

**ICR Treatment Study Summary Report**

**Evaluation of GAC Performance Using the RSSCT**  
**For Compliance with the Information Collection Rule**  
**At the P.O. Hoffer Water Treatment Plant**

Conducted during the period of April 14, 1998 through January 1, 1999

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P.O. Hoffer Water Treatment Plant ICR # 448

Attachments: 2 diskettes containing the Data Collection Spreadsheet

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# Section 1

## Conclusions and Recommendations

### 1.1 Main Conclusions

- The settled water SDS-DBP analyses for the summer (3rd) and fall (4th) quarters demonstrated that on the day of sampling the Hoffer plant would be expected to typically not exceed an HAA5 limit of < 60 ug/L but may not consistently be below a THM4 limit of 80 ug/L based on the water quality on the day of sampling.
- The GAC columns were able to reduce the SDS-DBP concentrations to levels below the proposed Stage 2 limits of 30 and 40 ug/L for HAA5 and THM4, respectively.
- Breakthrough of the SDS-THM4 contaminants to the proposed Stage 2 Rule limit occurred before breakthrough of the SDS-HAA contaminants.
- Generally, a greater breakthrough of the SDS-DBP contaminants was observed in the summer quarter than in the fall quarter.
- For a GAC contactor with EBCT of 10 minutes, the breakthrough of SDS-THM4 at the level of the proposed Stage 2 Rule occurred between 6,500 and 7,000 bed volumes.
- For a GAC contactor with EBCT of 20 minutes, the breakthrough of SDS-THM4 at the level of the proposed Stage 2 Rule occurred after 15,000 bed volumes.
- Previous bench-scale tests of the Hoffer plant water have demonstrated that the system can meet the Stage 1 DBP rule by switching to chloramines for residual disinfection. A switch to chloramines would be of much lower cost than the addition of a GAC contactor to meet the Stage 1 limits.

## Section 2 Background

### 2.1 Location

The P. O. Hoffer Water Treatment Plant, under the operation of the Public Works Commission of the City of Fayetteville (PWC), serves the City of Fayetteville and surrounding communities. The state approved rated capacity of the plant is 32 MGD. In addition to the Hoffer plant, the PWC system includes a second water treatment plant with a rated capacity of 18 MGD.

### 2.2 Source Water Quality

The Hoffer plant utilizes the Cape Fear River for its raw water source. The source water has low alkalinity, high turbidity, and moderate to high TOC levels that vary seasonally. Typical water quality parameters for the source water are listed in Table 2.1.

### 2.3 Treatment Processes

The Hoffer plant is a conventional sedimentation and dual-media (sand/anthracite) filtration plant. A treatment train schematic is shown in Figure 2.1. Alum is used as a coagulant. Other chemicals currently added include sodium hydroxide, sodium hypochlorite, fluoride, and zinc orthophosphate. Hypochlorite is used for primary disinfection and as a residual disinfectant in the distribution system. ICR Water Utility Database reports A2 and A3 for the Hoffer plant are provided in Appendix A to provide treatment process parameters.

### 2.4 Finished Water Quality

Table 2.2 lists average finished water quality parameters for water leaving the Hoffer WTP and entering the distribution system.

### 2.5 Treatment Challenges

#### 2.5.1 Turbidity

The large turbidity spikes present a challenge for the Hoffer WTP. The plant has been successful at meeting this challenge.

### 2.5.2 DBP's

Based upon the historic data, it appears that the PWC system will not have a problem meeting the Stage I TTHM and HAA5 limits on average, though it may be occasionally difficult. However, the system would not currently reliably meet the proposed Stage II standards for TTHM and HAA5 of 40 and 30 µg/L.

**Figure 2-1:  
Schematic Diagram of P.O. Hoffer Water Treatment Facility**

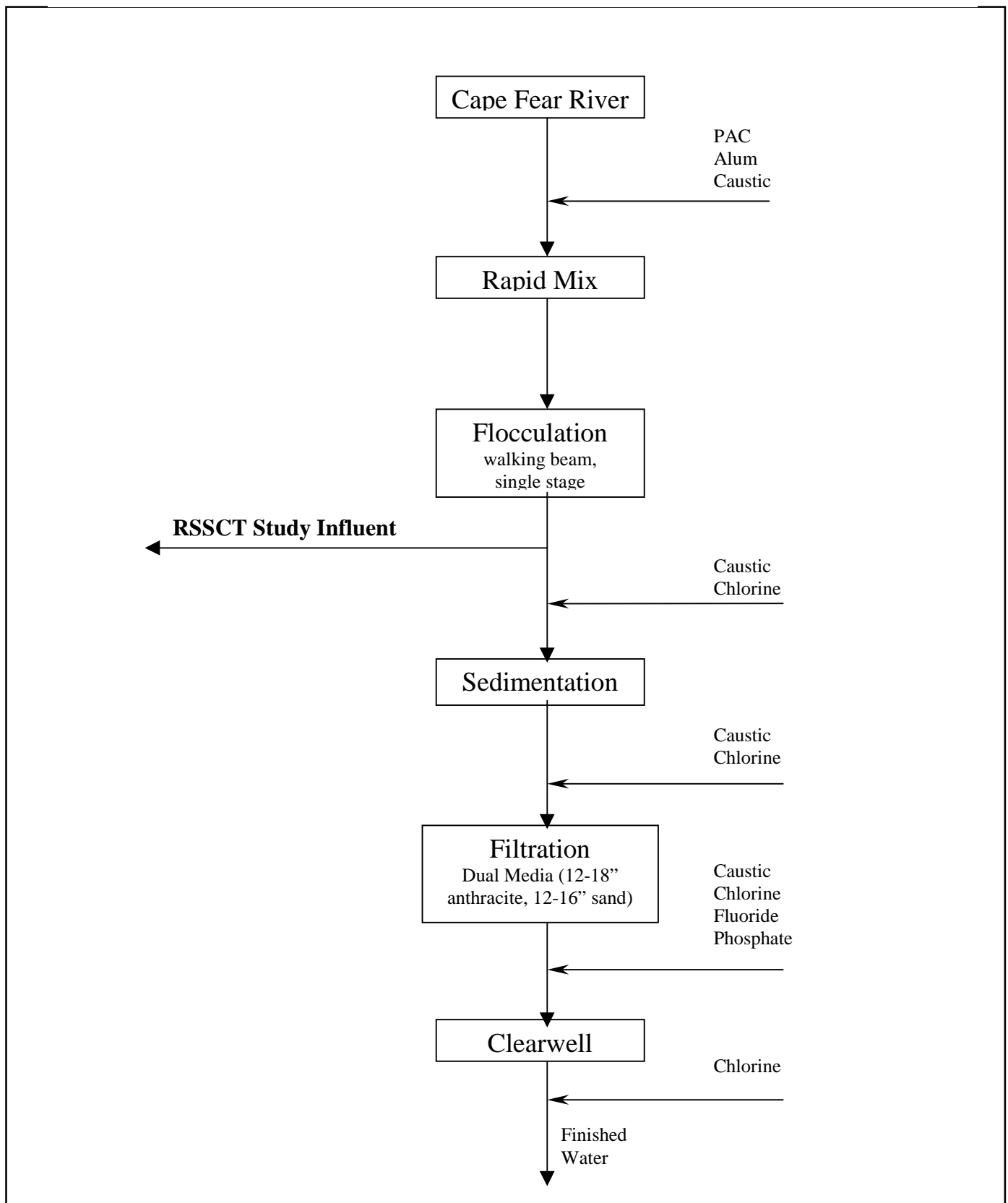




Table 2-1 Tabular Summary of Source Water Quality for the Hoffer WTP				
Water Quality Parameter	Average Yearly Value	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature [°C]	20.6	NA	34.0	7.0
pH	7.2	NA	7.5	6.2
Turbidity [ntu]	31.14	NA	186	5
Alkalinity [mg/L CaCO <sub>3</sub> ]	18.67	8.74	35.0	6.2
Calcium Hardness [mg/L CaCO <sub>3</sub> ]	11.63	4.03	16.5	5.1
Total Hardness [mg/L CaCO <sub>3</sub> ]	19.42	7.35	28.8	8.1
TOC [mg/L]	5.30	1.70	11.8	2.45
UV254 [cm-1]	0.175	0.053	0.287	0.111
Bromide [ug/L]	0.060	0.037	0.13	0

Table 2-2 Tabular Summary of Finished Water Quality Leaving the Hoffer WTP				
Water Quality Parameter	Average Yearly Value	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature [°C]	21	NA	34	7
pH	7.2	NA	7.6	6.8
Turbidity [ntu]	0.07	NA	0.71	0.01
TOC [mg/L]	2.72	1.06	6.87	1.37
UV254 [cm-1]	0.050	0.070	0.46	0.024
Avg Dist Syatem THM4 [ug/L]	63.6	30.3	155.9	18
Avg Dist Syatem HAA5 [ug/L]	27.9	11.0	59	0

## Section 3

### Materials and Methods

#### 3.1 RSSCT Study Set-Up

RSSCT treatment studies were run each quarter of 1998. Influent for the treatment study was collected at the P.O. Hoffer WTP and transported to the University of North Carolina at Chapel Hill where the RSSCT was conducted by a graduate student under the guidance of Dr. F. A. DiGiano. Figure 3-1 illustrates the pretreatment processes at the P.O. Hoffer WTP. As noted, influent water for this treatment study was taken at the effluent end of the sedimentation basins. The influent water was collected prior to chlorination. Before the start of the first RSSCT study, one trial run was made to identify and solve any unforeseen logistical issues.

##### 3.1.1 INFLUENT WATER COLLECTION DATES

The collection dates for the treatment study influent water were set such that there had been no abnormal (i.e., un-seasonal) rainfall or other weather event in the days preceding each collection day. The dates of influent water collection for each quarter were as follows:

Season	Date Sample Collected
Winter	3/16/98
Spring	5/18/98
Summer	8/11/98
Fall	11/15/98

##### 3.1.2 INFLUENT WATER COLLECTION PROCEDURE

For each quarter, approximately 150 gallons of settled water was collected in one batch. This volume of influent water was considered to be adequate for one run of both the 10- and 20-minute columns and to cover any contingencies. The water was collected using five or six 30-gallon water sample barrels from the UNC. Prior to water collection, each barrel was rinsed several times with de-ionized water (lab-pure water). Settled water was siphoned from the sedimentation basin effluent channel into the water barrels. The barrels and siphon hose were rinsed with the settled water at least three times before use. After filling, the barrels were immediately transported to the UNC (approximately an hour drive) where they were transferred to refrigerated storage at 5°C until use.

### 3.1.3 EXPERIMENTAL SET-UP

Figure 3-1 illustrates the RSSCT set-up. The RSSCT influent water was prepared by taking settled water from the Hoffer WTP and filtering it according to EPA-ICR procedures. Filtered water was stored in a 45-liter feed tank. A peristaltic pump with a pulse dampener was used to pump the feed water through one 10-minute column and one 20-minute glass GAC column.

At the start of each experimental run, 45 liters of the settled water was filtered into the feed tank. During each run, as the volume of water in the feed tank dropped, additional settled water from the 150-gallon batch was filtered into the feed tank. The feed water was allowed to warm to room temperature before filtration. For the Winter and Spring experimental runs, the Hoffer plant settled water was filtered with a 1- $\mu$ m resin bonded cellulose cartridge filter (Ametex Model RB1). Following the spring experimental run, these filters were determined to be a source of bromide contamination to the feed water. Thus for the Summer and Fall experimental runs, a 1- $\mu$ m glass fiber filter (MSI glass filter, 1.0  $\mu$ m) was used to pretreat the influent. Before use, each glass fiber filter was rinsed with organic-free, deionized water (OFDW) prepared by a Dracor system. The consequences of the bromide leaching during the Winter and Spring experimental runs are discussed in the Results section.

Tygon tubing was used to connect the feed tank to the GAC columns and to discharge product water from each column. A pulse dampener was used to minimize the effects of the peristaltic pump on the flow rate of the influent. Two glass chromatography columns were operated in parallel to provide scale-up data for EBCTs of 10 and 20 min. As suggested in the EPA-ICR, the diameter of the columns was 1.5 cm. A pressure gauge was used to check for excessive head loss in the system. During the course of a run, if the head loss exceeded 15 psi, a thin wire was used to break up clumps within the top layer of the GAC.

The RSSCT testing required use of a smaller particle size of GAC than is commercially available. The 12 x 40 U.S. standard sieve size of GAC (Calgon F400) was crushed using a ball mill crusher and the 80 x 100 U.S. sieve size fraction (0.16-mm mean geometric diameter) was reserved for the RSSCT. The fraction of GAC was rinsed with deionized water and fine particles were decanted. Rinsing was repeated until the supernatant was consistently clear. The carbon was then placed in a filtering flask and deionized water was added to a level of 2 cm above the carbon surface. The carbon was then deaerated overnight to avoid the release of air bubbles in the column. After deaeration, the carbon was then added as slurry to the RSSCT apparatus. The column was then allowed to operate overnight with deionized water in order to check for air leaks or unusual head losses.

## 3.2 Experimental Design

The experimental design summary is summarized in Table 3-1 below.

**Table 3-1 Experimental Design Summary for RSSCT Study**

<b>Season/ Collection Date</b>	<b>Full Scale Pretreatment</b>	<b>Bench Scale Pretreatment</b>	<b>EBCT</b>
<b>Winter 3/16/98</b>	Rapid Mix, Alum Coagulation, Sedimentation	Prefiltration (1µm resin bonded cellulose cartridge filter)	10 & 20
<b>Spring 5/18/98</b>	Rapid Mix, Alum Coagulation, Sedimentation	Prefiltration (1µm resin bonded cellulose cartridge filter)	10 & 20
<b>Summer 8/11/98</b>	Rapid Mix, Alum Coagulation, Sedimentation	Prefiltration (1µm glass fiber filter)	10 & 20
<b>Fall 11/15/98</b>	Rapid Mix, Alum Coagulation, Sedimentation	Prefiltration (1µm glass fiber filter)	10 & 20

### 3.2.1 RSSCT SCALING EQUATIONS

The Hoffer WTP RSSCT set-up was designed with the scaling equations outlined below. The scaling factor for the tests was calculated using a bench scale mean GAC particle diameter of 0.16 mm (average diameter of the 80 x 100 U.S. sieve fraction) and assuming a full-scale mean particle diameter of 1.00 mm (average diameter of the 12 x 40 U.S. sieve fraction). Thus, the scaling factor for these tests is

$$SF = \frac{d_{FS}}{d_{BS}} = \frac{1.05mm}{0.16mm} = 6.56$$

From the scaling factor, a full scale EBCT of 10 minutes corresponds to a bench scale EBCT of

$$EBCT_{BS} = \frac{EBCT_{FS}}{SF} = \frac{10 \text{ min}}{6.56} = 1.52 \text{ min}$$

To simulate a 20 minute full scale EBCT, the bench scale EBCT is 3.05 minutes. By estimating the full scale system Reynolds number to be 5.1 with an application rate of 10 m/h, and by setting the minimum Reynolds number for the bench scale system 0.2, the application rate for the small column is:

$$v_{BS} = SF * v_{FS} * \frac{Re_{BS,min}}{Re_{FS}} = 6.25 * 10m/hr * \frac{0.2}{5.1} = 2.45 \frac{m}{hr}$$

Thus the length of the bench scale column that corresponds to a full scale EBCT of 10 minutes is

$$L_{BS} = v_{BS} * EBCT_{BS} = 2.45m/hr * 1.52 \min * \frac{1hr}{60 \min} = 0.062m$$

The length of the bench scale column that corresponds to a full scale EBCT of 20 minutes is 0.124 meters.

### 3.3 Analytical Methods

The analytical methods used by all labs involved in this RSSCT study are summarized in Table 3-2. The tables of all labs involved and their contact information is listed in Table 3-3.

### 3.4 SDS Chlorination

Sample chlorination and incubation for the simulated distribution system (SDS) disinfection by-product testing was conducted at the UNC prior to the samples being sent to the Montgomery Watson Laboratories for analysis. The SDS protocol used by the UNC is as follows:

#### 3.4.1 PREPARATION OF SOLUTIONS

All glassware used in the chlorination process was made chlorine-demand free according to the procedure described in Standard Methods (APHA, 1989). The glassware was soaked overnight in a solution of organic-free deionized water and at least 25 mg/L of chlorine. The glassware was then rinsed five times with deionized water.

A 0.2 M phosphate buffer having a pH of 7.2 was prepared from a mixture of 0.2 M Na<sub>2</sub>HPO<sub>4</sub> and 0.2 M NaH<sub>2</sub>PO<sub>4</sub>. The stock chlorine solution was then standardized using the Iodometric Method I described in Standard Methods (APHA, 1989). A solution of sodium thiosulfate was prepared by dissolving 25 g of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>\*H<sub>2</sub>O in 1 L of distilled water. A solution of 0.1 N potassium chromate was prepared by dissolving 4.904 g K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in 1 L of water. To standardize the thiosulfate solution, 10 mL of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, 1 mL of H<sub>2</sub>SO<sub>4</sub>, 1 g of KI, and 80 mL of water was added to a beaker. The solution was stored in the dark for approximately 6 minutes. The solution was then titrated with 0.1 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> until the yellow color was discharged. Approximately 1 mL of starch indicator was then added to the beaker and the solution was

titrated until the blue color was discharged.

The concentration of the chlorine stock solution was determined using the following procedure. A dilution of the chlorine stock solution was prepared and mixed in a beaker. The pH of the solution was adjusted using 5 mL of acetic acid and 1 gram of KI was added as an indicator. The solution was then titrated with 0.1 N  $\text{Na}_2\text{S}_2\text{O}_3$  until the blue color disappeared. The strength of the solution was calculated using the equation:

$$\text{mg Cl as Cl}_2/\text{L} = (\text{A} \times \text{N} \times 35,450) / \text{mL sample}$$

A working solution of chlorine was prepared weekly. The solution was covered in aluminum foil and refrigerated between use.

### 3.4.2 CHLORINATION OF SAMPLES

The SDS condition requires chlorination of effluent samples from the GAC column to reproduce the temperature of the water in the distribution system and the maximum residence time. This allows for the formation of DBPs in the laboratory to occur as in the distribution system for each seasonal sample. In addition, the laboratory chlorination must produce a residual under specified SDS conditions that is typical of chlorine residual in the actual distribution system. The chlorine dosage to achieve the targeted residual depends on the chlorine demand produced by organic material in the sample water. The amount of organic material for the purpose of establishing the chlorine dose was measured using  $\text{UV}_{254}$  absorbance.

The chlorine dosage to achieve the target residual increases in samples collected from the RSSCT as the breakthrough of NOM increases because chlorine demand also increases. The target residual varied between seasons and is listed in the Results section of this report. A technique was needed, therefore, to determine the chlorine dose based on breakthrough of NOM.

The calibration curve was prepared by dosing the feed water sample with three different dosages of chlorine and storing at SDS conditions.  $\text{UV}_{254}$  measurements were also taken on all three samples before chlorination. At the end of the specified SDS incubation period, the chlorine residuals for each sample were measured. The technique for estimating chlorine doses was improved for RSSCTs in subsequent seasons. Instead of using the feed water sample to develop a calibration curve, the actual results from chlorine dosing of effluent samples of the previous RSSCTs were used to develop a new calibration curve of chlorine dosage versus  $\text{UV}_{254}$  absorbance. This was found to yield chlorinated samples having a chlorine residual closer to the desired SDS residual compared to the method of dosing feed water samples and developing a calibration curve based upon chlorine demand of raw water.

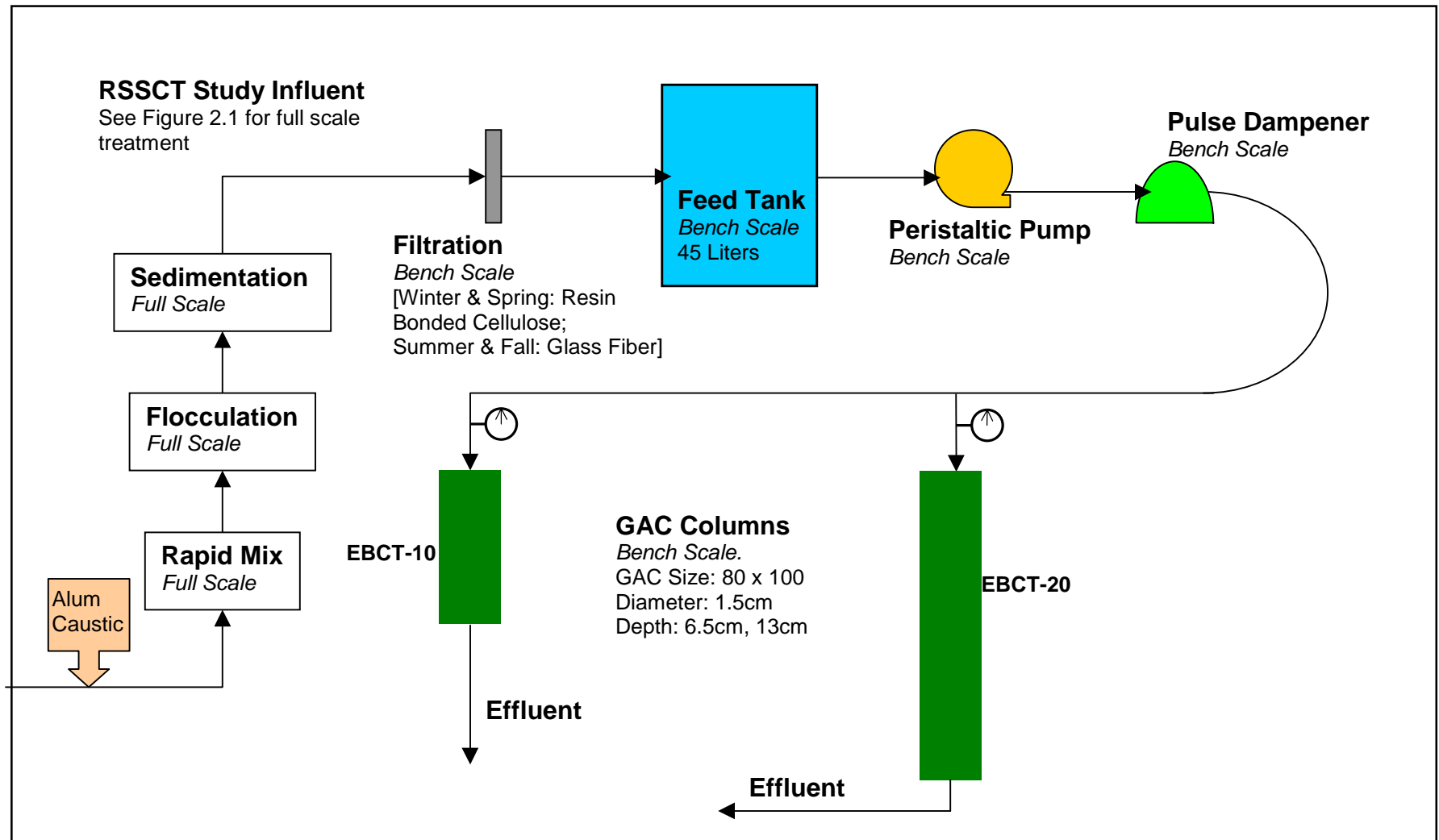
All samples were chlorinated in 1-L amber bottles with Teflon-lined caps. The bottle was filled halfway with the effluent water and 5 mL of phosphate buffer of pH 7.2 was added to the solution. The proper dose of chlorine, based upon the calibration procedure described above, was then added and the bottle was inverted three times and then filled up to the top. The bottles were capped and again inverted to assure headspace-free samples. All of the chlorinated samples

were immediately placed in a constant temperature incubator at the SDS temperature and stored for the required incubation time of 48 hours. The samples were then removed from the incubator and the free chlorine was measured using a Hach chlorine meter. The chlorine meter conforms to the DPD colorimetric method described in Standard Methods (APHA, 1989). The pH of the chlorinated sample was then measured and the water was poured into the appropriate vials and stored headspace-free in the refrigerator before a biweekly shipment to the analytical laboratory. The samples were analyzed for THMs, HAAs, and TOX by Montgomery Watson laboratory (Pasadena, California, contact person: Jim Hein). The sample vials were supplied by Montgomery Watson.

### 3.5 TOC Analyses

To maximize reliability, the Cross Creek Water Reclamation Facility Laboratory of the Public Works Commission of Fayetteville was chosen to conduct the TOC analyses for this project since it is an ICR certified lab. During the study, duplicate TOC analyses were conducted at the UNC for purposes of tracking the experimental system. For an unknown reason during the 2nd (spring) and 3rd (summer) quarters, many of the TOC samples shipped by the UNC staff to the PWC laboratory were contaminated resulting in unreliable TOC data. These TOC breakthrough curves for the 2nd and 3rd quarter produced a “shotgun” pattern that did not correspond to an expected breakthrough curve and that did not match the breakthrough curves for other organic parameters (e.g. UV<sub>254</sub>, DBPs). The TOC analyses conducted on-site at the UNC lab were not contaminated and they demonstrated a more realistic TOC breakthrough pattern. Thus, the TOC data provided in the Study Summary Report for the 2nd and 3rd quarters are the results from the UNC laboratory.

