ICR Treatment Study Summary Report

Evaluation of GAC Using the Rapid Small-Scale Column Test for Compliance with the Information Collection Rule

Conducted during the period of August 1998 through May 1999

Prepared by:
Carollo Engineers
12426 West Explorer Drive
Suite 200
Boise, ID 83713

In July 1999

For:
Minneapolis Water Works MN1270024
250 South 4th Street, Room 206
Minneapolis, MN 55415

Attachment: Zip Disk containing the Data Collection Spreadsheets, Summary Report Spreadsheets, and a file containing the Summary Report

carollo engineers

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1

CONCLUSIONS AND RECOMMENDATIONS

Rapid small-scale column tests (RSSCT) were performed on softened and recarbonated water from the Minneapolis Water Works (MWW) Minneapolis Softening and Filtration Plant following procedures presented in the *ICR Manual for Bench- and Pilot-Scale Studies*. The results of the study exhibited the following general trends:

- RSSCT column influent TOC ranged from 3.5 to 5.9 mg/L. Simulated distribution system (SDS) TTHM and HAA5 values for the influent ranged from 60 to 149 μg/L and 24 to 85 μg/L, respectively.

- In general, UV254 breakthrough occurred later than TOC breakthrough, and THM and HAA breakthrough appear to correlate better with UV254 breakthrough than TOC breakthrough.

- THM precursor material exhibited more rapid breakthrough than HAA precursor material, and THM levels controlled bed life based on a goal of achieving the D/DBP Stage II MCL:

The RSSCT results from this study indicate that GAC provides effective THM and HAA control. Should advanced treatment technologies be required in the future to reduce DBP precursor material, the information from this and previous studies should be used to evaluate the feasibility of GAC treatment.

SECTION 2

BACKGROUND INFORMATION

INTRODUCTION

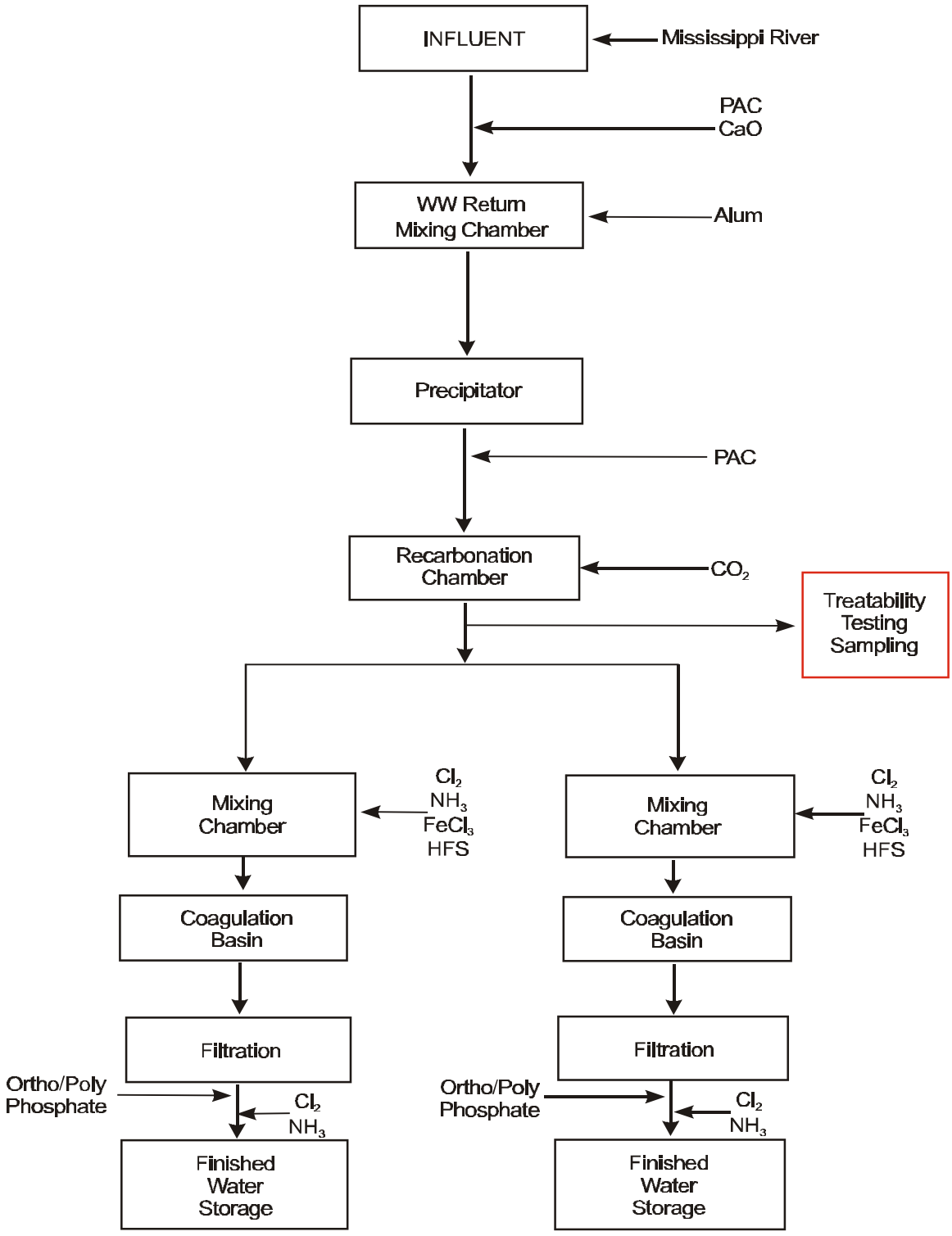
Minneapolis Water Works (MWW, PWSID # MN1270024) operates the Minneapolis Softening and Filtration Plant (Plant ICR # 425). The estimated population served by MWW is greater than 100,000. The Information Collection Rule (ICR) thus requires that the plant monitor for disinfection by-product (DBP) and microbiological water quality parameters. As average TOC is greater than 4.0 mg/L, testing of an advanced treatment technology for the removal of DBP precursors is also required.

Treatment Plant Description

Figure 1 is a schematic of the MWW Water Treatment Facilities. As shown in the figure, Mississippi River water is treated through lime softening followed by conventional treatment. Powdered activated carbon (PAC), lime, and alum are added to the raw water, and the chemically treated water flows into precipitators. Carbon dioxide and PAC are added to precipitator effluent, and the flow is split between two conventional filtration plants. At the filtration plants, chlorine, ammonia, ferric chloride, and fluosilicic acid are added, and the water is settled and filtered. Ortho/poly phosphate, chlorine, and ammonia are added to filter effluent. As indicated in the plant schematic, water for the ICR study will be obtained after the recarbonation basin prior to the first point of chlorine addition. Table 1 lists plant design parameters, and Table 2 provides plant chemical parameters, both using data acquired from the ICR Water Utility Database System.

Source and Finished Water Quality

The source for MWW is the Mississippi River and is characterized as having high TOC, high hardness and alkalinity, and moderate to high turbidity. Softening and conventional filtration provide substantial reduction in TOC, hardness, and alkalinity; however, TOC of the finished water remains high. Tables 3 and 4 summarize typical water quality parameters for raw and finished water, as determined through ICR monitoring during the 1998 calender year.



MINNEAPOLIS WATER WORKS
PROCESS FLOW DIAGRAM

Figure 1

TABLE 1

MINNEAPOLIS WATER WORKS DESIGN PLANT PARAMETERS

Treatment Plant Name: Minneapolis Softening & Filtration Plant
ICR Treatment Plant ID: 425
Treatment Plant PWS ID:
Treatment Plant Category: SOFT

State Approved Plant Capacity (MGD): 200.0
Historical Min. Water Temperature (°C): 0.1
Installed Sludge Handling Capacity: (DTD): 80.00
Blending Indicator: N

Water Resource Name: Mississippi River
Water Resource Type: Flowing stream
Intake Name: Pump Station #5
Watershed Control: N

Latitude (degrees, minutes, seconds): +45°2'35"
Longitude (degrees, minutes, seconds): -93°16'45"

Unit		Description	Design Parameters
Process Train Name: Columbia Heights Filtration Plant **Process Train Category:** CONV			
1	Pre Chlorine	Disinfectant Addition	Chemical Code: Cl_2 Measurement Formula: Cl_2 Dose Rate (mg/L): 4.20
2	Pre Ammonia	Disinfectant Addition	Chemical Code: NH_3A Measurement Formula: NH_3 Dose Rate (mg/L): 1.05
3	Mix CH E & W	Rapid Mix	Type of Mixer: HY Baffling Type: PF Liquid Volume (gal): 1,158,000
4	CH Sand Filters	Filtration	Surface Area (ft^2): 29,375 Liquid Volume (gal): 1,563,000 Total Media Depth (in): 30 Media Type: Sand Water Depth to Top of Media (ft): 2.8 Top of Media to Top of Trough (ft): 1.7
5	Post Chlorine	Disinfectant Addition	Chemical Code: Cl_2 Measurement Formula: Cl_2 Dose Rate (mg/L): 0.40
6	Post Ammonia	Disinfectant Addition	Chemical Code: NH_3A Measurement Formula: NH_3 Dose Rate (mg/L): 0.10

TABLE 1

MINNEAPOLIS WATER WORKS DESIGN PLANT PARAMETERS
(Continued)

