

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	4009
Study Protocol	GAC bench-scale treatment study
Plant ICR Number	675
PWS Name	Newport News Waterworks
City, State, Zip	Newport News, VA 23607

General comments:

1. This bench-scale study examined DBP precursor removal by F816, a bituminous coal-based GAC, over four quarterly sessions at 10 and 20 minute EBCTs.
2. The SDS conditions utilized for this study were an incubation time of 72 hours, a free chlorine residual after 72 hours between 0.5 and 1.5 mg/L, pH 8.0, and an incubation temperature of 30°C. The incubation temperature of 30°C was applied to SDS testing during all quarterly RSSCT runs. The constant temperature allows for DBP formation comparison across all four quarters under similar SDS conditions, but does not simulate the seasonal impact of variable temperature on DBP formation.
3. The RSSCT flow rate and bed length values used during this study (presented in Table 7 of the Summary Report) did not exactly match those determined using the RSSCT design in the Data Collection Spreadsheet. The flow rate was less than 2 percent lower than the design flow rate. The bed length used yielded full-scale EBCTs 8 percent greater than the target 10 and 20 minutes. Since the actual EBCT simulated is within 10 percent of 10 and 20 minutes, the discrepancy is acceptable, and these values are used for further data analysis.
4. During the first quarter of testing, problems were encountered in maintaining a constant flow rate. These difficulties were attributed to the development of air pockets in the GAC beds, which required temporarily stopping the run for up to 1 hour to purge the air and restore the flow rates to the design values. These problems did not reoccur during subsequent quarters of testing.
5. Since the study was conducted in 1996, samples for the first two quarters were analyzed following standard laboratory protocol. For the third and fourth quarter analyses, ICR analysis procedures were followed.

Outlier Data:

Seven outliers removed in Quarter 1, one outlier removed in Quarter 2.

Cell: A1

Comment: 4009-SAS.xls 3/21/00 10:09

All curve fits reviewed and approved. See below for log of refit datasets.

Cell: C2

Comment: 4009-10-01 - Run 1 (BCAA) 3/21/00 09:40
Original value (CoefA0) = -3.8 New value = -1.5142
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D2

Comment: 4009-10-01 - Run 1 (BCAA) 3/21/00 09:40
Original value (CoefAf) = 11.4 New value = 137.2777
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E2

Comment: 4009-10-01 - Run 1 (BCAA) 3/21/00 09:40
Original value (CoefB) = 491.5813 New value = 7006.2258
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F2

Comment: 4009-10-01 - Run 1 (BCAA) 3/21/00 09:40
Original value (CoefD) = 0.0889 New value = 0.0739
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J2

Comment: 4009-10-01 - Run 1 (BCAA) 3/21/00 09:40
Original value (S) = 0 New value = -0.011
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C30

Comment: 4009-10-02 - Run 3 (DBAA) 3/21/00 09:46
Original value (CoefA0) = 0.006 New value = -0.4217
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D30

Comment: 4009-10-02 - Run 3 (DBAA) 3/21/00 09:46
Original value (CoefAf) = 1.666 New value = 5.4806
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E30

Comment: 4009-10-02 - Run 3 (DBAA) 3/21/00 09:46
Original value (CoefB) = 27.1787 New value = 20.2992
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F30

Comment: 4009-10-02 - Run 3 (DBAA) 3/21/00 09:46
Original value (CoefD) = 0.0961 New value = 0.0956
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J30

Comment: 4009-10-02 - Run 3 (DBAA) 3/21/00 09:46
Original value (S) = -0.0027 New value = -0.0133
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C31

Comment: 4009-10-02 - Run 3 (DBCM) 3/21/00 09:45
Original value (CoefA0) = -4.5 New value = 2.4334
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D31

Comment: 4009-10-02 - Run 3 (DBCM) 3/21/00 09:45
Original value (CoefAf) = 11.7325 New value = 5.3168
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E31

Comment: 4009-10-02 - Run 3 (DBCM) 3/21/00 09:45
Original value (CoefB) = 0.3554 New value = 18.3988
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F31

Comment: 4009-10-02 - Run 3 (DBCM) 3/21/00 09:45
Original value (CoefD) = 0.0259 New value = 0.5998
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J31

Comment: 4009-10-02 - Run 3 (DBCM) 3/21/00 09:45
Original value (S) = 0 New value = -0.0256
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C101

Comment: 4009-20-01 - Run 2 (HAA6) 3/21/00 10:03
Original value (CoefA0) = -0.4287 New value = -0.7354
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D101

Comment: 4009-20-01 - Run 2 (HAA6) 3/21/00 10:03
Original value (CoefAf) = 75.525 New value = 38.1908
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E101

Comment: 4009-20-01 - Run 2 (HAA6) 3/21/00 10:03
Original value (CoefB) = 130.6184 New value = 66.2492
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F101

Comment: 4009-20-01 - Run 2 (HAA6) 3/21/00 10:03
Original value (CoefD) = 0.0383 New value = 0.0487
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J101

Comment: 4009-20-01 - Run 2 (HAA6) 3/21/00 10:03
Original value (S) = 0 New value = 0
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: C103

Comment: 4009-20-01 - Run 2 (MBAA) 3/21/00 09:44
Original value (CoefA0) = 0 New value = 0
Fewer than 6 points above MRL. Peak curve/step function combination applied.

Cell: D103

Comment: 4009-20-01 - Run 2 (MBAA) 3/21/00 09:44
Original value (CoefAf) = 0 New value = 10.8
Fewer than 6 points above MRL. Peak curve/step function combination applied.

Cell: E103

Comment: 4009-20-01 - Run 2 (MBAA) 3/21/00 09:44
Original value (CoefB) = 0 New value = 0
Fewer than 6 points above MRL. Peak curve/step function combination applied.

Cell: F103

Comment: 4009-20-01 - Run 2 (MBAA) 3/21/00 09:44
Original value (CoefD) = 0 New value = 0
Fewer than 6 points above MRL. Peak curve/step function combination applied.

Cell: J103

Comment: 4009-20-01 - Run 2 (MBAA) 3/21/00 09:44
Original value (S) = 0 New value = -1.2673
Fewer than 6 points above MRL. Peak curve/step function combination applied.

Cell: C110

Comment: 4009-20-01 - Run 2 (TSUVA) 3/21/00 09:41
Original value (CoefA0) = 0 New value = -0.0531
Fewer than 6 points. Logistic function (type 1) applied.

Cell: D110

Comment: 4009-20-01 - Run 2 (TSUVA) 3/21/00 09:41
Original value (CoefAf) = 0 New value = 1.1074
Fewer than 6 points. Logistic function (type 1) applied.

Cell: E110

Comment: 4009-20-01 - Run 2 (TSUVA) 3/21/00 09:41
Original value (CoefB) = 0 New value = 20.0031
Fewer than 6 points. Logistic function (type 1) applied.

Cell: F110

Comment: 4009-20-01 - Run 2 (TSUVA) 3/21/00 09:41
Original value (CoefD) = 0 New value = 0.0212
Fewer than 6 points. Logistic function (type 1) applied.

Cell: J110

Comment: 4009-20-01 - Run 2 (TSUVA) 3/21/00 09:41

Original value (S) = 0 New value = 0
Fewer than 6 points. Logistic function (type 1) applied.

