ICR Treatment Study Summary Report

Evaluation of Granular Activated Carbon Contactors on a Pilot Scale for Compliance with the Information Collection Rule

Conducted during the period of April 14, 1998 through September 9, 1998

Prepared by:
I&D Water Plant Staff
6183 Highway 21
Port Wentworth, Ga 31407

In December 1998

For:
Savannah Water System, GA0510003
208 Agonic Road
Savannah, Ga 31406
Phone: (912)351-3434
FAX: (912)351-3444

Savannah I&D Water Plant, #323

Attachments: 2 Diskettes containing the Data Collection Spreadsheets and the Summary Report Spreadsheets and hard copies of the spreadsheets.

Section I: Conclusions and Recommendations

Based upon the effluent Total Organic Carbon concentration reaching levels very near those of the influent, and the fact that the concentrations of disinfection by-products in the effluent actually exceeded those of the influent, the initial conclusion drawn from a review of the data is the 10 minute contactor lost it's activity after approximately 6 weeks of operation. The effluent Total Organic Carbon concentration of the 20 minute contactor became extremely erratic after approximately 12 weeks of operation. This erratic behavior made it very difficult to determine proper sample taking protocol. However, the samples collected indicated that the effluent Total Organic Carbon concentration of the 20 minute contactor did approach that of the influent in a manner similar to that of the 10 minute contactor. The concentrations of disinfection by-products in the effluent of the 20 minute contactor approached, or slightly exceeded, the levels of the influent, but not nearly as obvious as the 10 minute contactor.

The inherent instability of the source water particularly with regard to the TOC concentration, renders a comparison of an average influent value to a single effluent value questionable at best.

Since the I&D plant is meeting the Stage I DBP regulations at this time, as well as meeting the proposed Stage II DBP regulations the majority of the time, an expenditure of the magnitude of full-scale GAC contactors appears unwarranted at this time.

The I&D plant staff is evaluating methods of optimizing all stages of the treatment process on an ongoing basis. Based upon previous success with improving the treatment train, staff is confident the plant will be able to meet the Stage II DBP regulations without major modifications to the facility.

Section II: Background Information

This section includes copies of the ICR Data Collection Software's A2 and A3 reports which contain the appropriate data regarding each of the treatment processes. Also included is a plant schematic diagraming the treatment process.
Please note the tabular water quality data is the results from the ICR monitoring.

Water Quality Parameter	Average Yearly Concentration	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature (^{0}C)	21.1	6.4	29.0	12.5
pH	6.67	0.13	6.89	6.50
Turbidity (ntu)	15.3	5.5	23.0	7.51
Alkalinity (mg/L as $CaCO_3$)	21.3	3.5	26	15
Calcium Hardness (mg/L as $CaCO_3$)	13.3	2.3	16	9
Total Hardness (mg/L as $CaCO_3$)	19.5	2.8	24	13
TOC (mg/L)	4.9	1.0	6.5	2.7
UV_{254} (cm^{-1})	0.211	0.105	0.37	0.024
Bromide (PPB)	0.042	0.016	0.066	0.022

Table 1 Tabular Summary of Source Water Quality

Water Quality Parameter	Average Yearly Concentration	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
Temperature (^{0}C)	20.8	6.5	28.5	12.0
pH	7.00	.25	7.63	6.67
Turbidity (ntu)	.30	.10	.44	.16
TOC (mg/L)	2.3	0.3	2.7	1.6
Distribution System THM4 (ppb)	31.9	4.8	36.5	25.1

Table 2 Tabular Summary of Treated Water Quality

A.2 -- Design Plant Parameters

Date: 1/31/97

PWS Name: Savannah Water System
PWS ID: GA0510003
WIDB:
ICR Contact Person: Mr. Tony Tucker

Sampling Period: Design
Design Sampling Start Date: 2/4/97
Design Sampling End Date: 7/31/98

Treatment Plant Name: Savannah I & D Water Plant
ICR Treatment Plant ID: 323
Treatment Plant PWS ID: GA0510004
Treatment Plant Category: CONV

State Approved Plant Capacity (MGD): 55.0
Historical Min. Water Temperature (deg C): 7.0
Installed Sludge Handling Capacity (DPD): 15,000.00
Blending Indicator: N

Water Resource Name: Abercorn Creek
Water Resource Type: Flowing stream
Intake Name: Raw water pumping station
Watershed Control: N
Hydrologic Unit Code:

On River Reach Code:
Latitude (degrees, minutes, seconds): +32°15'20''
Longitude (degrees, minutes, seconds): -81°10'42''
River Reach Miles:

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.
	Influent	INF	1

Process Train Name: I & D Train
Process Train Category: CONV

1	Rapid Mix	Rapid Mix	Type of Mixer: HY

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.	
				Baffling Type: PR Liquid Volume (gal): 20,320 Short Circuiting Factor: Mean Velocity Gradient (sec-1): 250.0
2	Flocculation	Flocculation Basin		Type of Mixer: ME Liquid Volume (gal): 1,024,070 Short Circuiting Factor: Baffling Type: AV Stage Sequence Number: 1 Stage Mean Velocity Gradient (sec-1): 75 Stage Liquid Volume (gal): 85,339 Stage Sequence Number: 2 Stage Mean Velocity Gradient (sec-1): 50 Stage Liquid Volume (gal): 85,339 Stage Sequence Number: 3 Stage Mean Velocity Gradient (sec-1): 42 Stage Liquid Volume (gal): 85,339
3	Sedimentation	Sedimentation	5	Surface Area (ft2): 49,580 Liquid Volume (gal): 5,564,000 Baffling Type: PR Short Circuiting Factor:

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.	
				Plate Settler Surface Area (ft2): Plate Settler Brand Name: Tube Settler Surface Area (ft2): Tube Settler Brand Name:
4	Chlorine gas	Disinfectant Addition		Chemical Code: CL2 Measurement Formula: CL2 Dose Rate (mg/L): 1.60
5	Filtration	Filtration	10	Surface Area (ft2): 14,400 Liquid Volume (gal): 371,606 Total Media Depth (in): 28 Depth of GAC (in): Media Type: DUAL Type of Activated Carbon: Minimum Water Depth To Top of Media (ft): 3.7 Depth From Top of Media to Top of Backwash Trough (ft): 41.5
6	Chlorine gas	Disinfectant Addition		Chemical Code: CL2 Measurement Formula: CL2 Dose Rate (mg/L): 0.60
7	Aftermix	Other Treatment Process		Surface Area (ft2): Liquid Volume (gal): Short Circuiting Factor:

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.
	Finished Water	FIN	15

A.3 -- Design Plant Chemical Parameters

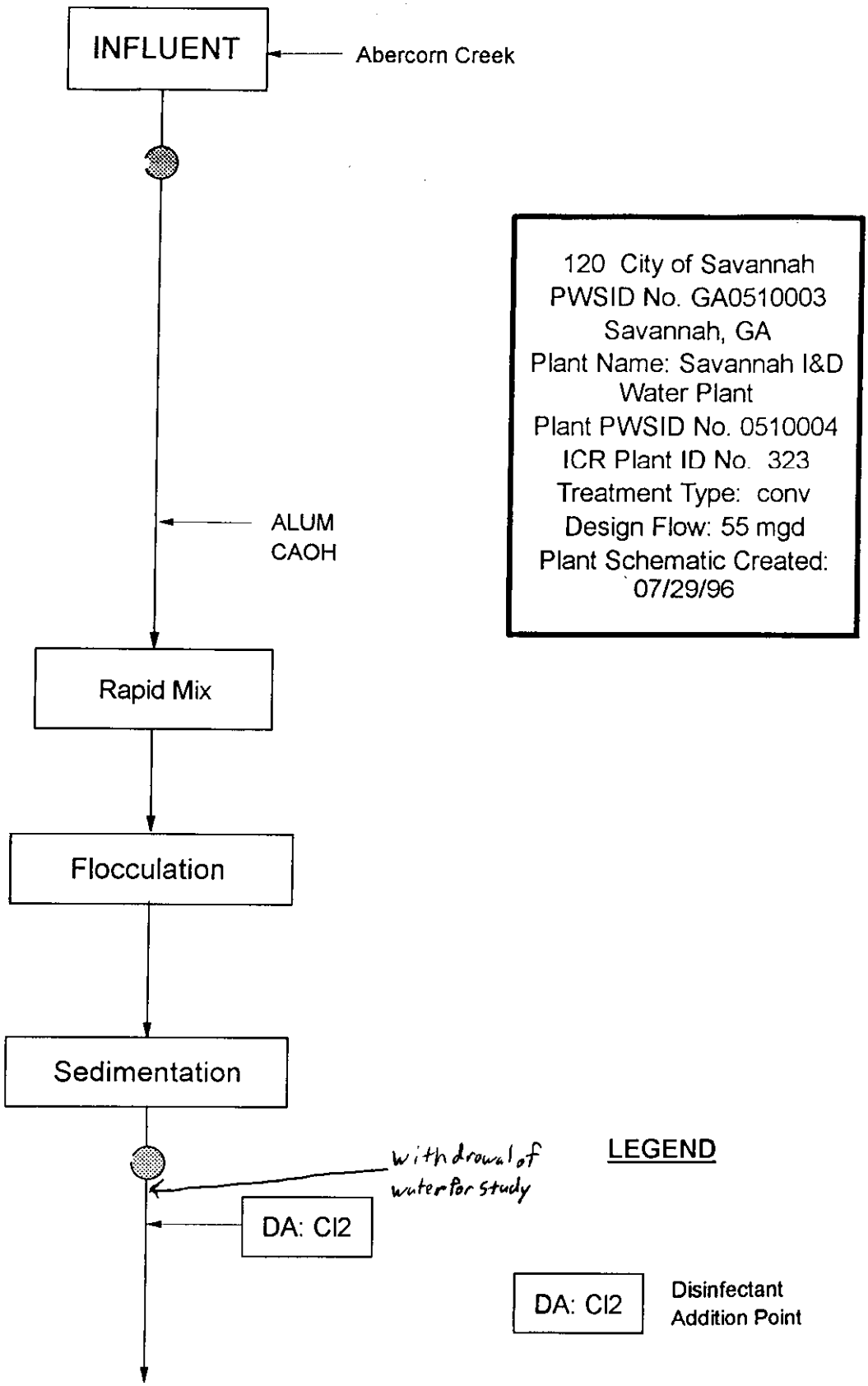
Date: 1/31/97

PWS Name: Savannah Water System
PWS ID: GA0510003
WIDB:
ICR Contact Person: Mr. Tony Tucker