Unit		Description	Design Parameters
7	CH 10 MG Res	Clearwell	Surface Area (ft^2): 70,300 Liquid Volume (gal): 10,000,000 Min Liquid Volume (gal): 5,000,000 Baffling Type: UN Covered Indicator Code: Y
Process Train Name: Fridley Filtration Plant			
1	Pre Chlorine	Disinfectant Addition	Chemical Code: Cl_2 Measurement Formula: Cl_2 Dose Rate (mg/L): 4.20
2	Pre Ammonia	Disinfectant Addition	Chemical Code: NH_3A Measurement Formula: NH_3 Dose Rate (mg/L): 1.05
3	Mixing Ch #1-4	Rapid Mix	Type of Mixer: HY Baffling Type: PF Liquid Volume (gal): 834,000 Mean Velocity Gradient (sec-1): 1.0
4	Coag Basin #1-4	Sedimentation	Surface Area (ft^2): 132,400 Liquid Volume (gal): 14,900,000 Baffling Type: SP
5	Fridley Filters	Filtration	Surface Area (ft_2): 28,000 Liquid Volume (gal): 1,770,000 Total Media Depth (in): 26 Media Type: OTHR Depth to Top of Media (ft): 4.2 Depth Media to Trough (ft): 3.2
6	Post Chlorine	Disinfectant Addition	Chemical Code: Cl_2 Measurement Formula: Cl_2 Dose Rate (mg/L): 0.40
7	Post Ammonia	Disinfectant Addition	Chemical Code: NH_3A Measurement Formula: NH_3 Dose Rate (mg/L): 0.10
8	Fridley Res 1-2	Clearwell	Surface Area (ft^2): 263,700 Liquid Volume (gal): 32,000,000 Min Liquid Volume (gal): 15,000,000 Baffling Type: PR Covered Indicator Code: Y

TABLE 1

MINNEAPOLIS WATER WORKS DESIGN PLANT PARAMETERS
(Continued)

Unit		Description	Design Parameters
9	CH 45 MG Res	Clearwell	Surface Area (ft^2): 333,000 Liquid Volume (gal): 45,000,000 Min Liquid Volume (gal): 30,000,000 Baffling Type: UN Covered Indicator Code: Y
10	Hilltop Res 1&2	Clearwell	Surface Area (ft^2): 270,900 Liquid Volume (gal): 40,000,000 Min Liquid Volume (gal): 23,000,000 Baffling Type: UN Covered Indicator Code: Y
Process Train Name: Fridley Softening Plant **Process Train Category:** SOFT			
1	WW Pmp Sta 2&3	Washwater Return Sample Point	
2	WW Pmp Sta 2&3	Washwater Return	Washwater Treated: N Coagulation/Sedimentation: N Filtration: N Disinfectant Addition: N Plain Sedimentation: N 24 hr Avg Flow Returned (MGD): 0.7
3	Mix Ch #209-212	Rapid Mix	Type of Mixer: HY Baffling Type: PF Liquid Volume (gal): 90,000
4	Spaulding Precp	Solids Contact Filter	Clarifier Type: SB Clarifier Type: UP Brand Name: U.S. Filter Surface Area (ft^2): 65,600 Liquid Volume (gal): 6,200,000 Baffling Type: AV
5	No. & So. Recarb	Recarbonation Basin	Surface Area (ft^2): 20,100 Liquid Volume (gal): 2,255,000 Baffling Type: UN
	Finished Water	FIN	

TABLE 2

MINNEAPOLIS WATER WORKS PLANT CHEMICAL PARAMETERS

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
Treatment Plant Name: Minneapolis Softening & Filtration Plant **ICR Treatment Plant ID No:** 425 **Treatment Plant Category:** SOFT						
Process Train Name: Columbia Heights Filtration Plant **Process Train Category:** CONV						
1	Pre Chlorine	Disinfectant Addition		Chlorine gas	C12	4.20
2	Pre Ammonia	Disinfectant Addition		Anhydrous ammonia	NH3	1.05
3	Mix Ch E & W	Rapid Mix		Hydrofluorosilic acid Ferric chloride	H2SiF6 FeCl3	5.40 5.00
4	CH Sand Filters	Filtration				
5	Post Chlorine	Disinfectant Addition		Chlorine gas	C12	0.4
6	Post Ammonia	Disinfectant Addition		Anhydrous ammonia	NH3	0.10
7	CH 10 MG Res	Clearwell		Other chemical	PO4	0.60
Process Train Name: Fridley Filtration Plant **Process Train Category:** CONV						
1	Pre Chlorine	Disinfectant Addition		Chlorine gas	Cl2	4.20
2	Pre Ammonia	Disinfectant Addition		Anhydrous ammonia	NH3	1.05
3	Mixing Ch #1-4	Rapid Mix	4	Ferric chloride Hydrofluorosilic acid	FeCl3 H2SiF6	5.00 5.40

TABLE 2

MINNEAPOLIS WATER WORKS PLANT CHEMICAL PARAMETERS
(Continued)

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
4	Coag Basin #1-4	Sedimentation	5			
5	Fridley Filters	Filtration	6			
6	Post Chlorine	Disinfectant Addition		Chlorine gas	Cl2	0.40
7	Post Ammonia	Disinfectant Addition		Anhydrous ammonia	NH3	0.10
8	Fridley Res 1-2	Clearwell		Other chemical	PO4	0.60
9	CH 45 MG Res	Clearwell				
10	Hilltop Res 1 & 2	Clearwell				
Process Train Name: Fridley Softening Plant **Process Train Category:** SOFT						
1	WW Pmp Sta 2&3	Washwater Return Sample Point	2			
2	WW Pmp Sta 2&3	Washwater Return				
3	Mix Ch #209-212	Rapid Mix		Other chemical PAC Aluminum sulfate Calcium oxide	CaCO3 C Al2(SO4)3.14H2O CaO	0.86 3.00 18.67 138.65
4	Spaulding Precp	Solids Contact Clarifier				
5	No. & So. Recarb	Recarbonation Basin	3	Powdered activated carbon Carbon dioxide	C CO2	4.00 216.00

TABLE 3

MINNEAPOLIS RAW WATER QUALITY SUMMARY-1998

Water Quality Parameter	Average Yearly concentration	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature (°C)	14.1	8.5	26	2.7
pH	8.3	0.2	8.5	7.9
Turbidity (NTU)	10.3	7.3	30	3.3
Alkalinity (mg/L as $CaCO_3$)	160	14.6	178	132
Calcium Hardness (mg/L as $CaCO_3$)	131	11.1	142	108
Total Hardness (mg/L as $CaCO_3$)	182	17.9	203	150
TOC (mg/L)	7.9	2.3	10.7	2.3
UV 254 (1/cm)	0.3	0.09	0.45	0.2
Bromide (μg)	BMRL	0.01	0.04	BMRL

TABLE 4

MINNEAPOLIS FINISHED WATER QUALITY SUMMARY-1998

Water Quality Parameter	Average Yearly concentration	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature (°C)	16.6	6.1	25	6
pH	8.5	0.14	8.7	8.3
Turbidity (NTU)	0.1	0.05	0.25	0.1
Alkalinity (mg/L as CaCO3)	41	3.8	46	33
Calcium Hardness (mg/L as CaCO3)	60	5.3	67	52
Total Hardness (mg/L as CaCO3)	79	4.3	89	74
TOC (mg/L)	4.5	1.1	6.4	3.1
UV 254 (1/cm)	0.1	0.02	0.14	0.1

SECTION 3

MATERIALS AND METHODS

Pretreatment and Advanced Process Information

RSSCTs were performed using procedures presented in the *ICR Manual for Bench- and Pilot-Scale Studies*. The tests were performed quarterly for one year at the Carollo Laboratory using water collected from the MWW treatment plant after softening and recarbonation and prior to chlorine and ammonia addition. pH was adjusted and maintained at a value representative of full-scale finished water (8.5) using sulfuric acid. This pH allowed simulation of a post-filtration GAC contactor, the most favorable location in terms of carbon usage. The RSSCT apparatus included a 1 μm cartridge prefilter to simulate filtration and prevent excessive pressure build-up in the RSSCT columns. RSSCT testing was run in parallel mode, with simulated 10- and 20-minute empty bed contact time (EBCT) RSSCT columns run concurrently on the same batch of water.

The RSSCT apparatus was constructed using two 11-mm diameter glass chromatography columns outfitted with Teflon fittings and tubing. Water was pumped via gear pumps from holding tanks through a 1 μm cartridge filters and into the columns. The columns were operated independently with separate pumps, and flow rate and pressure were controlled by pump speed and effluent needle valve adjustment. Figure 2 is a diagram of the RSSCT apparatus.

The RSSCT columns were designed to simulate 10- and 20-minute EBCT. Using the procedures outlined in the *ICR Manual*, GAC (Calgon F400) was pulverized, sieved, and added to the columns. A summary of the RSSCT design and operating parameters are listed in Table 5.

