EXHIBIT D

Revised Report

Section 2.306 Site Specific Water Quality Study:
Town Branch, Holman Creek, and War Eagle Creek

Prepared for:

City of Huntsville, Arkansas
Huntsville, AR 72740

Prepared by:

GBM^c & Associates
219 Brown Lane
Bryant, AR 72022

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1.0 INTRODUCTION

1.1 Background

The City of Huntsville, Arkansas (Huntsville) discharges to Town Branch Creek then to Holman Creek, and then to War Eagle Creek in Segment 4K of the White River Basin. Holman Creek has been identified on the Arkansas 2008 303(d) list for Total Dissolved Solids (TDS) in excess of the domestic water supply use. In order to address the situation a 3rd party rulemaking process is being proposed. The Arkansas Department of Environmental Quality (ADEQ) has advised Huntsville that chloride could also be added to the list of pollutants associated with Holman Creek's presence on the 303(d) list. In addition, when the study was initiated development of a site specific criterion for sulfate was not contemplated as sulfate was not a known issue based upon ADEQ's ambient monitoring. Therefore, sulfate was only collected during the study on four occasions in Town Branch Creek below the outfall and in War Eagle Creek (downtown of Town Branch). However, after study completion it was determined that sulfate concentration had increased at ADEQ's Holman Creek monitoring station. The increase in sulfate was caused by the City of Huntsville's use of aluminum sulfate to meet a phosphorus permit limit. It was determined that the sulfate issue could be addressed in the proposed rulemaking. Therefore, TDS, chloride, and sulfate will be addressed in the 3r d party rulemaking studies to be conducted pursuant to Section 2.306 of Regulation 2 (the Arkansas Water Quality Standards).

This Quality Assurance Project Plan (QAPP) for the project was originally submitted to the ADEQ for review on March 31, 2011. Comments from ADEQ and EPA were received, reviewed and the QAPP was modified and resubmitted to ADEQ on June 16, 2011. No additional comments on the QAPP were received.

The City of Huntsville Waste Water Treatment Plant (WWTP) is located within Segment 4K of the White River Basin, in Madison County, Arkansas. Sampling reaches for the study are show in Figure 1.1. The receiving stream for the discharge is located in reach No. 959, USGS HUC 11010001 and is classified for secondary contact recreation, domestic water supply, industrial and agricultural water supply, aquatic life, (Ozark Highlands) and other uses. The Huntsville WWTP facility is classified under Standard Industrial Classification code 4952 as a sewage treatment plant and is currently authorized to discharge wastewater through NPDES Outfall 001 (NPDES No. AR0022004) to Town Branch Creek.

The effective permit for the City of Huntsville WWTP contains a weekly monitoring requirement for TDS. For purposes of this study the Huntsville WWTP also monitored chloride and sulfate weekly in Outfall 001 during the one-year field study period. The project described in the QAPP is intended to provide data in support of development of site specific minerals criteria and removal of the non-existing but designated Domestic Water Supply uses.

Figure 1.1. Sampling reaches used during this study of Town Branch, Holman Creek, and War Eagle Creek (July 2011- June 2012).

1.2 Study Focus and Objective

The focus of the study completed and described in this report is the discharge from the City of Huntsville WWTP outfall (Outfall 001), Town Branch, Holman Creek and War Eagle Creek. The study was conducted pursuant to Reg. 2.306, which describes the procedures necessary to request removal of the Domestic Water Supply use, and modify certain criteria to make them less stringent. Other guidance for completing the study included the "Minerals Implementation Policy" (Appendix D, Arkansas CPP 2000), "Information Required in Applying for Site Specific Water Quality Standards Modification in Accordance with Section 2.306 of the Water Quality Standards (WQS), and the "Administrative Guidance Document" (Arkansas CPP 2000).

The primary report objectives are to:

Propose, if warranted by the study results, site-specific water quality criteria for chloride, TDS, and sulfate that:

- reflect the current instream and discharged concentrations of minerals from the City of Huntsville WWTP, and
- support the designated aquatic life use in the Town Branch, Holman Creek and War Eagle Creek downstream of the discharge, and
- remove the designated, but not existing, domestic water supply use from Town Branch and Holman Creek, and
- support the existing domestic water supply use of Beaver Lake.

2.0 SIGNIFICANT FINDINGS AND RECOMMENDATIONS

2.1 Recommendations

The following recommendations are based on the information developed during this study of the Town Branch, Holman Creek and War Eagle Creek.

1. Ecoregion Reference Stream Values for the Town Branch, Holman Creek and War Eagle Creek should be amended as follows:

Town Branch from Point of Discharge of the City of Huntsville WWTP downstream to the confluence with Holman Creek.			**Holman Creek from the confluence with Town Branch downstream to the confluence with War Eagle Creek.**			**War Eagle Creek from the confluence with Holman Creek to Clifty Creek.**		
Site Specific Criteria Proposed			**Site Specific Criteria Proposed**			**Site Specific Criteria Proposed**		
Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
223	61	779	180	48	621	39	17[1]	248

[1] Existing Ecoregion Reference Stream Value, no revision recommended.

Removal of the Domestic Water Supply use is requested for Town Branch beginning at Latitude 36.112330º, Longitude -93.732833º and extending downstream to its confluence with Holman Creek at Latitude 36.118158º, Longitude -93.736039º; and for Holman Creek beginning at its confluence with Town Branch at Latitude 36.118158º, Longitude -93.736039º and extending downstream to its confluence with War Eagle Creek at Latitude 36.140824º, Longitude -93.729594º.

2.2 Significant Findings

1. The designated Aquatic Life Uses for Town Branch, Holman Creek, and War Eagle Creek are being maintained.
2. The whole effluent toxicity testing results for the City of Huntsville WWTP reveal an excellent toxicity record, containing only two historical records of sub-lethal test failure. Additional correlation analysis indicates that the observed toxicity was not associated with TDS.
3. Habitat quality of each of the reaches examined was classified as sub-optimal but the habitat

quality of each was adequate to support the designated Aquatic Life Use.

4. With respect to the macroinvertebrate community:
    a. A significant proportion of each downstream community was comprised of EPT taxa (>50% during the fall and >30% during the spring) which included 6-13 different taxa at each station.
    b. Key metric scores at each station indicated that the downstream reaches (TB-2, HC-2 and WEC-2) during the fall have greater taxa richness, a higher proportion of the sensitive EPT taxa, and lower biotic Index scores.
    c. The better performance of the macroinvertebrate community during the fall assessment, when background flow is lower and effluent percent instream composition is higher, indicates that the point source discharge is not adversely affecting the biota during the most critical conditions.
    d. All biometric and multimetric paired scoring systems achieved scores sufficient to make a determination of full attainment of the Aquatic Life Use.
5. The fish collections for each of the creeks evaluated were typical of Ozark Highlands Ecoregion fisheries (ADEQ, 1987), in addition:
    a. The fish community at each downstream station was generally more diverse than its corresponding upstream reference station, and had similar richness.
    b. The fish communities at all stations were found to contain significant number of key and indicator taxa (6 or more) and a significant percent composition of ecoregion Key and Indicator Species as identified in Arkansas Regulation No. 2 (ADEQ, 2017).
    c. Sensitive darter species (greenside and rainbow) were found during the study at both upstream and downstream stations in Holman Creek and War Eagle Creek. War Eagle Creek also contained banded darters and yoke darters (both sensitive) at its upstream and downstream locations.
    d. The aquatic life field study demonstrated that the designated Aquatic Life Use was being maintained at all study reaches as demonstrated by the dominance of intolerant and intermediate species.
    e. The Aquatic Life Use was also determined to be fully supporting based on the ADEQ Community Similarity Index which shows that all stations were generally or mostly similar to Ecoregion Reference, and the downstream stations scored higher in every stream.

3.0 BACKGROUND

3.1 Introduction

The current permit for the City of Huntsville was effective June 1, 2011 and expires May 31, 2014 (and has not been reissued as of June 2017). According to the Fact Sheet for the effective permit, the facility design flow is 2.0 MGD. The facility discharges treated sanitary wastewater and industrial wastewater from a Butterball turkey processing facility. Approximately 80% of the flow from the WWTP originates from the turkey processing facility. The treatment system for the Huntsville WWTP, which underwent a $4.7 million dollar upgrade in 2008, consists of bar screen and grit removal, an anaerobic selector, an anoxic basin, an oxidation ditch, UV disinfection, and cascade aeration.

The Arkansas Water Quality Standards (WQS) Regulation No. 2 (ADEQ 2017) allows modification of water quality standards under various conditions. Specifically, Section 2.306 of the WQS allows the removal of a designated use other than a fishable or swimmable use, and for establishment of less stringent water quality criteria without affecting fishable or swimmable uses. This project report documents the information required to amend Regulation 2 through 3rd party rulemaking.

Holman Creek first appeared on the Arkansas 2008 303(d) list for TDS (category 5a) with a listed cause of municipal point source. The Holman Creek listing is continued in the most current Arkansas 303(d) list (2016) for TDS and Town Branch was added to the 303(d) list for TDS also. War Eagle Creek was on the 2008 303(d) list for Beryllium due to an unknown source but has not been on subsequent 303(d) lists.

3.2 Designated Uses – Water Quality Criteria

The designated uses for the Town Branch, Holman Creek and War Eagle Creek listed in the WQS are for Ozark Highland streams with watersheds both less than 10 mi^2 and greater than 10 mi^2. The designated uses for the streams are listed as follows.

Town Branch Creek

Secondary Contact Recreation
Industrial and Agricultural Water Supply
Aquatic Life - Seasonal Ozark Highlands
Domestic Water Supply Use
Ecoregion Reference Stream Values for Town Branch – chloride 13 mg/L, sulfate 17 mg/L, and TDS 240 mg/L

Holman Creek and War Eagle Creek

Primary Contact Recreation
Industrial and Agricultural Water Supply
Aquatic Life - Perennial Ozark Highlands
Domestic Water Supply Use
Ecoregion Reference Stream Values for Holman Creek and War Eagle Creek – chloride 13 mg/L, sulfate 17 mg/L, and TDS 240 mg/L

In addition, Reg. 2.511, Mineral Quality, states that “In no case shall discharges cause concentrations in any waterbody to exceed 250, 250, and 500 mg/L of chlorides, sulfates, and total dissolved solids, respectively, or cause concentrations to exceed the applicable limits in streams to which they are tributary, except in accordance with Reg. 2.306.”

The designated Domestic Water Supply use is not an existing use in any of the creeks studied, as the summer time flows of each of the creeks in the vicinity of Huntsville is too small to ensure a continuous reliable source of water. However, War Eagle Creek flows approximately 27.5 miles to Beaver Lake (War Eagle Creek from its confluence with Holman Creek downstream to confluence with the White River arm of Beaver Lake is approximately 36.5 miles), and Beaver Lake does have an existing Domestic Water Supply use that requires criteria maintenance.

3.3 Permit Limitations

The effective permit for the facility (June 1, 2011 – May 31, 2014) contains both interim and final permit limits for Outfall 001, however for purposes of this study only the final limitations are shown (Table 3.1).

Table 3.1. Final Effluent Limitations for Outfall 001, Huntsville WWTP (NPDES AR0022004).

Effluent Characteristics	**Discharge Limitations**			**Monitoring Requirements**	
	Mass (lbs/day), unless otherwise specified	Concentration (mg/L), unless otherwise specified		Frequency	Sample Type
	Monthly Avg.	Monthly Avg.	7-Day Avg.		
Flow	N/A	Report MGD	Report MGD (Daily Maximum)	once/day	totalizing meter
Carbonaceous Biochemical Oxygen Demand (CBOD5)	167	10	15	once/week	composite
Total Suspended Solids (TSS)	250	15	22.5	once/week	composite
Ammonia Nitrogen (NH3)					
(April-October)	26.7	1.6	3.9	once/week	composite
(November-March)	50.0	3.0	4.5	once/week	composite
Dissolved Oxygen	N/A	6.6 (Inst. Min.)		once/week	composite
Fecal Coliform Bacteria	(colonies/100 ml)				
	N/A	1000	2000	once/week	grab
Total Phosphorus	33.3	2.0	3.0	once/week	composite
Nitrate+Nitrite Nitrogen	166.8	10	15	once/week	grab
Total Dissolved Solids	Report	Report	Report	once/week	composite
pH	N/A	Minimum 6.0 su.	Maximum 9.0 su.	once/week	grab
Chronic WET Testing	N/A	Report		once/quarter	composite

4.0 OUTFALL 001 CHARACTERIZATION

Appendix A contains discharge monitoring results (DMR) for the Huntsville WWTP for July 2011 through June 2012. Appendix B contains analytical reports and data that were collected from Outfall 001 for this study (July 2011 - June 2012).

4.1 Chloride, Sulfate, TDS and Discharge – Outfall 001

During the study period July 2011- June 2012, monthly samples of Outfall 001 were collected by GBMc & Associates and analyzed for a number of parameters including chloride and TDS. In addition, the City of Huntsville collected weekly samples of effluent that were analyzed for chloride, sulfate, and TDS. Samples of effluent collected weekly by Huntsville and analyzed for TDS were for permit Discharge Monitoring Report (DMR) purposes. Analysis of chloride and sulfate were completed from these same samples, for study purposes. All data for chloride, sulfate and TDS collected from Outfall 001 during the study period are provided in Table 4.1.

Table 4.1. Chloride, sulfate, and TDS analyzed for Outfall 001 Huntsville WWTP during the study period.

Date	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
7/6/2011	1042	420	45
7/11/2011	1100	320	48
7/13/2011	649	290	44
7/20/2011	889	370	47
7/27/2011	1548	590	45
8/3/2011	1146	430	41
8/10/2011	632	245	80
8/17/2011	495	185	26
8/24/2011	--	240	76
8/24/2011	640	200	84
8/31/2011	579	210	66
9/7/2011	1095	400	78
9/14/2011	718	250	65
9/14/2011	730	230	--
9/21/2011	538	190	73
9/28/2011	489	190	69
10/5/2011	603	190	83
10/12/2011	578	220	100
10/12/2011	710	22	8
10/19/2011	535	190	79
10/26/2011	530	180	44
11/2/2011	590	190	59
11/9/2011	280	70	40
11/16/2011	404	130	52

Date	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
11/17/2011	430	130	--
11/22/2011	336	120	31
11/30/2011	393	100	40
12/7/2011	383	110	33
12/8/2011	430	110	--
12/14/2011	515	125	44
12/21/2011	331	90	40
12/28/2011	365	110	33
1/4/2012	392	140	39
1/11/2012	480	160	80
1/18/2012	480	130	72
1/18/2012	550	170	--
1/25/2012	505	180	66
2/1/2012	445	130	49
2/2/2012	480	140	--
2/8/2012	345	116	45
2/15/2012	422	140	52
2/22/2012	412	140	55
2/29/2012	878	300	60
3/14/2012	564	212	58
3/21/2012	251	88	37
3/27/2012	400	82	--
3/28/2012	372	206	57
4/4/2012	484	128	78
4/10/2012	500	140	83
4/11/2012	506	162	80
4/18/2012	735	230	88
4/25/2012	799	242	76
5/2/2012	659	240	16
5/9/2012	710	230	--
5/9/2012	606	220	57
5/16/2012	844	260	56
5/23/2012	852	272	56
5/30/2012	830	204	--
6/6/2012	668	274	36
6/13/2012	638	198	44
6/20/2012	647	196	47
6/21/2012	650	210	--
6/27/2012	649	220	58
Count	62	63	54
Max	1,548	590	100
Average	604	200	56
Minimum	251	22	7.5
95th Percentile	1,092	397	83
99th Percentile	1,303	491	94

Monthly average and daily maximum discharged flow rates from the Huntsville WWTP during the study period as reported on DMRs are shown in Table 4.2

Table 4.2. Discharge flow rates from DMR's for Outfall 001 Huntsville WWTP during the study period.

Date	**Monthly Average Flow (MGD)**	**Daily Maximum Flow (MGD)**
July 2011	0.80	1.37
August 2011	0.80	1.37
September 2011	1.01	1.59
October 2011	1.02	1.53
November 2011	1.03	3.50
December 2011	1.32	1.97
January 2012	1.12	2.52
February 2012	1.32	2.14
March 2012	1.46	3.63
April 2012	1.06	1.53
May 2012	1.02	1.50
June 2012	0.91	1.28
Highest Monthly Average Flow	1.46	----
Highest Daily Maximum Flow	-----	3.63

4.2 Salinity Toxicity Modeling

In accordance with the QAPP, the GRI-STR model was set up and run to determine the potential for toxicity given the specific ion analysis of the Huntsville WWTP effluent. In order to run the GRI-STR model to further evaluate proposed mineral levels and to predict toxicity potential based on dissolved mineral concentrations additional constituents were analyzed from samples collected from Outfall 001 during this study. The data used in the GRI-STR model are provided in Table 4.3.

Table 4.3. Summary of ionic data used for GRI-STR salinity modeling (Huntsville WWTP Outfall 001).

Statistic	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L	Alk (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)
Minimum	10.00	7.50	238.00	68.00	61.00	2.80	23.00	110.00
Maximum	**590.00**	**99.89**	**1635.0**	**130.00**	**130.00**	**3.80**	**29.00**	**160.00**
Average	209.41	52.45	644.36	102.00	84.75	3.48	26.25	135.00
St Dev	86.92	17.34	220.53	25.87	30.79	0.46	2.50	23.80
Count	110.00	99.00	146.00	4.00	4.00	4.00	4.00	4.00

The maximum value measured for each mineral was input into the GRI-STR model to represent the worst-case combination of minerals in the effluent. The model was run assuming organisms were exposed to 100% effluent (no dilution). Survival in the 100% effluent was predicted at >95% after 48-h of exposure for each organism. Control quality assurance standards allow for 90% survival, which is consistent with the predicted survival under worse case minerals levels. A summary of the results is provided in Table 4.4.

Table 4.4. Summary of results of GRI-STR Model.

Organism	Percent Survival at 48-h
Ceriodaphnia	98.7
Daphnia	96.8
Fathead Minnow	98.1

4.3 Whole Effluent Toxicity Testing and Minerals Toxicity

Whole effluent toxicity testing (biomonitoring) was implemented as a part of the NPDES program in Arkansas in the late 1980's. Biomonitoring generally involves the exposure of a fish species and an invertebrate species to various concentrations (dilutions) of effluent over a set period of time. The reaction (survival, growth, reproduction, etc.) of the organisms is monitored in the effluent dilutions each day and compared to the reaction of the same organisms in control water. Statistical analysis of the resulting data determines if the effluent causes a significant adverse effect on the organisms. Adverse effects that cause mortality are labeled as "lethal" and adverse effects that impact growth or reproduction are labeled as "sub-lethal."

The Huntsville WWTP NPDES permit requires chronic 7-day testing of *Ceriodaphina dubia* (ceriodaphnid) and *Pimephales promelas* (fathead minnow) at the critical effluent dilution of 100% effluent on a quarterly basis, using a standard dilution series. Approximately 4 years of quarterly WET tests (from January 2009 – May 2012), a total of 14 tests, were obtained for the City of Huntsville WWTP. A summary of the WET tests is provided in Appendix C. The fathead minnow exhibited no significant adverse effects from the effluent during any of the past testing. The no observed effect concentration (NOEC) for both survival and growth was 100% effluent for every test conducted. The ceriodaphnid tests displayed no adverse survival effects to the effluent and had a survival NOEC of 100% effluent for each test conducted. The same was true of reproductive effects for 12 out of 14 tests examined. However, during two ceriodaphnid tests (April 2009 and April 2010) reproductive effects (sub-lethal) were observed. The reproductive NOEC in April 2009 and April 2010 was 75% effluent and 42% effluent, respectively. This indicates that at 100% effluent the ceriodaphnids were producing less young (at a statistically significant level) then they were in the control water. Over the past 2.5 years, 9 ceriodaphnid tests have been completed without a recurrence of the apparent sub-lethal toxicity.

Specific conductance measured during the WET tests ranged from 460 µs/cm to 1300 µs/cm with an average of 795 µs/cm. Regular dissolved minerals sampling and analysis began in 2010. By the middle of 2010 routine samples were being collected for analysis of TDS, chloride, and sulfate. TDS ranged from 430 mg/l to 933 mg/L. Specific conductance (SC) data can be used to estimate TDS using a factor of 0.65 (SC * 0.65 = TDS), (*In-situ*, Inc., Technical Note 14, 2005). Measured specific conductance and TDS from effluent samples taken during the study ranged from TDS = 0.57 – 0.69 x SC. The mean from our study data was TDS = 0.67 x SC. The first sub-lethal test endpoint showing an effect was realized in April 2009 with a SC of 1000 µs/cm (TDS~650 mg/L). The second sub-lethal effect occurred in April 2010 with a SC of 900 µs/cm (TDS~585). TDS was actually measured during the 2010 test and found to be 727 mg/L. Since April 2010 SC has been equal to or in excess of 1000 µs/cm on three occasions during WET testing and TDS has been in excess of 727 mg/l on four occasions, none of which caused an adverse effect on the ceriodaphnids. In addition, there is no significant correlation of TDS to either ceriodaphnid reproductive NOEC or number of young produced (Figures 4.1 & 4.2). That is, higher TDS was not related to poor organism performance. The R^2 values are very low, below 0.10, indicating no ability of TDS to be a predictor of toxicity in the WET tests conducted. The slope of the regression line was also insignificant (p-values in excess of 0.29) at the α=0.05 level for each test.

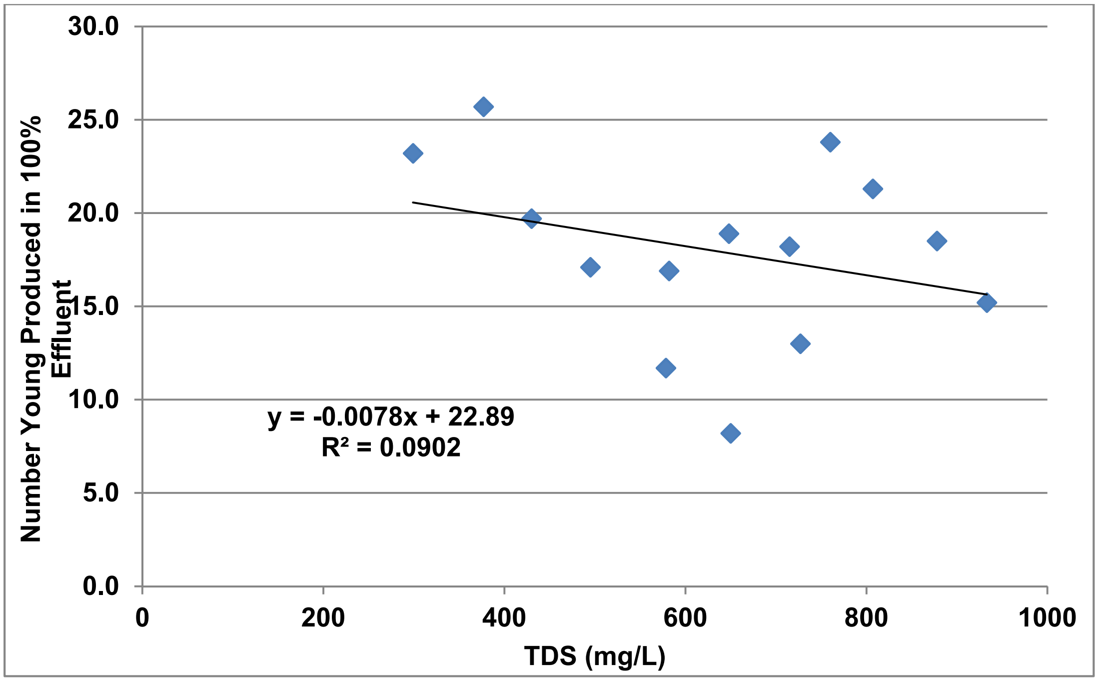

Figure 4.1. Regression analysis of TDS to ceriodaphnid reproduction.

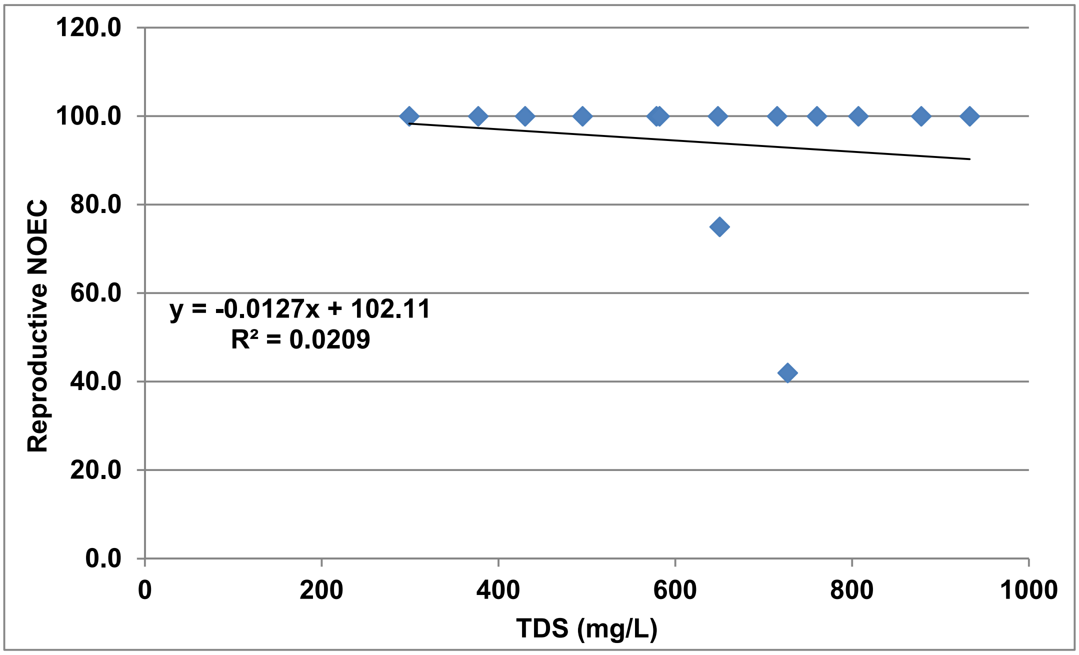

Figure 4.2. Regression analysis of TDS to reproductive NOEC.