**Figure 3.1: RSSCT Study Schematic Diagram**



**PWC - P.O. Hoffer Water Treatment Facility**



**Table 3-2 Summary of Analytical Methods and MRLs Used During RSSCT Study**

Analyte	PWC Fayetteville		Montgomery Watson		University of North Carolina	
	Method	Minimum Reporting Level	Method	Minimum Reporting Level	Method	Minimum Reporting Level
Alkalinity	SM 2320 B	5 mg/L CaCO <sub>3</sub>				
Ammonia	SM 4500-NH <sub>3</sub> D	0.10 mg/l NH <sub>3</sub> -N				
Bromide			EPA 300.0	20 ug/L		
Total Hardness	SM 2340 B	5 mg/L CaCO <sub>3</sub>				
Calcium Hardness	SM 3500-Ca D	5 mg/L CaCO <sub>3</sub>				
Chlorine Residual					SM 4500-Cl G	0.1 mg/L
BCAA, DBAA, DCAA, MBAA, TCAA, BDCAA,			SM 6251 B	1.0 ug/L for each analyte		
MCAA, DBCAA			SM 6251 B	2.0 ug/L for each analyte		
TBAA			SM 6251 B	4.0 ug/L		
pH					SM 4500-H+ (Elec Method)	N/A
Temperature					SM 2550 B	N/A
CHCl <sub>3</sub> , BDCM, DBCM, CHBr <sub>3</sub>			EPA 502.2	0.5 ug/L for each analyte		
TOC	SM 5310 B	0.35 mg/L			SM 5310 B	0.2 mg/L
TOX			SM 5320	25 ug/L		
Turbidity					SM 2130 B	0.05 ntu
UV254					SM 5910	0.005 cm-1

**Table 3-3 Summary of Laboratories Conducting Analyses During RSSCT Study**

Laboratory	Contact	Dates of Service	Analyses Performed	Comments
Public Works Commission Cross Creek Water Reclamation Facility 601 North Eastern Boulevard Fayetteville, NC 28301 Tel: 910 678 7407 Fax: 910 678 7455 ICR#: ICRNC016	Bernice Kidd Public Works Commission Cross Creek Water Reclamation Facility 601 North Eastern Boulevard Fayetteville, NC 28301 Tel: 910 678 7407 Fax: 910 678 7455	Quarter 1 (3/26/98 - 4/21/98) Quarter 2 (5/26/98 - 6/29/98) Quarter 3 (8/25/98 - 9/28/98) Quarter 4 (11/20/98 - 12/14/98)	Ammonia, Alkalinity, Total Hardness, Calcium Hardness	
Public Works Commission Cross Creek Water Reclamation Facility 601 North Eastern Boulevard Fayetteville, NC 28301 Tel: 910 678 7407 Fax: 910 678 7455 ICR#: ICRNC016	Bernice Kidd Public Works Commission Cross Creek Water Reclamation Facility 601 North Eastern Boulevard Fayetteville, NC 28301 Tel: 910 678 7407 Fax: 910 678 7455	Quarter 1 (3/26/98 - 4/21/98) Quarter 4 (11/20/98 - 12/14/98)	TOC	PWC laboratory QC standards not met for TOC analyses during Quarters 2 and 3
University of North Carolina at Chapel Hill School of Public Health Department of Environmental Sciences and Engineering CB# 7400, Rosenau Hall Chapel Hill, NC 27599-7400 Tel: 919 966 9220 Fax: 919 966 7911	Dr. Francis A. Digiano University of North Carolina at Chapel Hill School of Public Health Department of Environmental Sciences and Engineering CB# 7400, Rosenau Hall Chapel Hill, NC 27599-7400 Tel: 919 966 9220 Fax: 919 966 7911	Quarter 1 (3/26/98 - 4/21/98) Quarter 2 (5/26/98 - 6/29/98) Quarter 3 (8/25/98 - 9/28/98) Quarter 4 (11/20/98 - 12/14/98)	Chlorine Residual, pH, Temperature, UV254, Turbidity,	
University of North Carolina at Chapel Hill School of Public Health Department of Environmental Sciences and Engineering CB# 7400, Rosenau Hall Chapel Hill, NC 27599-7400 Tel: 919 966 9220 Fax: 919 966 7911	Dr. Francis A. Digiano University of North Carolina at Chapel Hill School of Public Health Department of Environmental Sciences and Engineering CB# 7400, Rosenau Hall Chapel Hill, NC 27599-7400 Tel: 919 966 9220 Fax: 919 966 7911	Quarter 2 (5/26/98 - 6/29/98) Quarter 3 (8/25/98 - 9/28/98)	TOC	
Montgomery Watson Laboratories, 555 East Walnut Street, Pasadena, CA 91101 Tel: 626 568 6400 Fax: 626 568 6324	James C. Hein Montgomery Watson Laboratories, 555 East Walnut Street, Pasadena, CA 91101 Tel: 626 568 6400 Fax: 626 568 6324	Quarter 1 (3/26/98 - 4/21/98) Quarter 2 (5/26/98 - 6/29/98) Quarter 3 (8/25/98 - 9/28/98) Quarter 4 (11/20/98 - 12/14/98)	Bromide, TOX, CHCl <sub>3</sub> , BDCM, DBCM, CHBr <sub>3</sub> , MCAA, DCAA, TCAA, MBAA, DBAA, TBAA, BCAA, BDCAA, DBCAA	

## Section 4

### Results and Discussion

#### 4.1 Variations in Influent Water Quality

Table 4-1 presents average water quality characteristics of the feed water entering the RSSCT bench tests for each quarter of testing.

##### 4.1.1 BROMIDE CONTAMINATION

Table 4-1 shows very large bromide values reported in the influent water during the winter and spring quarters. These levels seemed unrealistically high when they were compared to bromide concentrations typically encountered at the Hoffer WTP. Analyses of the disinfection by-product speciation during these quarters revealed a larger than normal percentage of brominated compounds as compared to chlorinated compounds. Due to the variation in bromide levels between the full scale and the bench scale testing, a source of bromide contamination was suspected. The time delay between taking water samples and receiving laboratory reports resulted in the start of the Spring quarter testing before the source of bromide contamination was identified.

A thorough investigation into the source of the bromide contamination was conducted at the UNC under the direction of Dr. Francis A. DiGiano. As a result of this investigation it was determined that the pre-filter (1-um resin bonded cellulose cartridge filter-Ametex Model RB1) was leaching the bromide into the water. The protocol followed for the RSSCT experiment involved filtering source water into the feed tank as needed to maintain an adequate feed water supply. Thus, the feed water was filtered in several batches, and as a result, the bromide contamination was not consistent throughout either the Winter and Spring quarters. Due to the bromide contamination, the DBP data provided in the Treatment Study Summary Report for the Winter and Spring quarters are not representative of expected conditions at the Hoffer WTP. Also, the bromide concentration affected the DBP SDS tests for those quarters and as a result, it is impossible to comment on DBP trends through the winter and spring quarters.

##### 4.1.2 SEASONAL VARIATION

The influent water characteristics showed little seasonal variation among the four quarters. TOC, UV<sub>254</sub>, turbidity, and hardness levels are almost identical for all four quarters. Slightly higher alkalinity and pH values were found in the summer and fall quarters than in the winter and spring quarters.

The SDS-THM4 level was significantly higher in the summer quarter than in the fall quarter. However, during the summer quarter the SDS temperature was set at 27°C while the fall quarter it was set at 15°C. Thus, the differences in THM levels observed during these quarters could be due to the temperature differences and not water quality differences. The levels of SDS-TOX

and SDS-HAA were similar between the summer and fall quarters were similar and did not show the differences seen with the THMs.

## 4.2 Breakthrough Curves

### 4.2.1 AGGREGATE ORGANIC CONSTITUENTS

Figures 4-1 and 4-2 show TOC breakthrough curves of each of the four quarters for the EBCT-10 and 20 minute experiments. The breakthrough curves show that the levels of TOC breakthrough during the Winter and Spring quarters were slightly higher than the levels in the Summer and Fall quarters. However, the breakthrough curves for all four quarters have a similar appearance and overlap in several places. Since the influent water quality appeared fairly consistent across the four quarters, it is not unexpected that the GAC columns would perform similarly.

Figures 4-3 and 4-4 show  $UV_{254}$  absorbance breakthrough curves for each of the four quarters for both the EBCT-10 and 20 minute experiments. The  $UV_{254}$  breakthrough curves are similar to the TOC curves.

There is no known explanation for the drop in effluent TOC during the summer quarter. For such a drop in the organic concentration in the effluent, it is expected that a corresponding drop in the  $UV_{254}$  absorbance would also be observed. However, no drop is seen in the  $UV_{254}$  absorbance, which indicates that the drop in the TOC may have come as a result of analytical errors.

### 4.2.2 DBP'S

Figures 4-5 to 4-10 show the breakthrough curves for THM4, HAA6, and TOX of the summer and fall quarters for the EBCT-10 and 20 minute experiments. A higher level of breakthrough of the DBP's was observed during the fall quarter than the summer quarter. This occurred despite the fact that the influent THM4 concentration was higher in the summer quarter.

Tables 4-2 through 4-5 list the GAC bed throughput volumes that were achieved at the point of breakthrough of SDS-THM and SDS-HAA at the levels for compliance with the Stage 1 and proposed Stage 2 DBP rules. Also, shown in the tables are the bed volumes to achieve 90% of the Stage 1 and Stage 2 rules. The following are important observations that can be made from these tables.

- The GAC effluent SDS-DBP levels during the summer and fall quarters never reached the Stage 1 DBP levels. The average influent SDS-HAA levels during the summer and fall quarters were 61 and 57  $\mu\text{g/L}$ , respectively.
- The GAC bed volumes achieved prior to the breakthrough of the SDS-THM4 at the proposed stage 2 limit was substantially less than the volumes that were achieved prior to meeting the SDS-HAA limit for the 10 minute EBCT experiments.
- For the 20 minute EBCT experiments, the sampling intervals at the time of SDS-DBP

breakthrough were too great to demonstrate the precise amount of bed volumes that could be achieved prior to reaching the Stage 2 DBP limits.

- A greater number of bed volumes were achieved in the summer quarter than in the fall prior to meeting the SDS-HAA Stage 1 and 2 limits.
- Despite the higher SDS-THM concentrations present in the summer than the fall quarter, a similar number of bed volumes were achieved in both quarters prior to meeting the SDS-THM Stage 1 and 2 limits.

### 4.3 Operational Experiences

In addition to the bromide contamination that occurred during the winter and spring quarters, the following operational issues should be considered.

#### 4.3.1 COLUMN BREAK DURING THE SPRING QUARTER

During each testing quarter, the EBCT-10 and 20 minute columns were conducted simultaneously, using the same batch started at the same time. The spring quarter of testing was started on 5/26/98. A sample of the influent water was taken on 5/26/98 following the initiation of the run. After about one week of operation, the EBCT-10 minute column cracked. A new EBCT-10 minute column was prepared and started on 6/3/98 using the same batch water. On that day an influent sample was taken for both the EBCT-10 and 20 minute columns. A final influent sample was taken on 6/25/98. This resulted in three influent samples for the EBCT-20 minutes column, but only two influent samples for the EBCT-10 minutes column.

#### 4.3.2 CHLORINE DOSE DURING THE FIRST QUARTER

At the start of the winter quarter of testing the laboratory staff was under the belief that the chlorine dose for the SDS testing could be held constant as long as the residual remained above 0.2 mg/L. After discussions with the USEPA staff, it became clear that it was desirable to hold the chlorine residual constant. Thus, in subsequent quarters the chlorine dose was adjusted to try to obtain a constant chlorine residual.

