

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	3005
Study Protocol	GAC pilot-scale treatment study
Plant ICR Number	620
PWS Name	City of Dallas Water Utilities Department
City, State, Zip	Dallas, TX 75201

General comments:

1. This pilot-scale treatment study evaluated DBP precursor removal at 10 and 20 minute EBCTs, using Calgon Filtrasorb 820, a bituminous coal-based 8x20 mesh size GAC. During the study, the coagulant dosage was varied to evaluate the impact of enhanced coagulation on GAC performance after 51 days of operation. This change only affected the 20 minute EBCT run, as the 10 minute EBCT run had already reached 70 percent TOC breakthrough and sampling had been discontinued. Table 4-1 in the Summary Report summarizes chemical doses applied during the entire run. The primary ferric sulfate dose ranged from 10 to 100 mg/L, and the primary calcium hydroxide dose ranged from 0 to 120 mg/L. Figure 1 in this document shows graphically the variation in chemical doses applied during the treatment study. At times during the remainder of run, the calcium hydroxide feed was shut off completely, to investigate the impact of lower influent pH values on GAC performance. However, the impact of varying these parameters on GAC performance during one run is difficult to determine because GAC is an unsteady-state process. In general, increasing the ferric sulfate dose decreased the concentration of TOC and DBP precursors in the GAC influent, resulting in lower GAC effluent concentrations. An ambient pH was targeted for SDS chlorination.
2. The data in the Data Collection Spreadsheets have been separated to differentiate between the two halves of the run (in terms of pretreatment). The "first" run (up to 51 days of operation) utilized chemical pretreatment doses similar to the full-scale plant. The weighted average ferric sulfate dose was 20 mg/L (range: 10 to 30 mg/L). The weighted average calcium hydroxide dose was 52 mg/L (range: 40 to 60 mg/L). During the "second" run (changing pretreatment conditions which affected the second half of the 20 minute EBCT run, after 51 days of operation), the average ferric sulfate dose was 39 mg/L (range: 20 to 100 mg/L) and the average calcium hydroxide dose was 11 mg/L (range: 0 to 120 mg/L). The original data has been included as a third sheet for reference, but should not be used for further data analysis. It should be noted when interpreting the results of the second half of the run in terms of pretreatment, that the first half of the run was conducted under conventional coagulant doses (similar to the full-scale plant). The GAC influent data

collected during the entire run has been included with the GAC effluent data from the second half of the run.

- Due to the variation in calcium hydroxide dose applied during the study (0 to 120 mg/L), the GAC effluent pH varied widely, and therefore so did the SDS chlorination pH, which varied from 6.2 to 10.5. This variability in SDS chlorination pH may have had a significant effect on DBP formation and speciation.

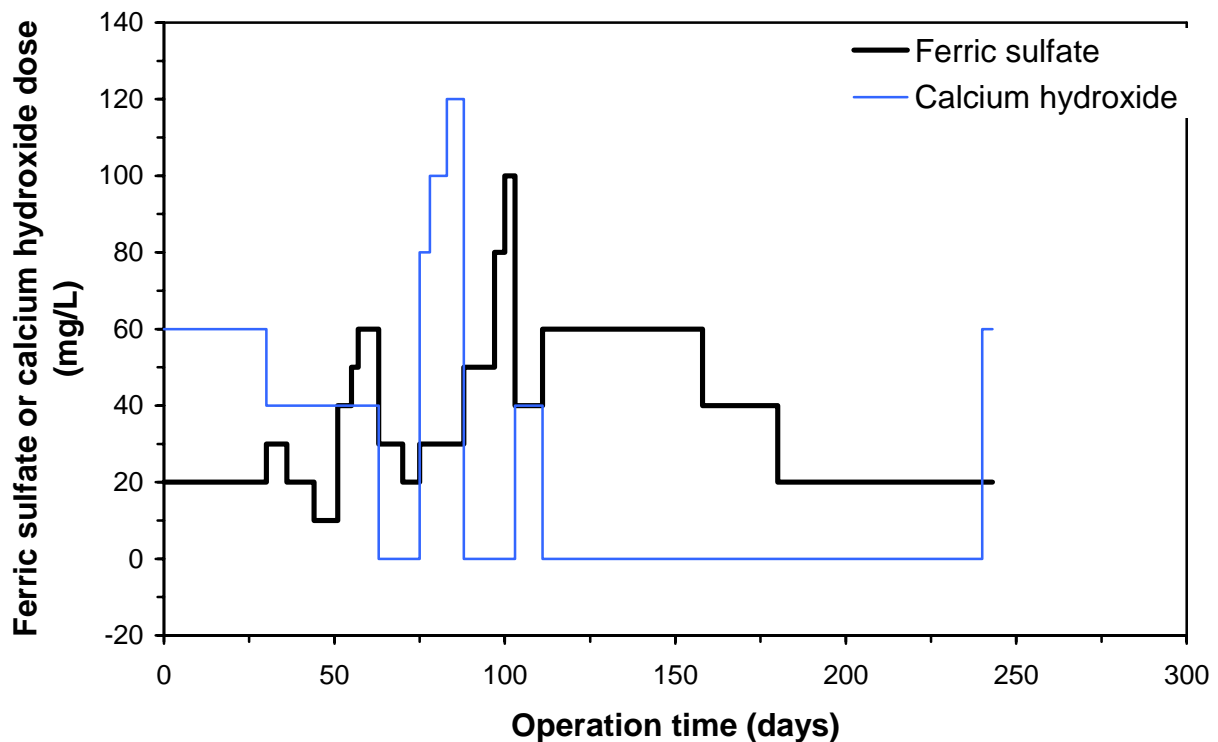


Figure 1 Ferric sulfate and calcium hydroxide dosage during treatment study

Outlier data:

One outlier was removed.

Sheet3 deleted from the OUT.xls file for outlier upload.

Cell: A1

Comment: 3005-SAS.xls 2/15/00 21:50

All curve fits reviewed and approved. See below for log of refit datasets. Note: there is no 'Run 3' for this study.