Minerals toxicity has long been known to vary depending on which ions are contributing the most to the TDS. Generally, K is more toxic than HCO_3, which is more toxic than Mg>Cl>SO_4, etc. Recent research on minerals toxicity at Colorado State University (Clements and Kotalik, 2016) using mesocosms found that of the families tested, Heptageniidae, Baetidae, and Ephemerellidae were the most sensitive families to high specific conductance. Since TDS and conductivity are directly related, these families were evaluated in the samples from the Huntsville study. A table is provided below that summarizes upstream versus downstream abundances of the most sensitive families according to the Colorado State's recent publication.

Family	**TB-1**	**TB-2**	**HC-1**	**HC-2**	**WC-1**	**WC-2**
Baetidae	129	120	275	316	66	93
Heptageniidae	12	0	91	20	35	91

Ephemerellidae was not present in any of the stream reaches. Heptageniidae abundance was higher at the downstream station in War Eagle Creek. At Town Branch, there were no Heptageniidaes downstream of the discharge, however, since abundance was also low upstream they may have been present downstream just not captured in our sample. In Holman Creek, the Heptageniidaes were present in reasonable numbers downstream of the discharge, but were more abundant upstream. Baetidae abundances were higher downstream of the effluent at Holman and War Eagle Creeks and slightly lower in Town Branch.

Clements and Kotalik also found that of the three salts tested, MgSO4, NaHCO3, and NaCl, macroinvertebrates had a higher tolerance for NaCl than the other two salts. They measured the differences between the control and experimental mesocosms with an EC20 endpoint, which was the specific conductance that reduced one or all twelve macroinvertebrate metrics (Heptageniidae, EPT abundance, Total Diptera, etc.) by 20% compared to the control mesocosms. The effect that NaCl had on macroinvertebrate communities collected from the river with lower background conductivity (60-72 μS/cm) was greater than those collected at the river with higher background conductivity (200-250 μS/cm). The EC20 value for all macroinvertebrate metrics was 42% lower in the river with lower background conductivity compared to the river with higher background conductivity. This finding indicates that macroinvertebrates that have been historically exposed to higher conductivities or elevated TDS and chlorides are less sensitive to dissolved minerals than those that have not been exposed. The study found that in the river with lower background conductivity, macroinvertebrate abundance was not effected by NaCl until the specific conductance reached over 1,000 μS/cm. Over 1,000 μS/cm specific conductance was not achieved until 300 mg/L of NaCl was added to the lower background conductivity water (60-72 μS/cm). Data from TB-2, just downstream from the City of Huntsville discharge had an average conductivity of 673 μS/cm, with a maximum of 1070 μS/cm. Chloride concentrations averaged 120 mg/L with a maximum of 250 mg/L from

September 2010 to June 2012. According to the study findings, conductivity was not sufficiently high to negatively impact macroinvertebrates, even assuming they were not acclimated to high conductivity (which they are). Therefore, it is unlikely that the mineral levels discharged by the Huntsville WWTP are having a negative impact on the macroinvertebrate community, especially since the organisms have been well acclimated to higher conductivity for decades.

4.4 Effluent *In-situ* Measurements

Each time samples were collected from the Huntsville WWTP Outfall 001 during the study *in-situ* measurements were also obtained. In-situ parameters are routinely measured when water samples are obtained as a check of WWTP general performance. This data was not significant to the results of the study. Table 4.5 provides the results of those measurements.

Table 4.5. *In-situ* measurements from Huntsville WWTP Outfall 001 during the study period (July 2011 – June 2012).

Date	Temp (ºC)	DO mg/L	DO % Sat	Sp. Cond (µS/µm)	pH (s.u.)	Turb (ntu)
7/11/2011	27.6	6.8	87.1	1107	7.2	1.2
8/24/2011	26.4	6.1	76.0	1120	6.0	1.6
9/14/2011	22.5	5.3	62.1	1180	7.5	2.8
10/12/2011	21.2	7.5	84.0	1160	7.9	1.0
11/17/2011	15.8	8.7	87.8	620	7.5	1.0
12/8/2011	11.3	8.4	76.3	580	6.7	1.7
1/18/2012	10.8	8.0	72.0	797	7.3	1.8
2/2/2012	11.9	7.9	74.0	692	7.8	1.6
3/27/2012	17.2	7.9	86.0	574	7.8	4.1
4/10/2012	19.3	8.1	91.6	440	7.4	7.7
5/9/2012	22.3	7.5	86.3	976	7.9	2.3
6/21/2012	24.5	7.2	87.4	1072	7.7	1.8

5.0 FIELD STUDY

5.1 Introduction

A field study consisting of collection of physical, biological, *in-situ*, and water samples for laboratory analysis from stations located on the Town Branch Creek, Holman Creek, and War Eagle Creek (Figure 5.1). Monitoring stations used in the study were as follows:

1. TB-1, Town Branch Creek upstream of the Huntsville WWTP discharge.
2. TB-2, Town Branch Creek downstream from the Huntsville WWTP discharge.
3. HC-1, Holman Creek upstream of the confluence with Town Branch.
4. HC-2, Holman Creek downstream of the confluence with Town Branch.
5. WEC-1, War Eagle Creek upstream of the confluence with Holman Creek.
6. WEC-2, War Eagle Creek downstream from the confluence with Holman Creek.

As outlined in the QAPP for the project, the field study consisted primarily of habitat characterization, spring and fall macroinvertebrate collections, fall fish collection, twelve monthly collections of water quality samples, and *in-situ* and flow measurements.

5.2 Ambient Water Quality

Measurements of water quality at Stations TB-1, TB-2, HC-1, HC-2, WEC-1, and WEC-2 were made during 12 separate site visits completed during the study period. *In-situ* measurements consisting of pH, dissolved oxygen, temperature, and specific conductance were obtained on each trip. A sample for site analysis of turbidity was also collected on each of the 12 site visits. Chloride and TDS samples were collected on each of the 12 sampling trips and sulfate, calcium, magnesium, potassium, sodium, and alkalinity were collected on four occasions. Ambient water quality data collected for this study are provided in Appendix B.

Figure 5.1. Monitoring stations used during this study of Town Branch, Holman Creek, and War Eagle Creek (July 2011- June 2012).

5.2.1 Total Dissolved Solids and Chloride Data

Summary statistics for chloride and TDS collected monthly by GBMc from Outfall 001 and the monitoring stations used for the study are shown in Table 5.1. The summary statistics are from the data collected during the monthly field trips conducted from July 2011 – June 2012. As can be seen from Table 5.1 the minerals data from Outfall 001 is considerably higher than any of the ambient monitoring stations.

Table 5.1. Summary statistics for selected parameters (July 2011 – June 2012).

Station	Statistic	Chloride (mg/L)	TDS (mg/L)
TB-1	Minimum	7.6	150.0
	Maximum	27.0	230.0
	Average	17.6	195.0
	STD DEV	5.6	28.4
TB-2	Minimum	30.0	220.0
	Maximum	250.0	900.0
	Average	120.2	468.3
	STD DEV	70.2	209.8
HC-1	Minimum	3.4	79.0
	Maximum	15.0	270.0
	Average	7.7	156.7
	STD DEV	3.1	65.1
HC-2	Minimum	4.9	130.0
	Maximum	180.0	640.0
	Average	81.5	365.4
	STD DEV	66.4	209.0
WEC-1	Minimum	1.9	58.0
	Maximum	10.0	270.0
	Average	3.9	103.8
	STD DEV	2.0	55.6
WEC-2	Minimum	2.9	72.0
	Maximum	42.0	270.0
	Average	15.4	145.6
	STD DEV	13.3	64.4
Outfall 001[1]	Minimum	22	251
	Maximum	590	1548
	Average	200	604
	STD DEV	95	234

[1] The Outfall 001 statistics are from the data provided in Table 4.1.

From a comparison of the paired stations (TB-1 v. TB-2, HC-1 v. HC-2, and WEC-1 v. WEC-2) the influence of the discharge upon the stream systems can be evaluated. Town Branch, which receives the discharge, is most influenced, followed by Holman Creek. Minerals concentrations measured in War Eagle Creek at WEC-2 are only somewhat higher than at WEC-1, indicating that the influence of the discharge, with respect to TDS and chloride, is greatly diminished once it reaches War Eagle Creek. On an average basis, the data shows that both chloride and TDS measured at WEC-2, downstream from the discharge, were lower than TB-1, upstream of the discharge. Figures 5.2 and 5.3 show the average concentrations of chloride and TDS measured during the study along with data from the ADEQ monitoring station for War Eagle Creek at Hindsville (ADEQ WHI0116). The ADEQ monitoring station at Hindsville is approximately 13 miles downstream from the Holman/War Eagle Creek confluence, or about half way between the confluence and Beaver Lake.

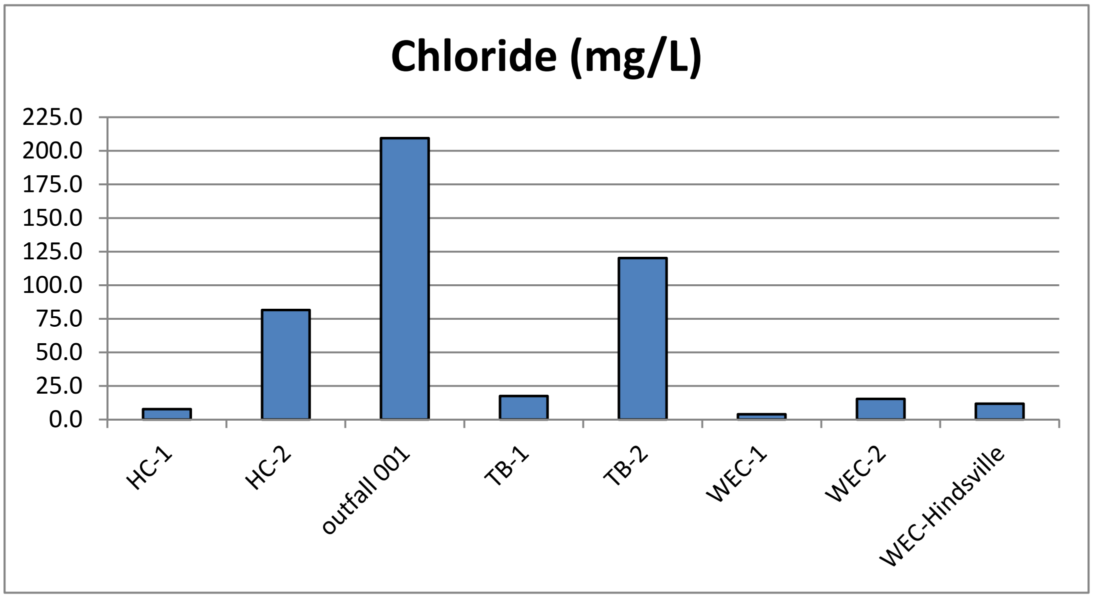

Figure 5.2. Average chloride concentrations during the study period and from ADEQ Station WHI0116.

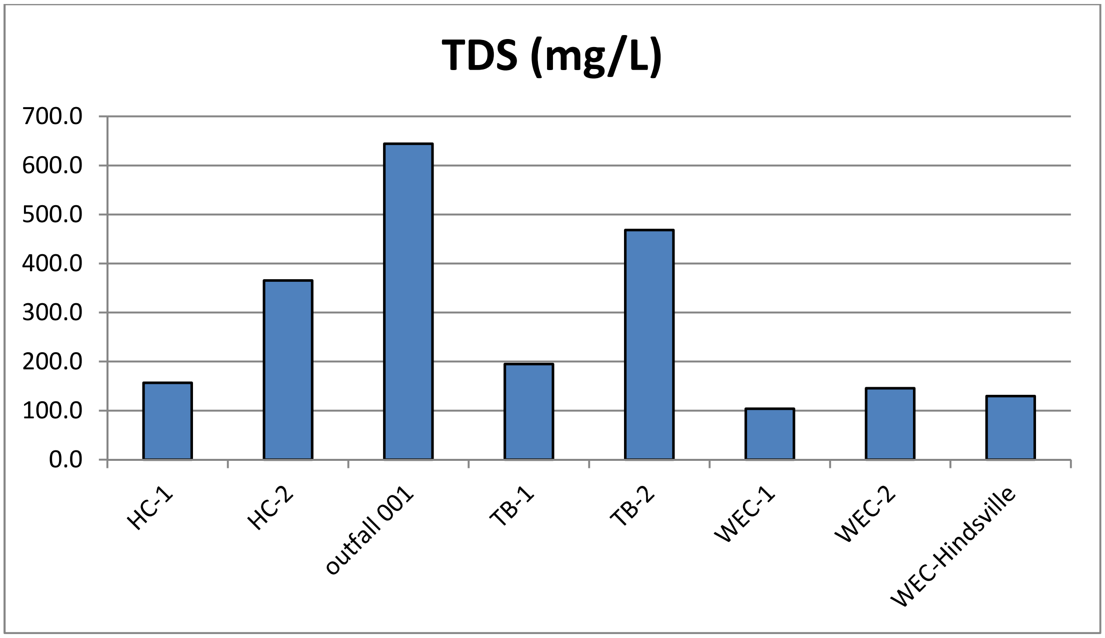

Figure 5.3. Average TDS concentrations during the study period and from ADEQ Station WHI0116.

Other parameters analyzed by the laboratory, which were collected on four occasions during the study, are shown in Table 5.2, sulfate is included in this table. In addition to laboratory analysis in-situ parameters were measured at each station and in the outfall and are presented in Table 5.3

Table 5.2. Summary statistics of laboratory analyzed parameters obtained on four occasions during the study period (July 2011 – June 2012).

Station	Statistic	Sulfate (mg/L)	Alkalinity as $CaCo_3$ (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)
TB-1	Minimum	14.0	110.0	45.0	4.3	2.0	7.2
	Maximum	17.0	140.0	59.0	5.6	3.0	10.0
	Average	15.3	127.5	52.3	4.8	2.7	9.0
	St Dev	1.3	12.6	6.4	0.6	0.5	1.2
TB-2	Minimum	40.0	80.0	56.0	3.6	13.0	54.0
	Maximum	62.0	130.0	110.0	4.2	22.0	130.0
	Average	51.0	110.0	74.0	4.1	18.0	83.0
	St Dev	9.0	21.6	20.9	0.3	3.3	28.1
HC-1	Minimum	11.0	70.0	38.0	3.2	2.5	4.3
	Maximum	16.0	120.0	51.0	4.0	5.3	20.0
	Average	12.4	94.7	45.3	3.6	3.3	8.4
	St Dev	2.2	25.0	6.3	0.3	1.3	7.7
HC-2	Minimum	27.0	88.0	27.0	2.7	1.9	3.4
	Maximum	44.0	120.0	78.0	4.5	13.0	62.0
	Average	33.8	99.3	59.2	3.9	10.0	43.5
	St Dev	8.0	14.9	20.6	0.8	4.7	24.0
WEC-1	Minimum	6.3	47.0	17.0	2.0	1.5	2.1
	Maximum	9.4	270.0	32.0	3.1	2.5	3.5
	Average	7.3	132.0	23.8	2.6	2.1	2.9
	St Dev	1.4	120.6	6.7	0.5	0.5	0.6
WEC-2	Minimum	7.2	63.0	24.0	2.0	1.9	3.3
	Maximum	19.0	110.0	49.0	3.0	4.1	16.0
	Average	1.1	81.8	33.5	2.5	2.8	8.0
	St Dev	5.4	21.8	11.2	0.4	1.0	5.3
Outfall 001	Minimum	7.5	68.0	61.0	2.8	23.0	110.0
	Maximum	99.9	130.0	130.0	3.8	29.0	160.0
	Average	51.7	102.0	84.8	3.5	26.3	135.0
	St Dev	17.1	25.9	30.8	0.5	2.5	23.8

5.2.2 *In-Situ* Parameters

During the yearlong study *in-situ* parameters were measured at each study station and the outfall. Additionally, flow measurements were made and a sample collected and analyzed on-site for turbidity. The summary statistics for the measured in-situ parameters, turbidity, and flow are provided in Table 5.3.

Table 5.3. Summary statistics of in-situ parameters and flow (July 2011-June 2012).

Station	Statistic	Temp. (°C)	DO (mg/L)	DO (%)	Sp. Cond (µS/µm)	pH	Turbidity (NTU)	Flow (cfs)
TB-1	Minimum	4.7	6.2	71.0	202.0	7.2	0.4	0.2
	Maximum	27.9	15.4	137.0	393.0	9.0	4.3	6.7
	Average	17.1	10.0	99.1	295.5	8.2	1.9	1.8
	St Dev	7.6	3.3	19.0	55.5	0.5	1.1	2.3
TB-2	Minimum	7.5	5.8	72.0	326.0	7.5	0.9	1.4
	Maximum	29.0	15.7	140.0	1070.0	9.4	3.8	9.7
	Average	18.6	9.3	97.2	673.4	8.1	2.0	3.3
	St Dev	7.3	3.0	18.8	272.9	0.5	1.0	2.7
HC-1	Minimum	8.3	6.6	75.5	116.0	7.2	1.0	0.0
	Maximum	29.2	14.6	126.0	355.0	8.3	9.8	45.5
	Average	18.0	9.5	98.6	223.5	7.7	3.2	6.9
	St Dev	6.8	2.0	13.2	77.0	0.3	2.9	13.7
HC-2	Minimum	5.4	5.8	71.8	198.0	7.6	0.4	0.9
	Maximum	30.6	15.1	132.0	980.0	8.5	13.5	38.3
	Average	18.4	9.5	97.8	486.3	8.0	2.5	9.7
	St Dev	8.2	2.9	15.1	269.3	0.3	3.6	12.9
WEC-1	Minimum	6.0	4.8	8.9	82.0	7.2	2.0	0.7
	Maximum	29.1	13.5	113.0	187.0	8.5	39.1	342.5
	Average	18.2	8.3	78.5	129.3	7.5	7.5	77.1
	St Dev	8.2	2.6	26.7	37.3	0.4	10.1	108.9
WEC-2	Minimum	5.8	7.4	82.3	105.0	6.5	2.0	5.3
	Maximum	27.9	13.6	126.0	402.0	7.8	408.0	412.1
	Average	17.2	9.8	100.5	217.4	7.3	38.8	95.9
	St Dev	7.6	2.2	13.6	109.3	0.5	116.3	129.8
Outfall 001[1]	Minimum	10.8	5.3	62.1	440.0	6.7	1.0	[1]
	Maximum	26.4	8.7	91.6	1180.0	7.9	7.7	[1]
	Average	18.5	7.5	80.3	837.4	7.5	2.5	[1]
	St Dev	5.5	1.0	8.9	271.9	0.4	1.9	[1]

[1] Flow data for Outfall 001 from DMR records is shown in Table 4.2.

5.2.1.1 Station TB-1

Individual measurement of chloride, sulfate, and TDS from Station TB-1 are provided in Table 5.4. The data from TB-1 were compared with the Ecoregion Reference Stream Values for the Ozark Highlands contained within Regulation 2, which are chloride – 13 mg/L, sulfate – 17 mg/L, and TDS – 240 mg/L. The data from TB-1 for chloride was 13 mg/L or higher on nine of 12 sampling events, sulfate was at 17 mg/L or below on all four sampling events and TDS was less than 240 mg/L for each sampling event.

Table 5.4. Results of flow measurements, and chloride, sulfate and TDS analysis from Station TB-1.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	0.55	19.0	15.0	230.0
8/24/2011	0.87	22.0	17.0	230.0
9/14/2011	0.30	27.0	--	220.0
10/12/2011	0.82	18.0	14.0	180.0
11/17/2011	0.66	20.0	--	210.0
12/8/2011	1.66	12.0	--	170.0
1/18/2012	1.52	17.0	--	170.0
2/2/2012	6.45	12.0	--	150.0
3/27/2012	6.73	7.6	--	160.0
4/10/2012	1.88	13.0	15.0	190.0
5/9/2012	0.56	19.0	--	210.0
6/21/2012	0.16	24.0	--	220.0

5.2.1.2 Station TB-2

Station TB-2 is downstream of the Huntsville WWTP discharge to the system. For the parameters analyzed the station reflects the discharged concentrations of dissolved minerals as with a few exceptions the data were all above the Ecoregion Reference Stream Values. This was anticipated as it was the reason for conducting the study. Table 5.5 provides the analytical results for Station TB-2

Table 5.5. Results of flow measurements, and chloride, sulfate and TDS analysis from Station TB-2.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	2.33	250	40	900
8/24/2011	1.86	150	62.0	530
9/14/2011	1.83	200	--	680
10/12/2011	2.51	130	50.0	620
11/17/2011	1.46	80	--	270
12/8/2011	2.06	42	--	250
1/18/2012	3.43	100	--	380
2/2/2012	8.06	41	--	240
3/27/2012	9.71	30	--	220
4/10/2012	2.68	79	52	420
5/9/2012	2.18	150	--	540
6/21/2012	1.39	190	--	570

5.2.1.3 Station HC-1

Station HC-1 is upstream of the confluence with Town Branch and the Huntsville WWTP discharge. Concentrations of chloride from HC-1 samples were all below the Ozark Highlands Ecoregion Reference Stream Values, with the exception of one measurement. All sulfate analyses were below the reference values and two of 12 samples contained TDS in concentration at or in excess of the reference values. The results are shown in Table 5.6.

Table 5.6. Results of flow measurements, and chloride, sulfate and TDS analysis from Station HC-1.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	0.42	5.0	11	210
8/24/2011	1.25	7.4	11	120
9/14/2011	0.04	9.5	13	210
10/12/2011	0.07	8.8	--	270
11/17/2011	1.37	7.7	16	250
12/8/2011	5.19	5.7	--	79
1/18/2012	3.96	6.6	--	100
2/16/2012	45.48	15.0	--	100
3/27/2012	27.17	3.4	--	90
4/10/2012	3.71	4.7	11	98
5/9/2012	0.54	5.9	--	140
6/21/2012	0.00	10.0	--	190

5.2.1.4 Station HC-2

Station HC-2 was located downstream of the confluence with Town Branch and the Huntsville WWTP discharge. Concentrations of the dissolved minerals measured at Station HC-2 were elevated relative to HC-1 and the Ecoregion Reference Stream Values. This reflects a continuing effect of the WWTP discharge into Town Branch. The concentrations of chloride measured were less than the Ecoregion Reference Stream Values on two occasions, during periods of higher upstream flow. Sulfate was higher than the Ecoregion Reference Stream Values for all four sampling events, and TDS was higher than the reference values on six of 12 sampling days. Table 5.7 shows the results of analysis of dissolved minerals and flow for Station HC-2.

Table 5.7. Results of flow measurements, and chloride, sulfate and TDS analysis from Station HC-2.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	2.62	150	27	630
8/24/2011	3.46	83	41	340
9/14/2011	1.63	180	--	610
10/12/2011	2.94	87	44	620
11/17/2011	2.51	27	--	180
12/8/2011	8.94	16	--	150
1/18/2012	9.97	38	--	210
2/16/2012	38.34	5	--	140
3/27/2012	34.81	10	--	130
4/10/2012	7.70	32	28	220
5/9/2012	0.89	92	--	370
6/21/2012	2.22	180	--	510

5.2.1.5 Station WEC-1

Station WEC-1 was located on War Eagle Creek upstream of the Holman Creek and War Eagle Creek confluence and is uninfluenced by the Huntsville WWTP discharge. Concentrations of dissolved minerals from the station are shown in Table 5.8. All of the measurements were below the Ecoregion Reference Stream Values.

Table 5.8. Results of flow measurements, and chloride, sulfate and TDS analysis from Station WEC-1.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	3.40	3	6.4	110
8/24/2011	14.25	3.7	7.2	100.0
9/14/2011	0.86	3.6	--	100.0
10/12/2011	4.32	4.6	9.4	--*
11/17/2011	34.50	10.0	--	110.0
12/8/2011	113.81	3.4	--	70.0
1/18/2012	96.95	3.7	--	58.0
2/16/2012	238.28	3.4	--	88.0
3/27/2012	342.49	1.9	--	64.0
4/10/2012	61.43	2.5	6.3	72.0
5/9/2012	14.30	3.1	--	93.0
6/21/2012	0.65	4.1	--	110.0

*Laboratory measurements of 270 mg/L appears to be an error, the duplicate for the sample was 100 mg/L and conductivity for that day suggests that the lower duplicate value is more accurate.

5.2.1.6 Station WEC-2

Station WEC-2 was located on War Eagle Creek downstream from the confluence with Holman Creek and thus its chemical characteristics are influenced by the Huntsville WWTP discharge. Concentrations of chloride were below the Ecoregion Reference Stream Values on six of 12 occasions. Sulfate concentration at WEC-2 was less than the Ecoregion Reference Stream Value on three of four sampling events, and TDS was less than the reference value for

11 of 12 measurements. Concentrations of dissolved minerals at WEC-2 were considerably lower than concentrations measured at HC-2, indicating a much reduced effect on War Eagle Creek from the WWTP discharge. Concentrations of dissolved minerals from the station are provided in Table 5.9.

Table 5.9. Results of flow measurements, and chloride, sulfate and TDS analysis from Station WEC-2.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	13.55	22.0	7.2	270.0
8/24/2011	35.29	14.0	10.0	150.0
9/14/2011	6.51	42.0	--	230.0
10/12/2011	10.84	35.0	--	230.0
11/17/2011	48.56	7.0	19.0	110.0
12/8/2011	100.85	4.6	--	80.0
1/18/2012	122.86	6.6	--	94.0
2/16/2012	301.53	3.5	--	72.0
3/27/2012	412.10	2.9	--	82.0
4/10/2012	72.26	6.0	8.2	110.0
5/9/2012	21.67	15.0	--	160.0
6/21/2012	5.30	36.0	--	200.0

5.3 Habitat Characterization

Physical habitat in streams includes all those physical characteristics that influence or provide sustenance to biological attributes, both botanical and zoological, within the stream. Stream physical habitat varies naturally, as do biological characteristics; thus, habitat conditions differ even in the absence of point and anthropogenic non-point disturbance. Within a given ecoregion, stream drainage area, stream gradient, and the local geology are likely to be strong natural determinants of many aspects of stream habitat, because of their influence on discharge, flood stage, and stream energy (both static and kinetic). In addition, land-use activities or instream physical modifications, such as channelization, channel diversion or dam construction directly or indirectly impact the habitat in a stream. The objectives of a habitat characterization are to:

1) assess the availability and quality of habitat for the development and maintenance of benthic invertebrate and fish communities, and
2) evaluate the role of habitat quality in relation to biological integrity and overall stream system health.