Cell: C115

Comment: 4009-20-02 - Run 4 (CHBr3) 3/21/00 09:48
Original value (CoefA0) = -0.0078 New value = -0.6046
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D115

Comment: 4009-20-02 - Run 4 (CHBr3) 3/21/00 09:48
Original value (CoefAf) = 3 New value = 3.6219
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E115

Comment: 4009-20-02 - Run 4 (CHBr3) 3/21/00 09:48
Original value (CoefB) = 10 New value = 20.0236
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F115

Comment: 4009-20-02 - Run 4 (CHBr3) 3/21/00 09:48
Original value (CoefD) = 0.157 New value = 1.0597
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J115

Comment: 4009-20-02 - Run 4 (CHBr3) 3/21/00 09:48
Original value (S) = -0.0041 New value = -0.0214
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C118

Comment: 4009-20-02 - Run 4 (DBAA) 3/21/00 09:49
Original value (CoefA0) = -0.2998 New value = -0.1641
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D118

Comment: 4009-20-02 - Run 4 (DBAA) 3/21/00 09:49
Original value (CoefAf) = 1.4567 New value = 1.9144
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E118

Comment: 4009-20-02 - Run 4 (DBAA) 3/21/00 09:49
Original value (CoefB) = 1.4301 New value = 20.012
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F118

Comment: 4009-20-02 - Run 4 (DBAA) 3/21/00 09:49
Original value (CoefD) = 0.101 New value = 0.4804
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J118

Comment: 4009-20-02 - Run 4 (DBAA) 3/21/00 09:49
Original value (S) = -0.0032 New value = -0.0086