Figure 4.1: Comparison of TOC Breakthrough Curves for EBCT10 Columns

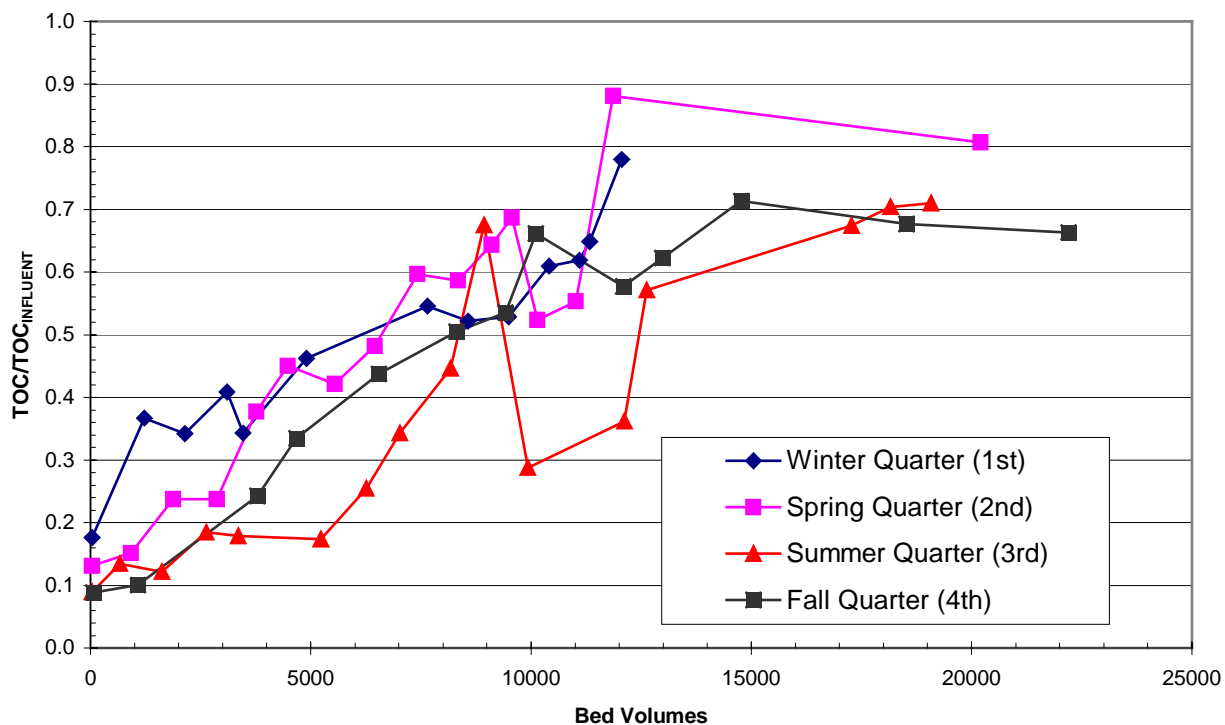


Figure 4.2: Comparison of TOC Breakthrough Curves for EB CT20 Columns

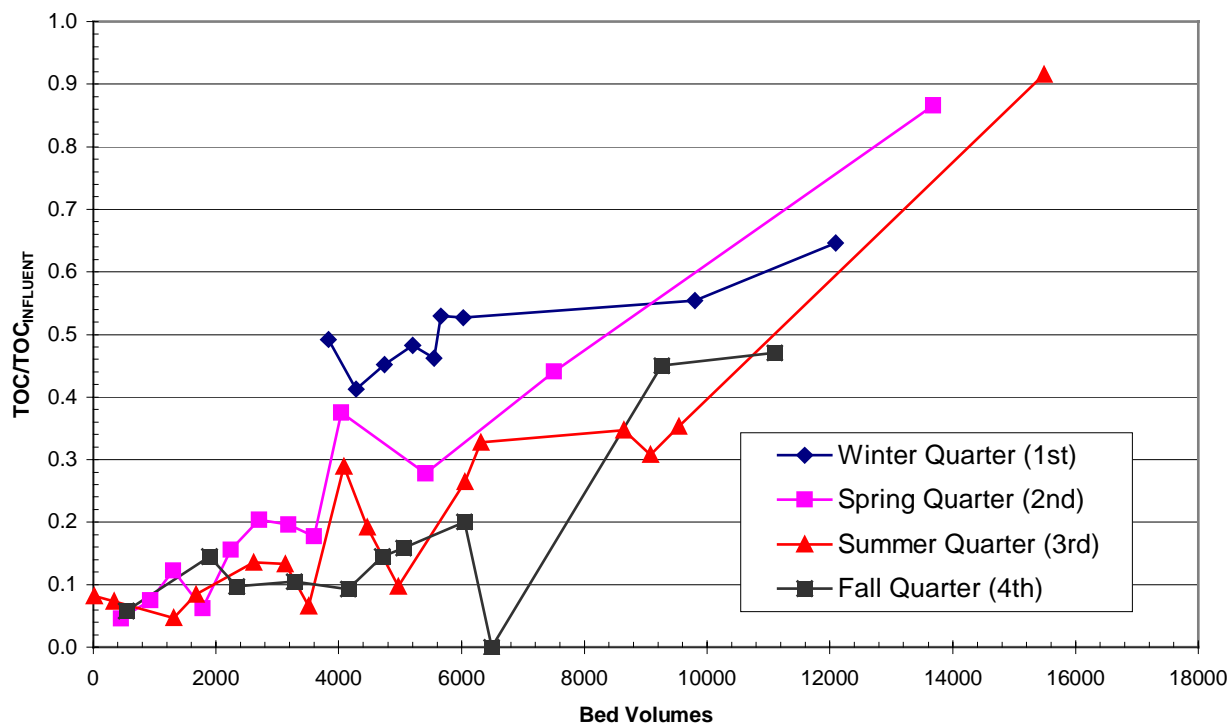


Figure 4.3: Comparison of UV254 Breakthrough Curves for EBCT10 Columns

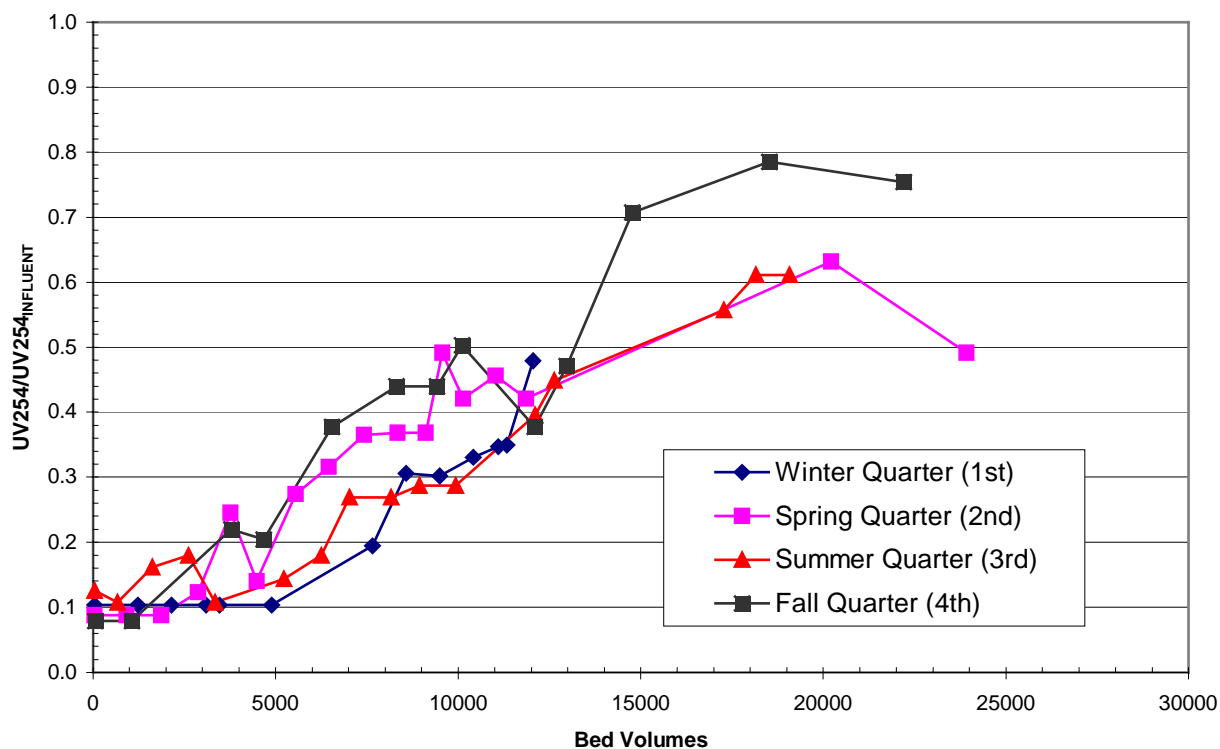


Figure 4.4: Comparison of UV254 Breakthrough Curves for EBCT20 Columns

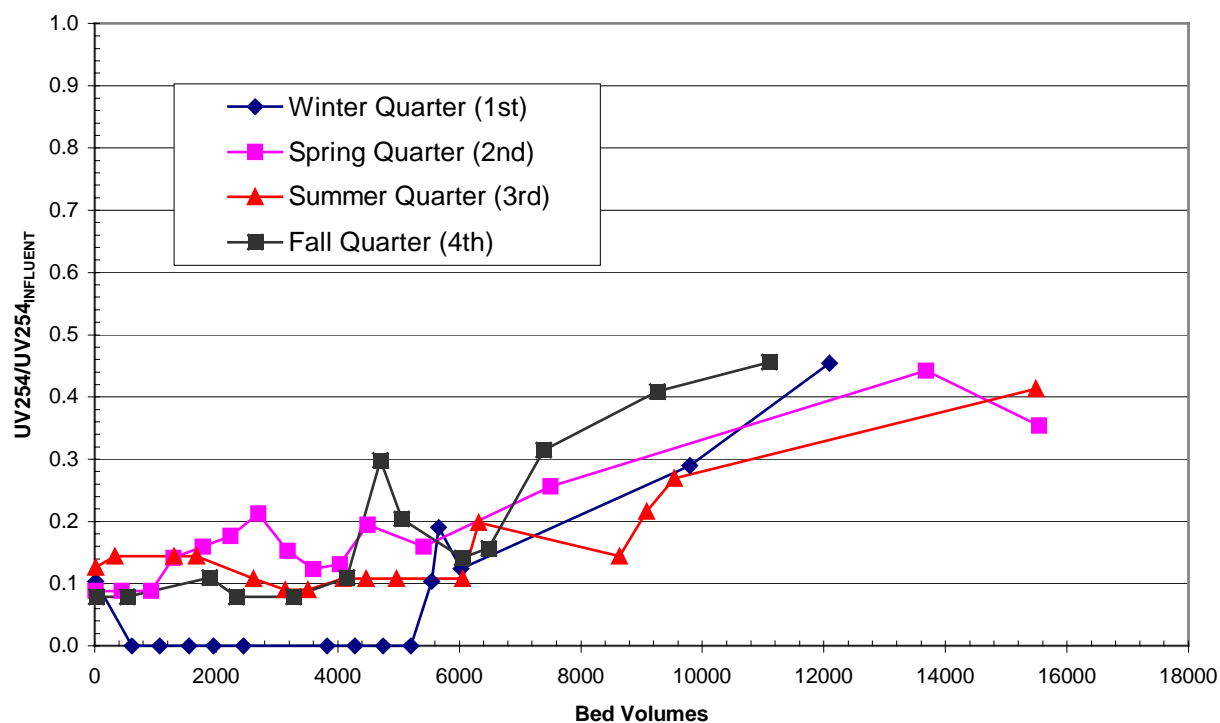


Figure 4.5: Comparison of SDS-THM4 Breakthrough Curves for EBCT10 Columns

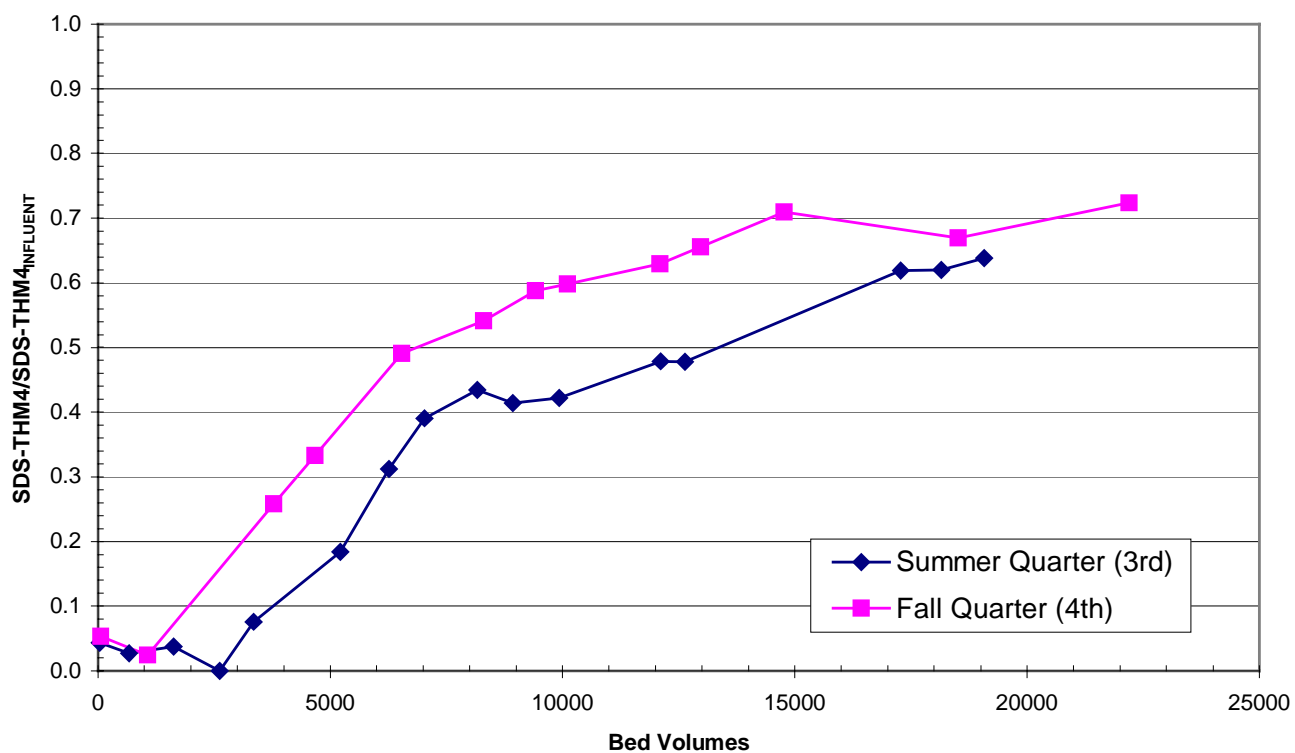


Figure 4.6: Comparison of SDS-THM4 Breakthrough Curves for EBCT20 Columns

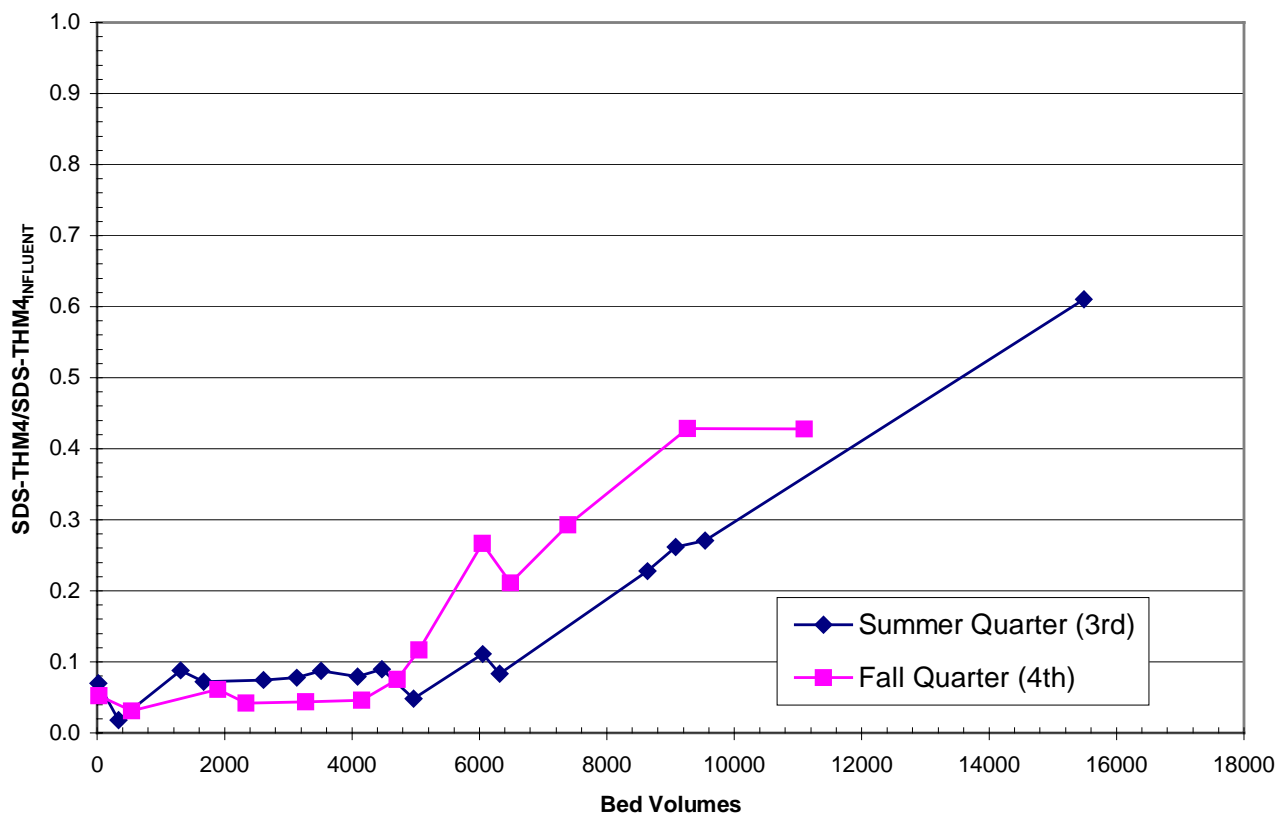




Figure 4.7: Comparison of SDS-HAA6 Breakthrough Curves for EBCT10 Columns

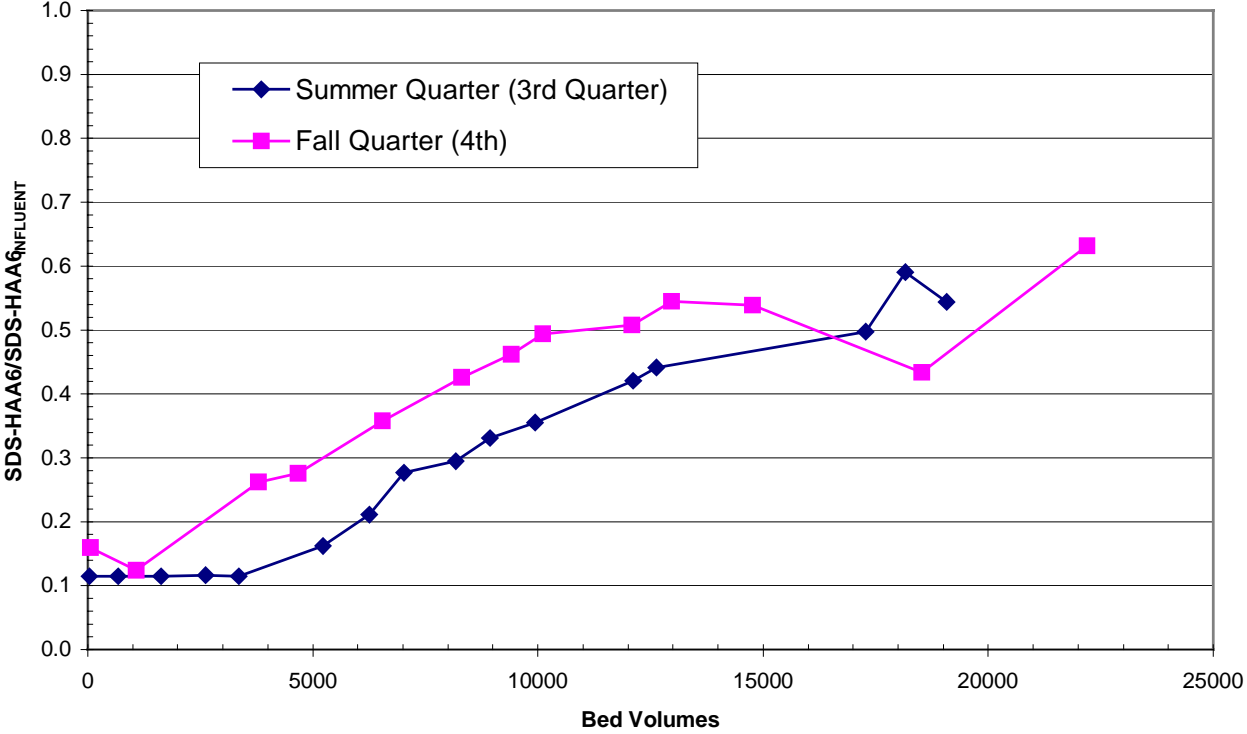


Figure 4.8: Comparison of SDS-HAA6 Breakthrough Curves for EBCT20 Columns

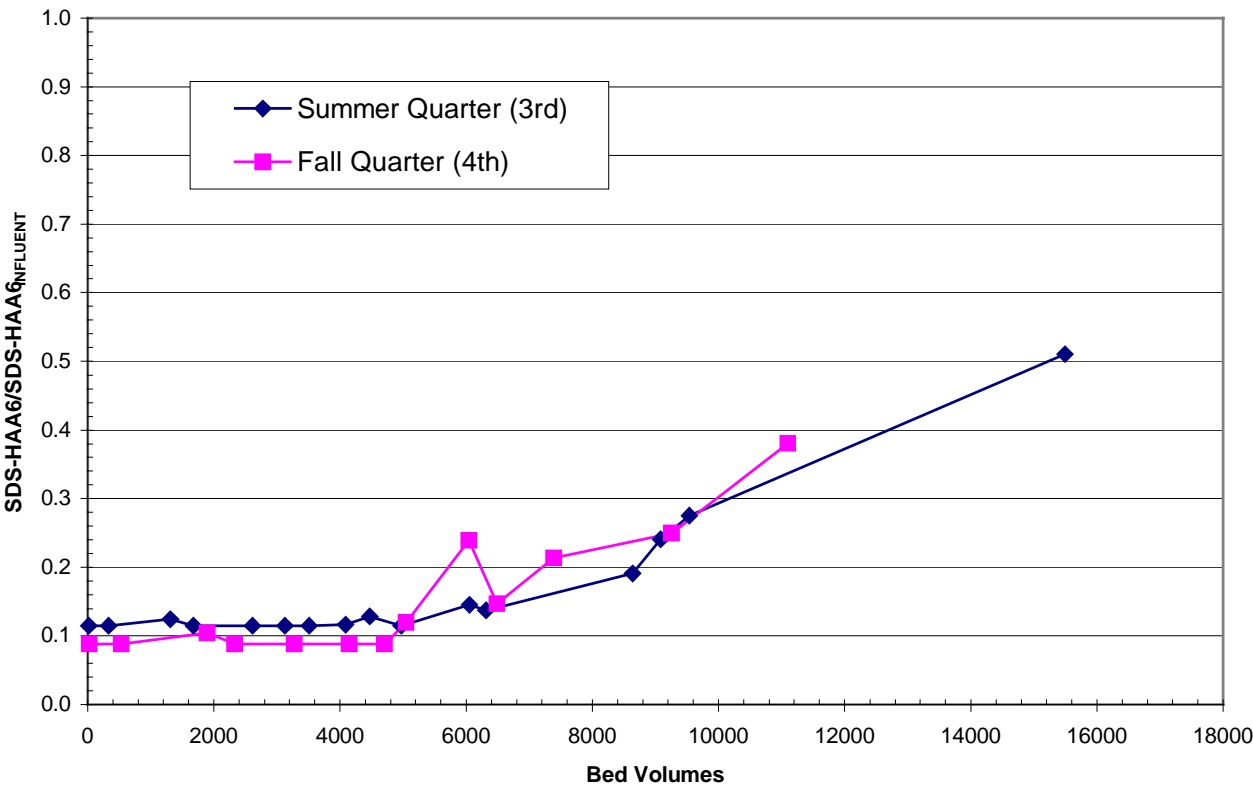


Figure 4.9: Comparison of SDS-TOX Breakthrough Curves for EBCT10 Columns

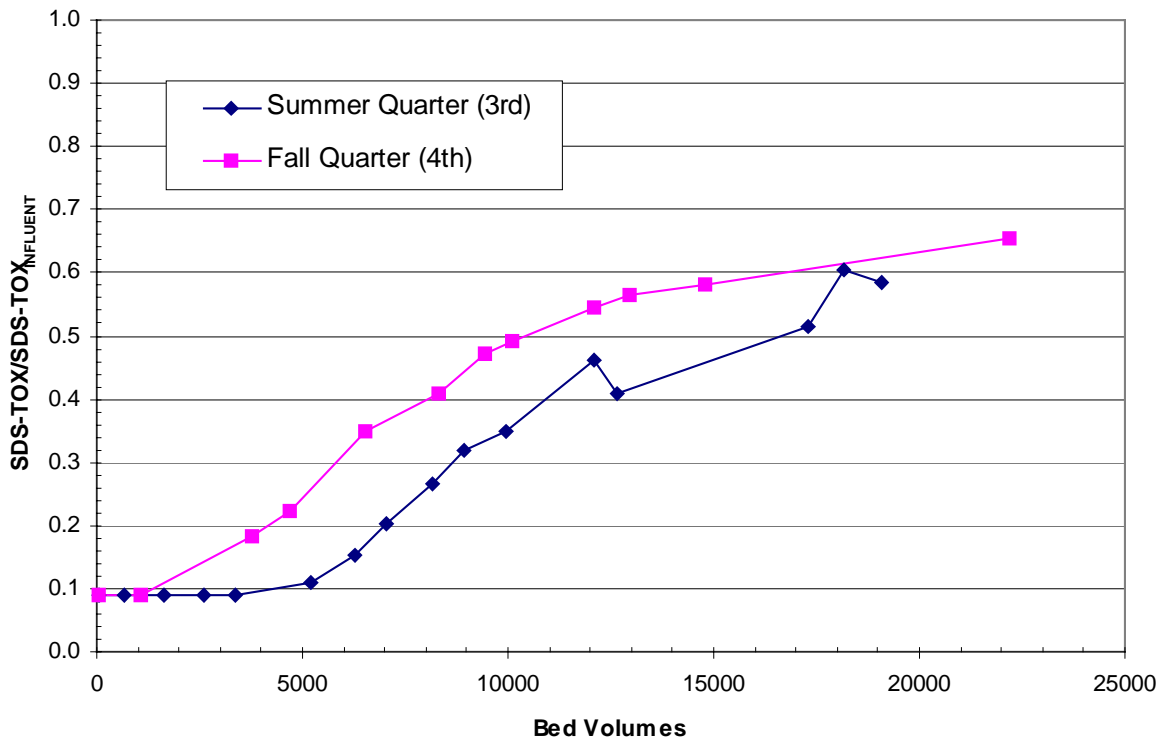
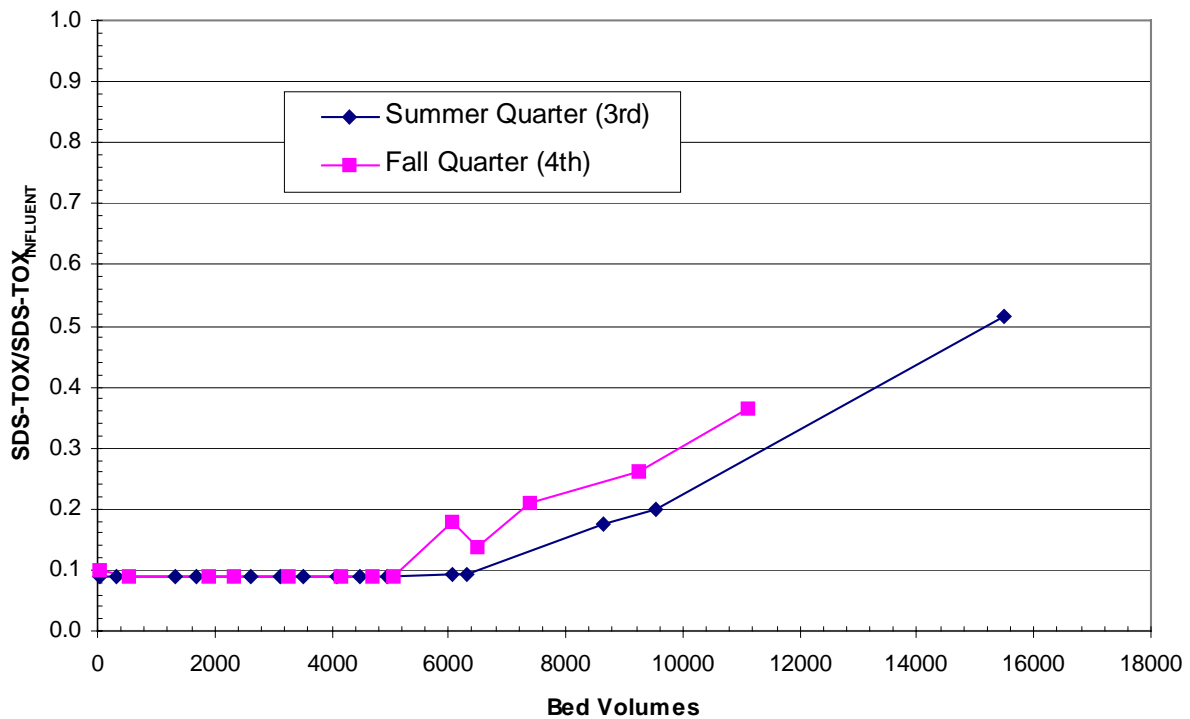


Figure 4.10: Comparison of SDS-TOX Breakthrough Curves for EBCT20 Columns



<b>Table 4-1 RSSCT Study Influent Water Quality</b>								
<b>Water Quality Parameter</b>	<b>1st Quarter</b> <i>11/20/98 - 12/14/98</i>		<b>2nd Quarter</b> <i>06/03/98 - 06/29/98</i>		<b>3rd Quarter</b> <i>08/25/98 - 09/15/98</i>		<b>4th Quarter</b> <i>11/20/98 - 12/14/98</i>	
	Average	% S.D.	Average	% S.D.	Average	% S.D.	Average	% S.D.
Temperature [°C]	19.67	2.94	23.33	4.95	20.33	2.84	22.67	2.55
pH	6.28	0.33	6.14	1.47	6.88	1.35	6.76	1.07
Turbidity [ntu]	0.65	18.72	0.63	7.92	0.26	43.68	0.83	9.08
Alkalinity [mg/L as CaCO <sub>3</sub> ]	7.60	5.58	8.90	7.95	13.55	3.65	15.35	0.46
Calcium Hardness [mg/L CaCO <sub>3</sub> ]	11.70	0.00	13.40	2.11	13.15	0.54	12.90	0.00
Total Hardness [mg/L CaCO <sub>3</sub> ]	19.15	1.85	22.40	5.05	13.15	0.00	21.70	0.00
TOC [mg/L]	2.84	0.35	2.85	18.30	2.88	3.29	2.99	0.83
UV254 [cm-1]	0.05	9.34	0.06	5.50	0.06	5.77	0.06	5.52
Bromide [ug/L]	754.7	97.81	200.0	105.36	91.0	1.55	94.0	3.01
SDS-THM4 [ug/L]	98.63	47.57	191.53	64.09	110.37	7.98	80.67	3.12
SDS-HAA5 [ug/L]	30.47	20.45	33.07	32.13	50.13	11.67	46.27	11.75
SDS-HAA6 [ug/L]	37.53	7.56	25.50	32.18	61.13	11.17	56.50	10.09
SDS-TOX [ug/L]	197.5	5.52	216.7	18.65	281.7	8.00	275.0	6.56
SDS- Chlorine Demand [mg/L]	2.62	2.86	3.38	5.18	3.12	2.24	3.27	3.88

*Note: % S.D. = Standard Deviation x 100 / Average*

**Table 4-2 Summary of Times to Breakthrough and GAC Effluent Water Quality at Breakthrough with EBCT 10 for the Summer Quarter**

Breakthrough Criterion	Value of Listed Parameter When Breakthrough Criterion is Met						
	Full Scale Run Time (days)	Through put (Bed Vol.)	TOC (mg/L)	SDS-THM4 (ug/L)	SDS-HAA5 (ug/L)	SDS-HAA6 (ug/L)	SDS-TOX (ug Cl-/L)
SDS THM4 = 80 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 72 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 40 ug/L	49	7023	0.986	43.1	12.2	16.9	57
SDS THM4 = 36 ug/L	49	7023	0.986	43.1	12.2	16.9	57
SDS HAA5 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 30 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 27 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 30 ug/L	120	17280	1.938	68.3	22.4	30.4	145
SDS HAA6 = 27 ug/L	88	12630	1.642	52.7	19.5	27	115

**Table 4-3 Summary of Times to Breakthrough and GAC Effluent Water Quality at Breakthrough with EBCT 10 for the Fall Quarter**

Breakthrough Criterion	Value of Listed Parameter When Breakthrough Criterion is Met						
	Full Scale Run Time (days)	Through put (Bed Vol.)	TOC (mg/L)	SDS-THM4 (ug/L)	SDS-HAA5 (ug/L)	SDS-HAA6 (ug/L)	SDS-TOX (ug Cl-/L)
SDS THM4 = 80 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 72 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 40 ug/L	58	8305	1.51	43.70	17.45	24.05	112.50
SDS THM4 = 36 ug/L	45	6545	1.31	39.60	14.50	20.20	96.00
SDS HAA5 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 30 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 27 ug/L	154	22198	1.98	58.40	28.30	35.70	180.00
SDS HAA6 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 30 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 27 ug/L	70	10104	1.97	48.25	20.40	27.90	135.00

**Table 4-4 Summary of Times to Breakthrough and GAC Effluent Water Quality at Breakthrough with **EBCT 20 for the Summer Quarter****

Breakthrough Criterion	Value of Listed Parameter When Breakthrough Criterion is Met						
	Full Scale Run Time (days)	Throughput (Bed Vol.)	TOC (mg/L)	SDS-THM4 (ug/L)	SDS-HAA5 (ug/L)	SDS-HAA6 (ug/L)	SDS-TOX (ug Cl-/L)
SDS THM4 = 80 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 72 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 40 ug/L	215	15491	0.00	0.00	0.00	0.00	0.00
SDS THM4 = 36 ug/L	215	15491	0.00	0.00	0.00	0.00	0.00
SDS HAA5 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 30 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 27 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 30 ug/L	215	15491	0.00	0.00	0.00	0.00	0.00
SDS HAA6 = 27 ug/L	215	15491	0.00	0.00	0.00	0.00	0.00

**Table 4-5 Summary of Times to Breakthrough and GAC Effluent Water Quality at Breakthrough with **EBCT 20 for the Fall Quarter****

Breakthrough Criterion	Value of Listed Parameter When Breakthrough Criterion is Met						
	Full Scale Run Time (days)	Throughput (Bed Vol.)	TOC (mg/L)	SDS-THM4 (ug/L)	SDS-HAA5 (ug/L)	SDS-HAA6 (ug/L)	SDS-TOX (ug Cl-/L)
SDS THM4 = 80 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 72 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 40 ug/L	NA	---	---	---	---	---	---
SDS THM4 = 36 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 30 ug/L	NA	---	---	---	---	---	---
SDS HAA5 = 27 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 60 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 54 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 30 ug/L	NA	---	---	---	---	---	---
SDS HAA6 = 27 ug/L	NA	---	---	---	---	---	---

## Section 5

### QA/QC Summary

#### 5.1 QA/QC

The QA/QC information for the laboratory analyses is included in the Treatment Study Summary Report Spreadsheet.

##### 5.1.1 MONTGOMERY WATSON LABORATORY

The QA/QC summary information for the bromide and SDS-DBP analyses from the Montgomery Watson Laboratories reflects not only the samples for PWSID# NC0326010, but other bench test utilities as well, as per agreement with Steve Allegeier of EPA.

##### 5.1.2 UNIVERSITY OF NORTH CAROLINA LABORATORY

The following issues concerning the QA/QC data from the UNC laboratory have been previously discussed with Steve Allegeier of EPA:

- Duplicate measurements of UV<sub>254</sub> absorbance were made on each sample and averaged to produce the reported value. Only the averaged values were recorded, the duplicate measurement readings are not available.
- The UNC TOC data was felt to be more representative of the true conditions of the experiment during the spring and summer quarters. While the UNC ran duplicate and matrix sample checks, they did not retain records of these for use in this QA/QC evaluation.

#### 5.2 Summary of Calibration Procedures

##### 5.2.1 PUBLIC WORKS COMMISSION OF FAYETTEVILLE CROSS CREEK LAB

Summaries of the calibration procedures used by the Cross Creek Laboratory for the TOC analyses are located in Appendix B.

##### 5.2.2 MONTGOMERY WATSON LAB

Summaries of the calibration procedures used by the Montgomery Watson Laboratory for the HAA, THM, and Bromide analyses are shown in the attached tables located in Appendix B.

##### 5.2.3 UNIVERSITY OF NORTH CAROLINA LAB

The UNC-CH laboratory staff followed the calibration and quality control procedures as described in Standard Methods 5910 for the UV<sub>254</sub> absorbance analyses. The UNC-CH laboratory staff followed the calibration and quality control procedures as described in Standard Methods 5310B for the TOC analyses.

## **Appendix A**

### **Plant Design Parameters**

**Note: Available in Hardcopy Only**

## **Appendix B**

### **Calibration Summaries**

**Note: Calibration Summary for Cross Creek  
Lab available in hardcopy only**



**MONTGOMERY WATSON LABORATORY**  
**CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC**

Performance Criteria	Method	THMs EPA 502.2	TOX SM 5320B
	Analytes	<i>THM</i>	<i>TOX</i>
	Target Analytes	Trihalomethanes (THMs) Chloroform (CHCl <sub>3</sub> ) Bromodichloromethane (BDCM) Dibromochloromethane (DBCM) Bromoform (CHBr <sub>3</sub> )	Total Organic Halide (Dissolved Organic Halogen) (DOX)
1.0 IDC			
1.1 IDLSB	Method Blank	< 1/2 MRL	< 1/2 MRL
1.2 IDA	QC check sample	+/- 20% of true value	+/- 20% of true value
1.3 IDP	No. of replicates		5
	Spike conc.	THM 20 ug/L	TOX 250 ug/L
	% RSD	< 20	< 20
	% Recovery	80-120	80-120
1.4 MDL	No. of replicates	7	7
	Spike conc.	1/2 MRL	1/2 MRL
	% Recovery	50-150	50-150
2.0 MRL		THM 1.0 ug/L	50 ug Cl <sup>-</sup> /L 25 ug Cl <sup>-</sup> /L (during treatment studies)
3.0 Calibration Verification	Verification Frequency	Lowest level std. analyzed at the beginning of each 24 hr before the first sample  Mid level and high level analyzed alternately after every 10th sample and last 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.  Mid level and high level analyzed alternately after every 7th sample and last sample
Conc. and QC criteria (%rec)			<i>TOX</i> (ug Cl <sup>-</sup> /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

## CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC

	Performance Criteria	Method	THMs EPA 502.2	TOX SM 5320B
4.0	Reagent (Method) Blank       QC criteria	<i>Frequency</i>	One per analysis batch (one per analysis batch)    < 1/2 MRL	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 batch.   <0.80 ug/Cl-/40 mg of activated carbon; < 1/2 of MRL, <25 or < 12.5
5.0	Shipping Blank Criteria	Travel Blank	Not required	NA
6.0	LFM Frequency   Matrix spike level   QC criteria	<i>Fortified Sample</i>     % Recovery	one sample in each analysis batch  same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc. NA	at least 5% of all ICR samples analyzed each quarter (fortified sample analyzed in duplicate same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc. NA
7.0	Lab (Field) Duplicate   QC Criteria	   % RPD	field duplicate   NA	lab duplicate   NA
8.0	Internal Std.   QC Criteria	   IS Recoveries	Not applicable   Not applicable	NA   NA
9.0	Surrogate QC Standards	   Surrogate Recoveries	chlorofluorobenzene-elcd   80-120 % recovery	NA   NA
10.0	Method Calibration Procedures Trihalomethan	Initial Calibration Curve Standard 1 Standard 2 Standard 3	THMs: CHCL <sub>3</sub> , BDCM,DBCM,CHBr <sub>3</sub> Concentration (ug/L) 0.5 1 5	

# CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC

Performance Criteria	Method	THMs EPA 502.2	TOX SM 5320B
	Standard 4	20	
	Standard 5	40	
	Standard 6	50	
	Standard 7		
	Standard 8		
	Standard 9		
	Standard 1	%RSD < 10%	
	Standard 2		
	Standard 3		
	Standard 4		
	Standard 5		
	Standard 6		
	Standard 7		
	Standard 8		
	Standard 9		

**Appendix C**  
**Data Collection Spreadsheet**

**FIELD-SET 1: 1st QUARTER RSSCT RESULTS (FILE: ICR448.xls)****Field 1-1: PWS And Treatment Plant Data**

PWS Name	Public Works Commision of the City of Fayetteville
er System Identification Number	NC 0326010
ry Data Base Number ( <i>optional</i> )	1244
Official ICR Contact Person	Mr. M. J. Noland
Mailing Address	P.O. Box 1089 Fayetteville, NC 28302
Phone Number	(910)-223-4733
FAX Number	(910)-829-0203
E-Mail Address ( <i>optional</i> )	N/A
Technical ICR Contact Person	Mr. Kevin Christmas
Mailing Address	508 Hoffer Dr. Fayetteville, NC 28301
Phone Number	(910)-223-4709
FAX Number	(910)-484-5838
E-Mail Address ( <i>optional</i> )	N/A
Plant Name	P.O. Hoffer Water Treatment Plant
Treatment Plant Category	CONV
Process Train Name	Conventional train
ent Plant Identification Number	448
D Number of Plant ( <i>if assigned</i> )	NC 0326010
imum Water Temperature (°C)	4
Average Water Temperature (°C)	34.0
Approved Plant Capacity (MGD)	32.0

**Field 1-2: Full-Scale GAC Characteristics**

Carbon manufacturer	Calgon Corp.
Carbon trade name	Filtrisorb-400
Carbon type	Bituminous
Original GAC mesh size, upper (US standard mesh)	12
Original GAC mesh size, lower (US standard mesh)	40
Original carbon particle diameter, d <sub>LC</sub> (mm)	1.053

1: These are the characteristics before the carbon is ground for RSSCT experiments.

**Field 1-3: RSSCT Design Parameters****Input Design Parameters**

RSSCT influent TOC (mg/L)	2.8
Inner diameter of the RSSCT column, $D_{SC}$ (mm)	15.0
Minimum RSSCT Reynolds number, $Re_{SC, min}$	0.2
Full-scale operating temperature, $T^{\circ}C$ ( $^{\circ}C$ )	11.1
Full-scale bed porosity, $\epsilon_{LC}$	0.45
Measured RSSCT dry bed density, $\rho_{SC}$ (g/cm <sup>3</sup> )	0.463
RSSCT GAC mesh size, upper (US standard mesh)	80
RSSCT GAC mesh size, lower (US standard mesh)	100

**Estimated Run Length**

Bed volumes to 50% TOC breakthrough, $BV_{50}$	5825
Estimated run length, $BV_T$ ( $= 2 \times BV_{50}$ )	11651
$BV_T + 30\%$ safety factor, $BV_{T+30\%}$ ( $= 2.6 \times BV_{50}$ )	15146

**General RSSCT Design Parameters**

Kinematic viscosity at $T^{\circ}C$ , $\nu_{LC}$ (m <sup>2</sup> /s)	1.285E-06
RSSCT carbon particle diameter, $d_{SC}$ (mm)	0.1650
Scaling factor, SF	6.38
RSSCT hydraulic loading rate, $v_{SC}$ (m/hr)	2.52
RSSCT flow rate, $Q_{SC}$ (mL/min)	7.43
Estimated total influent volume required, $V_{SC}$ (L)	529

**10-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	10
Estimated full-scale run time, $t_{LC}$ (days)	105
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	1.57
Estimated RSSCT run time, $t_{SC}$ (days)	16.49
RSSCT bed length, $l_{SC}$ (cm)	6.6
Estimated volume required for 10-minute EBCT, $V_{SC}$ (L)	176
Mass GAC required, $m_{SC}$ (g)	5.39

**20-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	20
Estimated full-scale run time, $t_{LC}$ (days)	210
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	3.14
Estimated RSSCT run time, $t_{SC}$ (days)	32.98
RSSCT bed length, $l_{SC}$ (cm)	13.2
Estimated volume required for 20-minute EBCT, $V_{SC}$ (L)	353
Mass GAC required, $m_{SC}$ (g)	10.79

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US standard mesh size	Opening (mm)
4	4.750
6	3.350
8	2.360
10	2.000
12	1.680
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
70	0.210
80	0.180
100	0.150
120	0.125
140	0.106
170	0.088
200	0.075
230	0.062
270	0.053
325	0.044
400	0.037

[illegible]

1: Design information, similar to that shown in Tables 6c and 6d of the ICR rule, must be included in the hard-copy *Treatment Study Summary Report* (see Section 10.0). The purpose of this table is to list the pretreatment processes used in this particular RSSCT run.