Cell: C5

Comment: 3005-10-01 - Run 1 (CHBr3) 2/15/00 21:37
Original value (CoefA0) = 0 New value = 1.1415
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D5

Comment: 3005-10-01 - Run 1 (CHBr3) 2/15/00 21:37
Original value (CoefAf) = 15 New value = 14.1971
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E5

Comment: 3005-10-01 - Run 1 (CHBr3) 2/15/00 21:37
Original value (CoefB) = 10 New value = 20.0561
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F5

Comment: 3005-10-01 - Run 1 (CHBr3) 2/15/00 21:37
Original value (CoefD) = 0.15 New value = 2.2497
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J5

Comment: 3005-10-01 - Run 1 (CHBr3) 2/15/00 21:37
Original value (S) = 0 New value = -0.1659
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C8

Comment: 3005-10-01 - Run 1 (DBAA) 2/15/00 21:37
Original value (CoefA0) = -4.2 New value = -0.8628
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D8

Comment: 3005-10-01 - Run 1 (DBAA) 2/15/00 21:37
Original value (CoefAf) = 10.6239 New value = 7.1453
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E8

Comment: 3005-10-01 - Run 1 (DBAA) 2/15/00 21:37
Original value (CoefB) = 1.9608 New value = 11.4008
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F8

Comment: 3005-10-01 - Run 1 (DBAA) 2/15/00 21:37
Original value (CoefD) = 0.3822 New value = 0.7478
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J8

Comment: 3005-10-01 - Run 1 (DBAA) 2/15/00 21:37
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: C15

Comment: 3005-10-01 - Run 1 (MBAA) 2/15/00 21:36
Original value (CoefA0) = 0 New value = -0.0583
Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: D15

Comment: 3005-10-01 - Run 1 (MBAA) 2/15/00 21:36
 Original value (CoefAf) = 0 New value = 1.246
 Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: E15

Comment: 3005-10-01 - Run 1 (MBAA) 2/15/00 21:36
 Original value (CoefB) = 0 New value = 4097.8112
 Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: F15

Comment: 3005-10-01 - Run 1 (MBAA) 2/15/00 21:36
 Original value (CoefD) = 0 New value = 0.2816
 Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: J15

Comment: 3005-10-01 - Run 1 (MBAA) 2/15/00 21:36
 Original value (S) = 0 New value = 0
 Fewer than 6 points above MRL. Logistic function (type 1) applied.

Cell: C103

Comment: 3005-20-01 - Run 2 (MBAA) 2/15/00 21:28
 Original value (CoefA0) = 0 New value = 1.1
 Fewer than 6 points above MRL. Step function applied.

Cell: D103

Comment: 3005-20-01 - Run 2 (MBAA) 2/15/00 21:28
 Original value (CoefAf) = 0 New value = 0
 Fewer than 6 points above MRL. Step function applied.

Cell: E103

Comment: 3005-20-01 - Run 2 (MBAA) 2/15/00 21:28
 Original value (CoefB) = 0 New value = 0
 Fewer than 6 points above MRL. Step function applied.

Cell: F103

Comment: 3005-20-01 - Run 2 (MBAA) 2/15/00 21:28
 Original value (CoefD) = 0 New value = 0
 Fewer than 6 points above MRL. Step function applied.

Cell: J103

Comment: 3005-20-01 - Run 2 (MBAA) 2/15/00 21:28
 Original value (S) = 0 New value = 0
 Fewer than 6 points above MRL. Step function applied.

Cell: K103

Comment: 3005-20-01 - Run 2 (MBAA) 2/15/00 21:28
 Original value (t0) = 0 New value = 37.8403
 Fewer than 6 points above MRL. Step function applied.

Cell: C110

Comment: 3005-20-01 - Run 2 (TSUVA) 2/15/00 21:38
 Original value (CoefA0) = 0 New value = -0.1902
 Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D110

Comment: 3005-20-01 - Run 2 (TSUVA) 2/15/00 21:38
 Original value (CoefAf) = 2.5 New value = 1.8398
 Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E110

Comment: 3005-20-01 - Run 2 (TSUVA) 2/15/00 21:38

Original value (CoefB) = 10 New value = 19.9922
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F110

Comment: 3005-20-01 - Run 2 (TSUVA) 2/15/00 21:38
Original value (CoefD) = 0.15 New value = 0.8232
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J110

Comment: 3005-20-01 - Run 2 (TSUVA) 2/15/00 21:38
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: C117

Comment: 3005-20-02 - Run 4 (CI2-D) 2/15/00 21:46
Original value (CoefA0) = 0.1749 New value = -0.6398
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D117

Comment: 3005-20-02 - Run 4 (CI2-D) 2/15/00 21:46
Original value (CoefAf) = 3.3062 New value = 2.4345
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E117

Comment: 3005-20-02 - Run 4 (CI2-D) 2/15/00 21:46
Original value (CoefB) = 57.4496 New value = 20.0002
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F117

Comment: 3005-20-02 - Run 4 (CI2-D) 2/15/00 21:46
Original value (CoefD) = 0.0492 New value = 0.2398
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J117

Comment: 3005-20-02 - Run 4 (CI2-D) 2/15/00 21:46
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: C122

Comment: 3005-20-02 - Run 4 (HAA5) 2/15/00 21:44
Original value (CoefA0) = -8.75 New value = -66.3455
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: D122

Comment: 3005-20-02 - Run 4 (HAA5) 2/15/00 21:44
Original value (CoefAf) = 26.25 New value = 79.6811
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: E122

Comment: 3005-20-02 - Run 4 (HAA5) 2/15/00 21:44
Original value (CoefB) = 5.0834 New value = 0.8382
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: F122

Comment: 3005-20-02 - Run 4 (HAA5) 2/15/00 21:44
Original value (CoefD) = 0.019 New value = 0.025
Peak curve fit with S = 0. Refit to type 1 curve fit by iterative curve fit procedure.

Cell: J122

Comment: 3005-20-02 - Run 4 (HAA5) 2/15/00 21:44
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: C126

Comment: 3005-20-02 - Run 4 (MCAA) 2/15/00 21:33
Original value (CoefA0) = 0 New value = 3.5
Fewer than 6 points above MRL. Step function applied.