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C119

Comment: 4009-20-02 - Run 4 (DBCM) 3/21/00 09:47

Original value (CoefA0) = 0 New value = 0.1287

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D119

Comment: 4009-20-02 - Run 4 (DBCM) 3/21/00 09:47

Original value (CoefAf) = 9 New value = 8.879

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E119

Comment: 4009-20-02 - Run 4 (DBCM) 3/21/00 09:47

Original value (CoefB) = 10 New value = 19.9852

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F119

Comment: 4009-20-02 - Run 4 (DBCM) 3/21/00 09:47

Original value (CoefD) = 0.15 New value = 1.2773

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J119

Comment: 4009-20-02 - Run 4 (DBCM) 3/21/00 09:47

Original value (S) = 0 New value = -0.0255

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C134

Comment: 4009-20-03 - Run 6 (BCAA) 3/21/00 09:51

Original value (CoefA0) = -0.4601 New value = -0.5498

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D134

Comment: 4009-20-03 - Run 6 (BCAA) 3/21/00 09:51

Original value (CoefAf) = 12.585 New value = 54.9946

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E134

Comment: 4009-20-03 - Run 6 (BCAA) 3/21/00 09:51

Original value (CoefB) = 305.1515 New value = 1824.1186

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F134

Comment: 4009-20-03 - Run 6 (BCAA) 3/21/00 09:51

Original value (CoefD) = 0.0522 New value = 0.0526

Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J134

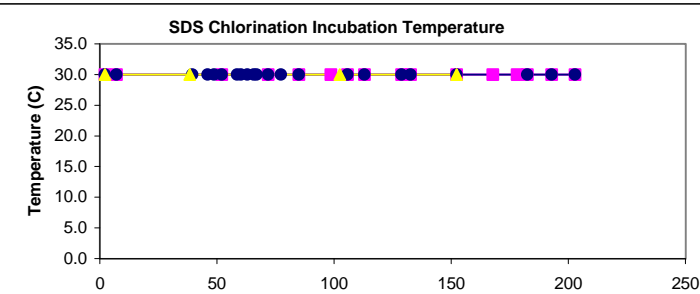
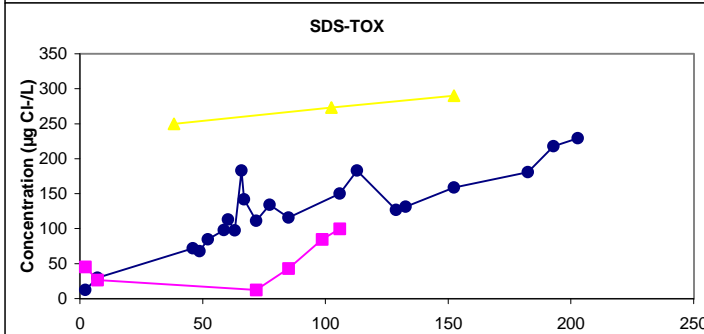
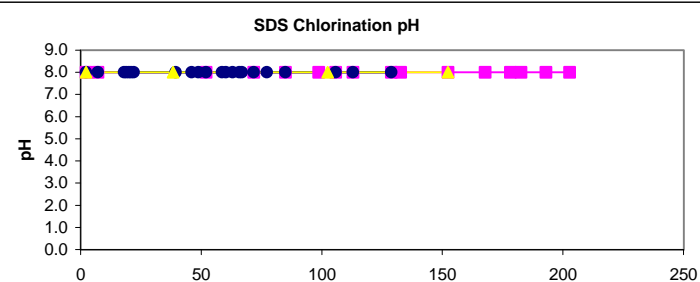
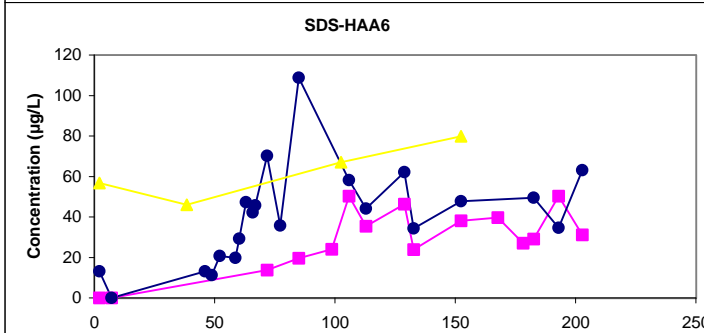
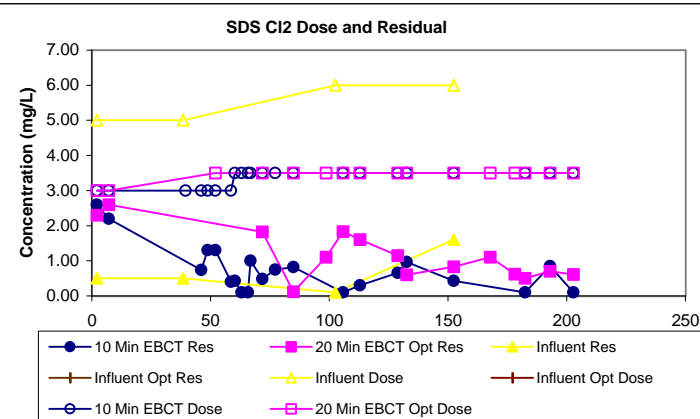
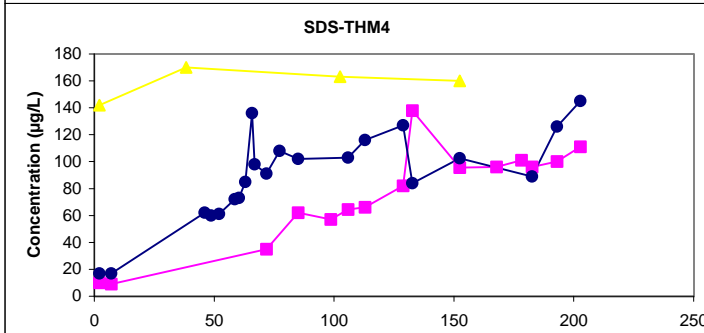
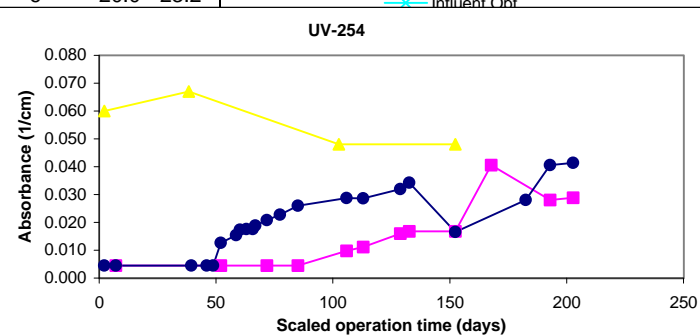
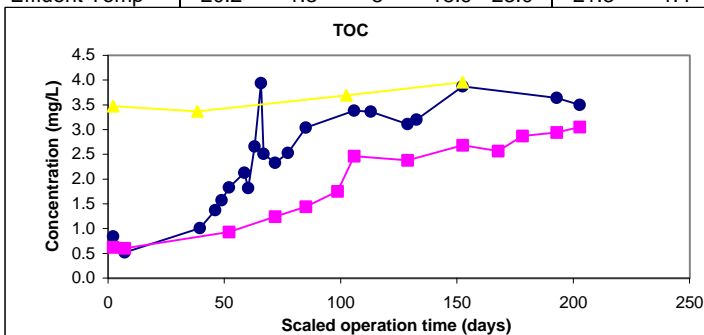
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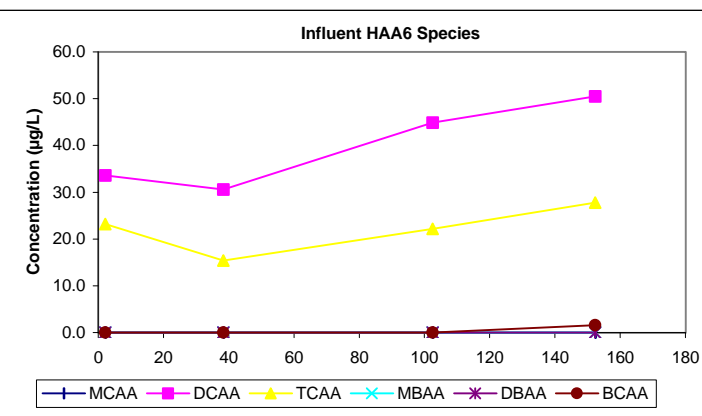
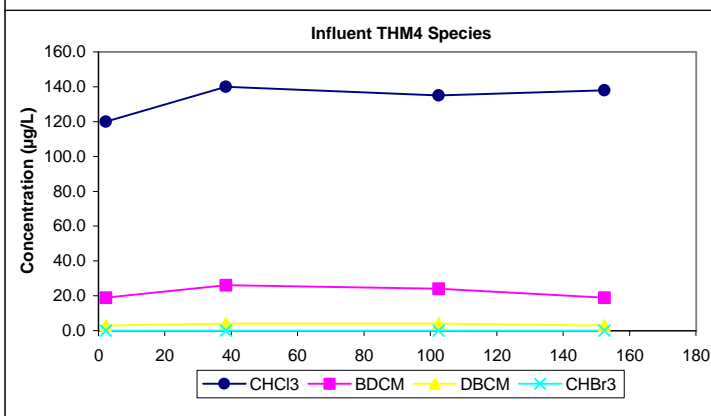
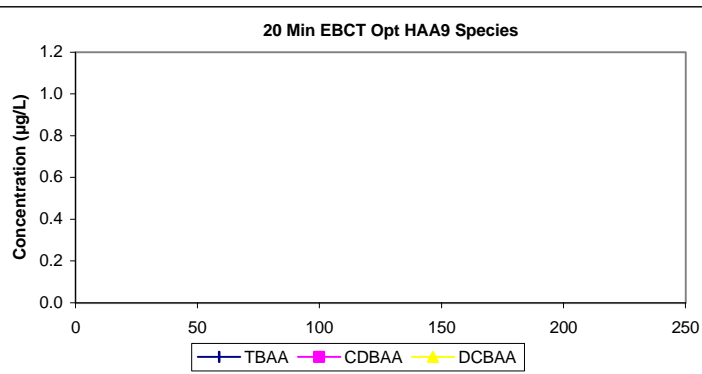
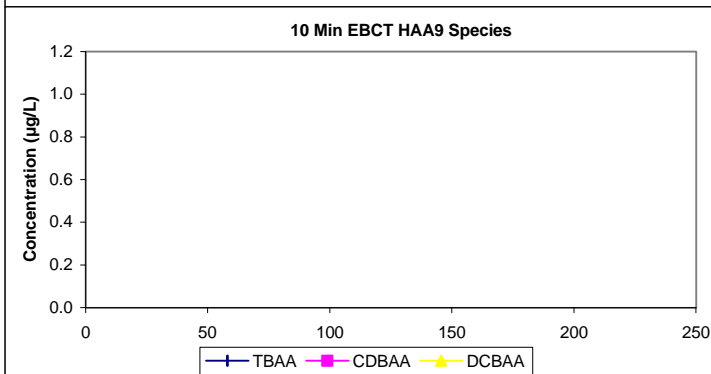
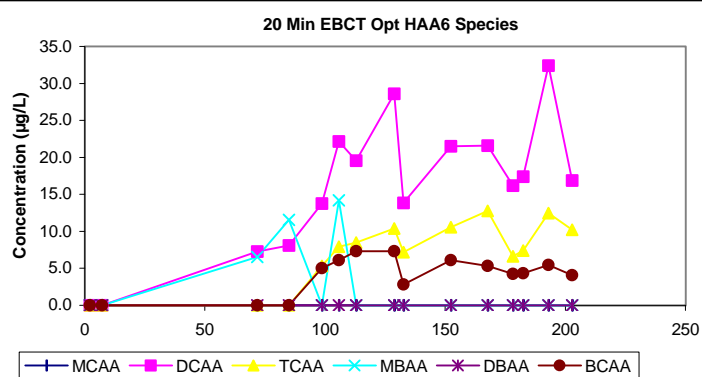
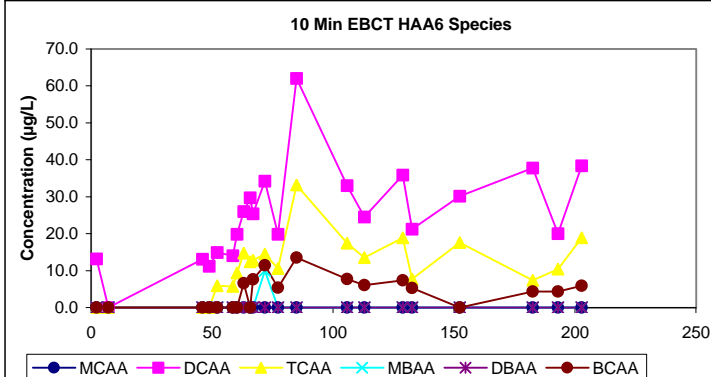
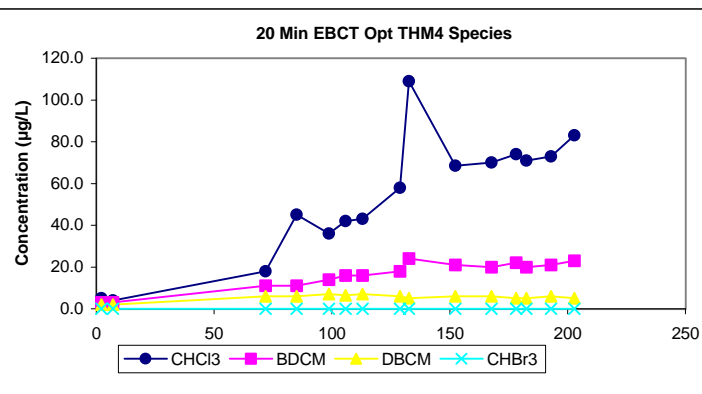
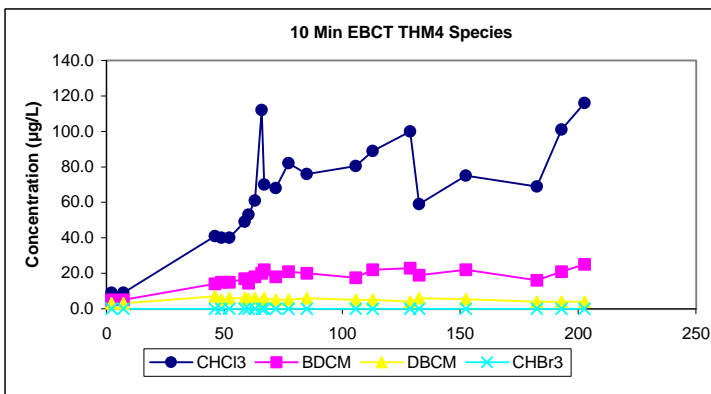
Original value (S) = 0 New value = -0.0107