## Field 1-5: GAC Influent Water Quality For The 10-Minute EBCT Run

10-min. EBCT Start Date	3/26/98
10-min. EBCT Start Time	8:00

## Group A, 2 samples per batch

Parameter	Units	Sample A1-10	Sample A2-10	Sample A3-10	Average	RPD
Sampling date	MM/DD/YY	3/26/98	4/7/98	4/24/98	---	---
Sampling time	hh:mm	9:00	16:00	14:00	---	---
Operation time	hh.hh	1.00	296.00	702.00	---	---
Bed volumes	(10 minutes)	38.3	11328.7	26867.5	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	7.9	7.3	NA	7.6	7.89
Total hardness	mg/L as CaCO <sub>3</sub>	18.9	19.4	NA	19.2	2.61
Calcium hardness	mg/L as CaCO <sub>3</sub>	11.7	11.7	NA	11.7	0.00
Ammonia	mg NH <sub>3</sub> -N / L	0.02	0.03	NA	0.03	40.00
Bromide	µg/L	740.00	1500.0	24.0	754.7	97.81

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	3/26/98	4/7/98	4/24/98	---	---
Sampling time	hh:mm	9:00	16:00	14:00	---	---
Operation time	hh.hh	1.00	296.00	702.00	---	---
Bed volumes	(10 minute)	38.3	11328.7	26867.5	---	---
pH	---	6.26	6.29	6.30	6.28	0.33
Turbidity	ntu	0.79	0.59	0.57	0.65	18.72
Temperature	°C	20.0	19.0	20.0	19.7	2.94
Total organic carbon	mg/L	2.84	2.83	NR	2.84	0.35
UV <sub>254</sub>	cm <sup>-1</sup>	0.047	0.045	0.053	0.048	9.34
SUVA	L/(mg*m)	1.66	1.58	NR	1.62	3.66
SDS-Cl <sub>2</sub> dose	mg/L	3.00	3.00	3.00	3.00	0.00
SDS-Free Cl <sub>2</sub> residual	mg/L	0.38	0.30	0.45	0.38	19.93
SDS-Cl <sub>2</sub> demand	mg/L	2.62	2.70	2.55	2.62	2.86
SDS-Chlorination temp.	°C	14.0	14.0	14.0	14.0	0.00
SDS-Chlorination pH	---	7.27	7.30	7.35	7.31	0.55
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> / L	185.00	202.50	205.00	197.50	5.52
SDS-CHCl <sub>3</sub>	µg/L	5.40	2.40	36.00	14.60	127.35
SDS-BDCM	µg/L	19.00	10.00	11.00	13.33	37.00
SDS-DBCM	µg/L	43.00	32.00	2.10	25.70	82.36
SDS-CHBr <sub>3</sub>	µg/L	37.00	98.00	BMRL	67.50	63.90
SDS-THM <sub>4</sub>	µg/L	104.40	142.40	49.10	98.63	47.57
SDS-MCAA*	µg/L	BMRL	BMRL	2.30	2.30	NR
SDS-DCAA*	µg/L	4.00	3.00	15.00	7.33	90.80
SDS-TCAA*	µg/L	2.80	2.00	20.00	8.27	123.01



SDS-MBAA*	µg/L	2.30	4.00	BMRL	3.15	38.16
SDS-DBAA*	µg/L	16.00	20.00	BMRL	18.00	15.71
SDS-BCAA*	µg/L	11.00	6.70	3.50	7.07	53.26
SDS-TBAA	µg/L	15.00	24.00	NR	19.50	32.64
SDS-CDBAA	µg/L	12.00	11.00	NR	11.50	6.15
SDS-DCBAA	µg/L	8.60	7.20	NR	7.90	12.53
SDS-HAA5	µg/L	25.10	29.00	37.30	30.47	20.45

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-HAA6	µg/L	36.10	35.70	40.80	37.53	7.56

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 1-6: GAC Influent Water Quality For The 20-Minute EBCT Run<sup>1</sup>

20-min. EBCT Start Date	3/26/98
20-min. EBCT Start Time	8:00

**Group A, 2 samples per batch**

Parameter	Units	Sample A1-20	Sample A2-20	Sample A3-20	Average	RPD
Sampling date	MM/DD/YY	3/26/98	4/7/98	4/24/98	---	---
Sampling time	hh:mm	9:00	16:00	14:00	---	---
Operation time	hh.hh	1.00	296.00	702.00	---	---
Bed volumes	(20 minutes)	19.1	5664.4	26867.5	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	7.9	7.3	NA	7.6	7.89
Total hardness	mg/L as CaCO <sub>3</sub>	18.9	19.4	NA	19.2	2.61
Calcium hardness	mg/L as CaCO <sub>3</sub>	11.7	11.7	NA	11.7	0.00
Ammonia	mg NH <sub>3</sub> -N / L	0.0	0.0	NA	0.0	40.00
Bromide	µg/L	740.0	1500.0	24.0	754.7	97.81

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-20	Sample B2-20	Sample B3-20	Average	%SD
Sampling date	MM/DD/YY	3/26/98	4/7/98	4/24/98	---	---
Sampling time	hh:mm	9:00	16:00	14:00	---	---
Operation time	hh.hh	1.00	296.00	702.00	---	---
Bed volumes	(20 minute)	19.1	5664.4	13433.7	---	---
pH	---	6.26	6.29	6.30	6.28	0.33
Turbidity	ntu	0.79	0.59	0.57	0.65	18.72
Temperature	°C	20.0	19.0	20.0	19.7	2.94
Total organic carbon	mg/L	2.84	2.83	NR	2.84	0.35
UV <sub>254</sub>	cm <sup>-1</sup>	0.047	0.045	0.053	0.048	9.34
SUVA	L/(mg*m)	1.66	1.58	NR	1.619	3.66
SDS-Cl <sub>2</sub> dose	mg/L	3.00	3.00	3.00	3.00	0.00
SDS-Free Cl <sub>2</sub> residual	mg/L	0.38	0.30	0.45	0.38	19.93
SDS-Cl <sub>2</sub> demand	mg/L	2.62	2.70	2.55	2.62	2.86
SDS-Chlorination temp.	°C	14.0	14.0	14.0	14.0	0.00
SDS-Chlorination pH	---	7.27	7.30	7.35	7.3	0.55
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> / L	185.00	202.50	205.00	197.50	5.52
SDS-CHCl <sub>3</sub>	µg/L	5.40	2.40	36.00	14.60	127.35
SDS-BDCM	µg/L	19.00	10.00	11.00	13.33	37.00
SDS-DBCM	µg/L	43.00	32.00	2.10	25.70	82.36
SDS-CHBr <sub>3</sub>	µg/L	37.00	98.00	BMRL	67.50	63.90
SDS-THM <sub>4</sub>	µg/L	104.40	142.40	49.10	98.63	47.57
SDS-MCAA*	µg/L	BMRL	BMRL	2.30	2.30	NR
SDS-DCAA*	µg/L	4.00	3.00	15.00	7.33	90.80
SDS-TCAA*	µg/L	2.80	2.00	20.00	8.27	123.01

SDS-MBAA*	µg/L	2.30	4.00	ND	3.15	38.16
SDS-DBAA*	µg/L	16.00	20.00	ND	18.00	15.71
SDS-BCAA*	µg/L	11.00	6.70	3.50	7.07	53.26
SDS-TBAA	µg/L	15.00	24.00	NR	19.50	32.64
SDS-CDBAA	µg/L	12.00	11.00	NR	11.50	6.15
SDS-DCBAA	µg/L	8.60	7.20	NR	7.90	12.53
SDS-HAA5	µg/L	25.10	29.00	37.30	30.47	20.45

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-20	Sample B2-20	Sample B3-20	Average	%SD
SDS-HAA6	µg/L	36.10	35.70	40.80	37.53	7.56

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

**Field 1-7: GAC Effluent Water Quality For The 10-Minute EBCT Run<sup>1</sup>****Group C, 12 effluent samples per run**

Sample ID	Was sample duplicated Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes 10 minute	pH	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS free Cl <sub>2</sub> residue mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS chlorination temp °C	SDS Chlorination pH
C1	N	3/26/98	9:00	1.00	38.3	6.38	18.0	BMRL	BMRL	BMRL	3.00	2.19	0.81	14.0	7.34
C2	N	3/27/98	16:00	32.00	1224.7	6.28	18.0	1.04	0.005	0.48	3.00	2.12	0.88	14.0	7.29
C3	N	3/28/98	16:00	56.00	2143.3	6.25	19.0	0.97	BMRL	BMRL	3.00	1.85	1.15	14.0	7.28
C4	N	3/29/98	17:00	81.00	3100.1	6.40	19.0	1.16	BMRL	BMRL	3.00	1.64	1.36	14.0	7.03
Avg-C5	Y	3/30/98	2:30	90.50	3463.7	6.22	19.0	0.97	BMRL	BMRL	3.00	1.57	1.44	14.0	7.28
C6	N	3/31/98	16:00	128.00	4898.9	6.21	20.0	1.31	BMRL	BMRL	3.00	2.15	0.85	14.0	7.17
C7	N	4/3/98	16:00	200.00	7654.5	6.33	19.0	1.55	0.009	0.61	3.00	1.70	1.30	14.0	7.37
C8	N	4/4/98	16:00	224.00	8573.1	6.41	20.0	1.48	0.015	1.00	3.00	1.68	1.32	14.0	7.38
C9	N	4/5/98	16:00	248.00	9491.6	6.33	19.0	1.50	0.015	0.97	3.00	1.46	1.54	14.0	7.38
Avg-C10	Y	4/6/98	16:00	272.00	10410.2	6.23	20.0	1.73	0.016	0.93	3.00	1.34	1.67	14.0	7.36
C11	N	4/7/98	10:00	290.00	11099.1	6.21	19.0	1.75	0.017	0.96	3.00	0.91	2.09	14.0	7.36
Avg-C12	Y	4/7/98	16:00	296.00	11328.7	6.21	20.0	1.84	0.017	0.92	3.00	1.05	1.95	14.0	7.37
C13	N	4/8/98	11:00	315.00	12055.9	6.50	20.0	2.21	0.023	1.05	3.00	1.05	1.95	14.0	7.42

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for

**Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)**

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes 10 minute	pH	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS free Cl <sub>2</sub> residue mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS chlorination temp °C	SDS Chlorination pH
D5	Primary	3/30/98	2:30	90.50	3463.7	6.22	19.0	1.07	BMRL	BMRL	3.00	1.54	1.46	14.0	7.31
D-D5	Duplicate	3/30/98	2:30	90.50	3463.7	6.22	19.0	0.88	BMRL	BMRL	3.00	1.59	1.41	14.0	7.24
Avg-D5	Average	---	---	---	---	6.22	19.0	0.97	BMRL	BMRL	3.00	1.57	1.44	14.0	7.28
RPD-D5	RPD	---	---	---	---	0.00	0.00	####	BMRL	BMRL	0.00	3.19	3.48	0.00	0.96
D10	Primary	4/6/98	16:00	272.00	10410.2	6.23	20.0	1.76	0.016	0.91	3.00	1.35	1.65	14.0	7.33
D-D10	Duplicate	4/6/98	16:00	272.00	10410.2	6.23	20.0	1.69	0.016	0.95	3.00	1.32	1.68	14.0	7.39
Avg-D10	Average	---	---	---	---	6.23	20.0	1.73	0.016	0.93	3.00	1.34	1.67	14.0	7.36
RPD-D10	RPD	---	---	---	---	0.00	0.00	4.11	0.00	4.11	0.00	2.25	1.80	0.00	0.82
D12	Primary	4/7/98	16:00	296.00	11328.7	6.21	20.0	1.90	0.017	0.89	3.00	1.01	1.99	14.0	7.38
D-D12	Duplicate	4/7/98	16:00	296.00	11328.7	6.21	20.0	1.78	0.017	0.95	3.00	1.09	1.91	14.0	7.35
Avg-D12	Average	---	---	---	---	6.21	20.0	1.84	0.017	0.92	3.00	1.05	1.95	14.0	7.37
RPD-D12	RPD	---	---	---	---	0.00	0.00	6.26	1.18	7.44	0.00	7.62	4.10	0.00	0.41

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 1-7: GAC Effluent Water Quality For The 10-Minute EBCT Run (continued)

incubation time hours	SDS TOX µg Cl <sub>2</sub> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
48.0	BMRL	BMRL	0.60	1.00	0.60	2.20	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
48.0	BMRL	BMRL	BMRL	1.00	2.60	3.60	BMRL	BMRL	BMRL	BMRL	1.50	BMRL	BMRL	BMRL	BMRL	1.50	1.50
48.0	BMRL	BMRL	BMRL	1.70	9.70	11.40	BMRL	BMRL	BMRL	1.00	4.10	BMRL	8.80	BMRL	BMRL	5.10	5.10
48.00	36.00	BMRL	BMRL	1.60	17.50	19.10	BMRL	BMRL	BMRL	BMRL	2.05	BMRL	9.30	2.20	BMRL	2.05	2.05
48.0	BMRL	BMRL	BMRL	1.60	6.10	7.70	BMRL	BMRL	BMRL	BMRL	1.60	BMRL	4.90	BMRL	BMRL	1.60	1.60
48.0	45.00	BMRL	2.40	8.40	20.00	30.80	BMRL	BMRL	1.10	1.40	5.30	2.20	12.00	4.40	3.00	7.80	10.00
48.0	62.00	0.60	3.30	11.00	24.00	38.90	BMRL	BMRL	1.10	BMRL	6.60	2.70	14.00	5.40	3.50	7.70	10.40
48.0	66.00	0.60	3.60	13.00	31.00	48.20	BMRL	BMRL	1.20	1.70	8.20	3.00	16.00	6.30	3.80	11.10	14.10
48.0	74.75	BMRL	4.25	15.00	37.00	56.25	BMRL	1.60	BMRL	1.90	6.55	3.10	11.30	3.60	2.60	10.05	13.15
48.0	85.00	1.00	4.30	15.00	41.00	61.30	BMRL	2.70	BMRL	1.70	9.60	3.50	9.80	5.60	3.30	14.00	17.50
48.0	84.25	1.00	3.95	15.50	43.50	63.45	BMRL	BMRL	1.15	2.95	10.50	3.50	17.00	6.10	3.55	14.60	18.10
48.0	73.00	1.70	7.40	19.00	20.00	48.10	BMRL	1.60	1.00	1.30	6.80	5.00	7.30	6.70	4.20	10.70	15.70

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.  
the primary and duplicate analyses below.

incubation time hours	SDS TOX µg Cl <sub>2</sub> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
48.0	BMRL	BMRL	BMRL	1.10	12.00	13.10	BMRL	BMRL	BMRL	BMRL	1.50	BMRL	4.60	BMRL	BMRL	1.50	1.50
48.0	36.00	BMRL	BMRL	2.10	23.00	25.10	BMRL	BMRL	BMRL	BMRL	2.60	BMRL	14.00	2.20	BMRL	2.60	2.60
48.0	36.00	BMRL	BMRL	1.60	17.50	19.10	BMRL	BMRL	BMRL	BMRL	2.05	BMRL	9.30	2.20	BMRL	2.05	2.05
0.00	BMRL	BMRL	BMRL	62.50	62.86	62.83	BMRL	BMRL	BMRL	BMRL	53.66	B	B	BMRL	BMRL	53.66	53.66
48.0	77.00	BMRL	4.20	15.00	38.00	57.20	BMRL	1.30	BMRL	1.50	8.70	3.10	14.00	5.20	2.60	11.50	14.60
48.0	72.50	BMRL	4.30	15.00	36.00	55.30	BMRL	1.90	BMRL	2.30	4.40	BMRL	8.60	2.00	BMRL	8.60	8.60
48.0	74.75	BMRL	4.25	15.00	37.00	56.25	BMRL	1.60	BMRL	1.90	6.55	3.10	11.30	3.60	2.60	10.05	13.15
0.00	6.02	BMRL	2.35	0.00	5.41	3.38	BMRL	37.50	BMRL	42.11	65.65	B	47.79	88.89	BMRL	28.86	45.63
48.0	85.50	1.00	4.10	16.00	43.00	64.10	BMRL	BMRL	1.20	2.30	10.00	3.60	17.00	6.30	3.70	13.50	17.10
48.0	83.00	BMRL	3.80	15.00	44.00	62.80	BMRL	BMRL	1.10	3.60	11.00	3.40	17.00	5.90	3.40	15.70	19.10
48.0	84.25	1.00	3.95	15.50	43.50	63.95	BMRL	BMRL	1.15	2.95	10.50	3.50	17.00	6.10	3.55	14.60	18.10
0.00	2.97	BMRL	7.59	6.45	2.30	2.03	BMRL	BMRL	8.70	44.07	9.52	5.71	0.00	6.56	8.45	15.07	11.05

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

**Field 1-8: GAC Effluent Water Quality For The 20-Minute EBCT Run<sup>1</sup>****Group C, 12 effluent samples per run**

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 20 minute	pH	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp °C
C1	N	3/26/98	9:00	1.00	19.1	6.45	18.0	BMRL	BMRL	BMRL	3.00	1.97	1.03	14.0
C2	N	3/27/98	16:00	32.00	612.4	6.41	18.0	BMRL	BMRL	BMRL	3.00	2.20	0.80	14.0
C3	N	3/28/98	16:00	56.00	1071.6	6.35	19.0	BMRL	BMRL	BMRL	3.00	1.90	1.10	14.0
C4	N	3/29/98	17:00	81.00	1550.0	6.45	19.0	BMRL	BMRL	BMRL	3.00	1.50	1.50	14.0
Avg-C5	Y	3/30/98	14:30	102.50	1961.5	6.41	19.0	BMRL	BMRL	BMRL	3.00	1.92	1.08	14.0
C6	N	3/31/98	16:00	128.00	2449.5	6.34	20.0	BMRL	BMRL	BMRL	3.00	2.10	0.90	14.0
C7	N	4/3/98	16:00	200.00	3827.3	6.17	19.0	1.40	BMRL	BMRL	3.00	1.72	1.28	14.0
C8	N	4/4/98	16:00	224.00	4286.5	6.28	20.0	1.17	BMRL	BMRL	3.00	1.28	1.72	14.0
C9	N	4/5/98	16:00	248.00	4745.8	6.25	19.0	1.28	BMRL	BMRL	3.00	1.58	1.42	14.0
Avg-C10	Y	4/6/98	16:00	272.00	5205.1	6.31	20.0	1.37	BMRL	BMRL	3.00	1.15	1.85	14.0
C11	N	4/7/98	10:00	290.00	5549.5	6.33	19.0	1.31	0.005	0.38	3.00	1.52	1.48	14.0
Avg-C12	Y	4/7/98	16:00	296.00	5664.4	6.33	20.0	1.50	0.009	0.61	3.00	1.54	1.47	14.0
C13	N	4/8/98	11:00	315.00	6028.0	6.25	20.0	1.49	0.006	0.40	3.00	1.28	1.73	14.0
C14	N	4/16/98	16:00	512.00	9797.8	6.31	18.0	1.57	0.014	0.89	3.00	1.10	1.90	14.0
C15	N	4/21/98	16:00	632.00	#####	6.38	19.0	1.83	0.022	1.20	3.00	0.85	2.15	14.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results

**Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)**

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 20 minute	pH	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp °C
D5	Primary	3/30/98	14:30	102.50	1961.5	6.38	19.0	BMRL	BMRL	BMRL	3.00	1.98	1.02	14.0
D-D5	Duplicate	3/30/98	14:30	102.50	1961.5	6.44	19.0	BMRL	BMRL	BMRL	3.00	1.86	1.14	14.0
Avg-D5	Average	---	---	---	---	6.41	19.0	BMRL	BMRL	BMRL	3.00	1.92	1.08	14.0
RPD-D5	RPD	---	---	---	---	0.94	0.00	BMRL	BMRL	BMRL	0.00	6.25	11.11	0.00
D10	Primary	4/6/98	16:00	272.00	5205.1	6.30	20.0	1.40	BMRL	BMRL	3.00	1.10	1.90	14.0
D-D10	Duplicate	4/6/98	16:00	272.00	5205.1	6.32	20.0	1.34	BMRL	BMRL	3.00	1.20	1.80	14.0
Avg-D10	Average	---	---	---	---	6.31	20.0	1.37	BMRL	BMRL	3.00	1.15	1.85	14.0
RPD-D10	RPD	---	---	---	---	0.32	0.00	4.02	BMRL	BMRL	0.00	8.70	5.41	0.00
D12	Primary	4/7/98	16:00	296.00	5664.4	6.33	20.0	1.55	0.009	0.60	3.00	1.42	1.58	14.0
D-D12	Duplicate	4/7/98	16:00	296.00	5664.4	6.33	20.0	1.46	0.009	0.63	3.00	1.65	1.35	14.0
Avg-D12	Average	---	---	---	---	6.33	20.0	1.50	0.009	0.61	3.00	1.54	1.47	14.0
RPD-D12	RPD	---	---	---	---	0.00	0.00	6.00	0.00	6.00	0.00	14.98	15.70	0.00

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

## Field 1-8: GAC Effluent Water Quality For The 20-Minute EBCT Run (continued)

SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
7.38	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
7.41	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
7.27	48.0	BMRL	BMRL	BMRL	BMRL	1.20	1.20	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
7.29	48.0	NR	NR	NR	NR	NR	0.00	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.00	0.00
7.38	48.0	32.00	BMRL	BMRL	2.60	5.10	7.70	BMRL	BMRL	1.00	BMRL	1.60	BMRL	7.30	2.50	1.80	2.60	2.60
7.45	48.0	BMRL	BMRL	BMRL	1.30	1.50	2.80	BMRL	BMRL	BMRL	BMRL	1.00	BMRL	BMRL	BMRL	1.50	1.00	1.00
7.35	48.0	BMRL	BMRL	BMRL	0.70	2.30	3.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
7.40	48.0	BMRL	BMRL	0.70	2.00	5.80	8.50	BMRL	BMRL	BMRL	BMRL	1.60	BMRL	6.60	2.50	1.80	1.60	1.60
7.41	48.0	BMRL	BMRL	0.90	3.10	10.00	14.00	BMRL	BMRL	BMRL	BMRL	2.50	BMRL	7.70	2.70	1.80	2.50	2.50
7.33	48.0	38.50	BMRL	BMRL	2.25	16.00	18.25	BMRL	2.10	1.00	3.10	7.15	3.40	11.35	6.20	2.65	13.35	16.75
7.33	48.0	33.00	BMRL	1.00	3.80	16.00	20.80	BMRL	BMRL	BMRL	1.50	3.60	BMRL	9.90	2.90	2.10	5.10	5.10
7.35	48.0	32.25	BMRL	1.00	4.00	18.50	23.50	BMRL	BMRL	BMRL	2.70	4.50	BMRL	9.65	2.70	1.90	7.20	7.20
7.33	48.0	31.00	BMRL	2.00	6.50	12.00	20.50	BMRL	3.50	BMRL	1.60	3.40	1.80	5.10	3.60	2.20	8.50	10.30
7.32	48.0	81.00	9.3	7.3	4.8	BMRL	21.40	BMRL	6.5	6.7	BMRL	1.5	4.7	BMRL	3.6	6.90	14.70	19.40
7.29	48.0	100.00	14.00	8.80	3.90	BMRL	26.70	BMRL	6.40	7.00	BMRL	BMRL	3.00	NR	NR	4.10	13.40	16.40

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

the primary and duplicate analyses below.

SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
7.35	48.0	BMRL	BMRL	BMRL	1.30	1.70	3.00	BMRL	BMRL	1.00	BMRL	1.10	BMRL	BMRL	BMRL	BMRL	2.10	2.10
7.40	48.0	32.00	BMRL	BMRL	3.90	8.50	12.40	BMRL	BMRL	1.00	BMRL	2.10	BMRL	7.30	2.50	1.80	3.10	3.10
7.38	48.0	32.00	BMRL	BMRL	2.60	5.10	7.70	BMRL	BMRL	1.00	BMRL	1.60	BMRL	7.30	2.50	1.80	2.60	2.60
0.68	0.00	BMRL	BMRL	BMRL	100.00	133.33	122.08	BMRL	BMRL	0.00	BMRL	62.50	BMRL	BMRL	BMRL	BMRL	38.46	38.46
7.32	48.0	34.00	BMRL	BMRL	2.10	17.00	19.10	BMRL	BMRL	BMRL	BMRL	4.30	BMRL	6.70	BMRL	1.00	4.30	4.30
7.33	48.0	43.00	BMRL	BMRL	2.40	15.00	17.40	BMRL	2.10	1.00	3.10	10.00	3.40	16.00	6.20	4.30	16.20	19.60
7.33	48.0	38.50	BMRL	BMRL	2.25	16.00	18.25	BMRL	2.10	1.00	3.10	7.15	3.40	11.35	6.20	2.65	13.35	16.75
0.12	0.00	23.38	BMRL	BMRL	13.33	12.50	9.32	BMRL	BMRL	BMRL	BMRL	79.72	BMRL	81.94	BMRL	124.53	89.14	91.34
7.35	48.0	34.50	BMRL	1.00	4.10	20.00	25.10	BMRL	BMRL	BMRL	BMRL	3.60	BMRL	9.30	2.70	1.90	3.60	3.60
7.34	48.0	30.00	BMRL	1.00	3.90	17.00	21.90	BMRL	BMRL	BMRL	2.70	5.40	BMRL	10.00	2.70	1.90	8.10	8.10
7.35	48.0	32.25	BMRL	1.00	4.00	18.50	23.50	BMRL	BMRL	BMRL	2.70	4.50	BMRL	9.65	2.70	1.90	7.20	7.20
0.14	0.00	13.95	BMRL	0.00	5.00	16.22	13.62	BMRL	BMRL	BMRL	BMRL	40.00	BMRL	7.25	0.00	0.00	62.50	62.50

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

**Field 1-9: GAC Cost Parameters**

<b>Cost Parameter</b>	<b>Parameter value</b>
Capital Recovery Interest Rate (%)	5.3
Capital Recovery Period (years)	45
Overhead & Profit Factor (% of construction costs)	10
Special Sitework Factor (% of construction costs)	5
Construction Contingencies (% of construction costs)	10
Engineering Fee Factor (% of construction costs)	10
1998 ENR Construction Cost Index (CCI base year 1913)	77.8
1998 Producers Price Index (PPI base year 1982 = 100)	131.3
Labor Rate + Fringe (\$/work-hour)	21
Labor Overhead Factor (% of labor)	4.1
Electric Rate (\$/kW-h)	0.035
Fuel Oil Rate (\$/gal)	0.55
Natural Gas Rate (\$/ft <sup>3</sup> )	0.007
Current Process Water Rate (\$/1000 gal)	0.35
Modifications to Existing Plant (% of construction costs)	20



**FIELD-SET 2: 2nd QUARTER RSSCT RESULTS (FILE: ICR448.xls)****Field 2-1: PWS And Treatment Plant Data**

PWS Name	Public Works Commision of the City of Fayetteville
Public Water System Identification Number	NC 0326010
Water Industry Data Base Number ( <i>optional</i> )	1244
Official ICR Contact Person	Mr. M. J. Noland
Mailing Address	P.O. Box 1089 Fayetteville, NC 28302
Phone Number	(910)-223-4733
FAX Number	(910)-829-0203
E-Mail Address ( <i>optional</i> )	N/A
Technical ICR Contact Person	Mr. Kevin Christmas
Mailing Address	508 Hoffer Dr. Fayetteville, NC 28301
Phone Number	(910)-223-4709
FAX Number	(910)-484-5838
E-Mail Address ( <i>optional</i> )	N/A
Plant Name	P.O. Hoffer Water Treatment Plant
Treatment Plant Category	CONV
Process Train Name	Conventional train
ICR Treatment Plant Identification Number	448
PWSID Number of Plant ( <i>if assigned</i> )	NC 0326010
Historical Minimum Water Temperature (°C)	4.0
Historical Average Water Temperature (°C)	34.0
State Approved Plant Capacity (MGD)	32.0

**Field 2-2: Full-Scale GAC Characteristics**

Carbon manufacturer	Calgon Corp.
Carbon trade name	Filtrisorb-400
Carbon type	Bituminous
Original GAC mesh size, upper (US standard mesh)	12
Original GAC mesh size, lower (US standard mesh)	40
Original carbon particle diameter, $d_{LC}$ (mm)	1.053

1: These are the characteristics before the carbon is ground for RSSCT experiments.

