ICR TREATMENT STUDY SUMMARY REPORT

Evaluation of Membrane Technology Using the Rapid Bench-Scale Membrane Test for Compliance with the Information Collection Rule

Conducted during the period of February 3rd, 1997 through November 1st, 1997

Prepared by
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in January 1998

For
City of Portsmouth, DPU
PWSID# 3740600
Lake Kilby Water Treatment Facility
105 Maury Place
Suffolk, VA 23434
Phone: (757) 539-2201
Fax: (757) 539-7608

Plant name: Lake Kilby Water Treatment Facility
Plant ICR #: 678

Attachments: diskettes containing the *Data Collection Spreadsheets* and the *Treatment Study Summary report*

SECTION I. CONCLUSIONS AND RECOMMENDATIONS

Four quarters of nanofiltration (NF) testing using water following coagulation, flocculation, sedimentation and cartridge filtration was successfully completed. Two NF membranes were used to conduct RBSMT experiments: FilmTec NF45 (Dow Chemical Company, Midland, MI), and NTR7450 (Hydranautics Corp., San Diego, CA). The NF45 membrane was capable of achieving higher rejections of a variety of organic and inorganic water quality parameters including disinfection by-product precursor (DBP) materials and total organic carbon (TOC). Simple linear regression analysis suggests that there maybe seasonal variations in fouling rates for both membranes. This study demonstrated that high removals of DBP precursors could be achieved by NF, and that NF is technically capable of controlling DBP concentrations in the finished water.

SECTION II. BACKGROUND INFORMATION

Objectives. The objective of this treatment study was to evaluate the ability of two nanofiltration (NF) membranes to remove DBP precursor materials. Results from bench-scale experiments conducted as specified in the *ICR Manual for Bench- and Pilot-Scale Treatment Studies* (EPA 814-B-96-003) are summarized in this report.

Existing water treatment processes. A schematic of the existing water treatment processes for the Lake Kilby Water Treatment Facility is given in Figure 1. This schematic was generated earlier during the development of the initial sampling plan for the 18 months of DBP/microbiological monitoring under the ICR. The water for NF testing was obtained following sedimentation and prior to chlorine addition (near the sample location 2).

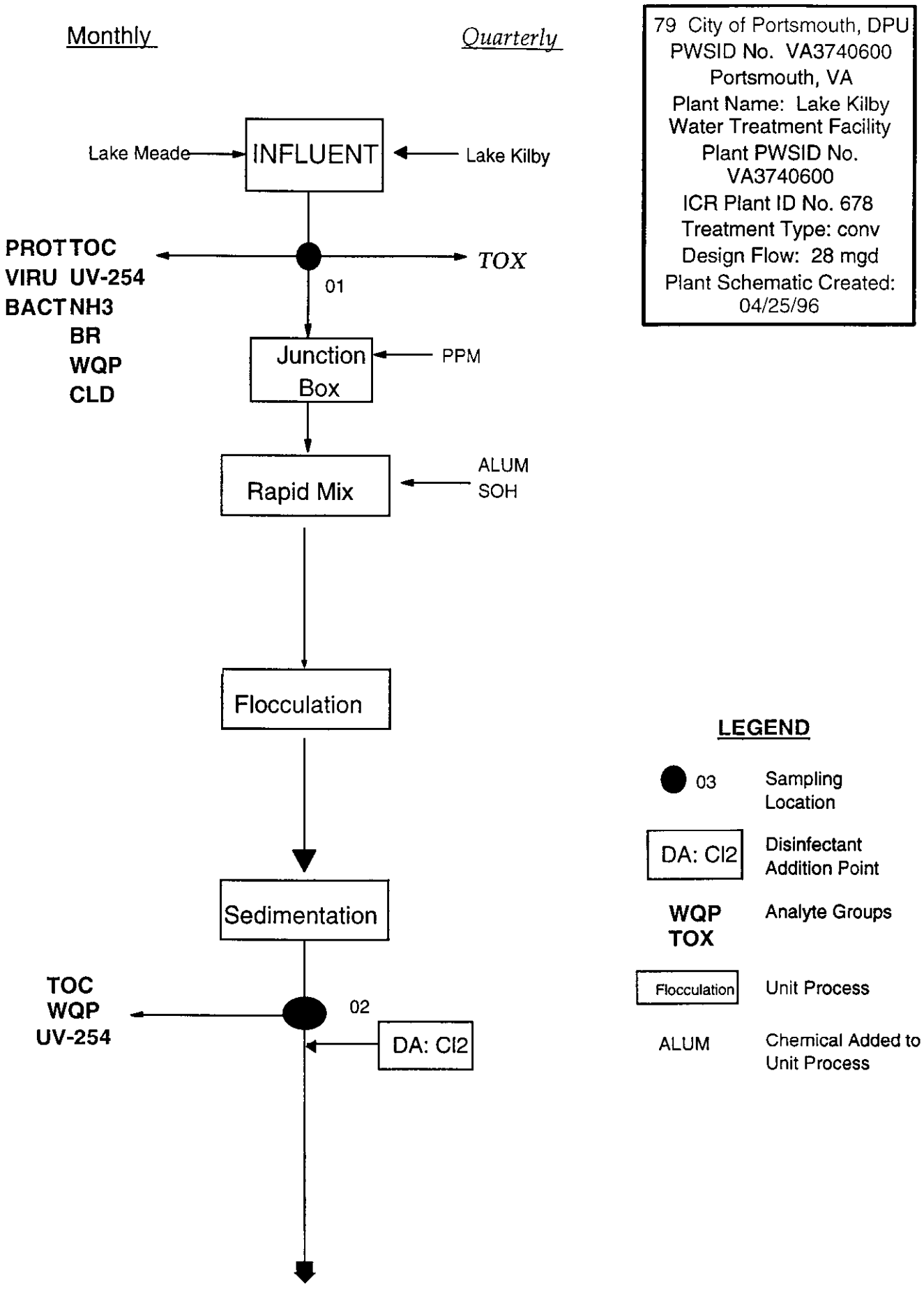
Basic engineering and chemical feed data for each unit process are summarized in Tables A.2 and A.3 respectively. These tables were also generated earlier using the *ICR Water Utility Database System* (EPA 814-B-96-004) to report the results from the 18 months of DBP/microbiological monitoring under the ICR.

Terminology for membrane productivity. Fouling in pressure-driven membrane systems is typically manifested as a decline in the value of the ratio of the permeate flux and net driving pressure. This ratio is usually referred to as the specific flux. However, the ICR treatment studies manual refers to this ratio as the water mass transfer coefficient (MTC_w). To maintain consistency with EPA's terminology, the term water mass transfer coefficient will be used in this document.

Modifications to the existing water treatment plant. Presently in Phase III, Lake Kilby WTF is undergoing modifications in four major areas.

Filtration: filters are being modified to be tri-media (from single, dual, and tri), operate at high-rate (from various rates), have new wheeler balls, and include filter-to-waste option.

Clarification: facility is be converted to superpulsator technology from conventional treatment.


Monthly
Quarterly
79 City of Portsmouth, DPU
PWSID No. VA3740600
Portsmouth, VA
Plant Name: Lake Kilby Water Treatment Facility
Plant PWSID No. VA3740600
ICR Plant ID No. 678
Treatment Type: conv
Design Flow: 28 mgd
Plant Schematic Created: 04/25/96
Lake Meade
INFLUENT
Lake Kilby
PROT TOC
VIRU UV-254
BACT NH3
BR
WQP
CLD
TOX
01
Junction Box
PPM
Rapid Mix
ALUM
SOH
Flocculation
Sedimentation
TOC
WQP
UV-254
02
DA: Cl2
LEGEND
03
Sampling Location
DA: Cl2
Disinfectant Addition Point
WQP
TOX
Analyte Groups
Flocculation
Unit Process
ALUM
Chemical Added to Unit Process

Monthly

Quarterly

79 City of Portsmouth, DPU
PWSID No. VA3740600
Portsmouth, VA
Plant Name: Lake Kilby Water Treatment Facility
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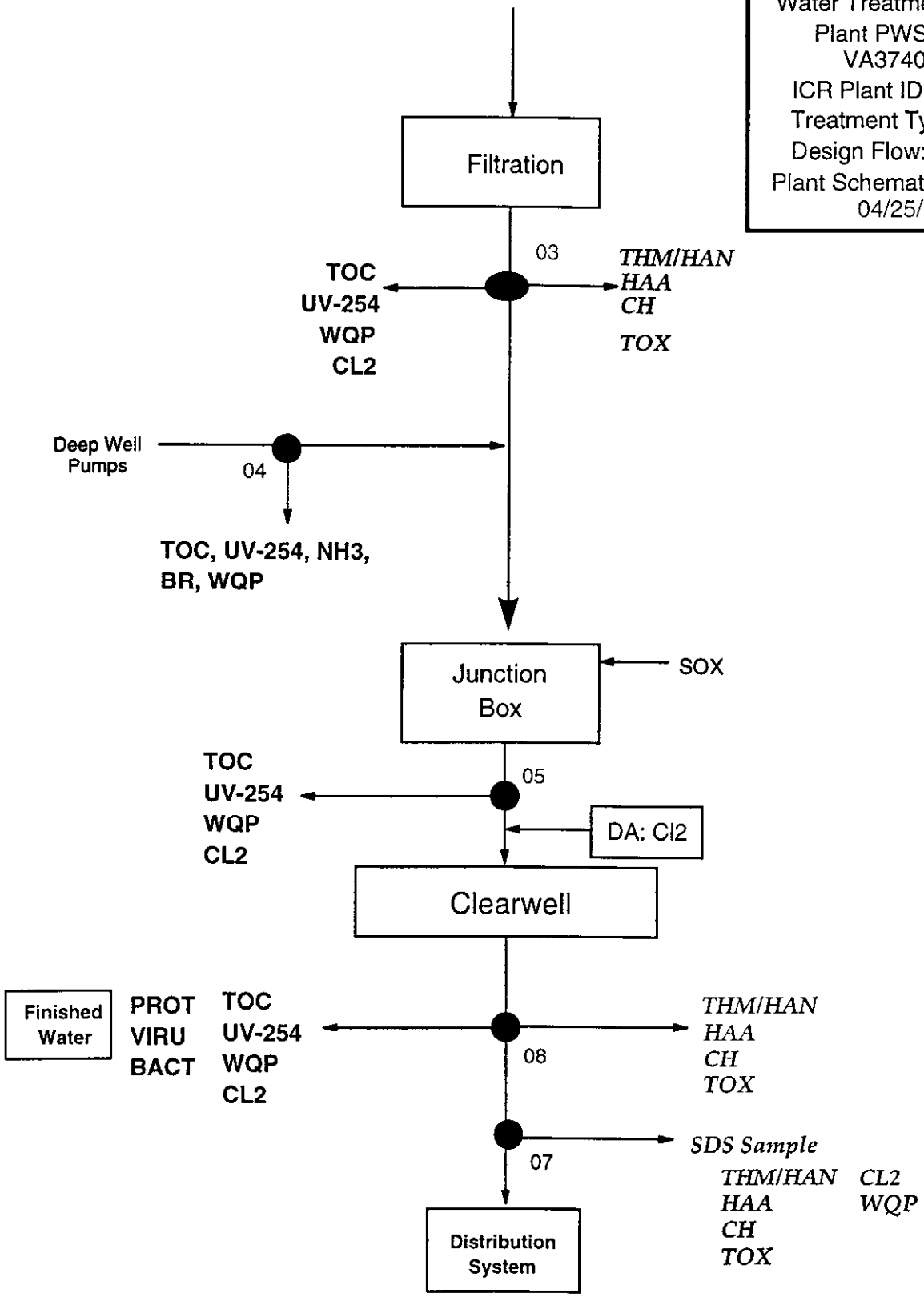
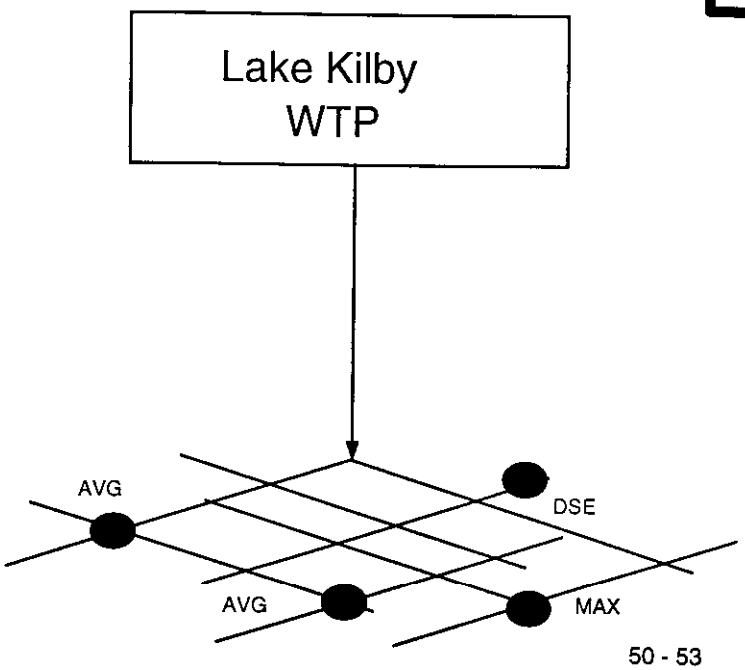


79 City of Portsmouth,
DPU
PWSID No. VA3740600
Portsmouth, VA
System Schematic
Created: 03/06/96

Quarterly



THM/HAN
HAA
CH
TOX

CL2
WQP

LEGEND

50 - 53	Sampling Locations
DSE	Distribution System Equivalent--Corresponds to SDS Residence Time
AVG	Average Residence Time in the Distribution System
MAX	Maximum Residence Time in the Distribution System

A.2 -- Design Plant Parameters

Date: 12/15/97

PWS Name: City of Portsmouth, DPU
PWS ID: VA3740600
WIDB:
ICR Contact Person: Mr. David Haddaway

Sampling Period: Design
Design Sampling Start Date: 7/1/97
Design Sampling End Date: 12/31/98

Treatment Plant Name: Lake Kilby Water Treatment Facility
ICR Treatment Plant ID: 678
Treatment Plant PWS ID: VA3740600
Treatment Plant Category: CONV

State Approved Plant Capacity (MGD): 28.0
Historical Min. Water Temperature (deg C): 5.0
Installed Sludge Handling Capacity (GPD): 0.00
Blending Indicator: N

Water Resource Name: Lake Meade
Water Resource Type: Reservoir/lake
Average Residence Time (Days): 120
Intake Name: Lake Meade 1
Watershed Control: Y

Hydrologic Unit Code:
River Reach:
Latitude (degrees, minutes, seconds): +36°43'48"
Longitude (degrees, minutes, seconds): -76°36'10"
River Reach Miles:

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

Process Train Name: Conventional
Process Train Category: CONV

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.	
1	Junction Box	Other Treatment Process		Surface Area (ft2): Liquid Volume (gal): Short Circuiting Factor: 0.0
2	Rapid Mix	Rapid Mix		Type of Mixer: ME Baffling Type: UN Liquid Volume (gal): 26,200 Short Circuiting Factor: 0.0 Mean Velocity Gradient (sec-1): 340.0
3	Flocculation	Flocculation Basin		Type of Mixer: ME Liquid Volume (gal): 665,986 Short Circuiting Factor: 0.0 Baffling Type: UN Stage Sequence Number: 1 Stage Mean Velocity Gradient (sec-1): 8 Stage Liquid Volume (gal): 665,986
4	Sedimentation	Sedimentation	2	Surface Area (ft2): 54,998 Liquid Volume (gal): 5,473,300 Baffling Type: PR Short Circuiting Factor: Plate Settler Surface Area (ft2): Plate Settler Brand Name: Tube Settler Surface Area (ft2):

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.	
				Tube Settler Brand Name:
5	Chlorine gas	Disinfectant Addition		Chemical Code: CL2 Measurement Formula: Cl2 Dose Rate (mg/L): 2.00
6	Filtration	Filtration	3	Surface Area (ft2): 6,520 Liquid Volume (gal): 337,015 Total Media Depth (in): 28 Depth of GAC (in): Media Type: OTHR Type of Activated Carbon: Minimum Water Depth To Top of Media (ft): 6.9 Depth From Top of Media to Top of Backwash Trough (ft): 3.1
7	Deep Wells	Additional Water Source	4	Water Source Type: UGW
8	Junction Box	Other Treatment Process	5	Surface Area (ft2): Liquid Volume (gal): Short Circuiting Factor:
9	Chlorine gas	Disinfectant Addition		Chemical Code: CL2 Measurement Formula: Cl2 Dose Rate (mg/L): 3.00
10	Clearwell	Clearwell		Surface Area (ft2): 24,000

Seq. No.	Sample Location Name	Sample Location Type	Sample Loc. No.	
				Liquid Volume (gal): 3,000,000 Minimum Liquid Volume (gal): 1,061,520 Baffling Type: SP Short Circuiting Factor: 0.0 Covered Indicator Code: Y
	Finished Water	FIN	8	

End of Report A.2 -Design Plant Parameters

A.3 -- Design Plant Chemical Parameters

Date: 12/15/97

PWS Name: City of Portsmouth, DPU
PWS ID: VA3740600
WIDB:
ICR Contact Person: Mr. David Haddaway

Sampling Period: Design
Sampling Start Date: 7/1/97
Sampling End Date: 12/31/98

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
Treatment Plant Name: Lake Kilby Water Treatment Facility						
ICR Treatment Plant ID No: 678						
Treatment Plant Category: CONV						
Process Train Name: Conventional						
Process Train Category: CONV						
1	Junction Box	Other Treatment Process				
				Potassium permanganate	KMnO4	0.07
2	Rapid Mix	Rapid Mix				
				Sodium hydroxide	NaOH	19.60
				Powdered activated carbon	C	4.00
				Aluminum sulfate (Alum)	Al2(SO4)3-14H2O	100.00
3	Flocculation	Flocculation Basin				
4	Sedimentation	Sedimentation	2			
5	Chlorine gas	Disinfectant Addition				

Sep. No.	Sample Location Name	Sample Location Type	Sample Location Number	Chemical Name	Measurement Formula	Dose (mg/L)
				Chlorine gas	Cl2	2.00
6	Filtration	Filtration	3			
7	Deep Wells	Additional Water Source	4			
8	Junction Box	Other Treatment Process	5			
				Sodium hexametaphosphate	[NA(PO3)]6	0.08
9	Chlorine gas	Disinfectant Addition				
				Chlorine gas	Cl2	3.00
10	Clearwell	Clearwell				

End of Report A.3 --Design Plant Chemical Parameters

Chemical addition: sodium hydroxide has already replaced lime, hypochlorite will be replacing liquid chlorine, and polymers will used.