There are three main headings for the components of the physical habitat characterization; each with several categories. Measurements for each of the components (14 categories total) are taken in ten equally spaced sub-reaches at each reach, and recorded on copies of a two-page field form entitled Stream Habitat Assessment (Semi-Quantitative), and include:

1) Channel Morphology
   a) Reach Length Determination
   b) Riffle-Pool Sequence
   c) Depth and Width Regime

2) Instream Structure
   a) Epifaunal Substrate
   b) Instream Habitat
   c) Substrate Characterization
   d) Embeddedness
   e) Sediment Deposition
   f) Aquatic Macrophytes and Periphyton

3) Riparian Characteristics
   a) Canopy Cover
   b) Bank Stability and Slope
   c) Vegetative Protection
   d) Riparian Vegetative Zone Width
   e) Land-use Stream Impacts

Physical habitat measurements from a field habitat characterization are used in conjunction with water chemistry, temperature, macroinvertebrate and fish community analyses, and other data sources to determine the status of the target streams attainment of uses (e.g. fishing, swimming, aesthetics, or other recreation) and the water quality required to maintain those uses.

In addition to direct habitat feature measurements, habitat potential was evaluated using procedures adapted from EPA’s rapid bioassessment protocols (Barbour et al. 1999). This procedure was used to numerically score each of 10 habitat features. This effort resulted in categorizing each survey reach as “optimal”, “suboptimal”, “marginal” or “poor” with respect to habitat providing the physical features necessary to support balanced populations of aquatic life.

5.3.1 Town Branch Creek

The Town Branch habitat assessment was completed in the fall of 2011 and spring 2012. Town Branch's watershed area is approximately 4.6 mi^2, (at its confluence with Holman Creek) the smallest watershed of the study. The habitat characterization at TB-1 covered 600 ft of total stream length. Photos of a typical portion of reach TB-1 are presented in Figure 5.4. The average bankfull width and depth (the point at which the stream enters its active floodplain) of the stream were 30 ft and1.6 ft, respectively. Measured flow was 0.82 cfs on October 12th, 2011, with an average velocity of 0.27 fps. On April 20th, 2012, the measured flow was 1.88 cfs with an average velocity of 0.52 fps. The morphological characteristics were distributed between riffles, runs, and pools at 36%, 29%, and 36%, respectively. Instream stable habitat for TB-1 measured 53% for macroinvertebrates and 56% for fish. Dominant substrate for the reach was boulder in riffles, boulder/cobble in runs and boulder/bedrock in pool habitats. In fall 2011, both the left and right banks at TB-1 had moderately unstable banks with average bank protection of 54% for the left and 53% for the right bank. In spring 2012, both the left and right banks were moderately stable with an average left bank vegetative protection of 53% for left bank and 54% on the right bank. Riparian protection average width was approximately 19.8 ft for the left and right banks. There were moderate industrial and urban land-use impacts along the stream corridor, mostly due to proximity to Hwy 23 and adjacent city property where the WWTP operates.

Figure 5.4. Typical habitat sampled at TB-1.

Habitat assessment of reach TB-2, the downstream reach of Town Branch Creek, was also completed in October 2011 and in April 2012. The habitat characterization covered an average of 825 ft of total stream length. A typical portion of TB-2 is presented photographically in Figure 5.5. The average bankfull width and depth of the stream was 40.0 ft and 1.8 ft, respectively. Measured flow was 2.5 cfs in fall 2011 on the day of the survey with an average velocity of 0.13 fps. In spring 2012, measured flow was 2.68 cfs with an average velocity of 0.22 fps. The morphological characteristics were distributed between riffles, runs, and pools at 44.5%, 27.5%, and 37.5%, respectively. Instream stable habitat for TB-2 measured 64% for macroinvertebrates and 67% for fish. Dominant substrate for the reach was cobble and fine gravel in runs, while cobble was dominant for riffle and pool habitats. TB-2 stream bank stability in fall 2011 was moderately stable for both the left and right banks with average bank protection of 72% for the left bank and 75% for the right bank. In spring 2012, the left bank was stable with 80% vegetative protection and the right bank was moderately stable with 71% protection. Riparian protection average width was approximately 33 ft for the left and right banks. There were minor cattle land-use impacts along the stream corridor.

Figure 5.5. Typical habitat sampled at TB-2.

Using the measured and estimated characteristics as described above an overall habitat potential score was calculated. The potential score for TB-1 was 11.7 in fall 2011 and 12.7 in spring 2012, which placed it in the sub-optimal category for both seasons. The habitat score for TB-2 was 14.4 in fall 2011 and 13.8 in spring 2012, which placed it in the sub-optimal category for both years.

5.3.2 Holman Creek

The Holman Creek habitat assessment was completed in October 2011 and again in April 2012. Watershed area for Holman Creek is approximately 27.5 mi^2 (at its confluence with War Eagle Creek, excluding the Town Branch watershed). The habitat characterization at HC-1 covered approximately 1,394 ft of total stream length. A typical portion of reach HC-1 is presented photographically in Figure 5.6. The average bankfull width and depth of the stream was 69.7 ft and

1.48 ft, respectively. Measured flow was 0.07 cfs in fall 2011 on the day of the survey with an average velocity of 0.05 fps. In spring 2012, the flow was higher on the day of the survey, 3.7 cfs, with an average velocity of 0.10 fps. On average, stream morphology was distributed between riffle (38%), run (30%), and pool (34%) habitat, respectively. Dominant substrate for the reach was cobble/coarse gravel in riffle, run, and coarse gravel in the pool habitats. Instream stable habitat for HC-1 measured 69% for macroinvertebrates and 67% for fish. Stream bank stability for HC-1 was moderately stable for the left bank and moderately unstable for the right with average bank protection of 77% for the left bank and 50% for the right bank in the fall of 2011. Both banks were moderately stable in the spring 2012 with an average bank protection of 74% for the left bank and 53% for the right bank. Riparian protection average width was approximately 30 ft for the left and right banks. There were minor to moderate pasture land-use impacts along the stream corridor.

Figure 5.6. Typical habitat sampled at HC-1.

The habitat characterization for HC-2 covered approximately 1,238 ft of total stream length. A typical portion of reach HC-2 is presented photographically in Figure 5.7. The average bankfull width and depth of the stream were 62 ft and 2.9 ft, respectively. Measured flow in fall 2011 was 2.94 cfs on the day of the survey with an average velocity of 0.17 fps. In spring 2012, the flow was higher at 7.7 cfs with an average velocity of 0.58 fps. The morphological characteristics were distributed between riffles, runs, and pools on average at 28%, 30%, and 43%, respectively. Instream stable habitat for HC-2 measured 66% for macroinvertebrates and 66% for fish. Dominant substrate for the reach was coarse gravel in riffle, run, and pool habitats. Stream bank stability for HC-2 in fall 2011 was moderately stable on the right bank with 79% average bank protection and moderately unstable on left bank with 70% average bank protection. In spring 2012, the banks were moderately stable on the left and right banks with an average vegetative protection of 75% on right bank and 74% on left bank. Riparian protection average width was approximately 40 ft for the left and right banks. There were minor to moderate pasture land-use impacts along the stream corridor.

Figure 5.7. Typical habitat sampled at HC-2.

Using the measured physical characteristics described above an overall habitat potential score was established. The habitat potential score for HC-1 was 12.8 in fall 2011 and 13.8 in the spring 2012, which placed it in the sub-optimal category for both seasons. The potential score for HC-2 was 13.2 in fall 2011 and 14.6 in spring 2012, which placed it in the sub-optimal category for both seasons.

5.3.3 War Eagle Creek

The War Eagle Creek habitat assessment was completed in October 2011 and again in April 2012. Watershed area for War Eagle Creek is approximately 172 mi^2 (at its confluence with Holman Creek, excluding the Town Branch and Holman Creek watersheds), the largest watershed of the study. The habitat characterization at WEC-1 covered 1,300 ft of total stream length. A typical portion of reach WEC-1 is presented photographically in Figure 5.8. The average bankfull width and depth (the point at which the stream enters its active floodplain) of the stream was 71 ft and 2.7 ft, respectively. Measured flow was 4.3 cfs in fall 2011 on the day of the survey with an average velocity of 0.37 fps. In spring 2012, measured flow was 61.4 cfs with an average velocity of 0.76 fps. The morphological characteristics were distributed between riffles, runs, and pools at 15%, 19%, and 66%, respectively. Instream stable habitat for WEC-1 on average measured 51% for macroinvertebrates and 59% for fish. Dominant substrate for the reach was coarse gravel in riffle, run, and coarse gravel, silt, and clay for the pool habitats. Stream bank stability for WEC-1 in fall 2011 was moderately stable for the left and right banks with average bank protection of 76% for the left bank and 72% for the right bank. In spring 2012, both right and left banks were moderately stable with 61% vegetation protection on the left bank and 73% on the right bank. Riparian protection average width was approximately 27 ft for the left and right banks. There were minor urban (due to proximity to Highway Bridge) and moderate cattle land-use impacts along the stream corridor.

Figure 5.8. Typical habitat sampled at WEC-1.

The WEC-2 habitat characterization covered 1,900 ft of total stream length. A typical portion of reach WEC-2 is presented photographically in Figure 5.9. The average bankfull width and depth of the stream was 93.4ft and 1.9 ft, respectively. Measured flow in fall 2011 was 10.8 cfs with an average velocity of 0.45 fps. In spring 2012, the flow was 72.2 cfs with an average velocity of 0.71 fps. The morphological characteristics were distributed between riffles (14%), runs (11%), and pools (76%). Instream stable habitat for WEC-2 measured 43% for macroinvertebrates and 58% for fish. Dominant substrate for the reach was coarse gravel in riffle and runs, and coarse gravel/sand in pool habitats. Stream bank stability for WEC-2 in fall 2011 was moderately stable on the right bank with 74% average bank protection and moderately unstable on left bank with 77% average bank protection. In spring 2012, the right and left banks were moderately stable with 71% vegetative protection on the right bank and 65% on the left bank. Riparian protection average width was approximately 41.3 ft for the left and right banks. There were minor pasture land-use impacts along the stream corridor. A detailed breakdown of the complete habitat characteristics at each reach is provided in Appendix D.

Figure 5.9. Typical habitat sampled at WEC-2.

Using the measured and estimated characteristics as described above an overall habitat potential score was calculated. The habitat potential score for WEC-1 was 13.9 in fall 2011 and 13.5 in spring 2012 which placed it in the sub-optimal category for both seasons. The potential score for WEC-2 was 12.9 in fall 2011 and 13.8 in spring 2012, which placed it in the sub-optimal category for both seasons. Tables 5.10, 5.11 and Figure 5.10 provide a summary of the habitat potential breakdown.

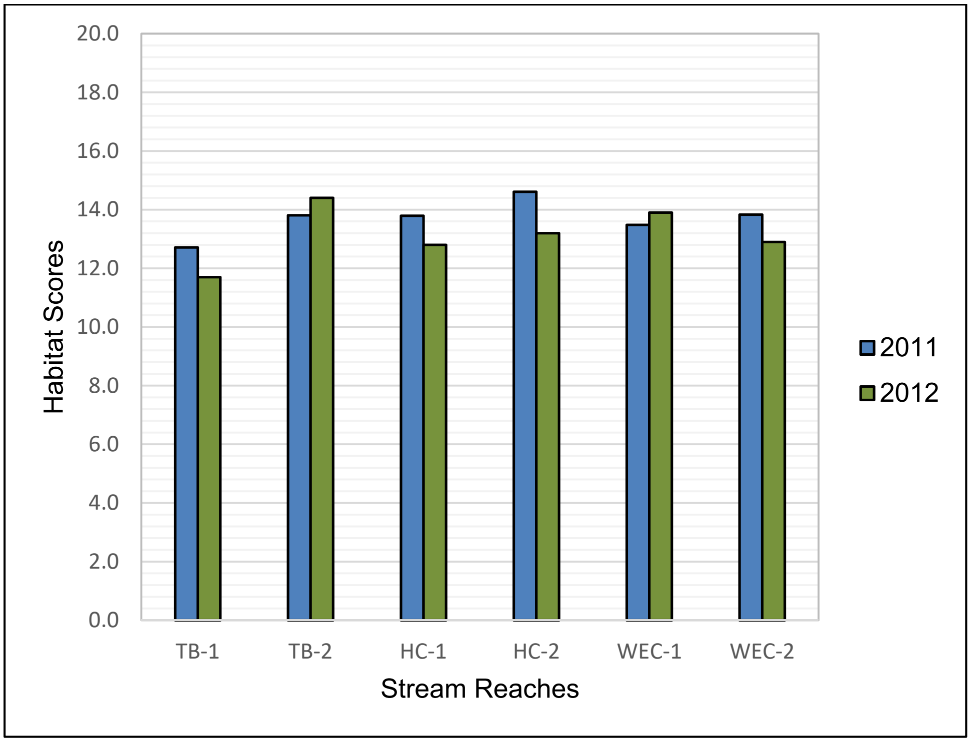

Figure 5.10. Summary of habitat quality in each biological assessment reach.

In summary, the following conclusions can be drawn concerning habitat:

1. Habitat scores at all stations for each season were in the sub-optimal category.
2. Habitat is sufficient in each reach to support healthy and diverse aquatic communities.

Table 5.10. Habitat potential summary scores for Town Branch, Holman Creek, and War Eagle Creek, October 2011.

Parameters	**Reach**					
	TB-1	**TB-2**	**HC-1**	**HC-2**	**WEC-1**	**WEC-2**
1. Epifaunal Substrate	12	16	16	16	16	12
2. Embeddedness	14	14	14	11	16	15
3. Velocity/Depth Regime	10	16	16	17	17	17
4. Channel Alteration	16	16	14	15	15	17
5. Sediment Deposition	13	12	15	12	12	5
6. Frequency of Riffles	16	19	14	17	17	16
7. Channel Flow Status	13	14	9	11	11	14
8. Bank Stability						
Left Bank	5	7	8	5	6	5
Right Bank	5	7	4	6	6	6
9. Vegetative Protection						
Left Bank	3	6	6	6	6	6
Right Bank	3	6	3	7	6	6
10. Riparian Vegetative Zone Width						
Left Bank	4	8	7	2	2	3
Right Bank	3	3	2	7	9	7
Score (Total)	117	144	128	132	139	129
Score Average	11.7	14.4	12.8	13.2	13.9	12.9
Ranking	S	S	S	S	S	S
Scores: 16-20 = optimal, 11-15 = sub-optimal, 6-10 = marginal, 0-5 = poor						

Table 5.11. Habitat potential summary scores for Holman Creek, Town Branch, and War Eagle Creek, April 2012.

Parameters	Reach					
	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
1. Epifaunal Substrate	12	14	15	14	15	9
2. Embeddedness	17	11	18	18	18	18
3. Velocity/Depth Regime	12	13	15	14	17	17
4. Channel Alteration	16	16	14	15	15	17
5. Sediment Deposition	13	15	20	15	11	12
6. Frequency of Riffles	19	17	14	19	17	15
7. Channel Flow Status	13	14	10	12	14	14
8. Bank Stability						
Left Bank	7	9	8	7	6	7
Right Bank	6	8	6	7	7.8	6.2
9. Vegetative Protection						
Left Bank	3	7	6	6	4	5
Right Bank	3	6	3	6	6	6
10. Riparian Vegetative Zone Width						
Left Bank	3	7	6	3	2	8
Right Bank	3	2	3	10	2	5
Score (Total)	127	138	138	146	135	138
Score Average	12.7	13.8	13.8	14.6	13.5	13.8
Ranking	S	S	S	S	S	S
Scores: 16-20 = optimal, 11-15 = sub-optimal, 6-10 = marginal, 0-5 = poor						

5.4 Benthic Macroinvertebrate Community

Benthic macroinvertebrates inhabit the sediment or live on the bottom substrates of streams, rivers and lakes. Macroinvertebrates are a fundamental linkage in food web dynamics of streams. They act as a middleman in the food web between organic matter resources such as algae, leaf litter, and detritus, and fishes (Allan, 1995). The presence of these organisms and their diversity and tolerance to environmental perturbation at an expected level reflects the maintenance of a systems biological integrity. Monitoring these assemblages is useful in assessing the Aquatic Life Use status of the water body and detecting trends in ecological condition.

5.4.1 Methods

Semi-quantitative benthic macroinvertebrate samples were collected in each of the six reaches, Town Branch (TB-1 and TB-2), Holman Creek (HC-1 and HC-2), and War Eagle Creek (WEC-1 and WEC-2) on October 11th, 12th, and 13th of 2011 and on April 10th and 11th of 2012. The Rapid Bioassessment Protocol for riffle dominated streams was used to sample 5m^2 of multiple habitat types (riffle, root-wads, emergent vegetation, undercut banks, deposition, etc.) using a 500 µm mesh dip net. Samples collected from riffles were kept separately (independent) of all other habitat types that were combined. Samples were preserved in Kahle's solution and transported to the laboratory. Once in the laboratory, macroinvertebrate samples were subsampled using a Caton (1991) sorting tray. The entire sample was also examined for large or rare specimens included in the collection. Macroinvertebrates were sorted, ensuring each sample had 100 organisms ± 10% in each habitat type (i.e. riffle and multi-habitat) with a total of 200 ± 10%. Macroinvertebrates were then identified to the lowest practical taxonomic level, usually genus, following taxonomic keys of Merritt and Cummings (Merritt et. al. 2008).

A series of macroinvertebrate metrics were analyzed for each reach. The two habitat types (riffle and multi-habitat) were combined for the community-level analyses. Taxa richness (number of taxa), Shannon-Wiener Diversity, biotic index, percent EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera), EPT taxa richness, dominance of macroinvertebrate orders, and functional feeding group composition were of the primary metrics assessed. Biotic index was calculated using the Hilsenhoff Biotic Index (EPA, 1999). Tolerance values used in the calculations were assigned to each taxon based on tolerance values from Missouri Department of Natural Resources (MDNR, 2011) and EPA (Barbour, 1999). A multimetric biocriteria that was developed for Arkansas (Shackleford, 1988) was used in comparing the reference upstream section to the downstream section of each stream.

An ADEQ adaptation of rapid bioassessment protocol III developed by the Environmental Protection Agency was also used to compare the downstream sections of the streams to the upstream or reference reach using macroinvertebrate community metrics (ADEQ, 2013). A comprehensive listing of the macroinvertebrate taxa identified from the fall 2011 and spring 2012 samples can be found in Appendix E. A summary of biometric values are present in Table 5.12.

5.4.2 Results

5.4.2.1 Reach TB-1

In fall 2011, 29 different taxa were found at TB-1 with Shannon-Weiner diversity of 2.46. The biotic index for TB-1 was 6.47. The macroinvertebrate community consisted of 59% EPT taxa, with eight different EPT taxa represented. Ephemeroptera (32.4%) was the dominant order found, with Diptera (27.3%), and Trichoptera (26.6%) following in the fall season. Collectors (51.6%) and filterers (28.1%) were the dominant functional feeding group at TB-1, indicating fine benthic organic matter may be a primary food source for the macroinvertebrate community. In spring 2012, 30 different taxa were found at TB-1. Shannon-Weiner diversity was 2.29. The biotic index for TB-1 was 6.86. The macroinvertebrate community consisted of 42.9% EPT taxa, with 10 different EPT taxa represented. Diptera (48.7%) was the dominant order, followed by Trichoptera (24.9%). Collectors (58.1%) and filterers (31.6%) were the dominant functional feeding groups at TB-1 in the spring of 2012.

5.4.2.2 Reach TB-2

In fall 2011, 30 different taxa were found at TB-2. Shannon-Weiner diversity was 2.07. The biotic index for TB-2 was 6.25. The macroinvertebrate community consisted of 67.7% EPT taxa, with six different EPT taxa included. Trichoptera (55.5%) and Diptera (22.6%) were the dominant orders found at TB-2 in the fall of 2011. Filterers (56.5%) and collectors (31.1%) were the dominant functional feeding groups collected in the fall season.

In spring 2012, 24 different taxa were found at TB-2. Shannon-Weiner diversity was 2.48, which was higher than the fall season. The biotic index for TB-2 was 7.29, higher than in the fall. The macroinvertebrate community consisted of 33.3% EPT taxa, with six different EPT taxa. Diptera (41.1%) was the most dominant order, followed by Trichoptera (22.5%). Collectors (52%) and filterers (26.4%) were again the dominant functional feeding groups at TB-2 in the spring of 2012.

5.4.2.3 Reach HC-1

In fall 2011, 35 different taxa were found at HC-1. Shannon-Weiner diversity was 2.60. The biotic index at HC-1 was 5.81. The macroinvertebrate community consisted of 47.1% EPT taxa, with 13 different EPT taxa represented. Ephemeroptera (41.4%) and Diptera (30.3%) were the two most dominant orders in fall 2011. Collectors (55.7%) and scrapers (31.3%) were the two dominant functional feeding groups, indicating fine benthic organic matter and algae as primary food sources in Holman Creek at this reach.

In spring 2012, 30 different taxa were found at HC-1. Shannon-Weiner diversity was 2.27. The biotic index at HC-1 was 6.34 in the spring of 2012. The macroinvertebrate community consisted of 48.1% EPT taxa, with 14 different EPT taxa collected. Diptera (44.8%) and Ephemeroptera (37.2%) were the dominant orders present in the spring season. Collectors (71.9%) were the dominant functional feeding group with fewer scrapers (5.9%) present when compared to the fall season macroinvertebrate community.

5.4.2.4 Reach HC-2

In fall 2011, 37 different taxa were found at HC-2. Shannon-Weiner diversity was 2.51. The biotic index at Holman Creek was 6.25 in the fall of 2011. The macroinvertebrate community consisted of 56.6% EPT taxa, with nine different EPT taxa collected. Ephemeroptera (37.8%), Trichoptera (18.2%), and Coleoptera (18.0%) were the dominant orders in Holman Creek below the confluence with Town Branch. Collectors (44.2%) and scrapers (27.3%) were the dominant functional feeding groups in fall 2011.

In spring 2012, 34 different taxa were found at HC-2. Shannon-Weiner diversity was 2.14. The macroinvertebrate community consisted of 55.5% EPT taxa, with 13 different EPT taxa represented. The biotic index at HC-2 was 6.60 in the spring of 2012. Diptera (37.0%), Ephemeroptera (27.2%), and Trichoptera (27.1%) were the dominant orders found. Collectors (55.1%), and filterers (35.8%) were the most dominant functional feeding groups found in the spring of 2012 at HC-2.

5.4.2.5 Reach WEC-1

In fall 2011, 32 different taxa were found at the WEC-1. Shannon-Weiner diversity was 2.07. The biotic index for WEC-1 was 7.18 in the fall of 2011. EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera) made up 52.4% of the macroinvertebrate community with nine different EPT taxa found. Diptera (39.1%) were the dominant order, followed by Ephemeroptera (25.8%), and Trichoptera (25.0%). Collectors (61.2%) were dominant functional feeding group, followed by filterers (27.7%), indicating fine benthic and suspended organic matter as a primary food source for the community.

In spring 2012, 30 different taxa were found at the WEC-1 with a Shannon-Weiner diversity was 2.31, higher than in the fall 2011. The biotic index for WEC-1 was 6.91 in the spring of 2012. EPT taxa composition was 33.9% of the macroinvertebrate community and the number of different EPT taxa increased to 13 in the spring of 2012. Diptera (58.4%) again was the dominant order, followed by Ephemeroptera (21.6%). Collectors (69.6%) were the dominant functional feeding group with fewer filterers (17.6%) compared to the fall of 2011.

5.4.2.6 Reach WEC-2

In fall 2011, 35 different taxa were found at WEC-2. Shannon-Weiner diversity was 2.41. The biotic index for WEC-2 was 6.78 in the fall of 2011. The macroinvertebrate community consisted of 65.1% EPT taxa with 10 different EPT taxa found. Ephemeroptera (53.3%) was the dominant order, followed by Diptera (15.9%). Collectors (60.4%) were the dominant functional feeding group in this reach.

In spring 2012, 33 different taxa were found at the WEC-2. Shannon-Weiner diversity was 2.60, higher than the fall season. The biotic index for WEC-2 was 6.89 in the spring of 2012, slightly higher than the fall season. The macroinvertebrate community consisted of fewer EPT taxa, 32.8%, than in fall of 2011 with 11 different taxa. Diptera (52.3%) was the dominant order collected, followed by Ephemeroptera (23.2%). Collectors (62.4%) were the dominant functional feeding group with filterers (17.7%) as the next highest functional feeding group.

5.4.3 Summary and Discussion

In fall 2011, taxa richness ranged from 29-37, and was higher in the downstream reaches of each of the three streams. Shannon-Weiner's diversity values ranged from 2.07-2.60 in the six stream reaches. The biotic index ranged from 5.81-7.18, with HC-1 having the lowest and WEC-1 the highest values. EPT taxa percentages of the macroinvertebrate community ranged from 47.1-67.7%, with 6-13 different EPT taxa. Ephemeroptera dominated the WEC-2, TB-1, HC-1, and HC-2 reaches, Trichoptera dominated the TB-2 reach, and Diptera dominated the WEC-1 reach in fall 2011 (Figure 5.11). Collectors dominated the functional feeding group at all reaches except the TB-2 reach, which was dominated by filterers.

