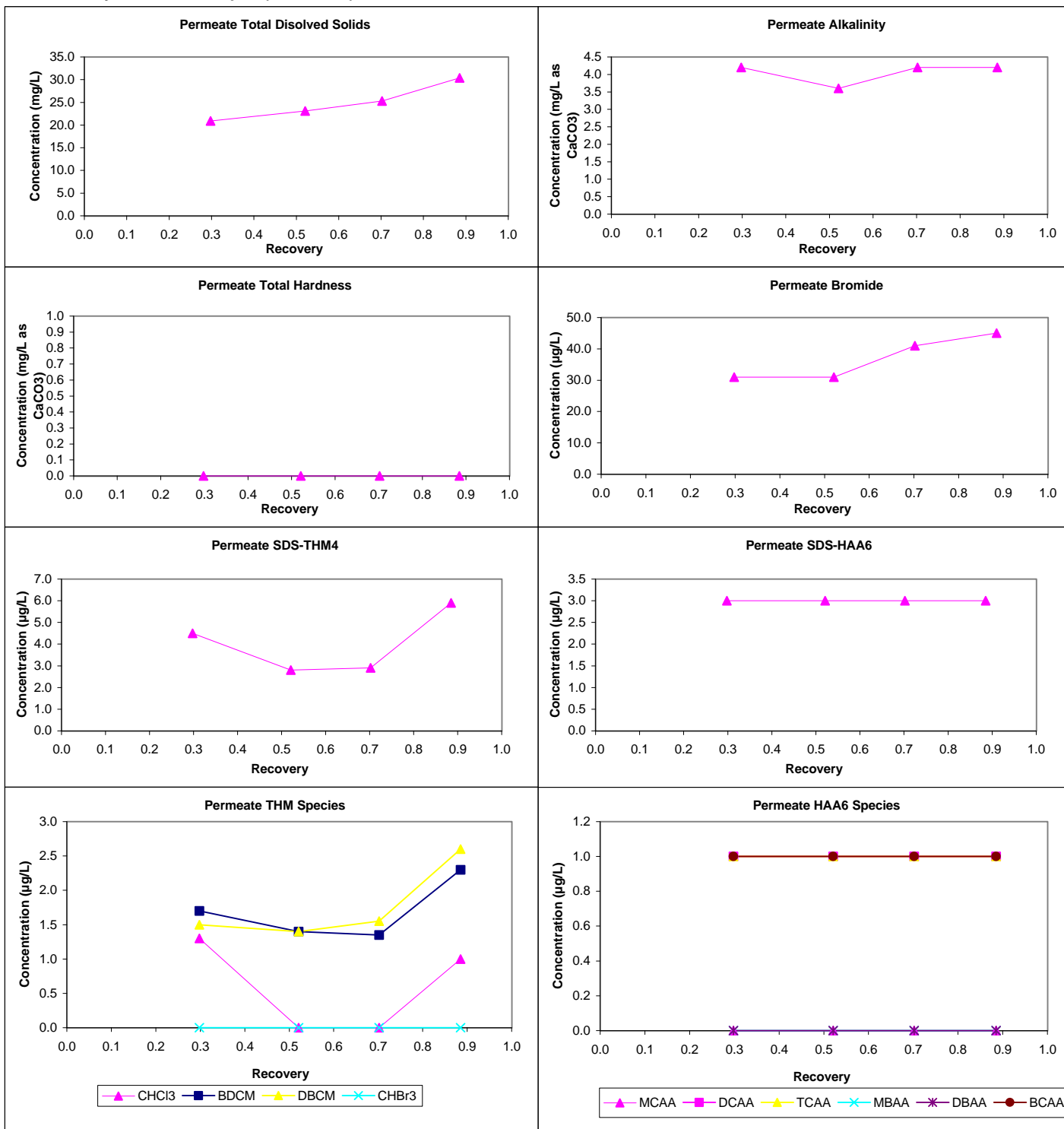
Water Quality Summary

Source ->		Feed		Permeate				Concentrate				Mass Balance Closure Err (%)						
Recovery ->		Avg	Diff	0.30	0.52	0.70	0.89	0.30	0.52	0.70	0.89	WQP	Count	Avg	SD			
pH		6.9	0.2	6.8	6.8	6.8	6.9	6.8	6.6	6.6	6.7	TDS	38	-11	40			
Temp		20.4	1.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	Alk	4	-122	80			
Alk		7	1	4	4	4	4	6	4	6	8	TDS	4	-4	5			
TDS		75	0	21	23	25	30	97	127	173	413	TotHard	1	-4	n/a			
TotHard		24	1	0	0	0	0	34	50	76	173	CaHard	1	-12	n/a			
CaHard		17	1	0	0	0	0	22	32	51	111	Turb	4	-118	119			
Turb		0.14	0.05	0.09	0.07	0.06	0.09	0.17	0.15	0.11	0.15	Amm	0	n/a	n/a			
Amm		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TOC	4	-2	7			
TOC		3.1	0.1	0.7	0.5	0.3	0.8	4.2	6.0	9.2	19.4	UV254	1	-13	n/a			
UV254		0.051	0.000	0.005	0.005	0.005	0.005	0.068	0.101	0.151	0.336							
SUVA		1.67	0.03	0.64	0.90	1.80	0.56	1.62	1.68	1.64	1.73							
Bromide		41	5	31	31	41	45	Pretreatment Information										
TOX		57	9	57	42	27	51											
		Process Description Scale																
CHCl3		31.1	0.0	1.3	0.0	0.0	1.0	Preoxidation		KMnO4 dose = 1.1 mg/L		Full-scale						
BDCM		12.4	0.4	1.7	1.4	1.4	2.3	PAC addition		PAC dose = 1 mg/L		Full-scale						
DBCM		3.0	0.0	1.5	1.4	1.6	2.6	Coagulation		Alum dose = 63 mg/L, pH 6		Full-scale						
CHBr3		0.0	0.0	0.0	0.0	0.0	0.0	Flocculation		One stage, 8 s-1		Full-scale						
THM4		46.5	0.3	4.5	2.8	2.9	5.9	Sedimentation		Upflow		Full-scale						
MCAA		0.0	0.0	0.0	0.0	0.0	0.0	Cartridge Filtration		5 micron nominal rating		Bench-scale						
DCAA		16.5	0.5	1.0	1.0	1.0	1.0	Plant flow		13.8 mgd		Full-scale						
TCAA		23.5	0.5	1.0	1.0	1.0	1.0	Design Parameters										
MBAA		1.0	1.0	0.0	0.0	0.0	0.0											
DBAA		1.0	0.0	0.0	0.0	0.0	0.0											
BCAA		5.0	0.0	1.0	1.0	1.0	1.0											
TBAA		0.0	0.0	0.0	0.0	0.0	0.0											
CDBAA		1.0	1.0	0.0	0.0	0.0	0.0											
DCBAA		9.0	0.0	1.0	1.0	1.0	2.0											
HAA5		42.0	2.0	2.0	2.0	2.0	2.0											
HAA6		47.0	2.0	3.0	3.0	3.0	3.0											
HAA9		57.0	3.0	4.0	4.0	4.0	5.0											
SDS Conditions								Active memb area: 0.167 ft ² Active width: 0.313 ft Norm Temp: 22.2 °C Feed TDS: 80.6 mg/L Manuf rep TDS rej: 60% Temp Norm MTC-w: 0.212 gfd/psi										
WQP		Avg	SD	Count	Min - Max											ID#	Recov (dec.)	F _{w-des} (gfd)
Res (mg/L) (0)		1.47	0.13	6	1.31 - 1.59													
Temp (°C)		10.0	0.0	6	10.0 - 10.0													
pH (unit)		7.3	0.0	6	7.3 - 7.4													
Time (hr)		60.0	0.0	6	60.0 - 60.0													
Comments:																		