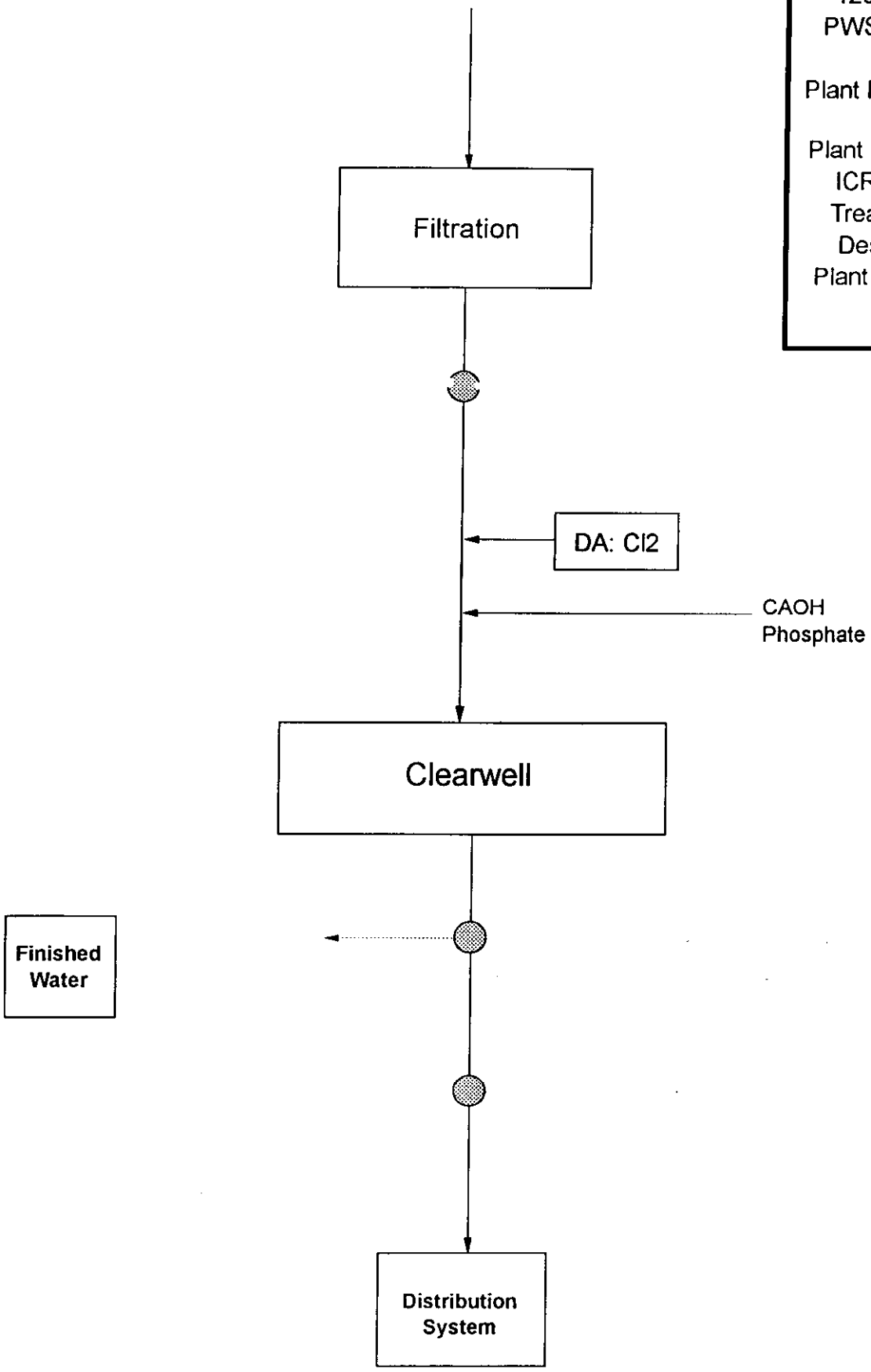
Sampling Period: Design
Sampling Start Date: 2/4/97
Sampling End Date: 7/31/98

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
Treatment Plant Name: Savannah I & D Water Plant **ICR Treatment Plant ID No:** 323 **Treatment Plant Category:** CONV						
Process Train Name: I & D Train **Process Train Category:** CONV						
1	Rapid Mix	Rapid Mix				
				Calcium oxide	CAO	1.00
				Aluminum sulfate (Alum)	Alum	25.00
2	Flocculation	Flocculation Basin				
				Organic polymer - coagulant aid	OPC	0.05
3	Sedimentation	Sedimentation	5			
4	Chlorine gas	Disinfectant Addition				
				Chlorine gas	CL2	1.60
5	Filtration	Filtration	10			

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
6	Chlorine gas	Disinfectant Addition				
7	Aftermix	Other Treatment Process		Chlorine gas	CL2	0.60
				Calcium oxide	CAO	9.00
				Other chemical	PHOS	0.40


INFLUENT
Abercorn Creek
ALUM
CAOH
Rapid Mix
Flocculation
Sedimentation
withdrawal of water for study
DA: Cl2
120 City of Savannah
PWSID No. GA0510003
Savannah, GA
Plant Name: Savannah I&D Water Plant
Plant PWSID No. 0510004
ICR Plant ID No. 323
Treatment Type: conv
Design Flow: 55 mgd
Plant Schematic Created: 07/29/96
LEGEND
DA: Cl2
Disinfectant Addition Point
Flocculation
Unit Process
ALUM
Chemical Added to Unit Process

120 City of Savannah
PWSID No. GA0510003
Savannah, GA
Plant Name: Savannah I&D Water Plant
Plant PWSID No. 0510004
ICR Plant ID No. 323
Treatment Type: conv
Design Flow: 55 mgd
Plant Schematic Created: 07/29/96



Section III: Materials and Methods

A list of the laboratories and analytical methods can be found on the Summary Report Diskette.

I&D Water Laboratory
PO Box 4038/6183 Highway 21
Port Wentworth, Ga 31407
Phone: (912)964-4473
FAX: (912)964-8342
Contact: Tony Tucker

E.S. Babcock & Sons Inc.
6100 Quail Valley Court
Riverside, CA 92502
Phone: (909)653-3351
FAX: (909)653-1662
Contact: Shawn Jenkins

EXISTING TREATMENT SYSTEM

The Industrial and Domestic Water Treatment Plant uses conventional processes to treat approximately 50 MGD of surface water to potable and industrial standards. A schematic of the existing processes is provided in Figure 1. General raw water quality data and chemical dosage are as follows.

RAW WATER QUALITY [1,3]			
PARAMETER	MAX	MIN	AVG
ALKALINITY (ppm)	33.6	14.4	23
pH	6.9	6.2	6.6
COLOR	200	7	60.3
TURBIDITY (ntu)	97.1	5.09	15.36
CO_2 (ppm)	18.75	4.95	10.6
TEMPERATURE (°C)	29	9	20.8

CHEMICAL DOSAGE [1,3] (ppm)			
CHEMICAL	MAX	MIN	AVG
PRE-LIME	4.5	0.29	2.2
ALUM	42.9	16.5	23
POLYMER	0.1	0.05	0.05
POST-LIME	12.2	3.8	7.2
CHLORINE	3.3	1.2	2.2
PHOSPHATE	0.75	0.4	0.55

Notes:

1. Maximum, minimum and average chemical dosages do not necessarily correspond to maximum, minimum or average raw water quality parameters.
2. Use of pre-lime is not always required. Therefore, the figure shown is relative only to periods of use.
3. Based on 1996 data.

PILOT CONFIGURATION & SPECIFICATIONS (ACTUAL)

PILOT STUDY OPERATION

A. General

The pilot study generally consisted of two (2) dual media rapid sand filters for production of non-chlorinated filtered water, and two (2) 10 minute EBCT GAC contactors in series. A Process and Instrumentation Diagram is provided in Figure 2.

B. Filtration

1. Normal Operation

As shown in Figure 1, current operation of the plant calls for chlorine injection within the sedimentation basin effluent launders. Therefore, plant filtered water could not be used for the purpose of this study. Therefore, settled water was taken directly from the sedimentation basin prior to entering the effluent launders. The settled water was transferred by gravity to one of either of the two pilot-filter columns. The pilot-filter columns were constructed to be dual media (10 inches sand and 18 inches anthracite) consistent with the plant production filters.

During normal operation, a single pilot-filter column was in operation at the current maximum plant production filtration rate of 3.15 gpm/ft^2. Filtration at this rate provided approximately 1.1 gpm of filtered water per pilot-filter column. Pilot filter effluent was directed to a 20 gallon process reservoir. The process reservoir allowed for complete shut down of both pilot-filter columns for approximately 20 minutes without disrupting the GAC run. Excess pilot filter effluent was wasted via a reservoir overflow to drain. The limited size of the process reservoir minimized detention time of the filtered water.

2. Backwash Operation

Pilot-filter effluent could also be directed to a 100 gallon backwash reservoir. A backwash rate of approximately 15 gpm/ft^2 was required to produce adequate expansion of both sand and anthracite layers and to elevate heavier particles and mudballs to the waste trough. In addition, approximately 10 minutes at this rate was required for adequate cleaning. As air-scour is available in the plant production filters, but not in the pilot-filter columns, an additional 5 minutes of backwash time was used to obtain acceptable pilot-filter cleaning. During the first several 100 hour runs of the pilot-filter columns, the backwash reservoir was filled using effluent from the stand-by pilot filter. However, large amounts of algae began to accumulate within the filter media due to the lack of chlorine. Therefore, the source of backwash water was changed to plant finished water. The plant finished water contained sufficient chlorine to minimize algae growth without any apparent affect on TOC levels through the actual run.