**Field 2-3: RSSCT Design Parameters****Input Design Parameters**

RSSCT influent TOC (mg/L)	2.8
Inner diameter of the RSSCT column, $D_{SC}$ (mm)	15.0
Minimum RSSCT Reynolds number, $Re_{SC, min}$	0.2
Full-scale operating temperature, $T^{\circ}C$ ( $^{\circ}C$ )	23.5
Full-scale bed porosity, $\epsilon_{LC}$	0.45
Measured RSSCT dry bed density, $\rho_{SC}$ (g/cm <sup>3</sup> )	0.463
RSSCT GAC mesh size, upper (US standard mesh)	80
RSSCT GAC mesh size, lower (US standard mesh)	100

**Estimated Run Length**

Bed volumes to 50% TOC breakthrough, $BV_{50}$	5825
Estimated run length, $BV_T$ ( $= 2 \times BV_{50}$ )	11651
$BV_T + 30\%$ safety factor, $BV_{T+30\%}$ ( $= 2.6 \times BV_{50}$ )	15146

**General RSSCT Design Parameters**

Kinematic viscosity at $T^{\circ}C$ , $\nu_{LC}$ (m <sup>2</sup> /s)	9.434E-07
RSSCT carbon particle diameter, $d_{SC}$ (mm)	0.1650
Scaling factor, SF	6.38
RSSCT hydraulic loading rate, $v_{SC}$ (m/hr)	1.85
RSSCT flow rate, $Q_{SC}$ (mL/min)	5.46
Estimated total influent volume required, $V_{SC}$ (L)	389

**10-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	10
Estimated full-scale run time, $t_{LC}^T$ (days)	105
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	1.57
Estimated RSSCT run time, $t_{SC}^T$ (days)	16.49
RSSCT bed length, $l_{SC}$ (cm)	4.8
Estimated volume required for 10-minute EBCT, $V_{SC}$ (L)	130
Mass GAC required, $m_{SC}$ (g)	3.96

**20-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	20
Estimated full-scale run time, $t_{LC}^T$ (days)	210
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	3.14
Estimated RSSCT run time, $t_{SC}^T$ (days)	32.98
RSSCT bed length, $l_{SC}$ (cm)	9.7
Estimated volume required for 20-minute EBCT, $V_{SC}$ (L)	259
Mass GAC required, $m_{SC}$ (g)	7.92

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US standard mesh size	Opening (mm)
4	4.750
6	3.350
8	2.360
10	2.000
12	1.680
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
70	0.210
80	0.180
100	0.150
120	0.125
140	0.106
170	0.088
200	0.075
230	0.062
270	0.053
325	0.044
400	0.037

1: Design information, similar to that shown in Tables 6c and 6d of the ICR rule, must be included in the hard-copy *Treatment Study Summary Report* (see Section 10.0). The purpose of this table is to list the pretreatment processes used in this particular RSSCT run.

## Field 2-5: GAC Influent Water Quality For The 10-Minute EBCT Run

10-min. EBCT Start Date	6/3/98
10-min. EBCT Start Time	13:00

## Group A, 2 samples per batch

Parameter	Units	Sample A1-10	Sample A2-10	Average	RPD
Sampling date	MM/DD/YY	6/3/98	6/25/98	---	---
Sampling time	hh:mm	14:00	13:00	---	---
Operation time	hh.hh	1.00	528.00	---	---
Bed volumes	(10 minutes)	38.3	20208.0	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	8.4	10.4	9.4	21.28
Total hardness	mg/L as CaCO <sub>3</sub>	23.2	22.1	22.7	4.86
Calcium hardness	mg/L as CaCO <sub>3</sub>	13.6	13.4	13.5	1.48
Ammonia	mg NH <sub>3</sub> -N / L	0.05	0.02	0.04	85.71
Bromide	µg/L	349.0	30.0	189.5	168.34

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	6/3/98	6/25/98	NA	---	---
Sampling time	hh:mm	14:00	13:00	NA	---	---
Operation time	hh.hh	1.00	528.00	NA	---	---
Bed volumes	(10 minute)	38.3	20208.0	NA	---	---
pH	---	6.23	6.15	NA	6.19	0.91
Turbidity	ntu	0.59	NR	NA	0.59	NA
Temperature	°C	24.0	24.0	NA	24.0	0.00
Total organic carbon	mg/L	3.28	3.02	NA	3.15	5.85
UV <sub>254</sub>	cm <sup>-1</sup>	0.060	0.054	NA	0.057	7.44
SUVA	L/(mg*m)	1.83	1.79	NA	1.81	1.60
SDS-Cl <sub>2</sub> dose	mg/L	3.60	4.00	NA	3.80	7.44
SDS-Free Cl <sub>2</sub> residual	mg/L	0.22	0.45	NA	0.34	48.55
SDS-Cl <sub>2</sub> demand	mg/L	3.38	3.55	NA	3.47	3.47
SDS-Chlorination temp.	°C	20.0	20.0	NA	20.0	0.00
SDS-Chlorination pH	---	7.31	7.33	NA	7.32	0.19
SDS-Incubation time	hours	48.0	48.0	NA	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> /L	240.00	240.00	NA	240.00	0.00
SDS-CHCl <sub>3</sub>	µg/L	BMRL	3.20	NA	3.20	NA
SDS-BDCM	µg/L	4.70	15.00	NA	9.85	73.94
SDS-DBCm	µg/L	21.00	68.00	NA	44.50	74.68
SDS-CHBr <sub>3</sub>	µg/L	260.00	150.00	NA	205.00	37.94
SDS-THM4	µg/L	285.70	236.20	0.00	173.97	87.76
SDS-MCAA*	µg/L	BMRL	BMRL	NA	NA	NA
SDS-DCAA*	µg/L	2.00	3.90	NA	2.95	45.54

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-TCAA*	µg/L	BMRL	2.80	NA	2.80	NA
SDS-MBAA*	µg/L	4.10	4.60	NA	4.35	8.13
SDS-DBAA*	µg/L	33.00	28.00	NA	30.50	11.59
SDS-BCAA*	µg/L	3.80	11.00	NA	7.40	68.80
SDS-TBAA	µg/L	35.00	NR	NA	35.00	NA
SDS-CDBAA	µg/L	9.80	15.00	NA	12.40	29.65
SDS-DCBAA	µg/L	4.90	4.40	NA	4.65	7.60
SDS-HAA5	µg/L	39.10	39.30	0.00	26.13	86.60
SDS-HAA6	µg/L	42.90	50.30	0.00	31.07	87.42

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

Field 2-6: GAC Influent Water Quality For The 20-Minute EBCT Run<sup>1</sup>

20-min. EBCT Start Date	5/26/98
20-min. EBCT Start Time	18:00

## Group A, 2 samples per batch

Parameter	Units	Sample A1-20	Sample A2-20	Average	RPD
Sampling date	MM/DD/YY	5/26/98	6/3/98	---	---
Sampling time	hh:mm	18:00	14:00	---	---
Operation time	hh.hh	0.00	188.00	---	---
Bed volumes	(20 minutes)	0.0	3597.6	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	9.4	8.4	8.9	11.24
Total hardness	mg/L as CaCO <sub>3</sub>	21.6	23.2	22.4	7.14
Calcium hardness	mg/L as CaCO <sub>3</sub>	13.2	13.6	13.4	2.99
Ammonia	mg NH <sub>3</sub> -N / L	0.05	0.05	0.05	0.00
Bromide	µg/L	51.0	349.0	200.0	149.00

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	5/26/98	6/3/98	6/25/98	---	---
Sampling time	hh:mm	18:00	14:00	13:00	---	---
Operation time	hh.hh	0.00	188.00	715.00	---	---
Bed volumes	(20 minute)	0.0	3597.6	13682.5	---	---
pH	---	6.05	6.23	6.15	6.14	1.47
Turbidity	ntu	0.66	0.59	NR	0.63	7.92
Temperature	°C	22.0	24.0	24.0	23.3	4.95
Total organic carbon	mg/L	2.27	3.28	3.02	2.85	18.30
UV <sub>254</sub>	cm <sup>-1</sup>	0.056	0.060	0.054	0.057	5.50
SUVA	L/(mg*m)	2.45	1.83	1.79	2.02	18.25
SDS-Cl <sub>2</sub> dose	mg/L	3.40	3.60	4.00	3.67	8.33
SDS-Free Cl <sub>2</sub> residual	mg/L	0.20	0.22	0.45	0.29	47.90
SDS-Cl <sub>2</sub> demand	mg/L	3.20	3.38	3.55	3.38	5.18
SDS-Chlorination temp.	°C	20.0	20.0	20.0	20.0	0.00
SDS-Chlorination pH	---	7.26	7.31	7.33	7.3	0.49
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> /L	170.00	240.00	240.00	216.67	18.65
SDS-CHCl <sub>3</sub>	µg/L	31.00	BMRL	3.20	17.10	114.96
SDS-BDCM	µg/L	16.00	4.70	15.00	11.90	52.57
SDS-DBCm	µg/L	5.70	21.00	68.00	31.57	102.85
SDS-CHBr <sub>3</sub>	µg/L	BMRL	260.00	150.00	205.00	37.94
SDS-THM <sub>4</sub>	µg/L	52.70	285.70	236.20	191.53	64.09
SDS-MCAA*	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-DCAA*	µg/L	10.00	2.00	3.90	5.30	78.86

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-TCAA*	µg/L	9.70	BMRL	2.80	6.25	78.06
SDS-MBAA*	µg/L	BMRL	4.10	4.60	4.35	8.13
SDS-DBAA*	µg/L	1.10	33.00	28.00	20.70	82.89
SDS-BCAA*	µg/L	4.70	3.80	11.00	6.50	60.35
SDS-TBAA	µg/L	BMRL	35.00	NR	35.00	#DIV/0!
SDS-CDBAA	µg/L	BMRL	9.80	15.00	12.40	29.65
SDS-DCBAA	µg/L	4.90	4.40	10.00	6.43	48.17
SDS-HAA5	µg/L	20.80	39.10	39.30	33.07	32.13
SDS-HAA6	µg/L	25.50	42.90	50.30	39.57	32.18

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 2-7: GAC Effluent Water Quality For The 10-Minute EBCT Run<sup>1</sup>

## Group C, 12 effluent samples per run

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:hh	Bed volumes (10 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorin. temp. °C
C1	N	6/3/98	14:00	1.00	38.3	7.10	24.0	0.41	BMRL	BMRL	2.65	1.06	1.59	20.0
C2	N	6/4/98	13:00	24.00	918.5	6.95	23.0	0.48	0.005	1.05	2.65	1.03	1.62	20.0
C3	N	6/5/98	14:00	49.00	1875.4	5.78	22.0	0.75	BMRL	BMRL	2.65	1.00	1.65	20.0
C4	N	6/6/98	16:00	75.00	2870.5	6.80	23.0	0.75	0.007	0.94	2.70	1.27	1.43	20.0
C5	N	6/7/98	15:30	98.50	3769.9	6.50	23.0	1.19	0.014	1.18	2.70	1.70	1.00	20.0
C6	N	6/8/98	10:00	117.00	4477.9	6.45	22.0	1.42	0.008	0.56	2.70	1.26	1.44	20.0
C7	N	6/9/98	14:00	145.00	5549.5	6.30	23.0	1.32	0.016	1.18	2.87	0.45	2.42	20.0
C8	N	6/10/98	13:30	168.50	6449.0	6.10	24.0	1.51	0.018	1.19	2.90	0.35	2.55	20.0
C9	N	6/11/98	15:00	194.00	7424.9	6.03	24.0	1.88	0.021	1.11	3.00	0.30	2.70	20.0
Avg-C10	Y	6/12/98	15:00	218.00	8343.5	6.30	24.0	1.91	0.021	1.10	3.00	1.10	1.90	20.0
C11	N	6/13/98	11:00	238.00	9108.9	6.40	23.0	2.02	0.021	1.04	3.00	1.13	1.87	20.0
Avg-C12	Y	6/13/98	23:00	250.00	9568.2	6.35	23.0	2.15	0.028	1.30	3.10	1.09	2.01	20.0
C13	N	6/14/98	14:00	265.00	10142.3	6.31	24.0	1.65	0.024	1.46	3.00	1.05	1.95	20.0
Avg-C14	Y	6/15/98	13:00	288.00	11022.5	6.36	24.0	1.74	0.026	1.49	3.00	0.97	2.03	20.0
C15	N	6/16/98	11:00	310.00	11864.5	6.34	23.0	2.77	0.024	0.87	3.00	0.74	2.26	20.0
C16	N	6/25/98	13:00	528.00	20208.0	6.23	24.0	2.54	0.036	1.42	3.10	0.65	2.45	20.0
C17	N	6/29/98	14:00	625.00	23920.5	6.27	23.0	NA	0.028	NA	3.50	0.82	2.68	20.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results

## Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:hh	Bed volumes (10 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp °C
D10	Primary	6/12/98	15:00	218.00	8343.5	6.30	24.0	1.84	0.021	1.14	3.00	1.10	1.90	20.0
D-D10	Duplicate	6/12/98	15:00	218.00	8343.5	6.30	24.0	1.98	0.021	1.06	3.00	1.10	1.90	20.0
Avg-D10	Average	---	---	---	---	6.30	24.0	1.9	0.021	1.10	3.00	1.10	1.90	20.0
RPD-D10	RPD	---	---	---	---	0.00	0.00	7.07	0.00	7.07	0.00	0.00	0.00	0.00
D12	Primary	6/13/98	23:00	250.00	9568.2	6.35	23.0	2.159	0.028	1.30	3.10	1.08	2.02	20.0
D-D12	Duplicate	6/13/98	23:00	250.00	9568.2	6.35	23.0	2.138	0.028	1.31	3.10	1.10	2.00	20.0
Avg-D12	Average	---	---	---	---	6.35	23.0	2.1	0.028	1.30	3.10	1.09	2.01	20.0
RPD-D12	RPD	---	---	---	---	0.00	0.00	0.98	0.00	0.98	0.00	1.83	1.00	0.00
D14	Primary	6/15/98	13:00	288.00	11022.5	6.36	24.0	1.74	0.026	1.50	3.00	0.97	2.03	20.0
D-D14	Duplicate	6/15/98	13:00	288.00	11022.5	6.36	24.0	1.75	0.026	1.49	3.00	0.97	2.03	20.0
Avg-D14	Average	---	---	---	---	6.36	24.0	1.7	0.026	1.49	3.00	0.97	2.03	20.0
RPD-D14	RPD	---	---	---	---	0.00	0.00	0.63	0.00	0.63	0.00	0.00	0.00	0.00

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Field 2-7: GAC Effluent Water Quality For The 10-Minute EBCT Run (continued)

SDS Chlorin. pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L
7.26	48.0	BMRL	BMRL	BMRL	BMRL	17.00	17.00	BMRL	BMRL	BMRL	1.00
7.24	48.0	BMRL	BMRL	BMRL	BMRL	16.00	16.00	BMRL	BMRL	BMRL	BMRL
7.15	48.0	BMRL	BMRL	BMRL	BMRL	25.00	25.00	BMRL	BMRL	BMRL	BMRL
7.22	48.0	BMRL	BMRL	BMRL	BMRL	16.00	16.00	BMRL	BMRL	BMRL	BMRL
7.31	48.0	37.00	BMRL	BMRL	2.70	32.00	34.70	BMRL	BMRL	BMRL	1.20
7.22	48.0	41.00	BMRL	BMRL	2.50	44.00	46.50	BMRL	5.30	BMRL	1.10
7.35	48.0	71.00	BMRL	1.20	4.60	51.00	56.80	BMRL	BMRL	BMRL	1.30
7.39	48.0	80.00	BMRL	1.20	4.40	62.00	67.60	BMRL	2.70	BMRL	2.40
7.28	48.0	93.00	BMRL	1.90	7.50	83.00	92.40	BMRL	1.90	BMRL	2.40
7.24	48.0	115.00	BMRL	3.40	14.00	98.50	115.90	BMRL	BMRL	BMRL	3.15
7.36	48.0	122.50	BMRL	3.40	15.00	105.00	123.40	BMRL	BMRL	BMRL	3.15
7.29	48.0	130.00	BMRL	3.60	15.50	110.00	129.10	BMRL	BMRL	BMRL	2.85
7.30	48.0	130.00	BMRL	4.10	16.00	120.00	140.10	BMRL	BMRL	BMRL	3.80
7.29	48.0	147.50	BMRL	3.55	15.00	130.00	148.55	BMRL	BMRL	BMRL	3.90
7.36	48.0	150.00	BMRL	2.60	10.00	140.00	152.60	BMRL	BMRL	BMRL	3.00
7.25	48.0	190.00	1.40	6.20	29.00	130.00	166.60	BMRL	2.10	1.00	4.10
7.22	48.0	135.00	1.40	8.50	38.00	130.00	177.90	BMRL	3.20	1.00	3.80

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

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for the primary and duplicate analyses below.

SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L
7.26	48.0	115.00	BMRL	3.40	14.00	97.00	114.40	BMRL	BMRL	BMRL	3.50
7.21	48.0	115.00	BMRL	3.40	14.00	100.00	117.40	BMRL	BMRL	BMRL	2.80
7.24	48.0	115.00	BMRL	3.40	14.00	98.50	115.90	BMRL	BMRL	BMRL	3.15
0.69	0.00	0.00	BMRL	0.00	0.00	3.05	2.59	BMRL	BMRL	BMRL	22.22
7.29	48.0	125.00	BMRL	3.80	15.00	110.00	128.80	BMRL	BMRL	BMRL	2.60
NA	48.0	135.00	BMRL	3.40	16.00	110.00	129.40	BMRL	BMRL	BMRL	3.10
7.29	48.0	130.00	BMRL	3.60	15.50	110.00	129.10	BMRL	BMRL	BMRL	2.85
NA	0.00	7.69	BMRL	11.11	6.45	0.00	0.46	BMRL	BMRL	BMRL	17.54
7.30	48.0	145.00	BMRL	3.00	14.00	140.00	157.00	BMRL	BMRL	BMRL	4.10
7.28	48.0	150.00	BMRL	4.10	16.00	120.00	140.10	BMRL	BMRL	BMRL	3.70
7.29	48.0	147.50	BMRL	3.55	15.00	130.00	148.55	BMRL	BMRL	BMRL	3.90
0.27	0.00	3.39	BMRL	30.99	13.33	15.38	11.38	BMRL	BMRL	BMRL	10.26

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Field 2-7: GAC Effluent Water Quality For The 10-Minute EBCT Run (continued)

SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
3.40	BMRL	5.00	BMRL	BMRL	4.40	4.40
3.00	BMRL	4.20	BMRL	BMRL	3.00	3.00
2.80	BMRL	4.00	BMRL	BMRL	2.80	2.80
3.30	BMRL	BMRL	BMRL	BMRL	3.30	3.30
6.90	BMRL	5.50	BMRL	BMRL	8.10	8.10
7.80	BMRL	8.30	BMRL	1.40	14.20	14.20
9.60	1.10	9.90	2.00	1.00	10.90	12.00
12.00	1.40	6.50	2.00	1.20	17.10	18.50
14.00	1.40	16.00	3.00	1.60	18.30	19.70
16.50	2.60	17.00	5.00	19.65	19.65	22.25
17.50	2.65	24.00	7.40	3.00	20.65	23.30
18.00	2.70	24.00	7.50	20.85	20.85	23.55
19.00	3.10	24.00	8.00	3.50	22.80	25.90
23.00	2.90	17.00	5.15	2.65	26.90	29.80
22.00	1.80	20.00	4.20	2.50	25.00	26.80
25.00	6.00	NR	8.30	4.80	32.20	38.20
22.00	6.80	24.00	10.00	5.30	30.00	36.80

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for the primary and duplicate analyses below.

SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
18.00	2.50	19.00	5.40	21.50	21.50	24.00
15.00	2.70	15.00	4.60	17.80	17.80	20.50
16.50	2.60	17.00	5.00	19.65	19.65	22.25
18.18	7.69	23.53	16.00	18.83	18.83	15.73
18.00	2.70	24.00	7.20	20.60	20.60	23.30
18.00	2.70	24.00	7.80	21.10	21.10	23.80
18.00	2.70	24.00	7.50	20.85	20.85	23.55
0.00	0.00	0.00	8.00	2.40	2.40	2.12
24.00	2.60	17.00	4.30	2.40	28.10	30.70
22.00	3.20	17.00	6.00	2.90	25.70	28.90
23.00	2.90	17.00	5.15	2.65	26.90	29.80
8.70	20.69	0.00	33.01	18.87	8.92	6.04

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Field 2-8: GAC Effluent Water Quality For The 20-Minute EBCT Run<sup>1</sup>

## Group C, 12 effluent samples per run

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes (20 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L
C1	N	5/26/98	19:00	1.00	19.1	6.80	22.0	BMRL	BMRL	BMRL	2.65	1.23	1.42
C2	N	5/27/98	17:30	23.50	449.7	7.14	22.0	0.13	BMRL	BMRL	2.65	1.15	1.50
C3	N	5/28/98	18:30	48.50	928.1	6.80	24.0	0.21	BMRL	BMRL	2.65	1.75	0.90
C4	N	5/29/98	14:00	68.00	1301.3	6.30	23.0	0.35	0.008	2.29	2.70	1.56	1.14
C5	N	5/30/98	15:00	93.00	1779.7	6.50	22.0	0.18	0.009	5.06	2.70	1.33	1.37
C6	N	5/31/98	15:00	117.00	2239.0	6.60	23.0	0.45	0.010	2.24	2.75	1.39	1.36
Avg-C7	Y	6/1/98	15:00	141.00	2698.2	6.40	24.0	0.58	0.012	2.07	2.80	0.71	2.09
C8	N	6/2/98	16:00	166.00	3176.6	6.45	24.0	0.56	0.009	1.54	2.80	0.58	2.22
C9	N	6/3/98	14:00	188.00	3597.6	6.40	24.0	0.51	0.007	1.39	2.70	1.27	1.43
C10	N	6/4/98	13:00	211.00	4037.8	6.53	23.0	1.07	0.007	0.69	2.80	1.32	1.48
C11	N	6/5/98	13:00	235.00	4497.0	6.36	22.0	NA	0.011	NA	2.80	1.53	1.27
Avg-C12	Y	6/7/98	13:00	283.00	5415.6	6.21	23.0	0.79	0.009	1.13	2.70	1.26	1.44
Avg-C13	Y	6/12/98	2:00	392.00	7501.5	6.27	23.0	1.26	0.015	1.15	2.90	1.45	1.45
C14	N	6/25/98	13:00	715.00	13682.5	6.20	24.0	2.47	0.025	1.01	2.80	0.67	2.13
C15	N	6/29/98	14:00	812.00	15538.7	6.30	24.0	NA	0.020	NA	3.00	0.79	2.21

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1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for the primary and duplicate analyses below.

## Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes (20 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L
D7	Primary	6/1/98	15:00	141.00	2698.2	6.40	24.0	0.58	0.012	2.07	2.80	0.71	2.09
D-D7	Duplicate	6/1/98	15:00	141.00	2698.2	6.40	24.0	NR	NR	NR	2.80	0.71	2.09
Avg-D7	Average	---	---	---	---	6.40	24.0	0.58	0.012	2.07	2.80	0.71	2.09
RPD-D7	RPD	---	---	---	---	0.00	0.00	NR	NR	NR	0.00	0.00	0.00
D12	Primary	6/7/98	13:00	283.00	5415.6	6.21	23.0	0.80	0.009	1.13	2.70	1.26	1.44
D-D12	Duplicate	6/7/98	13:00	283.00	5415.6	6.21	23.0	0.79	0.009	1.14	2.70	1.26	1.44
Avg-D12	Average	---	---	---	---	6.21	23.0	0.79	0.009	1.13	2.70	1.26	1.44
RPD-D12	RPD	---	---	---	---	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00
D13	Primary	6/12/98	2:00	392.00	7501.5	6.27	23.0	1.36	0.015	1.10	2.90	1.45	1.45
D-D13	Duplicate	6/12/98	2:00	392.00	7501.5	6.27	23.0	1.15	0.014	1.22	2.90	1.45	1.45
Avg-D13	Average	---	---	---	---	6.27	23.0	1.26	0.015	1.16	2.90	1.45	1.45
RPD-D13	RPD	---	---	---	---	0.00	0.00	16.79	6.90	9.92	0.00	0.00	0.00

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## Field 2-8: GAC Effluent Water Quality For The 20-Minute EBCT Run (continued)

SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L
20.0	7.19	48.0	BMRL	2.00	1.50	0.80	BMRL	4.30	BMRL	BMRL	BMRL	BMRL
20.0	7.15	48.0	27.00	2.20	2.10	1.40	BMRL	5.70	BMRL	1.40	1.10	BMRL
20.0	7.14	48.0	BMRL	1.60	2.00	3.00	0.80	7.40	BMRL	1.40	1.00	BMRL
20.0	7.17	48.0	29.00	3.30	3.80	5.20	1.40	13.70	BMRL	3.30	2.40	BMRL
20.0	7.22	48.0	35.00	4.00	4.80	5.20	1.60	15.60	BMRL	2.40	1.90	BMRL
20.0	7.23	48.0	BMRL	BMRL	BMRL	BMRL	24.00	24.00	BMRL	BMRL	BMRL	BMRL
20.0	7.35	48.0	BMRL	BMRL	BMRL	BMRL	19.50	19.50	BMRL	BMRL	BMRL	1.10
20.0	7.27	48.0	30.00	BMRL	BMRL	1.00	33.00	34.00	BMRL	BMRL	BMRL	1.10
20.0	NR	48.0	BMRL	BMRL	BMRL	BMRL	16.00	16.00	BMRL	BMRL	BMRL	BMRL
20.0	7.43	48.0	BMRL	BMRL	BMRL	1.00	24.00	25.00	BMRL	BMRL	BMRL	BMRL
20.0	7.26	48.0	BMRL	BMRL	BMRL	1.40	26.00	27.40	BMRL	BMRL	BMRL	1.30
20.0	7.24	48.0	34.00	BMRL	BMRL	1.45	29.00	30.45	BMRL	BMRL	BMRL	1.45
20.0	7.33	48.0	87.00	BMRL	2.60	12.50	70.00	85.10	BMRL	BMRL	BMRL	2.75
20.0	7.24	48.0	145.00	1.70	5.80	22.00	100.00	129.50	BMRL	2.20	BMRL	3.40
20.0	7.35	48.0	135.00	NA	NA	NA	NA	0.00	BMRL	2.80	BMRL	2.80

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SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L
20.0	7.36	48.0	BMRL	BMRL	BMRL	BMRL	17.00	17.00	BMRL	BMRL	BMRL	BMRL
20.0	7.33	48.0	BMRL	BMRL	BMRL	BMRL	22.00	22.00	BMRL	BMRL	BMRL	1.10
20.0	7.35	48.0	BMRL	BMRL	BMRL	BMRL	19.50	19.50	BMRL	BMRL	BMRL	1.10
0.00	0.41	0.00	BMRL	BMRL	BMRL	BMRL	25.64	25.64	BMRL	BMRL	BMRL	BMRL
20.0	7.27	48.0	31.00	BMRL	BMRL	1.40	32.00	33.40	BMRL	BMRL	BMRL	1.70
20.0	7.21	48.0	37.00	BMRL	BMRL	1.50	26.00	27.50	BMRL	BMRL	BMRL	1.20
20.0	7.24	48.0	34.00	BMRL	BMRL	1.45	29.00	30.45	BMRL	BMRL	BMRL	1.45
0.00	0.83	0.00	17.65	BMRL	BMRL	6.90	20.69	19.38	BMRL	BMRL	BMRL	34.48
20.0	7.36	48.0	88.00	BMRL	2.40	12.00	70.00	84.40	BMRL	BMRL	BMRL	2.80
20.0	7.30	48.0	86.00	BMRL	2.80	13.00	70.00	85.80	BMRL	BMRL	BMRL	2.70
20.0	7.33	48.0	87.00	BMRL	2.60	12.50	70.00	85.10	BMRL	BMRL	BMRL	2.75
0.00	0.82	0.00	2.30	BMRL	15.38	8.00	0.00	1.65	BMRL	BMRL	BMRL	3.64

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 2-8: GAC Effluent Water Quality For The 20-Minute EBCT Run

SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
BMRL	BMRL	BMRL	BMRL	1.20	2.50	2.50
BMRL	1.20	BMRL	BMRL	1.00	2.40	3.60
1.10	2.40	BMRL	BMRL	2.10	6.80	9.20
1.00	2.50	BMRL	BMRL	1.70	5.30	7.80
4.80	BMRL	BMRL	BMRL	BMRL	4.80	4.80
2.60	BMRL	NR	NR	BMRL	3.70	3.70
6.40	BMRL	5.30	BMRL	BMRL	7.50	7.50
2.30	BMRL	4.10	BMRL	BMRL	2.30	2.30
4.70	BMRL	BMRL	BMRL	BMRL	4.70	4.70
3.20	BMRL	5.10	BMRL	1.20	4.50	4.50
5.95	BMRL	6.10	BMRL	1.10	7.40	7.40
14.50	2.60	14.50	4.50	3.20	17.25	19.85
18.00	5.10	NR	6.90	4.10	23.60	28.70
17.00	3.60	19.00	5.70	3.10	22.60	26.20

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species,

TBAA, CDBAA and DCBAA, should be reported if measured.

SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
2.10	BMRL	NR	NR	BMRL	2.10	2.10
3.10	BMRL	NR	NR	BMRL	4.20	4.20
2.60	BMRL	NR	NR	BMRL	3.70	3.70
38.46	BMRL	NR	NR	BMRL	56.76	56.76
6.40	BMRL	6.20	BMRL	1.10	8.10	8.10
5.50	BMRL	6.00	BMRL	BMRL	6.70	6.70
5.95	BMRL	6.10	BMRL	1.10	7.40	7.40
15.13	B	3.28	BMRL	BMRL	18.92	18.92
15.00	2.70	15.00	4.60	4.60	17.80	20.50
14.00	2.50	14.00	4.40	1.80	16.70	19.20
14.50	2.60	14.50	4.50	3.20	17.25	19.85
6.90	7.69	6.90	4.44	87.50	6.38	6.55

**Field 2-9: GAC Cost Parameters**

<b>Cost Parameter</b>	<b>Parameter value</b>
Capital Recovery Interest Rate (%)	5.3
Capital Recovery Period (years)	45
Overhead & Profit Factor (% of construction costs)	10
Special Sitework Factor (% of construction costs)	5
Construction Contingencies (% of construction costs)	10
Engineering Fee Factor (% of construction costs)	10
1998 ENR Construction Cost Index (CCI base year 1913)	131.3
1998 Producers Price Index (PPI base year 1982 = 100)	78.8
Labor Rate + Fringe (\$/work-hour)	21
Labor Overhead Factor (% of labor)	4.1
Electric Rate (\$/kW-h)	0.035
Fuel Oil Rate (\$/gal)	0.55
Natural Gas Rate (\$/ft <sup>3</sup> )	0.007
Current Process Water Rate (\$/1000 gal)	0.35
Modifications to Existing Plant (% of construction costs)	20

**FIELD-SET 3: 3rd QUARTER RSSCT RESULTS (FILE: ICR448.xls)****Field 1-1: PWS And Treatment Plant Data**

PWS Name	Public Works Commision of the City of Fayetteville
er System Identification Number	NC 0326010
ry Data Base Number (optional)	1244
Official ICR Contact Person	Mr. M. J. Noland
Mailing Address	P.O. Box 1089 Fayetteville, NC 28302
Phone Number	(910)-223-4733
FAX Number	(910)-829-0203
E-Mail Address (optional)	N/A
Technical ICR Contact Person	Mr. Kevin Christmas
Mailing Address	508 Hoffer Dr. Fayetteville, NC 28301
Phone Number	(910)-223-4709
FAX Number	(910)-484-5838
E-Mail Address (optional)	N/A
Plant Name	P.O. Hoffer Water Treatment Plant
Treatment Plant Category	CONV
Process Train Name	Conventional train
ent Plant Identification Number	448
D Number of Plant (if assigned)	NC 0326010
inimum Water Temperature (°C)	4
Average Water Temperature (°C)	34.0
Approved Plant Capacity (MGD)	32.0

**Field 1-2: Full-Scale GAC Characteristics<sup>1</sup>**

Carbon manufacturer	Calgon Corp.
Carbon trade name	Filtrisorb-400
Carbon type	Bituminous
Original GAC mesh size, upper (US standard mesh)	12
Original GAC mesh size, lower (US standard mesh)	40
Original carbon particle diameter, d <sub>LC</sub> (mm)	1.053

1: These are the characteristics before the carbon is ground for RSSCT experiments.

**Field 1-3: RSSCT Design Parameters****Input Design Parameters**

RSSCT influent TOC (mg/L)	2.8
Inner diameter of the RSSCT column, $D_{SC}$ (mm)	15.0
Minimum RSSCT Reynolds number, $Re_{SC, min}$	0.2
Full-scale operating temperature, $T^{\circ}C$ ( $^{\circ}C$ )	29.8
Full-scale bed porosity, $\epsilon_{LC}$	0.45
Measured RSSCT dry bed density, $\rho_{SC}$ (g/cm <sup>3</sup> )	0.463
RSSCT GAC mesh size, upper (US standard mesh)	80
RSSCT GAC mesh size, lower (US standard mesh)	100

**Estimated Run Length**

Bed volumes to 50% TOC breakthrough, $BV_{50}$	5825
Estimated run length, $BV_T$ ( $= 2 \times BV_{50}$ )	11651
$BV_T + 30\%$ safety factor, $BV_{T+30\%}$ ( $= 2.6 \times BV_{50}$ )	15146

**General RSSCT Design Parameters**

Kinematic viscosity at $T^{\circ}C$ , $\nu_{LC}$ (m <sup>2</sup> /s)	8.143E-07
RSSCT carbon particle diameter, $d_{SC}$ (mm)	0.1650
Scaling factor, SF	6.38
RSSCT hydraulic loading rate, $v_{SC}$ (m/hr)	1.60
RSSCT flow rate, $Q_{SC}$ (mL/min)	4.71
Estimated total influent volume required, $V_{SC}$ (L)	335

**10-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	10
Estimated full-scale run time, $t_{LC}$ (days)	105
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	1.57
Estimated RSSCT run time, $t_{SC}$ (days)	16.49
RSSCT bed length, $l_{SC}$ (cm)	4.2
Estimated volume required for 10-minute EBCT, $V_{SC}$ (L)	112
Mass GAC required, $m_{SC}$ (g)	3.42

**20-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	20
Estimated full-scale run time, $t_{LC}$ (days)	210
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	3.14
Estimated RSSCT run time, $t_{SC}$ (days)	32.98
RSSCT bed length, $l_{SC}$ (cm)	8.4
Estimated volume required for 20-minute EBCT, $V_{SC}$ (L)	224
Mass GAC required, $m_{SC}$ (g)	6.84



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US standard mesh size	Opening (mm)
4	4.750
6	3.350
8	2.360
10	2.000
12	1.680
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
70	0.210
80	0.180
100	0.150
120	0.125
140	0.106
170	0.088
200	0.075
230	0.062
270	0.053
325	0.044
400	0.037

[illegible]

1: Design information, similar to that shown in Tables 6c and 6d of the ICR rule, must be included in the hard-copy *Treatment Study Summary Report* (see Section 10.0). The purpose of this table is to list the pretreatment processes used in this particular RSSCT run.

## Field 3-5: GAC Influent Water Quality For The 10-Minute EBCT Run

10-min. EBCT Start Date	8/25/98
10-min. EBCT Start Time	17:30

## Group A, 2 samples per batch

Parameter	Units	Sample A1-10	Sample A2-10	Average	RPD
Sampling date	MM/DD/YY	8/25/98	9/2/98	---	---
Sampling time	hh:mm	17:30	10:00	---	---
Operation time	hh.hh	0.00	184.50	---	---
Bed volumes	(10 minutes)	0.0	99.0	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	13.2	13.9	13.6	5.17
Total hardness	mg/L as CaCO <sub>3</sub>	24.4	24.4	24.4	0.00
Calcium hardness	mg/L as CaCO <sub>3</sub>	13.1	13.2	13.2	0.76
Ammonia	mg NH <sub>3</sub> -N / L	0.03	0.02	0.03	40.00
Bromide	µg/L	90.0	92.0	91.0	2.20

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	8/25/98	9/2/98	9/17/98	---	---
Sampling time	hh:mm	17:30	10:00	14:00	---	---
Operation time	hh.hh	0.00	184.50	548.50	---	---
Bed volumes	(10 minute)	0.0	99.0	294.3	---	---
pH	---	6.85	6.98	6.80	6.88	1.35
Turbidity	ntu	0.15	0.26	0.38	0.26	43.68
Temperature	°C	20.0	21.0	20.0	20.3	2.84
Total organic carbon	mg/L	2.81	2.84	2.98	2.88	3.29
UV <sub>254</sub>	cm <sup>-1</sup>	0.052	0.057	0.058	0.056	5.77
SUVA	L/(mg*m)	1.85	2.01	1.94	1.94	4.07
SDS-Cl <sub>2</sub> dose	mg/L	4.40	3.90	3.90	4.07	7.10
SDS-Free Cl <sub>2</sub> residual	mg/L	1.33	0.81	0.70	0.95	35.55
SDS-Cl <sub>2</sub> demand	mg/L	3.07	3.09	3.20	3.12	2.24
SDS-Chlorination temp.	°C	27.0	27.0	27.0	27.0	0.00
SDS-Chlorination pH	---	7.33	7.25	7.37	7.32	0.84
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> /L	305.00	260.00	280.00	281.67	8.00
SDS-CHCl <sub>3</sub>	µg/L	65.00	60.00	52.00	59.00	11.11
SDS-BDCM	µg/L	33.00	37.00	32.00	34.00	7.78
SDS-DBCM	µg/L	16.00	17.00	15.00	16.00	6.25
SDS-CHBr <sub>3</sub>	µg/L	1.30	1.60	1.20	1.37	15.23
SDS-THM4	µg/L	115.30	115.60	100.20	110.37	7.98
SDS-MCAA*	µg/L	2.10	3.10	BMRL	2.60	27.20
SDS-DCAA*	µg/L	23.00	19.00	20.00	20.67	10.07
SDS-TCAA*	µg/L	27.0	19.0	25.0	23.0	34.78

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-MBAA*	µg/L	1.30	1.10	1.00	1.13	13.48
SDS-DBAA*	µg/L	3.20	3.00	2.60	2.93	10.41
SDS-BCAA*	µg/L	12.00	10.00	11.00	11.00	9.09
SDS-TBAA	µg/L	BMRL	BMRL	NR	NR	NR
SDS-CDBAA	µg/L	5.70	5.70	NR	5.70	0.00
SDS-DCBAA	µg/L	21.00	16.00	21.00	19.33	14.93
SDS-HAA5	µg/L	56.60	45.20	48.60	50.13	11.67
SDS-HAA6	µg/L	68.60	55.20	59.60	61.13	11.17

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 3-6: GAC Influent Water Quality For The 20-Minute EBCT Run<sup>1</sup>

20-min. EBCT Start Date	8/25/98
20-min. EBCT Start Time	17:30

## Group A, 2 samples per batch

Parameter	Units	Sample A1-20	Sample A2-20	Average	RPD
Sampling date	MM/DD/YY	8/25/98	9/2/98	---	---
Sampling time	hh:mm	17:30	10:00	---	---
Operation time	hh.hh	0.00	184.50	---	---
Bed volumes	(20 minutes)	0.0	49.5	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	13.2	13.9	13.6	5.17
Total hardness	mg/L as CaCO <sub>3</sub>	24.4	24.4	24.4	0.00
Calcium hardness	mg/L as CaCO <sub>3</sub>	13.1	13.2	13.2	0.76
Ammonia	mg NH <sub>3</sub> -N / L	0.03	0.02	0.03	40.00
Bromide	µg/L	90.0	92.0	91.0	2.20

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	8/25/98	9/2/98	9/17/98	---	---
Sampling time	hh:mm	17:30	10:00	14:00	---	---
Operation time	hh.hh	0.00	184.50	548.50	---	---
Bed volumes	(20 minute)	0.0	49.5	147.2	---	---
pH	---	6.85	6.98	6.80	6.88	1.35
Turbidity	ntu	0.15	0.26	0.38	0.26	43.68
Temperature	°C	20.0	21.0	20.0	20.3	2.84
Total organic carbon	mg/L	2.81	2.84	2.98	2.88	3.29
UV <sub>254</sub>	cm <sup>-1</sup>	0.052	0.057	0.058	0.056	5.77
SUVA	L/(mg*m)	1.85	2.01	1.94	1.94	4.07
SDS-Cl <sub>2</sub> dose	mg/L	4.40	3.90	3.90	4.07	7.10
SDS-Free Cl <sub>2</sub> residual	mg/L	1.33	0.81	0.70	0.95	35.55
SDS-Cl <sub>2</sub> demand	mg/L	3.07	3.09	3.20	3.12	2.24
SDS-Chlorination temp.	°C	27.0	27.0	27.0	27.0	0.00
SDS-Chlorination pH	---	7.33	7.25	7.37	7.3	0.84
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> / L	305.00	260.00	280.00	281.67	8.00
SDS-CHCl <sub>3</sub>	µg/L	65.00	60.00	52.00	59.00	11.11
SDS-BDCM	µg/L	33.00	37.00	32.00	34.00	7.78
SDS-DBCM	µg/L	16.00	17.00	15.00	16.00	6.25
SDS-CHBr <sub>3</sub>	µg/L	1.30	1.60	1.20	1.37	15.23
SDS-THM <sub>4</sub>	µg/L	115.30	115.60	100.20	110.37	7.98
SDS-MCAA*	µg/L	2.10	3.10	BMRL	2.60	27.20
SDS-DCAA*	µg/L	23.00	19.00	20.00	20.67	10.07
SDS-TCAA*	µg/L	27.0	19.0	25.0	23.67	17.59

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-MBAA*	µg/L	1.30	1.10	1.00	1.13	13.48
SDS-DBAA*	µg/L	3.20	3.00	2.60	2.93	10.41
SDS-BCAA*	µg/L	12.00	10.00	11.00	11.00	9.09
SDS-TBAA	µg/L	BMRL	BMRL	NR	NR	NR
SDS-CDBAA	µg/L	5.70	5.70	NR	5.70	0.00
SDS-DCBAA	µg/L	21.00	16.00	21.00	19.33	14.93
SDS-HAA5	µg/L	56.60	45.20	48.60	50.13	11.67
SDS-HAA6	µg/L	68.60	55.20	59.60	61.13	11.17

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 3-7: GAC Effluent Water Quality For The 10-Minute EBCT Run<sup>1</sup>

## Group C, 12 effluent samples per run

Sample ID	Was sample duplicated Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 10 minute	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorin. temp. °C
C1	N	8/25/98	18:30	1.00	38.3	7.53	20.0	0.26	0.007	2.71	2.30	2.00	0.30	27.0
C2	N	8/26/98	11:00	17.50	669.8	7.20	20.0	0.39	0.006	1.55	2.30	1.95	0.35	27.0
C3	N	8/27/98	12:00	42.50	1626.6	7.20	20.0	0.35	0.009	2.58	2.30	2.13	0.17	27.0
C4	N	8/28/98	14:00	68.50	2621.7	7.21	21.0	0.53	0.010	1.89	2.30	1.00	1.30	27.0
C5	N	8/29/98	9:00	87.50	3348.9	7.23	21.0	0.51	0.006	1.17	2.10	1.92	0.18	27.0
Avg-C6	Y	8/31/98	10:00	136.50	5224.2	7.13	20.0	0.50	0.008	1.60	2.20	1.37	0.84	27.0
C7	N	9/1/98	13:00	163.50	6257.6	7.14	20.0	0.73	0.010	1.37	2.30	1.33	0.97	27.0
C8	N	9/2/98	9:00	183.50	7023.0	7.20	21.0	0.99	0.015	1.52	2.80	1.22	1.58	27.0
C9	N	9/3/98	15:00	213.50	8171.2	7.17	21.0	1.28	0.015	1.17	2.40	1.53	0.87	27.0
Avg-C10	Y	9/4/98	11:00	233.50	8936.7	7.14	20.0	1.32	0.016	1.21	2.40	1.09	1.32	27.0
C11	N	9/5/98	13:00	259.50	9931.8	7.20	20.0	0.83	0.016	1.93	2.40	1.08	1.32	27.0
C12	N	9/7/98	22:00	316.50	12113.3	7.16	20.0	1.04	0.022	2.12	2.60	1.24	1.36	27.0
C13	N	9/8/98	11:30	330.00	12630.0	7.14	21.0	1.64	0.025	1.52	2.70	0.82	1.88	27.0
C17	N	9/13/98	13:00	451.50	17280.1	7.13	21.0	1.94	0.031	1.60	2.80	0.91	1.89	27.0
C18	N	9/14/98	12:00	474.50	18160.4	7.07	22.0	2.02	0.034	1.53	2.80	0.75	2.05	27.0
Avg-C19	Y	9/15/98	12:00	498.50	19079.0	6.96	22.0	2.04	0.034	1.67	3.20	0.78	2.42	27.0

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for

## Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 10 minute	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp °C
C6	Primary	8/31/98	10:00	136.50	73.2	7.10	20.0	0.5	0.008	1.61	2.20	1.37	0.83	27.0
D-C6	Duplicate	8/31/98	10:00	136.50	73.2	7.15	20.0	0.5	0.008	1.59	2.20	1.36	0.84	27.0
Avg-C6	Average	---	---	---	---	7.13	20.0	0.5	0.008	1.60	2.20	1.37	0.84	27.00
RPD-C6	RPD	---	---	---	---	0.70	0.00	1.00	0.00	1.00	0.00	0.73	1.20	0.00
C10	Primary	9/4/98	11:00	233.50	125.3	7.13	20.0	1.3	0.016	1.20	2.40	1.14	1.26	27.0
D-C10	Duplicate	9/4/98	11:00	233.50	125.3	7.15	20.0	1.3	0.016	1.21	2.40	1.03	1.37	27.0
Avg-C10	Average	---	---	---	---	7.14	20.0	1.3	0.016	1.21	2.40	1.09	1.32	27.00
RPD-C10	RPD	---	---	---	---	0.28	0.00	0.91	0.00	0.91	0.00	10.14	8.37	0.00
C19	Primary	9/15/98	11:00	497.50	266.9	6.95	22.0	2.0	0.034	1.67	3.20	0.70	2.50	27.0
D-C19	Duplicate	9/15/98	11:00	497.50	266.9	6.96	22.0	2.0	0.034	1.67	3.20	0.86	2.34	27.0
Avg-C19	Average	---	---	---	---	6.96	22.0	2.0	0.034	1.67	3.20	0.78	2.42	27.00
RPD-C19	RPD	---	---	---	---	0.14	0.00	0.25	0.00	0.25	0.00	20.51	6.61	0.00

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 3-7: GAC Effluent Water Quality For The 10-Minute EBCT Run (continued)

SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCm µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
7.19	48.0	BMRL	1.50	1.60	1.20	BMRL	4.30	BMRL	BMRL
7.22	48.0	BMRL	BMRL	1.00	1.00	BMRL	2.00	BMRL	BMRL
7.29	48.0	BMRL	1.00	1.30	1.30	BMRL	3.60	BMRL	BMRL
7.33	48.0	BMRL	NA	NA	NA	NA	0.00	BMRL	1.10
7.25	48.0	BMRL	1.30	2.20	3.20	1.70	8.40	BMRL	BMRL
7.29	48.0	31.00	2.70	5.65	8.40	3.60	20.35	BMRL	1.40
7.33	48.0	43.00	4.50	9.40	14.00	6.50	34.40	BMRL	1.80
7.41	48.0	57.00	7.50	13.00	17.00	5.60	43.10	BMRL	3.00
7.30	48.0	75.00	8.50	15.00	19.00	5.40	47.90	BMRL	3.30
7.26	48.0	100.00	8.50	14.50	17.50	4.70	45.20	BMRL	4.00
7.44	48.0	98.00	8.70	15.00	18.00	4.90	46.60	BMRL	4.60
7.23	48.0	130.00	13.00	18.00	18.00	3.80	52.80	BMRL	6.10
7.32	48.0	115.00	13.00	17.00	18.00	4.70	52.70	BMRL	6.20
7.26	48.0	145.00	21.00	24.00	20.00	3.30	68.30	BMRL	8.10
7.26	48.0	170.00	23.00	23.00	19.00	3.40	68.40	BMRL	9.90
7.29	48.0	165.00	23.50	24.50	19.50	2.90	70.40	BMRL	10.50

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured. the primary and duplicate analyses below.

SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCm µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
7.30	48.0	31.00	2.80	5.80	8.10	3.10	19.80	BMRL	1.40
7.28	48.0	BMRL	2.60	5.50	8.70	4.10	20.90	BMRL	1.40
7.29	48.00	31.00	2.70	5.65	8.40	3.60	20.35	BMRL	1.40
0.27	0.00	BMRL	7.41	5.31	7.14	27.78	5.41	BMRL	0.00
7.27	48.0	90.00	9.00	15.00	17.00	4.70	45.70	BMRL	4.00
7.25	48.0	110.00	8.00	14.00	18.00	4.70	44.70	BMRL	4.00
7.26	48.00	100.00	8.50	14.50	17.50	4.70	45.20	BMRL	4.00
0.28	0.00	20.00	11.76	6.90	5.71	0.00	2.21	BMRL	0.00
7.29	48.0	165.00	23.00	25.00	20.00	2.90	70.90	BMRL	10.00
7.28	48.0	165.00	24.00	24.00	19.00	2.90	69.90	BMRL	11.00
7.29	48.00	165.00	23.50	24.50	19.50	2.90	70.40	BMRL	10.50
0.14	0.00	0.00	4.26	4.08	5.13	0.00	1.42	BMRL	9.52

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measure

Field 3-7: GAC Effluent Water Quality For The 10-Minute EBCT Run (continued)

SDS <i>TCAA</i> * µg/L	SDS <i>MBAA</i> * µg/L	SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.00	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.20	1.10	1.10
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
1.10	BMRL	2.15	2.25	BMRL	3.05	2.70	4.65	6.90
1.40	BMRL	3.60	3.10	BMRL	4.00	3.60	6.80	9.90
2.40	1.00	3.80	4.70	BMRL	5.20	5.50	10.20	14.90
2.50	BMRL	4.20	5.00	BMRL	4.40	5.00	10.00	15.00
3.20	1.00	4.20	5.85	BMRL	5.10	6.15	12.40	18.25
3.60	1.00	4.40	6.10	BMRL	5.30	6.80	13.60	19.70
5.00	1.20	4.20	7.20	BMRL	4.20	6.70	16.50	23.70
4.90	BMRL	5.40	7.50	NR	3.50	5.70	16.50	24.00
7.00	1.30	4.00	8.00	NR	5.30	9.40	20.40	28.40
8.80	BMRL	4.80	9.60	BMRL	4.20	9.20	23.50	33.10
7.95	BMRL	3.75	8.05	BMRL	3.05	7.60	22.20	30.25

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured. the primary and duplicate analyses below.

SDS <i>TCAA</i> * µg/L	SDS <i>MBAA</i> * µg/L	SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
1.10	BMRL	2.00	2.20	BMRL	3.00	2.70	4.50	6.70
1.10	BMRL	2.30	2.30	BMRL	3.10	2.70	4.80	7.10
1.10	BMRL	2.15	2.25	BMRL	3.05	2.70	4.65	6.90
0.00	BMRL	13.95	4.44	BMRL	3.28	0.00	6.45	5.80
3.20	BMRL	4.30	5.90	BMRL	5.30	6.30	11.50	17.40
3.20	1.00	4.10	5.80	BMRL	4.90	6.00	12.30	18.10
3.20	1.00	4.20	5.85	BMRL	5.10	6.15	12.40	18.25
0.00	BMRL	4.76	1.71	BMRL	7.84	4.88	6.45	3.84
7.70	BMRL	3.60	7.80	BMRL	3.00	7.30	21.30	29.10
8.20	BMRL	3.90	8.30	BMRL	3.10	7.90	23.10	31.40
7.95	BMRL	3.75	8.05	BMRL	3.05	7.60	22.20	30.25
6.29	BMRL	8.00	6.21	BMRL	3.28	7.89	8.11	7.60

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.