Cell: D126

Comment: 3005-20-02 - Run 4 (MCAA) 2/15/00 21:33
Original value (CoefAf) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: E126

Comment: 3005-20-02 - Run 4 (MCAA) 2/15/00 21:33
Original value (CoefB) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: F126

Comment: 3005-20-02 - Run 4 (MCAA) 2/15/00 21:33
Original value (CoefD) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: J126

Comment: 3005-20-02 - Run 4 (MCAA) 2/15/00 21:33
Original value (S) = 0 New value = 0
Fewer than 6 points above MRL. Step function applied.

Cell: K126

Comment: 3005-20-02 - Run 4 (MCAA) 2/15/00 21:33
Original value (t0) = 0 New value = 112.8
Fewer than 6 points above MRL. Step function applied.

Cell: C129

Comment: 3005-20-02 - Run 4 (THM4) 2/15/00 21:42
Original value (CoefA0) = 24.2508 New value = -30.5838
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: D129

Comment: 3005-20-02 - Run 4 (THM4) 2/15/00 21:42
Original value (CoefAf) = 23.5561 New value = 79.9643
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: E129

Comment: 3005-20-02 - Run 4 (THM4) 2/15/00 21:42
Original value (CoefB) = 1237.2128 New value = 36.7261
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: F129

Comment: 3005-20-02 - Run 4 (THM4) 2/15/00 21:42
Original value (CoefD) = 0.0962 New value = 0.053
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: J129

Comment: 3005-20-02 - Run 4 (THM4) 2/15/00 21:42
Original value (S) = -0.1088 New value = -0.2496
Poor peak curve fit. Data was refit by iterative curve fit procedure.

Cell: C130

Comment: 3005-20-02 - Run 4 (TOC) 2/15/00 21:39
Original value (CoefA0) = 1.2102 New value = -0.5018
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: D130

Comment: 3005-20-02 - Run 4 (TOC) 2/15/00 21:39

Original value (CoefAf) = 1.5641 New value = 3.3883
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: E130

Comment: 3005-20-02 - Run 4 (TOC) 2/15/00 21:39
Original value (CoefB) = 16.3205 New value = 20.07
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: F130

Comment: 3005-20-02 - Run 4 (TOC) 2/15/00 21:39
Original value (CoefD) = 0.0182 New value = 0.0224
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: J130

Comment: 3005-20-02 - Run 4 (TOC) 2/15/00 21:39
Original value (S) = 0 New value = 0
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: C132

Comment: 3005-20-02 - Run 4 (TSUVA) 2/15/00 21:40
Original value (CoefA0) = -0.4465 New value = -0.2554
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: D132

Comment: 3005-20-02 - Run 4 (TSUVA) 2/15/00 21:40
Original value (CoefAf) = 2.7835 New value = 1.6895
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: E132

Comment: 3005-20-02 - Run 4 (TSUVA) 2/15/00 21:40
Original value (CoefB) = 0.538 New value = 19.981
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: F132

Comment: 3005-20-02 - Run 4 (TSUVA) 2/15/00 21:40
Original value (CoefD) = 0.0007 New value = 0.0407
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: J132

Comment: 3005-20-02 - Run 4 (TSUVA) 2/15/00 21:40
Original value (S) = 0 New value = 0
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: C133

Comment: 3005-20-02 - Run 4 (UV254) 2/15/00 21:45
Original value (CoefA0) = -0.0236 New value = -0.0074
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: D133

Comment: 3005-20-02 - Run 4 (UV254) 2/15/00 21:45
Original value (CoefAf) = 0.075 New value = 0.1296
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: E133

Comment: 3005-20-02 - Run 4 (UV254) 2/15/00 21:45
Original value (CoefB) = 0.1743 New value = 20.0003
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: F133

Comment: 3005-20-02 - Run 4 (UV254) 2/15/00 21:45
Original value (CoefD) = 0.0004 New value = 0.0103
Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

Cell: J133

Comment: 3005-20-02 - Run 4 (UV254) 2/15/00 21:45

Original value (S) = 0 New value = 0

Poor type -1 or 1 curve fit. Data was refit by iterative curve fit procedure.

ICR Information

ID / ICR#: TX0570004 / Two-stage softening
 ICR Contact: Mr. Ted Kilpatrick
 Phone No.: Sunnyvale, TX 75182
 Period: 4/13/98 - 6/23/98 (71 days)

Design Information

Design TOC: 4.7 mg/L
 Col Diameter: 101.6 mm

Full-Scale GAC Size: 8x20 US Std Mesh
 Full-Scale particle dia.: 1.605 mm
 Meas Dry Bed Density: 549.1 kg/m3

Water Quality Summary

Influent	Mean	SD	Count	Min/Max
TOC	3.8	0.1	10	3.7 - 3.9
pH	8.3	0.3	10	7.9 - 8.7
UV254	0.085	0.006	10	0.077 - 0.097
SUVA	2.24	0.18	10	2.0 - 2.6
Bromide	136	20	10	110 - 160
SDS-TOX	298	41	7	250 - 360
SDS-THM4	125	12	10	105 - 142
SDS-HAA6	55	9	10	44 - 73
Ammonia	0.00	0.00	10	0.00 - 0.00

Cumulative SDS Conditions

	Mean	SD	Count	Min/Max
Res (0)	0.93	0.12	36	0.60 - 1.20
Temp	24.5	3.2	36	19.7 - 29.0
pH	8.2	0.4	36	7.3 - 9.2
Time	24.0	0.0	36	24.0 - 24.0