C. GAC Contactors

1. Design Parameters

Two (2) 10 minute EBCT contactors were used in series as shown in Figure 3. Upon commencement of operation of the GAC contactors, it became apparent that the headloss through the 10 minute contactor and effluent piping was higher than anticipated. Therefore, the Volumetric Flow Rate as proposed in the Treatment Study Application (copy attached) was decreased from 0.87 gpm to 0.50 gpm. At the newly established flow rate, both the 10 minute and 20 minute contactors operated at a constant level above the GAC bed. Therefore, the initial design parameters were modified and the actual design parameters for the study are as follows:

Column Diameter	8 inches
Cross-sectional area	0.349 ft^2
Hydraulic Loading Rate	1.43 gpm/ft^2
Volumetric Flow Rate	0.50 gpm
E B C T (each column)	10 minutes
GAC Bed Length (each column)	1.9 ft
GAC Bed Volume (each column)	0.663 ft^3
Water Height above GAC	6.3 ft
GAC specifications	Activated Lignite Coal from Norit Americas Inc. 0.60 mm - 2.36 mm

2. Operation

Non-chlorinated filtered water was pumped from the 20 gallon process reservoir (see A 1 above.) into the first contactor. Utilizing a continuous overflow of the incoming filtered water a constant water column level above the GAC bed was maintained without the use of additional sophisticated controls. Effluent from the first contactor was then piped in as the influent to the second contactor. Total flow through the system was controlled via an electrically actuated control valve. A flow meter producing a 4-20 mA signal provided feedback to the control valve. The flow meter and control valve was located on the discharge of the second contactor for flow control through both contactors.

3. Backwash Operation

The modulating effluent valve controlling flow through the second 10 minute contactor provided a constant flow until such time as headloss became sufficient to reduce the maximum output to less than 0.5 gpm. The point at which sufficient flow could not be maintained, both contactors were taken off-line and backwashed and placed back in service.

SIMULATED DISTRIBUTION SYSTEM

The SDS samples was taken prior to entering the first GAC contactor and immediately after exiting the effluent flow meter of the second GAC contactor . As residence time in the actual distribution system is approximately two (2) hours, the samples were also held for two (2) hours. Plant pH ranges from approximately 7.0 to 7.4. Therefore, SDS samples were pH adjusted to 7.2 plus or minus 0.2. SDS samples were dosed with chlorine of an amount sufficient to obtain a free chlorine residual of 1.2 ppm plus or minus 0.2. SDS samples were held under a free flowing stream of plant effluent to ensure that the sample maintained a temperature as close as possible to the temperature in the distribution system. Temperature variations in the plant effluent were monitored and recorded enabling seasonal temperature variation accountability. All chlorination and pH adjustments were accomplished under laboratory conditions.

Following are the diagrams for the plant process and contactors as well as the Study Concept Form and a chemical data sheet for the activated carbon.

Included in Appendix A are copies of the original GAC Treatment Study Application letters.

PLANT PROCESS SCHEMATIC
SOURCE
CALCIUM HYDROXIDE
(AS REQ'D FOR pH AND
ALKALINITY ADJUSTMENT)
ALUMINUM SULFATE
(COAGULATION)
RAPID
MIX
POLYMER
3 STAGE
FLOCCULATION
SEDIMENTATION
PROPOSED ICR TESTING
SOURCE WATER
PRE-FILTRATION
CHLORINATION
DUAL MEDIA
RAPID SAND
FILTRATION
CLEARWELL
CHLORINE, FINAL DISINFECTION
CALCIUM HYDROXIDE, FINAL pH ADJUST
DISTRIBUTION
PUMPING
ORTHOPHOSPHATE

FIGURE 1

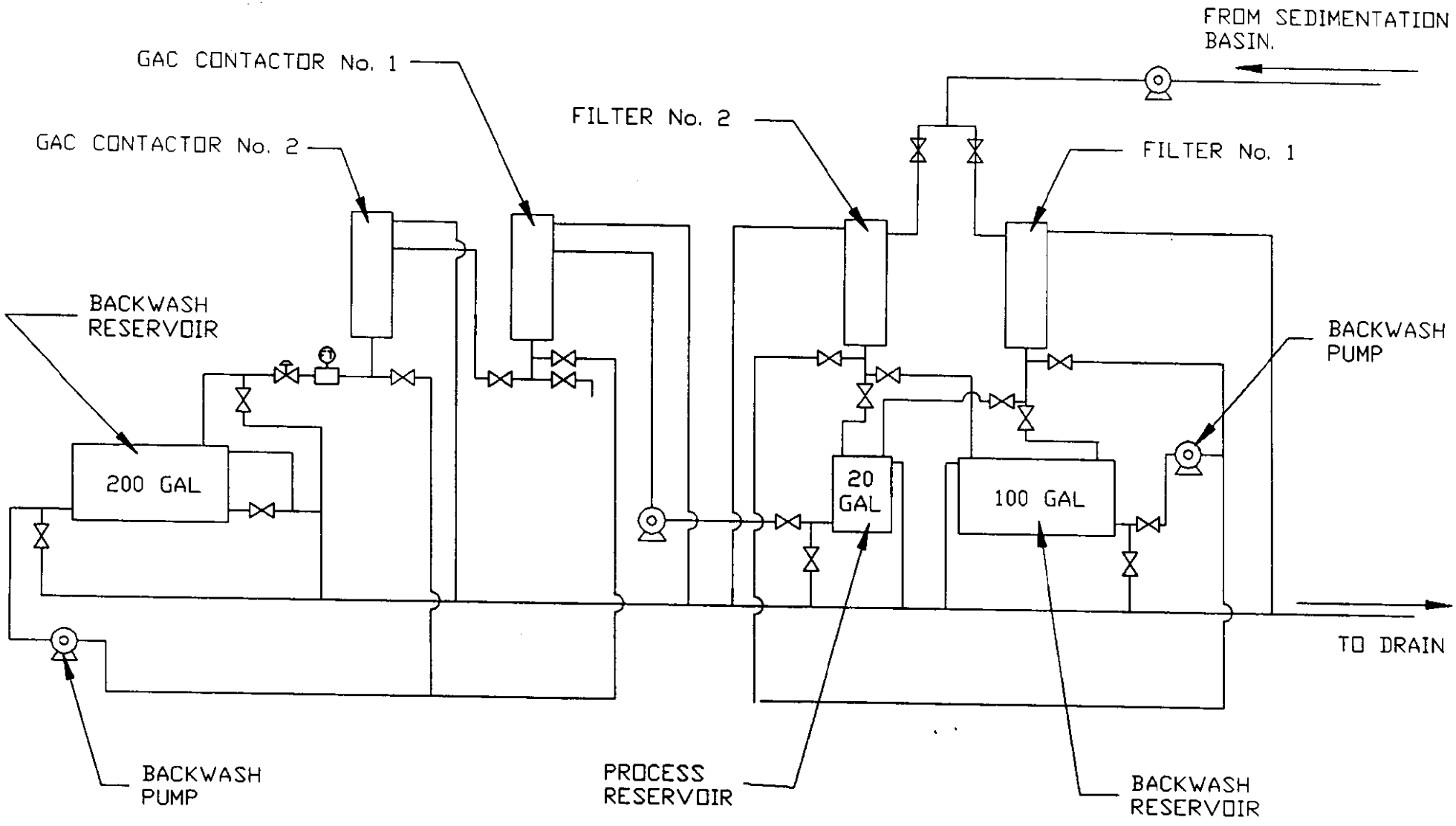
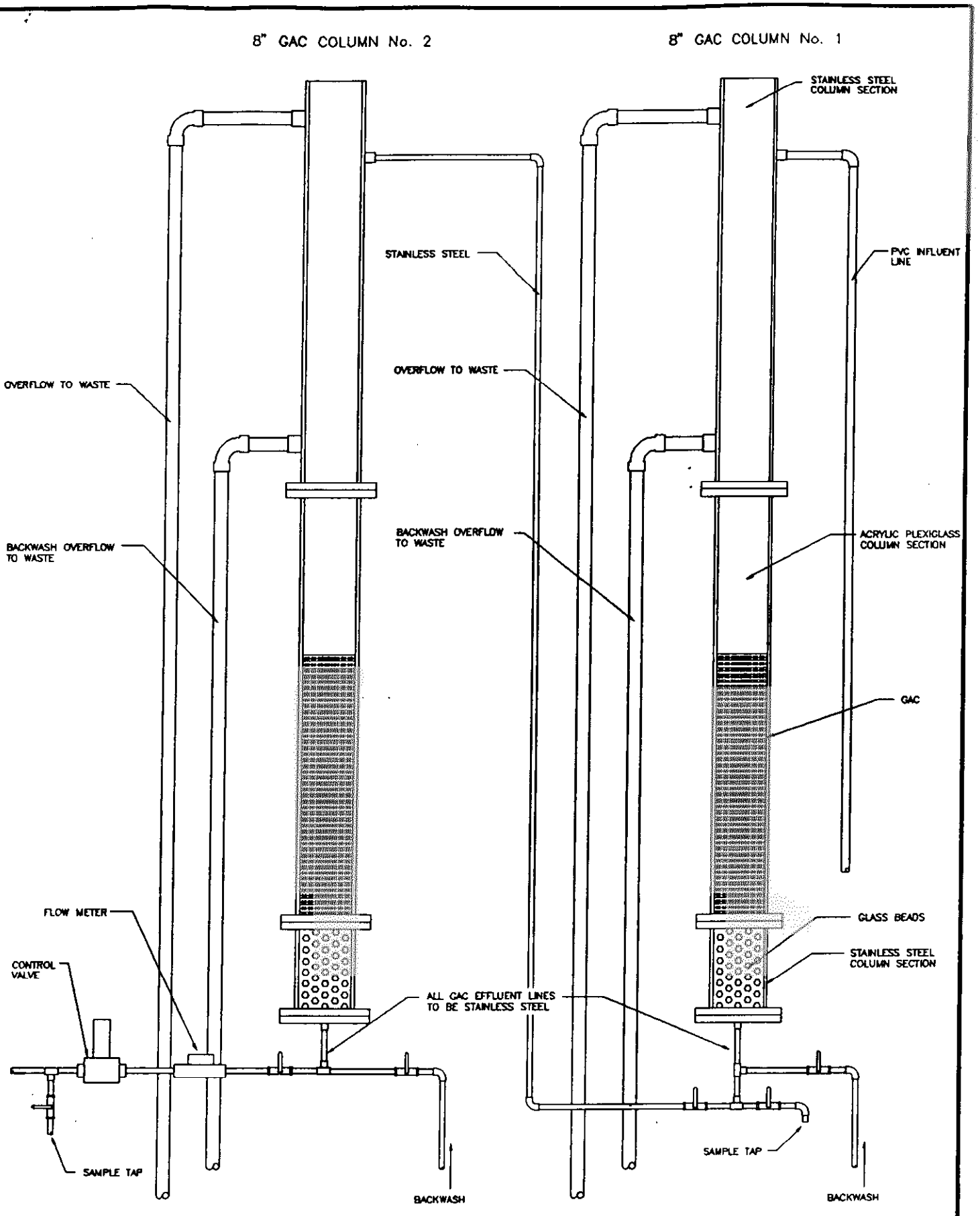