Source water: an additional intake is being added (to the same source) at a lower level to increase safe yield.

Source and finished water quality. A summary of important source and finished water quality parameters are summarized in Tables 1 and 2, respectively.

Table 1. Summary of source water quality (Lake Meade, 1997 values).

Water Quality Parameter	Units	Average yearly value	Standard deviation	Maximum yearly value	Minimum yearly value
Temperature	°C	18.8	7.05	30.6	6.1
pH	-	7.13	0.347	8.2	6.0
Turbidity	ntu	4.70	1.47	38	1.6
Alkalinity	mg/L as $CaCO_3$	32.4	20.28	123	10
Calcium hardness	mg/L as $CaCO_3$	34[a]	NA	NA	NA
Total hardness	mg/L as $CaCO_3$	50[a]	NA	NA	NA
TOC	mg/L	6.58	1.16	10.95	3.77
UV-254	cm^{-1}	0.217	0.054	0.355	0.145
Bromide	mg/L	0.05[a]	NA	NA	NA

Table 2. Summary of finished water quality from Lake Kilby Water Treatment Facility

Water Quality Parameter	Units	Average yearly value	Standard deviation	Maximum yearly value	Minimum yearly value
Temperature	°C	18	6.87	28.9	6.1
pH	-	6.88	0.09	7.6	6.6
Turbidity	ntu	0.07	0.016	0.22	0.03
TOC	mg/L	2.9	0.797	6.044	1.88
Distribution system THM4	μg/L	76.4	31.7	120.5	45.3

[a] Samples are not routinely taken and the values represent single samples collected from Lake Meade on 7/9/97.

SECTION III. MATERIALS AND METHODS

A simple schematic of the pretreatment processes employed is given in Figure 2.

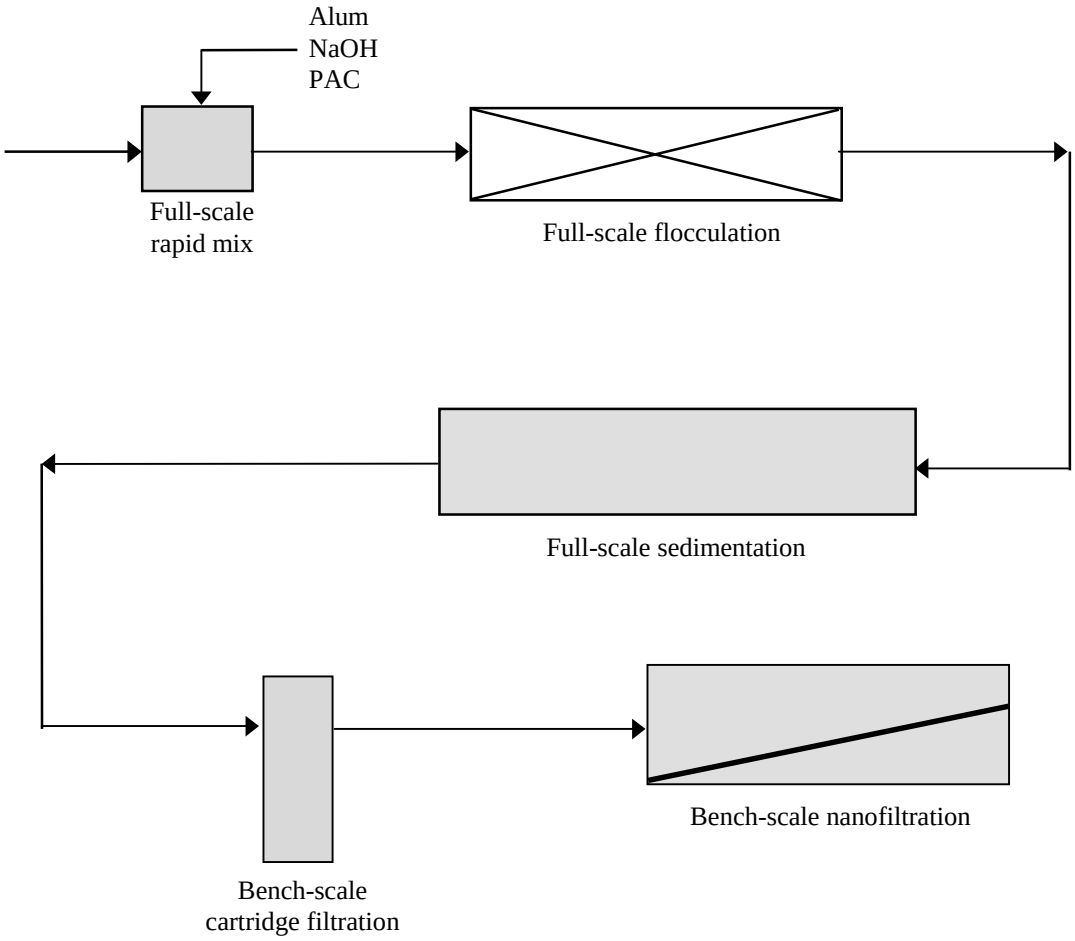


Figure 2. Simple schematic of the pretreatment used prior to bench-scale nanofiltration.

Design information for all nanofiltration pretreatment processes are summarized in Table 3.

Table 3. Tabular summary of pretreatment design data

Unit process	Description
Rapid mix (full-scale)	Type of mixer: ME Baffling type: UN Liquid volume (gal): 26,200 Mean velocity gradient: 340 s^{-1} Coagulant addition: Alum Coagulant dose: 100 mg/L Base addition: NaOH Base dose: 19.60 mg/L Coagulation pH: 6 Preoxidant addition: $KMnO_4$ Preoxidant dose: 0.07
Flocculation (full-scale)	Type of mixer: ME Liquid volume: 665,986 gal Short circuiting factor: 0.0 Baffling type: UN Number of flocculators 1 Stage sequence number: 1 Stage mean velocity gradient: 8 s^{-1} Stage liquid volume: 665,986 gal
Sedimentation (full-scale)	Surface area (ft^2): 54,998 Liquid volume (gal): 5,473,300 Baffling type: PR Short circuiting factor:
Cartridge filtration (bench-scale)	Manufacturer: Ryan Herco Rating: 5 micron

A schematic of the bench-scale NF system is provided in Figure 3.

Feed water. As required by the ICR, water was sampled prior to the point of continuous chlorination but after existing pretreatment processes designed to remove DBP precursor materials (preoxidation using $KMnO_4$, coagulation, flocculation and sedimentation). Water from Lake Meade was treated using alum at a dose in the range 60 - 90 mg/L. $KMnO_4$ and PAC had also been dosed near 1 mg/L and 5 mg/L, respectively. The coagulation pH was maintained near 6. Prior to the RBSMT experiments, this water was filtered using a 5 µm cartridge filter.

Membranes and cleaning procedure. Two membranes were used to conduct RBSMT experiments: FilmTec NF45 (Dow Chemical Company, Midland, MI), and NTR7450 (Hydranautics Corp., San Diego, CA). Both membranes were cleaned by circulating a 0.5% (w/w) (pH~12) sodium hydroxide solution. Cleaning was conducted at a temperature of approximately 40 °C. The cleaning solution was initially circulated for 10 minutes at a

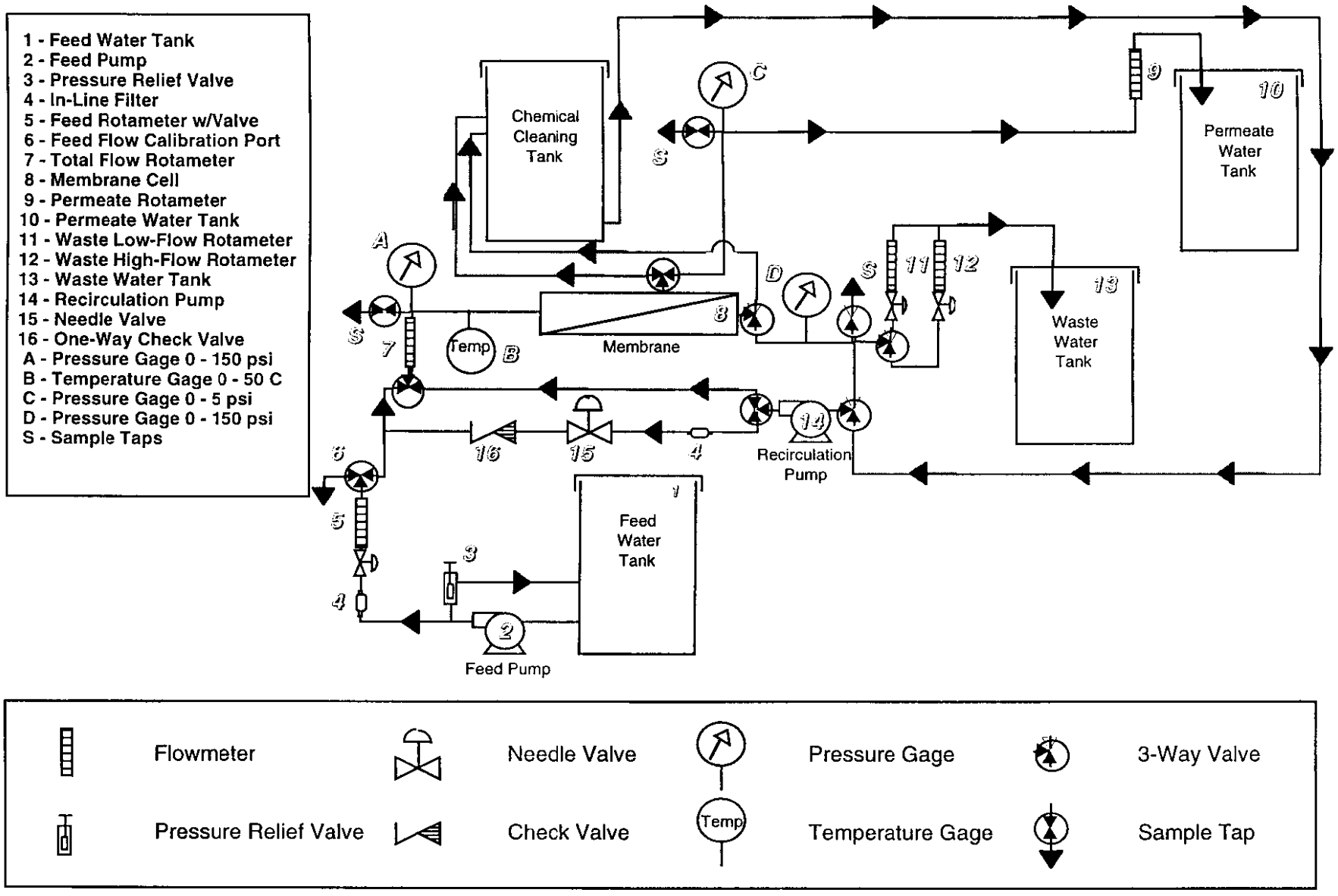


Figure 3. Schematic of the RBSMT ICR apparatus

transmembrane pressure of 10 psig. The membrane was then allowed to soak for 30 minutes. Finally, the cleaning solution was circulated again for 10 minutes at 10 psig. The crossflow velocity was maintained at 1 fps during the circulation portion of the cleaning cycle. A pressure-flux profile was also established for both membranes following chemical cleaning using deionized water.

Membrane operation. Deionized water was filtered at the start of each set of RBSMT experiments for approximately 24 hours. This period is sometimes referred to as "membrane setting". The average experimental conditions used for NF45 and NTR7450 membranes during all quarters of testing are summarized in Table 4 and 5, respectively.

Table 4. Summary of quarterly RBSMT experiments using NF45 membrane

Quarter	Season	Recovery (%)	Pressure (psi)	Permeate flux (gfd)	MTC_w (gfd/psi)
1	Winter	70	71	13.4	0.193
1	Winter	89	67	12.6	0.192
1	Winter	52	66	12.1	0.188
1	Winter	30	68	12.9	0.194
2	Spring	69.6	69.6	13	0.191
2	Spring	87.4	70.6	11.4	0.165
2	Spring	51.9	69.5	11.9	0.175
2	Spring	30.9	70.3	12.3	0.179
3	Summer	71.3	73.4	13.8	0.192
3	Summer	90.3	73.3	11.9	0.166
3	Summer	50.9	68	10.7	0.161
3	Summer	30.6	59.6	9.9	0.170
4	Autumn	72.0	73.3	15.7	0.219
4	Autumn	92.1	71.4	14.2	0.203
4	Autumn	48.8	71.6	14.9	0.213
4	Autumn	31.2	73.5	15.6	0.217

Table 5. Summary of quarterly RBSMT experiments using NTR7450 membrane

Quarter	Season	Recovery (%)	Pressure (psi)	Permeate flux (gfd)	MTC_w (gfd/psi)
1	Winter	69	74	11.0	0.149
1	Winter	88	74	11.3	0.153
1	Winter	51	76	11.5	0.151
1	Winter	31	77	12.4	0.161
2	Spring	68.9	72.3	9.8	0.136
2	Spring	88.7	73.7	8.9	0.121
2	Spring	50.4	71.2	8.3	0.117
2	Spring	30.2	73.5	8.5	0.116
3	Summer	70.4	72.5	7.4	0.102
3	Summer	90.5	72.4	5.6	0.077
3	Summer	50.5	73.2	5.6	0.077
3	Summer	30.3	74.1	5.6	0.076
4	Autumn	71.4	76.3	9.88	0.129
4	Autumn	91.3	75.6	9.19	0.122
4	Autumn	52.1	75.3	9.12	0.121
4	Autumn	32.8	77.6	9.14	0.118

As described earlier in the subsection "Feed water", pretreatment consisted of coagulation, flocculation and sedimentation at the full-scale followed by cartridge filtration at bench-scale. Experiments using pretreated Lake Meade water were conducted continuously without any shut-downs with each membrane. The feed water recovery, R, for the first experiment was maintained near 70%. This was followed by experiments where R was maintained at values near 90%, 50% and 30%. As required under the ICR, these experiments were run continuously without any cleaning when changing the feed water recovery.

Simulated distribution system tests. One of the important components of ICR treatment studies is simulated distribution system (SDS) testing. The SDS test conditions for all quarters of testing are summarized in Table 6.

Table 6. Simulated distribution system test conditions used in this study

Parameter	Winter	Spring	Summer	Autumn
Disinfectant	Free chlorine	Free chlorine	Free chlorine	Free chlorine
Temperature (°C)	10	18	28	15.5
pH	7.3	7.3	7.3	7.3
Holding time (hour)	60	60	72	72
Free chlorine residual (mg/L)	~ 1	~ 1	~ 1	~ 1

Analytical methods. A list of all analytical methods and the corresponding minimum reporting levels is given in Table 7. All analyses were performed using the methods and QA/QC procedures described in the *DBP/ICR Analytical Methods Manual*.

Table 7. Summary of analytical methods and MRLs used in this study

Analyte	Method	Units	Minimum Reporting Level
Alkalinity	SM 2320 B	mg/L as $CaCO_3$	2
Bromide	EPA 300	mg/L	0.02
Calcium hardness	SM 3500 Ca D	mg/L as $CaCO_3$	5
Total hardness	SM 2340 C	mg/L as $CaCO_3$	5
Chlorine residual	SM 4500 Cl G	mg/L	0.5
pH	SM 4500 H^+ B	-	-
TDS	SM 2510 B (probe)	mg/L	10
Temperature	SM 2550 B	°C	-
Turbidity	SM 2130 B	ntu	0.05
TOC	SM 5310 C	mg/L	0.50
UV_{254}	SM 5910 B	cm^{-1}	0.009
$CHCl_3$, BDCM, DBCM, $CHBr_3$	EPA 524.2	µg/L	1 for each analyte
MCAA, DCAA, TCAA, MBAA, DBAA, TBAA, BCAA, BDCAA, DBCAA	SM 6251 B	µg/L	2, 1, 1, 1, 1, 4, 1, 1, and 2 respectively
TOX	SM 5320 B	µg Cl^-/L	25

Laboratories involved. All analytical measurements were made either by the operator conducting the RBSMT experiments or in Montgomery Watson Laboratories. The analyses performed as well as some information about these different sites are provided in Table 8.