Poor peak curve fit. Data was refit by iterative curve fit procedure.

ID / ICR#: VA3700500	/ 675	Design TOC: 3.7 mg/L	Full-Scale GAC Size: 8x30 Bituminous coal
ICR Contact: Brian L. Ramaley		Col Diameter: 11.0 mm	Bench-Scale GAC Size: 100x200
Phone No.: 757-247-8545		Min Reynolds#: 0.50	Scaling Factor: 13.16
Period: 3/7/96 - 3/23/96 (15 B-S days)		Full-Scale Temp: 20 C	Meas Dry Bed Density: 0.40 g/cm3

Influent	Influent				Influent Opt				Cumulative SDS Conditions			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max	Mean	SD	Count	Min/Max
TOC	3.6	0.3	4	3.4 - 4.0					Res (6)	0.90	0.70	40 0.10 - 2.60
pH	7.0	0.3	3	6.7 - 7.2					Temp	30.0	0.0	42 30.0 - 30.0
UV254	0.056	0.009	4	0.048 - 0.067					pH	8.0	0.0	42 8.0 - 8.0
SUVA	1.17	0.54	4	0.90 - 1.99					Time	72.0	0.0	42 72.0 - 72.0
Bromide	10	0	4	10 - 10					Comments:			
SDS-TOX	271	20	3	250 - 290								
SDS-THM4	159	12	4	142 - 170					Chart			
SDS-HAA6	62	14	4	46 - 80								
Effluent	10 Min EBCT (9 B-S days)				20 Min EBCT Opt (15 B-S days)				Legend:			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max				
Effluent pH	6.9	0.2	10	6.7 - 7.2	6.9	0.2	7	6.8 - 7.3	10 Min EBCT			
Effluent Temp	20.2	1.3	8	18.9 - 23.0	21.3	1.4	6	20.0 - 23.2	20 Min EBCT Opt			
									Influent			
									Influent Opt			