FIGURE 2

GAC CONTACTOR/FILTER P&ID

NO SCALE



GAC CONTACTOR

NO SCALE

FIGURE 3

Table 5-1 General Public Water System And Plant Information (page 1 of 2)

Public Water System Information

Utility name	CITY OF SAVANNAH WATER SYSTEM
PWSID#	0510003
WIDB# (optional)	
PWS combined population served	143,500
PWS ground water population served	137,000

Official Contact Person

Name	HARRY JUE
Mailing address	P.O. BOX 1027 SAVANNAH GA 31402
Phone #	912-651-4241
FAX #	912-651-6808
E-mail address	

ICR Contact Person

Name	TONY TUCKER
Mailing address	P.O. BOX 4038 PT. WENTWORTH GA 31407
Phone #	912-964-4473
FAX #	912-964-8342
E-mail address	

Treatment Plant Information

Plant name	SAVANNAH I&D PLANT
Plant ICR #	323
Plant combined population served	0
Plant ground water population served	0
Plant surface water population served	6500

Plant Contact Person

Name	TONY TUCKER
Mailing address	P.O. BOX 4038 PT. WENTWORTH GA 31407
Phone #	912-964-4473
FAX #	912-964-8342
E-mail address	

Table 5-11 Study Concept Form[1]

General Study Information

Is this an individual or a joint study?	INDIVIDUAL
Will GAC or membranes be investigated?	GAC
Is this a pilot- or a bench-scale study?	PILOT
At what point in the full-scale plant will water be collected for the study?	POST SEDIMENTATION
Where is the first point that chlorine is added in the full-scale plant?	PRE FILTRATION
Will the treatment study influent be collected prior to the addition of chlorine based oxidants?	YES
What is the average TOC concentration of the treatment study influent?	MAX = 3.82; MIN = 2.03; AVG = 2.70
How many tests will be required to evaluate seasonal variability?	ONE (1)

GAC Study Information

Carbon type and manufacturer to be investigated	ACTIVATED LIGNITE COAL/NORIT AMERICAS, INC.
Carbon particle diameter	0.60 MM - 2.36 MM
Carbon column diameter	8"

(SEE ATTACHED GAC DATA SHEET.)

Membrane Study Information

Procedure to be used (RBSMT, SEBST, pilot)	
Element size to be investigated	
Model number and manufacturer of membrane #1	
Molecular weight cutoff of membrane #1	
Model number and manufacturer of membrane #2	
Molecular weight cutoff of membrane #2	

Study Plan

Attach a brief study plan (usually not more than two pages of text and two pages of figures) which should include the equipment to be used, pretreatment to be used prior to GAC or membranes, design parameters, operating parameters, whether or not seasonal variability need to be evaluated and if seasonal variability can be evaluated in fewer than four quarters, the parameters that will be investigated in lieu of seasonal variability.

1 One study concept form must be submitted for each study to be conducted

NORIT Americas Inc.

Solutions Through Carbon Technology

DATASHEET

Bulletin No 5352
Revised 8-96

HYDRODARCO® 3000
GRANULAR ACTIVATED CARBON

HYDRODARCO 3000 is a carbon designed for water treatment applications. It is produced by high temperature steam activation of lignite coal. **HYDRODARCO 3000** has a wide pore size distribution and large pore volume. These characteristics provide **HYDRODARCO 3000** with rapid adsorption rate and high capacity for dissolved organics.

Potable Water

HYDRODARCO 3000 adsorbs taste, odor, color and toxic organic compounds from drinking water. It has the highest capacity of any commercial water carbon for tannic and humic compounds which are precursors for trihalomethane (THM) formation. **HYDRODARCO 3000** effectively removes pesticides, herbicides, synthetic organic chemicals and many other suspected carcinogenic compounds which may find their way into water supplies. **HYDRODARCO 3000** meets all AWWA B-604 standards for activated carbon for rapid gravity filters and pressure contactors used in potable water purification systems. It is certified to ANSI/NSF Standard 61.

Wastewater and Contaminated Groundwater

Whether applied at point source or in a polishing filter, HYDRODARCO 3000 can be used to meet discharge limits for most regulated organics. The broad pore size distribution of **HYDRODARCO 3000** allows treatment of complex wastewater streams containing large and small molecular pollutants. The macroporous structure of **HYDRODARCO 3000** provides high tolerance for natural organic matter which interferes with adsorption of organic contaminants.

Product Specifications

Molasses decolorizing efficiency, %	85 min.
Moisture, % as packed	8 max.
Dust, %	0.30 max.
Mesh size (U.S. Sieve Series)	
Greater than 8 mesh (2.36mm), %	5 max.
Less than 30 mesh (0.60mm), %	5 max.

Typical Properties*

Tannin value, ppm	220
Molasses number	425
Iodine number, mg/g	660
pH, water extract	4.8
Apparent density, vibrating feed, g/ml	0.40
lbs./ft^3	25
Bed density, backwashed and drained, lbs./ft^3	22
Mean particle diameter, mm	1.3
Abrasion number (NBS)	80

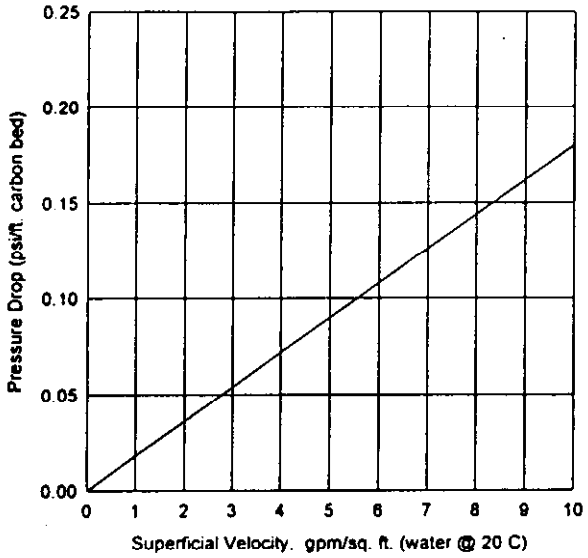
(Continued on reverse)

General Characteristics*

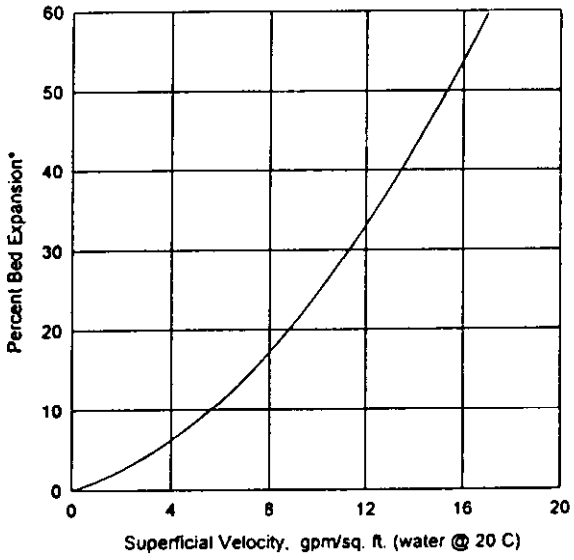
Surface area, m^2/g	600
Total pore volume, ml/g	0.93

*For general information only, not to be used as purchase specifications.

Pressure Drop Curve
for HYDRODARCO 3000



Bed Expansion Curve
for HYDRODARCO 3000



*Expansion is expressed as percent of the backwashed and settled bed depth.

Packaging

Standard package is 40 lb. bags, 30 bags per pallet for a net pallet weight of 1200 lbs. Alternate package includes woven bulk polypropylene bags, 880 lbs. net, with glued plastic liner.

Safety

CAUTION: Wet activated carbon depletes oxygen from air and, therefore, dangerously low levels of oxygen may be encountered. Whenever workers enter a vessel containing activated carbon, the vessel's oxygen content should be determined and work procedures for potentially low oxygen areas should be followed. Appropriate protective equipment should be worn. Avoid inhalation of excessive carbon dust. No problems are known to be associated in handling this material. However, dust may contain greater than 1.0% silica (quartz). Longterm inhalation of high dust concentrations can lead to respiratory impairment. Use forced ventilation or a dust mask when necessary for protection against airborne dust exposure (see Code of Federal Regulations - Title 29, Subpart Z, par. 1910.1000, Table Z-3).