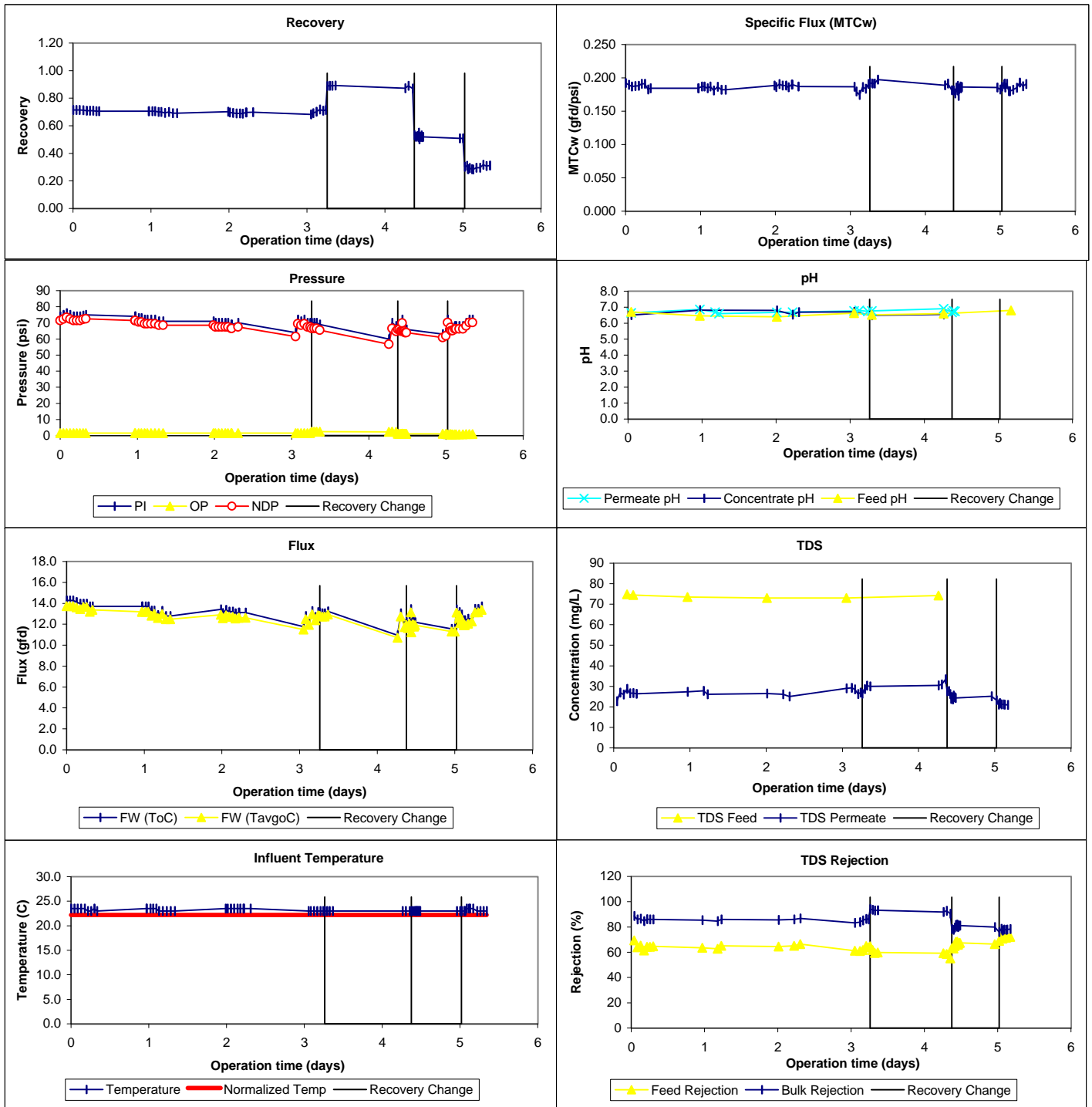
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
ICR Contact: Mr. David Haddaway, Water Quality S
Phone No.: (757) 539-2201
Period: 5/15/97 - 5/21/97 (6 days)

Membrane Information

Manufacturer: Dow Chemical Co., Midland, MI
Trade Name: FilmTec NF45
MWCO: 200 Daltons
Mfr. Flux: 28.0 gfd
Mfr. NDP: 120.0 psi
Mfr. MTCw: 0.230 gfd/psi
Mfr. Temp: 25.0 °C
840 Element Area: 390.0 ft²
840 Purchase Price: \$600
840 Maximum Flow: 60.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 69.0 ft
840 Feed Spacer Thickness: 0.0025 ft