Table 8. Laboratory information

Laboratory	Dates of service	Analyses performed	Contact information
Field site	Feb 7, 1997 - Nov 1, 1997	Alkalinity, calcium and total hardness, pH, Cl_2 residual, TDS, temperature, turbidity, UV_{254}	Dr. Shankar Chellam Montgomery Watson, 560 Herndon Parkway #300, Herndon, VA 20170. Phone: (703)-397-0367 Fax: (703) 478-3375
Montgomery Watson Laboratory	Feb 7, 1997 - Nov 1, 1997	Bromide, TOC, HAA, THM, TOX	ICR ID# ICRCA013 Dr. Andrew Eaton 555 E. Walnut Street, Pasadena, CA 91101. Phone: (626) 568-6425 Fax: (626) 568-6324

SECTION IV. RESULTS AND DISCUSSION

Membrane feed water quality. Membrane feed water quality for all four seasons of testing are summarized in Table 9.

Table 9. Summary of membrane feed water quality for all four seasons of testing

Parameter	Units	Winter	Spring	Summer	Autumn
Alkalinity	mg/L as $CaCO_3$	7.2	7.2	6	14
Ca hardness	mg/L as $CaCO_3$	17	20	30	31
Total hardness	mg/L as $CaCO_3$	23.5	28	40	41
Manganese	µg/L	64	53.5	190	130
TDS	mg/L	74.7	76.5	82.4	88
Bromide	mg/L	0.041	0.039	0.046	0.042
SDS Cl_2 demand	mg/L	1.69	2.17	3.05	2.68
TOC	mg/L	3.05	3.2	3.85	3.1
TOX	µg/L	225	275	412.5	190
THM	µg/L	46.5	66.2	122	63.6
HAA(5)	µg/L	42	59	84.4	56.1
HAA(9)	µg/L	57.5	80	109.5	76.3
UV_{254}	cm^{-1}	0.051	0.053	0.055	0.054
pH	-	6.7	6.49	6.2	6.56
Turbidity	NTU	0.19	0.20	0.14	0.160

Water mass transfer coefficient profiles. Temporal profiles of the water mass transfer coefficient for all four quarters of testing using the NF45 and the NTR7450 membranes are summarized in Figures 4 and 5, respectively.

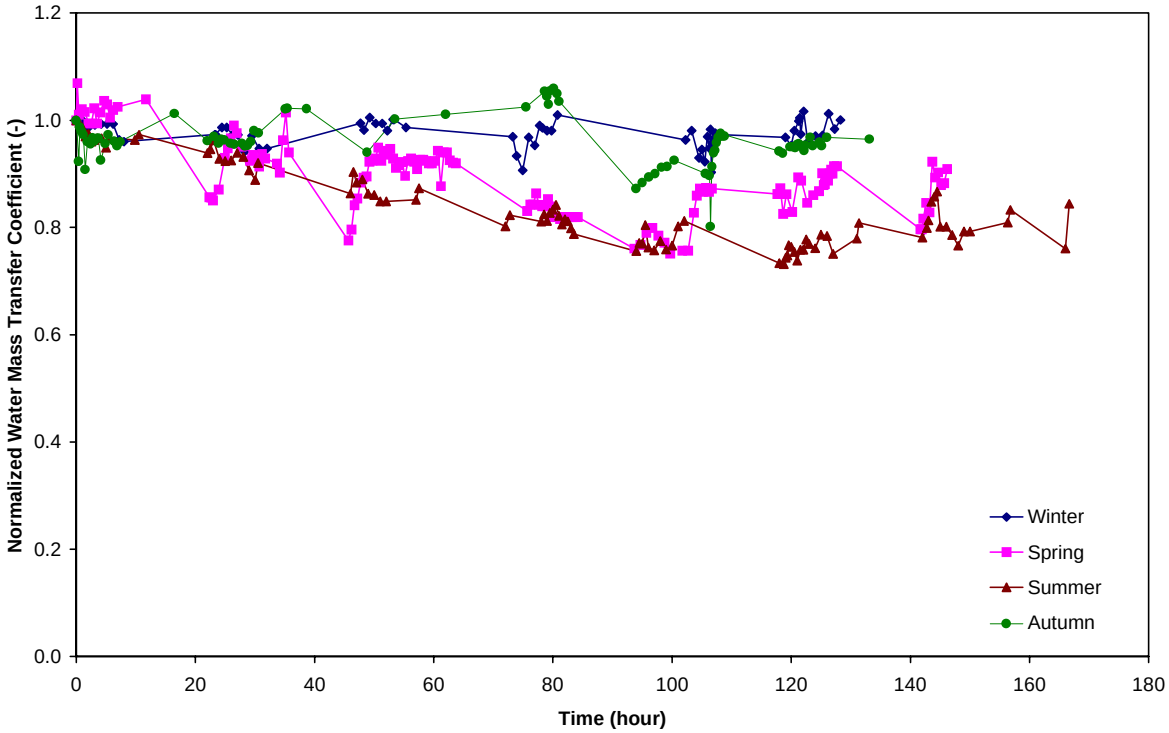


Figure 4. Comparison of temporal MTC_w profiles for all four quarters of testing using the NF45 membrane.

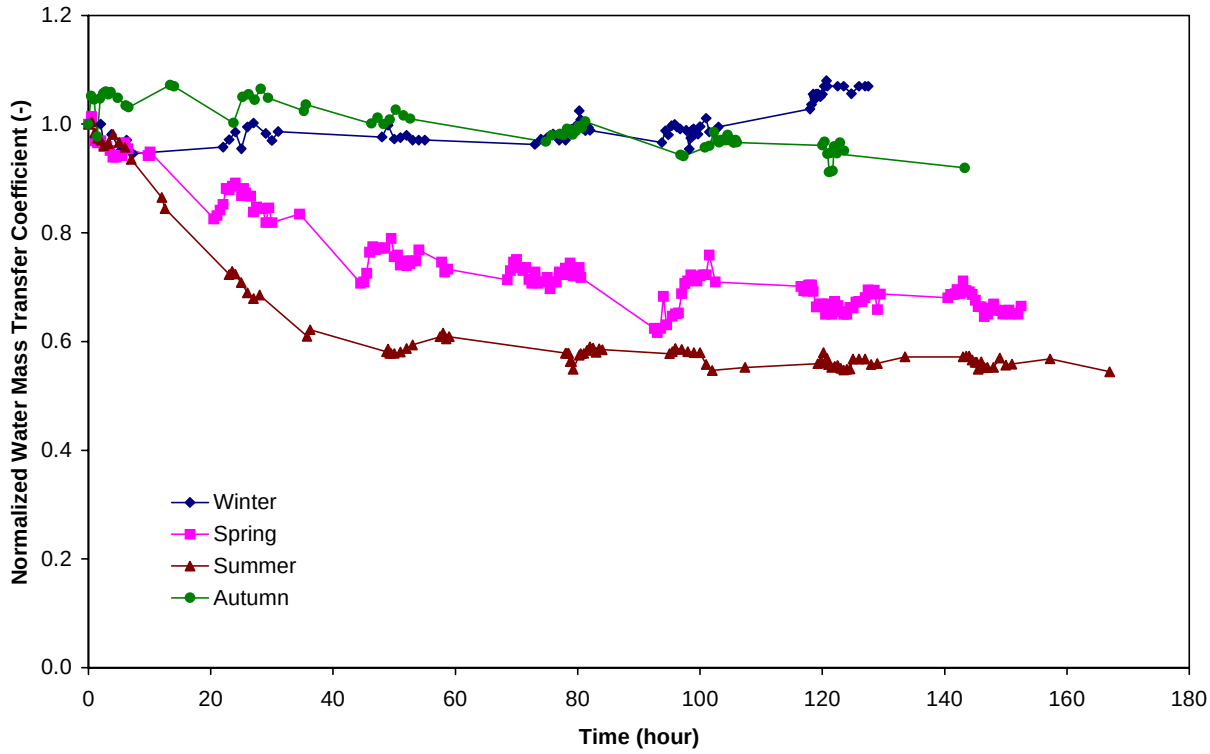


Figure 5. Comparison of temporal MTC_w profiles for all four quarters of testing using the NTR7450 membrane.

Straight line fits to these temporal MTC_w data were obtained using linear regression techniques and are tabulated in Table 10. It should be observed that the coefficient of regression was low in many instances.

Table 10. Summary of straight-line fits to temporal MTC_w data

Season	NF45 straight line fit	NF45 fit R^2	NTR7450 straight line fit	NTR7450 fit R^2
Winter	$0.98 - 8 \times 10^{-5}t^{\wedge}$	0.02	0.95 + 0.0007t	0.5
Spring	0.97 - 0.001t	0.4	1 - 0.0008t	0.8
Summer	0.95 - 0.0013t	0.7	0.89 - 0.0018t	0.77
Autumn	0.97 - 0.0002t	0.04	0.82 - 0.0022t	0.61

$^{\wedge}$ t is time in hour

Membrane cleaning. Membrane resistances were measured by conducting a pressure-flux profile using deionized water initially before conducting the experiments as well as after chemical cleaning. The resistance of the membrane (R_m) was calculated using Darcy's law as given in Equation 1 where J denotes the permeate flux, P_{tm} is the transmembrane pressure and μ is the absolute viscosity.

$$J = \frac{P_{tm}}{\mu R_m} \quad (1)$$

Thus, R_m denotes the hydraulic resistance presented by the membrane to the filtration of water. In all cases, membrane compaction was determined to be negligible for pressures < 100 psi. Table 11 provides a summary of membrane resistances measured using DI water prior to experiments using the test water and after cleaning membranes following experiments. Cleaning using acid and/or base was found to be feasible as demonstrated in Table 11.

Table 11. Summary of membrane cleaning

Quarter	Membrane	Initial R_m (m^{-1})	R_m after cleaning (m^{-1})	Change (%)	Cleaning solution
I	NF45	7.76×10^{13}	8.49×10^{13}	+ 9	NaOH and H_2SO_4
I	NTR7450	9.27×10^{13}	9.86×10^{13}	+ 6	NaOH and H_2SO_4
II	NF45	7.12×10^{13}	7.06×10^{13}	- 0.8	H_2SO_4
II	NTR7450	8.58×10^{13}	8.22×10^{13}	- 4	NaOH and H_2SO_4
III	NF45	7.21×10^{13}	7.05×10^{13}	- 2	NaOH
III	NTR7450	1.04×10^{14}	1.25×10^{14}	+ 20	NaOH
IV	NF45	6.64×10^{13}	6.77×10^{13}	+ 5	NaOH
IV	NTR7450	1.18×10^{14}	1.30×10^{14}	+ 10	NaOH

Permeate water quality. Table 12 provides a summary of permeate water quality obtained using the NF45 membrane at 70% recovery for all four quarters of testing. Note that this membrane was able to achieve higher rejections of hardness, TOC, and many other water quality parameters compared to the NTR7450 membrane.

Table 12. NF45 permeate water quality for all four quarters of testing at 70% recovery

Parameter	Units	Winter	Spring	Summer	Autumn
Alkalinity	mg/L as $CaCO_3$	4.2	9	6	12
Ca hardness	mg/L as $CaCO_3$	BMRL	BMRL	BMRL	BMRL
Total hardness	mg/L as $CaCO_3$	BMRL	BMRL	BMRL	BMRL
Manganese	µg/L	< 2	2.55	2.5	3.6
TDS	mg/L	25.3	34.25	24.6	32.2
Bromide	mg/L	0.04	0.04	0.035	38
SDS Cl_2 demand	mg/L	0.16	0.41	0.26	0.46
TOC	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
TOX	µg/L	27	57	41.5	40.5
THM	µg/L	4	16	13.6	7.45
HAA(5)	µg/L	2	10	4.5	4.2
HAA(9)	µg/L	5	21	9.5	8.4
UV_{254}	cm^{-1}	0.005	0.004	0.002	0.003
pH	-	6.75	6.88	6.4	7.13
Turbidity	NTU	0.06	0.05	0.044	0.117

Table 13 shows the effect of recovery on the rejection of selected water quality parameters by the NF45 membrane. These data were also obtained during by averaging data from all quarters of testing (the standard deviations are shown following the ± sign). It is observed that this membrane was able to achieve lower concentrations of all measured inorganic and organic water quality parameters. Hence, the NF45 membrane may be preferred over the NTR7450 membrane for treating Lake Meade water. However, pilot-scale studies should be conducted to confirm this especially in light of membrane fouling issues.

Table 13. Effect of recovery on rejection of selected water quality parameters using the NF45 membrane.

Parameter	Units	30%	50%	70%	90%
Ca hardness	mg/L as $CaCO_3$	BMRL	BMRL	BMRL	BMRL
Total hardness	mg/L as $CaCO_3$	BMRL	BMRL	BMRL	BMRL
TDS	mg/L	69.8 ± 6.6	67.0 ± 6.3	63.7 ± 6.3	57.6 ± 3.6
Bromide	µg/L	17.9 ± 15.4	14.8 ± 17.4	8.3 ± 11.5	-3.3 ± 6.9
SDS Cl_2 demand	mg/L	87.7 ± 6.0	84.9 ± 3.8	86.5 ± 5.3	80.1 ± 6.7
TOC	mg/L	79.1 ± 3.0	80.9 ± 3.9	BMRL	78.4 ± 6.6
TOX	µg/L	84.3 ± 7.4	85.4 ± 4.5	84.0 ± 5.8	79.2 ± 5.8
THM	µg/L	90.5 ± 3.7	89.5 ± 5.0	86.1 ± 7.0	80.8 ± 5.3
HAA(5)	µg/L	94.4 ± 2.3	93.9 ± 2.8	91.4 ± 5.7	90.0 ± 6.0
HAA(9)	µg/L	90.5 ± 4.8	89.1 ± 5.4	86.3 ± 8.5	83.3 ± 7.5
UV_{254}	cm^{-1}	BMRL	BMRL	BMRL	BMRL

Table 14 provides a summary of permeate water quality obtained using the NTR7450 membrane at 70% recovery for all four quarters of testing. Note that this membrane was able to achieve lower rejections of hardness, TOC and many other water quality parameters compared to the NF45 membrane.

Table 14. NTR7450 permeate water quality for all four quarters of testing at 70% recovery

Parameter	Units	Winter	Spring	Summer	Autumn
Alkalinity	mg/L as $CaCO_3$	7.8	4.8	7.2	13.2
Ca hardness	mg/L as $CaCO_3$	10	16	18	22
Total hardness	mg/L as $CaCO_3$	14	24	24	31.5
Manganese	µg/L	40	42	125	102.5
TDS	mg/L	60	67.8	61.7	75.8
Bromide	mg/L	0.037	0.04	0.048	0.042
SDS Cl_2 demand	mg/L	0.94	1.25	1.01	1.37
TOC	mg/L	1.75	1.8	0.9	1.6
TOX	µg/L	115	141.2	137.5	135
THM	µg/L	25.6	43	44.6	38.7
HAA(5)	µg/L	16	28	20	22.1
HAA(9)	µg/L	26	42	34.8	33
UV_{254}	cm^{-1}	0.022	0.027	0.018	0.025
pH	-	6.81	6.93	7.30	7.46
Turbidity	NTU	0.11	0.063	0.16	0.107

A variety of inorganic and organic permeate water quality parameters were dependent on feed water recovery for the NTR7450 membrane. Table 15 shows the effect of recovery on the rejection of selected water quality parameters by the NTR7450 membrane. These data were obtained by averaging data from all quarters of testing (the standard deviations are shown following the ± sign).