**Field 3-8: GAC Effluent Water Quality For The 20-Minute EBCT Run<sup>1</sup>****Group C, 12 effluent samples per run**

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes (20 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L
C1	N	8/25/98	18:30	1.00	19.1	7.40	20.0	0.24	0.007	2.98	2.30	1.83	0.47
C2	N	8/26/98	11:00	17.50	334.9	7.30	20.0	0.21	0.008	3.81	2.30	1.70	0.60
C3	N	8/28/98	14:00	68.50	1310.8	7.20	21.0	0.13	0.008	5.97	2.20	2.04	0.16
C4	N	8/29/98	9:00	87.50	1674.4	7.31	21.0	0.24	0.008	3.29	2.20	1.50	0.70
Avg-C5	Y	8/31/98	10:00	136.50	2612.1	7.25	21.0	0.37	0.006	1.62	2.10	1.36	0.75
C6	N	9/1/98	13:00	163.50	3128.8	7.20	21.0	0.38	BMRL	BMRL	2.10	1.31	0.79
C7	N	9/2/98	9:00	183.50	3511.5	7.13	21.0	0.19	0.005	2.66	2.10	1.30	0.80
C8	N	9/3/98	15:00	213.50	4085.6	7.09	20.0	0.83	0.006	0.72	2.00	1.33	0.67
Avg-C9	Y	9/4/98	11:00	233.50	4468.3	7.05	20.0	0.55	0.006	1.09	2.00	1.12	0.88
C10	N	9/5/98	13:00	259.50	4965.9	7.06	21.0	0.28	0.006	2.15	2.00	1.25	0.75
C11	N	9/7/98	22:00	316.50	6056.7	6.80	21.0	0.76	0.006	0.79	2.00	0.96	1.04
C12	N	9/8/98	11:30	330.00	6315.0	6.97	21.0	0.94	0.011	1.17	2.30	1.21	1.09
C13	N	9/13/98	13:00	451.50	8640.1	7.03	21.0	1.00	0.008	0.80	2.20	1.21	0.99
C17	N	9/14/98	12:00	474.50	9080.2	6.89	21.0	0.88	0.012	1.36	2.30	1.14	1.16
Avg-C18	Y	9/15/98	12:00	498.50	9539.5	6.87	22.0	1.01	0.015	1.48	2.40	1.06	1.34
C19	N	9/28/98	11:00	809.50	15490.9	6.90	22.0	2.60	0.023	0.88	2.90	0.79	2.11

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for the primary and duplicate analyses below.

**Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)**

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh.hh	Bed volumes (20 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L
C5	Primary	8/31/98	10:00	136.50	36.6	7.25	21.0	0.39	0.006	1.54	2.10	1.45	0.65
D-C5	Duplicate	8/31/98	10:00	136.50	36.6	7.15	20.0	0.35	0.006	1.71	2.10	1.26	0.84
Avg-C5	Average	---	---	---	---	7.20	20.5	0.37	0.006	1.63	2.10	1.36	0.75
RPD-C5	RPD	---	---	---	---	1.39	4.88	10.81	0.00	10.81	0.00	14.02	25.50
C9	Primary	9/4/98	11:00	233.50	62.6	7.05	20.0	0.55	0.006	1.09	2.00	1.12	0.88
D-C9	Duplicate	9/4/98	11:00	233.50	62.6	7.10	20.0	0.55	0.006	1.09	2.00	1.12	0.88
Avg-C9	Average	---	---	---	---	7.08	20.0	0.55	0.006	1.09	2.00	1.12	0.88
RPD-C9	RPD	---	---	---	---	0.71	0.00	0.36	0.00	0.36	0.00	0.00	0.00
C18	Primary	9/15/98	12:00	498.50	133.7	6.87	22.0	1.02	0.015	1.48	2.40	1.06	1.34
D-C18	Duplicate	9/15/98	12:00	498.50	133.7	6.91	22.0	1.01	0.015	1.49	2.40	1.04	1.36
Avg-C18	Average	---	---	---	---	6.89	22.0	1.01	0.015	1.48	2.40	1.05	1.35
RPD-C18	RPD	---	---	---	---	0.58	0.00	0.49	0.00	0.49	0.00	1.90	1.48

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 3-8: GAC Effluent Water Quality For The 20-Minute EBCT Run (continued)

SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
27.0	7.15	48.0	BMRL	2.20	2.80	2.20	BMRL	7.20	BMRL	1.00
27.0	7.22	48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL
27.0	7.41	48.0	BMRL	2.30	2.90	3.30	1.20	9.70	BMRL	1.30
27.0	7.33	48.0	BMRL	1.40	2.40	2.80	1.40	8.00	BMRL	BMRL
27.0	7.29	48.0	BMRL	1.35	2.15	3.10	1.65	8.25	BMRL	BMRL
27.0	7.25	48.0	BMRL	1.70	2.50	3.00	1.40	8.60	BMRL	BMRL
27.0	7.35	48.0	BMRL	1.90	2.80	3.20	1.70	9.60	BMRL	BMRL
27.0	7.27	48.0	BMRL	1.60	2.50	3.00	1.70	8.80	BMRL	BMRL
27.0	7.22	48.0	BMRL	1.70	2.60	3.55	2.05	9.90	BMRL	1.10
27.0	7.20	48.0	BMRL	BMRL	1.60	2.10	1.10	4.80	BMRL	BMRL
27.0	7.19	48.0	26.00	1.80	3.20	4.60	2.70	12.30	BMRL	1.30
27.0	7.33	48.0	26.00	1.20	2.40	4.40	1.20	9.20	BMRL	1.20
27.0	7.33	48.0	49.00	2.60	6.40	11.00	5.10	25.10	BMRL	1.70
27.0	7.28	48.0	NA	3.60	8.10	12.00	5.20	28.90	BMRL	2.20
27.0	7.29	48.0	56.50	4.20	9.60	14.50	5.65	33.95	BMRL	2.95
27.0	7.23	48.0	145.00	20.00	24.00	20.00	3.40	67.40	BMRL	8.40

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

SDS Chlorination temp. °C	SDS Chlorination pH ---	SDS Incubation time hours	SDS TOX µg Cl /L	SDS CHCl3 µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr3 µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L
27.0	7.28	48.0	BMRL	1.30	2.10	2.70	1.20	7.30	BMRL	BMRL
27.0	7.29	48.0	BMRL	1.40	2.20	3.50	2.10	9.20	BMRL	BMRL
27.0	7.29	48.0	BMRL	1.35	2.15	3.10	1.65	8.25	BMRL	BMRL
0.00	0.14	0.00	BMRL	7.41	4.65	25.81	54.55	23.03	BMRL	BMRL
27.0	7.29	48.0	BMRL	1.90	2.70	3.50	1.90	10.00	BMRL	1.00
27.0	7.30	48.0	BMRL	1.50	2.50	3.60	2.20	9.80	BMRL	1.20
27.0	7.30	48.0	BMRL	1.70	2.60	3.55	2.05	9.90	BMRL	1.10
0.00	0.14	0.00	BMRL	23.53	7.69	2.82	14.63	2.02	BMRL	18.18
27.0	7.28	48.0	58.00	4.30	9.80	15.00	5.70	34.80	BMRL	3.00
27.0	7.27	48.0	55.00	4.10	9.40	14.00	5.60	33.10	BMRL	2.90
27.0	7.28	48.0	56.50	4.20	9.60	14.50	5.65	33.95	BMRL	2.95
0.00	0.14	0.00	5.31	4.76	4.17	6.90	1.77	5.01	BMRL	3.39

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 3-8: GAC Effluent Water Quality For The 20-Minute EBCT Run (continued)

SDS <i>TCAA</i> * µg/L	SDS <i>MBAA</i> * µg/L	SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.20	1.00	1.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
1.00	BMRL	BMRL	1.30	BMRL	BMRL	1.40	2.30	3.60
1.00	BMRL	BMRL	BMRL	BMRL	BMRL	1.60	1.00	1.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.60	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
1.00	BMRL	BMRL	BMRL	BMRL	BMRL	1.70	1.00	1.00
1.00	BMRL	1.00	1.10	BMRL	BMRL	1.30	2.00	3.10
1.05	BMRL	1.35	1.35	BMRL	BMRL	1.25	3.50	4.85
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.10	0.00	0.00
1.40	BMRL	1.50	1.70	BMRL	BMRL	1.40	4.20	5.90
BMRL	BMRL	1.80	1.40	BMRL	BMRL	1.10	3.00	4.40
1.20	BMRL	2.90	2.90	BMRL	2.70	2.30	5.80	8.70
1.50	BMRL	3.60	4.40	BMRL	2.90	3.20	7.30	11.70
1.80	BMRL	5.00	4.10	BMRL	2.20	2.10	9.75	13.85
7.30	BMRL	3.90	8.60	NR	NR	9.80	19.60	28.20

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measure

SDS <i>TCAA</i> * µg/L	SDS <i>MBAA</i> * µg/L	SDS <i>DBAA</i> * µg/L	SDS <i>BCAA</i> * µg/L	SDS <i>TBAA</i> µg/L	SDS <i>CDBAA</i> µg/L	SDS <i>DCBAA</i> µg/L	SDS <i>HAA5</i> µg/L	SDS <i>HAA6</i> µg/L
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.60	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.60	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.60	0.00	0.00
BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00	0.00
1.00	BMRL	1.30	1.30	BMRL	BMRL	1.20	3.30	4.60
1.10	BMRL	1.40	1.40	BMRL	BMRL	1.30	3.70	5.10
1.05	BMRL	1.35	1.35	BMRL	BMRL	1.25	3.50	4.85
9.52	BMRL	7.41	7.41	BMRL	BMRL	8.00	11.43	10.31
1.70	BMRL	4.10	3.90	BMRL	2.20	2.60	8.80	12.70
1.90	BMRL	5.90	4.30	BMRL	BMRL	1.60	10.70	15.00
1.80	BMRL	5.00	4.10	BMRL	2.20	2.10	9.75	13.85
11.11	BMRL	36.00	9.76	BMRL	BMRL	47.62	19.49	16.61

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measure

**Field 3-9: GAC Cost Parameters**

<b>Cost Parameter</b>	<b>Parameter value</b>
Capital Recovery Interest Rate (%)	5.3
Capital Recovery Period (years)	45
Overhead & Profit Factor (% of construction costs)	10
Special Sitework Factor (% of construction costs)	5
Construction Contingencies (% of construction costs)	10
Engineering Fee Factor (% of construction costs)	10
1998 ENR Construction Cost Index (CCI base year 1913)	77.8
1998 Producers Price Index (PPI base year 1982 = 100)	131.3
Labor Rate + Fringe (\$/work-hour)	21
Labor Overhead Factor (% of labor)	4.1
Electric Rate (\$/kW-h)	0.035
Fuel Oil Rate (\$/gal)	0.55
Natural Gas Rate (\$/ft <sup>3</sup> )	0.007
Current Process Water Rate (\$/1000 gal)	0.35
Modifications to Existing Plant (% of construction costs)	20

**FIELD-SET 4: 4th QUARTER RSSCT RESULTS (FILE: ICR448.xls)**

**Field 4-1: PWS And Treatment Plant Data**

PWS Name	Public Works Commision of the City of Fayetteville
Public Water System Identification Number	NC 0326010
Water Industry Data Base Number ( <i>optional</i> )	1244
Official ICR Contact Person	Mr. M. J. Noland
Mailing Address	P.O. Box 1089 Raleigh, NC 28302
Phone Number	(910)-223-4733
FAX Number	(910)-829-0203
E-Mail Address ( <i>optional</i> )	N/A
Technical ICR Contact Person	Mr. Kevin Christmas
Mailing Address	508 Hoffer Dr. Fayetteville, NC 28301
Phone Number	(910)-223-4709
FAX Number	(910)-484-5838
E-Mail Address ( <i>optional</i> )	N/A
Plant Name	P.O. Hoffer Water Treatment Plant
Treatment Plant Category	CONV
Process Train Name	Conventional train
ICR Treatment Plant Identification Number	448
PWSID Number of Plant ( <i>if assigned</i> )	NC 0326010
Historical Minimum Water Temperature (°C)	4
Historical Average Water Temperature (°C)	34.0
State Approved Plant Capacity (MGD)	32.0

**Field 4-2: Full-Scale GAC Characteristics'**

Carbon manufacturer	Calgon Corp.
Carbon trade name	Filtrisorb-400
Carbon type	Bituminous
Original GAC mesh size, upper (US standard mesh)	12
Original GAC mesh size, lower (US standard mesh)	40
Original carbon particle diameter, d <sub>LC</sub> (mm)	1.053

1: These are the characteristics before the carbon is ground for RSSCT experiments.

**Field 4-3: RSSCT Design Parameters**
**Input Design Parameters**

RSSCT influent TOC (mg/L)	2.8
Inner diameter of the RSSCT column, $D_{SC}$ (mm)	15.0
Minimum RSSCT Reynolds number, $Re_{SC, min}$	0.2
Full-scale operating temperature, $T^{\circ}C$ ( $^{\circ}C$ )	18.1
Full-scale bed porosity, $\epsilon_{LC}$	0.45
Measured RSSCT dry bed density, $\rho_{SC}$ (g/cm <sup>3</sup> )	0.463
RSSCT GAC mesh size, upper (US standard mesh)	80
RSSCT GAC mesh size, lower (US standard mesh)	100

**Estimated Run Length**

Bed volumes to 50% TOC breakthrough, $BV_{50}$	5825
Estimated run length, $BV_T$ ( $= 2 \times BV_{50}$ )	11651
$BV_T + 30\%$ safety factor, $BV_{T+30\%}$ ( $= 2.6 \times BV_{50}$ )	15146

**General RSSCT Design Parameters**

Kinematic viscosity at $T^{\circ}C$ , $\nu_{LC}$ (m <sup>2</sup> /s)	1.076E-06
RSSCT carbon particle diameter, $d_{SC}$ (mm)	0.1650
Scaling factor, SF	6.38
RSSCT hydraulic loading rate, $v_{SC}$ (m/hr)	2.11
RSSCT flow rate, $Q_{SC}$ (mL/min)	6.22
Estimated total influent volume required, $V_{SC}$ (L)	443

**10-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	10
Estimated full-scale run time, $t_{LC}$ (days)	105
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	1.57
Estimated RSSCT run time, $t_{SC}$ (days)	16.49
RSSCT bed length, $l_{SC}$ (cm)	5.5
Estimated volume required for 10-minute EBCT, $V_{SC}$ (L)	148
Mass GAC required, $m_{SC}$ (g)	4.52

**20-Minute EBCT Run**

Full-scale empty bed contact time, $EBCT_{LC}$ (min)	20
Estimated full-scale run time, $t_{LC}$ (days)	210
RSSCT empty bed contact time, $EBCT_{SC}$ (min)	3.14
Estimated RSSCT run time, $t_{SC}$ (days)	32.98
RSSCT bed length, $l_{SC}$ (cm)	11.0
Estimated volume required for 20-minute EBCT, $V_{SC}$ (L)	295
Mass GAC required, $m_{SC}$ (g)	9.03

**Field 4-4: Pretreatment Used Prior To GAC'**

US standard mesh size	Opening (mm)
4	4.750
6	3.350
8	2.360
10	2.000
12	1.680
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
70	0.210
80	0.180
100	0.150
120	0.125
140	0.106
170	0.088
200	0.075
230	0.062
270	0.053
325	0.044
400	0.037

[illegible]

1: Design information, similar to that shown in Tables 6c and 6d of the ICR rule, must be included in the hard-copy *Treatment Study Summary Report* (see Section 10.0). The purpose of this table is to list the pretreatment processes used in this particular RSST run.

## Field 4-5: GAC Influent Water Quality For The 10-Minute EBCT Run

10-min. EBCT Start Date	11/20/98
10-min. EBCT Start Time	10:00

## Group A, 2 samples per batch

Parameter	Units	Sample A1-10	Sample A2-10	Average	RPD
Sampling date	MM/DD/YY	11/20/98	12/1/98	---	---
Sampling time	hh:mm	11:30	13:00	---	---
Operation time	hh.hh	1.50	267.00	---	---
Bed volumes	(10 minutes)	57.4	10218.8	---	---
Alkalinity	ng/L as CaCO <sub>3</sub>	15.3	15.4	15.4	0.65
Total hardness	ng/L as CaCO <sub>3</sub>	21.7	21.7	21.7	0.00
Calcium hardness	ng/L as CaCO <sub>3</sub>	12.9	12.9	12.9	0.00
Ammonia	mg NH <sub>3</sub> -N / L	0.02	0.04	0.03	69.09
Bromide	µg/L	96.0	92.0	94.0	4.26

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	11/20/98	12/1/98	12/6/98	---	---
Sampling time	hh:mm	11:30	13:00	10:00	---	---
Operation time	hh.hh	1.50	267.00	384.00	---	---
Bed volumes	(10 minute)	57.4	10218.8	14696.7	---	---
pH	---	6.78	6.68	6.82	6.76	1.07
Turbidity	ntu	0.83	0.75	0.90	0.83	9.08
Temperature	°C	23.0	22.0	23.0	22.7	2.55
Total organic carbon	mg/L	2.97	3.01	2.98	2.99	0.83
UV <sub>254</sub>	cm <sup>-1</sup>	0.064	0.060	0.067	0.064	5.52
SUVA	L/(mg*m)	2.16	1.99	2.25	2.13	6.17
SDS-Cl <sub>2</sub> dose	mg/L	7.00	5.00	5.00	5.67	20.38
SDS-Free Cl <sub>2</sub> residual	mg/L	3.80	1.58	1.80	2.39	51.11
SDS-Cl <sub>2</sub> demand	mg/L	3.20	3.42	3.20	3.27	3.88
SDS-Chlorination temp.	°C	15.0	15.0	15.0	15.0	0.00
SDS-Chlorination pH	---	7.40	7.35	7.45	7.40	0.68
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> /L	295.00	260.00	270.00	275.00	6.56
SDS-CHCl <sub>3</sub>	µg/L	45.00	41.00	44.00	43.33	4.80
SDS-BDCM	µg/L	26.00	25.00	27.00	26.00	3.85
SDS-DBCM	µg/L	10.00	12.00	12.00	11.33	10.19
SDS-CHBr <sub>3</sub>	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-THM4	µg/L	81.00	78.00	83.00	80.67	3.12
SDS-MCAA*	µg/L	2.10	2.00	2.30	2.13	7.16
SDS-DCAA*	µg/L	18.00	15.00	17.00	16.67	9.17
SDS-TCAA*	µg/L	29.00	21.00	25.00	25.00	16.00
SDS-MBAA*	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-DBAA*	µg/L	2.20	2.50	2.70	2.47	10.20
SDS-BCAA*	µg/L	10.00	9.70	11.00	10.23	6.65
SDS-TBAA	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-CDBAA	µg/L	6.60	5.70	6.20	6.17	7.31
SDS-DCBAA	µg/L	23.00	19.00	21.00	21.00	9.52



**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-HAA5	µg/L	51.30	40.50	47.00	46.27	11.75
SDS-HAA6	µg/L	61.30	50.20	58.00	56.50	10.09

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 4-6: GAC Influent Water Quality For The 20-Minute EBCT Run<sup>1</sup>

20-min. EBCT Start Date	11/20/98
20-min. EBCT Start Time	10:00

## Group A, 2 samples per batch

Parameter	Units	Sample A1-20	Sample A2-20	Average	RPD
Sampling date	MM/DD/YY	11/20/98	12/1/98	---	---
Sampling time	hh:mm	11:30	13:00	---	---
Operation time	hh.hh	1.50	267.00	---	---
Bed volumes	(20 minutes)	57.4	10218.8	---	---
Alkalinity	mg/L as CaCO <sub>3</sub>	15.3	15.4	15.4	0.65
Total hardness	mg/L as CaCO <sub>3</sub>	21.7	21.7	21.7	0.00
Calcium hardness	mg/L as CaCO <sub>3</sub>	12.9	12.9	12.9	0.00
Ammonia	mg NH <sub>3</sub> -N / L	0.02	0.04	0.03	69.09
Bromide	µg/L	96.0	92.0	94.0	4.26

## Group B, 3 samples per batch

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
Sampling date	MM/DD/YY	11/20/98	12/1/98	12/6/98	---	---
Sampling time	hh:mm	11:30	13:00	10:00	---	---
Operation time	hh.hh	1.50	267.00	384.00	---	---
Bed volumes	(20 minute)	57.4	10218.8	14696.7	---	---
pH	---	6.78	6.68	6.82	6.76	1.07
Turbidity	ntu	0.83	0.75	0.90	0.83	9.08
Temperature	°C	23.0	22.0	23.0	22.7	2.55
Total organic carbon	mg/L	2.97	3.01	2.98	2.99	0.83
UV <sub>254</sub>	cm <sup>-1</sup>	0.064	0.060	0.067	0.064	5.52
SUVA	L/(mg*m)	2.16	1.99	2.25	2.13	6.17
SDS-Cl <sub>2</sub> dose	mg/L	7.00	5.00	5.00	5.67	20.38
SDS-Free Cl <sub>2</sub> residual	mg/L	3.80	1.58	1.80	2.39	51.11
SDS-Cl <sub>2</sub> demand	mg/L	3.20	3.42	3.20	3.27	3.88
SDS-Chlorination temp.	°C	15.0	15.0	15.0	15.0	0.00
SDS-Chlorination pH	---	7.40	7.35	7.45	7.4	0.68
SDS-Incubation time	hours	48.0	48.0	48.0	48.0	0.00
SDS-TOX	µg Cl <sup>-</sup> / L	295.00	260.00	270.00	275.00	6.56
SDS-CHCl <sub>3</sub>	µg/L	45.00	41.00	44.00	43.33	4.80
SDS-BDCM	µg/L	26.00	25.00	27.00	26.00	3.85
SDS-DBCM	µg/L	10.00	12.00	12.00	11.33	10.19
SDS-CHBr <sub>3</sub>	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-THM <sub>4</sub>	µg/L	81.00	78.00	83.00	80.67	3.12
SDS-MCAA*	µg/L	2.10	2.00	2.30	2.13	7.16
SDS-DCAA*	µg/L	18.00	15.00	17.00	16.67	9.17
SDS-TCAA*	µg/L	29.00	21.00	25.00	25.00	16.00
SDS-MBAA*	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-DBAA*	µg/L	2.20	2.50	2.70	2.47	10.20
SDS-BCAA*	µg/L	10.00	9.70	11.00	10.23	6.65
SDS-TBAA	µg/L	BMRL	BMRL	BMRL	BMRL	BMRL
SDS-CDBAA	µg/L	6.60	5.70	6.20	6.17	7.31
SDS-DCBAA	µg/L	23.00	19.00	21.00	21.00	9.52

**Group B, 3 samples per batch**

Parameter	Units	Sample B1-10	Sample B2-10	Sample B3-10	Average	%SD
SDS-HAA5	µg/L	51.30	40.50	47.00	46.27	11.75
SDS-HAA6	µg/L	61.30	50.20	58.00	56.50	10.09

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 4-7: GAC Effluent Water Quality For The 10-Minute EBCT Run<sup>1</sup>

## Group C, 12 effluent samples per run

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 10 minute	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS free Cl <sub>2</sub> residue mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS chlorination temp °C	SDS chlorination pH ---
C1	N	11/20/98	11:30	1.50	57.4	7.75	23.0	0.265	BMRL	BMRL	3.30	3.00	0.30	15.0	7.40
C2	N	11/21/98	14:00	28.00	1071.6	6.22	22.0	0.301	BMRL	BMRL	2.90	2.20	0.70	15.0	7.23
C3	N	11/24/98	13:00	99.00	3789.0	7.02	22.0	0.724	0.014	1.93	3.20	2.40	0.80	15.0	7.33
C4	N	11/25/98	12:00	122.00	4669.3	6.92	22.0	0.999	0.013	1.30	3.20	2.08	1.12	15.0	7.40
C5	N	11/27/98	13:00	171.00	6544.6	7.05	22.0	1.305	0.024	1.84	3.20	1.73	1.47	15.0	7.35
Avg-C6	Y	11/29/98	11:00	217.00	8305.2	7.04	22.0	1.506	0.028	1.86	3.40	1.74	1.67	15.0	7.31
C7	N	11/30/98	16:00	246.00	9415.1	7.15	22.0	1.598	0.028	1.75	3.40	1.46	1.94	15.0	7.25
Avg-C8	Y	12/1/98	10:00	264.00	10104.0	7.19	23.0	1.974	0.032	1.62	3.60	1.30	2.14	15.0	7.33
C9	N	12/3/98	14:00	316.00	12094.2	7.28	23.0	1.722	0.024	1.39	3.70	1.37	2.41	15.0	7.32
C10	N	12/4/98	13:00	339.00	12974.5	7.18	24.0	1.858	0.030	1.61	3.90	1.25	2.53	15.0	7.24
Avg-C11	Y	12/6/98	12:00	386.00	14773.3	7.17	25.0	2.131	0.045	2.11	4.50	1.23	3.25	15.0	7.42
C12	N	12/10/98	14:00	484.00	18524.0	7.24	25.0	2.020	0.050	2.48	4.60	NR	3.38	15.0	7.35
C13	N	12/14/98	14:00	580.00	22198.2	7.32	24.0	1.980	0.048	2.42	5.00	1.80	3.20	15.0	7.29

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results

## Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:mm	Bed volumes 10 minute	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	SDS free Cl <sub>2</sub> residue mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS chlorination temp °C	SDS chlorination pH ---
C6	Primary	11/29/98	11:00	217.00	8305.2	7.10	22.0	1.482	0.028	1.89	3.40	1.71	1.69	15.0	7.3
D-C6	Duplicate	11/29/98	11:00	217.00	8305.2	6.98	22.0	1.530	0.028	1.83	3.40	1.76	1.64	15.0	7.3
Avg-C6	Average	---	---	---	---	7.04	22.0	1.506	0.028	1.86	3.40	1.74	1.67	15.0	7.3
RPD-C6	RPD	---	---	---	---	1.70	0.00	3.187	0.00	3.19	0.00	2.88	3.00	0.00	0.55
C8	Primary	12/1/98	10:00	264.00	10104.0	7.10	23.0	2.045	0.032	1.56	3.60	1.35	2.25	15.0	7.4
D-C8	Duplicate	12/1/98	10:00	264.00	10104.0	7.28	23.0	1.903	0.032	1.68	3.60	1.24	2.36	15.0	7.3
Avg-C8	Average	---	---	---	---	7.19	23.0	1.974	0.032	1.62	3.60	1.30	2.31	15.0	7.3
RPD-C8	RPD	---	---	---	---	2.50	0.00	7.194	0.00	7.19	0.00	8.49	4.77	0.00	0.82
C11	Primary	12/6/98	12:00	386.00	14773.3	7.17	25.0	2.194	0.045	2.05	4.50	1.22	3.28	15.0	7.4
D-C11	Duplicate	12/6/98	12:00	386.00	14773.3	7.17	25.0	2.067	0.045	2.18	4.50	1.23	3.27	15.0	7.4
Avg-C11	Average	---	---	---	---	7.17	25.0	2.131	0.045	2.11	4.50	1.23	3.28	15.0	7.42
RPD-C11	RPD	---	---	---	---	0.00	0.00	5.961	0.00	5.96	0.00	0.82	0.31	0.00	0.40