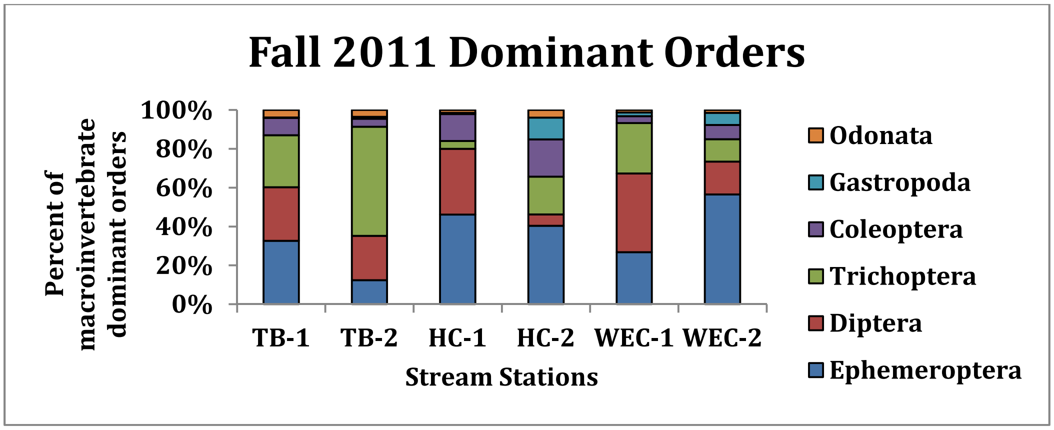

Figure 5.11. Fall 2011 dominant taxa composition for each reach.

In spring 2012, taxa richness ranged from 24-34, and Shannon-Weiner diversity values ranged from 2.14-2.60 in the six stream reaches. The biotic index ranged from 6.34-7.29, with HC-1 having the lowest and TB-2 had the highest biotic index. EPT taxa abundance ranged from 32.8-55.5%, with 6-14 different EPT taxa found. The order Diptera dominated all six of the stream reaches in the spring of 2012 (Figure 5.12). Collectors were the dominant functional feeding group at all of the stream reaches ranging from 52.0% to 71.9%. Overall, the communities represented by the collections in each stream reach were similar above and below the influence of the City of Huntsville wastewater discharge. The wastewater appears to have no adverse effect on the attainment of the Aquatic Life Use as measured by the macroinvertebrate community.

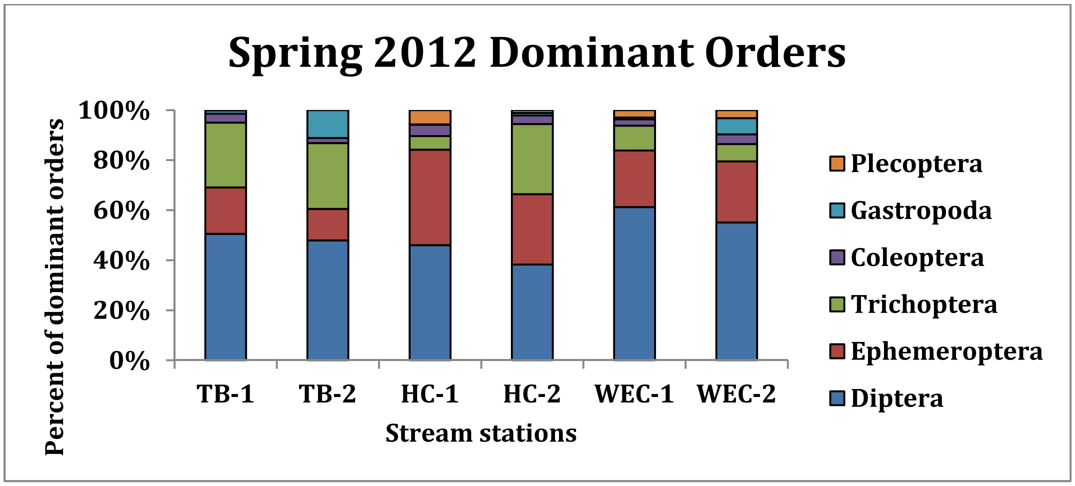

Figure 5.12. Spring 2012 dominant taxa composition for each reach.

A biometric scoring system was developed for Arkansas by the Arkansas Department of Pollution Control and Ecology (ADPCE) in the 1980's (Shackleford, 1988). The biometric scoring system was created to compare changes in the macroinvertebrate community structure and function in paired stream reaches. Paired streams reaches were used to analyze effects of nonpoint source and point source pollution on water quality. If water quality is altered, there is potential for macroinvertebrate communities to also be altered. The biometric scoring system is designed for comparison of a reach that has potential for water quality degradation from a suspected pollution source with a reach that is not influenced by the suspected pollution source and thus could be considered a reference site. This biometric approach measures metrics such as dominants in common, common taxa index, quantitative similarity index, taxa richness, indicator assemblage index, missing genera, and functional feeding group percentage similarity (Shackelford, 1986). The study design for the City of Huntsville involves three stream systems each with a reference reach upstream of effluent influence and a study reach downstream of the effluent discharge.

We completed the biometric analysis for each pair of stream reaches for the fall 2011. When we compared biometric scores for TB-1 and TB-2, and HC-1 and HC-2 each had minimal impairment, while WEC-1 and WEC-2 demonstrated no impairment (Figure 5.13). Town Branch's biometric score bordered between minimal impairment and no impairment but with rounding, minimal impairment was concluded. HC-1 and HC-2 biometric score was lowered by the Quantitative Similarity Index as there weren't as many taxa in common with each of the two sites. But with further evaluation, HC-2 has higher taxa richness than HC-1, indicating a more diverse community than the upstream reach. Overall, when comparing the biometric scores of the three downstream reaches to the three upstream they have no impairment to minimal impairment for the fall of 2011, which indicates they are quite similar and are each in full attainment of the Aquatic Life Use (Figure 5.13).

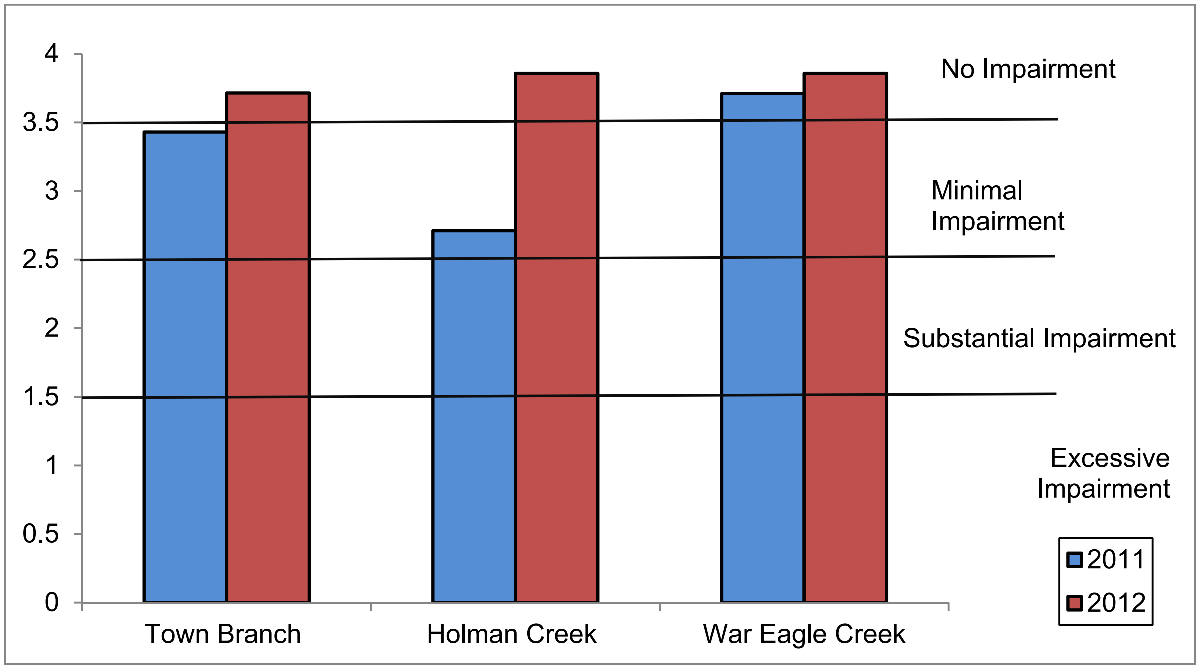

Figure 5.13. Comparison of downstream to upstream macroinvertebrate collections from fall 2011 and spring 2012 using the biometric scoring system developed for Arkansas by the Arkansas Department of Pollution Control and Ecology (Shackleford, 1988).

We completed the biometric analysis for each stream for the spring 2012; comparing each downstream reach to the upstream reference reach. WEC-1 and WEC-2, TB-1 and TB-2, and HC-1 and HC-2 all scored no impairment between the two reaches of each stream (Figure 5.13). Overall, when comparing the two reaches in each stream the downstream reach is quite similar to the reference reach (Table 5.13). Biometric analysis indicated that the streams are in full attainment of their designated Aquatic Life Use.

Table 5.12. Summary of biometric scoring system assessment from War Eagle, Town Branch, and Holman Creek in the fall of 2011.

Community Metric	TB-1 Vs. TB-2	HC-1 Vs. HC-2	WEC-1 Vs. WEC-2
Dominants in common	4	1	4
Common Taxa Index	3	2	3
Quantitative Similarity Index	3	1	3
Taxa Richness	4	4	4
Indicator Assemblage Index	4	4	4
Missing Taxa	4	4	4
Functional Group Percent Similarity	2	3	4
Mean Biometric Score	3.43	2.71	3.71
Aquatic Life Status	Minimal Impairment	Minimal Impairment	No Impairment

Table 5.13. Summary of biometric scoring system assessment from War Eagle, Town Branch, and Holman Creek in the spring of 2012.

Community Metric	TB-1 Vs. TB-2	HC-1 Vs. HC-2	WEC-1 Vs. WEC-2
Dominants in common	4	4	3
Common Taxa Index	3	4	4
Quantitative Similarity Index	4	4	4
Taxa Richness	3	4	4
Indicator Assemblage Index	4	4	4
Missing Taxa	4	4	4
Functional Group Percent Similarity	4	3	4
Mean Biometric Score	3.71	3.86	3.86
Aquatic Life Status	No Impairment	No Impairment	No Impairment

We also analyzed the data using ADEQs variation on Rapid Bioassessment Protocol III, developed by the Environmental Protection Agency (EPA) that compares upstream and downstream reaches of a stream using several different community metrics. The protocol (EPA 1989) was developed from compliance monitoring by the Vermont Department of Environmental Conservation in 1987 and discussions with other aquatic biologists. Metrics include taxa richness (ratio of study site to reference x 100), Hilsenhoff Biotic Index (ratio of reference site to study site x 100), ratio of EPT and Chironomid abundances (ratio of study site to reference site x 100), percent contribution of dominant taxon (scoring criteria evaluate actual percent contribution), EPT index (ratio of study site to reference x100), and community loss index (reference site taxa richness – taxa richness in common to both sites / study site taxa richness).

We completed the multimetric assessment of the macroinvertebrate communities for the fall 2011 season for each upstream/downstream stream pair. When WEC-2 was compared with WEC-1, the downstream reach was considered not impaired. TB-2 was compared with the upstream section, TB-1, and was considered slightly impaired. HC-2 was compared with the upstream section, HC-1, and was considered slightly impaired (Table 5.14). Overall, the three downstream reaches of stream ranged from no impairment to slightly impaired. Generally, scores attaining “slightly impaired” status or better are considered in attainment of designated uses. Therefore, the stream reaches assessed are in attainment of their Aquatic Life Use based on the multimetric analysis (Figure 5.14). Equations used in the macroinvertebrate analysis are provided in Appendix F.

Table 5.14. Summary of the macroinvertebrate multimetric assessment from War Eagle, Town Branch, and Holman Creek in the fall of 2011.

Community Metric	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
Taxa richness	--	103.4	--	105.7	--	109.4
Hilsenhoff Biotic Index	--	103.5	--	93.0	--	105.9
EPT index	--	75.0	--	69.2	--	111.1
Community loss index	--	0.3	--	0.5	--	0.2
Ratio of EPT and Chironomid abundance	245.3	308.7	164.9	1217.4	140.2	449.3
% contribution of dominant taxa	19.5	38.8	17.5	27.7	24.8	33.6
Bioassessment Scores						
Taxa richness	6	6	6	6	6	6
Hilsenhoff Biotic Index	6	6	6	6	6	6
EPT index	6	2	6	0	6	6
Community loss index	6	6	6	4	6	6
Ratio of EPT and Chironomid abundance	6	6	6	6	6	6
% contribution of dominant taxa	6	2	6	4	4	2
Total Score	36	28	36	26	34	32
% Comparison to reference	100	78	100	72	94	89
Impairment Status	Reference	Slightly impaired	Reference	Slightly impaired	Reference	Nonimpaired

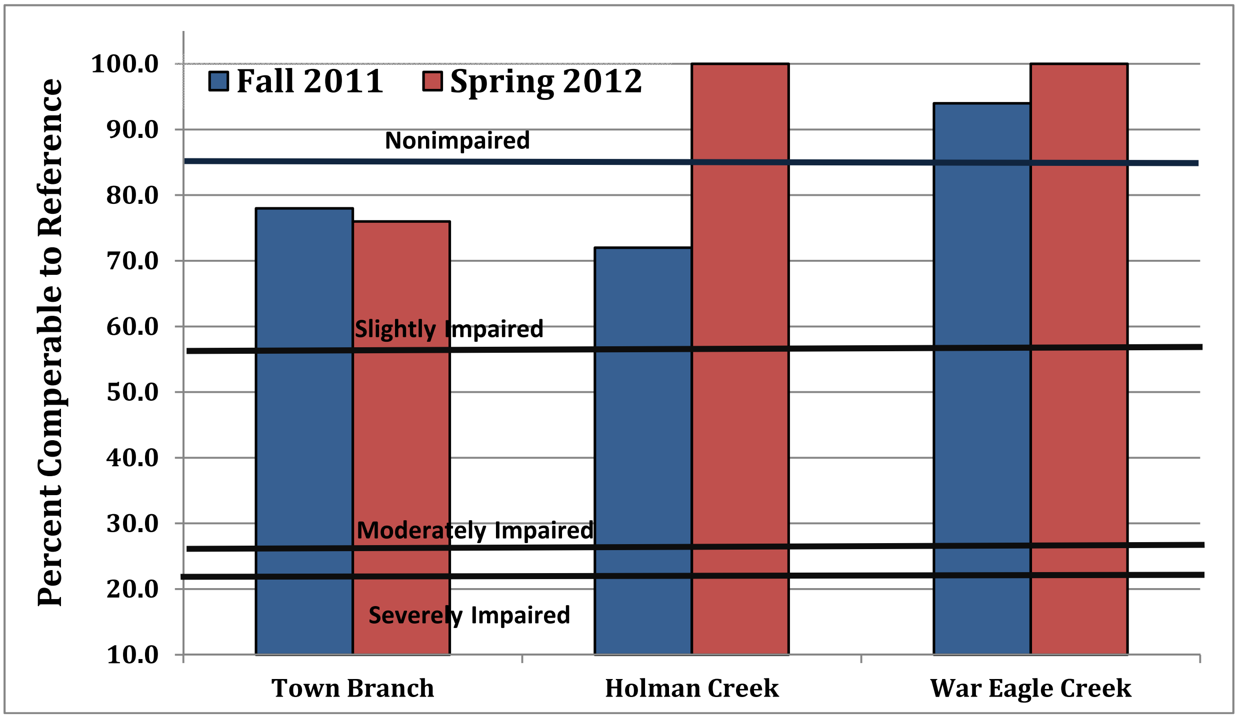

Figure 5.14. Comparison of downstream to upstream macroinvertebrate collections from fall 2011 and spring 2012 using the EPA protocol.

We completed the ADEQ multimetric assessment for each pair of streams' macroinvertebrate communities for the spring 2012 season. We compared the upstream reaches with the downstream reaches using the six community metrics described above. When WEC-2 was compared with WEC-1, the stream was considered not impaired. TB-2 was compared with the upstream reach, TB-1, and was considered slightly impaired. HC-2 was compared with the upstream reach, HC-1, and was considered slightly impaired (Table 5.15). The three downstream sections of stream ranged from no impairment to slightly impaired and are considered in attainment of their Aquatic Life Use based on the multimetric analysis.

Table 5.15. Summary of the macroinvertebrate multimetric assessment from War Eagle, Town Branch, and Holman Creek in the spring of 2012.

Community Metric	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
Taxa Richness	--	80.0	--	113.3	--	110.0
Hilsenoff Biotic Index	--	94.1	--	96.1	--	100.2
EPT index	--	60.0	--	92.9	--	84.6
Community loss index	--	0.4	--	0.1	--	0.2
Ratio of EPT and Chironomid abundance	101.3	70.7	131.6	191.3	66.4	75.8
% Contribution of dominant taxa	24.6	18.6	21.4	22.9	34.8	28.4
Bioassessment Scores						
Taxa richness	6	4	6	6	6	6
Hilsenoff Biotic Index	6	6	6	6	6	6
EPT index	6	0	6	6	6	4
Community loss index	6	6	6	6	6	6
Ratio of EPT and Chironomid abundance	6	4	6	6	4	6
% contribution of dominant taxa	4	6	4	4	2	4
Total Score	34	26	34	34	30	32
% Comparison to reference	94	72	94	94	83	89
Impairment Status	Reference	Slightly impaired	Reference	Nonimpaired	Reference	Nonimpaired

A summary of all macroinvertebrate metrics from fall 2011 is found in Table 5.16 and spring 2012 in Table 5.17. Based on the analysis of the macroinvertebrate community in each reach the following conclusions are provided:

1. A significant proportion of each downstream community was comprised of EPT taxa (>50% during the fall and >30% during the spring) which included 6-13 different taxa at each station.
2. Key metric scores at each station indicated that the downstream reaches (TB-2, HC-2 and WEC-2) during the fall have greater taxa richness, a higher proportion of the sensitive EPT taxa, and lower biotic Index scores.
3. The better performance of the macroinvertebrate community during the fall assessment, when background flow is lower and effluent percent composition

higher, indicates that the point source discharge is not adversely affecting the biota.

4. All biometric and multimetric paired scoring systems achieved scores sufficient to make a determination of full attainment of the Aquatic Life Use.

Table 5.16. Summary of macroinvertebrate metrics from War Eagle, Town Branch, and Holman Creek in the fall of 2011.

Parameter	**TB-1**	**TB-2**	**HC-1**	**HC-2**	**WEC-1**	**WEC-2**
Community Measures						
Total number of Taxa (Richness)	29	30	35	37	32	35
EPT Richness	8	6	13	9	9	10
EPT % Abundance	59.0	67.7	47.1	56.6	52.4	65.1
Shannon-Weiner Diversity Index	2.46	2.07	2.60	2.51	2.07	2.41
Percentage of Dominant Orders						
Gastropoda	0.3	1.0	0.6	10.5	1.8	5.9
Crustacea	0.3	0.2	7.0	0.4	0.6	0.3
Ephemeroptera	32.4	12.2	41.4	37.8	25.8	53.3
Odonata	3.8	3.5	1.3	3.6	1.2	1.3
Trichoptera	26.6	55.5	3.6	18.2	25.0	10.9
Coleoptera	8.9	4.0	12.4	18.0	3.5	6.9
Diptera	27.3	22.6	30.3	5.5	39.1	15.9
Functional Feeding Assemblage %						
Shredders	0.5	0.3	0.2	1.0	0.3	0.2
Scrapers	12.2	3.7	31.3	27.3	6.4	19.5
Filterers	28.1	56.5	4.3	20.0	27.7	16.4
Collectors	51.6	31.1	55.7	44.2	61.2	60.4
Predators	7.3	8.3	8.5	6.7	4.4	3.6
Biotic Index	6.47	6.25	5.81	6.25	7.18	6.78

Table 5.17. Summary of macroinvertebrate metrics from spring of 2012.

Parameter	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
Total number of Taxa (Richness)	30	24	30	34	30	33
EPT Richness	4	3	14	6	6	6
EPT % Abundance	42.9	33.3	48.1	55.5	33.9	32.8
Shannon-Weiner Diversity Index	2.29	2.48	2.27	2.14	2.31	2.60
Percentage of Dominant Orders						
Annelia	0.9	10.1	0.7	1.0	1.1	1.8
Gastropoda	1.3	9.6	0.1	1.0	0.7	6.1
Ephemeroptera	17.9	10.8	37.2	27.2	21.6	23.2
Odonata	1.8	4.1	0.1	1.3	1.1	1.5
Plecoptera	0.1	0.0	5.6	1.1	2.9	3.1
Trichoptera	24.9	22.5	5.3	27.1	9.5	6.6
Coleoptera	3.4	1.8	4.4	3.3	2.4	3.7
Diptera	48.7	41.1	44.8	37.0	58.4	52.3
Functional Feeding Assemblage %						
Shredders	0.3	0.2	0.8	0.4	0.4	0.0
Scrapers	3.7	10.8	5.9	5.4	6.6	12.0
Filterers	31.6	26.4	12.2	35.8	17.6	17.7
Collectors	58.1	52.0	71.9	55.1	69.6	62.4
Predators	6.2	10.6	9.2	3.2	5.7	7.9
Biotic Index	6.86	7.29	6.34	6.60	6.91	6.89

5.5 Fish Community

The condition of the fish community (abundance, diversity, sensitivity, species present, etc.) is an indicator of the water quality and habitat quality of a water body. Monitoring the fish community is useful in assessing the Aquatic Life Use status of a water body and indicating potential perturbations to the system. Fish were collected from two sample reaches on three different streams with one upstream reach and one downstream reach (upstream and downstream from point source influence) during the fall of 2011. Reaches TB-1, WEC-1, and HC-1 are upstream of the City of Huntsville wastewater discharge influence. Reaches TB-2, WEC-2, and HC-2 are located downstream of the wastewater discharge influence.

A three-person crew of experienced field biologists conducted the sampling. The fish collections were made using a Smith-Root backpack electroshocker supplemented by seine hauls and/or block netting. The shocker is equipped with an automated timing mechanism which records the amount of time that electricity is actually being applied, or “pedal down time” (PDT). Fish community sampling was conducted prior to the collection of macroinvertebrate samples, habitat data, and all physiochemical parameters. Shocked fish were captured with hand held dip nets and held in buckets until the sampling was completed. The entire stream width within the sampling reach was sampled. Both PDT and the total collection time were recorded. The fish sampling was terminated when, in the opinion of the principal investigator, a representative collection had been obtained. Similar levels of effort in collection of fish were expended in all the study reaches. Sampling information was recorded on the Fish Community Collection Forms and general comments (perceived fishing efficiency, missed fish, and gear operation suggestions) were also recorded. A completed listing of fish collected at each station is presented in Appendix G.

At the end of each sampling reach effort, collected fish were preserved in formalin for later identification in the laboratory. Fish identifications were made according to the Fishes of Arkansas (Robinson, 1988) and The Fishes of Missouri (Pflieger, 1975) to species level. Several community metrics were then calculated to facilitate comparison of each downstream collection to the corresponding upstream reference sites (TB-1, HC-1, and WEC-1). The ADEQ ecoregion based community similarity index (CSI) was also calculated for each collection at the request of ADEQ (ADEQ, 2013). This index was developed by the ADEQ, based on years of ecoregion reference streams data and takes into consideration watershed size. The majority of the ADEQ data used to develop this index originates from perennial streams with watersheds greater than 20 mi^2. Therefore, smaller intermittent streams do not always score well with the CSI. For all stream reaches in this study, the Ozark Highland streams CSI was utilized. A summary of fish metrics from fall 2011 can be found below in Table 5.18

Table 5.18. Fish community analysis on Town Branch, Holman, and War Eagle Creek for fall 2011.

Parameter	**Station**					
COMMUNITY MEASURES	**TB-1**	**TB-2**	**HC-1**	**HC-2**	**WEC-1**	**WEC-2**
Richness (Total Number of Taxa)	16	16	18	19	25	24
Darter Richness (Number of Taxa)	2	1	3	3	6	5
Sunfish Richness (Number of Taxa)	4	4	3	4	5	7
% Pollution Tolerant Species	4.8	4.6	5.4	6.1	7.9	2.1
% Pollution Intermediate Species	50.0	56.7	70.8	51.0	37.1	36.0
% Pollution Intolerant Species	45.2	38.7	23.8	42.6	55.0	61.9
% Diseased	0.0	0.0	0.0	0.0	0.0	0.0
Diversity Indices (Shannon-Wiener)	2.57	2.84	2.72	3.05	3.02	3.37
Abundance, fish collected/minute	25.4	18.7	16.7	13.4	17.8	13.7
Number of Key & Indicator Species Taxa	6	7	7	6	8	7
% Key & Indicator Species	49.9	42.2	35.0	51.7	22.1	31.0
Pedal down time (minutes)	26.7	28.4	24.5	30.4	25.4	24.7
TROPHIC STRUCTURE						
% Omnivores	2.6	2.0	4.2	2.9	2.6	0.9
% Piscivores	0.1	0.2	0.2	0.2	2.0	4.1
% Insectivores	26.5	31.7	45.3	68.9	80.4	90.0
% Herbivores	70.7	66.1	50.2	27.9	14.8	5.0
PERCENT OF 5 DOMINANT FAMILY GROUPS						
CYPRINIDAE	81.4	76.5	64.0	57.1	27.4	9.7
CATOSTOMIDAE	0.0	0.4	1.0	1.2	0.4	1.8
FUNDULIDAE	2.3	1.1	4.9	0.5	0.9	0.3
POECILIIDAE	0.0	0.0	0.0	0.0	0.2	0.0
COTTIDAE	1.0	1.3	1.0	0.0	0.4	7.1
ICTALURIDAE	1.6	3.1	3.2	2.9	0.9	4.8
CENTRARCHIDAE	7.4	12.1	12.1	25.5	51.2	27.4
PERCIDAE	6.2	5.7	14.5	12.7	18.3	49.6
PETROMYZONTIDAE	0.0	0.0	0.0	0.0	0.2	0.0
Total % of 5 Dominant Groups	99.0	98.5	97.9	98.0	98.7	97.6
FISH CSI	29	31	39	41	31	37

5.5.1 Station TB-1

A total of 690 fish were collected during the 26.7 minute PDT sampling effort at the TB-1 station. This equates to a relative fish abundance of 25.4 fish/minute of PDT, the highest relative abundance of the study. The fish community had a taxa richness of 16 (Figure 5.15), one of the lowest of the study. Shannon-Wiener Diversity Index was 2.51, the lowest value of the study. The minnow family (Cyprinidae) had the highest taxa richness with 6 species. The sunfish (Centrarchidae) and minnow families were the dominant groups based on number of individuals and accounted for 81.4% and 7.4% of the total collection, respectively (Figure 5.16). Fish community trophic structure at TB-1 was dominated by herbivores (70.7%) and insectivores (26.5%) (Figure 5.17). Tolerance analysis of the fish community indicated that the community was dominated by pollution intermediate species at 50.0%, followed by species intolerant to perturbation at 45.2%, and pollution tolerant species at 4.8% (Figure 5.18). Table 5.18 provides fish community structure analysis that includes tolerance analysis for all stream reaches. The overall fish community condition at TB-1, as calculated using the ADEQ Community Similarity Index (CSI) for Ozark Highland streams, yielded a total score of 29 which is indicative of a “generally similar” fish community when compared to similar reference sites. Figure 5.19 illustrates fish CSI scores. At station TB-1, 49.9% of the total fish community was comprised of “Key and Indicator” species as defined by Arkansas Department of Environmental Quality (ADEQ) Regulation 2 for the Ozark Highlands Ecoregion. Figure 5.20 compares fish community “Key and Indicator” species at each station.