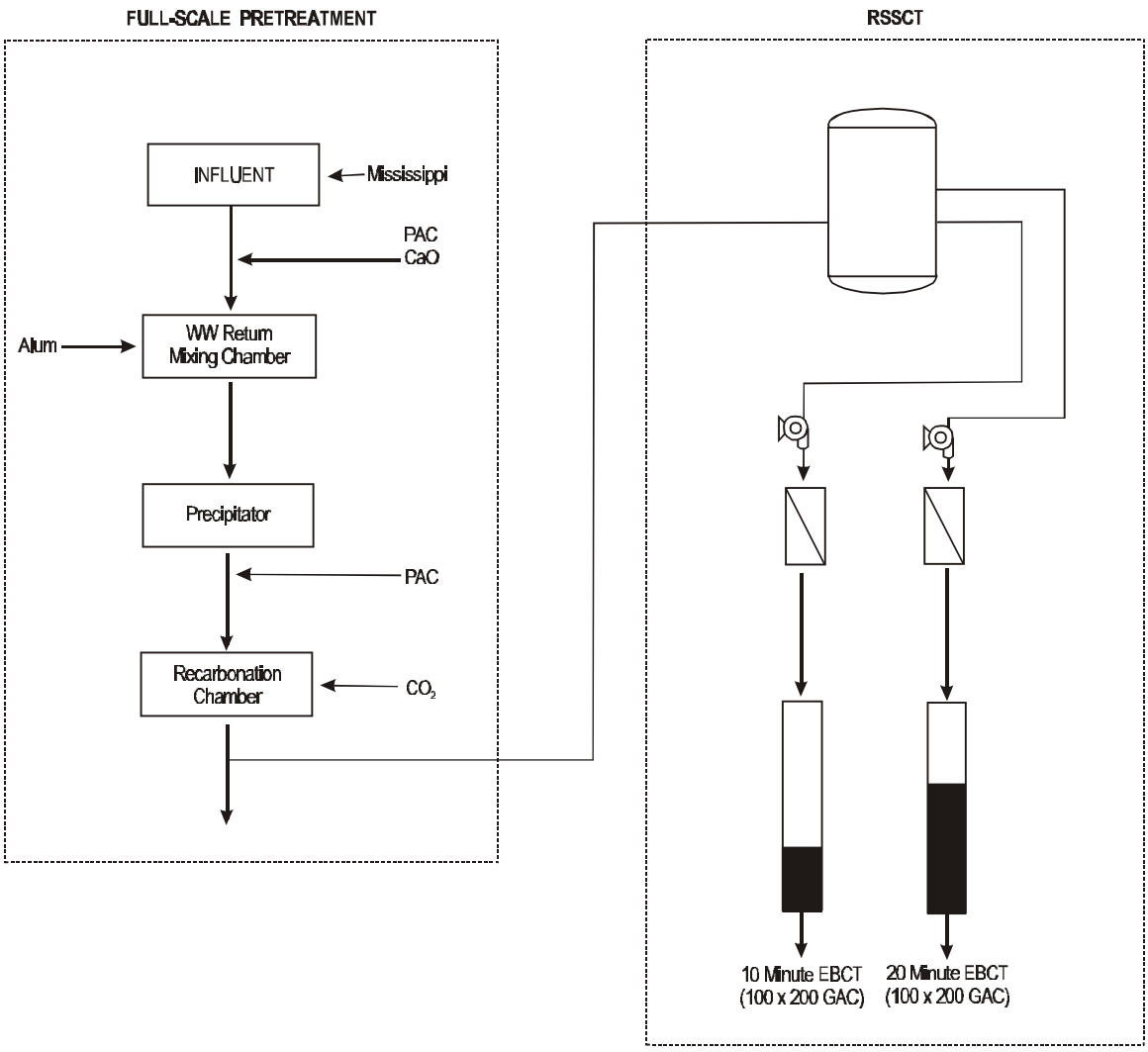
TABLE 5

RSSCT DESIGN AND OPERATING PARAMETERS*

Parameter	Value
Mesh Size	100x200
Carbon Diameter (d_{SC}, mm)	0.11
Flow Rate ** (Q_{SC}, mL/min)	10.5
$EBCT_{LC}$ = 10 min.	
$EBCT_{SC}$ (min)	0.76
Carbon Depth (l_{SC}, mm)	8.4
$EBCT_{LC}$ = 20 min	
$EBCT_{SC}$ (min)	1.52
Carbon Depth (l_{SC},mm)	16.8

* Simulates full-scale 8x30 mesh

** Per 11 mm diameter column



SCHEMATIC OF FULL-SCALE PRETREATMENT AND RSSCT CONFIGURATION

Figure 2

Experimental Design

Water for the treatability studies was collected after recarbonation and prior to chlorine and ammonia addition. For each quarterly test, water was collected in 15-gallon food-grade containers and shipped immediately to the Carollo Research facility.

At the lab, water was transferred to a 100-gallon tank from which the RSSCT columns were fed. To simulate GAC treatment of finished water, pH of the water in the feed tank was adjusted to 8.5 using sulfuric acid; pH of the water in the RSSCT feed tank was checked and adjusted daily.

Column influent and effluent samples were collected and analyzed as specified in the *ICR Manual for Bench- and Pilot-Scale Studies,* column effluent was sampled and analyzed for TOC and UV254 routinely. As indicated in Table 6, samples were collected from the effluent of each column at intervals corresponding to increases in the effluent TOC concentration of approximately 5 to 8 percent. In addition, duplicate samples were collected from the batch influent and effluent of each column three times during each quarterly study.

TABLE 6

ICR RSSCT SAMPLING SCHEDULE

Sampling Point	Analyses	Sample Frequency
GAC Influent	Alkalinity, total & calcium hardness, ammonia and bromide	Two samples per batch of influent evenly spaced over the RSSCT run
GAC Influent	pH, turbidity, temperature, TOC and UV_{254}, SDS for THM, HAA5, TOX and chlorine demand	Three samples per batch of influent evenly spaced over the RSSCT run
10-minute EBCT Column Effluent	pH, temperature, TOC and UV_{254}, SDS for THM, HAA5, TOX and chlorine demand	A minimum of 12 samples. One after one hour, and thereafter at 5% to 8% increments of the average influent TOC
20-minute EBCT Column Effluent	pH, temperature, TOC and UV_{254}, SDS for THM, HAA5, TOX and chlorine demand	A minimum of 12 samples. One after one hour, and thereafter at 5% to 8% increments of the average influent TOC

DBP and chlorine demand samples were prepared using the target Simulated Distribution System (SDS) parameters listed in Table 7. These SDS conditions are consistent with those used by MWW for the ICR Monitoring. ICR guidelines were followed in preparation of SDS DBP samples.

TABLE 7

DBP AND CHLORINE DEMAND SDS CONDITIONS

Parameter	Quarter			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Temperature (°C)	23	16.1	3.0	10
Incubation Time (hours)	18	18	18	18
pH	8.5	8.5	8.5	8.5
24-hour chlorine residual (mg/L)	1.0	1.0	1.0	1.0

Analytical Methods

Table 8 lists analytical methods for each parameter to be measured during testing. All analyses were conducted in strict accordance with ICR methods and QA/QC requirements. Analyses were performed by Carollo Engineers (CE) or Montgomery Watson Laboratories (MWL; ID#: ICRCA013) as indicated in Table 8.

TABLE 8

ANALYTICAL METHODS

Analyte	Method	Minimum Reporting Level
Alkalinity $_{CE}$	SM 2320 B	5 mg/L as CaCO3
Ammonia $_{MWL}$	EPA 350.1	0.05 mg/L
Bromide $_{MWL}$	EPA 300.0	20 µg/L
Calcium Hardness $_{CE}$	EPA 200.7	5 mg/L as CaCO3
Chlorine Residual $_{CE}$	SM 4500-Cl	0.2 mg/L
HAA5 $_{MWL}$	SM6251 B	2 µg/L
THM4 $_{MWL}$	EPA 502.2	1 µg/L
pH_{CE}	SM 4500 H+	N/A
Temperature $_{CE}$	SM 2550 B	N/A
Total Hardness $_{CE}$	SM 2340 B	10 mg/L as CaCO3
$TOC_{C E}$	SM 5310 C	0.5 mg/L
TOX $_{MWL}$	SM 5320 B	25 µg Cl/L
Turbidity $_{CE}$	SM 2130 B	0.05 ntu
$UV254_{CE}$	SM 5910	0.009 cm-1

CE - Carollo Engineers
MWL - Montgomery Watson Laboratory

SECTION 4

RESULTS AND DISCUSSION

Table 9 provides a summary of testing dates and feed water quality for each quarter. Alkalinity, pH, and hardness were very consistent for all quarters. The TOC concentration in the influent water ranged from 3.6 to 5.8 mg/L for the four quarters of testing, with the highest level occurring during the first quarter (summer). The SDS TTHM and HAA5 values of the feed water ranged from 60 to 149 μg/L and 24 to 85 μg/L, respectively. The highest levels for the both of these parameters occurred during the first quarter, during which the TOC, UV254, and incubation temperatures were all at the highest level tested.

TABLE 9

SUMMARY OF RSSCT FEED WATER QUALITY

Parameter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Dates of Testing	8/8/98-8/21/98	10/15/98-10/30/98	1/21/98-2/8/99	4/23/98-5/7/99
pH	8.34	8.44	8.7	8.45
Alkalinity (mg/L as $CaCO_3$)	42	42	50	38
Total Hardness (mg/L as $CaCO_3$)	69	64	72	65
Ammonia (mg/L)	0.1	0.1	0.5	0.1
Bromide (µg/L)	26	38	22	BMRL
TOC (mg/L)	5.82	3.64	4.7	5.08
UV254 (cm^{-1})	0.115	0.063	0.073	0.092
SDSTTHM (μg/L)	149	60	61	90
SDS HAA5 (μg/L)	85	24	26	40

Summary of Significant Results

Key results of the quarterly RSSCT tests are illustrated Figures 3 through 15. Some observations based on these data include :

- Data exhibited generally expected trends with regard to precursor breakthrough.
- In general, UV breakthrough occurred later than TOC breakthrough, and THM and HAA breakthrough appear to correlate better with UV breakthrough than TOC breakthrough.

As indicated in Tables 10 and 11, based on D/DBP Stage II proposed MCLs (30 μg/L and 40 μg/L for HAA5 and TTHM, respectively), TTHM precursor breakthrough generally controlled bed life. Table 12 lists carbon usage rate estimates based on the bed life of Table 11.