Water Quality Summary

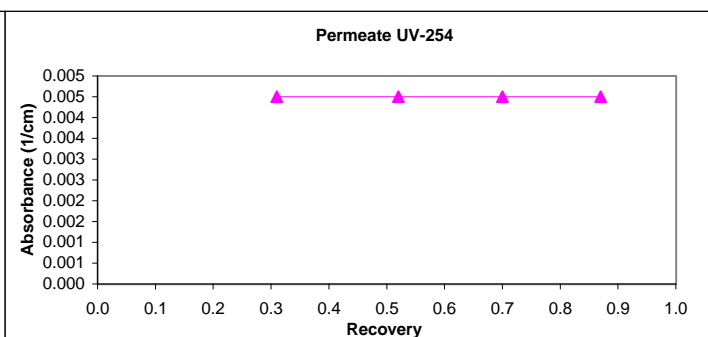
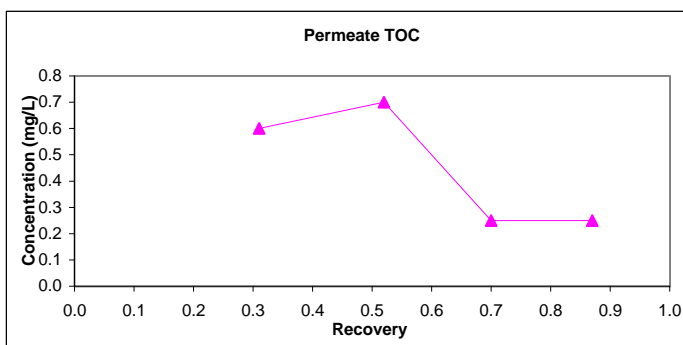
Source ->	Feed		Permeate			
Recovery ->	Avg	Diff	0.31	0.52	0.70	0.87
pH	6.5	0.1	6.9	7.0	6.9	7.0
Temp	22.5	1.5	22.1	21.9	22.9	22.1
Alk	7	2	4	7	9	6
TDS	77	1	31	32	34	36
TotHard	28	0	0	0	0	0
CaHard	20	0	0	0	0	0
Turb	0.24	0.08	0.06	0.05	0.05	0.05
Amm	NA	NA	NA	NA	NA	NA
TOC	3.4	0.0	0.6	0.7	0.3	0.3
UV254	0.053	0.001	0.005	0.005	0.005	0.005
SUVA	1.54	0.01	0.75	0.64	1.80	1.80
Bromide	40	1	41	43	41	41
TOX	264	11	39	44	57	62
CHCl3	48.9	1.1	3.1	3.5	5.4	5.9
BDCM	15.7	0.5	3.6	4.3	6.0	6.5
DBCM	3.5	0.3	3.0	3.6	4.5	4.8
CHBr3	0.0	0.0	0.0	0.0	0.0	0.0
THM4	68.1	1.9	9.7	11.4	15.8	17.2
MCAA	3.0	0.0	0.0	0.0	0.0	2.0
DCAA	23.0	2.0	2.0	2.0	4.5	4.0
TCAA	27.0	3.0	2.0	3.0	3.5	4.0
MBAA	0.0	0.0	0.0	0.0	0.0	0.0
DBAA	1.0	0.0	1.0	1.0	1.0	1.0
BCAA	6.5	0.5	2.0	2.0	3.5	3.0
TBAA	0.0	0.0	0.0	0.0	0.0	0.0
CDBAA	1.5	1.5	3.0	3.0	3.0	3.0
DCBAA	11.5	2.5	3.0	4.0	4.5	5.0
HAA5	54.0	5.0	5.0	6.0	9.0	11.0
HAA6	60.5	5.5	7.0	8.0	12.5	14.0
HAA9	73.5	6.5	13.0	15.0	20.0	22.0
SDS Conditions						
WQP	Avg	SD	Count	Min - Max		
Res (mg/L) (0)	1.25	0.48	6	0.47 - 1.61		
Temp (°C)	18.0	0.0	6	18.0 - 18.0		
pH (unit)	7.3	0.1	6	7.2 - 7.4		
Time (hr)	60.0	0.0	6	60.0 - 60.0		

Mass Balance Closure Err (%)