5.5.2 Station TB-2

The observed fish community at TB-2 included a total of 540 fish collected during the 28.4 minute PDT sampling effort. This equates to a relative fish abundance of 19.0 fish/minute of PDT. The fish community at TB-2 had a taxa richness of 16, the same as TB-1. Shannon-Wiener Diversity was 2.57. The minnow family had the highest taxa richness (6 species) and the highest percent of total individuals collected (76.5%), followed by sunfish accounting for 11.9%. The TB-2 fish community trophic structure was dominated by herbivores (66.1%) and insectivores (31.7%). The fish community was dominated by facultative species (intermediate in sensitivity, neither tolerant nor intolerant to perturbation) at 56.7%, followed by intolerant species (38.7%), and pollution tolerant species (4.6%). The overall fish community condition at TB-2 yielded a total score of 31 which indicates a “generally similar” to ecoregion reference sites. “Key and Indicator” species comprised 42.2% of the fish community at TB-2.

5.5.3 Station HC-1

A total of 408 fish were collected during the 24.5 minute PDT sampling effort at HC-1, equating to a relative fish abundance of 16.7 fish/minute of PDT. The fish community at HC-1 had a taxa richness of 18 and Shannon-Wiener Diversity was 2.72. The minnow family had the highest taxa richness (6 species), accounting for 64.0%, followed by the darter family (Percidae) at 14.5% of the total individuals collected at HC-1. The fish community trophic structure at HC-1 was dominated by herbivores accounting for 50.2% of the individuals collected, followed by insectivores at 45.3%. HC-1 was dominated by species with intermediate tolerance to perturbation at 70.8%, followed by species intolerant of perturbation (23.8%), and pollution tolerant species at 5.4%. The CSI at HC-1 yielded a total score of 39 which is indicative of a "mostly similar" fish community when compared to similar reference sites. "Key and Indicator" species comprised 35.0% of the fish community at HC-1.

5.5.4 Station HC-2

The observed fish community at HC-2 included a total of 408 fish collected during the 30.4 minute PDT sampling effort. This equates to a relative fish abundance of 13.4 fish/minute of PDT, the lowest relative abundance of the study. The fish community at HC-2 had a taxa richness of 19 and a Shannon-Wiener Diversity Index of 3.05. The minnow family had the highest taxa richness (7 species), and was also the dominant family accounting for 57.1% of total fishes collected. The sunfish family accounted for the second highest relative abundance of 25.5% for the total fish community. The HC-2 fish community trophic structure was dominated by insectivores accounting for 68.9% followed by herbivores at 27.9%. The fish community was dominated by intermediate pollution tolerant species at 51.0%, followed by species intolerant to perturbation at 42.6%, and pollution tolerant species at 6.1%. HC-2 had close to twice the relative abundance of species intolerant to perturbation than the upstream reach, HC-1. The CSI score of 41 indicates a 'generally similar' community at station HC-2, compared to similar reference sites. "Key and Indicator" species comprised 51.7% of the fish community at HC-2.

5.5.5 Station WEC-1

A total of 453 fish were collected during the 25.4 minute PDT sampling effort at the WEC-1 station. This equates to a relative fish abundance of 17.8 fish/minute of PDT. The fish community had a taxa richness of 25, the highest of the study and Shannon-Wiener Diversity was 3.02. Both the minnow and darter family had the highest taxa richness with 6 species in each family. The sunfish and minnow families were the dominant groups based on number of individuals and accounted for 51.2% and 27.4% of the total collection, respectively. Fish community trophic structure at WEC-1 was dominated by insectivores (80.4%) and herbivores (14.8%). Tolerance analysis of the fish community indicated that the community was dominated by species intolerant to perturbation at 55.0%, followed pollution intermediate species by at 37.1%, and pollution tolerant species at 7.9%. The overall fish community condition at WEC-1 yielded a total score of 31 which is indicative of a “generally similar” fish community, when compared to similar reference sites. At station WEC-1, 22.1% of the total fish community was comprised of “Key and Indicator” species, the lowest in the study.

5.5.6 Station WEC-2

A total of 339 fish were collected during the 24.7 minute PDT sampling effort at the WEC-2 station. This equates to a relative fish abundance of 13.7 fish/minute of PDT. The fish community had a taxa richness of 24 and Shannon-Wiener Diversity was 3.37, the highest of the study. Both the minnow and darter families had the same taxa richness as WEC-1, with 6 species in each family. The darter and sunfish families were the dominant groups based on number of individuals and accounted for 49.6% and 27.4% of the total collection, respectively. Fish community trophic structure at WEC-2 was dominated by insectivores (90.0%) and herbivores (5.0%). Tolerance analysis of the fish community indicated that the community was dominated by species intolerant to perturbation at 61.9%, followed pollution intermediate species at 36.0%, and pollution tolerant species at 2.1%. The overall fish community condition at WEC-2 yielded a total score of 37 which is indicative of a “mostly similar” fish community, when compared to similar reference sites. At station WEC-2, 24.7% of the total fish community was comprised of “Key and Indicator” species.

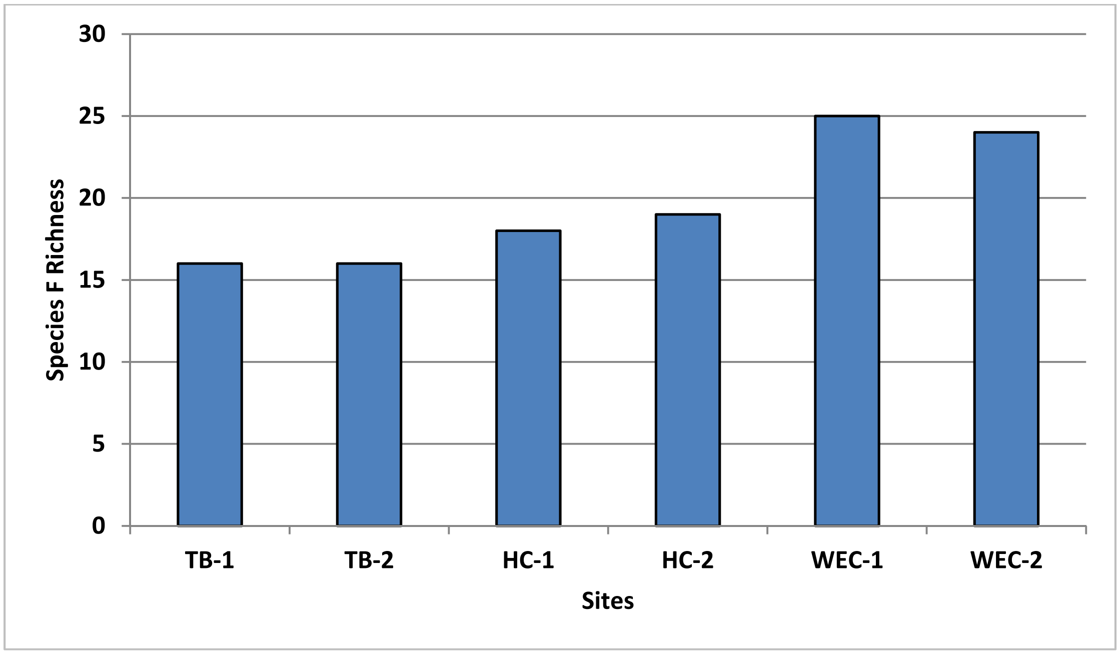

Figure 5.15. Comparison of fish community species richness at each station for fall 2011.

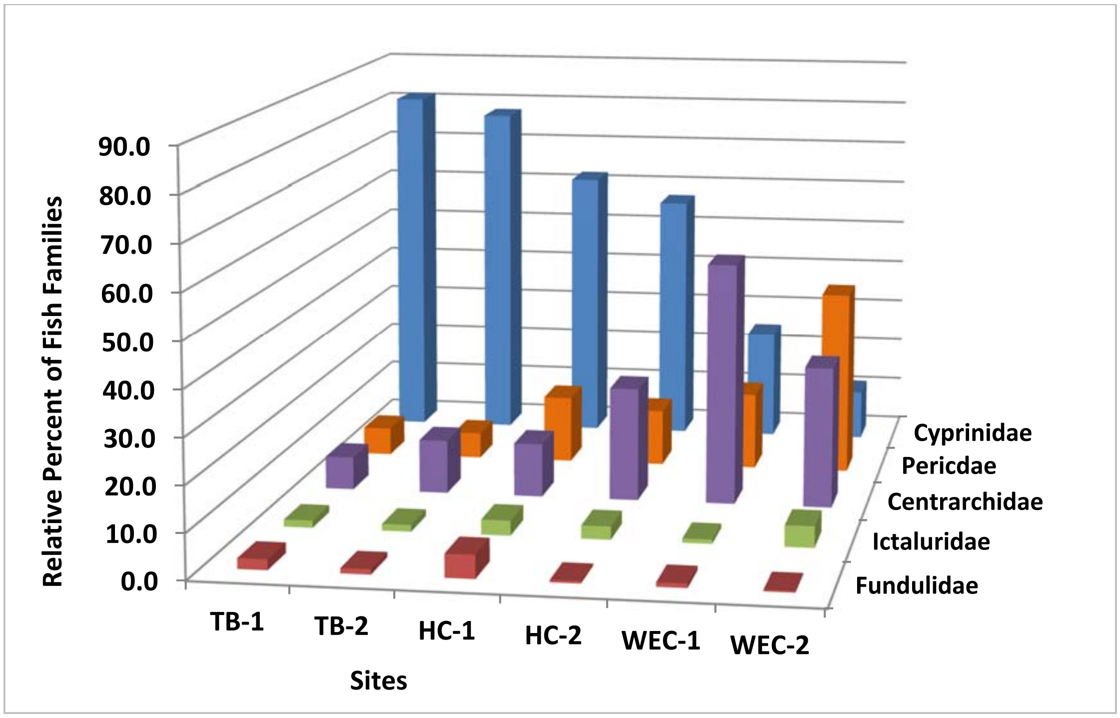

Figure 5.16. Comparison of dominant fish families collected at each station for fall 2011.

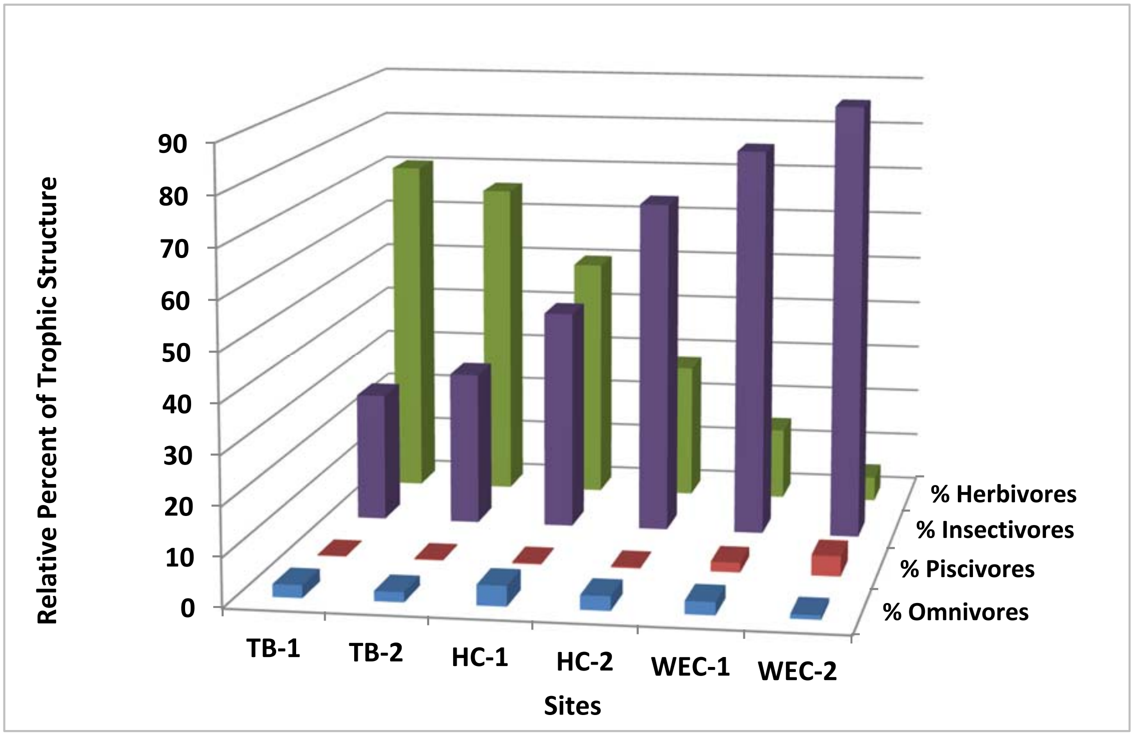

Figure 5.17. Comparisons of the community trophic structure at each station for fall 2011.

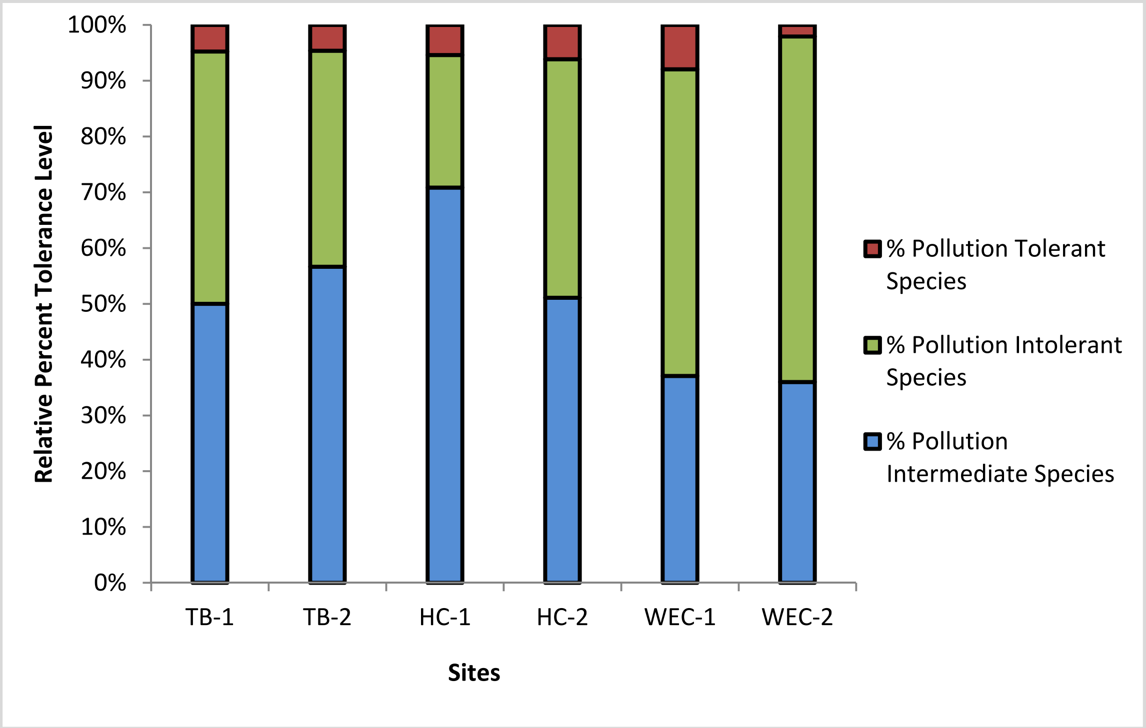

Figure 5.18. Comparison of percent composition of fish community tolerance to perturbation at each station for fall 2011.

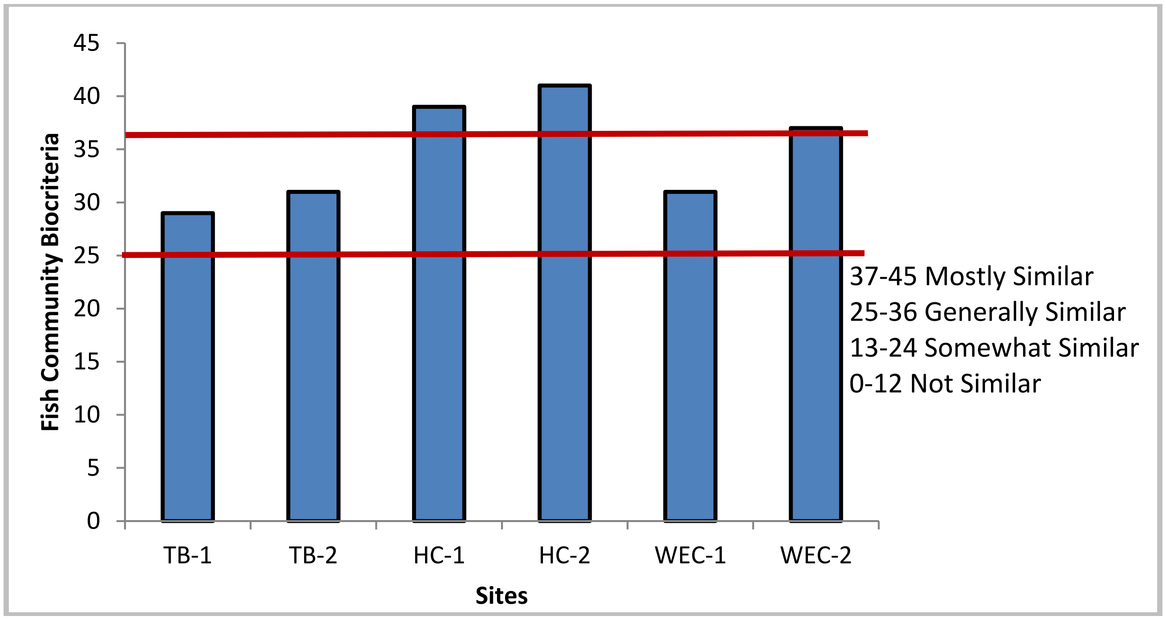

Figure 5.19. Summary of fish community similarity index at each station for fall 2011. The red line represents minimum biotic scores for support of the Aquatic Life Use.

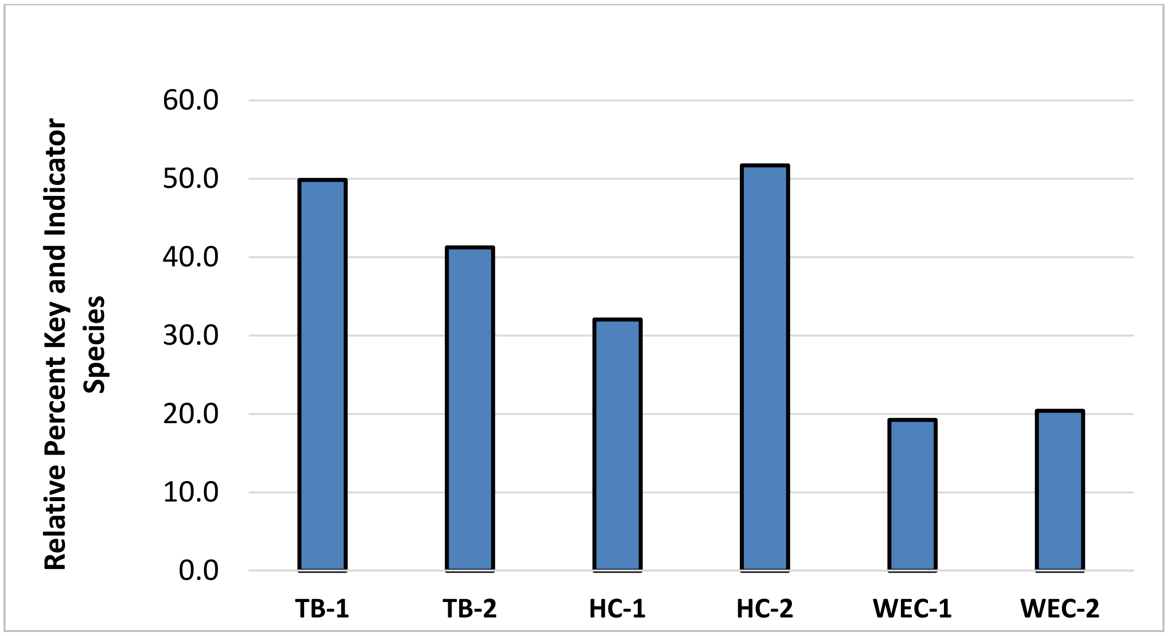

Figure 5.20. Percent of ecoregion “key and indicator” species collected from each stream reach.

5.5.7 Summary

According to the CSI for Ozark Highland streams, fish communities at three of the study reaches were found to be ‘generally similar’ when compared to reference streams in that ecoregion (IBI 25-36). The other three stream reaches scored ‘mostly similar’ (IBI 37-45) when compared to the reference streams found in the Ozark Highland ecoregion. Both reaches at Town Branch Creek were ‘mostly similar’. TB-2 had a slightly higher CSI score than the upstream reach, TB-1, because TB-2 had a higher relative abundance of the catfish family (Ictaluridae). The Ictaluridae metric in the CSI for Ozark Highland streams scores highest, 5, if a stream has moderate percentage (>2%) of catfish. The CSI gives a score of 3 if the Ictaluridae relative proportions are 1-2%, and give a score of 1 for <1% or >3% bullheads. The Ictaluridae percentage metric score was the only metric that TB-1 and TB-2 did not have in common, TB-2 scored a 5, and TB-1 scored a 3, giving TB-2 a slightly higher score.

Both reaches at Holman Creek were ‘mostly similar’; the downstream reach scored higher than the upstream reach. HC-1 had fewer sensitive taxa than the downstream reach, which contributed to HC-1’s lower CSI score. The only pair of stations to be in two different CSI categories was WEC-1 and WEC-2. WEC-2 had a higher CSI score because it had higher relative abundance of Ictaluridae and more key species than WEC-1. In general, all fish communities were dominated by species intolerant and intermediate to perturbation. Diversity of fish communities was highest at the War Eagle Creek but no reach scored below 2.5 which is above average for the range of Shannon-Weiner diversity index (range 0-4). The lowest diversity value was from TB-1 (2.51) just upstream of the City of Huntsville WWTP discharge. The smaller watershed size of Town Branch, and smaller stream size in general, are likely the reason for the lower diversity and richness in those reaches. Station WEC-1 had the highest species richness with 25 species, while stations TB-1 and TB-2 both had the lowest species richness of 16. The percent of “Key and Indicator” species was greatest at stations HC-2 (51.7%) and lowest at WEC-1 (22.1%).

Fish community trophic structure was split, half the sites (TB-1, TB-2, and HC-1) were dominated by herbivores and the other half (HC-2, WEC-1, and WEC-2) were dominated by insectivores. Herbivores followed insectivores in abundance or vice versa at all stations, comprising as much as 90.0% of the total fish community or as little as 5.0%. Fishes from the minnow family dominated the communities at TB-1 (81.4%), TB-2 (76.5%), HC-1 (64.0%), and HC-2 (57.1%), while station WEC-1 was dominated by individuals from the sunfish family (51.2%), and WEC-2 was dominated by the darter family (49.6%). Percidae and Centrarchidae relative proportions increased with larger watershed area, the highest numbers of darters and sunfish were found in the two War Eagle Creek reaches. Cyprinidae relative proportions were highest in the smallest watershed stream, Town Branch, and lowest in the largest watershed stream, War Eagle Creek. Overall, the fish communities from each reach are healthy and representative of streams in full attainment of their Aquatic Life Use. Raw fish numbers for all study reaches are provided below in Table 5.19.

Table 5.19. Raw fish numbers for stations of the Town Branch, Holman Creek, and War Eagle Creek in fall 2011.