TABLE 10
RUN TIME TO PROPOSED D/DBP STAGE II BREAKTHROUGH (HOURS)

		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
10 minute EBCT	TTHM	90	144	166	64
	HAA5	67	(1)	(1)	300 (4)
20 minute EBCT	TTHM	115	450(2)	520(3)	282
	HAA5	160	(1)	(1)	540(5)

(1) SDS DBP formation of influent is less than proposed D/DBP Stage II MCL
(2) Extrapolated from 355 Hours
(3) Extrapolated from 430 Hours
(4) Extrapolated from 234 Hours
(5) Extrapolated from 330 Hours

TABLE 11
BEB VOLUMES OF WATER PROCESSED TO PROPOSED D/DBP STAGE II BREAKTHROUGH

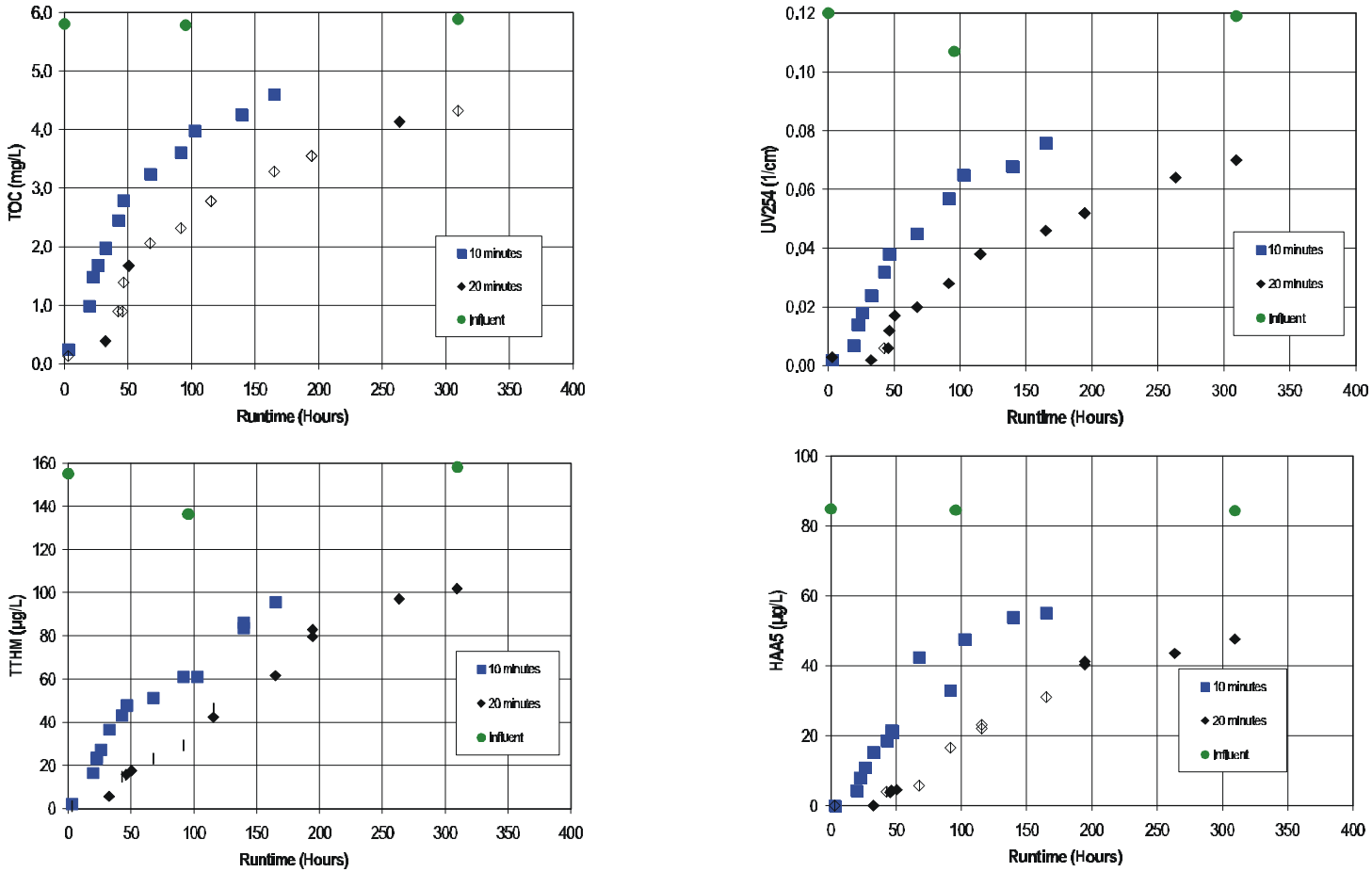
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
10 minute EBCT	TTHM	3200	11,300	13,100	5100
	HAA5	5300	(1)	(1)	23,700
20 minute EBCT	TTHM	4600	1800	20,800	
	HAA5	6300	(1)	(1)	21,300

(1) SDS DBP Formation of influent is less than proposed D/DBP Stage II MCL

TABLE 12
CARBON USAGE TO MEET PROPOSED D/DBP STAGE II MCLs (lb GAC/MILLION GALLONS PRODUCED)

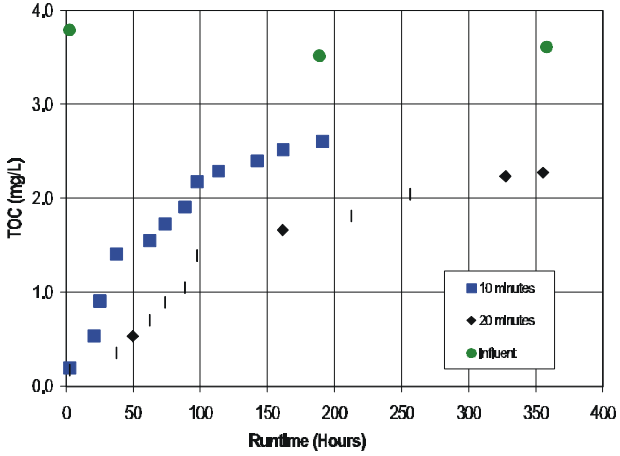
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
10 minute EBCT	TTHM	1266	352	305	792
	HAA5	755	(1)	(1)	(1)
20 minute EBCT	TTHM	880	222	193	360
	HAA5	635	(1)	(1)	188

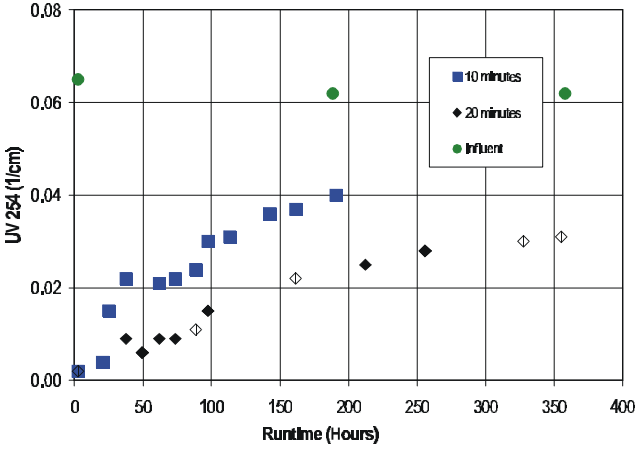
(1) SDS DBP Formation of influent is less than proposed D/DBP Stage II MCL