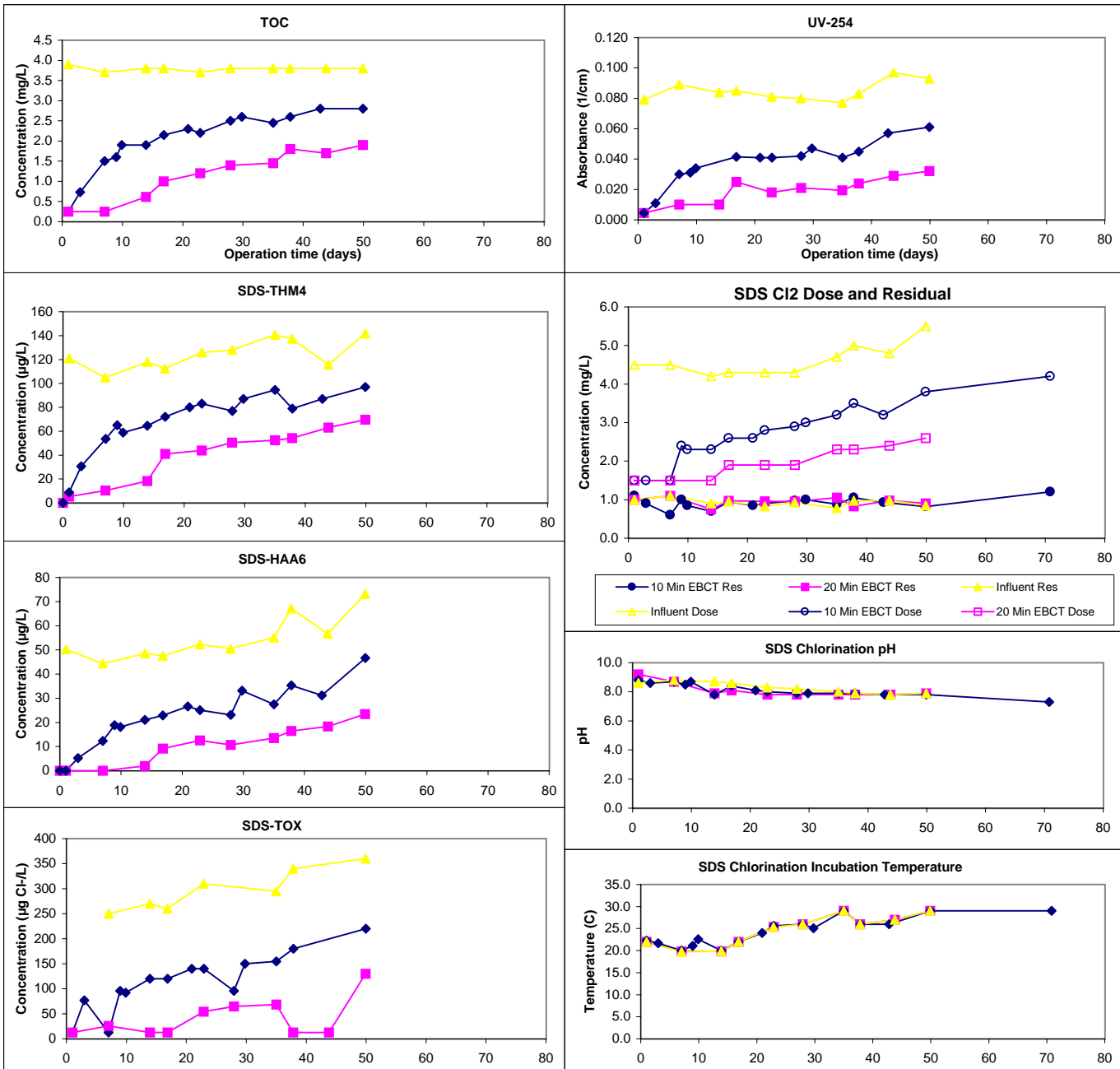
Comments:

Chart

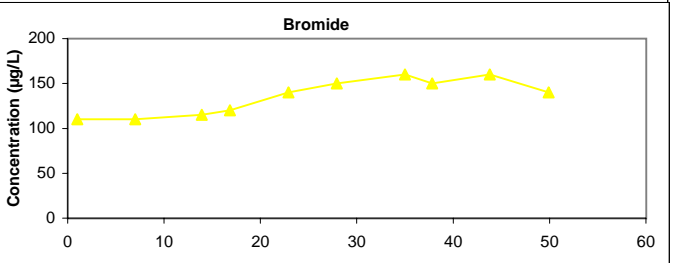
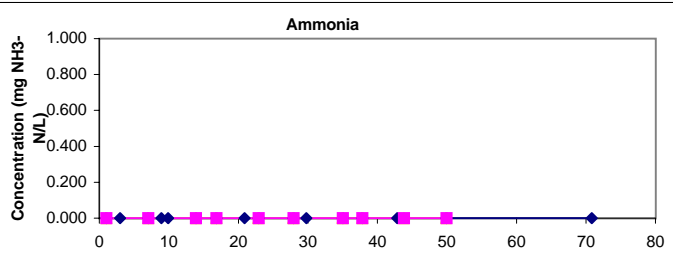
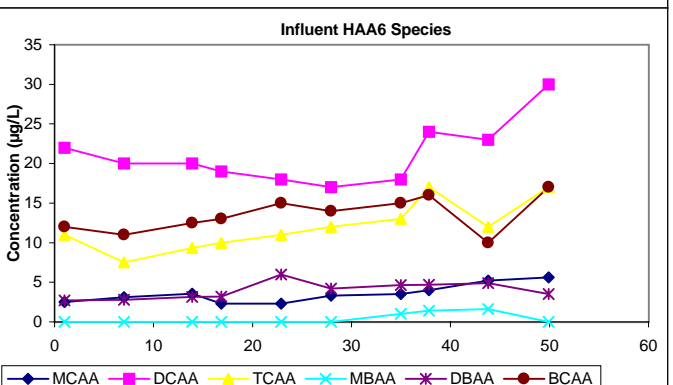
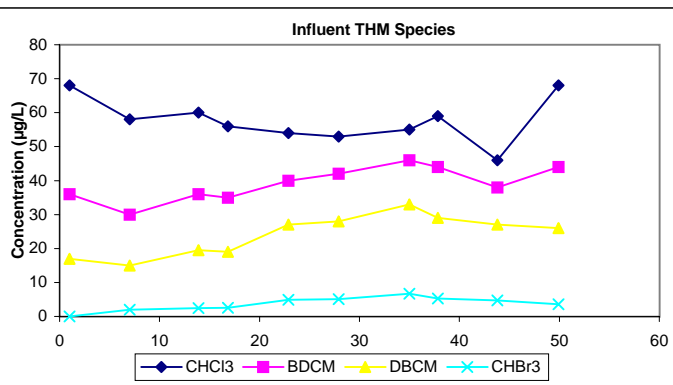
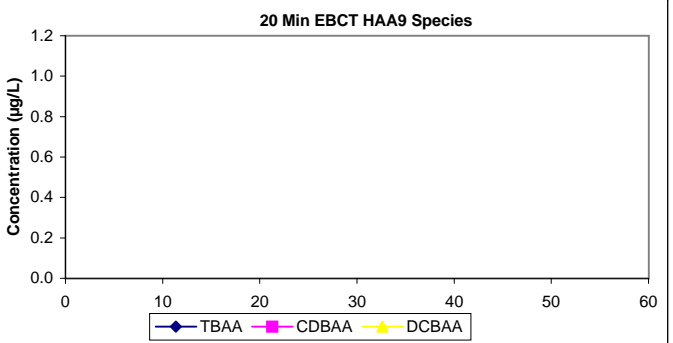
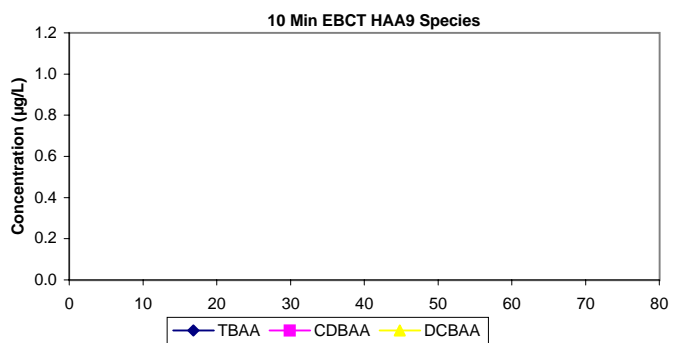
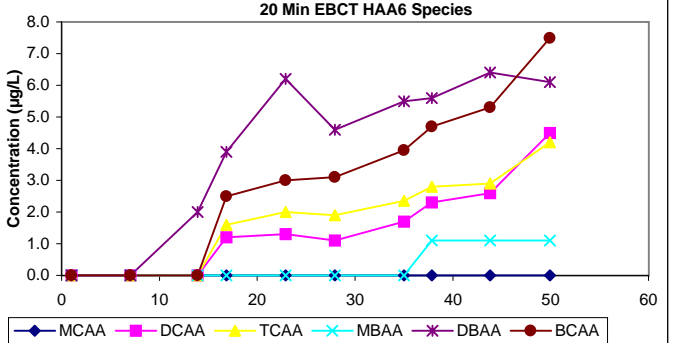
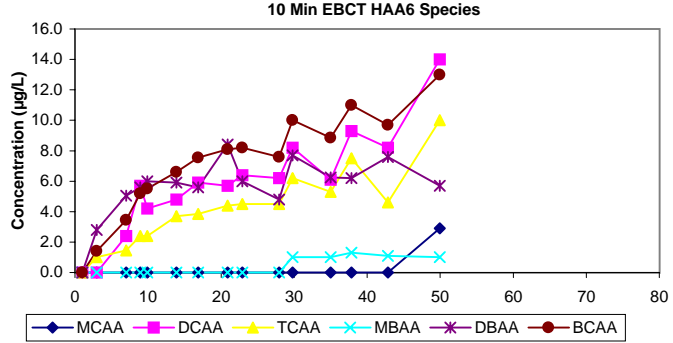
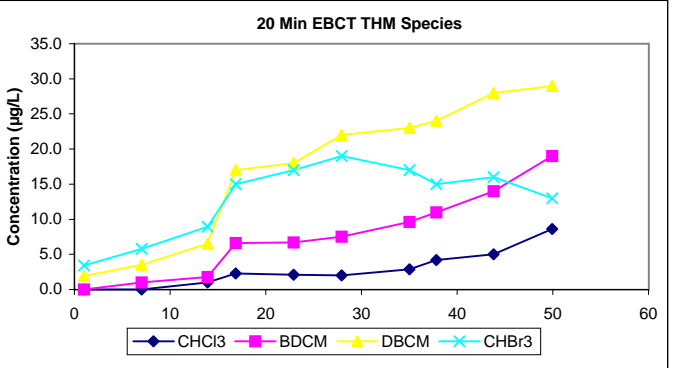
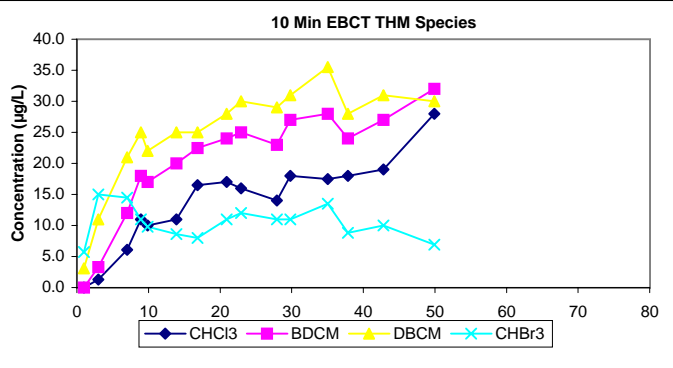
Legend: 10 Min EBCT
 20 Min EBCT
 Influent

Effluent	10 Min EBCT	(71 days)	20 Min EBCT	(50 days)
Effluent pH	8.1	0.5	16	7.2 - 9.0
Effluent Temp	23.9	3.4	16	19.5 - 30.0

Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



ICR Information

ID / ICR#: TX0570004 / Two-stage softening
 ICR Contact: Mr. Ted Kilpatrick
 Phone No.: Sunnyvale, TX 75182
 Period: 4/13/98 - 12/15/98 (246 days)

Design Information

Design TOC: 4.7 mg/L
 Col Diameter: 101.6 mm

Full-Scale GAC Size: 8x20 US Std Mesh
 Full-Scale particle dia.: 1.605 mm
 Meas Dry Bed Density: 549.1 kg/m3