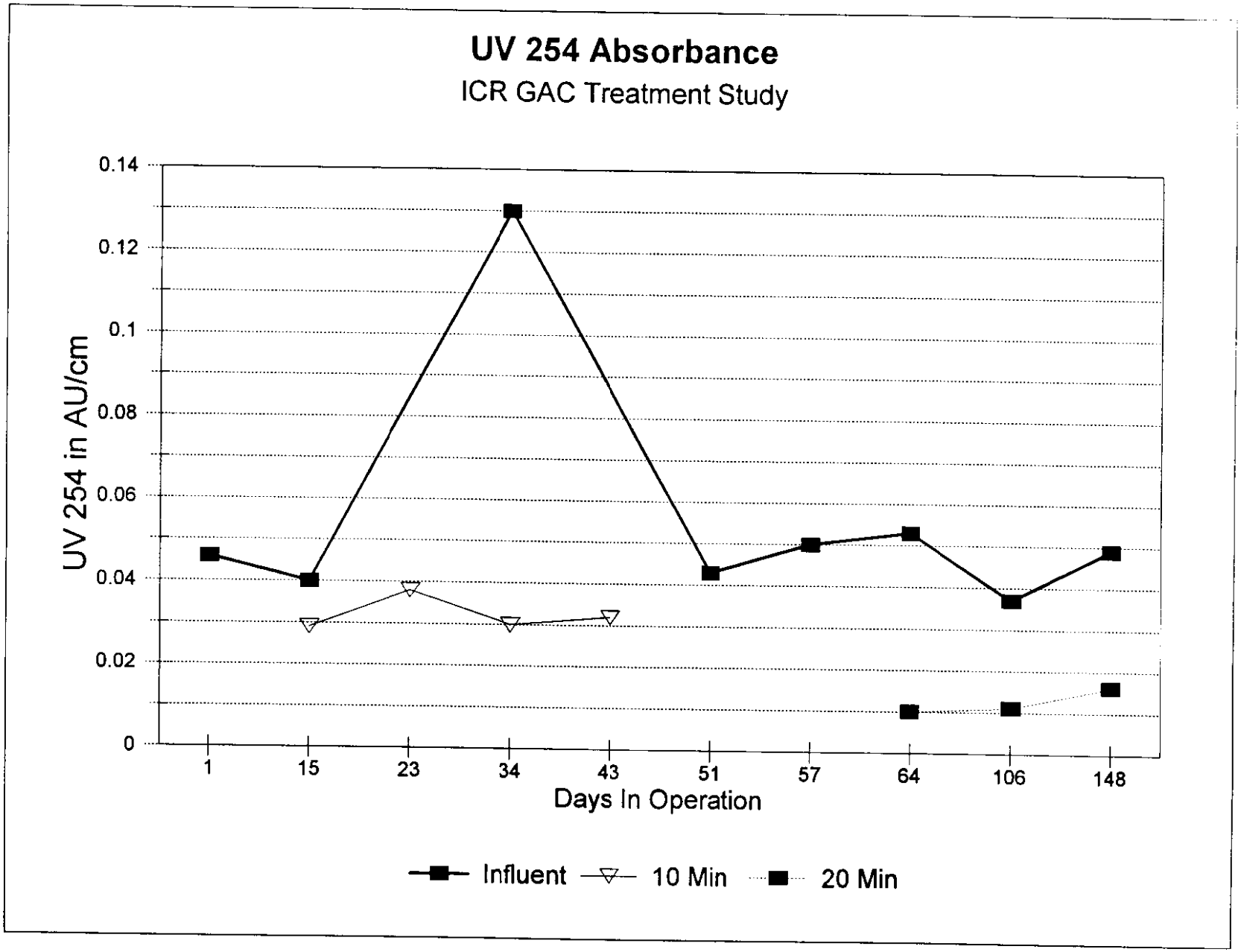
NSF

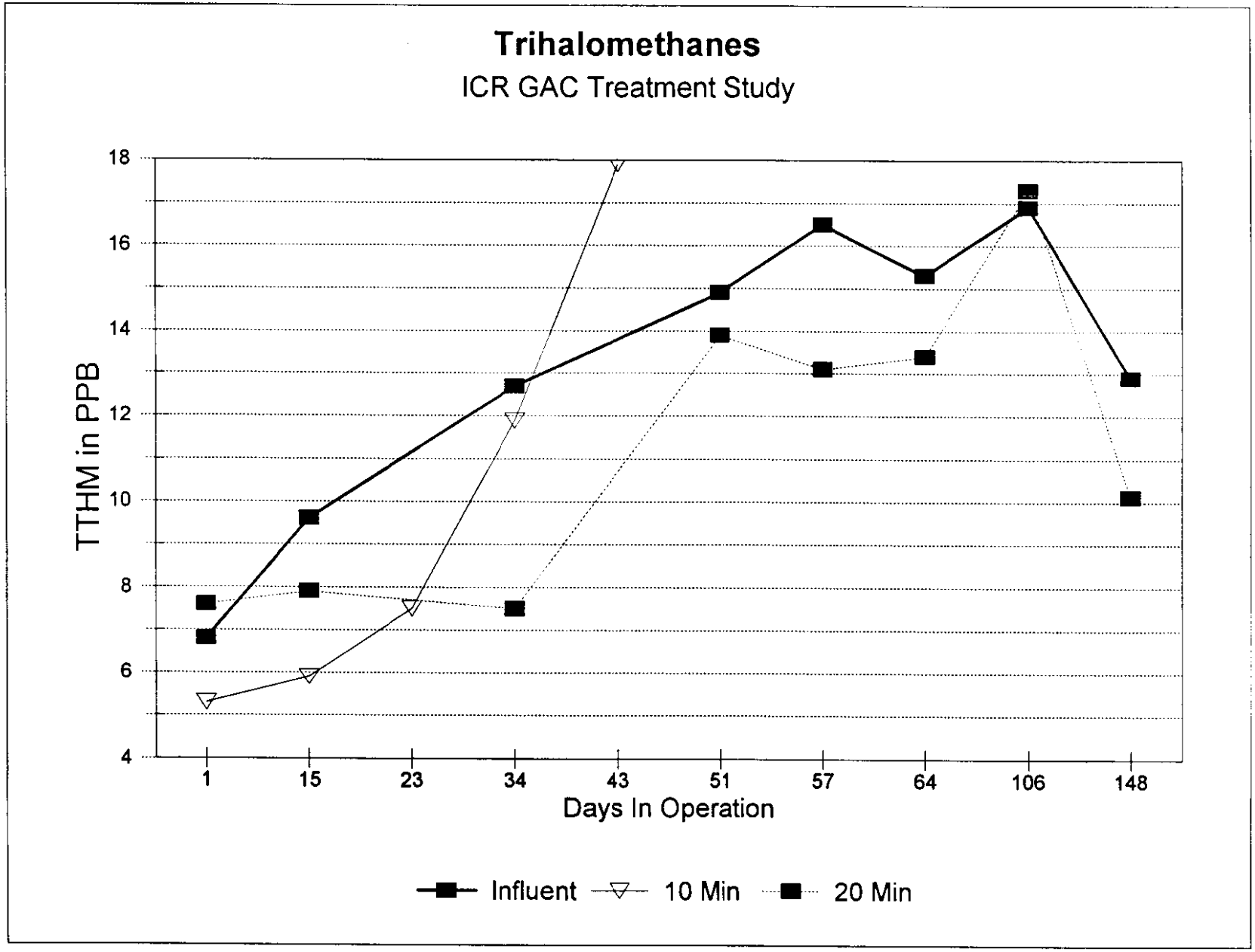
Section IV: Results and Discussion

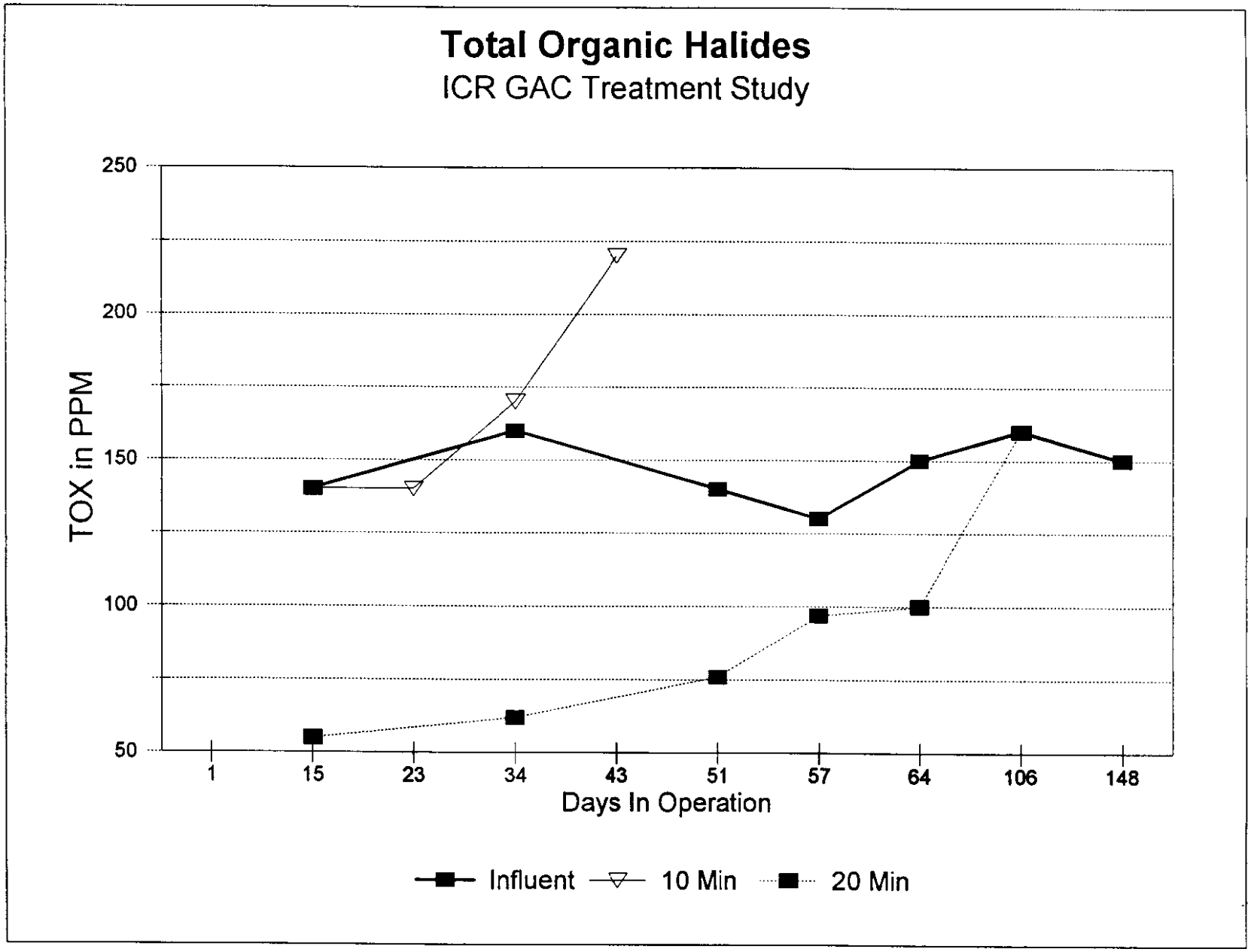
During the pilot-scale GAC study the water flow to the pre-filters was interrupted . This resulted in the contactors losing water flow for a period of approximately 3 hours (5/26/98 8:30 am to 11:30 am. The contactors were backwashed and production was re-started.
During the pilot-scale GAC study the water flow to the pre-filters was interrupted . This resulted in the contactors losing water flow for a period of approximately 4 hours (5/29/98 11:30 am to 3:30 pm. The contactors were backwashed and production was re-started.