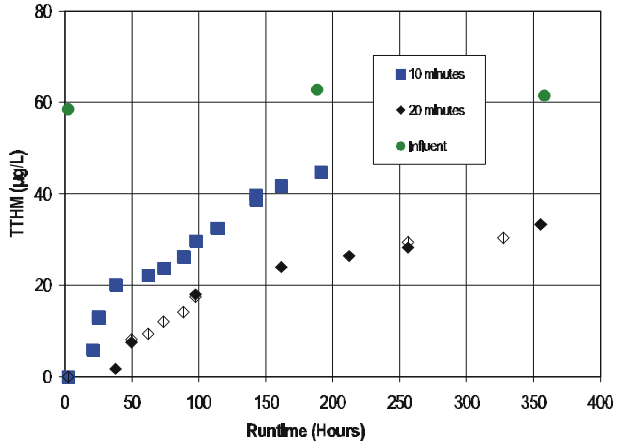


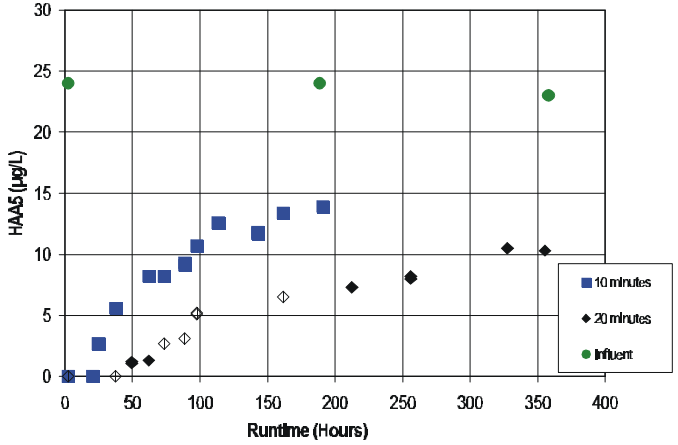
1st QUARTER
DBP PRECURSOR BREAKTHROUGH

Figure 3



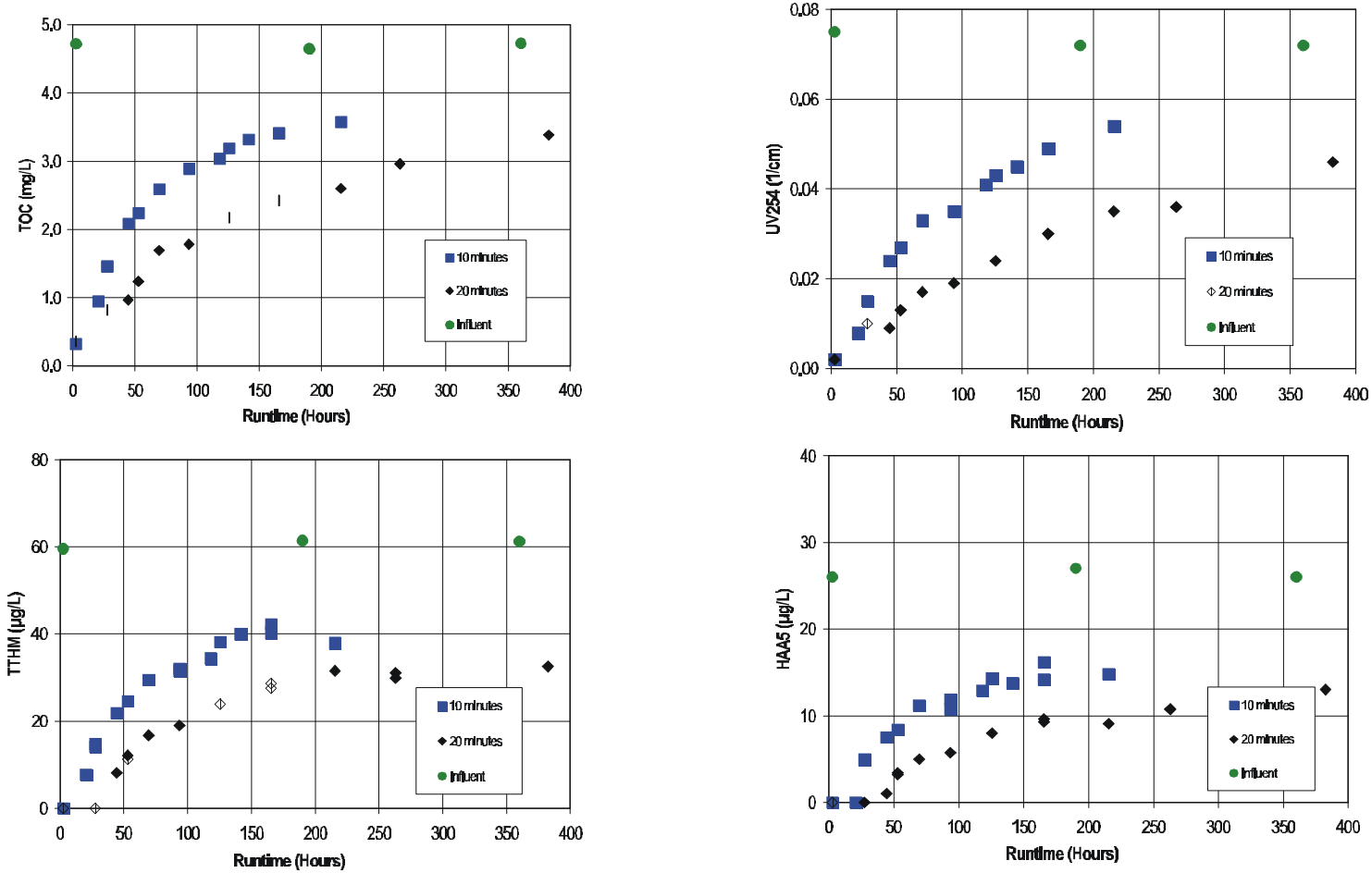






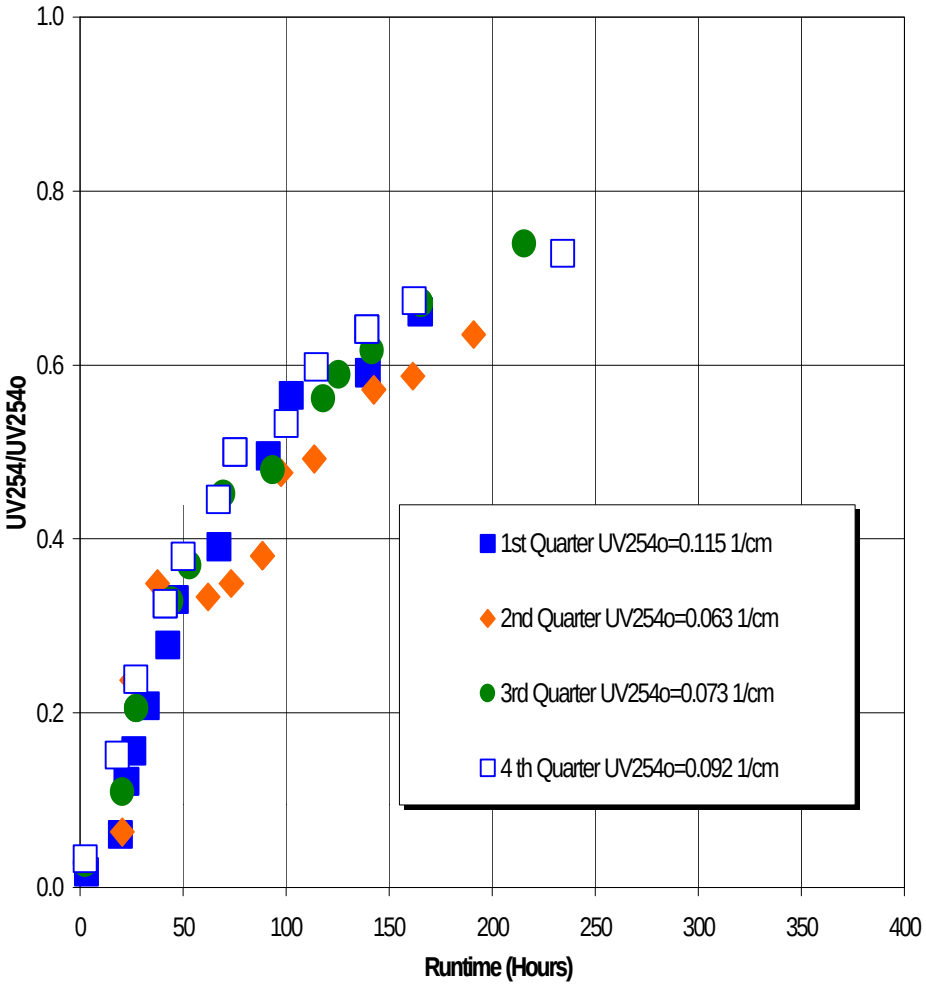
2nd QUARTER
DBP PRECURSOR BREAKTHROUGH

Figure 4



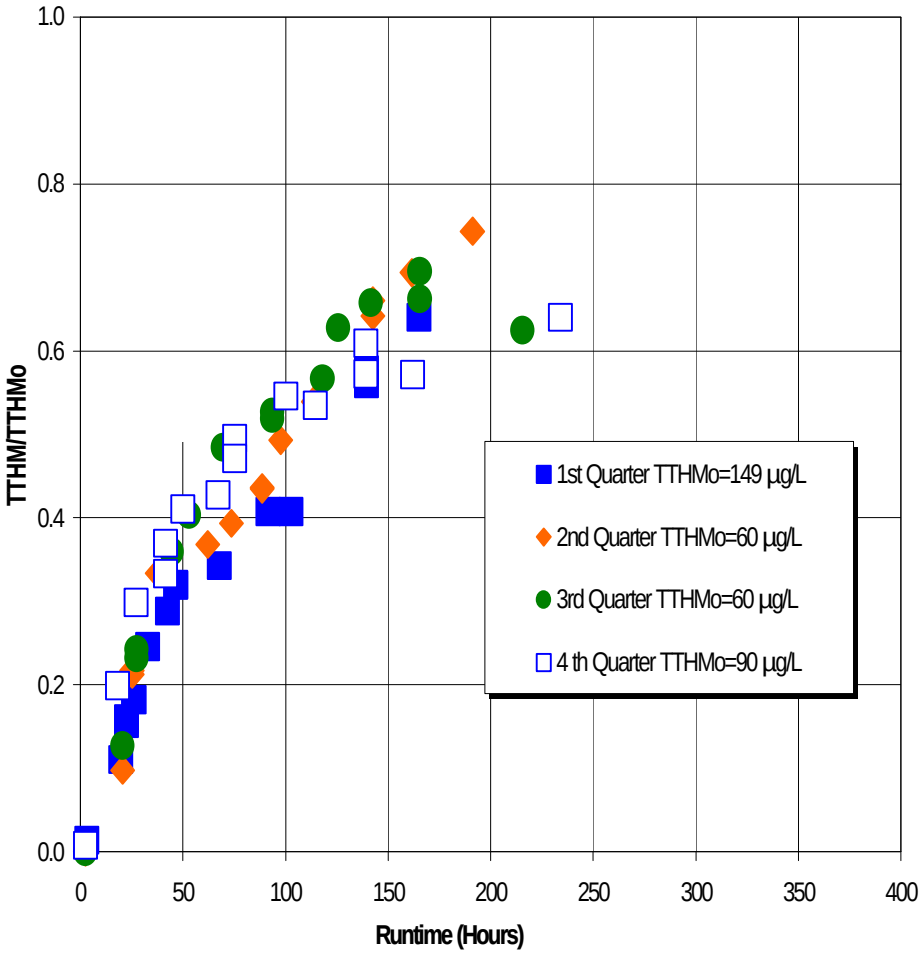
3rd QUARTER
DBP PRECURSOR BREAKTHROUGH

Figure 5



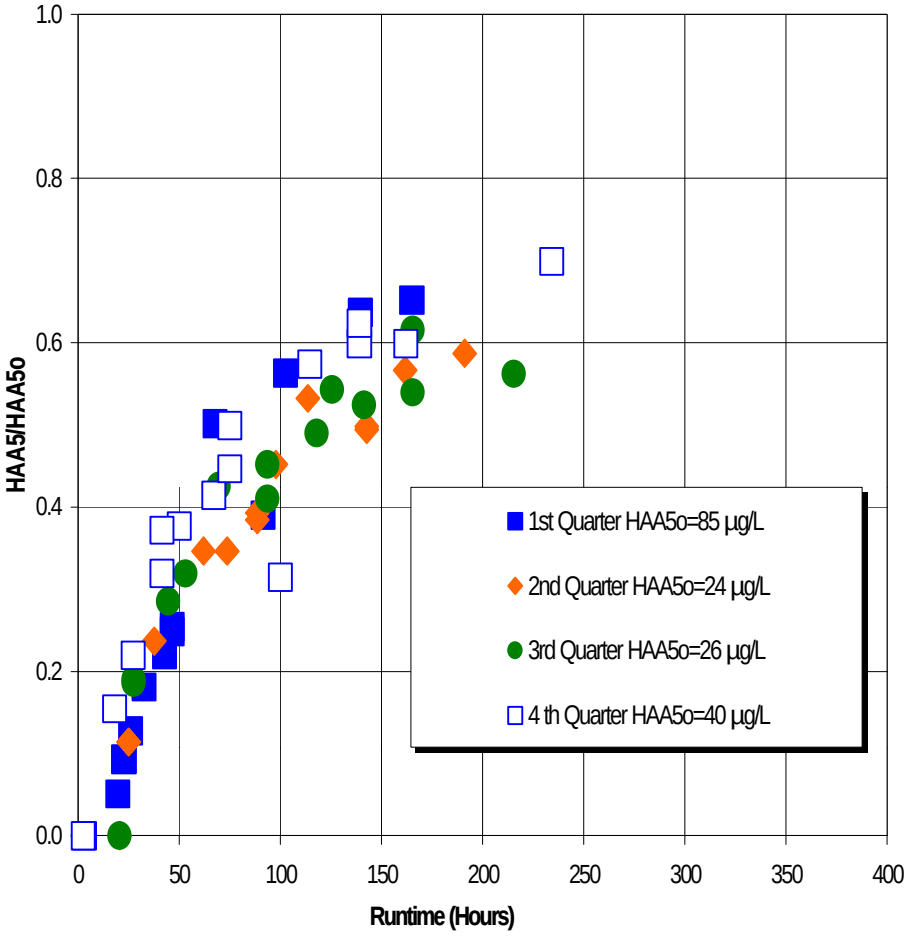
NORMALIZED UV254 BREAKTHROUGH
10 MINUTE EBCT