Water Quality Summary

Influent	Mean	SD	Count	Min/Max
TOC	3.2	0.7	23	2.1 - 3.9
pH	7.5	1.1	24	6.0 - 10.6
UV254	0.064	0.021	24	0.031 - 0.097
SUVA	2.05	0.32	23	1.5 - 2.7
Bromide	134	19	24	95 - 160
SDS-TOX	236	72	16	130 - 360
SDS-THM4	97	33	19	38 - 142
SDS-HAA6	43	15	20	21 - 73
Ammonia	0.00	0.02	24	0.00 - 0.11

Cumulative SDS Conditions

	Mean	SD	Count	Min/Max
Res (0)	0.91	0.16	32	0.61 - 1.25
Temp	27.0	4.1	32	18.0 - 31.5
pH	8.0	0.8	32	6.2 - 10.5
Time	24.0	0.0	32	24.0 - 24.0

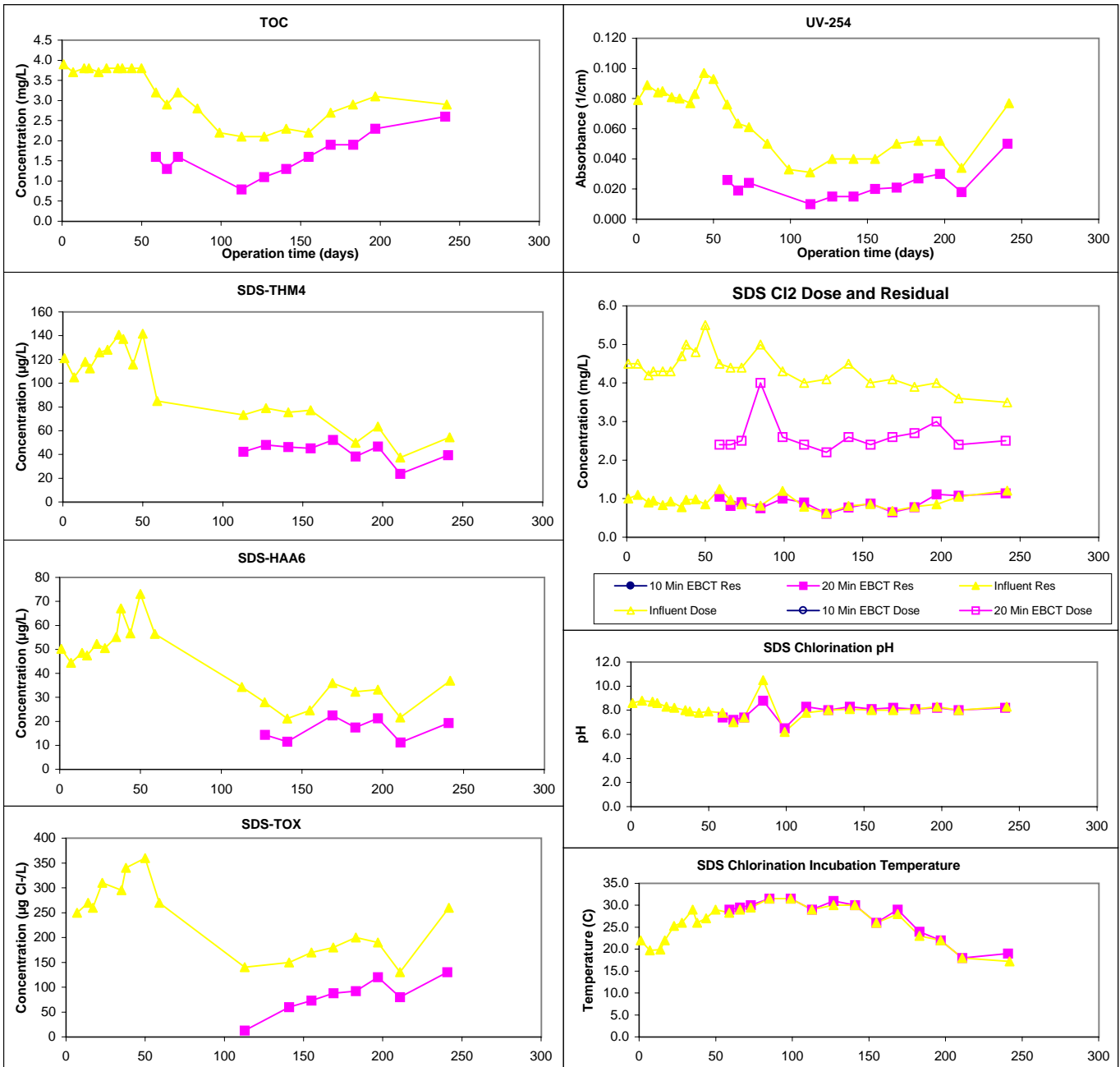
Comments:

Chart

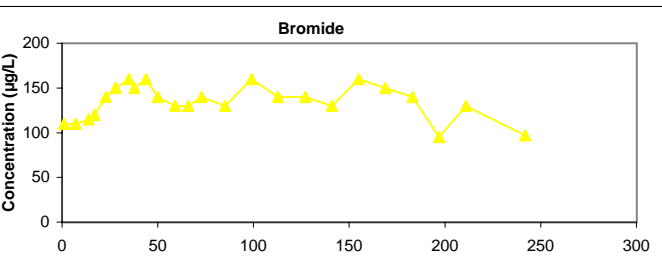
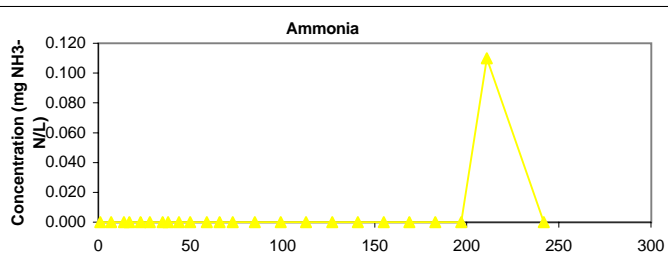
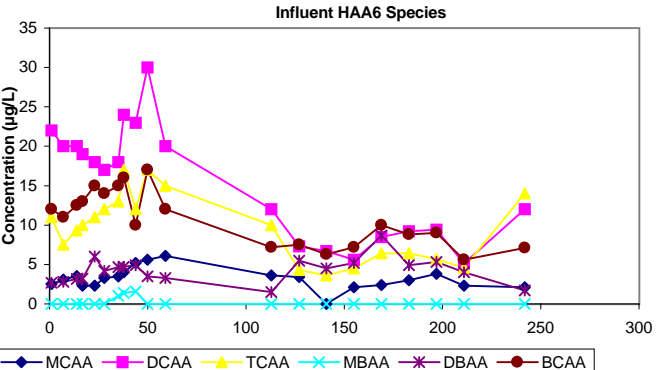
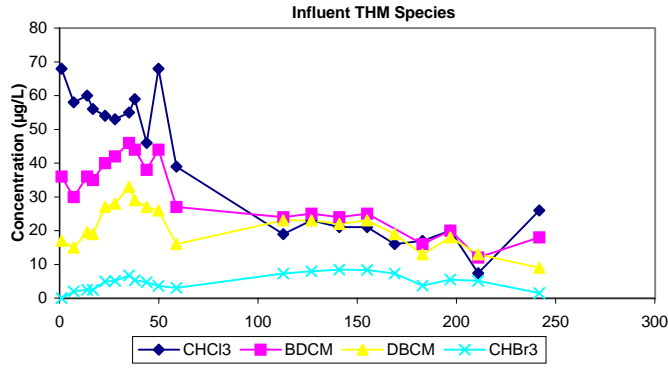
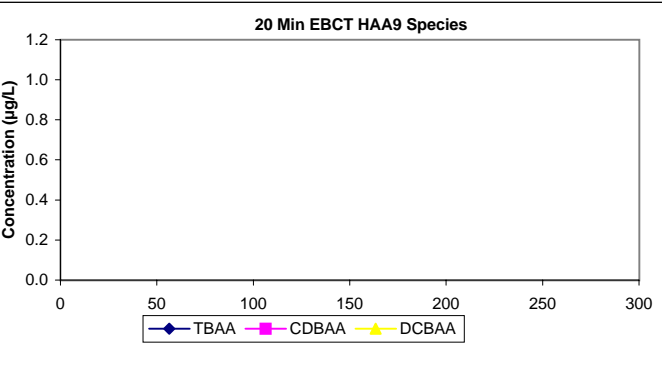
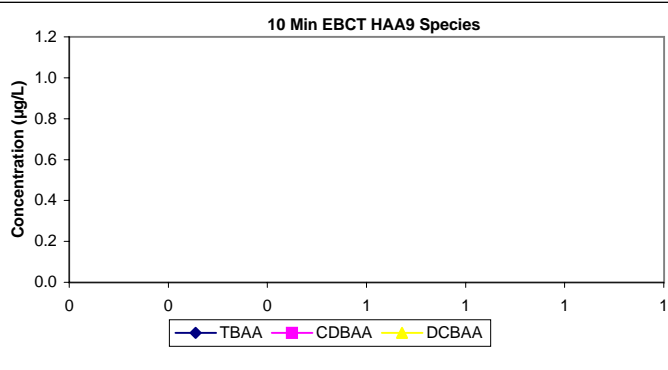
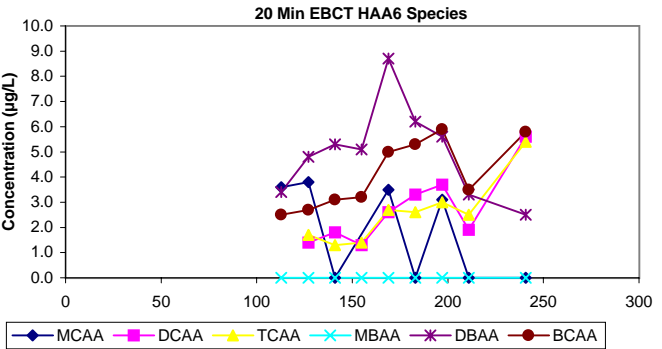
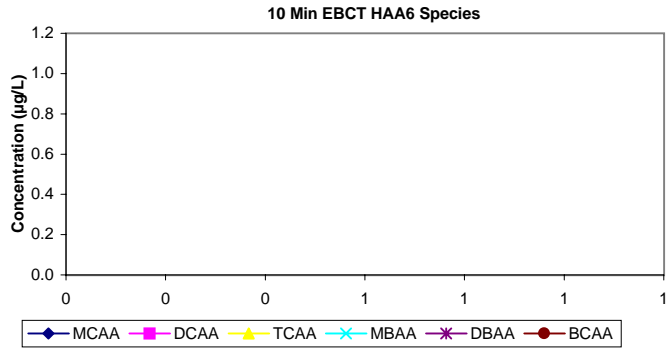
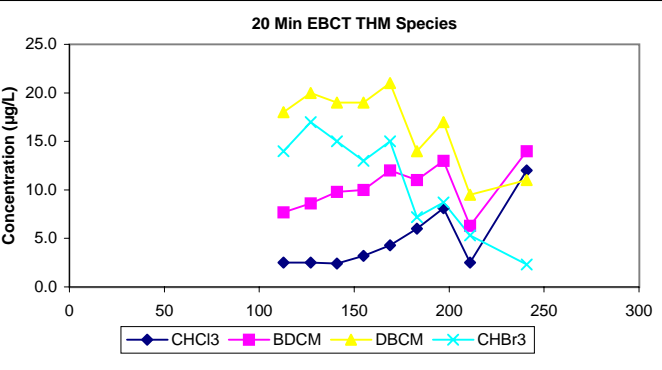
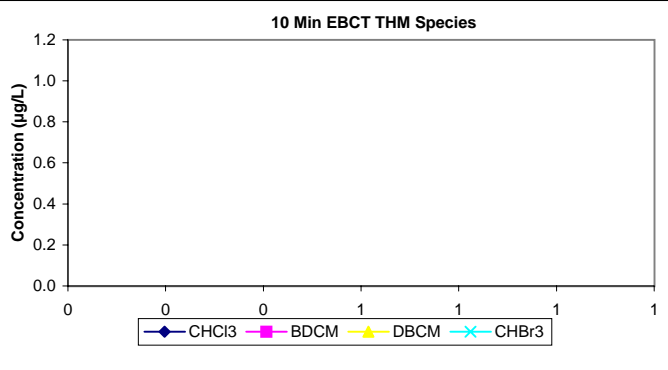
Legend: 10 Min EBCT
 20 Min EBCT
 Influent