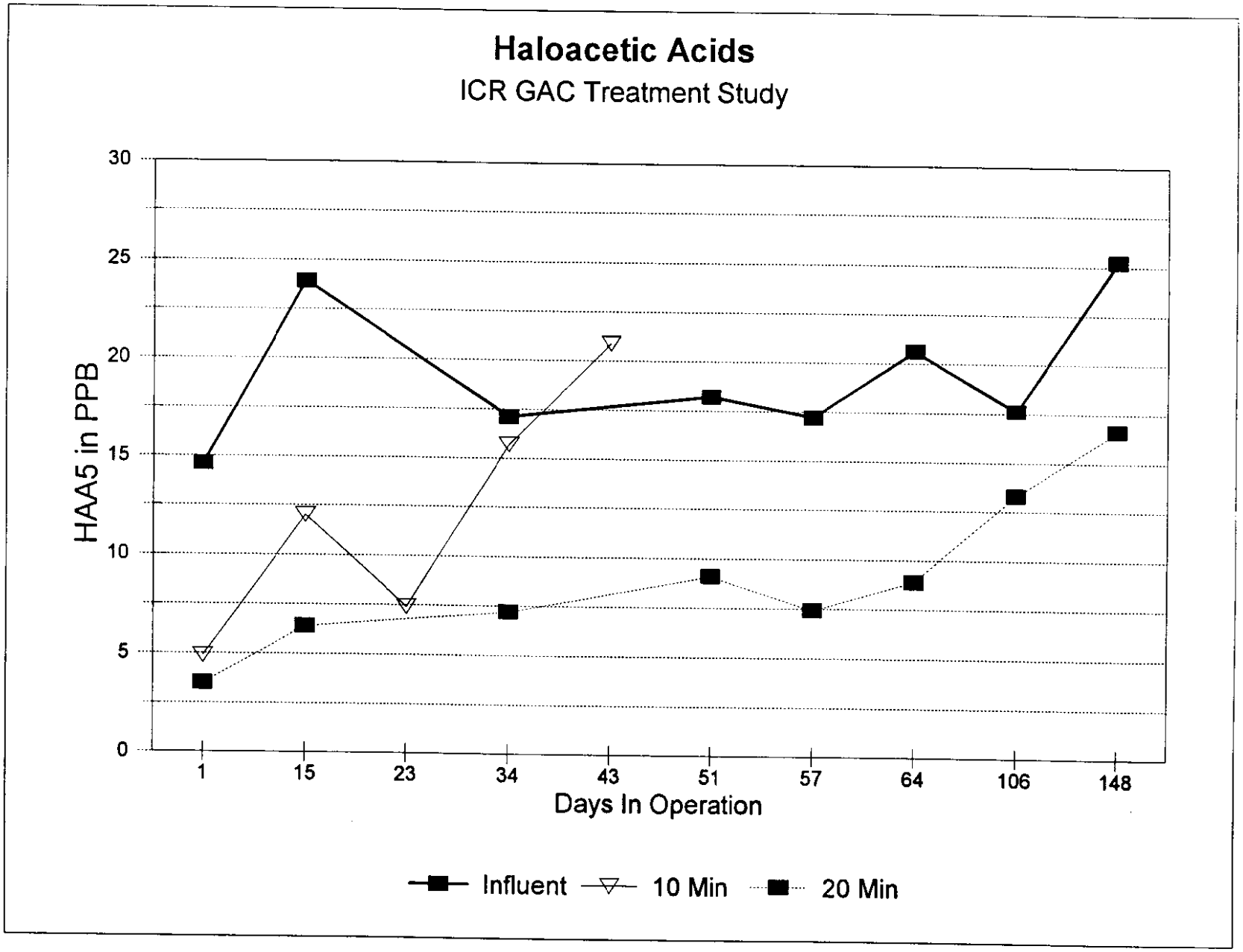
The source water quality demonstrates little or no seasonal variation with the exception of temperature. The water quality is unstable at all times of the year with no established seasonal trends.

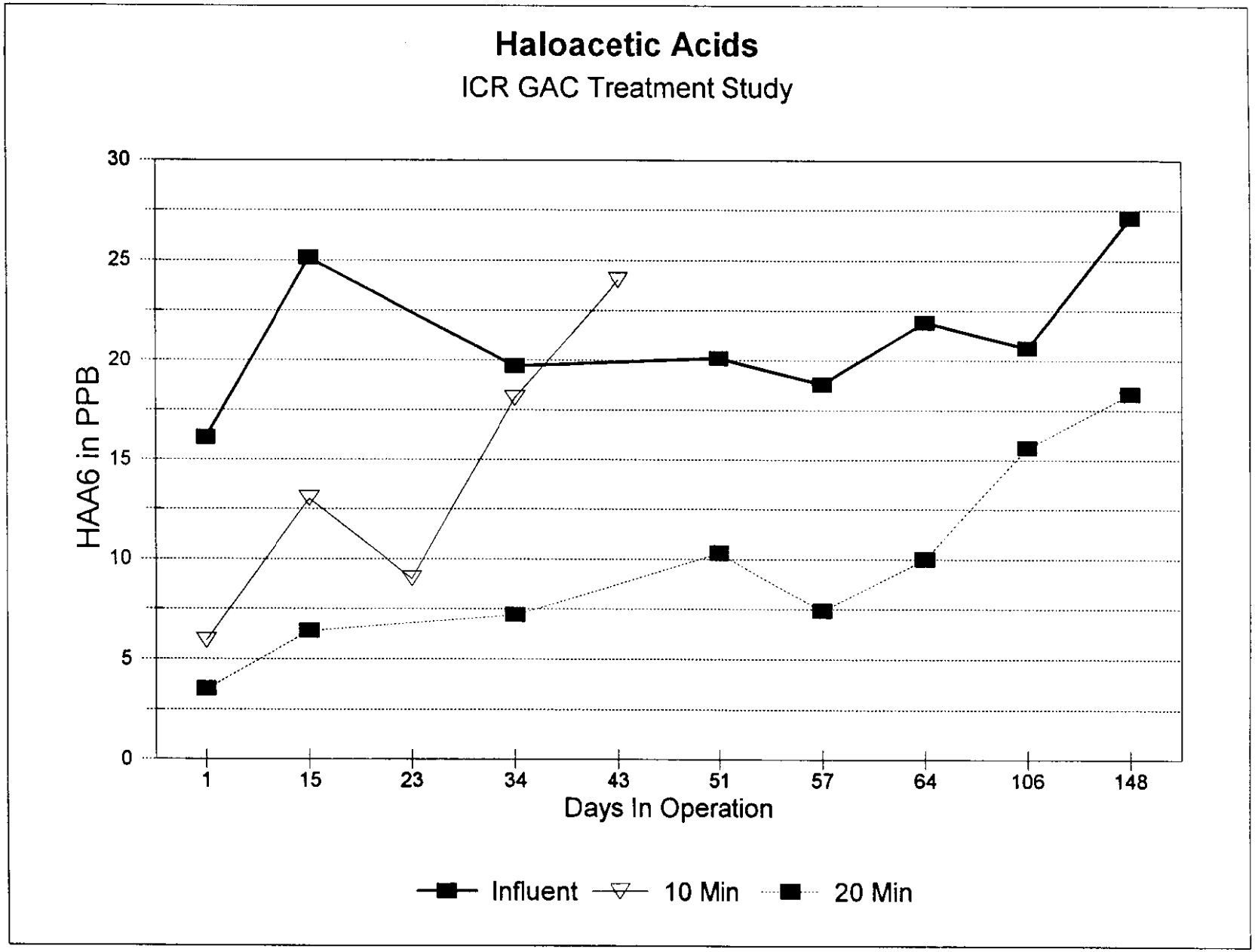
Examination of the enclosed GAC water quality graphs demonstrate that the 10 minute contactor lost its effectiveness at 30 to 40 days of operation. The effluent of the 10 minute contactor actually exceeded the influent for Total Trihalomethanes, Total Organic Halides and Haloacetic Acids. The Total Organic Carbon concentration of the effluent of the 10 minute contactor approached but never actually exceeded the concentration of the influent. The UV 254 absorbance did not show a significant trend during the course of the run.
The 20 minute contactor indicated possible exhaustion, based upon effluent TOC concentration after 80 to 90 days of operation. The Total Trihalomethanes, Total Organic Halides and Haloacetic Acids concentrations indicate exhaustion of the 20 minute contactor by the 104^{th} day of operation.
It is important to note that the effluent TOC concentrations of both contactors remained below the influent concentration even after apparent exhaustion. This indicates a portion of the TOC removal can be attributed to simple filtration.