ID / ICR#: VA3700500

/ 675 Design TOC: 3.7 mg/L

Full-Scale GAC Size: 8x30 Bituminous coal

ICR Contact: Brian L. Ramaley

Col Diameter: 11.0 mm

Bench-Scale GAC Size: 100x200

Phone No.: 757-247-8545

Min Reynolds#: 0.50

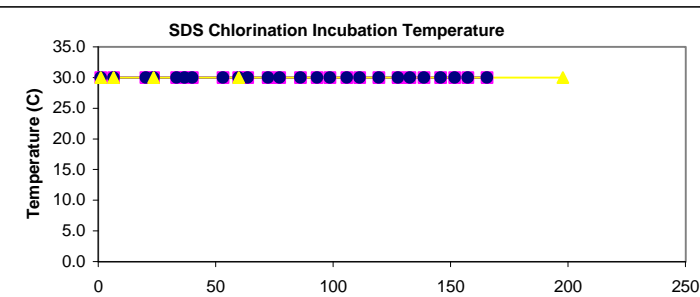
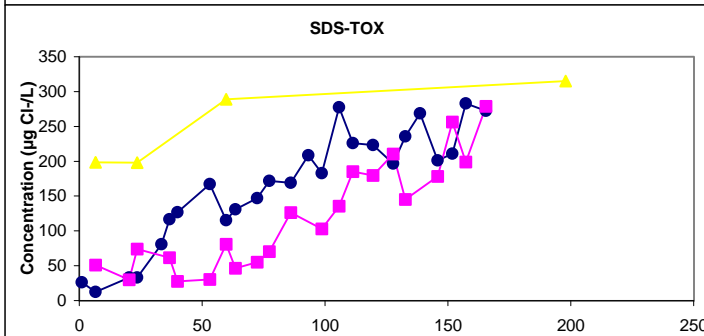
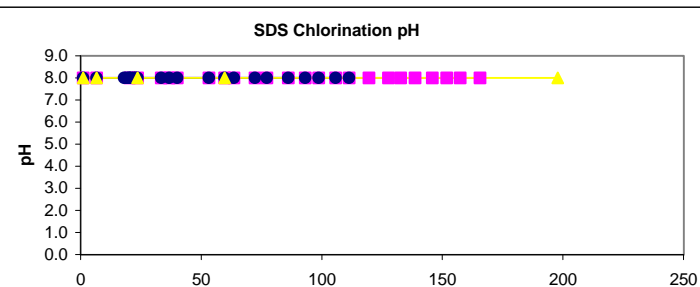
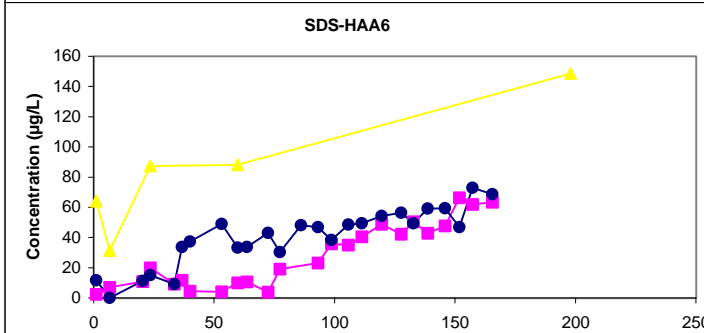
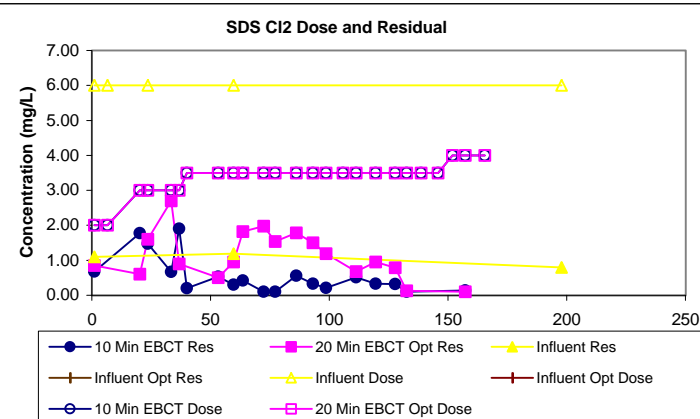
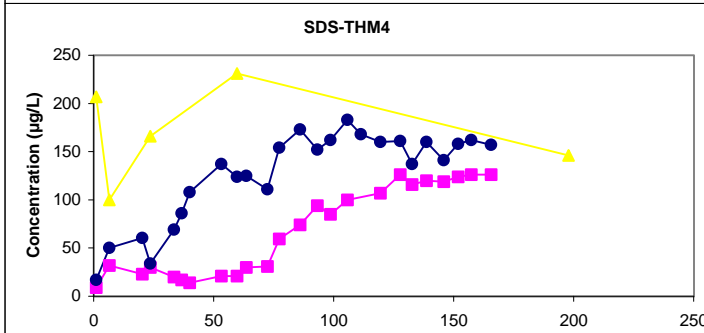
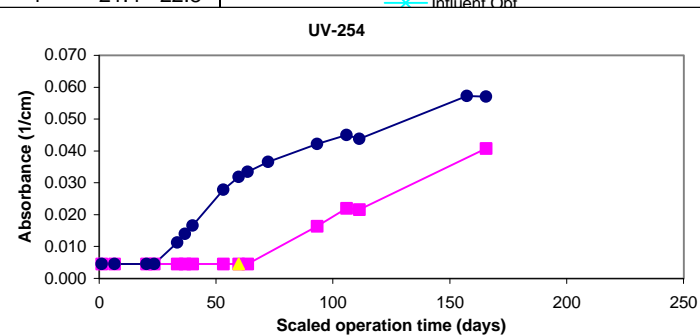
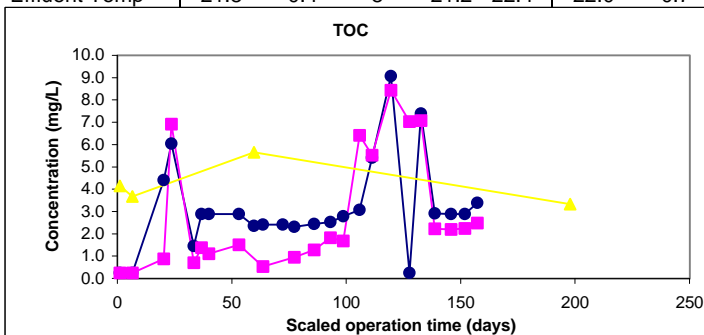
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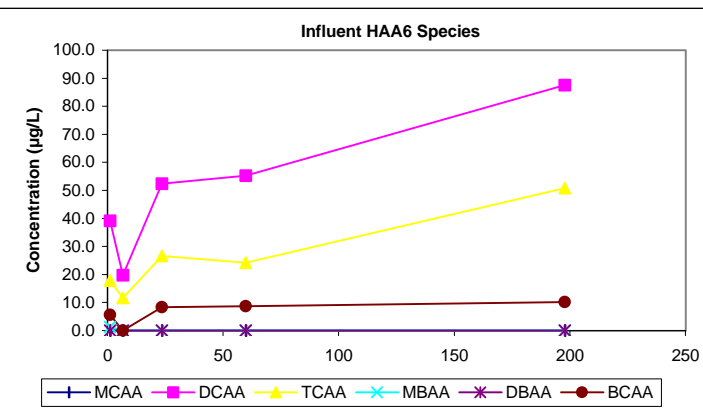
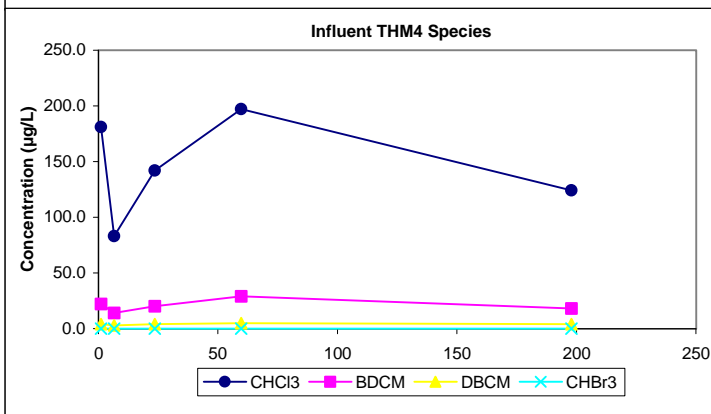
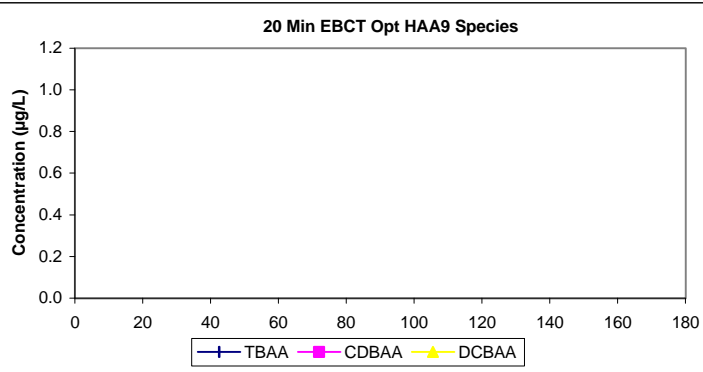
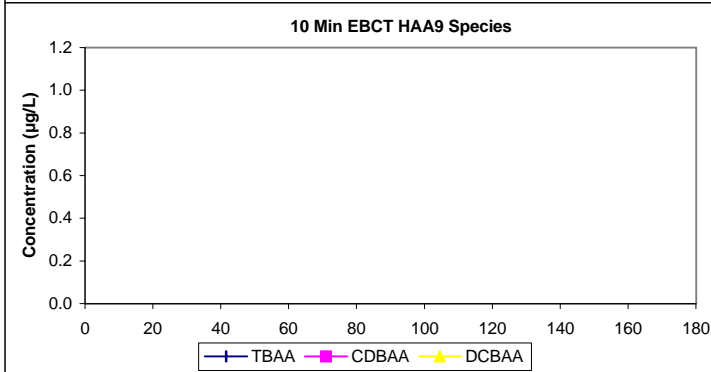
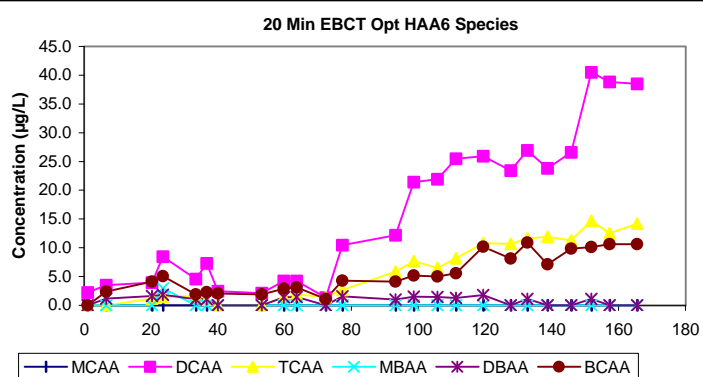
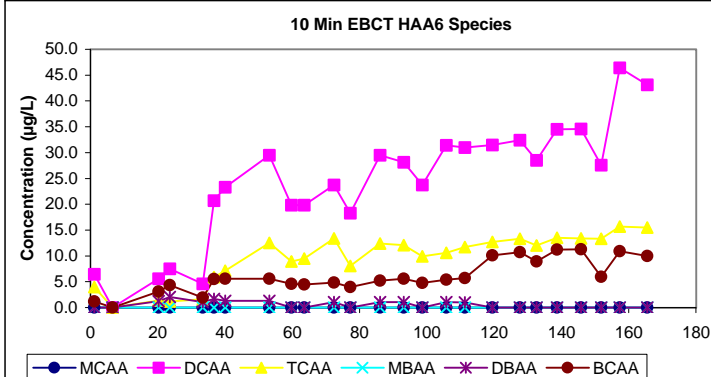
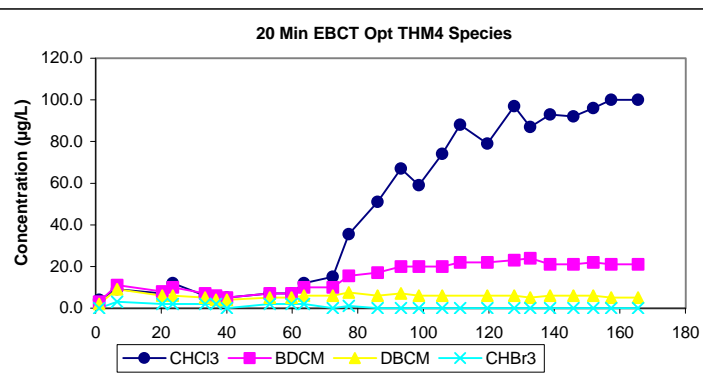
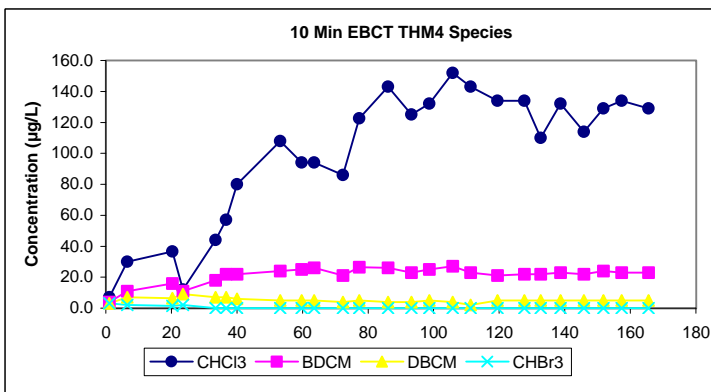
Period: 5/23/96 - 5/31/96 (8 B-S days)