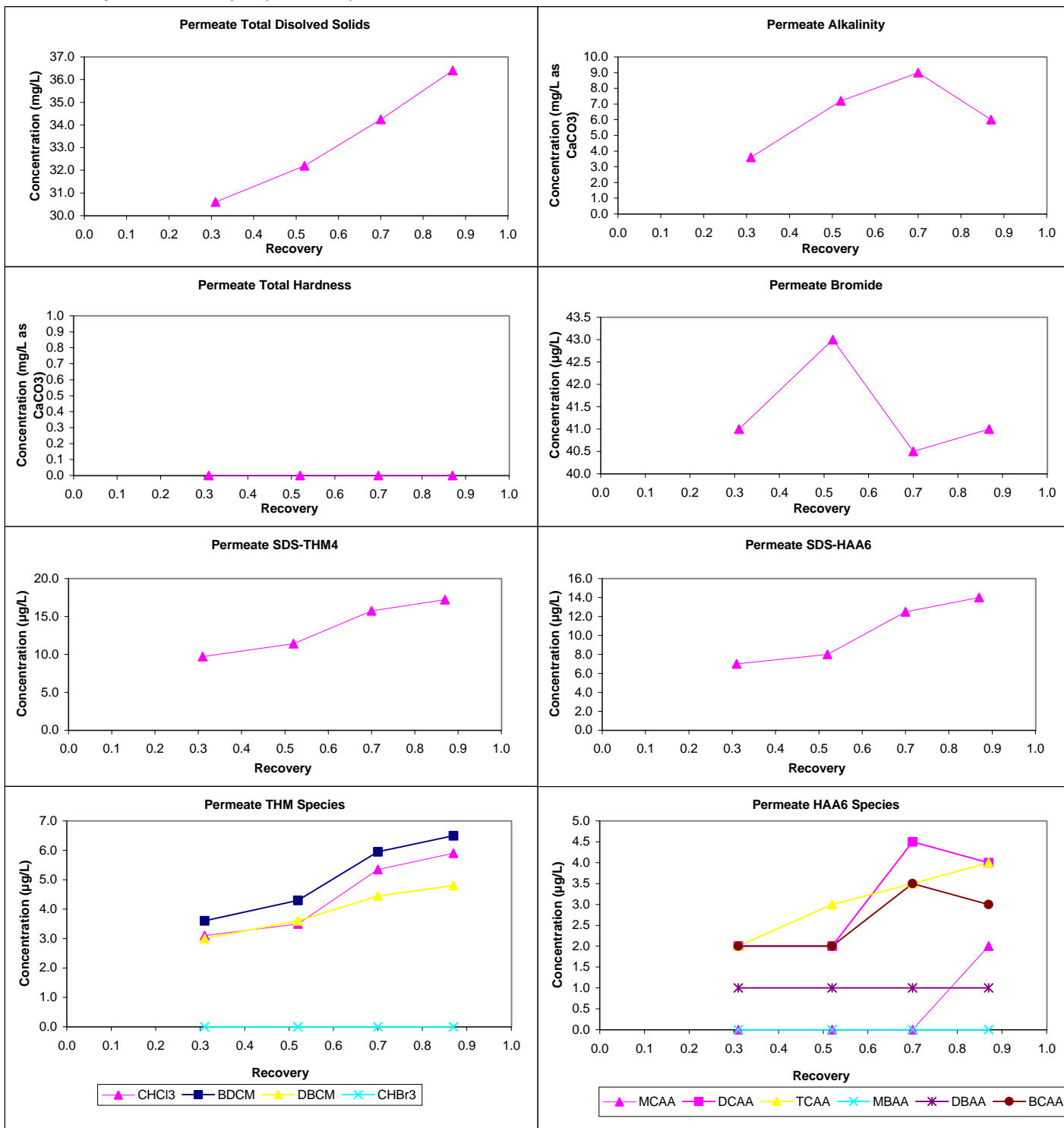
Concentrate				Mass Balance Closure Error (%)				
0.31	0.52	0.70	0.87	WQP	Count	Avg	SD	
7.0	7.1	7.2	6.7	TDS	39	-8	37	
21.2	22.0	20.3	23.2					
8	8	10	7	Alk	4	-8	76	
103	133	187	368	TDS	4	6	0	
42	62	102	262	TotHard	0	n/a	n/a	
30	44	72	168	CaHard	0	n/a	n/a	
0.13	0.13	0.12	0.18	Turb	4	-417	269	
NA	NA	NA	NA	Amm	0	n/a	n/a	
4.4	6.6	10.4	25.8	TOC	3	1	6	
0.070	0.106	0.165	0.424	UV254	0	n/a	n/a	
1.59	1.61	1.59	1.64					
Pretreatment Information								
Process		Description		Scale				
Preoxidation		KMnO4 dose = 0.63 mg/L		Full-scale				
PAC addition		PAC dose = 2.1 mg/L		Full-scale				
Coagulation		alum dose = 64 mg/L, pH = 5.8		Full-scale				
Flocculation		One stage, 8 s-1		Full-scale				
Sedimentation		Upflow		Full-scale				
Cartridge Filtration		5 micron nominal rating		Bench-scale				
Plant flow		8.9 mgd		Full-scale				
Design Parameters								
Active memb area:		0.167 ft ²		ID#	Recov (dec.)	F _{W-des}		
Active width:		0.313 ft				(gfd)		
Norm Temp:		22.2 °C		1	0.70	10.0		
Feed TDS:		80.6 mg/L		2	0.90	10.0		
Manuf rep TDS rej:		60%		3	0.50	10.0		
Temp Norm MTC-w:		0.212 gfd/psi		4	0.30	10.0		

Comments:

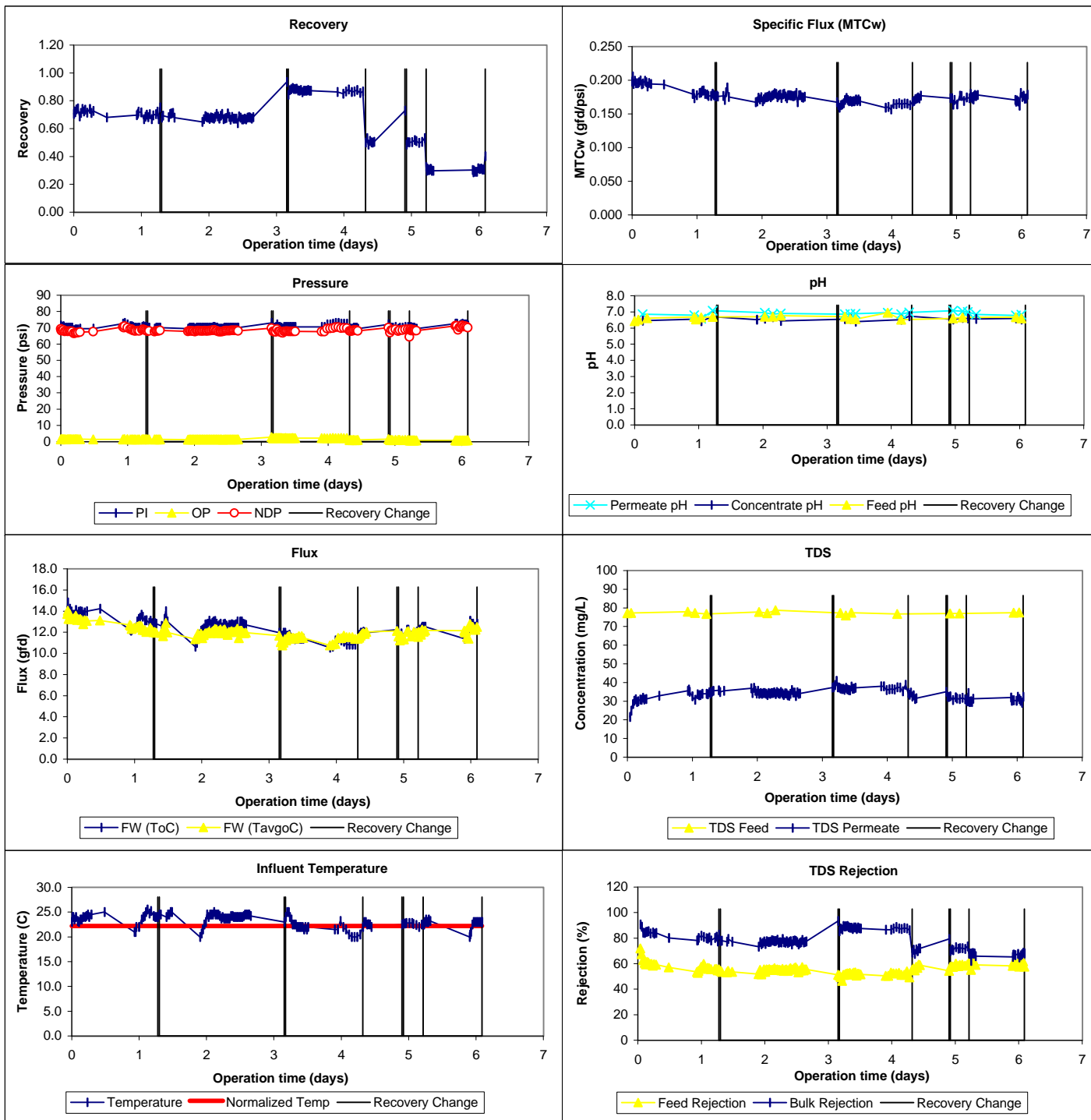
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
ICR Contact: Mr. David Haddaway, Water Quality S
Phone No.: (757) 539-2201
Period: 7/24/97 - 7/31/97 (7 days)