Figure 8



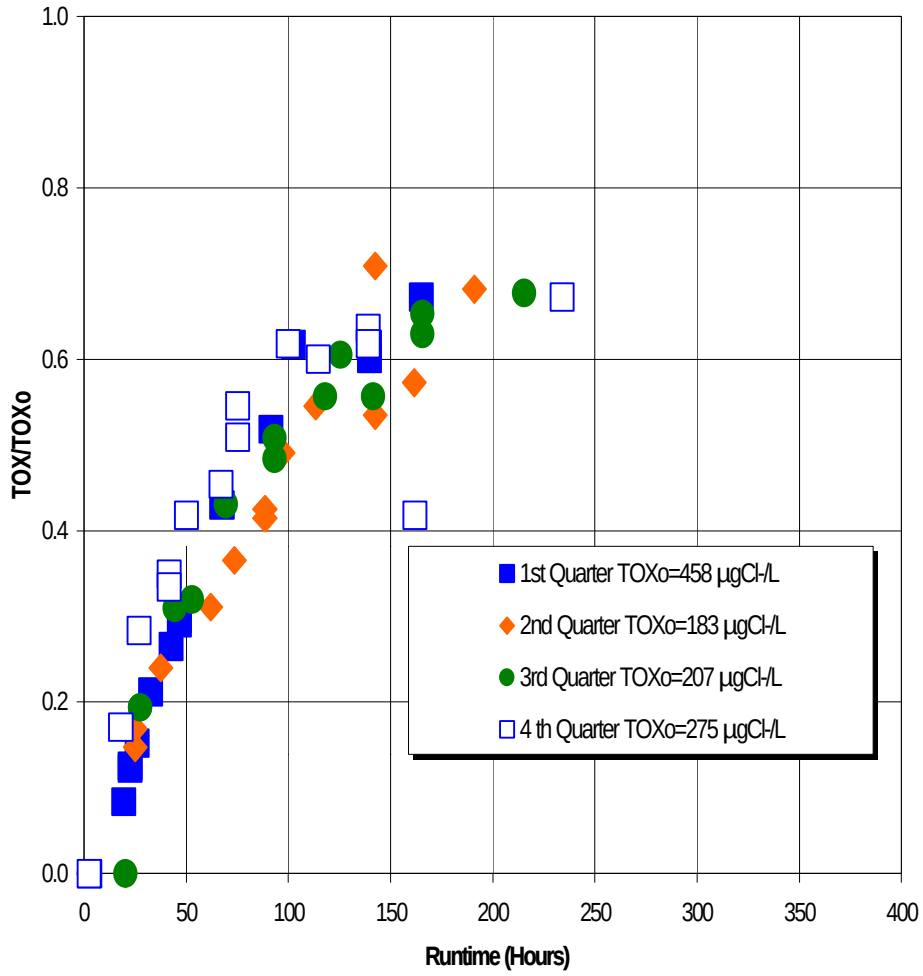
NORMALIZED TTHM BREAKTHROUGH
10 MINUTE EBCT

Figure 9



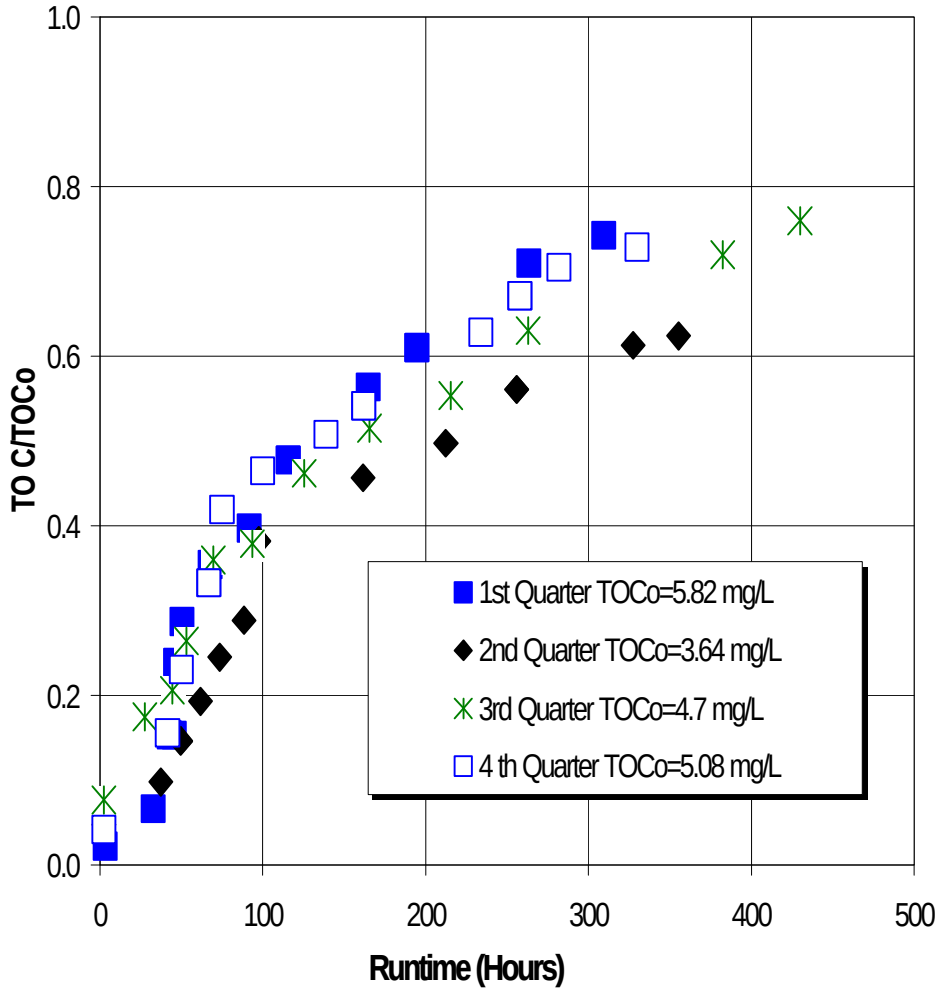
NORMALIZED HAA5 BREAKTHROUGH
10 MINUTE EBCT