Full-Scale Temp: 20 C

Meas Dry Bed Density: 0.40 g/cm3

Influent	Influent				Influent Opt				Cumulative SDS Conditions			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max	Mean	SD	Count	Min/Max
TOC	4.2	1.0	4	3.3 - 5.7					Res (4)	0.86	0.65	40 0.10 - 2.70
pH	6.7	0.2	3	6.5 - 6.9					Temp	30.0	0.0	55 30.0 - 30.0
UV254	0.005	0.000	1	0.005 - 0.005					pH	8.0	0.0	55 8.0 - 8.0
SUVA	0.90	0.00	1	0.90 - 0.90					Time	72.0	0.0	55 72.0 - 72.0
Bromide	10	0	5	10 - 10					Comments:			
SDS-TOX	250	61	4	198 - 315								
SDS-THM4	170	51	5	100 - 231					Chart			
SDS-HAA6	84	43	5	31 - 149								
Effluent	10 Min EBCT (8 B-S days)				20 Min EBCT Opt (8 B-S days)				Legend:			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max				
Effluent pH	6.8	0.2	10	6.5 - 7.2	6.8	0.3	8	6.4 - 7.4	10 Min EBCT			
Effluent Temp	21.8	0.4	8	21.2 - 22.4	22.0	0.7	4	21.4 - 22.8	20 Min EBCT Opt			
									Influent			
									Influent Opt			