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

## Field 4-7: GAC Effluent Water Quality For The 10-Minute EBCT Run (continued)

incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
48.0	BMRL	1.40	1.30	1.10	BMRL	3.80	BMRL	2.20	1.30	BMRL	BMRL	1.50	BMRL	BMRL	2.20	3.50	5.00
48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.30	0.00	0.00
48.0	50.00	3.30	6.40	8.70	2.40	20.80	BMRL	2.20	3.10	BMRL	2.70	3.80	BMRL	5.70	6.70	8.00	11.80
48.0	61.00	4.50	8.30	11.00	3.10	26.90	BMRL	2.80	2.10	BMRL	3.40	4.30	BMRL	3.10	3.40	8.30	12.60
48.0	96.00	8.60	14.00	14.00	3.00	39.60	BMRL	3.70	4.20	BMRL	3.60	5.70	BMRL	5.90	9.00	11.50	17.20
48.0	112.50	11.00	15.00	15.00	2.70	43.70	BMRL	5.10	5.65	BMRL	3.70	6.60	BMRL	6.40	11.00	14.45	21.05
48.0	130.00	13.00	17.00	15.00	2.40	47.40	BMRL	6.30	6.60	BMRL	3.30	6.90	BMRL	6.50	11.00	16.20	23.10
48.0	135.00	14.00	17.00	15.00	2.25	48.25	BMRL	6.90	6.75	BMRL	3.75	7.50	BMRL	5.90	11.00	17.40	24.90
48.0	150.00	16.00	19.00	14.00	1.80	50.80	BMRL	7.70	7.80	BMRL	2.60	7.60	NR	NR	NR	18.10	25.70
48.0	155.00	18.00	19.00	14.00	1.90	52.90	BMRL	7.70	8.50	BMRL	3.50	8.10	NR	NR	NR	19.70	27.80
48.0	160.00	20.00	21.00	14.50	1.75	57.25	BMRL	7.85	8.90	BMRL	3.30	7.40	BMRL	4.45	10.80	20.05	27.45
48.0	NA	16.00	21.00	15.00	2.00	54.00	BMRL	6.00	5.60	BMRL	3.50	6.40	NR	NR	NR	15.10	21.50
48.0	180.00	24.00	21.00	12.00	1.40	58.40	2.40	9.30	13.00	BMRL	2.60	7.40	NR	NR	NR	27.30	34.70

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

for the primary and duplicate analyses below.

incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
48.0	110.00	11.00	15.00	15.00	2.70	43.70	BMRL	5.20	5.40	BMRL	3.60	6.40	BMRL	6.20	11.00	14.20	20.60
48.0	115.00	11.00	15.00	15.00	2.70	43.70	BMRL	5.00	5.90	BMRL	3.80	6.80	BMRL	6.60	11.00	14.70	21.50
48.0	112.50	11.00	15.00	15.00	2.70	43.70	BMRL	5.10	5.65	BMRL	3.70	6.60	BMRL	6.40	11.00	14.45	21.05
0.00	4.44	0.00	0.00	0.00	0.00	0.00	BMRL	3.92	8.85	BMRL	5.41	6.06	BMRL	6.25	0.00	3.46	4.28
48.0	130.00	14.00	17.00	15.00	2.20	48.20	BMRL	6.90	6.80	BMRL	3.80	7.50	BMRL	5.80	11.00	17.50	25.00
48.0	140.00	14.00	17.00	15.00	2.30	48.30	BMRL	6.90	6.70	BMRL	3.70	7.50	BMRL	6.00	11.00	17.30	24.80
48.0	135.00	14.00	17.00	15.00	2.25	48.25	BMRL	6.90	6.75	BMRL	3.75	7.50	BMRL	5.90	11.00	17.40	24.90
0.00	7.41	0.00	0.00	0.00	4.44	0.21	BMRL	0.00	1.48	BMRL	2.67	0.00	BMRL	3.39	0.00	1.15	0.80
48.0	160.00	20.00	21.00	14.00	1.70	56.70	BMRL	8.00	8.90	BMRL	3.50	7.80	BMRL	5.00	12.00	20.40	28.20
48.0	160.00	20.00	21.00	15.00	1.80	57.80	BMRL	7.70	8.90	BMRL	3.10	7.00	BMRL	3.90	9.60	19.70	26.70
48.0	160.00	20.00	21.00	14.50	1.75	57.25	BMRL	7.85	8.90	BMRL	3.30	7.40	BMRL	4.45	10.80	20.05	27.45
0.00	0.00	0.00	0.00	6.90	5.71	1.92	BMRL	3.82	0.00	BMRL	12.12	10.81	BMRL	24.72	22.22	3.49	5.46

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 4-8: GAC Effluent Water Quality For The 20-Minute EBCT Run<sup>1</sup>

## Group C, 12 effluent samples per run

Sample ID	Was sample duplicated? Y/N	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:hh	Bed volumes (20 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---
C1	N	11/20/98	11:30	1.50	28.7	7.76	23.0	0.285	BMRL	BMRL	3.40	3.20	0.20	15.0	7.40
C2	N	11/21/98	14:00	28.00	535.8	6.56	22.0	0.173	BMRL	BMRL	2.90	2.90	0.00	15.0	7.26
C3	N	11/24/98	13:00	99.00	1894.5	7.01	22.0	0.434	0.007	1.61	3.10	1.84	1.26	15.0	7.33
C4	N	11/25/98	12:00	122.00	2334.6	6.90	22.0	0.291	BMRL	BMRL	2.90	1.84	1.06	15.0	7.39
C5	N	11/27/98	13:00	171.00	3272.3	7.10	22.0	0.313	BMRL	BMRL	2.90	1.90	1.00	15.0	7.25
Avg-C6	Y	11/29/98	11:00	217.00	4152.6	7.10	22.0	0.266	0.007	2.64	2.90	1.94	0.97	15.0	7.33
C7	N	11/30/98	16:00	246.00	4707.5	7.21	22.0	0.432	0.019	4.40	3.10	2.00	1.10	15.0	7.39
Avg-C8	Y	12/1/98	10:00	264.00	5052.0	7.28	23.0	0.487	0.013	2.67	3.05	2.05	1.00	15.0	7.27
C9	N	12/3/98	14:00	316.00	6047.1	7.19	23.0	0.599	0.009	1.50	3.00	1.80	1.20	15.0	7.42
C10	N	12/4/98	13:00	339.00	6487.2	7.09	24.0	NR	0.010	BMRL	3.00	1.50	1.50	15.0	7.47
Avg-C11	Y	12/6/98	12:00	386.00	7386.6	7.15	25.0	0.968	0.020	2.07	3.50	1.60	1.90	15.0	7.37
C12	N	12/10/98	14:00	484.00	9262.0	7.03	25.0	1.344	0.026	1.93	3.80	0.66	3.14	15.0	7.38
C13	N	12/14/98	14:00	580.00	11099.1	7.07	24.0	1.404	0.029	2.07	4.00	1.50	2.50	15.0	7.32
													0.00		
													0.00		
													0.00		
													0.00		

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

1: Do not enter the results from duplicate samples into the table above, instead enter the average value for the primary and duplicate analyses in the above table, and enter the results for the primary and duplicate analyses below.

## Group D, 3 duplicate effluent samples per run (results from primary and duplicate analyses)

Sample ID	Sample Type	Sampling date MM/DD/YY	Sampling time hh:mm	Operation time hh:hh	Bed volumes (20 minute)	pH ---	Temp. °C	TOC mg/L	UV <sub>254</sub> cm <sup>-1</sup>	SUVA L/(mg*m)	SDS Cl <sub>2</sub> dose mg/L	Free Cl <sub>2</sub> residual mg/L	SDS Cl <sub>2</sub> demand mg/L	SDS Chlorination temp. °C	SDS Chlorination pH ---
C6	Primary	11/29/98	11:00	217.00	4152.6	7.09	22.0	0.277	0.007	2.53	2.90	2.11	0.79	15.0	7.31
D-C6	Duplicate	11/29/98	11:00	217.00	4152.6	7.11	22.0	0.254	0.007	2.76	2.90	1.76	1.14	15.0	7.34
Avg-C6	Average	---	---	---	---	7.10	22.0	0.266	0.007	2.64	2.90	1.94	0.97	15.0	7.33
RPD-C6	RPD	---	---	---	---	0.28	0.00	8.663	0.00	8.66	0.00	18.09	36.27	0.00	0.41
C8	Primary	12/1/98	10:00	264.00	5052.0	7.28	23.0	0.473	0.013	2.75	3.10	2.10	1.00	15.0	7.27
D-C8	Duplicate	12/1/98	10:00	264.00	5052.0	7.28	23.0	0.500	0.013	2.60	3.00	2.00	1.00	15.0	7.27
Avg-C8	Average	---	---	---	---	7.28	23.0	0.487	0.013	2.67	3.05	2.05	1.00	15.0	7.27
RPD-C8	RPD	---	---	---	---	0.00	0.00	5.550	0.00	5.55	3.28	4.88	0.00	0.00	0.00
C11	Primary	12/6/98	12:00	386.00	7386.6	7.15	25.0	1.022	0.020	1.96	3.50	1.60	1.90	15.0	7.40
D-C11	Duplicate	12/6/98	12:00	386.00	7386.6	7.15	25.0	0.914	0.020	2.19	3.50	1.60	1.90	15.0	7.33
Avg-C11	Average	---	---	---	---	7.15	25.0	0.968	0.020	2.07	3.50	1.60	1.90	15.0	7.37
RPD-C11	RPD	---	---	---	---	0.00	0.00	11.157	0.00	11.16	0.00	0.00	0.00	0.00	0.95

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

Field 4-8: GAC Effluent Water Quality For The 20-Minute EBCT Run (continued)

incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
48.0	27.00	1.90	1.30	BMRL	BMRL	3.20	BMRL	BMRL	1.00	BMRL	BMRL	BMRL	BMRL	BMRL	1.60	1.00	1.00
48.0	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.20	0.00	0.00
48.0	BMRL	1.10	1.50	1.80	BMRL	4.40	BMRL	BMRL	1.70	BMRL	BMRL	1.20	BMRL	2.00	2.50	1.70	2.90
48.0	BMRL	3.50	1.00	1.40	BMRL	2.40	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00
48.0	BMRL	BMRL	1.20	1.30	BMRL	2.50	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
48.0	BMRL	BMRL	1.20	1.50	BMRL	2.70	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
48.0	BMRL	BMRL	1.90	2.60	1.10	5.60	BMRL	BMRL	BMRL	1.00	BMRL	BMRL	BMRL	BMRL	1.90	1.00	1.00
48.0	BMRL	1.45	2.70	3.80	1.45	9.40	BMRL	1.85	1.10	BMRL	1.35	1.45	BMRL	2.80	2.35	4.30	5.75
48.0	49.00	3.50	7.20	8.10	2.70	21.50	2.20	3.10	1.30	BMRL	2.80	5.30	NR	NR	NR	9.40	14.70
48.0	38.00	2.10	4.60	7.30	3.00	17.00	BMRL	1.10	1.50	BMRL	2.30	2.40	NR	NR	NR	4.90	7.30
48.0	58.00	4.70	8.05	9.20	2.25	24.20	BMRL	2.50	2.30	BMRL	2.65	3.60	BMRL	3.75	4.70	7.45	11.05
48.0	72.00	5.10	11.00	14.00	4.50	34.60	BMRL	2.30	2.20	BMRL	4.10	4.50	NR	NR	NR	8.60	13.10
48.0	100.00	8.20	12.00	12.00	2.30	34.50	BMRL	6.80	5.00	BMRL	3.10	5.60	BMRL	6.20	9.30	14.90	20.50

BMRL = Below Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*: These six species make up HAA6, but the other three HAA species, TBAA, CDBAA and DCBAA, should be reported if measured.

incubation time hours	SDS TOX µg Cl <sup>-</sup> /L	SDS CHCl <sub>3</sub> µg/L	SDS BDCM µg/L	SDS DBCM µg/L	SDS CHBr <sub>3</sub> µg/L	SDS THM4 µg/L	SDS MCAA* µg/L	SDS DCAA* µg/L	SDS TCAA* µg/L	SDS MBAA* µg/L	SDS DBAA* µg/L	SDS BCAA* µg/L	SDS TBAA µg/L	SDS CDBAA µg/L	SDS DCBAA µg/L	SDS HAA5 µg/L	SDS HAA6 µg/L
48.0	BMRL	BMRL	1.20	1.50	BMRL	2.70	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
48.0	BMRL	BMRL	1.20	1.50	BMRL	2.70	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
48.0	BMRL	BMRL	1.20	1.50	BMRL	2.70	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	1.50	0.00	0.00
0.00	BMRL	BMRL	0.00	0.00	BMRL	0.00	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	BMRL	0.00	0.00	0.00
48.0	BMRL	1.50	2.70	3.80	1.40	9.40	BMRL	1.80	1.10	BMRL	1.40	1.50	BMRL	2.70	2.50	4.30	5.80
48.0	BMRL	1.40	2.70	3.80	1.50	9.40	BMRL	1.90	BMRL	BMRL	1.30	1.40	BMRL	2.90	2.20	3.20	4.60
48.0	BMRL	1.45	2.70	3.80	1.45	9.40	BMRL	1.85	1.10	BMRL	1.35	1.45	BMRL	2.80	2.35	4.30	5.75
0.00	BMRL	6.90	0.00	0.00	6.90	0.00	BMRL	5.41	BMRL	BMRL	7.41	6.90	BMRL	7.14	12.77	25.58	20.87
48.0	57.00	4.50	7.90	9.00	2.20	23.60	BMRL	2.40	2.30	BMRL	2.90	3.80	BMRL	4.80	5.90	7.60	11.40
48.0	59.00	4.90	8.20	9.40	2.30	24.80	BMRL	2.60	2.30	BMRL	2.40	3.40	BMRL	2.70	3.50	7.30	10.70
48.0	58.00	4.70	8.05	9.20	2.25	24.20	BMRL	2.50	2.30	BMRL	2.65	3.60	BMRL	3.75	4.70	7.45	11.05
0.00	3.45	8.51	3.73	4.35	4.44	4.96	BMRL	8.00	0.00	BMRL	18.87	11.11	BMRL	56.00	51.06	4.03	6.33

Minimum Reporting Level; NA = Not Analyzed; NR = Not Reported

\*These six species make up HAA6; the other three HAA species, TBAA, CDBAA and DCBAA, should be reported.

**Field 4-9: GAC Cost Parameters**

<b>Cost Parameter</b>	<b>Parameter value</b>
Capital Recovery Interest Rate (%)	5.3
Capital Recovery Period (years)	45
Overhead & Profit Factor (% of construction costs)	10
Special Sitework Factor (% of construction costs)	5
Construction Contingencies (% of construction costs)	10
Engineering Fee Factor (% of construction costs)	10
1998 ENR Construction Cost Index (CCI base year 1913)	77.8
1998 Producers Price Index (PPI base year 1982 = 100)	131.3
Labor Rate + Fringe (\$/work-hour)	21
Labor Overhead Factor (% of labor)	4.1
Electric Rate (\$/kW-h)	0.035
Fuel Oil Rate (\$/gal)	0.55
Natural Gas Rate (\$/ft <sup>3</sup> )	0.007
Current Process Water Rate (\$/1000 gal)	0.35
Modifications to Existing Plant (% of construction costs)	20



**Appendix D**  
**Treatment Study Summary**  
**Report Spreadsheet**

**Miscellaneous Information**

PWSID NC0326010  
Plant ICR # 448

**Full-Scale Plant Information**

Item	Result
Primary Disinfectant	Free Cl2
Residual Disinfectant	Free Cl2
Source Type	River/Stream
Source Name	Cape Fear River

**Laboratory Information**

Item	ICR ID or Abbrev	Lab Name	Lab Type	Lab City	Lab State
Lab #1	NC016	Public Works Commission Cros Utility		Fayetteville	NC
Lab #2	CA013	Montgomery Watson Laboratori	Commercial	Pasadena	CA
Lab #3	UNCC	University of North Carolina at C	University	Chapel Hill	NC
Lab #4					

**Batch Sampling Dates for Quarterly Bench-Scale Testing**

Item	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Sample Collection Date	3/16/98	5/18/98	8/11/98	11/15/98

**1998 Flow and Population Information**

Source	Flow (mgd)	Population Served
Total Population Served		110,400
Surface Water	17	110,400
Ground Water	0	0
Purchased Finished Water	0	0
<b>Total</b>	<b>17</b>	

## Full-Scale Water Quality Data

### Full-Scale Influent Water Quality Data

Item	Units	Average	Std Dev	Min	Max	Count
Temperature	C	20.6	NR	7	34	12
pH	Unit	7.2	NR	6.2	7.5	12
Turbidity	ntu	31.14	NR	5	186	12
Alkalinity	mg/L as CaCO <sub>3</sub>	18.67	8.74	6.2	35	12
Total Hardness	mg/L as CaCO <sub>3</sub>	19.42	7.35	8.1	28.8	12
Calcium Hardness	mg/L as CaCO <sub>3</sub>	11.63	4.03	5.1	16.5	12
TOC	mg/L	5.3	1.7	2.45	11.8	12
UV <sub>254</sub>	1/cm	0.175	0.053	0.111	0.287	12
Bromide	µg/L	60	37	0	130	12
TSUVA*	L/(mg*m)	NR	NR	NR	NR	12

\*TSUVA = [UV<sub>254</sub> (1/m)] / [TOC (mg/L)]. Summary information for TSUVA should only be calculated from TSUVA values with paired TOC and UV<sub>254</sub> measurements

### Full-Scale Finished Water Quality Data

Item	Units	Average	Std Dev	Min	Max	Count
Temperature	C	21	NR	7	34	12
pH	unit	7.2	NR	6.8	7.6	12
Turbidity	ntu	0.07	NR	0.01	0.71	12
TOC	mg/L	2.72	1.06	1.37	6.87	12
UV <sub>254</sub>	1/cm	0.05	0.07	0.024	0.46	12
DS-THM4	µg/L	63.6	30.3	18	155.9	12
DS-HAA5	µg/L	27.9	11	0	59	12
DS-HAA6	µg/L	NR	NR	NR	NR	12

QA/QC Data - Sheet 1											Percentiles		
Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL		Count	Average	Std Dev	25th	50th	75th
pH	unit	UNCC	3/26/98	12/14/98	SM4500-H+B								
Temperature	C	UNCC	3/26/98	12/14/98	SM2550B								
Alkalinity	mg/L as CaCO <sub>3</sub>	NC016	3/26/98	12/14/98	SM2320B	5							
Ammonia	mg NH <sub>3</sub> -N/L	NC016	3/26/98	12/14/98	SM4500-NH3D	0.1							
Calcium Hardness	mg/L as CaCO <sub>3</sub>	NC016	3/26/98	12/14/98	SM3500-CaD	5							
SDS-Cl <sub>2</sub> Residual	mg/L	UNCC	3/26/98	12/14/98	SM4500-CIG	0.1							
Total Hardness	mg/L as CaCO <sub>3</sub>	NC016	3/26/98	12/14/98	SM2340B	5							
Turbidity	ntu	UNCC	3/26/98	12/14/98	SM2130B	0.05							
Bromide	µg/L	CA013	9/1/97	5/1/99	EPA 300.0	20	RPE of Analytical Duplicates:	192	2.7%	4.9%	0.0%	0.9%	3.9%
							% Recovery for Lab Fortified Matrix:	392	102%	7%	98%	101%	105%
							% Recovery for PE Samples:	5	100%	2%	99%	100%	100%
UV <sub>254</sub>	1/cm	UNCC	3/26/98	12/14/98	SM5910	0.005	RPE of Analytical Duplicates:	NR	NR	NR	NR	NR	NR
							% Recovery for Lab Fortified Matrix:	NR	NR	NR	NR	NR	NR
							% Recovery for PE Samples:	NR	NR	NR	NR	NR	NR
TOC	mg/L	NC016	3/26/98	12/14/98	SM5310B	0.35	RPE of Analytical Duplicates:	68	4.54%	4.54%	0.94%	3.20%	6.48%
							% Recovery for Lab Fortified Matrix:	34	104%	13%	101%	104%	106%
							% Recovery for PE Samples:	7	103%	7.10%	99%	102%	106%
SDS-TOX	µg Cl-/L	CA013	9/1/97	5/1/99	SM5320B	25	RPE of Analytical Duplicates:	865	4%	4%	1%	3%	6%
							% Recovery for Lab Fortified Matrix:	883	100%	20%	92%	98%	105%
							% Recovery for PE Samples:	5	88%	8%	85%	86%	88%
SDS-CHCl <sub>3</sub>	µg/L	CA013	1/1/98	5/1/99	EPA 502.2	1	RPE of Analytical Duplicates:	109	4%	4%	0%	4%	7%
							% Recovery for Lab Fortified Matrix:	145	84%	40%	75%	85%	95%
							% Recovery for PE Samples:	5	102%	8%	97%	104%	108%
SDS-BDCM	µg/L	CA013	1/1/98	5/1/99	EPA 502.2	1	RPE of Analytical Duplicates:	117	3%	4%	0%	2%	5%
							% Recovery for Lab Fortified Matrix:	145	98%	129%	80%	90%	100%
							% Recovery for PE Samples:	5	100%	9%	94%	105%	105%
SDS-DBCM	µg/L	CA013	1/1/98	5/1/99	EPA 502.2	1	RPE of Analytical Duplicates:	117	3%	4%	0%	2%	4%
							% Recovery for Lab Fortified Matrix:	146	104%	54%	90%	96%	100%
							% Recovery for PE Samples:	5	100%	11%	94%	101%	105%

SDS-CHBr <sub>3</sub>	µg/L	CA013	1/1/98	5/1/99	EPA 502.2	1	RPE of Analytical Duplicates:	86	4%	5%	0%	2%	6%
							% Recovery for Lab Fortified Matrix:	146	122%	77%	98%	100%	120%
							% Recovery for PE Samples:	4	93%	13%	88%	90%	95%
<b>THM4</b>	µg/L	CA013	1/1/98	5/1/99	EPA 502.2		<b>Avg</b> RPE of Indiv Anal Dupl:	144	3%	3%	1%	3%	4%
							<b>Avg</b> % Recov for Indiv Lab Fort Matrix:	146	102%	47%	88%	95%	103%
							<b>Avg</b> % Recov for Indiv PE Samples:	5	100%	9%	97%	99%	106%
SDS-MCAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	2	RPE of Analytical Duplicates:	94	11%	12%	3%	6%	13%
							% Recovery for Lab Fortified Matrix:	447	107%	25%	97%	105%	115%
							% Recovery for PE Samples:	5	92%	5%	90%	91%	93%
SDS-DCAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	1	RPE of Analytical Duplicates:	367	4%	6%	0%	2%	6%
							% Recovery for Lab Fortified Matrix:	444	106%	41%	97%	100%	106%
							% Recovery for PE Samples:	5	90%	9%	85%	88%	88%
SDS-TCAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	1	RPE of Analytical Duplicates:	325	3%	6%	0%	2%	5%
							% Recovery for Lab Fortified Matrix:	444	108%	57%	97%	100%	110%
							% Recovery for PE Samples:	5	96%	12%	90%	92%	93%
SDS-MBAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	1	RPE of Analytical Duplicates:	48	10%	12%	0%	7%	16%
							% Recovery for Lab Fortified Matrix:	448	112%	27%	100%	105%	110%
							% Recovery for PE Samples:	5	89%	7%	84%	93%	94%
SDS-DBAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	1	RPE of Analytical Duplicates:	199	5%	6%	0%	3%	7%
							% Recovery for Lab Fortified Matrix:	447	105%	24%	97%	100%	106%
							% Recovery for PE Samples:	5	98%	15%	91%	94%	95%
SDS-BCAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	1	RPE of Analytical Duplicates:	325	4%	6%	0%	3%	6%
							% Recovery for Lab Fortified Matrix:	447	103%	19%	97%	100%	105%
							% Recovery for PE Samples:	5	95%	12%	90%	91%	92%
SDS-TBAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	4	RPE of Analytical Duplicates:	11	3%	2%	1%	2%	4%
							% Recovery for Lab Fortified Matrix:	320	113%	24%	103%	115%	125%
							% Recovery for PE Samples:	0					
SDS-CDBAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	2	RPE of Analytical Duplicates:	133	4%	5%	0%	3%	5%
							% Recovery for Lab Fortified Matrix:	407	113%	24%	104%	110%	120%
							% Recovery for PE Samples:	0					
SDS-DCBAA	µg/L	CA013	9/1/97	5/1/99	SM6251B	1	RPE of Analytical Duplicates:	325	4%	6%	0%	3%	6%
							% Recovery for Lab Fortified Matrix:	435	113%	22%	103%	110%	120%
							% Recovery for PE Samples:	0					
<b>HAA5</b>	µg/L	CA013	9/1/97	5/1/99	SM6251B		<b>Avg</b> RPE of Indiv Anal Dupl:	385	5%	5%	1%	4%	6%
							<b>Avg</b> % Recov for Indiv Lab Fort Matrix:	448	108%	23%	99%	103%	109%
							<b>Avg</b> % Recov for Indiv PE Samples:	5	100%	8%	87%	93%	93%
<b>HAA6</b>	µg/L	CA013	9/1/97	5/1/99	SM6251B		<b>Avg</b> RPE of Indiv Anal Dupl:	385	5%	5%	2%	4%	6%
							<b>Avg</b> % Recov for Indiv Lab Fort Matrix:	448	107%	20%	99%	103%	108%
<b>HAA9</b>	µg/L	CA013	9/1/97	5/1/99	SM6251B		<b>Avg</b> RPE of Indiv Anal Dupl:	387	5%	4%	2%	4%	6%
							<b>Avg</b> % Recov for Indiv Lab Fort Matrix:	448	109%	17%	102%	106%	111%

QA/QC Data - Sheet 2											Percentiles		
Analyte Identification	Units	Laboratory Identification	Start Service Date	End Service Date	Method	MRL	Count	Average	Std Dev		25th	50th	75th
pH	unit												
Temperature	C												
Alkalinity	mg/L as CaCO <sub>3</sub>												
Ammonia	mg NH <sub>3</sub> -N/L												
Calcium Hardness	mg/L as CaCO <sub>3</sub>												
SDS-Cl <sub>2</sub> Residual	mg/L												
Total Hardness	mg/L as CaCO <sub>3</sub>												
Turbidity	ntu												
Bromide	µg/L									RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:			
UV <sub>254</sub>	1/cm									RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:			
TOC	mg/L	UNCC	5/26/98	9/28/98	SM5310B	0.2				RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:	NR	NR	NR
											NR	NR	NR
											NA	NA	NA
SDS-TOX	µg Cl-/L									RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:			
SDS-CHCl <sub>3</sub>	µg/L									RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:			
SDS-BDCM	µg/L									RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix: % Recovery for PE Samples:			
SDS-DBCM	µg/L									RPE of Analytical Duplicates: % Recovery for Lab Fortified Matrix:			

SDS-CHBr <sub>3</sub>	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
THM4	µg/L		% Recovery for PE Samples:	
			Avg RPE of Indiv Anal Dupl:	
			Avg % Recov for Indiv Lab Fort Matrix:	
SDS-MCAA	µg/L		Avg % Recov for Indiv PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-DCAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-TCAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-MBAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-DBAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-BCAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-TBAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-CDBAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
SDS-DCBAA	µg/L		% Recovery for PE Samples:	
			RPE of Analytical Duplicates:	
			% Recovery for Lab Fortified Matrix:	
HAA5	µg/L		% Recovery for PE Samples:	
			Avg RPE of Indiv Anal Dupl:	
			Avg % Recov for Indiv Lab Fort Matrix:	
HAA6	µg/L		Avg % Recov for Indiv PE Samples:	
			Avg RPE of Indiv Anal Dupl:	
			Avg % Recov for Indiv Lab Fort Matrix:	
HAA9	µg/L			
			Avg RPE of Indiv Anal Dupl:	
			Avg % Recov for Indiv Lab Fort Matrix:	