Table 15. Effect of recovery on rejection of selected water quality parameters using the NTR7450 membrane

Parameter	Units	30%	50%	70%	90%
Ca hardness	mg/L as $CaCO_3$	68.4 ± 12.8	56.4 ± 13.1	31.0 ± 11.2	18.2 ± 8.5
Total hardness	mg/L as $CaCO_3$	68.2 ± 13.6	52.8 ± 14.4	31.1 ± 14.9	12.9 ± 5.3
Manganese	µg/L	65.2 ± 9.8	51.9 ± 12.7	26.3 ± 7.7	17.8 ± 7.9
TDS	mg/L	45.7 ± 9.4	35.8 ± 11.7	17.8 ± 7.3	11.0 ± 7.1
Bromide	µg/L	18.8 ± 6.7	7.6 ± 2.2	2.3 ± 2.7	-0.7 ± 2.1
SDS Cl_2 demand	mg/L	68.8 ± 13.9	64.3 ± 12.7	51.7 ± 8.0	49.4 ± 13.9
TOC	mg/L	72.2 ± 4.4	64.1 ± 3.3	50.4 ± 13.4	55.4 ± 14.2
TOX	µg/L	72.4 ± 12.1	67.5 ± 12.8	52.6 ± 7.9	48.1 ± 15.6
THM	µg/L	68.0 ± 13.7	62.6 ± 14.1	46.8 ± 11.6	44.1 ± 15.1
HAA(5)	µg/L	81.4 ± 7.5	72.3 ± 11.5	60.7 ± 10.1	59.0 ± 12.4
HAA(9)	µg/L	73.9 ± 9.4	66.3 ± 11.3	53.6 ± 8.2	51.0 ± 12.1
UV_{254}	cm^{-1}	77.4 ± 12.0	70.4 ± 12.3	54.3 ± 6.6	51.2 ± 14.1

Blending. Because of the high rejection capabilities of nanofiltration membranes, permeate water quality is often superior to many maximum contaminant levels. This may allow the possibility of blending feed water with NF permeate thereby reducing membrane area and/or energy requirements for the plant. Assuming that feed/permeate blending is a viable option, the blend ratios to achieve various controlling treatment objectives (assuming a 10% safety factor on proposed Stage I THM and HAA concentrations, and placeholders for Stage II THM and HAA concentrations) were calculated for the 70% recovery experiment for all four quarters of testing, and given in Tables 16 and 17 for the NF45 and the NTR7450 respectively. In these tables, Q_p denotes the permeate flow rate and Q_T denotes the total flow rate.

Table 16. Calculated blend ratios to achieve various finished water qualities (NF45 membrane)

Controlling treatment objective	Season	Q_p/Q_T blend ratio	TOC (mg/L)	SDSTHM (µg/L)	SDSHAA5 (µg/L)	SDSHAA9 (µg/L)	SDSTOX (µg Cl^-/L)
Blending not reqd.	Winter	0 *					
SDSHAA5=27 µg/L	Winter	0.375	2.17	31	27	38	151
SDSHAA5=54 µg/L	Spring	0.102	2.92	61	54	74	253
SDSHAA5=27 µg/L	Spring	0.653	1.44	33	27	41	133
SDSTHM=72 µg/L	Summer	0.462	2.30	72	47	63	241
SDSTHM=36 µg/L	Summer	0.794	1.19	36	21	30	118
SDSHAA5=54 µg/L	Autumn	0.004	3.09	63	56	76	189
SDSHAA5=27 µg/L	Autumn	0.561	1.64	32	27	38	106

* Blending not required for this scenario because feed water itself meets water quality objective

Table 17. Calculated blend ratios to achieve various finished water qualities (NTR7450 membrane)

Controlling treatment objective	Season	Q_p/Q_T blend ratio	TOC (mg/L)	SDSTHM (µg/L)	SDSHAA5 (µg/L)	SDSHAA9 (µg/L)	SDSTOX (µg Cl^-/L)
Blending not reqd.	Winter	0 *					
SDSHAA5=27 µg/L	Winter	0.593	2.28	34	27	39	160
Blending not reqd.	Spring	0					
SDSTHM=36 µg/L	Spring	1.269	1.42	36	21	34	105
SDSTHM=72 µg/L	Summer	1.616	NA	NA	NA	NA	NA
SDSHAA5=27 µg/L	Summer	0.865	1.30	55	27	43	171
SDSHAA5=54 µg/L	Autumn	0.002	2.80	64	54	70	74
SDSTHM=36 µg/L	Autumn	1.113	1.46	36	18	29	142

* Blending not required for this scenario because feed water itself meets water quality objective

Problems encountered. Waste flow rates occassionally dropped by approximately 10% when the RBSMT apparatus was left unattended overnight especially during the experiment at 90% feed water recovery.

SECTION V. QA/QC SUMMARY

Results of all laboratory duplicates, fortified matrix sample analyses, performance evaluation samples and relevant calibration procedures are presented in this section as specified in the *DBP/ICR Analytical Methods Manual* (EPA 814-B-96-002). A summary of the acronyms used is presented in Table 18.

Table 18. Glossary of terms used in the QA/QC section

Acronym	Description
BMRL	Below minimum Reporting Level
DUP	Duplicate
IDA	Initial Demonstration of Accuracy
IDC	Initial Demonstration of Capability
IDLSB	Initial Demonstration of Low System Background
IDP	Initial Demonstration of Precision
IS	Internal Standard
LFB	Laboratory Fortified Blank
LFM	Laboratory Fortified Matrix
MDL	Method Detection Limit
ML	Montgomery Watson Laboratories
MRL	Method Reporting Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Analyzed
ND	Not Detected
NR	Not Reported
PE	Performance Evaluation
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SS	Surrogate Standard

Quarter I (Winter) QA/QC information

Parameter Name	Result	units	batch#	QC type	DUP result	%RPD	Spike Amt	%REC	Method
Bromide	0.106	mg/l	60288	MS			0.1	106	ML/EPA 300
Bromide	0.107	mg/l	59749	MSD			0.1	107	ML/EPA 300
Bromide	0.109	mg/l	60288	MSD			0.1	109	ML/EPA 300
Bromide	0.111	mg/l	59749	MS			0.1	111	ML/EPA 300
Bromochloroacetic acid	10	ug/l	60014	MS			10	100	ML/S6251B
Bromochloroacetic acid	10	ug/l	60015	MS			10	100	ML/S6251B
Bromochloroacetic acid	10	ug/l	60089	MS			10	100	ML/S6251B
Bromochloroacetic acid	10	ug/l	60417	MS			10	100	ML/S6251B
Bromochloroacetic acid	11	ug/l	60157	MS			10	110	ML/S6251B
Bromochloroacetic acid	1	ug/l	60157	DUP	1	0			ML/S6251B
Bromochloroacetic acid	2	ug/l	60014	DUP	2	0			ML/S6251B
Bromochloroacetic acid	5	ug/l	60089	DUP	5	0			ML/S6251B
Bromochloroacetic acid	ND	ug/l	60015	DUP	ND	0			ML/S6251B
Bromochloroacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	11	ug/l	60089	MS			10	110	ML/S6251B
Bromodichloroacetic acid	11	ug/l	60157	MS			10	110	ML/S6251B
Bromodichloroacetic acid	11	ug/l	60417	MS			10	110	ML/S6251B
Bromodichloroacetic acid	13	ug/l	60014	MS			10	130	ML/S6251B
Bromodichloroacetic acid	13	ug/l	60015	MS			10	130	ML/S6251B
Bromodichloroacetic acid	2	ug/l	60014	DUP	2	0			ML/S6251B
Bromodichloroacetic acid	9	ug/l	60089	DUP	9	0			ML/S6251B
Bromodichloroacetic acid	ND	ug/l	60015	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	ND	ug/l	60157	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	11	ug/l	60014	MS			10	110	ML/S6251B
Chlorodibromoacetic acid	11	ug/l	60015	MS			10	110	ML/S6251B
Chlorodibromoacetic acid	12	ug/l	60417	MS			10	120	ML/S6251B
Chlorodibromoacetic acid	13	ug/l	60089	MS			10	130	ML/S6251B
Chlorodibromoacetic acid	13	ug/l	60157	MS			10	130	ML/S6251B
Chlorodibromoacetic acid	1	ug/l	60089	DUP	2	67			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	60014	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	60015	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	60157	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Dibromoacetic acid	11	ug/l	60014	MS			10	110	ML/S6251B
Dibromoacetic acid	11	ug/l	60015	MS			10	110	ML/S6251B
Dibromoacetic acid	11	ug/l	60089	MS			10	110	ML/S6251B
Dibromoacetic acid	11	ug/l	60157	MS			10	110	ML/S6251B
Dibromoacetic acid	11	ug/l	60417	MS			10	110	ML/S6251B
Dibromoacetic acid	1	ug/l	60089	DUP	1	0			ML/S6251B
Dibromoacetic acid	2	ug/l	60015	DUP	2	0			ML/S6251B
Dibromoacetic acid	ND	ug/l	60014	DUP	ND	0			ML/S6251B
Dibromoacetic acid	ND	ug/l	60157	DUP	ND	0			ML/S6251B
Dibromoacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Dichloroacetic acid	16	ug/l	60089	DUP	17	6			ML/S6251B
Dichloroacetic acid	1	ug/l	60015	DUP	1	0			ML/S6251B
Dichloroacetic acid	1	ug/l	60417	DUP	1	0			ML/S6251B
Dichloroacetic acid	28	ug/l	60157	DUP	28	0			ML/S6251B
Dichloroacetic acid	29	ug/l	60014	DUP	28	4			ML/S6251B
Dichloroacetic acid	8	ug/l	60089	MS			10	80	ML/S6251B
Dichloroacetic acid	8	ug/l	60417	MS			10	80	ML/S6251B
Dichloroacetic acid	9	ug/l	60014	MS			10	90	ML/S6251B
Dichloroacetic acid	9	ug/l	60015	MS			10	90	ML/S6251B
Dichloroacetic acid	9	ug/l	60157	MS			10	90	ML/S6251B
Manganese, Total, ICAP/MS	49.4	ug/l	59784	MS			50	99	EPA/ML 200.8
Manganese, Total, ICAP/MS	51.3	ug/l	59784	MSD			50	103	EPA/ML 200.8
Monobromoacetic acid	10	ug/l	60089	MS			10	100	ML/S6251B
Monobromoacetic acid	11	ug/l	60157	MS			10	110	ML/S6251B

Quarter I (Winter) QA/QC information

Monobromoacetic acid	11	ug/l	60417	MS			10	110	ML/S6251B
Monobromoacetic acid	9	ug/l	60014	MS			10	90	ML/S6251B
Monobromoacetic acid	9	ug/l	60015	MS			10	90	ML/S6251B
Monobromoacetic acid	ND	ug/l	60014	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	60015	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	60089	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	60157	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Monochloroacetic acid	17	ug/l	60417	MS			20	85	ML/S6251B
Monochloroacetic acid	20	ug/l	60014	MS			20	100	ML/S6251B
Monochloroacetic acid	20	ug/l	60015	MS			20	100	ML/S6251B
Monochloroacetic acid	20	ug/l	60089	MS			20	100	ML/S6251B
Monochloroacetic acid	22	ug/l	60157	MS			20	110	ML/S6251B
Monochloroacetic acid	2	ug/l	60089	DUP	2	0			ML/S6251B
Monochloroacetic acid	2	ug/l	60157	DUP	3	40			ML/S6251B
Monochloroacetic acid	3	ug/l	60014	DUP	3	0			ML/S6251B
Monochloroacetic acid	ND	ug/l	60015	DUP	ND	0			ML/S6251B
Monochloroacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Total Organic Carbon	3.84	mg/l	60032	MSD			4	96	ML/SM 5310C
Total Organic Carbon	3.87	mg/l	60032	MS			4	97	ML/SM 5310C
Total Organic Carbon	4.26	mg/l	60266	MS			4	106	ML/SM 5310C
Total Organic Carbon	4.28	mg/l	60266	MSD			4	107	ML/SM 5310C
Total Organic Carbon	7.9	mg/l	60150	MSD			8	99	ML/SM 5310C
Total Organic Carbon	7.91	mg/l	60150	MS			8	99	ML/SM 5310C
Total Organic Carbon	8.18	mg/l	60265	MSD			8	102	ML/SM 5310C
Total Organic Carbon	8.18	mg/l	60265	MS			8	102	ML/SM 5310C
Total Organic Halogen	176	ug/l	60468	MS			200	88	ML/9020/SM5320
Total Organic Halogen	183	ug/l	60339	MSD			200	92	ML/9020/SM5320
Total Organic Halogen	186	ug/l	60468	MSD			200	93	ML/9020/SM5320
Total Organic Halogen	198	ug/l	60339	MS			200	99	ML/9020/SM5320
Total Organic Halogen	202	ug/l	60341	MSD			200	101	ML/9020/SM5320
Total Organic Halogen	211	ug/l	60341	MS			200	106	ML/9020/SM5320
Total Organic Halogen	222	ug/l	60027	MS			200	111	ML/9020/SM5320
Total Organic Halogen	222	ug/l	60153	MS			200	111	ML/9020/SM5320
Total Organic Halogen	223	ug/l	60027	MSD			200	112	ML/9020/SM5320
Total Organic Halogen	223	ug/l	60153	MSD			200	112	ML/9020/SM5320
Tribromoacetic acid	11	ug/l	60014	MS			10	110	ML/S6251B
Tribromoacetic acid	11	ug/l	60015	MS			10	110	ML/S6251B
Tribromoacetic acid	11	ug/l	60089	MS			10	110	ML/S6251B
Tribromoacetic acid	13	ug/l	60157	MS			10	130	ML/S6251B
Tribromoacetic acid	13	ug/l	60417	MS			10	130	ML/S6251B
Tribromoacetic acid	1	ug/l	60015	DUP	1	0			ML/S6251B
Tribromoacetic acid	ND	ug/l	60014	DUP	ND	0			ML/S6251B
Tribromoacetic acid	ND	ug/l	60089	DUP	ND	0			ML/S6251B
Tribromoacetic acid	ND	ug/l	60157	DUP	ND	0			ML/S6251B
Tribromoacetic acid	ND	ug/l	60417	DUP	ND	0			ML/S6251B
Trichloroacetic acid	11	ug/l	60014	MS			10	110	ML/S6251B
Trichloroacetic acid	11	ug/l	60015	MS			10	110	ML/S6251B
Trichloroacetic acid	11	ug/l	60089	MS			10	110	ML/S6251B
Trichloroacetic acid	11	ug/l	60157	DUP	11	0			ML/S6251B
Trichloroacetic acid	11	ug/l	60157	MS			10	110	ML/S6251B
Trichloroacetic acid	11	ug/l	60417	MS			10	110	ML/S6251B
Trichloroacetic acid	1	ug/l	60417	DUP	1	0			ML/S6251B
Trichloroacetic acid	24	ug/l	60089	DUP	24	0			ML/S6251B
Trichloroacetic acid	27	ug/l	60014	DUP	27	0			ML/S6251B
Trichloroacetic acid	ND	ug/l	60015	DUP	ND	0			ML/S6251B

Quarter II (Spring) QA/QC information

Parameter Name	Result	units	batch#	QC type	DUP result	%RPD	Spike Amt	%REC	Method
Bromide	0.099	mg/l	62989	MS			0.1	99	ML/EPA 300
Bromide	0.101	mg/l	62989	MSD			0.1	101	ML/EPA 300
Bromide	0.111	mg/l	62768	MSD			0.1	111	ML/EPA 300
Bromide	0.112	mg/l	62768	MS			0.1	112	ML/EPA 300
Bromide	0.114	mg/l	62988	MSD			0.1	114	ML/EPA 300
Bromide	0.114	mg/l	62991	MSD			0.1	114	ML/EPA 300
Bromide	0.116	mg/l	62988	MS			0.1	116	ML/EPA 300
Bromide	0.116	mg/l	62991	MS			0.1	116	ML/EPA 300
Bromochloroacetic acid	10	ug/l	62850	MS			10	100	ML/S6251B
Bromochloroacetic acid	3	ug/l	63383	DUP	3	0			ML/S6251B
Bromochloroacetic acid	9	ug/l	63383	MS			10	90	ML/S6251B
Bromochloroacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	13	ug/l	62850	MS			10	130	ML/S6251B
Bromodichloroacetic acid	4	ug/l	63383	DUP	4	0			ML/S6251B
Bromodichloroacetic acid	9	ug/l	63383	MS			10	90	ML/S6251B
Bromodichloroacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	11	ug/l	62850	MS			10	110	ML/S6251B
Chlorodibromoacetic acid	3	ug/l	63383	DUP	3	0			ML/S6251B
Chlorodibromoacetic acid	9	ug/l	63383	MS			10	90	ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Dibromoacetic acid	10	ug/l	63383	MS			10	100	ML/S6251B
Dibromoacetic acid	11	ug/l	62850	MS			10	110	ML/S6251B
Dibromoacetic acid	1	ug/l	63383	DUP	1	0			ML/S6251B
Dibromoacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Dichloroacetic acid	10	ug/l	62850	MS			10	100	ML/S6251B
Dichloroacetic acid	10	ug/l	63383	MS			10	100	ML/S6251B
Dichloroacetic acid	4	ug/l	63383	DUP	4	0			ML/S6251B
Dichloroacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Manganese, Total, ICAP/MS	47.6	ug/l	62907	MSD			50	95	EPA/ML 200.8
Manganese, Total, ICAP/MS	47.6	ug/l	63211	MS			50	95	EPA/ML 200.8
Manganese, Total, ICAP/MS	47.8	ug/l	62760	MSD			50	96	EPA/ML 200.8
Manganese, Total, ICAP/MS	47.8	ug/l	63211	MSD			50	96	EPA/ML 200.8
Manganese, Total, ICAP/MS	48.2	ug/l	62760	MS			50	96	EPA/ML 200.8
Manganese, Total, ICAP/MS	48.4	ug/l	62907	MS			50	97	EPA/ML 200.8
Monobromoacetic acid	10	ug/l	63383	MS			10	100	ML/S6251B
Monobromoacetic acid	11	ug/l	62850	MS			10	110	ML/S6251B
Monobromoacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	63383	DUP	ND	0			ML/S6251B
Monochloroacetic acid	20	ug/l	62850	MS			20	100	ML/S6251B
Monochloroacetic acid	20	ug/l	63383	MS			20	100	ML/S6251B
Monochloroacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Monochloroacetic acid	ND	ug/l	63383	DUP	ND	0			ML/S6251B
Total Organic Carbon	3.9	Units	63011	MS			4	98	ML/SM 4500H
Total Organic Carbon	3.92	Units	63011	MSD			4	98	ML/SM 4500H
Total Organic Carbon	4	Units	62755	MSD			4	100	ML/SM 4500H
Total Organic Carbon	4	Units	62755	MS			4	100	ML/SM 4500H
Total Organic Carbon	8.11	Units	62756	MS			8	101	ML/SM 4500H
Total Organic Carbon	8.21	Units	62756	MSD			8	103	ML/SM 4500H
Total Organic Halogen	181	Units	63168	MS			200	90	ML/SM 4500H
Total Organic Halogen	184	Units	63168	MSD			200	92	ML/SM 4500H
Total Organic Halogen	191	Units	63661	MSD			200	96	ML/SM 4500H
Total Organic Halogen	191	Units	63798	MSD			200	96	ML/SM 4500H