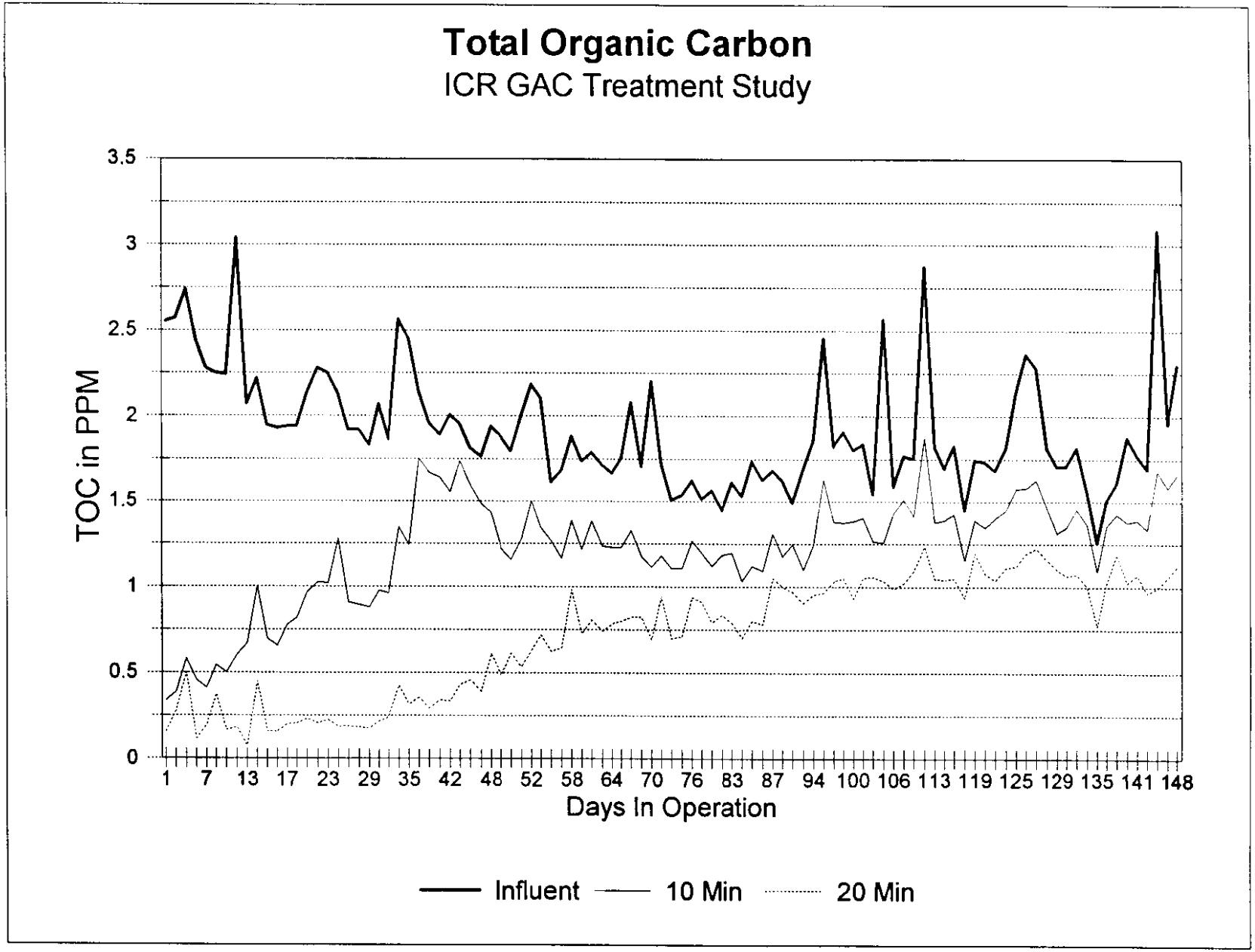

UV 254 Absorbance
ICR GAC Treatment Study
UV 254 in AU/cm
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1
15
23
34
43
51
57
64
106
148
Days In Operation
Influent
10 Min
20 Min


Trihalomethanes
ICR GAC Treatment Study
TTHM in PPB
18
16
14
12
10
8
6
4
1
15
23
34
43
51
57
64
106
148
Days In Operation
Influent
10 Min
20 Min


Total Organic Halides
ICR GAC Treatment Study
250
200
150
100
50
TOX in PPM
1
15
23
34
43
51
57
64
106
148
Days In Operation
Influent
10 Min
20 Min


Haloacetic Acids
ICR GAC Treatment Study
HAA5 in PPB
30
25
20
15
10
5
0
1
15
23
34
43
51
57
64
106
148
Days In Operation
Influent
10 Min
20 Min


Haloacetic Acids
ICR GAC Treatment Study
HAA6 in PPB
30
25
20
15
10
5
0
1
15
23
34
43
51
57
64
106
148
Days In Operation
Influent
10 Min
20 Min


Total Organic Carbon
ICR GAC Treatment Study
TOC in PPM
3.5
3
2.5
2
1.5
1
0.5
0
1 7 13 17 23 29 35 42 48 52 58 64 70 76 83 87 94 100 106 113 119 125 129 135 141 148
Days In Operation
Influent
10 Min
20 Min

Section V:QA/QC Summary

As noted above all analyses were performed by laboratories approved for ICR analyses.

Bromide		BDCM		DBCM		BROMOFORM		CHLOROFORM	
RPD	%Rec	RPD	%Rec	RPD	%Rec	RPD	%Rec	RPD	%Rec
0	76%	0	86%	0	90%	0	90%	0	60%
0	85%	0	88%	0	90%	0	90%	0	80%
0	85%	0	90%	0	95%	0	95%	0	80%
0	88%	0	90%	0	96%	0	95%	0	90%
0.7	89%	0	95%	0	100%	0	95%	4	95%
0.7	89%	5	100%	0	100%	0	95%	4	95%
0.96	89%	5	100%	0	100%	0	100%	4	100%
0.98	91%	10	100%	0	100%	0	100%	8	100%
1	96%	11	100%	4	105%	0	105%	17	115%
		11	110%	5	105%	0	105%	17	115%

Table 3 Summary of QA/QC data

DCAA		TCAA		MBAA		DBAA		BCAA		MCAA	
RPD	%Rec	RPD	%Rec	RPD	%Rec	RPD	%Rec	RPD	%Rec	RPD	%Rec
0	95%	0	95%	0	80%	0	80%	0	90%	0	95%
0	95%	0	100%	0	95%	0	90%	0	95%	0	95%
0	95%	0	100%	0	95%	0	95%	0	95%	0	95%
0	95%	0	100%	0	95%	0	95%	0	95%	0	95%
0	100%	0	100%	0	95%	0	100%	0	100%	0	100%
0	100%	0	100%	0	95%	0	100%	0	100%	0	105%
0	100%	0	100%	0	100%	0	100%	3	100%	0	105%
2	100%	1	105%	0	100%	0	100%	4	100%	5	105%
4	100%	4	105%	0	105%	0	105%	5	105%	7	110%
5	105%	6	105%	0	105%	0	105%	5	105%	15	110%
10	105%	6	110%	0	110%	0	105%	9	105%	17	115%
10	105%	0	110%	34	110%	0	105%	43	115%	17	120%

Table 3.1 Summary of QA/QC data

	UV254			TOX			TOC	
Value	Duplicate	RPD	Value	Duplicate	RPD	Value	Duplicate	RPD
0.046	0.047	2.15	0	0	0	2.1	2.1	0
0	0	0	0	0	0	0	0	0
0	0	0	140	150	6.89	0	0	0
0.04	0.039	2.53	140	130	7.40	1.6	1.6	0
0.029	0.03	3.38	55	54	1.83	1.2	1.2	0
0	0	0	140	140	0	0	0	0
0.038	0.036	5.40	160	170	6.06	1	1.1	9.52
0.13	.013	0	170	160	6.06	1.1	1.2	8.69
0.03	0.029	3.38	170	160	6.06	1.3	1.2	8
0.032	0.031	3.17	62	61	1.62	0	0	0
0	0	0	220	220	0	0.9	0.9	0
0.032	0.034	6.06	140	140	0	1.5	1.5	0
0.043	0.041	4.76	150	150	0	1.4	1.4	0
0.04	0.041	2.46	130	140	7.40	0	0	0
0	0	0	80	78	2.53	0	0	0
0.05	0.049	2.02	76	75	1.32	1	1	0
0	0	0	97	99	2.04	0	0	0
0	0	0	100	95	5.12	0.9	1	10.52
0.01	0.01	0	150	150	0	0	0	0
0.053	0.053	0	160	150	6.45	0.9	0.7	25
0.037	0.036	2.73	150	150	0	0.7	0.7	0
0.036	0.035	2.81	160	160	0	0	0	0
0.011	0.011	0	170	160	6.06	0	0	0
0.016	0.016	0	150	140	6.89	1.1	0.9	20
0.011	0.012	8.69	150	150	0			
0.049	0.049	0						

Table 3.2 Summary of QA/QC data

APPENDIX A

Originals of ICR Treatment Study Applications

January 7, 1998

Mr. James Westrick
United States Environmental Protection Agency
Office of Ground Water and Drinking Water
Technical Support Center
26 West Martin Luther King Dr.
Cincinnati, OH 45268

RE: Treatment Study Application for PWSID# GA0510003, Plant # 323

Mr. Westrick,

Although, plant# 323 is not required to participate in the ICR due to the size of its customer base it is our intent to participate by conducting an individual treatment study.

Please find enclosed the treatment study application and study plan as required by the ICR for your review and approval.

The final design has not been completed nor has the GAC media been selected. As soon as this information is available it will be forwarded to you.

If you have any questions or need any additional information please contact me.