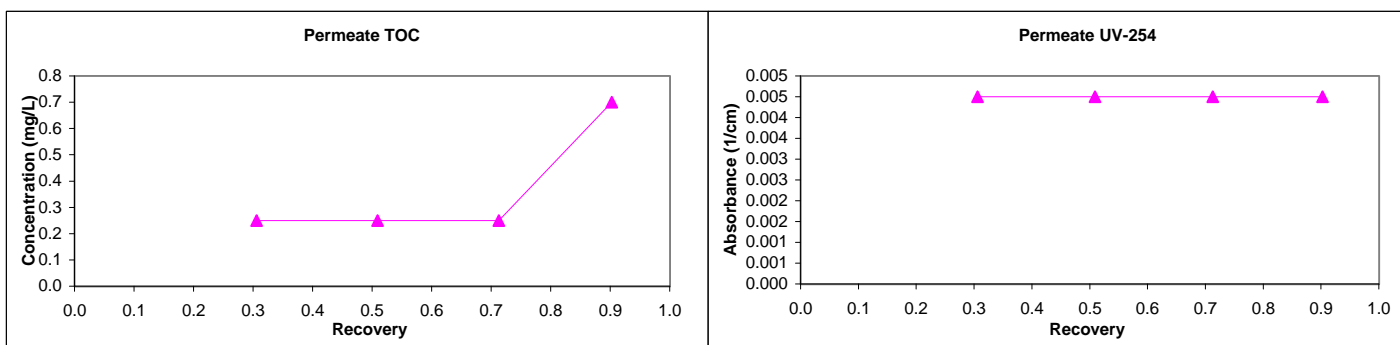
Membrane Information

Manufacturer: Dow Chemical Co., Midland, MI
Trade Name: FilmTec NF45
MWCO: 200 Daltons
Mfr. Flux: 28.0 gfd
Mfr. NDP: 120.0 psi
Mfr. MTCw: 0.230 gfd/psi
Mfr. Temp: 25.0 °C
840 Element Area: 390.0 ft²
840 Purchase Price: \$600
840 Maximum Flow: 60.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 69.0 ft
840 Feed Spacer Thickness: 0.0025 ft