Quarter II (Spring) QA/QC information

Total Organic Halogen	192	Units	63055	MS			200	96	ML/SM 4500H
Total Organic Halogen	192	Units	63169	MS			200	96	ML/SM 4500H
Total Organic Halogen	200	Units	62969	MS			200	100	ML/SM 4500H
Total Organic Halogen	203	Units	63661	MS			200	102	ML/SM 4500H
Total Organic Halogen	203	Units	63798	MS			200	102	ML/SM 4500H
Total Organic Halogen	204	Units	62969	MSD			200	102	ML/SM 4500H
Total Organic Halogen	208	Units	63055	MSD			200	104	ML/SM 4500H
Total Organic Halogen	208	Units	63169	MSD			200	104	ML/SM 4500H
Tribromoacetic acid	NA	ug/l	62850	MS			10	0	ML/S6251B
Tribromoacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	63383	DUP	NR	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	63383	MS			10	0	ML/S6251B
Trichloroacetic acid	11	ug/l	62850	MS			10	110	ML/S6251B
Trichloroacetic acid	3	ug/l	63383	DUP	4	29			ML/S6251B
Trichloroacetic acid	9	ug/l	63383	MS			10	90	ML/S6251B
Trichloroacetic acid	ND	ug/l	62850	DUP	ND	0			ML/S6251B

Quarter III (Summer) QA/QC information

Parameter Name	Result	units	batch#	QC type	DUP result	%RPD	Spike Amt	%REC	Method
Bromide	0.104	mg/l	65949	MS			0.1	104	ML/EPA 300
Bromide	0.106	mg/l	65949	MSD			0.1	106	ML/EPA 300
Bromide	0.114	mg/l	65553	MS			0.1	114	ML/EPA 300
Bromide	0.116	mg/l	65553	MSD			0.1	116	ML/EPA 300
Bromide	0.309	mg/l	65950	MS			0.3	103	ML/EPA 300
Bromide	0.312	mg/l	65950	MSD			0.3	104	ML/EPA 300
Bromochloroacetic acid	1	ug/l	65866	MS			1	100	ML/S6251B
Bromochloroacetic acid	32	ug/l	65965	MS			32	100	ML/S6251B
Bromochloroacetic acid	33	ug/l	66194	MS			32	103	ML/S6251B
Bromochloroacetic acid	6.1	ug/l	65965	DUP	6	2			ML/S6251B
Bromochloroacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Bromochloroacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	1.6	ug/l	65866	MS			1	160	ML/S6251B
Bromodichloroacetic acid	24	ug/l	66194	MS			32	75	ML/S6251B
Bromodichloroacetic acid	34	ug/l	65965	MS			32	106	ML/S6251B
Bromodichloroacetic acid	4.2	ug/l	65965	DUP	4	5			ML/S6251B
Bromodichloroacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Bromodichloromethane	22.3	ug/l	65425	MS			20	112	ML/EPA 524.2
Bromodichloromethane	23.7	ug/l	65526	MS			20	118	ML/EPA 524.2
Bromodichloromethane	23.7	ug/l	65530	MS			20	118	ML/EPA 524.2
Bromodichloromethane	23.7	ug/l	65931	MS			20	118	ML/EPA 524.2
Bromodichloromethane	25.2	ug/l	65526	DUP	23.7	6			ML/EPA 524.2
Bromodichloromethane	25.2	ug/l	65530	DUP	23.7	6			ML/EPA 524.2
Bromodichloromethane	25	ug/l	65931	DUP	24	4			ML/EPA 524.2
Bromodichloromethane	5.9	ug/l	65425	DUP	5.5	7			ML/EPA 524.2
Bromoform	19.5	ug/l	65526	MS			20	98	ML/EPA 524.2
Bromoform	19.5	ug/l	65530	MS			20	98	ML/EPA 524.2
Bromoform	19.5	ug/l	65931	MS			20	98	ML/EPA 524.2
Bromoform	20.8	ug/l	65425	MS			20	104	ML/EPA 524.2
Bromoform	4.79	ug/l	65526	DUP	4.8	0			ML/EPA 524.2
Bromoform	4.79	ug/l	65530	DUP	4.8	0			ML/EPA 524.2
Bromoform	4.8	ug/l	65931	DUP	4.8	0			ML/EPA 524.2
Bromoform	ND	ug/l	65425	DUP	ND	0			ML/EPA 524.2
Chlorodibromoacetic acid	2.2	ug/l	65866	MS			2	110	ML/S6251B
Chlorodibromoacetic acid	25	ug/l	66194	MS			32	78	ML/S6251B
Chlorodibromoacetic acid	31	ug/l	65965	MS			32	97	ML/S6251B
Chlorodibromoacetic acid	4.7	ug/l	65965	DUP	4.5	4			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Chlorodibromomethane	21.5	ug/l	65425	MS			20	108	ML/EPA 524.2
Chlorodibromomethane	23	ug/l	65526	MS			20	115	ML/EPA 524.2
Chlorodibromomethane	23	ug/l	65530	MS			20	115	ML/EPA 524.2
Chlorodibromomethane	23	ug/l	65931	MS			20	115	ML/EPA 524.2
Chlorodibromomethane	24.7	ug/l	65526	DUP	20.7	18			ML/EPA 524.2
Chlorodibromomethane	24.7	ug/l	65530	DUP	20.7	18			ML/EPA 524.2
Chlorodibromomethane	25	ug/l	65931	DUP	21	17			ML/EPA 524.2
Chlorodibromomethane	4.6	ug/l	65425	DUP	3.9	16			ML/EPA 524.2
Chloroform (Trichloromethane)	21.8	ug/l	65425	MS			20	109	ML/EPA 524.2
Chloroform (Trichloromethane)	22.8	ug/l	65526	DUP	22.6	1			ML/EPA 524.2
Chloroform (Trichloromethane)	22.8	ug/l	65530	DUP	22.6	1			ML/EPA 524.2
Chloroform (Trichloromethane)	23.6	ug/l	65526	MS			20	118	ML/EPA 524.2
Chloroform (Trichloromethane)	23.6	ug/l	65530	MS			20	118	ML/EPA 524.2
Chloroform (Trichloromethane)	23.6	ug/l	65931	MS			20	118	ML/EPA 524.2
Chloroform (Trichloromethane)	23	ug/l	65931	DUP	23	0			ML/EPA 524.2
Chloroform (Trichloromethane)	5.2	ug/l	65425	DUP	4.5	14			ML/EPA 524.2
Dibromoacetic acid	1.3	ug/l	65866	MS			1	130	ML/S6251B
Dibromoacetic acid	33	ug/l	65965	MS			32	103	ML/S6251B

Quarter III (Summer) QA/QC information

Dibromoacetic acid	33	ug/l	66194	MS			32	103	ML/S6251B
Dibromoacetic acid	5.6	ug/l	65965	DUP	5.5	2			ML/S6251B
Dibromoacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Dibromoacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Dichloroacetic acid	0.9	ug/l	65866	MS			1	90	ML/S6251B
Dichloroacetic acid	2.4	ug/l	65866	DUP	2.6	8			ML/S6251B
Dichloroacetic acid	32	ug/l	66194	MS			32	100	ML/S6251B
Dichloroacetic acid	33	ug/l	65965	MS			32	103	ML/S6251B
Dichloroacetic acid	4.6	ug/l	65965	DUP	4.6	0			ML/S6251B
Dichloroacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Manganese, Total, ICAP/MS	48.1	ug/l	65410	MS			50	96	EPA/ML 200.8
Manganese, Total, ICAP/MS	48.7	ug/l	65410	MSD			50	97	EPA/ML 200.8
Manganese, Total, ICAP/MS	49.8	ug/l	65850	MSD			50	100	EPA/ML 200.8
Manganese, Total, ICAP/MS	50.6	ug/l	65850	MS			50	101	EPA/ML 200.8
Monobromoacetic acid	1.2	ug/l	65866	MS			1	120	ML/S6251B
Monobromoacetic acid	33	ug/l	65965	MS			32	103	ML/S6251B
Monobromoacetic acid	35	ug/l	66194	MS			32	109	ML/S6251B
Monobromoacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	65965	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Monochloroacetic acid	2.4	ug/l	65866	MS			2	120	ML/S6251B
Monochloroacetic acid	34	ug/l	66194	MS			32	106	ML/S6251B
Monochloroacetic acid	36	ug/l	65965	MS			32	112	ML/S6251B
Monochloroacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Monochloroacetic acid	ND	ug/l	65965	DUP	ND	0			ML/S6251B
Monochloroacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Total Organic Carbon	0.53	Units	65547	MS			0.7	76	ML/SM 4500H
Total Organic Carbon	0.55	Units	65547	MSD			0.7	79	ML/SM 4500H
Total Organic Carbon	0.6	Units	65810	MSD			0.7	86	ML/SM 4500H
Total Organic Carbon	0.6	Units	65810	MS			0.7	86	ML/SM 4500H
Total Organic Carbon	4.06	Units	65548	MSD			4	102	ML/SM 4500H
Total Organic Carbon	4.06	Units	65548	MS			4	102	ML/SM 4500H
Total Organic Carbon	4.22	Units	65787	MSD			4	106	ML/SM 4500H
Total Organic Carbon	4.23	Units	65787	MS			4	106	ML/SM 4500H
Total Organic Carbon	8.26	Units	65546	MSD			8	103	ML/SM 4500H
Total Organic Carbon	8.29	Units	65546	MS			8	104	ML/SM 4500H
Total Organic Halogen	158	Units	65673	MS			200	79	ML/SM 4500H
Total Organic Halogen	166	Units	65673	MSD			200	83	ML/SM 4500H
Total Organic Halogen	193	Units	66504	MSD			200	96	ML/SM 4500H
Total Organic Halogen	201	Units	66504	MS			200	100	ML/SM 4500H
Total Organic Halogen	41.5	Units	65715	MSD			50	83	ML/SM 4500H
Total Organic Halogen	45.4	Units	65715	MS			50	91	ML/SM 4500H
Total Organic Halogen	50.1	Units	65658	MSD			50	100	ML/SM 4500H
Total Organic Halogen	50.8	Units	65658	MS			50	102	ML/SM 4500H
Total Organic Halogen	53.3	Units	65656	MSD			50	107	ML/SM 4500H
Total Organic Halogen	53.4	Units	65656	MS			50	107	ML/SM 4500H
Tribromoacetic acid	2.3	ug/l	65866	MS			4	58	ML/S6251B
Tribromoacetic acid	39	ug/l	66194	MS			32	122	ML/S6251B
Tribromoacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Tribromoacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	65965	DUP	ND	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	65965	MS			32	0	ML/S6251B
Trichloroacetic acid	1.4	ug/l	65866	MS			1	140	ML/S6251B
Trichloroacetic acid	2.4	ug/l	65965	DUP	2.3	4			ML/S6251B
Trichloroacetic acid	33	ug/l	65965	MS			32	103	ML/S6251B
Trichloroacetic acid	33	ug/l	66194	MS			32	103	ML/S6251B
Trichloroacetic acid	ND	ug/l	65866	DUP	ND	0			ML/S6251B
Trichloroacetic acid	ND	ug/l	66194	DUP	ND	0			ML/S6251B

Quarter IV (Autumn) QA/QC information

Parameter Name	Result	units	batch#	QC type	DUP result	%RPD	Spike Amt	%REC	Method
Bromide	0.099	mg/l	68991	MSD			0.1	99	ML/EPA 300
Bromide	0.1	mg/l	68991	MS			0.1	100	ML/EPA 300
Bromide	0.105	mg/l	68323	MS			0.1	105	ML/EPA 300
Bromide	0.106	mg/l	68323	MSD			0.1	106	ML/EPA 300
Bromide	0.307	mg/l	68722	MSD			0.3	102	ML/EPA 300
Bromide	0.308	mg/l	68722	MS			0.3	103	ML/EPA 300
Bromochloroacetic acid	0.8	ug/l	69128	MS			1	80	ML/S6251B
Bromochloroacetic acid	1.4	ug/l	68526	MS			1	140	ML/S6251B
Bromochloroacetic acid	18	ug/l	68715	MS			20	90	ML/S6251B
Bromochloroacetic acid	2.2	ug/l	68526	DUP	2.4	9			ML/S6251B
Bromochloroacetic acid	3.7	ug/l	69128	DUP	3.7	0			ML/S6251B
Bromochloroacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Bromodichloroacetic acid	0.3	ug/l	69128	MS			1	30	ML/S6251B
Bromodichloroacetic acid	1.1	ug/l	68526	MS			1	110	ML/S6251B
Bromodichloroacetic acid	1.8	ug/l	69128	DUP	1.9	5			ML/S6251B
Bromodichloroacetic acid	2.3	ug/l	68526	DUP	2.3	0			ML/S6251B
Bromodichloroacetic acid	20	ug/l	68715	MS			20	100	ML/S6251B
Bromodichloroacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Bromodichloromethane	11.4	ug/l	68812	DUP	11.6	2			ML/EPA 524.2
Bromodichloromethane	2.08	ug/l	68506	DUP	2.2	6			ML/EPA 524.2
Bromodichloromethane	20.3	ug/l	68812	MS			20	102	ML/EPA 524.2
Bromodichloromethane	20.6	ug/l	68506	MS			20	103	ML/EPA 524.2
Bromoform	0.32	ug/l	68506	DUP	0.2	46			ML/EPA 524.2
Bromoform	21.5	ug/l	68506	MS			20	108	ML/EPA 524.2
Bromoform	22.7	ug/l	68812	MS			20	114	ML/EPA 524.2
Bromoform	ND	ug/l	68812	DUP	ND	0			ML/EPA 524.2
Chlorodibromoacetic acid	1.4	ug/l	68526	MS			2	70	ML/S6251B
Chlorodibromoacetic acid	21	ug/l	68715	MS			20	105	ML/S6251B
Chlorodibromoacetic acid	4.2	ug/l	68526	DUP	4.1	2			ML/S6251B
Chlorodibromoacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Chlorodibromoacetic acid	NR	ug/l	69128	DUP	NR	0			ML/S6251B
Chlorodibromoacetic acid	NR	ug/l	69128	MS			2	0	ML/S6251B
Chlorodibromomethane	1.78	ug/l	68506	DUP	1.78	0			ML/EPA 524.2
Chlorodibromomethane	20.4	ug/l	68506	MS			20	102	ML/EPA 524.2
Chlorodibromomethane	21.4	ug/l	68812	MS			20	107	ML/EPA 524.2
Chlorodibromomethane	3.69	ug/l	68812	DUP	3.67	1			ML/EPA 524.2
Chloroform (Trichloromethane)	1.35	ug/l	68506	DUP	1.35	0			ML/EPA 524.2
Chloroform (Trichloromethane)	17.6	ug/l	68812	MS			20	88	ML/EPA 524.2
Chloroform (Trichloromethane)	19.8	ug/l	68506	MS			20	99	ML/EPA 524.2
Chloroform (Trichloromethane)	22.7	ug/l	68812	DUP	22.6	0			ML/EPA 524.2
Dibromoacetic acid	0.6	ug/l	68526	MS			1	60	ML/S6251B
Dibromoacetic acid	0.8	ug/l	69128	MS			1	80	ML/S6251B
Dibromoacetic acid	1.3	ug/l	69128	DUP	1.3	0			ML/S6251B
Dibromoacetic acid	18	ug/l	68715	MS			20	90	ML/S6251B
Dibromoacetic acid	6	ug/l	68526	DUP	5.9	2			ML/S6251B
Dibromoacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Dichloroacetic acid	1.8	ug/l	68526	MS			1	180	ML/S6251B
Dichloroacetic acid	19	ug/l	68715	MS			20	95	ML/S6251B
Dichloroacetic acid	2	ug/l	68526	DUP	1.9	5			ML/S6251B
Dichloroacetic acid	2	ug/l	69128	MS			1	200	ML/S6251B
Dichloroacetic acid	20	ug/l	69128	DUP	21	5			ML/S6251B
Dichloroacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Manganese, Total, ICAP/MS	48.5	ug/l	69528	MS			50	97	EPA/ML 200.8
Manganese, Total, ICAP/MS	49.1	ug/l	69528	MSD			50	98	EPA/ML 200.8