ID / ICR#: VA3700500

/ 675

Design TOC: 3.7 mg/L

Full-Scale GAC Size: 8x30 Bituminous coal

ICR Contact: Brian L. Ramaley

Col Diameter: 11.0 mm

Bench-Scale GAC Size: 100x200

Phone No.: 757-247-8545

Min Reynolds#: 0.50

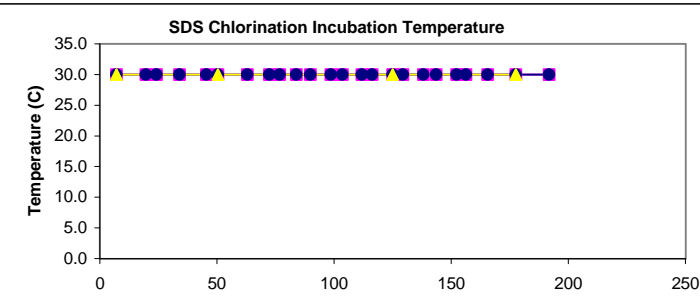
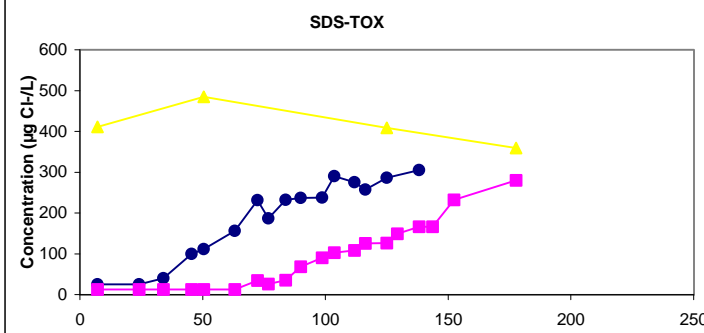
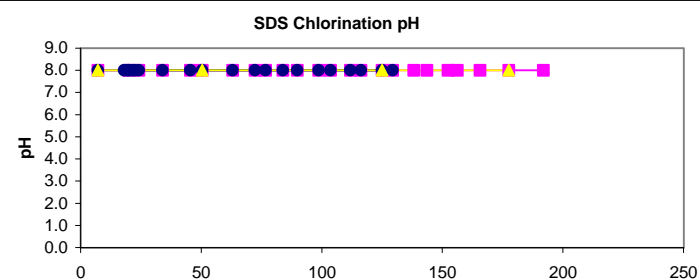
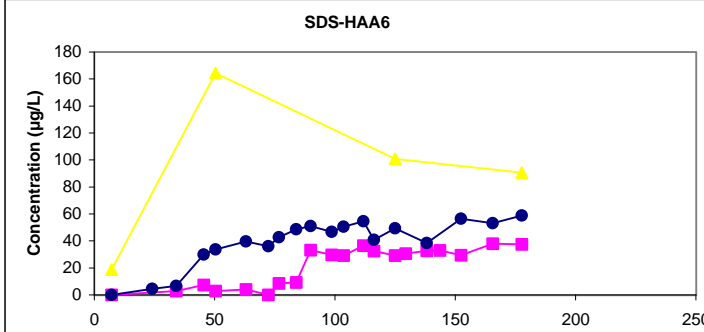
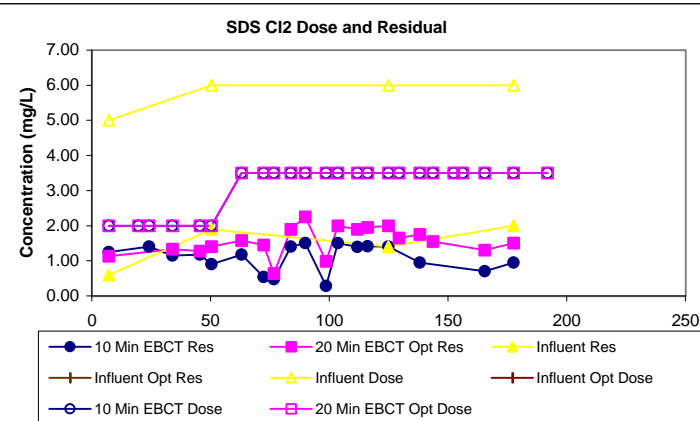
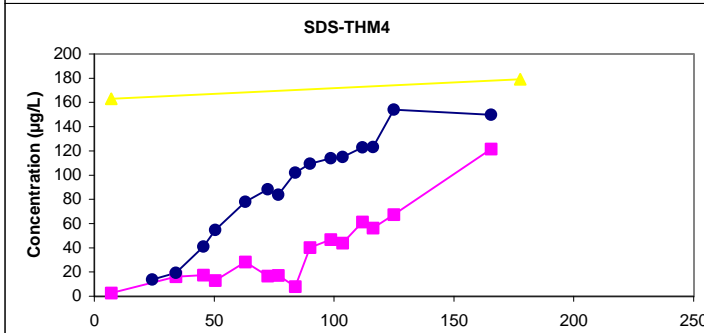
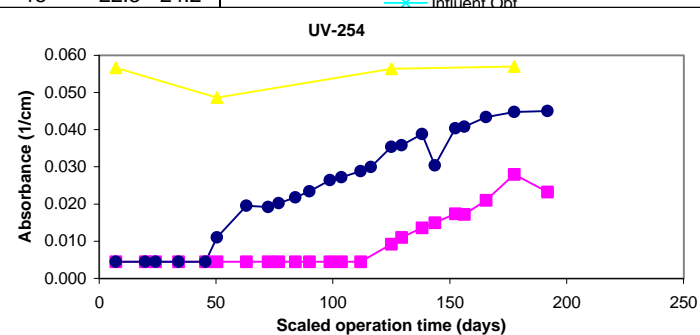
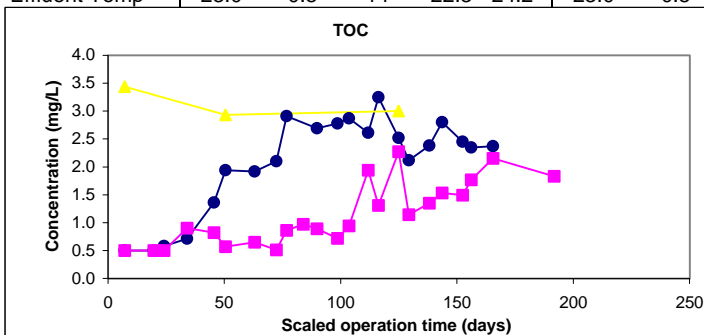
Scaling Factor: 13.16