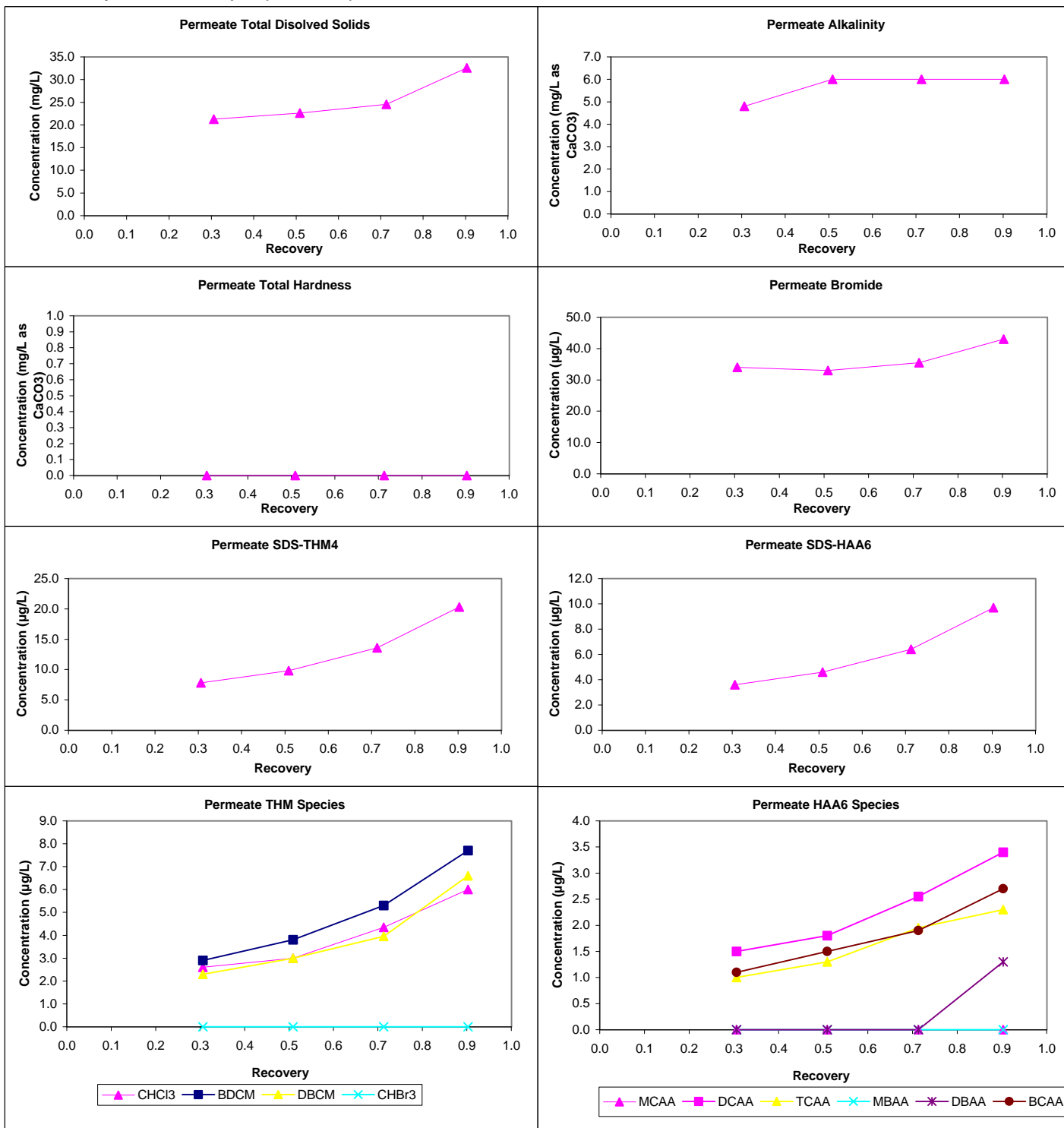
Water Quality Summary

Water Quality Summary							Concentrate				Mass Balance Closure Error (%)						
Source ->	Feed		Permeate														
Recovery ->	Avg	Diff	0.31	0.51	0.71	0.90	0.31	0.51	0.71	0.90	WQP	Count	Avg	SD			
pH	6.2	0.1	6.7	6.8	6.4	6.7	6.9	7.0	7.2	6.9	TDS	66	-18	54			
Temp	22.6	0.0	22.7	22.8	22.5	22.9	22.8	22.2	24.6	22.4							
Alk	7	1	5	6	6	6	7	7	10	11	Alk	4	0	12			
TDS	83	1	21	23	25	33	110	137	214	438	TDS	4	-10	11			
TotHard	44	4	0	0	0	0	58	88	140	390	TotHard	0	n/a	n/a			
CaHard	31	1	0	0	0	0	42	60	102	280	CaHard	0	n/a	n/a			
Turb	0.15	0.01	0.00	0.00	0.04	0.00	0.25	0.52	1.09	2.90	Turb	1	61	n/a			
Amm	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Amm	0	n/a	n/a			
TOC	3.5	0.4	0.3	0.3	0.3	0.7	4.7	7.3	10.8	27.2	TOC	1	-8	n/a			
UV254	0.056	0.000	0.005	0.005	0.005	0.005	0.078	0.112	0.184	0.488	UV254	0	n/a	n/a			
SUVA	1.61	0.20	1.80	1.80	1.80	0.64	1.66	1.53	1.70	1.79							
Bromide	48	2	34	33	36	43	Pretreatment Information										
TOX	398	15	13	34	42	52											
Process Description Scale																	
CHCl3	96.0	NA	2.6	3.0	4.4	6.0	Preoxidation	KMnO4 dose = 1.7 mg/L		Full-scale							
BDCM	22.0	NA	2.9	3.8	5.3	7.7	PAC addition	PAC dose = 5 mg/L		Full-scale							
DBCM	4.1	NA	2.3	3.0	4.0	6.6	Coagulation	alum dose = 92 mg/L, pH = 6.3		Full-scale							
CHBr3	0.0	NA	0.0	0.0	0.0	0.0	Flocculation	One stage, 8 s-1		Full-scale							
THM4	122.1	NA	7.8	9.8	13.6	20.3	Sedimentation	Upflow		Full-scale							
MCAA	4.1	0.3	0.0	0.0	0.0	0.0	Cartridge Filtration	5 micron nominal rating		Bench-scale							
DCAA	34.0	3.0	1.5	1.8	2.6	3.4	Plant flow	12.3 mgd		Full-scale							
TCAA	39.5	2.5	1.0	1.3	2.0	2.3											
MBAA	0.0	0.0	0.0	0.0	0.0	0.0											
DBAA	1.1	0.1	0.0	0.0	0.0	1.3	Design Parameters										
BCAA	7.9	0.9	1.1	1.5	1.9	2.7											
TBAA	0.0	NA	0.0	0.0	0.0	0.0	Active memb area:	0.167 ft ²		ID#	Recov	F _{W-des}					
CDBAA	1.2	1.2	0.0	0.0	0.0	2.3	Active width:	0.313 ft			(dec.)	(gfd)					
DCBAA	13.5	0.5	2.1	2.5	3.2	4.3	Norm Temp:	22.2 °C		1	0.70	10.0					
HAA5	78.7	5.7	2.5	3.1	4.5	7.0	Feed TDS:	80.6 mg/L		2	0.90	10.0					
HAA6	86.6	6.6	3.6	4.6	6.4	9.7	Manuf rep TDS rej:	60%		3	0.50	10.0					
HAA9	109.5	NA	5.7	7.1	9.6	16.3	Temp Norm MTC-w:	0.212 gfd/psi		4	0.30	10.0					
SDS Conditions							Comments:										
WQP	Avg	SD	Count	Min - Max													
Res (mg/L) (0)	1.65	0.56	6	0.60 - 2.09													
Temp (°C)	28.0	0.0	6	28.0 - 28.0													
pH (unit)	7.3	0.0	6	7.3 - 7.4													
Time (hr)	72.0	0.0	6	72.0 - 72.0													