Quarter IV (Autumn) QA/QC information

Manganese, Total, ICAP/MS	50.1	ug/l	67981	MS			50	100	EPA/ML 200.8
Manganese, Total, ICAP/MS	52.2	ug/l	67981	MSD			50	104	EPA/ML 200.8
Monobromoacetic acid	1.4	ug/l	68526	MS			1	140	ML/S6251B
Monobromoacetic acid	18	ug/l	68715	MS			20	90	ML/S6251B
Monobromoacetic acid	3	ug/l	68526	DUP	3.1	3			ML/S6251B
Monobromoacetic acid	3.4	ug/l	69128	MS			1	340	ML/S6251B
Monobromoacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Monobromoacetic acid	ND	ug/l	69128	DUP	ND	0			ML/S6251B
Monochloroacetic acid	1.2	ug/l	68526	MS			2	60	ML/S6251B
Monochloroacetic acid	1.3	ug/l	69128	MS			2	65	ML/S6251B
Monochloroacetic acid	18	ug/l	68715	MS			20	90	ML/S6251B
Monochloroacetic acid	5.2	ug/l	69128	DUP	5.3	2			ML/S6251B
Monochloroacetic acid	ND	ug/l	68526	DUP	ND	0			ML/S6251B
Monochloroacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B
Total Organic Carbon	0.51	mg/l	68883	MS			0.7	73	ML/SM 5310C
Total Organic Carbon	0.56	mg/l	68883	MSD			0.7	80	ML/SM 5310C
Total Organic Carbon	3.77	mg/l	68890	MS			4	94	ML/SM 5310C
Total Organic Carbon	3.78	mg/l	68890	MSD			4	94	ML/SM 5310C
Total Organic Carbon	0.56	Units	68623	MSD			0.7	80	ML/SM 4500H
Total Organic Carbon	0.57	Units	68623	MS			0.7	81	ML/SM 4500H
Total Organic Carbon	1.03	Units	68632	MS			0.7	147	ML/SM 4500H
Total Organic Carbon	1.04	Units	68632	MSD			0.7	149	ML/SM 4500H
Total Organic Carbon	4.05	Units	68624	MS			4	101	ML/SM 4500H
Total Organic Carbon	4.07	Units	68624	MSD			4	102	ML/SM 4500H
Total Organic Carbon	7.74	Units	68642	MS			8	97	ML/SM 4500H
Total Organic Carbon	7.81	Units	68642	MSD			8	98	ML/SM 4500H
Total Organic Halogen	456	ug/l	69830	MS			500	91	ML/9020/SM5320
Total Organic Halogen	461	ug/l	69830	MSD			500	92	ML/9020/SM5320
Total Organic Halogen	212	Units	69335	MSD			200	106	ML/SM 4500H
Total Organic Halogen	216	Units	69335	MS			200	108	ML/SM 4500H
Total Organic Halogen	224	Units	69273	MSD			200	112	ML/SM 4500H
Total Organic Halogen	232	Units	69273	MS			200	116	ML/SM 4500H
Tribromoacetic acid	NR	ug/l	68526	DUP	ND	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	68526	MS			4	0	ML/S6251B
Tribromoacetic acid	NR	ug/l	68715	DUP	ND	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	68715	MS			20	0	ML/S6251B
Tribromoacetic acid	NR	ug/l	69128	DUP	NR	0			ML/S6251B
Tribromoacetic acid	NR	ug/l	69128	MS			4	0	ML/S6251B
Trichloroacetic acid	1	ug/l	68526	DUP	1	0			ML/S6251B
Trichloroacetic acid	1.1	ug/l	69128	MS			1	110	ML/S6251B
Trichloroacetic acid	1.3	ug/l	68526	MS			1	130	ML/S6251B
Trichloroacetic acid	19	ug/l	68715	MS			20	95	ML/S6251B
Trichloroacetic acid	5.9	ug/l	69128	DUP	6	2			ML/S6251B
Trichloroacetic acid	ND	ug/l	68715	DUP	ND	0			ML/S6251B

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC

Performance Criteria	Method	THMs EPA 551.1	TOC SM 5310 C	TOX SM 5320B
	Analytes	***THM***	***TOC***	***TOX***
	Target Analytes	**Trihalomethanes (THMs)** Chloroform (CHCl3) Bromodichloromethane (BDCM) Dibromochloromethane(DBCM) Bromoform (CHBR3)	**Total Organic Carbon**	**Total Organic Halide** **(Dissolved Organic Halogen)** **(DOX)**
1.0 IDC				
1.1 IDLSB	**Method Blank**	< 1/2 MRL	< 1/2 MRL	< 1/2 MRL
1.2 IDA	**QC check sample**	+/- 20% of true value	+/- 20% of true value	+/- 20% of true value
1.3 IDP	**No. of replicates**	5	5	5
	Spike conc.	THM 20 ug/L	TOC 4 mg/L	TOX 250 ug/L
	% RSD	< 20	< 20	< 20
	% Recovery	80-120	80-120	80-120
1.4 MDL				
	No. of replicates	7	7	7
	Spike conc.	1/2 MRL	0.5	1/2 MRL
	% Recovery	50-150	50-150	50-150
2.0 MRL		THM 1.0 ug/L Others: 0.5 ug/L	0.70 mg/L 0.50 mg/L (during treatment studies)	50 ug Cl^-/L 25 ug Cl^-/L (during treatment studies)

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC

	Performance Criteria	Method	THMs EPA 551.1	TOC SM 5310 C	TOX SM 5320B
3.0	**Calibration Verification**	**Verification Frequency**	Lowest level std. analyzed at the beginning of each 24 hr before the first sample	Lowest level std. analyzed at the beginning of each 24 hr before the first sample	3 microcoulometer titration cell checks with NaCl std at start of 8-10 hr. work shift. Lowest level std. analyzed before the first sample.
			Mid level and high level analyzed alternately after every 10th sample and last sample	Mid level and high level analyzed alternately after every 10th sample and last sample	Mid level and high level analyzed alternately after every 7th sample and last sample
	Conc. and QC criteria (%rec)		*THM*	*TOC*	***TOX***
			(ug/L) (% rec)	***(mg/L) (% rec)***	(ug Cl-/L) (% rec)
		Low	1.0 50-150	0.7 (0.5) 50-150	50 (25) 75-125
		Mid-level	20 80-120	4 90-110	200 85-115
		High	40 80-120	9 90-110	500 85-115
4.0	**Reagent (Method) Blank**	***Frequency***	One per analysis batch (one per extraction batch)	One per analysis batch	2 nitrate-washed activated carbon at the start of ea analysis batch, then 1 after every 7 samples (run in duplicate)- minimum of 3 per day; Analyze 1 system blank per analysis batch.
	QC criteria		< 1/2 MRL	< 1/2 MRL,< 0.35, or< 0.25	<0.80 ug/Cl-/40 mg of activated carbon; < 1/2 of MRL, <25 or < 12.5
5.0	**Shipping Blank Criteria**	**Travel Blank**	NA	NA	NA
6.0	**LFM**	***Fortified Sample***			

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC

	Performance Criteria	Method	THMs EPA 551.1	TOC SM 5310 C	TOX SM 5320B
	Frequency		one sample in each extraction batch	at least 5% of ICR samples in an analysis batch (fortified sample analyzed in duplicate)	at least 5% of all ICR samples analyzed each quarter (fortified sample analyzed in duplicate
	Matrix spike level		same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.	same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.	same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.
	QC criteria	**% Recovery**	NA	NA	NA
7.0	**Lab (Field) Duplicate**		field duplicate	lab duplicate	lab duplicate
	QC Criteria	**% RPD**	NA	</= 10 % (TOC conc > 2.0 mg/L) </= 20 % (TOC conc </= 2.0 mg/L)	NA
8.0	**Internal Std.**		BFB if pentane solvent is used; Optional if MTBE is the extracting solvent	NA	NA
	QC Criteria	**IS Recoveries**	+/- 30% of calibration curve AVG IS response 70-130 % Rec.	NA	NA
9.0	**Surrogate QC Standards**		decafluorobiphenyl in ea sample	NA	NA
		Surrogate Recoveries	70-130 % Rec.	NA	NA
10.0	**Method Calibration Procedures**	**Initial Calibration Curve**	THMs: CHCL3, BDCM Concentration (ug/L)	Conc. (mg/L)	

CALIBRATION VERIFICATION AND QUALITY CONTROL PROCEDURES - METHOD SPECIFIC

Performance Criteria	Method	THMs EPA 551.1	TOC SM 5310 C	TOX SM 5320B
Trihalomethane	**Standard 1**	0.5	0.5	
	Standard 2	1	1.0	
	Standard 3	2	5	
	Standard 4	5	10	
	Standard 5	10	20	
	Standard 6	20		
	Standard 7	30		
	Standard 8	40		
	Standard 9	50		
		THMs: DBCM, CHBR3 Concentration (ug/L)		
	Standard 1	0.25		
	Standard 2	0.5		
	Standard 3	1		
	Standard 4	2.5		
	Standard 5	5		
	Standard 6	10		
	Standard 7	15		
	Standard 8	20		
	Standard 9	25		

Calib (Br, HAA)

Performance Criteria	Method →	EPA300.0 A, B	SM 6251B
	Analytes	**Anions and Oxyhalides**	**Haloacetic Acids (HAA)**
	Target Analytes	Bromide (Br^-)	Monochloroacetic (MCAA) Dichloroacetic acid (DCAA) Dibromoacetic acid(TCAA) Trichloroacetic acid (TCAA) Monobromoacetic acid (MBAA) Bromochloroacetic acid (BCAA)
1.0 IDC			
1.1 IDLSB	**Method Blank**	< 1/2 MRL	< 1/2 MRL
1.2 IDA	**QC check sample (external source)**	+/- 20% of true value	+/- 20% of true value
1.3 IDP	**No. of replicates**	5	5
	Spike conc.	Br^- 0 .10 mg/L	20
	% 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
Performance Criteria	**Method →**	**Anions EPA300 A, B**	**(HAA) SM 6251B**
2.0 MRL		Br: 0.020 mg/L	MCAA: 2.0 ug/L Others:1.0 ug/L
3.0 Calibration Verification/ Frequency		Lowest level std. analyzed at the beginning of each 24 hour- before first sample run Mid level and high level analyzed alternately after 10th sample and after the last sample.	Lowest level std. analyzed at the beginning of each 24 hour- before first sample run Mid level and high level analyzed alternately after 10th sample and after the last sample.
Calibration Verification Concentrations and Acceptance Criteria		***Br-***	***MCAA***
		(mg/L) (% rec.)	***(ug/L) (% rec.)***
	Low	0.02 50-150	2.0 50-150
	MIdlevel	0.10 90-110	20 80-120
	High	0.30 90-110	40 80-120
			All others
			(ug/L) (% rec.)
	Low		1 50-150
	MIdlevel		20 80-120

		High		40 80-120
Performance Criteria		**Method →**	**Anions EPA300 A, B**	**(HAA) SM 6251B**
4.0	**Reagent (Method) Blank**			
	Frequency		one per analysis batch	one per analysis batch (one per extraction batch)
	QC Criteria		< 1/2 of MRL	< 1/2 of MRL
5.0	**Shipping Blank**	**Travel Blank/ Field Reagent Blank**	NA	NA
	QC Criteria		NA	NA
6.0	**LFM**	**Fortified Sample**		
	Frequency		5 % per analysis batch	one sample per extraction batch
	Matrix spike Level		same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.	same concentration as cal verification. If no historical data for sample level, rotate low, mid, high as spike conc.
	QC criteria		NA	NA
7.0	**Field/Lab Duplicate**			
	Frequency		5% of the samples per analysis batch	one lab duplicate per extraction batch
	QC criteria		NA	NA
Performance Criteria		**Method →**	**Anions EPA300 A, B**	**(HAA) SM 6251B**
8.0	**Internal Std.**		NA	1,2-dibromopropane or 1,2,3-trichloropropane in each extract
	QC criteria		NA	+/- 30% of calibration curve AVG IS response 70-130 %
9.0	**Surrogate Standards**		NA	2,3-dibromopropionic acid or 2,3,5,6-tetrafluorobenzoic acid in each sample
	QC Criteria		NA	70-130 %

Montgomery Watson Laboratories Results of EPA ICR PE Samples

Parameter being tested	ICR 3/94 PE (PE Study #1)			ICR 3/95 PE (PE Study #2)			ICR 7/96 PE (PE Study #3)			ICR 4/97 &6/97 PE (PE-Study-#4/4m)			ICR 9/97 PE (PE-Study #5)			Status	Acceptance Limits
	Result	True Value	% Diff	Result	True Value	% Diff	Result	True Value	% Diff	Result	True Value	% Diff	Result	True Value	% Diff		
UV Absorbance																	
UV absorbance at 254 nm	0.324	0.308	5%	0.083	0.084	-1%	0.190	0.189	1%	0.300	0.323	-7%	0.410	0.435	-6%	**Pass**	25%
TOC																	
Total Organic Carbon	2.3	2.4	-4%	3.99	4.1	-3%	3.37	3.59	-6%	1.7	1.6	6%	4.4	4.7	-6%	**Pass**	25%
TOX																	
Total Organic Halogen	73	99.7	-27%	25.7	30.3	-15%	46.5	50.1	-7%	93.1	103	-10%	51.5	50.5	2%	**Pass**	25%
Haloacetic Acids (passing criteria = 4 of 5, excluding MCAA)																**Pass**	
Bromochloracetic acid (BCAA)	12.8	13.2	-3%	19	20.1	-5%	12.8	13.1	-2%	8.3	9.0	-8%	5.2	6.0	-13%		40%
Dibromoacetic acid (DBAA)	9.81	10.8	-9%	14	14.3	-2%	10.6	11.0	-4%	6.5	7.0	-7%	13.0	15.1	-14%		40%
Dichloroacetic acid (DCAA)	19.3	17.4	11%	29	29.3	-1%	14.5	15.0	-3%	21.2	24.0	-12%	10.0	12.0	-17%		40%
Monobromoacetic acid (MBAA)	7.46	8.73	-15%	12	12.2	-2%	6.3	??	??	9.1	10.0	??	10.0	11.9	-16%		40%
Monochloroacetic acid (MCAA)	7.08	7.41	-4%	11	10.2	8%	8.4	8.0	5%	11.5	12.0	-4%	5.5	6.1	-9%		Not Applic
Trichloroacetic acid (TCAA)	17.9	21.1	-15%	29	34.2	-15%	20.9	21.0	0%	12.8	15.0	-15%	8.0	9.0	-11%		40%
Haloacetonitriles (passing criteria = 4 of 5, excluding TCAN)																**Pass**	
1,1,1-Trichloropropanone (1,1-TCP	11	10	10%	20.4	14.7	39%	6.1	6.0	2%	16.6	15.0	11%	6.3	??	??		40%
1,1-Dichloropropanone (1,1-DCP)	5.9	7.3	-19%	10.1	9.6	6%	3.1	3.0	2%	10.2	8.9	14%	7.8	6.0	30%		40%
Bromochloroacetonitrile (BCAN)	18.5	18.4	1%	18.6	17.0	9%	11.1	12.0	-8%	14.7	14.0	5%	9.0	7.1	27%		40%
Dibromoacetonitrile (DBAN)	13.3	13.1	2%	12.3	10.8	14%	9.9	10.0	-1%	10.5	8.0	31%	7.3	6.2	18%		40%
Dichloroacetonitrile (DCAN)	17.1	18	-5%	21.6	19.6	10%	17.6	17.0	4%	12.2	11.0	11%	16.0	14.0	14%		40%
Trichloroacetonitrile (TCAN)	8.34	8.95	-7%	10.2	6.3	63%	7.3	8.0	-9%	17.2	15.0	15%	20.0	18.0	11%		Not Applic
Bromide																	
Bromide	**Not included in study 1**			0.031	0.031	0%	0.076	0.078	-3%	0.241	0.253	-5%	0.167	0.169	-1%	**Pass**	30%
Chloral Hydrate																	
Chloral Hydrate	16.8	15.5	8%	27.3	22.4	22%	24.4	18.3	33%	10.2	10.0	2%	15.0	17.0	-12%	**Pass**	40%
Inorganic DBPS (passing = 3 of 3)																**Pass**	
Bromate by IC	7.3	7.52	-3%	13.2	14.0	-6%	11.3	12.1	-7%	23.6	23.0	3%	9.0	8.7	3%		40%
Chlorate by IC	74.3	70	6%	129	130	-1%	352	351	0%	190	184	3%	446	457	-2%		40%
Chlorite by IC	257	260	-1%	560	570	-2%	169	175	-3%	352	375	-6%	213	226	-6%		40%
THMs by 551.1 (passing criteria = 3 of 4)																**Pass**	
Bromodichloromethane	26.8	31.1	-14%	17.1	13.8	24%	22.3	24.0	-7%	23.1	26.9	-14%	16.0	16.3	-2%		20%
Bromoform	13.4	14.4	-7%	18.7	16.4	14%	5.9	6.1	-3%	11.7	12.0	-3%	11.0	??	??		20%
Chloroform (Trichloromethane)	34.6	42.9	-19%	14.6	12.0	22%	38.9	38.0	2%	23.1	29.1	-21%	11.0	11.1	-1%		20%
Dibromochloromethane	20.8	22.9	-9%	18.7	18.6	1%	11.2	12.0	-7%	16.5	17.9	-8%	36.0	34.9	3%		20%
THMs ICR PE analyzed by 502.2																**Pass**	
Bromodichloromethane	32.9	31.1	6%	12.9	13.8	-7%				26.8	26.9	0%	17.9	16.3	10%		20%
Bromoform	15.8	14.4	10%	15.6	16.4	-5%				12.1	12.0	1%	10.4	??	??		20%
Chloroform (Trichloromethane)	43.6	42.9	2%	12.7	12.0	6%				26.6	29.1	-9%	12.0	11.1	8%		20%
Dibromochloromethane	24.2	22.9	6%	17.7	18.6	-5%				17.5	17.9	-2%	35.3	34.9	1%		20%

Note: EPA approval requires acceptable performance on the most current PE and submission of an acceptable Initial Demonstration of Capabilitiy (IDC), along with following all method QC.