Scientific Name	**Common Name**	**TB-1**	**TB-2**	**HC-1**	**HC-2**	**WEC-1**	**WEC-2**
PETROMYZONTIDAE							
Ichthyomyzon spp.	lamprey	0	0	0	0	1	0
CYPRINIDAE							
Campostoma anomalum	central stoneroller	237	219	176	49	47	12
Cyprinella whipplei	steelcolor shiner	0	1	0	17	25	5
Luxilus pilsbryi[1]	duskystripe shiner	35	39	39	87	16	5
Luxilus chrysocephalus	striped shiner	21	5	0	0	0	0
Notropis boops	bigeye shiner	0	0	0	2	4	0
Notropis atherinoides	emerald shiner	0	0	0	0	0	3
Notropis nubilis[2]	ozark minnow	251	138	20	65	20	5
Notropis telescopus	telescope shiner	0	0	0	1	0	0
Phoxinus erythrogster[2]	southern redbelly dace	0	0	9	0	0	0
Pimehpales notatus	bluntnose minnow	13	11	8	12	12	3
Semotilus atromaculatus	creek chub	5	0	9	0	0	0
CATOSTOMIDAE							
Hypentelium nigricans[1]	northern hog sucker	0	2	4	3	2	3
Moxostoma duquesnei	black redhorse	0	0	0	2	0	1
Moxostoma erythrurm	golden redhorse	0	0	0	0	0	2
FUNDULIDAE							
Fundulus olivaceus	blackspotted topminnow	0	0	2	2	4	1
Fundulus catenatus	northern studfish	16	6	18	0	0	0
POECILIIDAE							
Gambusia affinis	mosquitofish	0	0	0	0	1	0
ICTALURIDAE							
Noturus exilis[1]	slender madtom	8	10	12	7	1	0
Noturus albater[2]	ozark madtom	0	0	0	0	2	14

Scientific Name	Common Name	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
Ameiurus natalis	yellow bullhead	3	7	1	5	1	0
CENTRARCHIDAE							
Ambloplites constellatus[1]	ozark bass	0	0	0	1	3	4
Lepomis cyanellus	green sunfish	12	7	4	8	23	4
Lepomis gulosus	warmouth	0	0	0	0	0	2
Lepomis macrochirus	bluegill sunfish	1	3	0	1	1	3
Lepomis megalotis	longear sunfish	37	53	42	94	199	72
Micropterus salmoides	largemouth bass	0	0	1	0	0	1
Micropterus dolomieu[1]	smallmouth bass	1	1	0	0	0	0
Micropterus punctulatus	spotted bass	0	0	0	0	6	7
PERCIDAE							
Etheostoma blennioides	greenside darter	1	0	3	3	10	7
Etheostoma caeruleum[1]	rainbow darter	42	31	55	48	54	50
Etheostoma juliae	yoke darter	0	0	0	0	8	87
Etheostoma punctulatum	stippled darter	0	0	1	0	0	0
Etheostoma stigmaeum	speckled darter	0	0	0	0	3	2
Etheostoma zonale	banded darter	0	0	0	0	7	22
Percina caproides	Logperch	0	0	0	1	1	0
COTTIDAE							
Cottus carolinae[2]	banded sculpin	7	7	4	0	2	24
Total Fish Collected		690	540	408	408	453	339

[1] Ozark Highlands Ecoregion Key Species

[2] Ozark Highlands Ecoregion Indicator Species

5.5.8 Conclusions

Based on the results of the fish collections, the following conclusions are provided:

1. The fish community at the downstream station was generally more diverse than its corresponding upstream reference station and had similar richness.
2. The fish communities at all stations were found to contain significant number of key and indicator taxa (6 or more) and a significant percent composition of ecoregion Key and Indicator Species as identified in Arkansas Regulation No. 2 (ADEQ 2011).
3. Sensitive darter species (greenside and rainbow) were found during the study at both upstream and downstream stations in Holman Creek and War Eagle

Creek. War Eagle Creek also contained banded darters and yoke darters (both sensitive) at its upstream and downstream locations.

4. The aquatic life field study demonstrated that the designated Aquatic Life Use was being maintained at all study reaches as demonstrated by the dominance of intolerant and intermediate species.
5. The Aquatic Life Use was also determined to be fully based on the ADEQ CSI, which shows that all stations were generally or mostly similar to Ecoregion Reference, and the downstream stations scored higher in every stream.

6.0 WATERSHED DESCRIPTION

Town Branch and Holman Creek are part of the larger War Eagle Creek Watershed in Madison County. The entire watershed is approximately 200 square miles in size, with Holman Creek occupying 27 mi^2 and Town Branch 4.6 mi^2. War Eagle Creek is part of the Beaver Lake watershed which is a major water supply reservoir for North West Arkansas. Land use assessment was completed for the War Eagle Creek watershed using 2006 LULC data (USGS 2006). The War Eagle Creek watershed is dominated by forest (74%) and pasture (19%) land uses (Figure 6.1). A smaller but growing portion of the watershed is developed area (1.1%) which includes homes, business, schools, roadways, parking lots, etc. The majority of the development is in the Town Branch sub-watershed, which contains most of the City of Huntsville and is 28% developed land area, while the remainder of the city and surrounding sub-urban housing area is contained in the Holman Creek sub-watershed which has 10% developed land uses. A summary of the land uses in each sub-watershed is provided in Appendix H.

Soils in the watershed are dominated by Nixa-Clarksville-Noark and Enders-Leesburg in the upland areas and Cedar-Leadville-Cleora in the War Eagle Creek floodplain. The soils are mostly gravely loam or cherty silt loam with good drainage and land surface slopes vary from gently sloping to very steep. Soils in the flood plain of War Eagle Creek are gravelly sandy loam with flatter slopes. War Eagle Creek has an 8 digit hydrologic unit code (HUC) of 11010001 and is in ADEQ planning segment 4K. A TMDL for nitrate was completed for Holman Creek in 2001, and it is now categorized as 4a on the 2008 Arkansas 303(d) list. Holman Creek first appeared on the Arkansas 2008 303(d) list for TDS (category 5a) with a listed cause of municipal point source and remains on the most current (2016) draft list. War Eagle Creek appears on the 2008 303(d) list for Beryllium (category 5d) with cause listed as unknown.

Two watershed management plans have been prepared for Beaver Lake that includes War Eagle Creek. The first plan was completed by the ANRC as part of their Watershed Management Strategy for non-point source priority watersheds in 2004 (ARNC 2004). The more recent plan, the Beaver Lake Watershed Protection Strategy (Tetra Tech, 2009) was completed for the Northwest Arkansas Council in 2009 (updated in 2012). Both plans seek to determine the major sources of point and non-point source pollution. The ANRC lists agricultural operations and rural roads (un-paved roads) as the leading sources of sediment and nutrient pollution in the watershed. The newer and more comprehensive Beaver Lake Watershed Protection Strategy lists stream channel erosion and pasture/agriculture as the two primary sources of sediment and nutrients. However, model projections into the future predict that the watershed in and around Huntsville will experience dramatic growth in development which will become the No.2 source of nutrients and sediments by 2055. Controlled growth through use of construction best management practices (BMP), stream riparian buffer zones, city good housekeeping practices and storm water BMP’s in and around Huntsville will be key in preventing water quality degradation in the future, should the growth projections prove accurate.

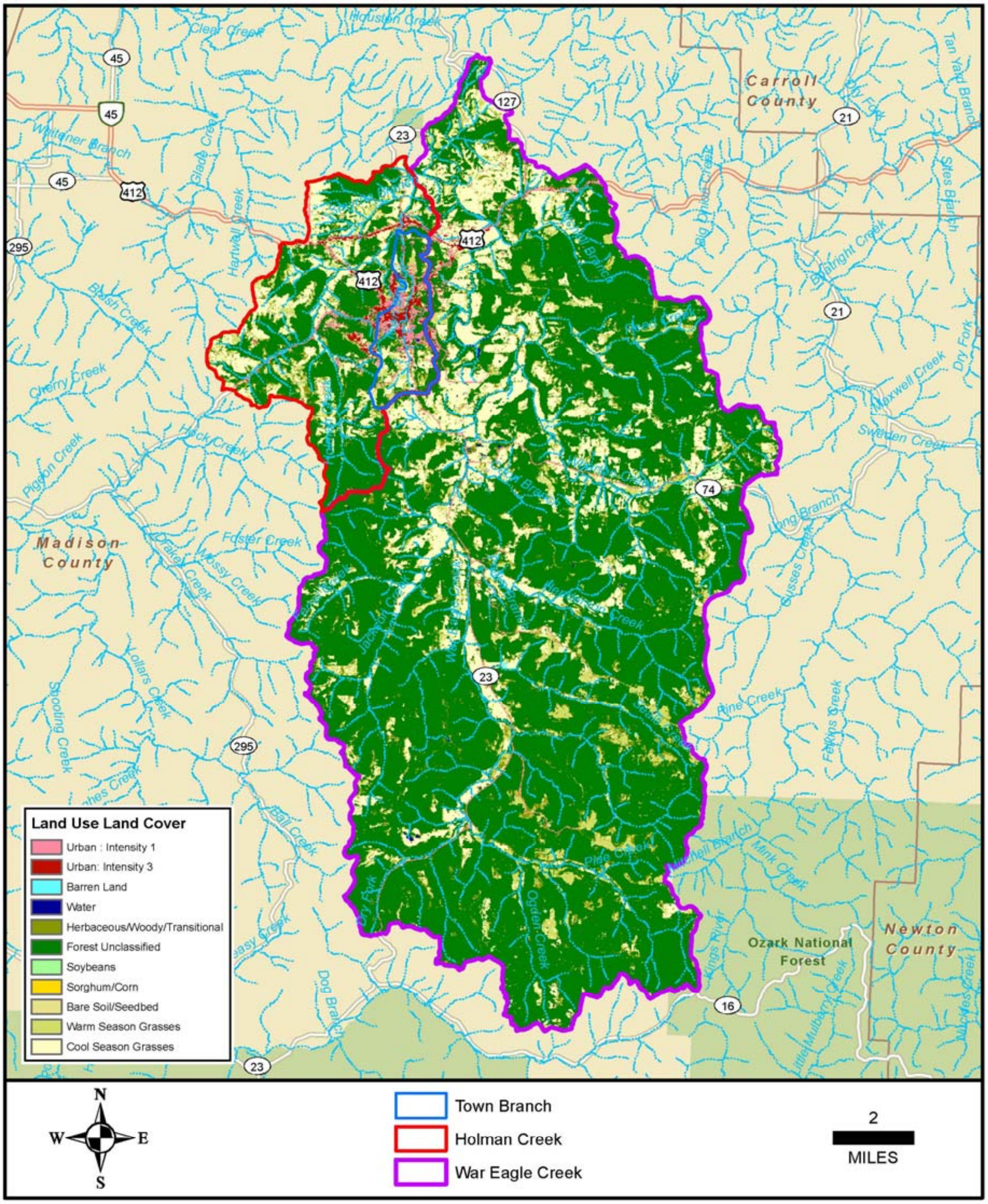

Figure 6.1. Land use and land cover map of War Eagle Creek watershed, including Holman Creek and Town Branch.

Cursory watershed and stream channel observations were made during this study, on each stream system, as part of the bioassessments. Observations indicate that stream bank erosion and cattle use of the stream riparian corridor are potentially significant sources of both sediment and nutrients to the watershed. Control of these sources could improve water quality, particularly in Holman Creek and War Eagle Creek. In addition, Town Branch runs through the center of Huntsville and appears to receive uncontrolled storm water runoff from impervious areas in town. This runoff will cause unusually high peak flows in the stream that will tend to degrade the channel and carry large sediment loads. Control of surface runoff near Town Branch through use of infiltration swales, bioretention and other storm water handling BMP's would benefit Town Branch's channel stability and water quality and could serve to increase baseflow during dry summer periods.

7.0 DEVELOPMENT OF SITE SPECIFIC MINERALS CRITERIA

7.1 Chloride, Sulfate, and TDS Site Specific Criteria

The 95th percentile of measured chloride, sulfate, and TDS data from TB-2, HC-2, and WEC-2 was used as the basis for site specific criteria. The data used for the percentile calculations are provided in Appendix I. Summary statistics from the data sets are shown in Tables 7.1 – 7.3.

Table 7.1. Summary statistics from station TB-2, Town Branch Creek.

Statistic	**Chloride (mg/L)**	**Sulfate (mg/L)**	**TDS (mg/L)**
Minimum	30	40	220
Maximum	250	62	900
Average	120	51	468
Standard Deviation	70	9	210
95th Percentile	223	61	779
N	12	4	12

Table 7.2. Summary statistics from station HC-2, Holman Creek.

Statistic	**Chloride (mg/L)**	**Sulfate (mg/L)**	**TDS (mg/L)**
Minimum	5	7	64
Maximum	270	61	790
Average	68	27	290
Standard Deviation	60	13	160
95th Percentile	180	47	621
N	75	67	75

Table 7.3 Summary statistics from station WEC-2, War Eagle Creek.

Statistic	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Minimum	3	7	72
Maximum	42	19	270
Average	16	11	149
Standard Deviation	14	5	69
95th Percentile	39	18	248
N	12	4	12

As seen in Tables 7.1 and 7.3 sulfate data analysis was limited to four events in Town Branch and War Eagle Creeks. When the study was initiated development of a site specific criterion for sulfate was not contemplated as sulfate was not a known issue based upon ADEQ's ambient monitoring. Therefore, sulfate was only collected during the study on four occasions in Town Branch below the outfall (TB-2) and War Eagle Creek at WEC-2. However, after study completion it was determined that sulfate concentration had increased at ADEQ's Holman Creek monitoring station. The increase in sulfate was caused by Huntsville WWTP's use of aluminum sulfate to meet a phosphorus permit limit. It was determined that the sulfate issue could be addressed in the proposed rulemaking.

TDS and chloride were collected at TB-2 during the study and can be used to predict the sulfate concentrations present during the biological study. In order to have the minimum of 12 in-stream data points to use in criterion development, other data collected during the study by GBMc, the City, and ADEQ were analyzed to determine how sulfate levels at TB-2 could best be calculated. The statistical analyses presented in Table 7.4 were completed with the outcome noted in the second column.

Table 7.4. Statistical Analysis Completed and used to Evaluate the 95th Percentile for Sulfate.

Regression analysis of effluent TDS to sulfate	Weak correlation – $R^2 = 0.008$
Regression analysis of effluent TDS to chloride	Strong Correlation – $R^2 = 0.78$
Regression analysis of Holman Creek downstream of discharge TDS to sulfate	Strong Correlation – $R^2 = 0.90$
Percentage of TDS composed of sulfate in effluent	9.4% (95%CI = 8.6 - 10.2)
Percentage of TDS composed of sulfate at TB-2	9.1% (95%CI – n/a)
Percentage of TDS as sulfate at HC-2	10.7% (95%CI = 10.0 - 11.5)

The two most reasonable methods were tested to predict sulfate level at TB-2 on the same days that TDS were collected. The regression equation from the HC-2 analysis was used for one method, and a conservative 9% of TDS was used for the other method. The resulting analysis, along with the projected criteria (95%tile), is provide in Table 7.5.

Table 7.5. Results from the Various Statistical Methods used to Evaluate the 95th Percentile for Sulfate.

Date	**Chloride (mg/L)**	**Sulfate (mg/L)**	**TDS (mg/L)**	**Predicted SO4 from HC-2 Correlation**	**Actual Measured % of TDS**	**9% of TDS**	**9% of TDS (with measured values inserted)**	**Predicted SO4 (with measured values inserted)**
7/7/2011	250	40	900	80.3	4.4	81.0	40.0	40.0
8/24/2011	150	62.0	530	50.9	11.7	47.7	62.0	62.0
9/14/2011	200	--	680	63.1		61.2	61.2	63.1
10/12/2011	130	50.0	620	58.3	8.1	55.8	50.0	50.0
11/17/2011	80	--	270	28.5		24.3	24.3	28.5
12/8/2011	42	--	250	26.7		22.5	22.5	26.7
1/18/2012	100	--	380	38.3		34.2	34.2	38.3
2/2/2012	41	--	240	25.8		21.6	21.6	25.8
3/27/2012	30	--	220	23.9		19.8	19.8	23.9
4/10/2012	79	52	420	41.7	12.4	37.8	52.0	52.0
5/9/2012	150	--	540	51.8		48.6	48.6	51.8
6/21/2012	190	--	570	54.2		51.3	51.3	54.2
			Mean	**45.3**	**9.1**	**42.2**	**40.6**	**43.0**
			95%tile	**70.9**		**70.1**	**61.6**	**62.5**

The recommended site specific criterion for sulfate based upon the four-sample 95th percentile calculation is 61 mg/L. The most conservative outcome from the additional statistical analysis is 61.6 mg/L resulting from the 9% of TDS method. The range of values from the additional statistical analysis was 61.6 mg/L to 70.9 mg/L. Based on the results of the analyses we recommend that a site specific criteria of 61 mg/L be used in Town Branch downstream of the effluent discharge. The calculated 95th percentile for sulfate was 18 mg/L and the existing Ecoregion Reference Stream Value is 17 mg/L. The difference between these two numbers is insignificant, therefore no change in the current Ecoregion Reference Stream Value of 17 mg/L is recommended.

7.1 Recommended Site Specific Criteria

Based upon the 95th percentile method of calculation the values presented in Table 7.6 are recommended for replacement of the Ozark Ecoregion Reference Values in the stream segments listed.

Table 7.6. Recommended Site Specific Criteria for chloride, sulfate, and TDS.

Town Branch from Point of Discharge of the City of Huntsville WWTP downstream to the confluence with Holman Creek.			**Holman Creek from the confluence with Town Branch downstream to the confluence with War Eagle Creek.**			**War Eagle Creek from the confluence with Holman Creek to Clifty Creek.**		
Site Specific Criteria Proposed			**Site Specific Criteria Proposed**			**Site Specific Criteria Proposed**		
Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
223	61	779	180	47	621	39	17[1]	248

[1] Existing Ecoregion Reverence Stream Value, no recommended revision

7.2 Drinking Water Use Water Quality Criteria

In Arkansas, the Domestic Water Supply use utilizes EPA's secondary drinking water recommendations for chloride, sulfate, and TDS criteria. According to the Arkansas WQS (Reg. 2.511) and the Arkansas CPP (Appendix D) the Domestic Water Supply use applies at the critical flow (7Q10) with chloride, sulfate, and TDS, criteria of 250 mg/l, 250 mg/L and 500 mg/l, respectively.

Town Branch and Holman Creek are small (watershed sizes less than 30mi^2) un-gauged streams and assumed to have a 7Q10 of 0 cfs. These are small streams (3rd order or smaller) and are intermittent in nature. These streams do not have existing drinking water uses, and do not contain adequate volumes of water to be utilized in the future for such purposes. Therefore, it is recommended and requested that the Domestic Water Supply use be removed from Town Branch and Holman Creek.

War Eagle Creek is a much larger stream than Holman Creek or Town Branch. It has a watershed size of approximately 200 square miles at the confluence of Holman Creek, nearly an order of magnitude larger than Holman Creek, and is a gauged stream with a USGS station (No.07049000) located near Hindsville, Arkansas. Review of the data collected during the study indicates that for each mineral, the 95th percentile concentrations are well below the Domestic Water Supply use criteria and therefore no removal of the use is recommended for War Eagle Creek.

8.0 ALTERNATIVE ANALYSES

This section summarizes the analyses of alternatives for the Huntsville WWTP to meet projected water quality based effluent projected limitations for chloride, sulfate, and TDS. Current discharge concentrations of chloride, sulfate and TDS would not be anticipated to maintain the projected water quality based effluent limits that would likely be assigned during the next permit renewal. In addition to examining the development of site specific criteria, alternatives to amending the water quality criteria were considered.

The primary source of dissolved minerals discharged from the WWTP is from an industrial discharger to the system, the Butterball LLC turkey processing facility. Butterball owns and operates a turkey processing facility in the City of Huntsville, located at 1294 N. College Street. Effluent from the Butterball facility makes up approximately 80% of the total volume of wastewater received by and treated at the City's WWTP. Butterball contributes the majority of the chloride and TDS loads that are ultimately discharged by the WWTP. However, the recent increase in sulfate levels discharged by the Huntsville WWTP is the result of aluminum sulfate additions by the WWTP which have been implemented to meet discharge limits for total phosphorus.

Alternatives were examined to determine if the projected water quality based permit limits for chloride, sulfate and TDS could be met by the City of Huntsville without amending the water quality criteria. These alternatives were as follows:

1) no action,
2) no discharge, or removal of the industrial source,
3) treatment,
4) source reduction/pollution prevention,
5) Water Quality Standards modification.

8.1 No Action

No action would maintain the current discharge situation. The projected limits for chloride, sulfate, and TDS in the next revision of the Huntsville's NPDES permit would be expected to be exceeded the first month of their effective date and put the City of Huntsville in a non-compliance situation. Non-compliance with the projected permit limits is not an acceptable alternative for the City or ADEQ.

8.2 No Discharge, or Removal of the Industrial Source

The no discharge alternative is not a feasible option for the City under any circumstance. It is anticipated that removal of the discharge from the Butterball Turkey Processing Facility would substantially reduce loads of chloride and TDS and would likely allow compliance with projected permit limits for chloride and TDS.

In order to cease discharge the Butterball Facility would either have to cease operations in Huntsville, or obtain an NPDES permit to discharge directly, which would only serve to transfer the minerals issues to a different permittee. A turkey processing facility has discharged wastewater to the City of Huntsville's Waste Water Treatment Plant for the past 40 plus years, since 1973. Dissolved minerals (specifically TDS) became a known issue with publication of the Arkansas 2008 303(d) list. Huntsville's WWTP is well suited to treat the Butterball wastewater for pollutants such as BOD, ammonia, and nutrients. It would be impractical for Butterball to obtain its own NPDES permit. First, the facility would need to build a separate advanced wastewater treatment plant (assuming they would be required to meet similar limits as the City). Second, they would be faced with the same dissolved minerals issue as the City, which an advanced waste water treatment plant would not remove. In addition, removal of the Butterball wastewater from the Huntsville WWTP would be devastating to the City financially, and a poor idea from a treatment perspective as an under loaded activated sludge plant would not function properly, causing Huntsville to violate their NPDES permit for some period of time.

8.3 Treatment

EPA has no Best Available Technology (BAT) for removal of chloride, sulfate, or TDS from waste streams. While ion exchange and reverse osmosis treatment technologies exist, these methods currently are not cost effective on a large scale and are not typically recommended for treatment of waters prior to discharge. Also, the concentrated reject streams generated from such processes present their own unique set of potential environmental risks.

The technical limitations and uncertain environmental effects of concentrated waste streams generated from ion exchange and reverse osmosis treatment make the treatment alternative infeasible when other alternatives are considered.

Despite these limitations, the City of Huntsville and Butterball have investigated the capital and annual operating costs to install advanced treatment for reduction of dissolved minerals in the effluent coming from the turkey processing plant. Specifically, the treatment process includes ultra-filtration, reverse osmosis, and concentration/crystallization of the facility effluent in addition to ancillary storage and equipment. Information on the treatment system cost estimates are provided in Appendix J.

The estimated capital cost ($30.1 million) and annual operating cost ($4.6 million) of reverse osmosis would be overly burdensome and place the facility at a significant competitive disadvantage. These costs would jeopardize the continued operation of the Butterball Facility, the largest employer in Madison County. The consequence of the loss of the Butterball Facility would likely prove to be disastrous for the City of Huntsville, Madison County and the surrounding northwest Arkansas community. This region relies heavily on the economic impact of the Butterball facility. The facility employs almost 700 citizens and provides them an annual payroll of more than $22,000,000. It also acts as a critical client/customer to a number of local businesses and pays more than $138,000 in local property taxes.

At the request of the Arkansas Pollution Control and Ecology Commission a second alternatives analysis was completed to determine if there were alternatives to the ultra-filtration, reverse osmosis, concentration/crystallization system.

A second alternative, electrodialysis reversal is described in the documentation contained in Appendix J. Electrodialysis reversal is another membrane-based separation technology that acts on ionic species. With this technology, the feed water is run through a chamber with an electrical potential created by charged electrodes. The chamber is divided into cells by alternatingly charged ion-exchange membranes. Each membrane is highly selective, passing only cations or only anions. Cations are passed to an adjacent cell through the first membrane they encounter as they travel toward the cathode, while anions are passed through to an opposite cell adjacent to that which the feed water originally entered by the first membrane they encounter on their way toward the anode. Each species, however, is blocked from entering subsequent cells by either an anion-exchange or cation-exchange membrane, respectively. These cells concentrate ions, reducing the TDS of the water fed into the initial cell. In the reversal stage of the process, the polarity of the electrode is reversed, and the diluate cells become concentrate cells. This helps regenerate the membranes, leading a large reduction in scaling and fouling. This also prolongs membrane life by reducing cleaning requirements.

The final steps are the same as for reverse osmosis: the concentrated brine reject solution from electrodialysis is sent to an evaporator to reduce the volume of water in the reject solution through a vapor-compression process. That process prepares the now extremely concentrated reject for the crystallization step where the brine is heated and swirled in a vortex where some brine evaporates, leading to the formation of crystals. A small stream carries these to a filter press where final dewatering to 20% moisture content results in a filter cake that can then be disposed of.

The total capital cost for electrodialysis treatment is estimated to be $22 million and the estimated annual operating cost was estimated at $2.89 million. Somewhat less than the estimates for reverse osmosis, these costs would nevertheless continue be overly burdensome and place the facility at a significant competitive disadvantage and would again continue to jeopardize the continued operation of the Butterball Facility in Huntsville.

8.4 Source Reduction/Pollution Prevention

Butterball owns and operates a turkey processing facility in the City of Huntsville, located at 1294 N. College Street. Effluent from the Butterball facility makes up approximately 80% of the total volume of wastewater received by and treated at the City's WWTP. Butterball contributes the majority of the chloride and TDS that is ultimately discharged by the WWTP. As such, source reduction/pollution prevention efforts were focused on the Butterball facility.

One alternative evaluated is discontinued use Butterballs existing freeze system, which uses a salt water solution. After evaluating, Butterball determined that it would cost approximately $15 million dollars to replace the current system with a blast system. However, based on calculations performed, it is estimated that TDS would be reduced insufficiently to meet the projected permit limits applicable to the City of Huntsville.

Butterball performed calculations to simulate the complete removal of all calcium chloride brine and sodium hypochloride brine associated with the chiller freeze system. This has been done twice, once reflecting the period of January - October 2010 and again January - October 2016. To accomplish the calculations, Butterball determined pounds of calcium chloride and sodium hypochloride purchased and used in the chiller system, and the average TDS concentration sent to the Huntsville WWTP during the period. Butterball then determined the pounds per day of calcium chloride and sodium hypochloride added to the wastewater effluent, and then converted the pounds per day to concentration. In the final step the concentration of calcium chloride and sodium hypochloride added to the wastewater effluent (assumed that these compounds made up TDS) was subtracted from the average TDS concentration sent to the Huntsville WWTP. For the 2010 period Butterball estimated that average TDS could be reduced from 1,047 mg/L to 685 mg/L, which is a 35% reduction. For 2016 Butterball estimated that average TDS could be reduced from 1,078 mg/L to 845 mg/L, which is a 22% reduction. In the original report this reduction was inaccurately described as minimal, however even with these reductions (potentially achieved at a cost $15 million to replace the chiller system) discharge concentrations would remain well above permit limits needed to achieve the current water quality criteria

Butterball has implemented best management practices designed to find, capture, and eliminate where possible, drips and spills of water high in TDS and chloride. Butterball evaluated their facility to determine each area of the plant and the processes that use salts. Butterball identified 20 potential points of loss of salts to the sewer system. Once identified, Butterball investigated management practices designed to reduce salt (brine) losses to the sewer system that are ultimately piped to the Huntsville WWTP. Meetings were held with employees at each area with the intent of educating the employees on the importance of preventing salt loss to the sewer system. Monitoring programs were established and estimates of percentage reductions were developed for the potential points of salt loss to the sewer system as shown in Table 8.1.