Effluent	10 Min EBCT	20 Min EBCT
Effluent pH	NA	7.0
Effluent Temp	NA	27.8

Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)



ICR Information

ID / ICR#: TX0570004 / Two-stage softening
 ICR Contact: Mr. Ted Kilpatrick
 Phone No.: Sunnyvale, TX 75182
 Period: 4/13/98 - 8/4/98 (113 days)

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Design TOC: 4.7 mg/L
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Full-Scale GAC Size: 8x20 US Std Mesh
 Full-Scale particle dia.: 1.605 mm
 Meas Dry Bed Density: 549.1 kg/m3

Water Quality Summary

Influent	Mean	SD	Count	Min/Max
TOC	3.2	0.7	23	2.1 - 3.9
pH	7.5	1.1	24	6.0 - 10.6
UV254	0.064	0.021	24	0.031 - 0.097
SUVA	2.05	0.32	23	1.5 - 2.7
Bromide	134	19	24	95 - 160
SDS-TOX	236	72	16	130 - 360
SDS-THM4	97	33	19	38 - 142
SDS-HAA6	43	15	20	21 - 73
Ammonia	0.00	0.02	24	0.00 - 0.11

Cumulative SDS Conditions

	Mean	SD	Count	Min/Max
Res (0)	0.92	0.14	52	0.60 - 1.25
Temp	26.2	3.8	52	19.7 - 31.5
pH	8.0	0.7	52	6.2 - 10.5
Time	24.0	0.0	52	24.0 - 24.0

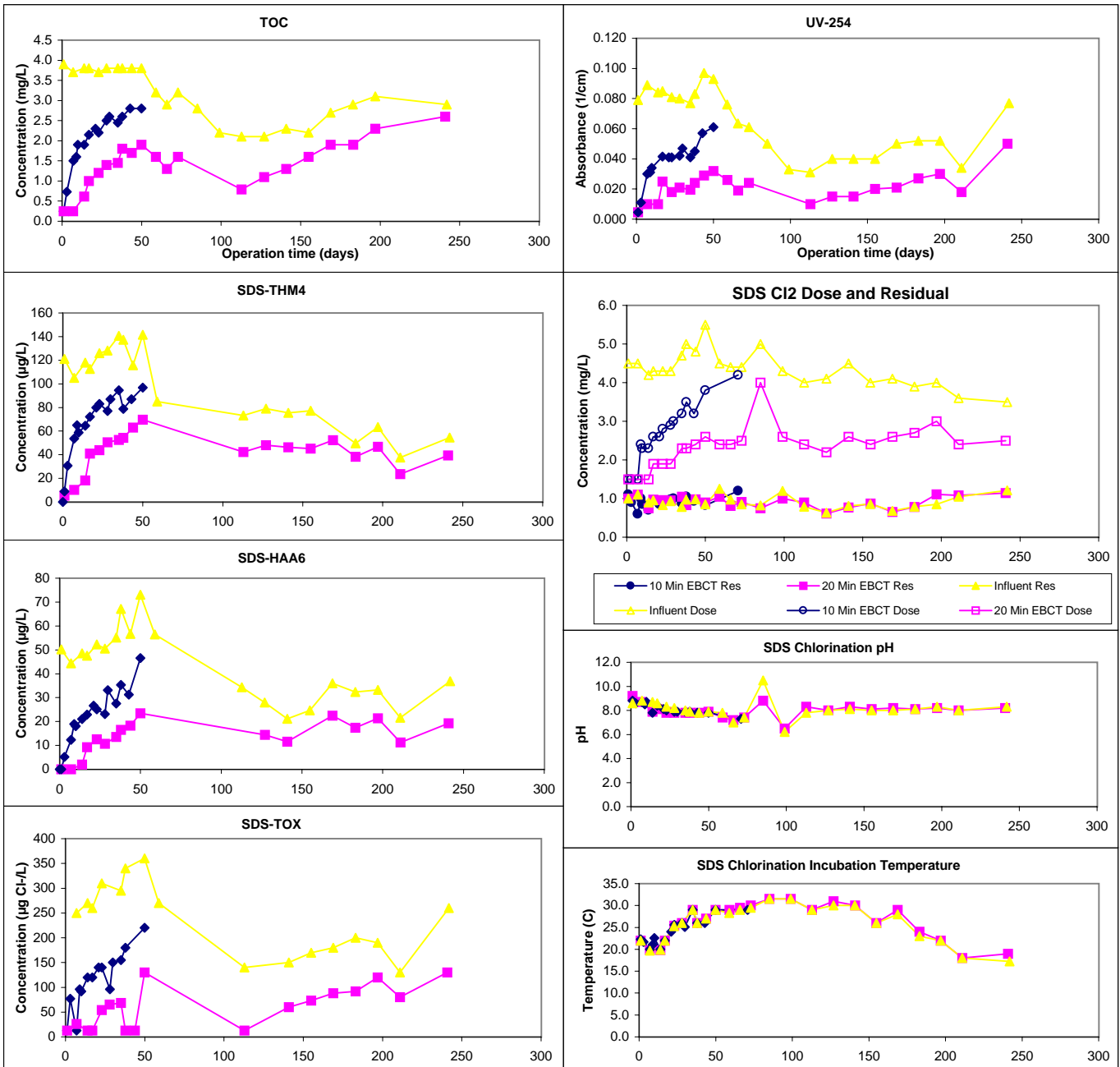
Comments:

Chart

Legend: 10 Min EBCT
 20 Min EBCT
 Influent

Effluent	10 Min EBCT	(71 days)	20 Min EBCT	(246 days)
Effluent pH	8.1	0.5	16	7.2 - 9.0
Effluent Temp	23.9	3.4	16	19.5 - 30.0
	7.4	0.9	24	6.3 - 9.6
	26.7	4.6	24	18.0 - 32.5

Water Quality Parameter Graphs



Water Quality Parameter Graphs (Continued)