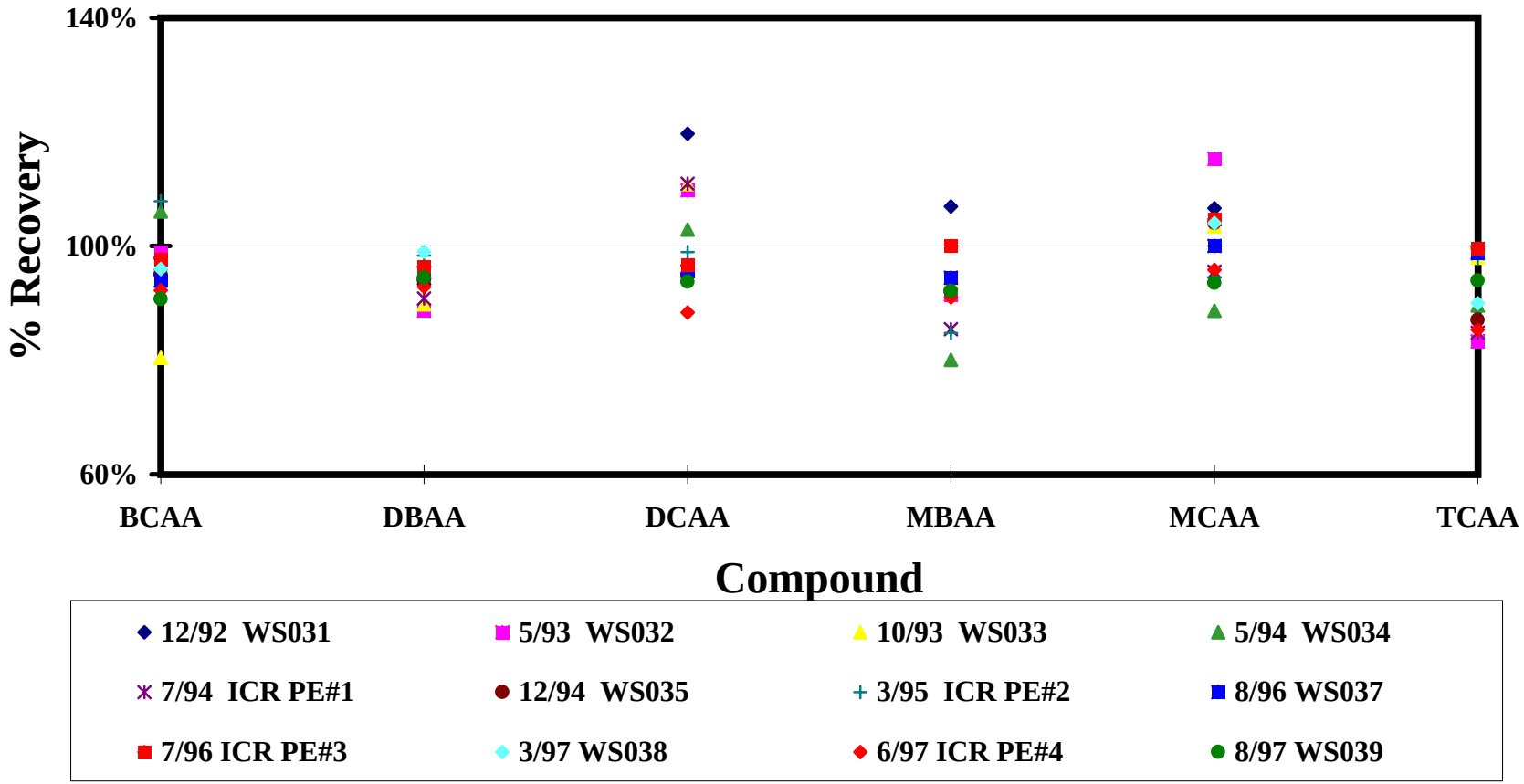
HAA historic performance

	Results								
Analyte	**ICR Criteria % Bias**	**12/92 WS031 % Bias**	**5/93 WS032 % Bias**	**10/93 WS033 % Bias**	**5/94 WS034 % Bias**	**7/94 ICR PE#1 % Bias**	**12/94 WS035 % Bias**	**3/95 ICR PE#2 % Bias**	**7/96 ICR PE#3 % Bias**
Bromochloracetic acid (BCAA)	**40%**	NA	-1%	-20%	6%	-3%	-5%	8%	-2%
Dibromoacetic acid (DBAA)	**40%**	-7%	-11%	-10%	-5%	-9%	-6%	-2%	-4%
Dichloroacetic acid (DCAA)	**40%**	20%	10%	11%	3%	11%	-5%	-1%	-3%
Monobromoacetic acid (MBAA)	**40%**	7%	-9%	-6%	-20%	-15%	-8%	-15%	
Monochloroacetic acid (MCAA)	**40%**	7%	15%	3%	-11%	-4%	4%	-5%	5%
Trichloroacetic acid (TCAA)	**40%**	NA	-17%	-2%	-10%	-15%	-13%	-2%	0%

Analyte	**BCAA**	**DBAA**	**DCAA**	**MBAA**	**MCAA**	**TCAA**
ICR Criteria % Bias	**40%**	**40%**	**40%**	**40%**	**40%**	**40%**
12/92 WS031	NA	-7%	20%	7%	7%	NA
5/93 WS032	-1%	-11%	10%	-9%	15%	-17%
10/93 WS033	-20%	-10%	11%	-6%	3%	-2%
5/94 WS034	6%	-5%	3%	-20%	-11%	-10%
7/94 ICR PE#1	-3%	-9%	11%	-15%	-4%	-15%
12/94 WS035	-5%	-6%	-5%	-8%	4%	-13%
3/95 ICR PE#2	8%	-2%	-1%	-15%	-5%	-2%
7/96 ICR PE#3 % Bias	-2%	-4%	-3%		5%	0%

Analyte	**BCAA**	**DBAA**	**DCAA**	**MBAA**	**MCAA**	**TCAA**
12/92 WS031		93%	120%	107%	107%	
5/93 WS032	99%	89%	110%	91%	115%	83%
10/93 WS033	80%	90%	111%	94%	103%	98%
5/94 WS034	106%	95%	103%	80%	89%	90%
7/94 ICR PE#1	97%	91%	111%	85%	96%	85%
12/94 WS035	95%	94%	95%	92%	104%	87%
3/95 ICR PE#2	108%	98%	99%	85%	95%	98%
8/96 WS037	94%	95%	96%	94%	100%	99%
7/96 ICR PE#3	98%	96%	97%	100%	105%	100%
3/97 WS038	96%	99%		92%	104%	90%
6/97 ICR PE#4	92%	93%	88%	91%	96%	85%
8/97 WS039	91%	94%	94%	92%	94%	94%

Montgomery Watson Laboratories
HAA Historic Performance on PE Studies (1992-1997)



RESULTS FOR ICR PE STUDY 4

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reported Value	Pass/ Fail
UV 254		0.323	0.242	0.404	.	
Total Organic Carbon		1.60	1.19	2.01		
Total Organic Halogen		103	77.2	129	.	
Inorganic DBPs:						
Chlorite		375	224	526	.	
Bromate		23.0	13.7	32.3	.	
Chlorate		184	110	258	.	
Bromide		0.253	0.164	0.342	.	
Haloacetic Acids:						
Monochloroacetic Acid		12.0	7.19	16.9	.	
Monobromoacetic Acid		10.0	5.99	14.1	.	
Dichloroacetic Acid		24.0	14.3	33.7	.	
Trichloroacetic Acid		15.0	8.99	21.1	.	
Bromochloroacetic Acid		9.00	5.39	12.7	.	
Dibromoacetic Acid		7.00	4.19	9.81	.	
Trihalomethanes:	502.2					PASS
Chloroform		29.1	23.2	35.0	26.60	PASS
Bromodichloromethane		26.9	21.5	32.3	26.80	PASS
Dibromochloromethane		17.9	14.3	21.5	17.50	PASS
Bromoform		12.0	9.59	14.5	12.10	PASS
Haloacetonitriles:						
Trichloroacetonitrile		13.0	7.79	18.3	.	
Dichloroacetonitrile		8.01	4.80	11.3	.	
1,1-Dichloropropanone		8.03	4.81	11.3	.	
Bromochloroacetonitrile		16.0	9.59	22.5	.	
1,1,1-Trichloropropanone		13.0	7.79	18.3	.	
Dibromoacetonitrile		13.0	7.79	18.3	.	
Chloral Hydrate		5.02	3.01	7.03	.	

(NR: indicates data were not reported for methods which the laboratory has been approved or is seeking ICR approval.)

RESULTS FOR ICR PE STUDY 5

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reported Value	Pass/ Fail
UV 254		0.435	0.326	0.544		
Total Organic Carbon		4.70	3.52	5.88	.	
Total Organic Halogen		50.5	37.8	63.2	.	
Inorganic DBPs:						
Chlorite		226	135	317		
Bromate		8.73	5.23	12.3	.	
Chlorate		457	274	640	.	
Bromide		0.169	0.109	0.229		
Haloacetic Acids:						
Monochloroacetic Acid		6.05	3.62	8.48	.	
Monobromoacetic Acid		11.9	7.13	16.7	.	
Dichloroacetic Acid		12.0	7.19	16.9	.	
Trichloroacetic Acid		9.03	5.41	12.7	.	
Bromochloroacetic Acid		5.96	3.57	8.35	.	
Dibromoacetic Acid		15.1	9.05	21.2	.	
Trihalomethanes:	502.2					PASS
Chloroform		11.1	8.87	13.4	12.00	PASS
Bromodichloromethane		16.3	13.0	19.6	17.90	PASS
Dibromochloromethane		34.9	27.9	41.9	35.30	PASS
Bromoform *					10.40	PASS
Haloacetonitriles:						
Trichloroacetonitrile		18.0	10.7	25.3	.	
Dichloroacetonitrile		14.0	8.39	19.7	.	
1,1-Dichloropropanone		6.00	3.59	8.41		
Bromochloroacetonitrile		7.10	4.25	9.95	.	
1,1,1-Trichloropropanone *					.	
Dibromoacetonitrile		6.20	3.71	8.69	.	
Chloral Hydrate		17.0	10.1	23.9		

* There was a problem with bromoform in the THM sample and with 1,1,1-TCP in the HAN sample. Therefore all labs that reported these 2 compounds were given a passing score for them.

(NR: indicates data were not reported on time for methods which the lab has been approved.)

RESULTS FOR ICR PE STUDY 4

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reported Value	Pass/ Fail
UV 254	5910	0.323	0.242	0.404	0.300	PASS
Total Organic Carbon	5310C	1.60	1.19	2.01	1.70	PASS
Total Organic Halogen	5320B	103	77.2	129	93.1	PASS
Inorganic DBPs:	300.0					PASS
Chlorite		375	224	526	352.0	PASS
Bromate		23.0	13.7	32.3	23.60	PASS
Chlorate		184	110	258	190.0	PASS
Bromide	300.0	0.253	0.164	0.342	0.241	PASS
Haloacetic Acids:	6251B					PASS
Monochloroacetic Acid		12.0	7.19	16.9	11.50	PASS
Monobromoacetic Acid		10.0	5.99	14.1	9.10	PASS
Dichloroacetic Acid		24.0	14.3	33.7	21.20	PASS
Trichloroacetic Acid		15.0	8.99	21.1	12.80	PASS
Bromochloroacetic Acid		9.00	5.39	12.7	8.30	PASS
Dibromoacetic Acid		7.00	4.19	9.81	6.50	PASS
Trihalomethanes:	551.1					PASS
Chloroform		29.1	23.2	35.0	23.10	FAIL
Bromodichloromethane		26.9	21.5	32.3	23.10	PASS
Dibromochloromethane		17.9	14.3	21.5	16.50	PASS
Bromoform		12.0	9.59	14.5	11.70	PASS
Haloacetonitriles:	551.1					FAIL
Trichloroacetonitrile		13.0	7.79	18.3	2.70	FAIL
Dichloroacetonitrile		8.01	4.80	11.3	2.50	FAIL
1,1-Dichloropropanone		8.03	4.81	11.3	2.00	FAIL
Bromochloroacetonitrile		16.0	9.59	22.5	4.30	FAIL
1,1,1-Trichloropropanone		13.0	7.79	18.3	3.00	FAIL
Dibromoacetonitrile		13.0	7.79	18.3	4.00	FAIL
Chloral Hydrate	551.1	5.02	3.01	7.03	1.20	FAIL

(NR: indicates data were not reported for methods which the laboratory has been approved or is seeking ICR approval.)

RESULTS FOR ICR PE STUDY 4

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reported Value	Pass/ Fail
UV 254		0.323	0.242	0.404	.	
Total Organic Carbon		1.60	1.19	2.01	.	
Total Organic Halogen		103	77.2	129	.	
Inorganic DBPs:						
Chlorite		375	224	526	.	
Bromate		23.0	13.7	32.3	.	
Chlorate		184	110	258	.	
Bromide		0.253	0.164	0.342		
Haloacetic Acids:						
Monochloroacetic Acid		12.0	7.19	16.9	.	
Monobromoacetic Acid		10.0	5.99	14.1	.	
Dichloroacetic Acid		24.0	14.3	33.7	.	
Trichloroacetic Acid		15.0	8.99	21.1	.	
Bromochloroacetic Acid		9.00	5.39	12.7	.	
Dibromoacetic Acid		7.00	4.19	9.81	.	
Trihalomethanes:	551					PASS
Chloroform		29.1	23.2	35.0	22.90	FAIL
Bromodichloromethane		26.9	21.5	32.3	23.50	PASS
Dibromochloromethane		17.9	14.3	21.5	15.90	PASS
Bromoform		12.0	9.59	14.5	11.00	PASS
Haloacetonitriles:						
Trichloroacetonitrile		13.0	7.79	18.3	.	
Dichloroacetonitrile		8.01	4.80	11.3	.	
1,1-Dichloropropanone		8.03	4.81	11.3	.	
Bromochloroacetonitrile		16.0	9.59	22.5	.	
1,1,1-Trichloropropanone		13.0	7.79	18.3	.	
Dibromoacetonitrile		13.0	7.79	18.3	.	
Chloral Hydrate		5.02	3.01	7.03	.	

(NR: indicates data were not reported for methods which the laboratory has been approved or is seeking ICR approval.)

RESULTS FOR ICR PE STUDY 3

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reported Value	Pass/ Fail
UV 254	5910	0.189	0.141	0.237	0.190	PASS
Total Organic Carbon	5310C	3.59	2.69	4.49	3.37	PASS
Total Organic Halogen	5320B	50.1	37.5	62.7	46.5	PASS
Inorganic DBPs:	300.0					PASS
Chlorite		175	104	246	169.0	PASS
Bromate		12.1	7.25	17.0	11.30	PASS
Chlorate		351	210	492	352.0	PASS
Bromide	300.0	0.078	0.050	0.106	0.076	PASS
Haloacetic Acids:	6251B					PASS
Monochloroacetic Acid		8.02	4.81	11.3	8.40	PASS
Monobromoacetic Acid *					6.30	PASS
Dichloroacetic Acid		15.0	8.99	21.1	14.50	PASS
Trichloroacetic Acid		21.0	12.5	29.5	20.90	PASS
Bromochloroacetic Acid		13.1	7.85	18.4	12.80	PASS
Dibromoacetic Acid		11.0	6.59	15.5	10.60	PASS
Trihalomethanes:	551.1					PASS
Chloroform		38.0	30.3	45.7	38.90	PASS
Bromodichloromethane		24.0	19.1	28.9	22.30	PASS
Dibromochloromethane		12.0	9.59	14.5	11.20	PASS
Bromoform		6.07	4.85	7.29	5.90	PASS
Haloacetonitriles:	551.1					PASS
Trichloroacetonitrile		8.01	4.80	11.3	7.32	PASS
Dichloroacetonitrile		17.0	10.1	23.9	17.60	PASS
1,1-Dichloropropanone		3.00	1.79	4.21	3.05	PASS
Bromochloroacetonitrile		12.0	7.19	16.9	11.10	PASS
1,1,1-Trichloropropanone		6.00	3.59	8.41	6.10	PASS
Dibromoacetonitrile		10.0	5.99	14.1	9.94	PASS
Chloral Hydrate	551.1	18.3	10.9	25.7	24.40	PASS

* There was a problem with MBAA in the PE#3 HAA sample. Therefore, all labs that reported MBAA data in this study were given a passing score for MBAA.