Table 8.1. Butterball Salts Reduction Program at the Huntsville Plant.

Plant Area	**Description**	**Est. Gal/Day Loss**	**Est. Annual Gal. Loss (260 days/year)**	**Action Taken**	**Status**	**Est. Reduction Percent**
Spice Room	Area where all spices are weighed out prior to use in brine formulas.	Not Measurable	NA	Meeting held with employee responsible, to dispose of in the trash.	Implemented	Not Estimated
Stunner	Salt used in stunner and in holding tank outside Kill room.	Not Measurable	NA	Meeting held with employees concerning issues of TDS, discussed way of reduction.	Implemented	Not Estimated
Packaging Brine Mixer	Consists of mixing system, holding tank, plate chiller.	Not Measurable	NA	Minimize batch sizes at shift end to reduce what is dumped daily.	Implemented	Not Estimated
Basters	Overhead piping system, basters, and 2 belts after baster.	428	111,360	Monitor basters, pumps and piping for leaks and report to maintenance. Establish PM's on equipment.	Implemented	50%
Sodium Hypochloride Brine	Salt system to chill BRT/BIB.	High Conc.	NA	Not feasible. Would require new Freezing System to eliminate.	Not Implemented	NA
Calcium Chloride Brine	Calcium chloride system to chill WB.	High Conc.	NA	Not feasible. Would require new Freezing System to eliminate.	Not Implemented	NA
Blenders	Spices added to MST blending, Prague and Salt.	Not Measurable	NA	Improve process for adding ingredients to reduce spills.	Implemented	Not Estimated
Mixing Tank	Mixing system for formulation of brine (tanks, piping).	Not Measurable	NA	Minimize batch sizes at shift end to reduce what is dumped daily.	Implemented	Not Estimated
Injectors	Injecting of product, including saddle tanks and returns	70	18,200	Monitor basters, pumps and piping for leaks and report to maintenance. Establish PM's on equipment.	Implemented	50%
Mixing Tank	Mixing system for formulation of brine. Consists of tanks, piping.	Not Measurable	NA	Minimize batch sizes at shift end to reduce what is dumped daily.	Implemented	Not Estimated
Injectors	Injecting of product, included saddle tanks and returns.	35	9,100	Monitor basters, pumps and piping for leaks and report to maintenance. Establish PM's on equipment.	Implemented	50%

Plant Area	Description	Est. Gal/Day Loss	Est. Annual Gal. Loss (260 days/year)	Action Taken	Status	Est. Reduction Percent
Mixing Tank	Mix gravy spice, includes 2 tanks and pipe.	Not Measurable	NA	Meeting held with employees to minimize spills, and run gravy until tanks emptied to eliminate draining at shift end.	Implemented	Not Estimated
Gravy Machine	Injection of Gravy into packets.	Not Measurable	NA	Insure process is stopped when leaks detected. Minimize rejected packets so not to enter sewer system.	Implemented	Not Estimated
Mixing Tank	Mixing system for formulation of brine. Consists of tanks, piping.	Not Measurable	NA	Minimize batch sizes at shift end to reduce discarded brine volume.	Implemented	Not Estimated
Injectors	Injecting of product, included saddle tanks and returns.	70	18,200	Monitor basters, pumps and piping for leaks and report to maintenance. Establish PM's on equipment. Catch purge on table prior to placing on racks.	Implemented	75%
Rack Loss	Time from injection to loading into oven, brine drainage from birds.	168	33,600	Not feasible. Would require moving cook operations to another Butterball facility.	Not Implemented	0%
Ovens	Purge from highly injected cooked whole birds, BIB's and drums on open racks.	Not Measurable	NA	Not feasible. Would require moving cook operations to another Butterball facility.	Not Implemented	NA
Cook side	Drainage of birds from chill.	Not Measurable	NA	Not feasible. Would require moving cook operations to another Butterball facility.	Not Implemented	Not Estimated
Cajun spice (HBH)	Floor loss by adding topical spice.	145	3,625	Make sure spills are cleaned up with broom and disposed of in trash vs. washing down the drain	Implemented	75%
Spice area	Floor loss by adding topical spice.	Not Measurable	NA	Make sure spills are cleaned up with broom and disposed of in trash vs. washing down the drain.	Implemented	Not Estimated

Source reduction and pollution prevention activities would not be sufficient to reduce average concentrations of chloride and TDS, although it is possible that maximum concentrations could be reduced by some, likely small, amount through increased efficiency of spill capture.

Reduction in sulfate levels could be achieved by a reduction in the amount of aluminum sulfate added in the wastewater treatment process. The City of Huntsville uses liquid aluminum sulfate at a feed rate of 0.394 liters/min. This equates to 150 gallons of liquid aluminum sulfate per day. No formal studies have been conducted but the City has used a series of trials to determine the feed rate needed to remain in compliance with the phosphorus effluent limit. It is the City's intent to use the minimum amount of aluminum sulfate necessary to remain in compliance with its phosphorus permit limit, both from a financial perspective and an ecological perspective.

8.5 WQS Modifications

Amendment of the water quality standards is considered a viable option. The purpose of this study was to collect data sufficient to evaluate the merit of deriving site specific criteria, and to derive those criteria if warranted. Water quality standards amendment, pursuant to Regulation 2.306, was selected as the appropriate option.

9.0 USGS DISSOLVED MINERALS MODELING

The United States Geological Survey (USGS) completed a modeling study of the Beaver Lake watershed (Green, 2013) to determine the potential effect on lake water quality of increasing dissolved minerals in the two primary drainages that carry treated wastewater from the cities of Fayetteville and Huntsville. Fayetteville discharges treated wastewater into the White River upstream of Beaver Lake and Huntsville discharges treated wastewater into Town Branch Creek which runs into Holman Creek to War Eagle Creek and then into Beaver Lake.

The USGS utilized the Corps of Engineers model CE-Qual-W2 to complete the modeling. The model was set-up to represent the lake and each main tributary as a series of interconnected longitudinal segments. The model also included vertical segmentation to allow water quality near the bottom of the lake and near the surface to be independently evaluated. Water quality monitoring data from multiple samples and sample locations in the main tributaries and the lake were collected between 2006 and 2010 and used to calibrate the model. Model calibration to actual measured water quality values helps ensure the models predictions are consistent with actual real world water quality in Beaver Lake and its tributaries.

Once calibrated the model was used to predict the effect in Beaver Lake of increasing dissolved mineral levels in each of the two primary tributaries (White River and War Eagle Creek) by a factor of 1.2, 1.5, 2.0, 5.0 and 10.0. This was accomplished by taking the average annual load from the nearest monitoring station to the lake in each respective tributary and calculating a daily average flow and concentration for that site. The daily average concentration could then be multiplied by each factor to increase the load of minerals entering the lake. For War Eagle Creek the monitoring station at Hindsville (Station S3) was used.

The result of these factorial increases, both in the main lake and in the arm of each tributary, was an increase in mineral levels with each factorial increase. However, the first three tiers of increases (1.2, 1.5 and 2.0) resulted in only minor increases in the lake arm. These increase factors are those most reasonable for use in evaluating the impact of mineral levels from the WWTPs in the watershed, as anything more than a two fold increase in loads from the WWTPs would be extraordinary. For War Eagle Creek, the baseline median TDS level in segment 48 (in the War Eagle Creek arm of the tributary) was 95 mg/L, and a doubling of the mineral levels in War Eagle Creek (at the Hindsville station) only increased this median level to 133 mg/L. Considering that the Huntsville WWTP effluent is only about 5% of the load of minerals in War Eagle Creek at Hindsville, the effect from a two fold increase in WWTP mineral loading would be less than 2 mg/L change, and therefore, negligible. The USGS study serves to prove that the requested change to the Arkansas WQS for TDS and chloride will have insignificant to no effect on the dissolved minerals concentration of Beaver Lake. A copy of the USGS Report is included in Appendix K.

10.0 SELECTED ALTERNATIVE

Based on the facility biomonitoring record, the results of the aquatic life field study, the mass balance modeling, toxicity modeling, the USGS modeling effort, and the assessment of alternatives presented previously, the selected alternative is to modify the WQS using site specific criteria for chloride, TDS and sulfate as presented in the Table 10.1.

Table 10.1. Site Specific Criteria Recommendations.

Town Branch from Point of Discharge of the City of Huntsville WWTP downstream to the confluence with Holman Creek.			**Holman Creek from the confluence with Town Branch downstream to the confluence with War Eagle Creek.**			**War Eagle Creek from the confluence with Holman Creek to Clifty Creek.**		
Site Specific Criteria Proposed			**Site Specific Criteria Proposed**			**Site Specific Criteria Proposed**		
Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
223	61	779	180	47	621	39	17[1]	248

[1] Existing Ecoregion Reverence Stream Value, no recommended revision.

11.0 REFERENCES

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Appendix A

DMR Data

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Environmental Services Co., Inc.
1107 Century
Springdale, AR 72762

pproved
o. 2040-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

7/2011

PERMIT NUMBER	AR0022004
DISCHARGE NUMBER	001-A

MONITORING PERIOD

	MM/DD/YYYY		MM/DD/YYYY
FROM	07/01/2011	TO	07/31/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	7.0	******	******		0	1/7	GRAB
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	6.9	******	7.2		0	1/7	GRAB
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	8 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	40.9	******		******	4.5	7.0		0	1/7	COMP
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<1.1	******		******	<0.2	0.4		0	1/7	COMP
00610 1 0 Effluent Gross	PERMIT REQUIREMENT	28.7 MO AVG	******	lb/d	******	1.6 MO AVG	3.9 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	35.4	******		******	7.2	11.4		0	1/7	COMP
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	168.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	11.3	******		******	1.9	3.2		0	1/7	GRAB
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	63.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	0.801129	1.372000		******	******	******	******	0	1/1	TOT
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-6629	08/11/2011
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

Form Approved
OMB No. 2040-0004

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

	MONITORING PERIOD		
	MM/DD/YYYY		MM/DD/YYYY
FROM	07/01/2011	TO	07/31/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	9388.6	******		******	1032	1548.0		0	1/7	COMP
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	<1	<1		0	1/7	GRAB
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<18.4	******		******	<2.0	<2.0		0	1/7	COMP
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-~~266~~ 6921	08/11/2011
LARRY GARRETT, DIRECTOR TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00016

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Environmental Services Co.
1107 Century
Springdale AR 72764
479-750-1170

Approved
No. 2040-0004

ERMITTEE NAME/ADDRESS *(Include Facility Name/Location If Different)*

AME: HUNTSVILLE, CITY OF
DDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
ACILITY: HUNTSVILLE, CITY OF
OCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
ATTN: LARRY GARRETT, DIRECTOR

8/2011

PERMIT NUMBER: AR0022004
DISCHARGE NUMBER: 001-A

MAJOR

MONITORING PERIOD
FROM (MM/DD/YYYY): 08/01/2011 TO (MM/DD/YYYY): 08/31/2011

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	7.0	******	******		0	1/7	GRAB
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	7.0	******	7.4		0	1/7	GRAB
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<25.3	******		******	<5.4	9.0		0	1/7	COMP
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<1.2	******		******	<0.1	0.3		0	1/7	COMP
00610 1 0 Effluent Gross	PERMIT REQUIREMENT	28.7 MO AVG	******	lb/d	******	1.6 MO AVG	3.9 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	36.0	******		******	5.0	5.9		0	1/7	COMP
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	168.5 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	3.1	******		******	0.3	0.8		0	1/7	GRAB
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	53.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	0.800434	1.37200		******	******	******	******	0	1/1	TOT
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: 479-738-6955 (AREA Code / NUMBER)
DATE: 09-16-2011 (MM/DD/YYYY)

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5, 44-00018

Form Approved
OMB No. 2040-0004

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

PERMIT NUMBER	DISCHARGE NUMBER
AR0022004	001-A

MONITORING PERIOD

	MM/DD/YYYY		MM/DD/YYYY
FROM	08/01/2011	TO	08/31/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSES	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	3089.4	******		******	639.0	671.4		0	1/7	COMP
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	2	4		0	1/7	GRAB
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<9.7	******		******	<2.0	<2.0		0	1/7	COMP
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-2661	09-16-2011
LARRY GARRETT, DIRECTOR TYPED OR PRINTED			AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 08/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

ENVIRONMENTAL SERVICES CO., INC.
1107 CENTURY
SPRINGDALE, AR 72762

Approved
No. 2040-0004

RMITTEE NAME/ADDRESS (Include Facility Name/Location if Different)

ME: HUNTSVILLE, CITY OF
DRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
CILITY: HUNTSVILLE, CITY OF
CATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
TN: LARRY GARRETT, DIRECTOR

9/2011

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD
FROM MM/DD/YYYY 09/01/2011 TO MM/DD/YYYY 09/30/2011

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

[redacted]

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
xygen, dissolved (DO) 0300 1 0 ffluent Gross	SAMPLE MEASUREMENT	******	******	******	~~6.5~~ [redacted]	******	******		0	1/7	GRAB
	PERMIT REQUIREMENT	******	******	******	6.0 INST MIN	******	******	mg/L		Weekly	GRAB
0400 1 0 fluent Gross	SAMPLE MEASUREMENT	******	******	******	6.9	******	7.3		0	1/7	GRAB
	PERMIT REQUIREMENT	******	******	******	6. MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
lids, total suspended 0530 1 0 fluent Gross	SAMPLE MEASUREMENT	39.5	******		******	5.5	10.2		0	1/7	COMP
	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
itrogen, ammonia total (as N) 0610 1 0 fluent Gross	SAMPLE MEASUREMENT	<1.5	******		******	<0.2	0.4		0	1/7	COMP
	PERMIT REQUIREMENT	26.7 MO AVG	******	lb/d	******	1.8 MO AVG	3.9 7 DA AVG	mg/L		Weekly	COMPOS
itrite plus nitrate total 1 det. (as N) 0630 1 0 ffluent Gross	SAMPLE MEASUREMENT	49.0	******		******	2.6	10.[illegible]		0	1/7	COMP
	PERMIT REQUIREMENT	156.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
osphorus, total (as P) 0665 1 0 ffluent Gross	SAMPLE MEASUREMENT	1.9	******		******	0.5	0.5		0	1/7	GRAB
	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.6 7 DA AVG	mg/L		Weekly	GRAB
ow, in conduit or thru treatment plant 0050 1 0 ffluent Gross	SAMPLE MEASUREMENT	1.0184737	1.592000		******	******	******	******	0	1/1	TOT
	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

~~Garrett~~ Larry D. Garrett
Director

Larry D. Garrett 479-738-6525 11-2-2011

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

[illegible]

Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE		DATE
479-738-6929		10-17-2011
AREA Code	NUMBER	MM/DD/YYYY

OMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

EPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE ART II, CONDITION #5. 44-00018

Form Approved
OMB No. 2040-0004

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

MITTEE NAME/ADDRESS *(Include Facility Name/Location If Different)*

ME: HUNTSVILLE, CITY OF
DRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
CILITY: HUNTSVILLE, CITY OF
CATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
TN: LARRY GARRETT, DIRECTOR

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD
FROM MM/DD/YYYY 09/01/2011 TO MM/DD/YYYY 09/30/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
lids, total dissolved	SAMPLE MEASUREMENT	5637.5	******		******	710	1025.0		0	1/7	COMP
295 1 0 luent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
liform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	20	1.31		0	1/7	GRAB
055 1 1 luent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
D, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<16.9	******		******	<2.0	<2.0		0	1/7	COMP
082 1 0 luent Gross	PERMIT REQUIREMENT	157 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

Larry D. Garrett
Director

Larry D. Garrett 479-738-6929 11-02-2011

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER	[illegible]	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE		DATE
Larry D. Garrett Director		Larry D. Garrett	479-738-2531 2929		10-17-2011
LARRY TYPED OR PRINTED OR			AREA Code	NUMBER	MM/DD/YYYY

OMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

EPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE RT II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

ENVIRONMENTAL SERVICES CO., INC.
1107 CENTURY
SPRINGDALE, AR 72762

Hoved
2042-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

10/2011

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD
FROM MM/DD/YYYY 10/01/2011 TO MM/DD/YYYY 10/31/2011

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	*****	*****	*****	7.1	*****	*****		0		
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	*****	*****	*****	6.6 INST MIN	*****	*****	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	*****	*****	*****	6.4	*****	7.1		0		
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	*****	*****	*****	6 MINIMUM	*****	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT		*****		*****						
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	*****	lb/d	*****	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT		*****		*****						
00610 1 0 Effluent Gross	PERMIT REQUIREMENT	26.7 MO AVG	*****	lb/d	*****	1.6 MO AVG	3.9 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT		*****		*****	7.6					
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	166.8 MO AVG	*****	lb/d	*****	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT		*****		*****						
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	*****	lb/d	*****	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1.015646	1-533000		*****	*****	*****	*****			
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	*****	*****	*****	*****		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE 479-738-1939
AREA Code NUMBER

DATE 11-28-2011
MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Form Approved
OMB No. 2040-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

AR0022004	001-A
PERMIT NUMBER	**DISCHARGE NUMBER**

MONITORING PERIOD

	MM/DD/YYYY		MM/DD/YYYY
FROM	10/01/2011	TO	10/31/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT		******		******	561.5					
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	2	6		0		
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT		******		******						
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	187 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE		DATE
	2529	11-28-2011
AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-0008

ENVIRONMENTAL SERVICES CO., INC.
1107 CENTURY
SPRINGDALE, AR 72762

pproved
o. 2040-0004

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

11/2011

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD
FROM MM/DD/YYYY 11/01/2011 TO MM/DD/YYYY 11/30/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	6.9	******	******		0		
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.8 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	6.9	******	7.1		0		
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT		******		******	<4.0			0		
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT		******		******	<0.3			0		
00610 1 1 Effluent Gross	PERMIT REQUIREMENT	50 MO AVG	******	lb/d	******	3 MO AVG	4.5 7 DA AVG	mg/L	0	Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT		******		******				0		
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	166.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT		******		******				0		
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1-034	3.495		******	******	******	******	0		
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

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Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: 479-738-6951
AREA Code NUMBER

DATE: 12/14/2011
MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00318

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Form Approved
OMB No. 2040-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

MONITORING PERIOD

	MM/DD/YYYY		MM/DD/YYYY
FROM	11/01/2011	TO	11/30/2011

DNR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT		******		******	400.6					
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	<2	0.35				
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT		******		******						
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett		6929	12/14/2011
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

EPA Form 3320-1 (Rev.01/06) Previous editions may be used.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

ENVIRONMENTAL SERVICES CO., INC.
1107 CENTURY
SPRINGDALE, AR 72762

ed
10-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

12/2011

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD
FROM MM/DD/YYYY 12/01/2011 TO MM/DD/YYYY 12/31/2011

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	7.0	******	******		0	1/7	GRAB
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	6.9	******	7.0		0	1/7	GRAB
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<57.94	******		******	<4.3	6.0		0	1/7	COMP
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<0.99	******		******	<0.1	<0.1		0	1/7	COMP
00610 1 1 Effluent Gross	PERMIT REQUIREMENT	53 MO AVG	******	lb/d	******	3 MO AVG	4.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	58.5	******		******	6.3	6.9		0	1/7	COMP
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	166.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	2.0	******		******	0.2	0.3		0	1/7	GRAB
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1.322516	1.971000		******	******	******	******	0	1/1	TOT
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: 479-738-6955 (AREA Code / NUMBER)
DATE: 01-19-2012 (MM/DD/YYYY)

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

Form Approved
OMB No. 2040-0004

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location If Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

	MONITORING PERIOD		
	MM/DD/YYYY		MM/DD/YYYY
FROM	12/01/2011	TO	12/31/2011

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	5153.2	******		******	398.5	515.0		0	1/7	COMP
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	0.66	5		0	1/7	GRAB
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1300 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<32.10	******		******	<2.4	4.0		0	1/7	COMP
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	TELEPHONE		DATE
Larry D. Garrett Director			479-738-~~2081~~ 2727		01-19-2012
LARRY GARRETT, DIRECTOR TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

ENVIRONMENTAL SERVICES CO., INC.
1107 CENTURY
SPRINGDALE, AR 72762

ved
140-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

1/2012

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD
FROM MM/DD/YYYY 01/01/2012 TO MM/DD/YYYY 01/31/2012

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO) 00300 1 0 Effluent Gross	SAMPLE MEASUREMENT	******	******	******	7.1	******	******		0	1/7	Grab
	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH 00400 1 0 Effluent Gross	SAMPLE MEASUREMENT	******	******	******	6.7	******	7.1		0	1/7	Grab
	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended 00530 1 0 Effluent Gross	SAMPLE MEASUREMENT	<59.1	******		******	<5.0	7.0		0	1/7	Comp
	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N) 00610 1 1 Effluent Gross	SAMPLE MEASUREMENT	<0.7	******		******	<0.1	<0.1		0	1/7	Comp
	PERMIT REQUIREMENT	50 MO AVG	******	lb/d	******	3 MO AVG	4.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N) 00630 1 0 Effluent Gross	SAMPLE MEASUREMENT	36.4	******		******	5.0	7.4		0	1/7	Comp
	PERMIT REQUIREMENT	166.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P) 00665 1 0 Effluent Gross	SAMPLE MEASUREMENT	3.6	******		******	0.4	0.3		0	1/7	Grab
	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant 50050 1 0 Effluent Gross	SAMPLE MEASUREMENT	1.119065	2.52000		******	******	******	******	0	1/1	TOT
	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

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Larry D. Garrett
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: 479-738-6131
AREA Code NUMBER

DATE: 02/16/2012
MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

EPA Form 3320-1 (Rev.01/06) Previous editions may be used.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Form Approved
OMB No. 2040-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

	MONITORING PERIOD		
	MM/DD/YYYY		MM/DD/YYYY
FROM	01/01/2012	TO	01/31/2012

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	5256.0	******		******	464.3	505		0	1/7	Comp
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	0.44	3		0	1/7	Comp
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<22.4	******		******	<2.0	2.0		0	1/7	Comp
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations	Larry D. Garrett	TELEPHONE		DATE
Larry D. Garrett Director			479	738-6930	2/16/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Environmental Services Co.
1107 Century
Springdale AR 72764
479-750-1170

ad
19-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

2/2012

AR0022004
PERMIT NUMBER

001-A
DISCHARGE NUMBER

MONITORING PERIOD			
	MM/DD/YYYY		MM/DD/YYYY
FROM	02/01/2012	TO	02/29/2012

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	7.0	******	******		0	1/7	Grab
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	7.0	******	7.3		0	1/7	Grab
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<46.8	******		******	<4.0	6.0		0	1/7	Comp
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<2.4	******		******	<0.2	0.6		0	1/7	Comp
00610 1 1 Effluent Gross	PERMIT REQUIREMENT	50 MO AVG	******	lb/d	******	3 MO AVG	4.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	65.6	******		******	7.2	8.2		0	1/7	Comp
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	168.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	<0.9	******		******	<0.1	1.2		0	1/7	Grab
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1.315828	2.144000		******	******	******	******	0	1/1	Tot
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-6535	03-14-2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

EPA Form 3320-1 (Rev.01/06) Previous editions may be used.