Figure 10



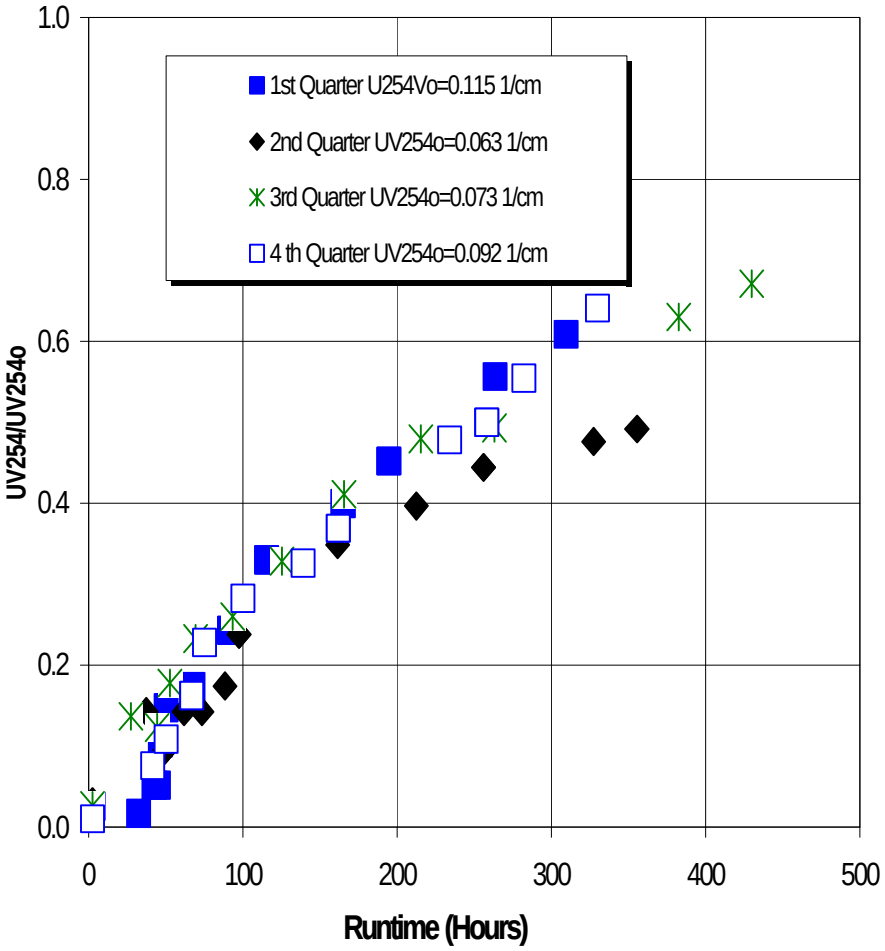
NORMALIZED TOX BREAKTHROUGH
10 MINUTE EBCT

Figure 11



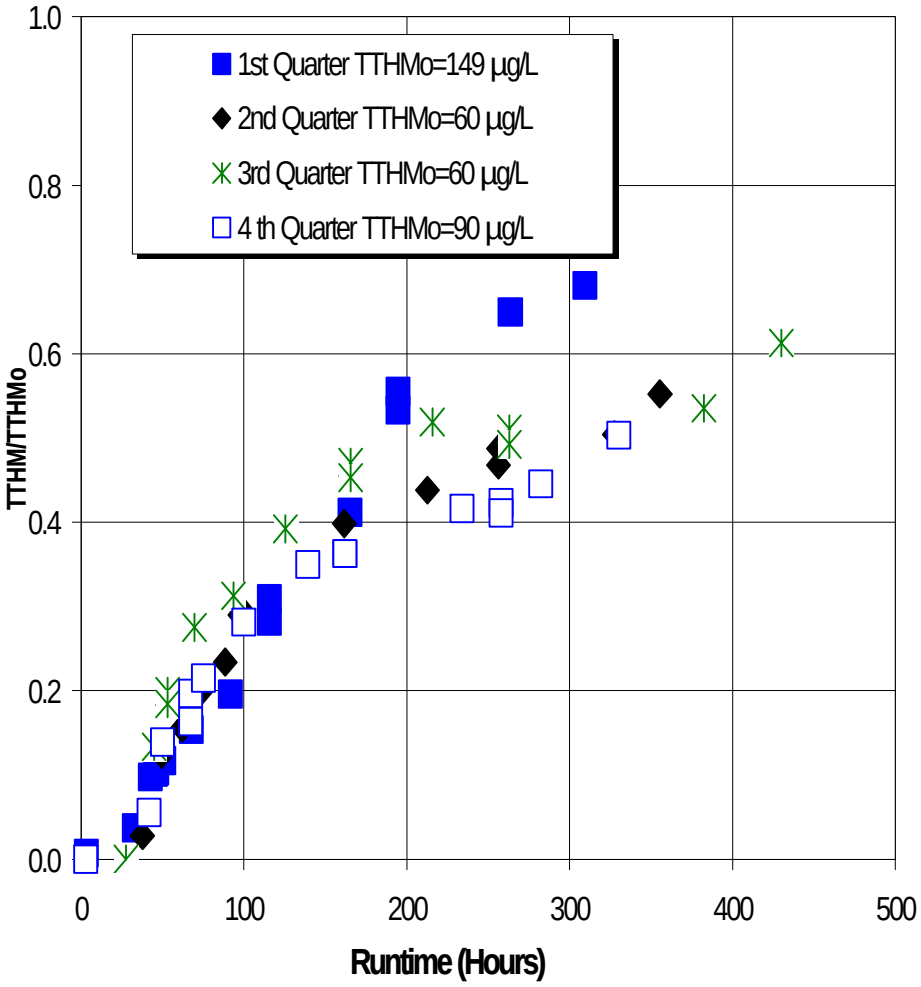
NORMALIZED TOC BREAKTHROUGH
20 MINUTE EBCT

Figure 12



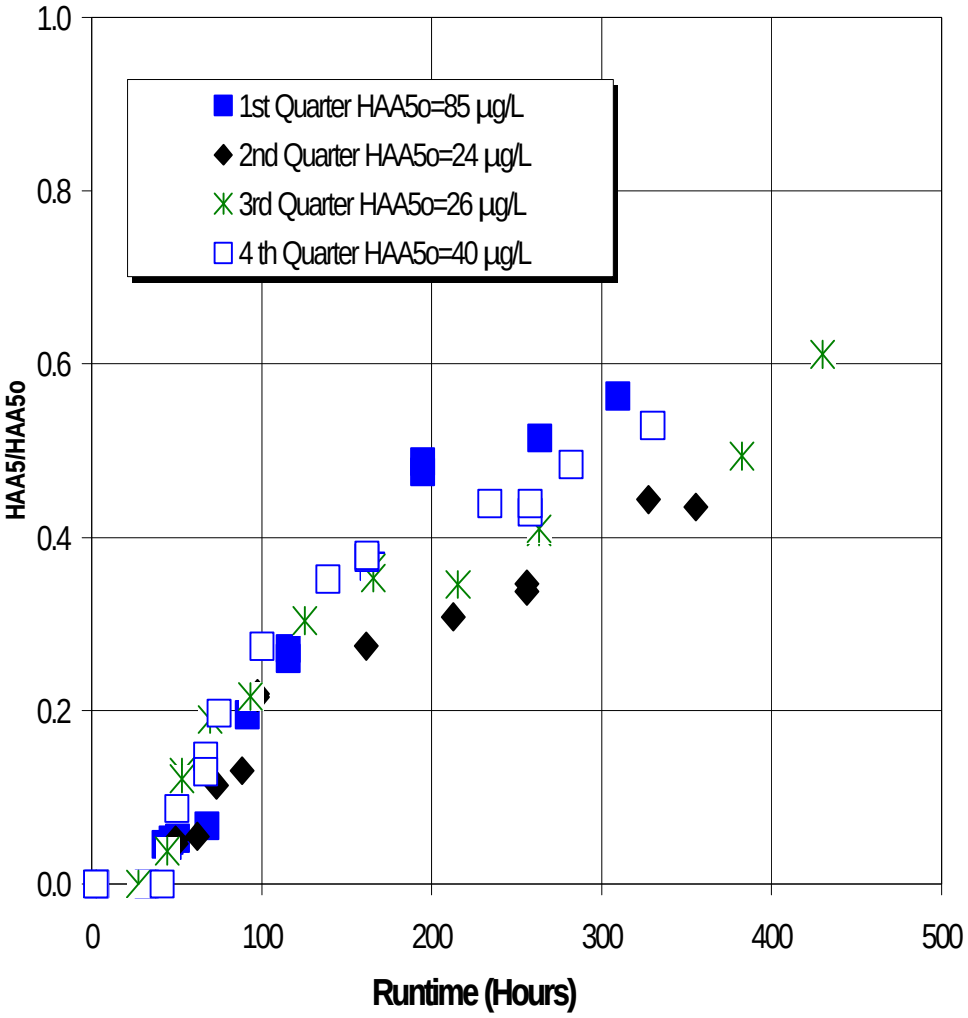
NORMALIZED UV254 BREAKTHROUGH
20 MINUTE EBCT

Figure 13



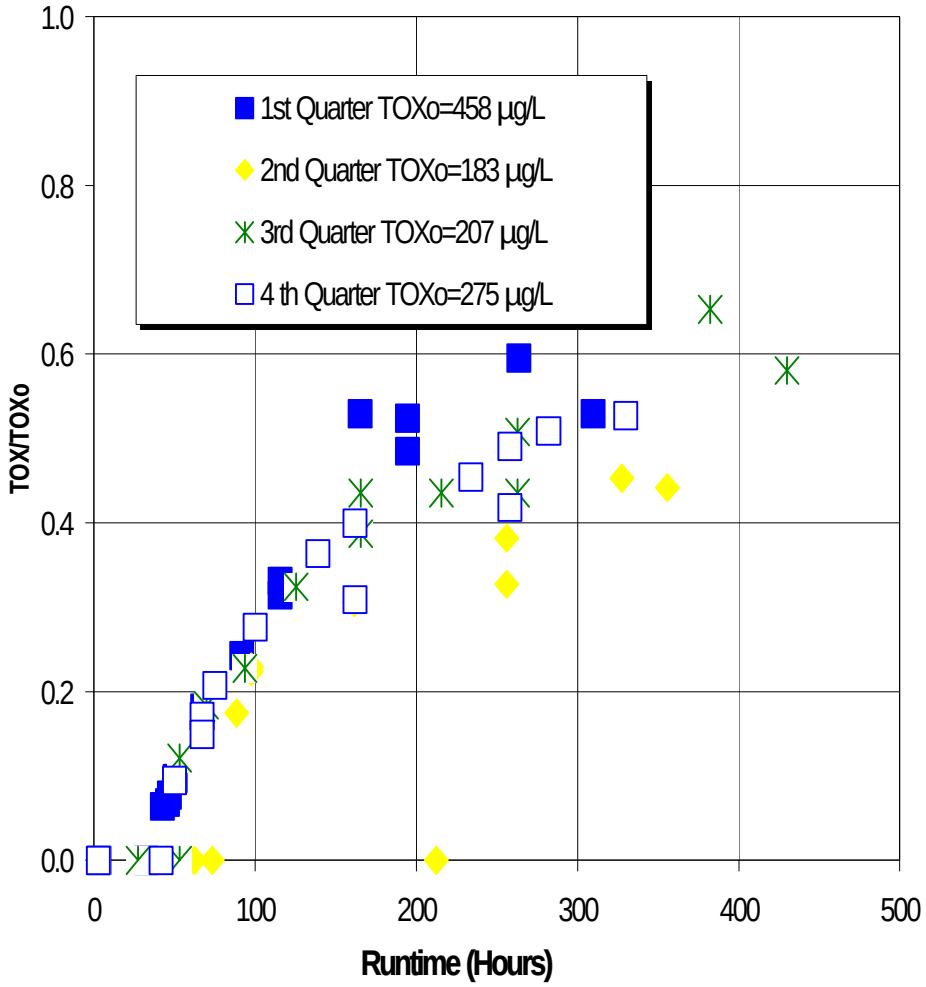
NORMALIZED TTHM BREAKTHROUGH
20 MINUTE EBCT

Figure 14



NORMALIZED HAA5 BREAKTHROUGH
20 MINUTE EBCT

Figure 15



NORMALIZED TOX BREAKTHROUGH
20 MINUTE EBCT

Figure 16

SECTION 5

QUALITY ASSURANCE AND QUALITY CONTROL SUMMARY

Table 13 summarizes the calibration and quality control procedures for THMs, HAAs, TOX, bromide, UV254, and TOC. QA/QC summary data are provided in Appendix B Summary Report Spreadsheets. THM, HAA, TOX, and bromide analyzes were performed by Montgomery Watson Laboratories (MWL). QA/QC summary data from MWL is provided in Appendix B and reflects not only our samples, but other bench test utilities as well, per agreement with Steve Allegeier of USEPA.