RESULTS FOR PE STUDY 2

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reported Value	Pass/ Fail
UV 254	5910	0.084	0.062	0.106	0.083	PASS
Total Organic Carbon	5310C	4.10	3.07	5.13	3.99	PASS
Total Organic Halogen	5320B	30.3	22.7	37.9	25.7	PASS
Inorganic DBPs:	300.0					PASS
Chlorite		570	341	799	560.0	PASS
Bromate		14.0	8.39	19.7	13.20	PASS
Chlorate		130	77.9	183	129.0	PASS
Bromide	300.0	0.031	0.020	0.042	0.031	PASS
Haloacetic Acids:	6233B					PASS
Monochloroacetic Acid		10.2	6.11	14.3	11.00	PASS
Monobromoacetic Acid		12.2	7.31	17.1	12.00	PASS
Dichloroacetic Acid		29.3	17.5	41.1	29.00	PASS
Trichloroacetic Acid		34.2	20.5	47.9	29.00	PASS
Bromochloroacetic Acid		20.1	12.0	28.2	19.00	PASS
Dibromoacetic Acid		14.3	8.57	20.1	14.00	PASS
Trihalomethanes:	551					FAIL
Chloroform		12.0	9.59	14.5	14.60	FAIL
Bromodichloromethane		13.8	11.0	16.6	17.10	FAIL
Dibromochloromethane		18.6	14.8	22.4	18.70	PASS
Bromoform		16.4	13.1	19.7	18.70	PASS
Haloacetonitriles:	551					PASS
Trichloroacetonitrile		6.25	3.74	8.76	10.20	FAIL
Dichloroacetonitrile		19.6	11.7	27.5	21.60	PASS
1,1-Dichloropropanone		9.55	5.72	13.4	10.10	PASS
Bromochloroacetonitrile		17.0	10.1	23.9	18.60	PASS
1,1,1-Trichloropropanone		14.7	8.81	20.6	20.40	PASS
Dibromoacetonitrile		10.8	6.47	15.2	12.30	PASS
Chloral Hydrate	551	22.4	13.4	31.4	27.30	PASS

RESULTS FOR PE STUDY 1

LAB ID: ICRCA013

	Method Number	True Value	Lower Acc. Limit	Upper Acc. Limit	Reprtd. Value	Pass/ Fail
UV 254	5910	0.308	0.231	0.385	0.324	PASS
Total Organic Carbon	5310C	2.4	1.8	3.0	2.30	PASS
Total Organic Halogen	5320B	99.7	74.8	125	73.0	FAIL
Inorganic DBPs:	300.0					PASS
Chlorite		260	156	364	257.0	PASS
Bromate		7.52	4.51	10.5	7.30	PASS
Chlorate		70	42	98	74.3	PASS
Haloacetic Acids:	6233B					PASS
Monochloroacetic Acid		7.41	4.45	10.4	7.08	PASS
Monobromoacetic Acid		8.73	5.24	12.2	7.46	PASS
Dichloroacetic Acid		17.4	10.4	24.4	19.30	PASS
Trichloroacetic Acid		21.1	12.7	29.5	17.90	PASS
Bromochloroacetic Acid		13.2	7.92	18.5	12.80	PASS
Dibromoacetic Acid		10.8	6.48	15.1	9.81	PASS
Trihalomethanes:	551					PASS
Chloroform		42.9	34.3	51.5	34.60	PASS
Bromodichloromethane		31.1	24.9	37.3	26.80	PASS
Dibromochloromethane		22.9	18.3	27.5	20.80	PASS
Bromoform		14.4	11.5	17.3	13.40	PASS
Haloacetonitriles:	551					PASS
Trichloroacetonitrile		8.95	5.37	12.5	8.34	PASS
Dichloroacetonitrile		18.0	10.8	25.2	17.10	PASS
1,1-Dichloropropanone		7.3	4.38	10.2	5.90	PASS
Bromochloroacetonitrile		18.4	11.0	25.8	18.50	PASS
1,1,1-Trichloropropanone		10.0	6.0	14.0	11.00	PASS
Dibromoacetonitrile		13.1	7.86	18.3	13.30	PASS
Chloral Hydrate	551	15.5	9.3	21.7	16.80	PASS

Performance Evaluation Report
USEPA Water Supply Study WS038

Participant ID: CA00006 Type: OTHER Requesting Office: CA

Sample Number	Reported Value	True Value*	Acceptance Limits	Performance Evaluation
MISCELLANEOUS ANALYTES:				
022-RESIDUAL FREE CHLORINE(MILLIGRAMS PER LITER)				
001	0.900	0.820	0.662-0.963	Accept.
023-TURBIDITY(NTU'S)				
001	5.50	5.89	4.72- 6.77	Accept.
024-TOTAL FILTERABLE RESIDUE(MILLIGRAMS PER LITER)				
001	652	419	249- 622	Not Accept.
025-CALCIUM HARDNESS(MG. CACO3/L)				
001	236	240	221- 252	Accept.
026-PH-UNITS				
001	9.13	9.13	8.89- 9.31	Accept.
027-ALKALINITY(MG. CACO3/L)				
001	46.6	43.5	42.4- 49.9	Accept.
029-SODIUM(MILLIGRAMS PER LITER)				
001	20.6	20.0	19.1- 22.2	Accept.
145-SULFATE(MILLIGRAMS PER LITER)				
001	15.9	17.0	14.5- 19	Accept.
146-TOTAL CYANIDE(MILLIGRAMS PER LITER)				
001	0.128	0.120	0.09- 0.15	Accept.
253-ASBESTOS(REPORTED VALUE IN MFL)				
001	0.900	1.25	D.L. - 2.99	Accept.
263-TOC				
001	4.80	4.90	4.39- 5.41	Accept.

********** END OF DATA FOR CA00006 **********
NOTE: FOR LIMITS AND TRUE VALUES, ASSUME THREE SIGNIFICANT DIGITS.
********** END OF REPORT FOR CA00006 **********

* Based on gravimetric calculations, or a reference value when necessary.

Performance Evaluation Report
USEPA Water Supply Study WS039

Participant ID: CA00006 Type: OTHER Requesting Office: CA

	Sample Number	Reported Value	True Value*	Acceptance Limits	Performance Evaluation
016-2,4,5-TP (SILVEX)	001	36.0	32.3	16.2- 48.5	Accept.
102-PENTACHLOROPHENOL	001	45.2	43.7	21.9- 65.6	Accept
115-DALAPON	001	72.9	63.0	D.L. - 111	Accept
116-DINOSEB	001	44.8	41.3	D.L. - 62.6	Accept.
117-PICLORAM	001	68.6	74.9	D.L. - 112	Accept.
247-DICAMBA	001	63.6	54.9	17.5- 76	Accept.
262-ACIFLUORFEN	001	48.6	38.6	14.6- 55.4	Accept
PAH'S IN MICROGRAMS PER LITER:					
122-BENZO(A)PYRENE	001	2.40	2.37	D.L. - 3.44	Accept.
ADIPATE/PHTHALATES IN MICROGRAMS PER LITER:					
134-DI (2-ETHYLHEXYL)ADIPATE	001	21.5	23.0	10.5- 34.7	Accept.
136-DI (2-ETHYLHEXYL)PHTHAL.	001	25.6	27.7	11.7- 46.9	Accept.
MISCELLANEOUS SOC'S IN MICROGRAMS PER LITER:					
137-DIQUAT	001	32.0	32.2	D.L. - 52.5	Accept.
138-ENDOTHALL	001	406	410	86.7- 598	Accept.
139-GLYPHOSATE	001	650	620	497- 734	Accept.
TRIHALOMETHANES IN MICROGRAMS PER LITER:					
017-CHLOROFORM	001	15.2	16.2	13- 19.4	Accept.
018-BROMOFORM	001	17.9	20.2	16.2- 24.2	Accept.
019-BROMODICHLOROMETHANE	001	20.7	22.8	18.2- 27.4	Accept.
020-CHLORODIBROMOMETHANE	001	27.0	28.6	22.9- 34.3	Accept.
021-TOTAL TRIHALOMETHANE	001	80.8	87.8	70.2- 105	Accept.
VOLATILE ORGANIC COMPOUNDS IN MICROGRAMS PER LITER:					
032-VINYL CHLORIDE	001	5.12	6.19	3.71- 8.67	Accept.

Participant ID: CA00006 Type: OTHER Requesting Office: CA

Sample Number	Reported Value	True Value*	Acceptance Limits	Performance Evaluation
076-1,2,4-TRICHLOROBENZENE				
001	21.6	23.6	18.9- 28.3	Accept.
081-HEXACHLOROBUTADIENE				
002	12.8	13.2	9.51- 17.5	Accept.
090-TOTAL XYLENES				
001	23.2	24.4	19.5- 29.3	Accept.
152-C 1,3 DICHLOROPROPENE				
002		Not Evaluated in this Study		
153-T 1,3 DICHLOROPROPENE				
002	12.2	14.8	8.91- 15.4	Accept
ORGANIC DISINFECTION BY-PRODUCTS IN MICROGRAMS PER LITER:				
157-DIBROMOACETIC ACID				
001	6.80	7.20	0.219- 11.5	Accept
158-DICHLOROACETIC ACID				
001	30.0	32.0	15.2- 41.3	Accept.
160-MONOBROMOACETIC ACID				
001	7.00	7.60	D.L. - 16.5	Accept
161-MONOCHLOROACETIC ACID				
001	14.4	15.4	3.84- 24.2	Accept
162-TRICHLOROACETIC ACID				
001	15.5	16.5	2.59- 24.1	Accept.
165-CHLORAL HYDRATE				
002	17.0	17.2	2.26- 28.1	Accept.
250-BROMOCHLOROACETIC ACID				
001	20.5	22.6	7.02- 31.9	Accept
INORGANIC DISINFECTION BY-PRODUCTS IN MICROGRAMS PER LITER:				
193-BROMATE				
002	11.2	9.31	D.L. - 24.4	Accept.
194-CHLORATE				
001	59.5	61.0	45.8- 80.2	Accept.
195-CHLORITE				
001	239	230	144- 345	Accept.
260-BROMIDE				
002	77.0	75.0	59.2- 90.7	Accept.
MISCELLANEOUS ANALYTES:				
022-RESIDUAL FREE CHLORINE(MILLIGRAMS PER LITER)				
001	4.00	3.56	3.15- 4.33	Accept.
023-TURBIDITY(NTU'S)				
001	0.600	0.550	0.446-0.897	Accept.
024-TOTAL FILTERABLE RESIDUE(MILLIGRAMS PER LITER)				
001	429	306	199- 574	Accept.
025-CALCIUM HARDNESS(MG. CACO3/L)				
001	171	170	157- 184	Accept.
026-PH-UNITS				
001	9.23	9.13	8.86- 9.32	Accept.

Performance Evaluation Report
USEPA Water Supply Study WS039

Participant ID: CA00006 Type: OTHER Requesting Office: CA

Sample Number	Reported Value	True Value*	Acceptance Limits	Performance Evaluation
027-ALKALINITY(MG. CACO3/L)				
001	35.1	31.0	30.7- 36.5	Accept.
029-SODIUM(MILLIGRAMS PER LITER)				
001	14.4	14.2	13.6- 16.4	Accept.
145-SULFATE(MILLIGRAMS PER LITER)				
001	503	490	440- 538	Accept.
146-TOTAL CYANIDE(MILLIGRAMS PER LITER)				
001	0.403	0.445	0.334-0.556	Accept.
253-ASBESTOS(REPORTED VALUE IN MFL)				
001	21.5	16.5	D.L. - 32.9	Accept.
263-TOC				
001	0.960	0.930	0.669- 1.29	Accept.

********** END OF DATA FOR CA00006 **********
NOTE: FOR LIMITS AND TRUE VALUES, ASSUME THREE SIGNIFICANT DIGITS.
********** END OF REPORT FOR CA00006 **********

* Based on gravimetric calculations, or a reference value when necessary.

Participant ID: CA00006 Type: OTHER Requesting Office: CA

Sample Number	Reported Value	True Value*	Acceptance Limits	Performance Evaluation
017-CHLOROFORM				
001	31.6	36.5	29.2- 43.8	Accept.
018-BROMOFORM				
001	25.7	26.5	21.2- 31.8	Accept.
019-BROMODICHLOROMETHANE				
001	28.8	32.2	25.8- 38.6	Accept.
020-CHLORODIBROMOMETHANE				
001	12.4	14.7	11.8- 17.6	Accept.
021-TOTAL TRIHALOMETHANE				
001	98.5	109.9	87.9- 132	Accept.
VOLATILE ORGANIC COMPOUNDS IN MICROGRAMS PER LITER:				
032-VINYL CHLORIDE				
001	16.3	17.9	10.7- 25.1	Accept.
035-1,2-DICHLOROETHANE				
001	15.3	15.6	12.5- 18.7	Accept.
036-1,1,1-TRICHLOROETHANE				
001	15.8	17.2	13.8- 20.6	Accept.
037-CARBON TETRACHLORIDE				
001	14.7	15.6	12.5- 18.7	Accept.
038-TRICHLOROETHYLENE				
001	11.9	12.4	9.92- 14.9	Accept.
039-BENZENE				
001	14.9	15.3	12.2- 18.4	Accept.
040-TETRACHLOROETHYLENE				
002	12.2	14.1	11.3- 16.9	Accept.
042-T 1,2 DICHLOROETHYLENE				
002	20.8	20.6	16.5- 24.7	Accept.
043-C 1,2 DICHLOROETHYLENE				
002	20.1	22.3	17.8- 26.8	Accept.
044-1,2 DICHLOROPROPANE				
002	16.2	18.3	14.6- 22	Accept.
045-1,2DIBROMO3CHLOROPROPANE				
004	0.410	0.429	0.257-0.601	Accept.
046-ETHYLENE DIBROMIDE (EDB)				
004	0.310	0.336	0.202- 0.47	Accept.
047-TOLUENE				
002	14.3	16.2	13- 19.4	Accept.
048-ETHYLBENZENE				
002	12.6	15.7	12.6- 18.8	Accept.
049-CHLOROBENZENE				
002	18.9	24.2	19.4- 29	Not Accept.
053-STYRENE				
002	13.5	14.2	11.4- 17	Accept.
054-1,2 DICHLOROBENZENE				
002	14.4	16.6	13.3- 19.9	Accept.

Performance Evaluation Report
USEPA Water Supply Study WS038

Participant ID: CA00006 Type: OTHER Requesting Office: CA

	Sample Number	Reported Value	True Value*	Acceptance Limits	Performance Evaluation
055-DICHLOROMETHANE	001	21.1	14.7	11.8- 17.6	Not Accept.
060-2,2-DICHLOROPROPANE	003	12.2	14.7	10.2- 17.7	Accept.
061-1,1,2-TRICHLOROETHANE	001	14.1	16.3	13- 19.6	Accept.
063-1,1,1,2TETRACHLOROETHANE	003	7.13	8.40	6.16- 9.66	Accept.
064-1,2,3-TRICHLOROPROPANE	003	11.9	16.9	10.1- 21.4	Accept.
076-1,2,4-TRICHLOROBENZENE	002	7.15	8.30	4.98- 11.6	Accept.
081-HEXACHLOROBUTADIENE	003	14.8	18.4	14.1- 24.7	Accept.
082-1,3,5-TRIMETHYLBENZENE	003	15.5	16.4	13- 19.6	Accept.
090-TOTAL XYLENES	002	19.4	22.9	18.3- 27.5	Accept.
152-C 1,3 DICHLOROPROPENE	003	7.15	9.40	6.55- 11.9	Accept.
153-T 1,3 DICHLOROPROPENE	003	9.71	12.5	7.75- 14.3	Accept.
ORGANIC DISINFECTION BY-PRODUCTS IN MICROGRAMS PER LITER:					
157-DIBROMOACETIC ACID	001	13.7	13.8	4.62- 21.8	Accept.
160-MONOBROMOACETIC ACID	001	11.8	12.8	5.3- 20.4	Accept.
161-MONOCHLOROACETIC ACID	001	9.70	9.30	D.L. - 17.8	Accept.
162-TRICHLOROACETIC ACID	001	25.6	28.3	6.94- 42.9	Accept.
165-CHLORAL HYDRATE	002	27.0	26.8	D.L. - 52.2	Accept.
250-BROMOCHLOROACETIC ACID	001	11.2	11.7	D.L. - 20.2	Accept.
INORGANIC DISINFECTION BY-PRODUCTS IN MICROGRAMS PER LITER:					
193-BROMATE	002	25.0	23.0	5.29- 43	Accept.
194-CHLORATE	001	192	180	139- 219	Accept.
195-CHLORITE	001	56.4	64.7	35.7- 92.9	Accept.
260-BROMIDE	002	247	260	215- 308	Accept.

I quarter (Winter) data
FilmTec NF45 membrane