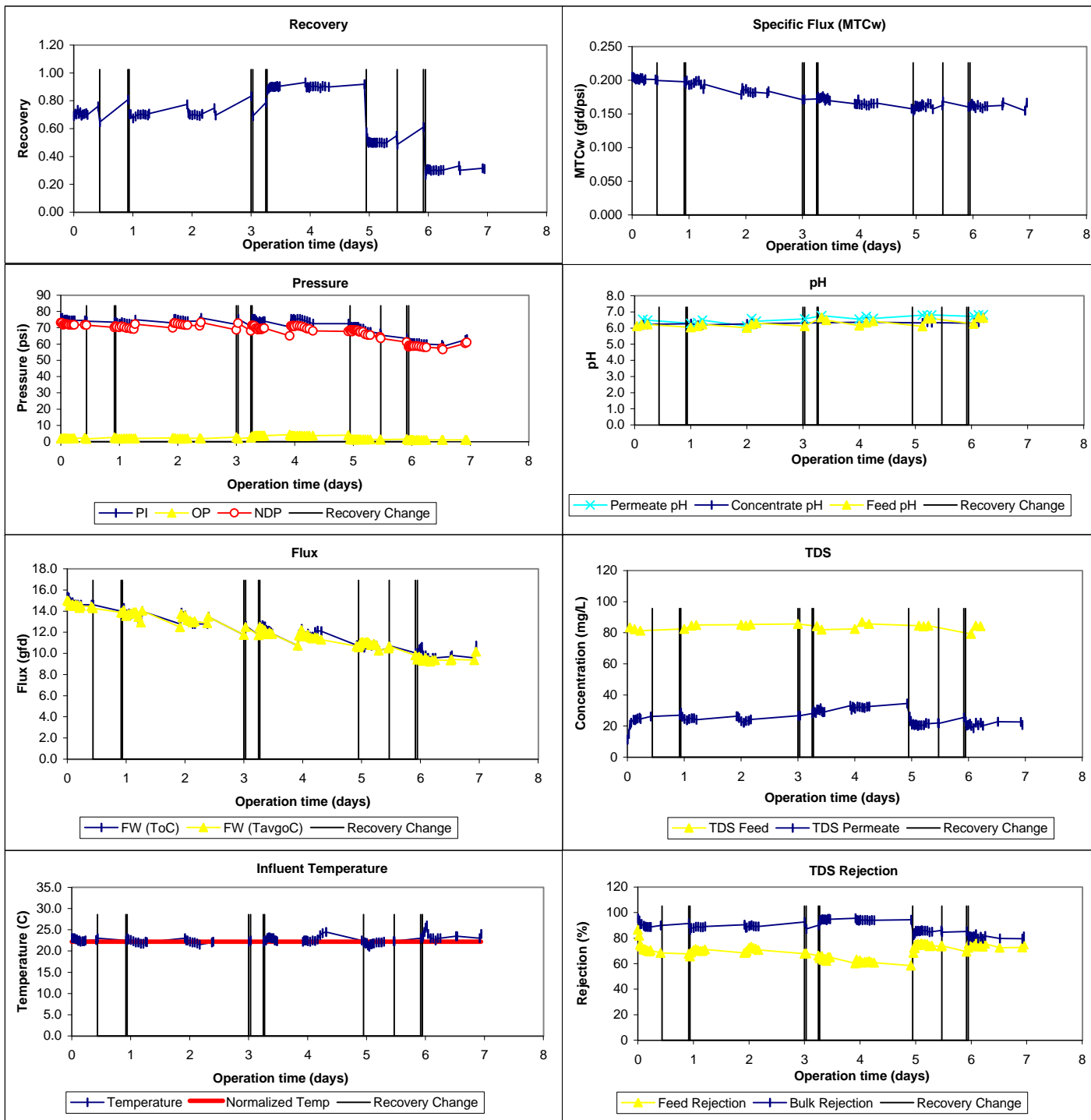
Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: VA3740600 / 678
ICR Contact: Mr. David Haddaway, Water Quality S
Phone No.: (757) 539-2201
Period: 10/9/97 - 10/14/98 (5 days)

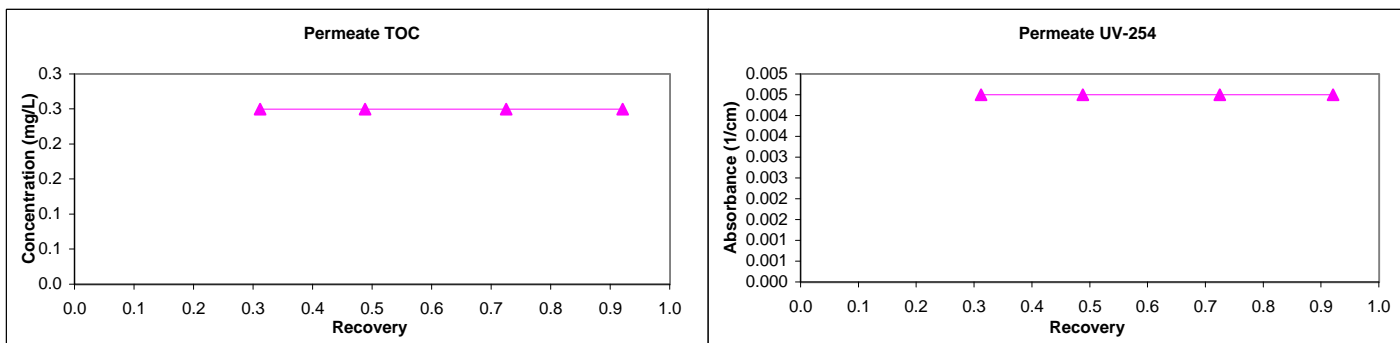
Membrane Information

Manufacturer: Dow Chemical Co., Midland, MI
Trade Name: FilmTec NF45
MWCO: 200 Daltons
Mfr. Flux: 28.0 gfd
Mfr. NDP: 120.0 psi
Mfr. MTCw: 0.230 gfd/psi
Mfr. Temp: 25.0 °C
840 Element Area: 390.0 ft²
840 Purchase Price: \$600
840 Maximum Flow: 60.0 gpm
840 Minimum Flow: 25.0 gpm
840 Total Width: 69.0 ft
840 Feed Spacer Thickness: 0.0025 ft