Calibration for TOC and UV 254 samples, was performed on a daily basis. Calibration consisted of two blank (distilled deionized water) injections followed by injection of a low, medium and high level calibration standards (0.5 mg/L, 4.0 mg/L, and 10.0 mg/L potassium pthalate, respectively). Prepared separately from the calibration standards, low, medium and high level check standards were analyzed to verify calibration.

After all calibration standards had been analyzed, a low-level calibration check standard was analyzed. Two injections of this standard were analyzed and used to compute a relative percent difference (RPD) which was required to be $\leq 20\%$. After the low level check standard had successfully verified the instrument calibration, 10 ICR treatment study samples were analyzed..

Once 10 ICR treatment study samples had been analyzed, a medium check standard was then analyzed. The RPD of the medium and high level check standard was required to be $\leq 20\%$. If the RPD of the check standard did not meet this criteria, the previous 10 samples would be reanalyzed. If any of the previous 10 ICR treatment study samples failed to meet the acceptance criteria with respect to sample RPD, the sample was then included in the next 10 ICR treatment study samples to be analyzed in duplicate. This procedure of analyzing 10 ICR treatment study samples followed by a check standard was repeated until 30 treatment study samples had been analyzed. After analyzing 30 treatment study samples, a medium or high level check standard was analyzed, which marked the end of analyses under the current calibration.

TABLE 13A

SUMMARY OF CALIBRATION AND QUALITY CONTROL PROCEDURES

Performance Criteria	Method	THMs EPA 551.1	TOX SM 5320B
	Analytes	***THM***	***TOX***
	Target Analytes	**Trihalomethanes (THMs)** Chloroform (CHCl3) Bromodichloromethane (BDCM) Dibromochloromethane(DBCM) Bromoform (CHBR3)	**Total Organic Halide (Dissolved Organic Halogen) (DOX)**
IDC			
IDLSB	**Method Blank**	< 1/2 MRL	< 1/2 MRL
IDA	**QC check sample**	+/- 20% of true value	+/- 20% of true value
IDP	**No. of replicates**	5	5
	Spike conc.	THM 20 ug/L	TOX 250 ug/L
	% RSD	< 20	< 20
	% Recovery	80-120	80-120
MDL	**No. of replicates**	7	7
	Spike conc.	1/2 MRL	1/2 MRL
	% Recovery	50-150	50-150

TABLE 13A

SUMMARY OF CALIBRATION AND QUALITY CONTROL PROCEDURES
(Continued)

Performance Criteria	Method	THMs EPA 551.1		TOX SM 5320B	
MRL		THM Others:	1.0 ug/L 0.5 ug/L	50 ug Cl-/L 25 ug Cl-/L (during treatment studies)	
Calibration Verification	**Verification Frequency**	Lowest level std. analyzed at the beginning of each 24 hr before the first sample		3 microcoulometer titration cell checks with NaCl std at start of 8-10 hr. work shift. Lowest level std. analyzed before the first sample.	
Conc. and QC criteria (%rec)		Mid level and high level analyzed alternately after every 10th sample and last sample		Mid level and high level analyzed alternately after every 7th sample and last sample	
		THM		***TOX***	
		(ug/L)	***(% rec)***	(ug Cl-/L)	(% rec)
	Low	1.0	50-150	50 (25)	75-125
	Mid-level	20	80-120	200	85-115
	High	40	80-120	500	85-115
Reagent (Method) Blank	***Frequency***	One per analysis batch (one per extraction batch)		2 nitrate-washed activated carbon at the start of ea analysis batch, then 1 after every 7 samples (run in duplicate)- minimum of 3 per day; Analyze 1 system blank per analysis	

TABLE 13A

SUMMARY OF CALIBRATION AND QUALITY CONTROL PROCEDURES
(Continued)

Performance Criteria	Method	THMs EPA 551.1	TOX SM 5320B
QC criteria		< 1/2 MRL	<0.80 ug/Cl-/40 mg of activated carbon; < 1/2 of MRL, <25 or < 12.5
Shipping Blank Criteria	**Travel Blank**	NA	NA
LFM	***Fortified Sample***		
Frequency		one sample in each extraction batch	at least 5% of all ICR samples analyzed each quarter (fortified sample analyzed in duplicate
Matrix spike level		same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.	same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.
QC criteria	**% Recovery**	NA	NA

TABLE 13A

SUMMARY OF CALIBRATION AND QUALITY CONTROL PROCEDURES
(Continued)

Performance Criteria	Method	THMs EPA 551.1	TOX SM 5320B
Lab (Field) Duplicate		field duplicate	lab duplicate
QC Criteria	**% RPD**	NA	NA
Internal Std.		BFB if pentane solvent is used; Optional if MTBE is the extracting solvent	NA
QC Criteria	**IS Recoveries**	+/- 30% of calibration curve AVG IS response	NA
		70-130 % Rec.	
Surrogate QC Standards		decafluorobiphenyl in ea sample	NA
	Surrogate Recoveries	70-130 % Rec.	NA
Method Calibration Procedures	**Initial Calibration Curve**	THMs: CHCL3, BDCM Concentration (ug/L)	
Trihalomethane	**Standard 1**	0.5	
	Standard 2	1	
	Standard 3	2	
	Standard 4	5	
	Standard 5	10	

TABLE 13A

SUMMARY OF CALIBRATION AND QUALITY CONTROL PROCEDURES
(Continued)

Performance Criteria	Method	THMs EPA 551.1	TOX SM 5320B
	Standard 6	20	
	Standard 7	30	
	Standard 8	40	
	Standard 9	50	
		THMs: DBCM, CHBR3 (ug/L) Concentration	
	Standard 1	0.25	
	Standard 2	0.5	
	Standard 3	1	
	Standard 4	2.5	
	Standard 5	5	
	Standard 6	10	
	Standard 7	15	
	Standard 8	20	
	Standard 9	25	

TABLE 13B

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES

Performance Criteria Analytes		EPA300.0 A, B *Br*	SM 6251B Haloacetic Acids *(HAA)*
	Target Analytes	Bromide (Br^-)	Monochloroacetic (MCAA) Dichloroacetic acid (DCAA) Dibromoacetic acid(TCAA) Trichloroacetic acid (TCAA) Monobromoacetic acid (MBAA) Bromochloroacetic acid (BCAA)
IDC			
IDLSB	**Method Blank**	< 1/2 MRL	< 1/2 MRL
IDA	**QC check sample (external source)**	+/- 20% of true value	+/- 20% of true value
IDP			
	No. of replicates	5	5
	Spike conc.	Br^- 0 .10 mg/L	20
	% RSD	< 20	< 20
	% Recovery	80-120	80-120
	No. of replicates	7	7

TABLE 13B

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES (Continued)

Performance Criteria Analytes		EPA300.0 A, B *Br*	SM 6251B Haloacetic Acids *(HAA)*
Spike conc.		1/2 MRL	1/2 MRL
% Recovery		50-150	50-150
MRL		Br: 0.020 mg/L	MCAA: 2.0 ug/L Others:1.0 ug/L
Calibration Verification/ Frequency		Lowest level std. analyzed at the beginning of each 24 hour- before first sample run Mid level and high level analyzed alternately after 10th sample and after the last sample.	Lowest level std. analyzed at the beginning of each 24 hour- before first sample run Mid level and high level analyzed alternately after 10th sample and after the last sample.
Calibration Verification Concentrations and Acceptance Criteria		***Br-***	***MCAA***
		(mg/L) (% rec.)	***(ug/L) (% rec.)***
	Low	0.02 50-150	2.0 50-150
	MIdlevel	0.10 90-110	20 80-120
	High	0.30 90-110	32 80-120
	Low		1 50-150
	MIdlevel		20 80-120
	High		32 80-120

TABLE 13B

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES (Continued)

Performance Criteria Analytes		EPA300.0 A, B *Br*	SM 6251B Haloacetic Acids *(HAA)*
Reagent (Method) Blank			
Frequency		one per analysis batch	one per analysis batch (one per extraction batch)
QC Criteria		< 1/2 of MRL	< 1/2 of MRL
Shipping Blank	**Travel Blank/ Field Reagent Blank**	NA	NA
QC Criteria		NA	NA
LFM	**Fortified Sample**		
Frequency		5 % per analysis batch	one sample per extraction batch
Matrix spike Level		same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.	same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.
QC criteria		NA	NA
Field/Lab Duplicate			
Frequency		5% of the samples per analysis batch	one lab duplicate per extraction batch
% RPD			
QC criteria		NA	NA
Internal Std.		NA	1,2-dibromopropane or 1,2,3-trichloropropane

TABLE 13B

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES
(Continued)

Performance Criteria Analytes		**EPA300.0 A, B** ***Br***	**SM 6251B** **Haloacetic Acids *(HAA)***	
QC criteria		NA	in each extract +/- 30% of calibration curve AVG IS response 70-130 %	
Surrogate Standards		NA	2,3-dibromopropionic acid	
Surrogate Standards			or 2,3,5,6-tetrafluorobenzoic acid in each sample	
QC Criteria		NA	70-130 %	
Method Calibration Procedures	**Initial Calibration Curve**	Bromide Concentration (mg/L)	MCAA	Concentration (ug/L)
	Standard 1	0		2
	Standard 2	0.02		5
	Standard 3	0.05		10
	Standard 4	0.1		20
	Standard 5	0.3		40
	Standard 6	0.5		-
			All others	Concentration (ug/L)
	Standard 1			1
	Standard 2			2
	Standard 3			5
	Standard 4			10
	Standard 5			20
	Standard 6			40