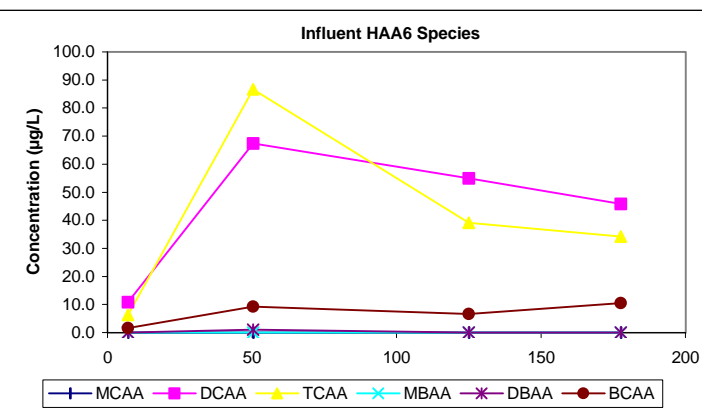
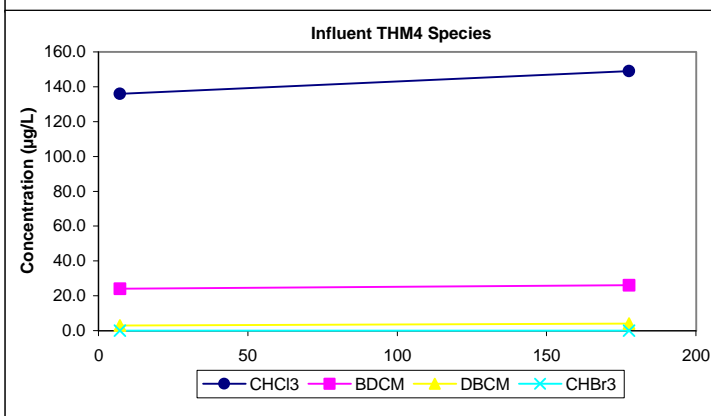
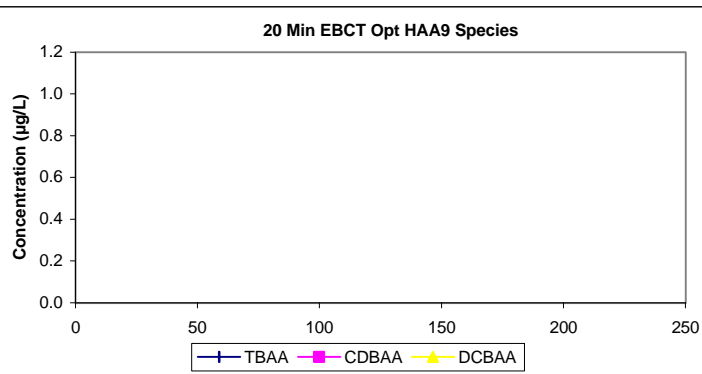
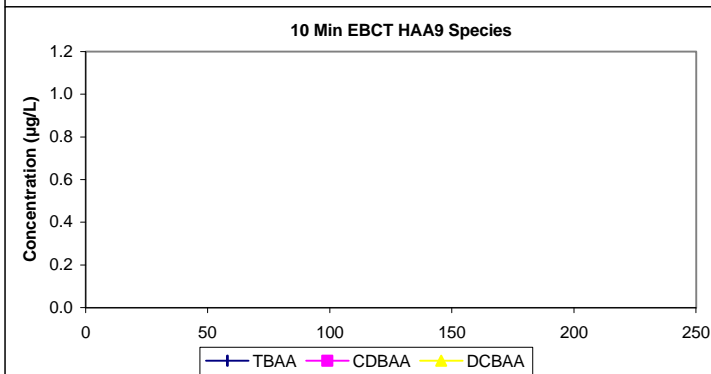
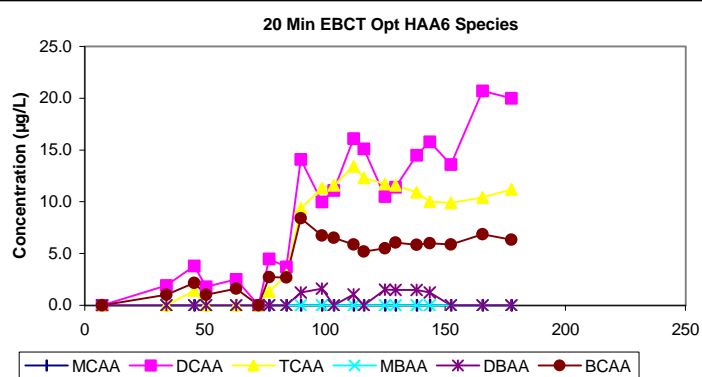
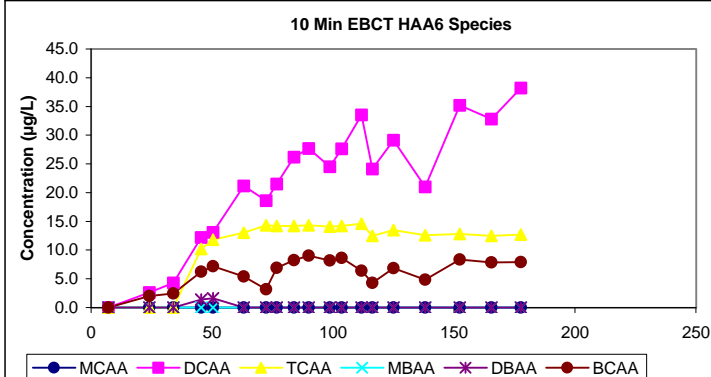
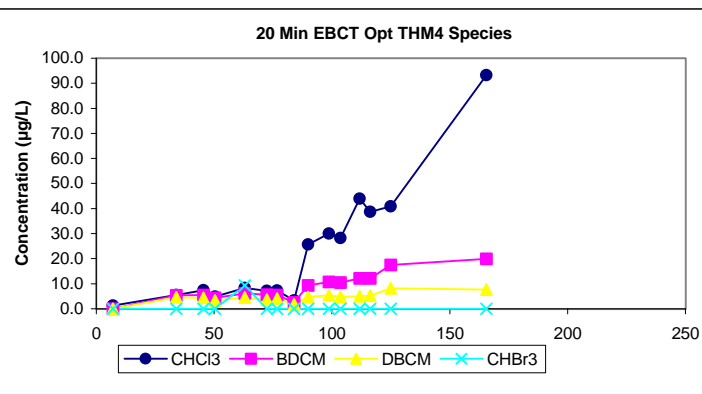
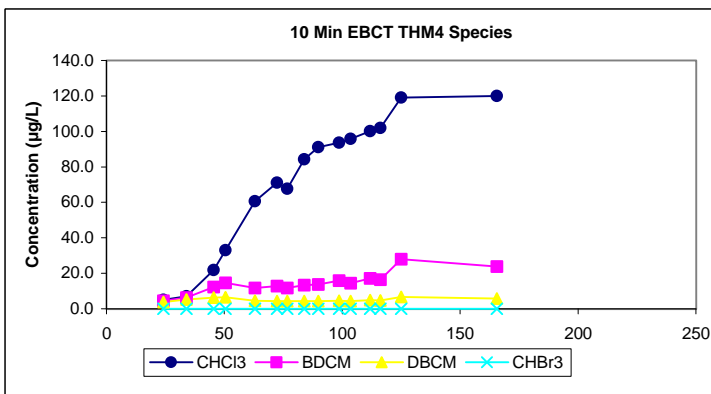
Period: 8/27/96 - 9/5/96 (9 B-S days)

Full-Scale Temp: 20 C

Meas Dry Bed Density: 0.40 g/cm3

Influent	Influent				Influent Opt				Cumulative SDS Conditions			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max	Mean	SD	Count	Min/Max
TOC	3.1	0.3	3	2.9 - 3.4					Res (0)	1.34	0.47	41 0.28 - 2.25
pH	6.7	0.5	4	6.0 - 7.0					Temp	30.0	0.0	52 30.0 - 30.0
UV254	0.055	0.004	4	0.049 - 0.057					pH	8.0	0.0	52 8.0 - 8.0
SUVA	1.23	0.57	3	0.90 - 1.88					Time	72.0	0.0	52 72.0 - 72.0
Bromide	10	0	4	10 - 10					Comments:			
SDS-TOX	416	52	4	359 - 485								
SDS-THM4	171	16	2	163 - 179					Chart			
SDS-HAA6	94	60	4	19 - 164								
Effluent	10 Min EBCT (9 B-S days)				20 Min EBCT Opt (9 B-S days)				Legend:			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max				
Effluent pH	6.7	0.2	15	6.3 - 7.0	6.7	0.2	16	6.3 - 7.0	10 Min EBCT			
Effluent Temp	23.0	0.5	14	22.3 - 24.2	23.0	0.5	15	22.3 - 24.2	20 Min EBCT Opt			
									Influent			
									Influent Opt			





ID / ICR#: VA3700500

/ 675 Design TOC: 3.7 mg/L

Full-Scale GAC Size: 8x30 Bituminous coal

ICR Contact: Brian L. Ramaley

Col Diameter: 11.0 mm

Bench-Scale GAC Size: 100x200

Phone No.: 757-247-8545

Min Reynolds#: 0.50

Scaling Factor: 13.16

Period: 11/25/96 - 12/14/96 (18 B-S days)

Full-Scale Temp: 20 C

Meas Dry Bed Density: 0.40 g/cm3

Influent	Influent				Influent Opt				Cumulative SDS Conditions			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max	Mean	SD	Count	Min/Max
TOC	3.4	0.0	2	3.4 - 3.4					Res (0)	0.75	0.38	28 0.20 - 1.45
pH	6.6	0.2	2	6.5 - 6.7					Temp	30.0	0.0	31 30.0 - 30.0
UV254	0.065	0.004	3	0.060 - 0.068					pH	8.0	0.0	31 8.0 - 8.0
SUVA	1.45	1.11	2	0.90 - 2.01					Time	72.0	0.0	31 72.0 - 72.0
Bromide	10	0	2	10 - 10					Comments:			
SDS-TOX	425	19	3	409 - 446								
SDS-THM4	185	57	2	156 - 213					Chart			
SDS-HAA6	115	38	2	96 - 133								
Effluent	10 Min EBCT (16 B-S days)				20 Min EBCT Opt (19 B-S days)				Legend:			
	Mean	SD/RD	Count	Min/Max	Mean	SD/RD	Count	Min/Max				
Effluent pH	6.8	0.1	13	6.5 - 7.0	6.8	0.1	13	6.6 - 6.8	10 Min EBCT			
Effluent Temp	20.2	1.0	13	18.4 - 21.9	20.0	1.0	13	18.4 - 21.9	20 Min EBCT Opt			
									Influent			
									Influent Opt			