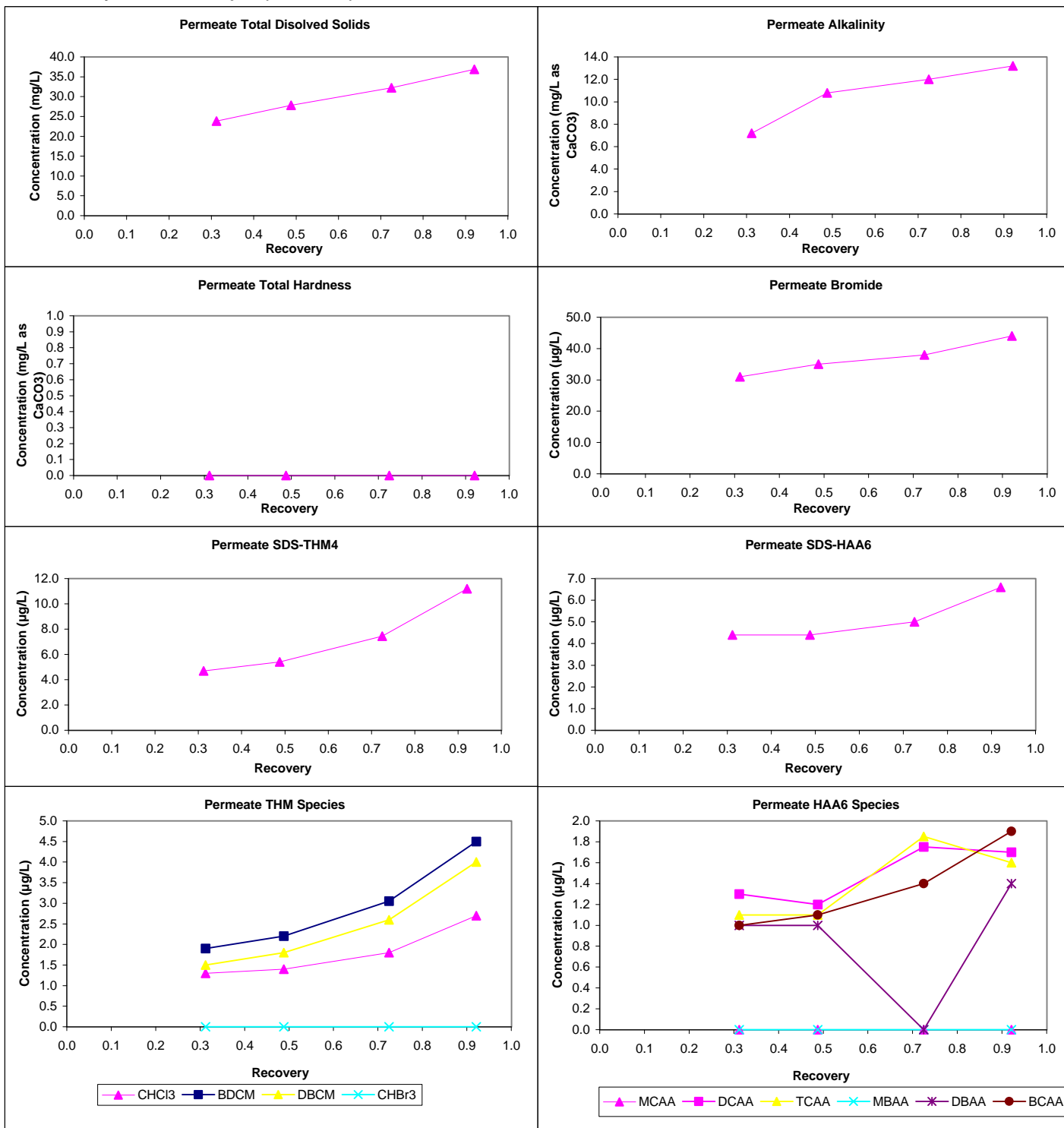
Water Quality Summary

Water Quality Summary							Mass Balance Closure Error (%)										
Source ->	Feed		Permeate				Concentrate										
Recovery ->	Avg	Diff	0.31	0.49	0.73	0.92	0.31	0.49	0.73	0.92	WQP	Count	Avg	SD			
pH	6.6	0.0	7.3	7.4	7.1	7.2	7.1	7.2	7.5	7.2	TDS	68	-27	76			
Temp	22.2	3.2	25.4	25.0	25.5	25.5	25.4	25.0	25.4	25.5	Alk	4	-4	18			
Alk	15	1	7	11	12	13	18	20	22	23	TDS	4	-13	20			
TDS	88	0	24	28	32	37	111	149	221	480	TotHard	0	n/a	n/a			
TotHard	41	1	0	0	0	0	58	86	154	514	CaHard	0	n/a	n/a			
CaHard	31	1	0	0	0	0	42	62	106	302	Turb	4	-23	102			
Turb	0.16	0.01	0.10	0.10	0.12	0.09	0.36	0.30	0.29	0.36	Amm	0	n/a	n/a			
Amm	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TOC	0	n/a	n/a			
TOC	3.1	0.0	0.3	0.3	0.3	0.3	4.1	6.3	10.9	30.3	UV254	0	n/a	n/a			
UV254	0.054	0.001	0.005	0.005	0.005	0.005	0.078	0.115	0.182	0.558							
SUVA	1.74	0.03	1.80	1.80	1.80	1.80	1.90	1.83	1.67	1.84							
Bromide	42	0	31	35	38	44	Pretreatment Information										
TOX	233	43	30	30	41	49											
							Process	Description	Scale								
CHCl3	48.0	2.0	1.3	1.4	1.8	2.7	Preoxidation	KMnO4 dose = 1.2 mg/L	Full-scale								
BDCM	16.0	1.0	1.9	2.2	3.1	4.5	PAC addition	5 mg/L	Full-scale								
DBCM	2.8	0.2	1.5	1.8	2.6	4.0	Coagulation	alum dose = 84.2 mg/L, pH = 6.1	Full-scale								
CHBr3	0.0	0.0	0.0	0.0	0.0	0.0	Flocculation	One stage, 8 s-1	Full-scale								
THM4	66.8	3.2	4.7	5.4	7.5	11.2	Sedimentation	Upflow	Full-scale								
MCAA	2.7	0.5	0.0	0.0	0.0	0.0	Cartridge Filtration	5 micron nominal rating	Bench-scale								
DCAA	21.0	0.0	1.3	1.2	1.8	1.7	Plant flow	12.4 mgd	Full-scale								
TCAA	30.5	0.5	1.1	1.1	1.9	1.6	Design Parameters										
MBAA	0.0	0.0	0.0	0.0	0.0	0.0											
DBAA	1.2	0.2	1.0	1.0	0.0	1.4											
BCAA	5.9	0.2	1.0	1.1	1.4	1.9											
TBAA	NA	NA	NR	NR	NA	NR											
CDBAA	2.1	NA	2.0	2.0	0.0	2.2											
DCBAA	11.0	1.0	1.0	1.1	1.8	1.8											
HAA5	55.3	0.8	3.4	3.3	3.6	4.7											
HAA6	61.2	1.0	4.4	4.4	5.0	6.6											
HAA9	NA	NA	NR	NR	NA	NR											
SDS Conditions							Active memb area: 0.167 ft ² Active width: 0.313 ft Norm Temp: 22.2 °C Feed TDS: 80.6 mg/L Manuf rep TDS rej: 60% Temp Norm MTC-w: 0.212 gfd/psi										
WQP	Avg	SD	Count	Min - Max											ID#	Recov (dec.)	F _{W-des} (gfd)
Res (mg/L) (0)	1.14	0.22	6	0.89 - 1.49											1	0.70	10.0
Temp (°C)	15.5	0.0	6	15.5 - 15.5											2	0.90	10.0
pH (unit)	7.3	0.1	6	7.3 - 7.5											3	0.50	10.0
Time (hr)	72.0	0.0	6	72.0 - 72.0			4	0.30	10.0								
							Comments:										

Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



Productivity Graphs