Respectfully,

Tony Tucker

Tony Tucker
Chemist

cc: Harry Jue
Kenny Dumas

Table 5-1 General Public Water System And Plant Information (page 1 of 2)

Public Water System Information

Utility name	CITY OF SAVANNAH WATER SYSTEM
PWSID#	0510003
WIDB# (optional)	
PWS combined population served	143,500
PWS ground water population served	137,000

Official Contact Person

Name	HARRY JUE
Mailing address	P.O. BOX 1027 SAVANNAH GA 31402
Phone #	912-651-4241
FAX #	912-651-6808
E-mail address	

ICR Contact Person

Name	TONY TUCKER
Mailing address	P.O. BOX 4038 PT. WENTWORTH GA 31407
Phone #	912-964-4473
FAX #	912-964-8342
E-mail address	

Treatment Plant Information

Plant name	SAVANNAH I&D PLANT
Plant ICR #	323
Plant combined population served	0
Plant ground water population served	0
Plant surface water population served	6500

Plant Contact Person

Name	TONY TUCKER
Mailing address	P.O. BOX 4038 PT. WENTWORTH GA 31407
Phone #	912-964-4473
FAX #	912-964-8342
E-mail address	

Table 5-11 Study Concept Form[1]

General Study Information

Is this an individual or a joint study?	INDIVIDUAL
Will GAC or membranes be investigated?	GAC
Is this a pilot- or a bench-scale study?	PILOT
At what point in the full-scale plant will water be collected for the study?	POST SEDIMENTATION
Where is the first point that chlorine is added in the full-scale plant?	RE FILTRATION
Will the treatment study influent be collected prior to the addition of chlorine based oxidants?	YES
What is the average TOC concentration of the treatment study influent?	NOT YET DETERMINED
How many tests will be required to evaluate seasonal variability?	ONE (1)

GAC Study Information

Carbon type and manufacturer to be investigated	NOT YET DETERMINED
Carbon particle diameter	NOT YET DETERMINED
Carbon column diameter	8 INCHES

Membrane Study Information

Procedure to be used (RBSMT, SEBST, pilot)	
Element size to be investigated	
Model number and manufacturer of membrane #1	
Molecular weight cutoff of membrane #1	
Model number and manufacturer of membrane #2	
Molecular weight cutoff of membrane #2	

Study Plan

Attach a brief study plan (usually not more than two pages of text and two pages of figures) which should include the equipment to be used, pretreatment to be used prior to GAC or membranes, design parameters, operating parameters, whether or not seasonal variability need to be evaluated and if seasonal variability can be evaluated in fewer than four quarters, the parameters that will be investigated in lieu of seasonal variability.

1 One study concept form must be submitted for each study to be conducted.

ICR STUDY PLAN
Granular Activated Carbon Pilot Study
PWSID# GA0510003; Plant# 323

EXISTING TREATMENT SYSTEM

The Industrial and Domestic Water Treatment Plant uses conventional processes to treat approximately 50 MGD of surface water to potable and industrial standards. A schematic of the existing processes is provided in Figure 1. General raw water quality data and chemical dosage are as follows.

RAW WATER QUALITY [1,3]			
PARAMETER	MAX	MIN	AVG
ALKALINITY (ppm)	33.6	14.4	23
pH	6.9	6.2	6.6
COLOR	200	7	60.3
TURBIDITY (ntu)	97.1	5.09	15.36
CO_2 (ppm)	18.75	4.95	10.6
TEMPERATURE (°C)	29	9	20.8

CHEMICAL DOSAGE [1,3] (ppm)			
CHEMICAL	MAX	MIN	AVG
PRE-LIME	4.5	0.29	2.2
ALUM	42.9	16.5	23
POLYMER	0.1	0.05	0.05
POST-LIME	12.2	3.8	7.2
CHLORINE	3.3	1.2	2.2
PHOSPHATE	0.75	0.4	0.55

Notes:

1. Maximum, minimum and average chemical dosages do not necessarily correspond to maximum, minimum or average raw water quality parameters.
2. Use of pre-lime is not always required. Therefore, the figure shown is relative only to periods of use.
3. Based on 1996 data.

PILOT CONFIGURATION & SPECIFICATIONS

PILOT STUDY OPERATION

A. General

The pilot study will generally consist of two (2) dual media rapid sand filters for production of non-chlorinated filtered water, and two (2) 10 minute EBCT GAC contactors in series. A Process and Instrumentation Diagram is provided in Figure 2.

Raw water quality is effected by seasonal water temperature. However, raw water quality is impacted to a greater degree by the changes between the wet and dry seasons. Complete wet/dry cycles generally occur between April and November. Therefore, it is proposed that testing and data collection will begin in April and run through November for a testing period of approximately 215 days. The exact run time will be determined by the completion of the wet/dry cycle.

B. Filtration

1. Normal Operation

As shown in Figure 1, current operation of the plant calls for chlorine injection within the sedimentation basin effluent launders. Therefore, plant filtered water cannot be used for the purpose of this study. It is proposed that settled water will be taken directly from the sedimentation basin prior to entering the effluent launders. The settled water will be transferred by gravity (pumped if required) to one or both of two pilot-filter columns. It is proposed that the pilot-filter columns will be dual media (10 inches sand and 18 inches anthracite) consistent with the plant production filters.

During normal operation, a single pilot-filter column will be in operation at the current maximum plant production filtration rate of 3.15 gpm/ft^2. Filtration at this rate will provide approximately 1.1 gpm of filtered water per pilot-filter column. Pilot filter effluent will be directed to a 20 gallon process reservoir. The process reservoir will allow for complete shut down of both pilot-filter columns for approximately 20 minutes without disrupting the GAC run. Excess pilot filter effluent will be wasted via a reservoir overflow to drain. The limited size of the process reservoir will minimize detention time of the filtered water.

2. Backwash Operation

Pilot-filter effluent may also be directed to a 100 gallon backwash reservoir. A backwash rate of approximately 15 gpm/ft^2 is required to produce adequate expansion of both sand and anthracite layers and to elevate heavier particles and mudballs to the waste trough. In addition, approximately 10 minutes at this rate is required for adequate cleaning. As air-scour is available in the plant production filters, but not in the pilot-filter columns, an additional 5 minutes of backwash times may be required to obtain acceptable pilot-filter cleaning. Approximately 2 hours prior to backwashing the "On-Line" pilot-filter column, the

stand-by pilot-filter will be placed in service to fill the backwash reservoir.

C. GAC Contactors

1. Design Parameters

It is proposed that 2 (two) 10 minute E B C T contactors be used in series as shown in Figure 3. Initial design parameters are as follows:

Column Diameter	8 inches
Cross-sectional area	0.349 ft^2
Hydraulic Loading Rate	2.5 gpm/ft^2
Volumetric Flow Rate	0.87 gpm
E B C T (each column)	10 minutes
GAC Bed Length (each column)	3.3 ft
GAC Bed Volume (each column)	1.15 ft^3
Water Height above GAC	6.2 ft
GAC specifications	GAC not yet selected

2. Operation

Non-chlorinated filtered water will be pumped from the 20 gallon process reservoir (see A 1 above.) into the first contactor. The first contactor shall have an ultrasonic level sensor. Changes in the level of the water column will cause an appropriate adjustment in the speed of the influent pump to maintain a constant water column level above the GAC bed. Effluent from the first contactor will be piped in as the influent to the second contactor. Total flow through the system will be controlled via an electrically actuated control valve. A flow meter producing a 4-20 mA signal will provide feedback to the control valve. The flow meter and control valve will be located on the discharge of the second contactor for flow control through both contactors.

3. Backwash Operation

Each contactor shall be equipped with a differential pressure transmitter and appropriate piping as required to monitor headloss through the contactors. Should headloss become excessive, contactor effluent will be diverted to a 200 gallon GAC backwash reservoir. It is expected that a backwash rate of 10 to 12 gpm/ft^2 for 20 minutes will be sufficient. The contactors will be taken off-line, backwashed, and placed back in service together.

SIMULATED DISTRIBUTION SYSTEM

The SDS samples will be taken prior to entering the first GAC contactor and

immediately after exiting the effluent flow meter of the second GAC contactor . As residence time in the actual distribution system is approximately two (2) hours, the samples will also be held for two (2) hours. Plant pH ranges from approximately 7.0 to 7.4. Therefore, SDS samples will be pH adjusted to 7.2 plus or minus 0.2. SDS samples will be dosed with chlorine of an amount sufficient to obtain a free chlorine residual of 1.2 ppm plus or minus 0.2. SDS samples will be held under a free flowing stream of plant effluent to ensure that the sample maintains a temperature as close as possible to the temperature in the distribution system. Temperature variations in the plant effluent will be monitored and recorded enabling seasonal temperature variation accountability. All chlorination and pH adjustment will be accomplished under laboratory conditions.

CITY OF SAVANNAH – Industrial And Domestic Water Supply
P.O. Box 4038 • Port Wentworth, Georgia 31407-0038 • 912-964-0698 • Fax 912-964-8342

March 9, 1998

Mr. James Westrick
United States Environmental Protection Agency
Office of Ground Water and Drinking Water
Technical Support Center
26 West Martin Luther King Dr.
Cincinnati, OH 45268

RE: Treatment Study Application for PWSID# GA0510003, Plant #323

Mr. Westrick,

As indicated in our original treatment study application dated January 7, 1998, information concerning specific GAC parameters was not available at the time the application was submitted. Subsequently, all required information has been acquired and is forwarded herewith.

A revised Study Concept Form has been completed and is attached.

In addition, a deviation from the GAC Contactor detail (figure 3) as provided with the original submittal has been made. In the original submittal, the center section of the contactor column was to be constructed of acrylic plexiglass. However, there was concern that the acrylic would not be structurally adequate to support the stainless steel upper section.

To overcome this concern, a section of clear schedule 80 PVC piping was considered. To ensure that the PVC would not impact TOC levels during the pilot study, a section of the PVC column was set up and un-chlorinated settled water was passed through such that a contact time of 10 minutes was maintained. Daily samples were collected at the column influent and effluent for a period of five days. An addition sample was collected after six days to ensure no long term effect. The sample data is attached.

Review of the sample data indicates that the values for the influent TOC vary from a maximum of 2.95 ppm to a minimum of 2.42 ppm, giving a range of influent values of 0.53 ppm. The average increase in TOC through the PVC column is 0.26 ppm. The average increase through the PVC column is less than one-half of the fluctuation in the influent TOC levels. Therefore, this small increase in TOC assumed to be caused by flow through the PVC column is, in our opinion, negligible and will have no practical impact on the results obtained from the pilot study.

If you have any questions or need any additional information please contact me.

Respectfully,

Tony Tucker
Chemist

cc: Harry Jue
Kenny Dumas

DISINFECTION BY-PRODUCT STUDY
EVALUATION OF GAC CONTATCTOR MATERIALS FOR TOC CONTRIBUTION

DATE	TIME	SETTLED	INFLUENT	EFFLUENT
2/9/98	13:30	2.52	2.70	2.85
2/10/98	11:00	2.54	2.80	2.76
2/11/98	11:15	2.41	2.95	3.30
2/12/98	11:05	2.52	2.56	2.66
2/13/98	10:55	2.36	2.42	3.30
2/20/98	13 30		.281	2.92