Form Approved
OMB No. 2040-0004

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

	MONITORING PERIOD		
	MM/DD/YYYY		MM/DD/YYYY
FROM	02/01/2012	TO	02/29/2012

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	5549.0	******		******	483.8	445		0	1/7	Comp
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	0.4	4		0	1/7	Grab
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<23.4	******		******	<2.0	<2.0		0	1/7	Comp
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	187 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry Garrett,Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.		479-738-~~298~~ [illegible]		03/14/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 05/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Environmental Services Co.
1107 Century
Sprindale AR 72764
479-750-1170

m Approved
B No. 2040-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

3/2012

PERMIT NUMBER	DISCHARGE NUMBER
AR0022004	001-A

MONITORING PERIOD			
	MM/DD/YYYY		MM/DD/YYYY
FROM	03/01/2012	TO	03/31/2012

I0

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	7.3	******	******		0	1/7	Grab
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	7.1	******	7.2		0	1/7	Grab
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<73.0	******		******	<4.0	6.0		0	1/7	Comp
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<1.0	******		******	<1.0	0.2		0	1/7	Comp
00610 1 1 Effluent Gross	PERMIT REQUIREMENT	50 MO AVG	******	lb/d	******	3 MO AVG	4.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	41.9	******		******	6.2	9.7		0	1/7	Comp
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	168.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	2.3	******		******	0.3	0.8		0	1/7	Grab
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1.460806	3.630000		******	******	******	******	0	1/1	Tot
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	Mgal/d	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-6989	04/12/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Form Approved
OMB No. 2040-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*

NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740
FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

PERMIT NUMBER	DISCHARGE NUMBER
AR0022004	001-A

MONITORING PERIOD
FROM MM/DD/YYYY 03/01/2012 TO MM/DD/YYYY 03/31/2012

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	6646.1	******		******	494.3	795		0	1/7	Comp
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	<1	1		0	1/7	Grab
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<39.9	******		******	<2.3	3		0	1/7	Comp
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-6539	04/12/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

PERMITTEE NAME/ADDRESS (Include Facility Name/Location if Different)
NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
ATTN: LARRY GARRETT DIRECTOR

4/2012

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMIT NUMBER: AR0022004
DISCHARGE NUMBER: 001-A

MONITORING PERIOD
MM/DD/YYYY 4/1/2012
MM/DD/YYYY 4/30/2012

Environmental Services Co.
1107 Century
Springdale AR 72764
479-750-1170

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	7.0	******	******		0	1/7	Grab
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	7.0	******	7.3		0	1/7	Grab
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<25.3	******		******	<2.5	4.0		0	1/7	Comp
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<1.3	******		******	<0.2	0.4		0	1/7	Comp
00610 1 0 Effluent Gross	PERMIT REQUIREMENT	26.7 MO AVG	******	lb/d	******	1.6 MO AVG	3.9 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	53.3	******		******	6.5	10.4		0	1/7	Comp
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	166.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	1.6	******		******	0.2	0.3		0	1/7	Grab
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1.057433	1.529000		******	******	******	******	0	1/1	Tot
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	MGD	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
Larry D. Garrett
Director
TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: 479-738-1285 (AREA Code, NUMBER)
DATE: 05/18/2012 (MM/DD/YYYY)

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*
NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740

ATTN: LARRY GARRETT, DIRECTOR

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMIT NUMBER	DISCHARGE NUMBER
AR0022004	001-A

MONITORING PERIOD

MM/DD/YYYY	MM/DD/YYYY
4/1/2012	4/30/2012

Form Approved
OMB No. 2040-0004

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	6624.3	******		******	631	799		0	1/7	Comp
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	0.19	2		0	1/7	Grab
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<21.2	******		******	<2.0	<2.0		0	1/7	Comp
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations		479	738-6591	05/15/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

1107 Century
Springdale AR 72764
479-750-1170

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*
NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
ATTN: LARRY GARRETT, DIRECTOR

5/2012

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

MONITORING PERIOD	
MM/DD/YYYY	MM/DD/YYYY
5/1/2012	5/31/2012

MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	6.8	******	******		0	1/7	Grab
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	7.0	******	7.4		0	1/7	Grab
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<40.3	******		******	<4.2	5.0		0	1/7	Comp
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<0.6	******		******	<0.1	0.1		0	1/7	Comp
00610 1 0 Effluent Gross	PERMIT REQUIREMENT	26.7 MO AVG	******	lb/d	******	1.6 MO AVG	3.9 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	69.9	******		******	11.2	12.9		1	1/7	Comp
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	163.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	3.6	******		******	0.7	0.6		0	1/7	Grab
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	83.4 MO AVG	******	lb/d	******	5 MO AVG	7.5 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	1.020903	1.497000		******	******	******	******	0	1/7	TOT
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	MGD	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479	738-6929	06/14/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*
NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
ATTN: LARRY GARRETT, DIRECTOR

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Form Approved
OMB No. 2040-0004

PERMIT NUMBER	DISCHARGE NUMBER
AR0022004	001-A

MONITORING PERIOD

MM/DD/YYYY	MM/DD/YYYY
5/1/2012	5/31/2012

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Solids, total dissolved	SAMPLE MEASUREMENT	7241.9	******		******	758.2	852.0		0	1/7	Comp
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	<1	3		0	1/7	Grab
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	******	******	******	******	1000 30DA GEO	2000 7 DA GEO	#/100mL		Weekly	GRAB
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<19.1	******		******	<2.0	<2.0		0	1/7	Comp
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
Larry D. Garrett Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.		479-738-6989		06/14/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

Environmental Services Co.
1107 Century
Springdale AR 72764
479-750-1170

ed
10-0004

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*
NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
ATTN: LARRY GARRETT, DIRECTOR

6/2012

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

PERMIT NUMBER	DISCHARGE NUMBER
AR0022004	001-A

MONITORING PERIOD

MM/DD/YYYY	MM/DD/YYYY
6/1/2012	6/30/2012

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		VALUE	VALUE	UNITS	VALUE	VALUE	VALUE	UNITS			
Oxygen, dissolved (DO)	SAMPLE MEASUREMENT	******	******	******	6.6	******	******		0	1/7	GRAB
00300 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6.6 INST MIN	******	******	mg/L		Weekly	GRAB
pH	SAMPLE MEASUREMENT	******	******	******	7.1	******	7.3		0	1/7	GRAB
00400 1 0 Effluent Gross	PERMIT REQUIREMENT	******	******	******	6 MINIMUM	******	9 MAXIMUM	SU		Weekly	GRAB
Solids, total suspended	SAMPLE MEASUREMENT	<37.8	******	#/day	******	<4.5	8.0	mg/L	0	1/7	COMP
00530 1 0 Effluent Gross	PERMIT REQUIREMENT	250 MO AVG	******	lb/d	******	15 MO AVG	22.5 7 DA AVG	mg/L		Weekly	COMPOS
Nitrogen, ammonia total (as N)	SAMPLE MEASUREMENT	<1.3	******	#/day	******	<0.2	0.6	mg/L	0	1/7	COMP
00610 1 0 Effluent Gross	PERMIT REQUIREMENT	25.7 MO AVG	******	lb/d	******	1.5 MO AVG	9.9 7 DA AVG	mg/L		Weekly	COMPOS
Nitrite plus nitrate total 1 det. (as N)	SAMPLE MEASUREMENT	24.6	******	#/day	******	3.7	9.3	mg/L	0	1/7	COMP
00630 1 0 Effluent Gross	PERMIT REQUIREMENT	166.8 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS
Phosphorus, total (as P)	SAMPLE MEASUREMENT	3.7	******	#/day	******	0.7	1.4	mg/L	0	1/7	GRAB
00665 1 0 Effluent Gross	PERMIT REQUIREMENT	33.3 MO AVG	******	lb/d	******	2 MO AVG	3 7 DA AVG	mg/L		Weekly	GRAB
Flow, in conduit or thru treatment plant	SAMPLE MEASUREMENT	0.907567	1.278000	MGD	******	******	******	******	0	1/1	TOT
50050 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon. MO AVG	Req. Mon. DAILY MX	MGD	******	******	******	******		Daily	TOTALZ

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE		DATE
LARRY D. GARRETT Director	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett	479-738	-6528	07/09/2012
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	AREA Code	NUMBER	MM/DD/YYYY

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*
NAME: HUNTSVILLE, CITY OF
ADDRESS: P.O. BOX 430
HUNTSVILLE, AR 72740

FACILITY: HUNTSVILLE, CITY OF
LOCATION: 30187 MADISON HWY 23
HUNTSVILLE, AR 72740
ATTN: LARRY GARRETT, DIRECTOR

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

AR0022004	001-A
PERMIT NUMBER	DISCHARGE NUMBER

MONITORING PERIOD	
MM/DD/YYYY	MM/DD/YYYY
6/1/2012	6/30/2012

Form Approved
OMB No. 2040-0004

DMR Mailing ZIP CODE: 72740
MAJOR

001-MONTHLY-TRTD MUNICIPAL WW
External Outfall

No Discharge ☐

PARAMETER		QUANTITY OR LOADING 5453.1 VALUE	 VALUE	 #/day UNITS	QUALITY OR CONCENTRATION VALUE	 650.5 VALUE	 830.0 VALUE	 mg/L UNITS	NO. EX 0	FREQUENCY OF ANALYSIS 1/7	SAMPLE TYPE COMP
Solids, total dissolved	SAMPLE MEASUREMENT	5453.1	******	#/day	******	650.5	830.0	mg/L	0	1/7	COMP
70295 1 0 Effluent Gross	PERMIT REQUIREMENT	Req. Mon MO AVG	******	lb/d	******	Req. Mon. MO AVG	Req. Mon. 7 DA AVG	mg/L		Weekly	COMPOS
Coliform, fecal general	SAMPLE MEASUREMENT	******	******	******	******	1	1		0	1/7	GRAB
74055 1 1 Effluent Gross	PERMIT REQUIREMENT	<16.8	******	#/day	******	1000 <2.0 30DA GEO	2000 2.0 7 DA GEO	#/100mL mg/L	0	Weekly	GRAB COMP
BOD, carbonaceous, 05 day, 20 C	SAMPLE MEASUREMENT	<16.8	******	#/day	******	<2.0	<2.0	mg/L	0	1/7	COMP
80082 1 0 Effluent Gross	PERMIT REQUIREMENT	167 MO AVG	******	lb/d	******	10 MO AVG	15 7 DA AVG	mg/L		Weekly	COMPOS

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	Larry D. Garrett SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE 479-738-2001 479-738-~~2001~~ 6929 AREA Code / NUMBER	DATE 07/09/2012 MM/DD/YYYY
LARRY GARRETT, DIRECTOR				
TYPED OR PRINTED LARRY GARRETT, DIRECTOR				

COMMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

REPORT FLOW AS MONTHLY AVERAGE & DAILY MAXIMUM IN MILLION GALLONS PER DAY. FINAL LIMITS FOR TOTAL PHOSPHORUS BEGIN 06/01/2012. SUBMIT TABULAR SSO REPORT EACH MONTH WITH THIS DMR. SEE PART II, CONDITION #5. 44-00018

Appendix B

WQ Data

AMERICAN INTERPLEX CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on July 8, 2011. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on July 8, 2011
Huntsville

Receipt Details:

A Chain of Custody was provided. The samples were delivered in two (2) ice chests.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
149252-1	WEC-1 7/7/11 1140	07-Jul-2011 1140	
149252-2	WEC-2 7/7/11 1550	07-Jul-2011 1550	
149252-3	HC-1 7/7/11 1240	07-Jul-2011 1240	
149252-4	HC-2 7/7/11 1515	07-Jul-2011 1515	
149252-5	HC-2 D 7/7/11 1517	07-Jul-2011 1517	
149252-6	TB-1 7/7/11 1415	07-Jul-2011 1415	
149252-7	TB-2 7/7/11 1445	07-Jul-2011 1445	
149252-8	Outfall 001 7/7/11 1400	07-Jul-2011 1400	

Qualifiers:

D	Result is from a secondary dilution factor
X	Spiking level is invalid due to the high concentration of analyte in the spiked sample

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 149252-1
Sample Identification: WEC-1 7/7/11 1140

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**79** Analyzed: 11-Jul-2011 1442 by 93	1	**mg/l** Batch: W36738	
Total Dissolved Solids SM 2540C	Prep: 14-Jul-2011 0818 by 292	**110** Analyzed: 15-Jul-2011 1632 by 292	10	**mg/l** Batch: W36763	
Calcium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**32** Analyzed: 09-Jul-2011 1313 by 270	0.1	**mg/l** Batch: S30426	
Magnesium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**3.1** Analyzed: 09-Jul-2011 1313 by 270	0.03	**mg/l** Batch: S30426	
Potassium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**2.5** Analyzed: 09-Jul-2011 1313 by 270	1	**mg/l** Batch: S30426	
Sodium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**3.5** Analyzed: 09-Jul-2011 1313 by 270	1	**mg/l** Batch: S30426	
Chloride EPA 300.0	Prep: 08-Jul-2011 1727 by 270	**3.2** Analyzed: 11-Jul-2011 1248 by 07	0.2	**mg/l** Batch: S30423	
Sulfate EPA 300.0	Prep: 08-Jul-2011 1727 by 270	**6.4** Analyzed: 11-Jul-2011 1248 by 07	0.2	**mg/l** Batch: S30423	

AIC No. 149252-2
Sample Identification: WEC-2 7/7/11 1550

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**110** Analyzed: 11-Jul-2011 1442 by 93	1	**mg/l** Batch: W36738	
Total Dissolved Solids SM 2540C	Prep: 14-Jul-2011 0818 by 292	**270** Analyzed: 15-Jul-2011 1632 by 292	10	**mg/l** Batch: W36763	
Calcium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**49** Analyzed: 09-Jul-2011 1315 by 270	0.1	**mg/l** Batch: S30426	
Magnesium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**2.6** Analyzed: 09-Jul-2011 1315 by 270	0.03	**mg/l** Batch: S30426	
Potassium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**3.8** Analyzed: 09-Jul-2011 1315 by 270	1	**mg/l** Batch: S30426	
Sodium EPA 200.7	Prep: 09-Jul-2011 1056 by 270	**13** Analyzed: 09-Jul-2011 1315 by 270	1	**mg/l** Batch: S30426	
Chloride EPA 300.0	Prep: 08-Jul-2011 1727 by 270	**22** Analyzed: 11-Jul-2011 1406 by 07	0.2	**mg/l** Batch: S30423	
Sulfate EPA 300.0	Prep: 08-Jul-2011 1727 by 270	**7.2** Analyzed: 11-Jul-2011 1406 by 07	0.2	**mg/l** Batch: S30423	

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219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 149252-3
Sample Identification: HC-1 7/7/11 1240

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**120**	1	**mg/l**	
SM 2320B		Analyzed: 11-Jul-2011 1442 by 93		Batch: W36738	
Total Dissolved Solids		**210**	10	**mg/l**	
SM 2540C	Prep: 14-Jul-2011 0818 by 292	Analyzed: 15-Jul-2011 1632 by 292		Batch: W36763	
Calcium		**51**	0.1	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1318 by 270		Batch: S30426	
Magnesium		**3.7**	0.03	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1318 by 270		Batch: S30426	
Potassium		**2.6**	1	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1318 by 270		Batch: S30426	
Sodium		**4.3**	1	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1318 by 270		Batch: S30426	
Chloride		**5.2**	0.2	**mg/l**	
EPA 300.0	Prep: 08-Jul-2011 1727 by 270	Analyzed: 11-Jul-2011 1446 by 07		Batch: S30423	
Sulfate		**11**	0.2	**mg/l**	
EPA 300.0	Prep: 08-Jul-2011 1727 by 270	Analyzed: 11-Jul-2011 1446 by 07		Batch: S30423	

AIC No. 149252-4
Sample Identification: HC-2 7/7/11 1515

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**88**	1	**mg/l**	
SM 2320B		Analyzed: 11-Jul-2011 1442 by 93		Batch: W36738	
Total Dissolved Solids		**630**	10	**mg/l**	
SM 2540C	Prep: 14-Jul-2011 0818 by 292	Analyzed: 15-Jul-2011 1632 by 292		Batch: W36763	
Calcium		**78**	0.1	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1321 by 270		Batch: S30426	
Magnesium		**4.5**	0.03	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1321 by 270		Batch: S30426	
Potassium		**13**	1	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1321 by 270		Batch: S30426	
Sodium		**62**	1	**mg/l**	
EPA 200.7	Prep: 09-Jul-2011 1056 by 270	Analyzed: 09-Jul-2011 1321 by 270		Batch: S30426	
Chloride		**150**	2	**mg/l**	D
EPA 300.0	Prep: 08-Jul-2011 1727 by 270	Analyzed: 11-Jul-2011 1209 by 07		Batch: S30423	Dil: 10
Sulfate		**27**	0.2	**mg/l**	
EPA 300.0	Prep: 08-Jul-2011 1727 by 270	Analyzed: 12-Jul-2011 1724 by 07		Batch: S30423	

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ANALYTICAL RESULTS

AIC No. 149252-5
Sample Identification: HC-2 D 7/7/11 1517

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**89** Analyzed: 11-Jul-2011 1442 by 93	1	**mg/l** Batch: W36738	
Total Dissolved Solids SM 2540C Prep: 14-Jul-2011 0818 by 292	**640** Analyzed: 15-Jul-2011 1632 by 292	10	**mg/l** Batch: W36763	
Calcium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**76** Analyzed: 09-Jul-2011 1324 by 270	0.1	**mg/l** Batch: S30426	
Magnesium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**4.5** Analyzed: 09-Jul-2011 1324 by 270	0.03	**mg/l** Batch: S30426	
Potassium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**13** Analyzed: 09-Jul-2011 1324 by 270	1	**mg/l** Batch: S30426	
Sodium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**61** Analyzed: 09-Jul-2011 1324 by 270	1	**mg/l** Batch: S30426	
Chloride EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**160** Analyzed: 29-Jul-2011 1100 by 270	2	**mg/l** Batch: S30423	D Dil: 10
Sulfate EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**29** Analyzed: 12-Jul-2011 1749 by 07	0.2	**mg/l** Batch: S30423	

AIC No. 149252-6
Sample Identification: TB-1 7/7/11 1415

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**130** Analyzed: 11-Jul-2011 1442 by 93	1	**mg/l** Batch: W36738	
Total Dissolved Solids SM 2540C Prep: 14-Jul-2011 0818 by 292	**230** Analyzed: 15-Jul-2011 1632 by 292	10	**mg/l** Batch: W36763	
Calcium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**56** Analyzed: 09-Jul-2011 1327 by 270	0.1	**mg/l** Batch: S30426	
Magnesium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**4.8** Analyzed: 09-Jul-2011 1327 by 270	0.03	**mg/l** Batch: S30426	
Potassium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**3.0** Analyzed: 09-Jul-2011 1327 by 270	1	**mg/l** Batch: S30426	
Sodium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**9.4** Analyzed: 09-Jul-2011 1327 by 270	1	**mg/l** Batch: S30426	
Chloride EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**19** Analyzed: 12-Jul-2011 1814 by 07	0.2	**mg/l** Batch: S30423	
Sulfate EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**15** Analyzed: 12-Jul-2011 1814 by 07	0.2	**mg/l** Batch: S30423	

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ANALYTICAL RESULTS

AIC No. 149252-7
Sample Identification: TB-2 7/7/11 1445

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**80** Analyzed: 11-Jul-2011 1442 by 93	1	**mg/l** Batch: W36738	
Total Dissolved Solids SM 2540C Prep: 14-Jul-2011 0818 by 292	**900** Analyzed: 15-Jul-2011 1632 by 292	10	**mg/l** Batch: W36763	
Calcium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**110** Analyzed: 10-Jul-2011 1226 by 270	1	**mg/l** Batch: S30426	D Dil: 10
Magnesium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**4.2** Analyzed: 09-Jul-2011 1331 by 270	0.03	**mg/l** Batch: S30426	
Potassium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**22** Analyzed: 09-Jul-2011 1331 by 270	1	**mg/l** Batch: S30426	
Sodium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**130** Analyzed: 10-Jul-2011 1226 by 270	10	**mg/l** Batch: S30426	D Dil: 10
Chloride EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**250** Analyzed: 12-Jul-2011 1839 by 07	2	**mg/l** Batch: S30423	D Dil: 10
Sulfate EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**40** Analyzed: 12-Jul-2011 1928 by 07	0.2	**mg/l** Batch: S30423	

AIC No. 149252-8
Sample Identification: Outfall 001 7/7/11 1400

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**68** Analyzed: 11-Jul-2011 1442 by 93	1	**mg/l** Batch: W36738	
Total Dissolved Solids SM 2540C Prep: 14-Jul-2011 0818 by 292	**1100** Analyzed: 15-Jul-2011 1632 by 292	10	**mg/l** Batch: W36763	
Calcium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**130** Analyzed: 10-Jul-2011 1229 by 270	1	**mg/l** Batch: S30426	D Dil: 10
Magnesium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**3.7** Analyzed: 09-Jul-2011 1334 by 270	0.03	**mg/l** Batch: S30426	
Potassium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**29** Analyzed: 09-Jul-2011 1334 by 270	1	**mg/l** Batch: S30426	
Sodium EPA 200.7 Prep: 09-Jul-2011 1056 by 270	**160** Analyzed: 10-Jul-2011 1229 by 270	10	**mg/l** Batch: S30426	D Dil: 10
Chloride EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**320** Analyzed: 12-Jul-2011 1903 by 07	2	**mg/l** Batch: S30423	D Dil: 10
Sulfate EPA 300.0 Prep: 08-Jul-2011 1727 by 270	**48** Analyzed: 12-Jul-2011 1953 by 07	0.2	**mg/l** Batch: S30423	

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DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Alkalinity as CaCO3	149117-7	3200 mg/l				11Jul11 1442 by 93		
Batch: W36738	Duplicate	3200 mg/l	0.927	20.0		11Jul11 1443 by 93		
Total Dissolved Solids	149252-1	110 mg/l			14Jul11 0818 by 292	15Jul11 1632 by 292		
Batch: W36763	Duplicate	110 mg/l	2.71	10.0	14Jul11 0820 by 292	15Jul11 1632 by 292		
Total Dissolved Solids	149245-2	260 mg/l			14Jul11 0818 by 292	15Jul11 1632 by 292		
Batch: W36763	Duplicate	280 mg/l	6.46	10.0	14Jul11 0820 by 292	15Jul11 1632 by 292		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	10 mg/l	99.0	85.0-115			S30426	09Jul11 1056 by 270	09Jul11 1246 by 270		
Magnesium	10 mg/l	102	85.0-115			S30426	09Jul11 1056 by 270	09Jul11 1246 by 270		
Potassium	10 mg/l	102	85.0-115			S30426	09Jul11 1056 by 270	09Jul11 1246 by 270		
Sodium	10 mg/l	102	85.0-115			S30426	09Jul11 1056 by 270	09Jul11 1246 by 270		
Chloride	20 mg/l	96.9	90.0-110			S30423	08Jul11 1727 by 270	11Jul11 1011 by 07		
Sulfate	20 mg/l	91.3	90.0-110			S30423	08Jul11 1727 by 270	11Jul11 1011 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	149125-2	10 mg/l	-		S30426	09Jul11 1056 by 270	09Jul11 1249 by 270		X
	149125-2	mg/l	-		S30426	09Jul11 1056 by 270	09Jul11 1252 by 270		X
	Relative Percent Difference:		-	-	S30426				X
Magnesium	149125-2	10 mg/l	87.2		S30426	09Jul11 1056 by 270	09Jul11 1249 by 270		
	149125-2	mg/l	88.2		S30426	09Jul11 1056 by 270	09Jul11 1252 by 270		
	Relative Percent Difference:		0.791		S30426				
Potassium	149125-2	10 mg/l	95.0		S30426	09Jul11 1056 by 270	09Jul11 1249 by 270		
	149125-2	mg/l	96.0		S30426	09Jul11 1056 by 270	09Jul11 1252 by 270		
	Relative Percent Difference:		0.784		S30426				
Sodium	149125-2	10 mg/l	-		S30426	09Jul11 1056 by 270	09Jul11 1249 by 270		X
	149125-2	mg/l	-		S30426	09Jul11 1056 by 270	09Jul11 1252 by 270		X
	Relative Percent Difference:		-	-	S30426				X
Chloride	149252-4	20 mg/l	100	80.0-120	S30423	08Jul11 1727 by 270	11Jul11 1050 by 07		
	149252-4	20 mg/l	109	80.0-120	S30423	08Jul11 1727 by 270	11Jul11 1129 by 07		
	Relative Percent Difference:		4.81	10.0	S30423				
Sulfate	149252-4	20 mg/l	97.8	80.0-120	S30423	08Jul11 1727 by 270	11Jul11 1050 by 07		
	149252-4	20 mg/l	106	80.0-120	S30423	08Jul11 1727 by 270	11Jul11 1129 by 07		
	Relative Percent Difference:		7.28	10.0	S30423				

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Bryant, AR 72022

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Alkalinity as CaCO3	< 1 mg/l	1	1	W36738-1		11Jul11 1443 by 93	
Total Dissolved Solids	< 10 mg/l	10	10	W36763-1	14Jul11 0820 by 292	15Jul11 1632 by 292	
Calcium	< 0.1 mg/l	0.1	0.1	S30426-1	09Jul11 1056 by 270	09Jul11 1243 by 270	
Magnesium	< 0.03 mg/l	0.03	0.03	S30426-1	09Jul11 1056 by 270	09Jul11 1243 by 270	
Potassium	< 1 mg/l	1	1	S30426-1	09Jul11 1056 by 270	09Jul11 1243 by 270	
Sodium	< 1 mg/l	1	1	S30426-1	09Jul11 1056 by 270	09Jul11 1243 by 270	
Chloride	< 0.2 mg/l	0.2	0.2	S30423-1	08Jul11 1727 by 270	11Jul11 0931 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S30423-1	08Jul11 1727 by 270	11Jul11 0931 by 07	

149252

GBM^c & Associates
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

Client/BILLING Information

Client: Greg Phillips
Company: GBMc & Associates
Address: 219 Brown Lane
Bryant, AR 72022
Phone No.: (501) 847-7077
Fax No.: (501) 847-7943

SPECIAL INSTRUCTIONS/PRECAUTIONS: Email results to Greg phillips @ gphillips@gbmcassoc.com

Project Name / Number: Huntsville

Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Parameters for Analysis/Methods									
							Cl, SO4, TDS Alk, T	CA, MG, K NA								
① WEC-1		7/7/11	1140	W	2	G	✓	✓								
② WEC-2			1550		2		✓	✓								
③ HC-1			1240		2		✓	✓								
④ HC-2			1515		2		✓	✓								
⑤ HC-20			1517		2		✓	✓								
⑥ TB-1			1415		2		✓	✓								
⑦ TB-2			1445		2		✓	✓								
⑧ outfall 001			1400		2		✓	✓								
Preservative (Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)							I	I, N								

Sampler(s): RHW/GLP
Shipment Method: GBMc Delivery
Turnaround Time Required: Normal

COC Completed by: Date: 7/8/11 Time: 1610
COC Checked by: Date: 7/8/11 Time: 1615
Relinquished by: Date: 7/8/11 Time: 1635
Received by: ______ Date:______ Time:______
Relinquished by:______ Date:______ Time:______
Received in lab by: Date: 7-8-11 Time: 1635

LABORATORY USE ONLY: Samples Received On Ice? [✓ YES] or NO
Sample Temperature: 2°C

V1.2 03/31/11

AMERICAN
INTERPLEX
CORPORATION
LABORATORIES

September 7, 2011
Control No. 150522

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on August 25, 2011. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

Steve Bradford

Steve Bradford
Deputy Laboratory Director

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:
Eight (8) water sample(s) received on August 25, 2011

Receipt Details:
A Chain of Custody was provided. The samples were delivered in two (2) ice chests.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
150522-1	001 08/24/2011 0930	24-Aug-2011 0930	
150522-2	TB-1 08/24/2011 0940	24-Aug-2011 0940	
150522-3	TB-2 08/24/2011 1030	24-Aug-2011 1030	
150522-4	TB-2D 08/24/2011 1032	24-Aug-2011 1032	
150522-5	HC-2 08/24/2011 1050	24-Aug-2011 1050	
150522-6	HC-1 08/24/2011 1115	24-Aug-2011 1115	
150522-7	WEC-1 08/24/2011 1200	24-Aug-2011 1200	
150522-8	WEC-2 08/24/2011 1315	24-Aug-2011 1315	

Qualifiers:

D	Result is from a secondary dilution factor
X	Spiking level is invalid due to the high concentration of analyte in the spiked sample

References:
"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 150522-1
Sample Identification: 001 08/24/2011 0930

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**110** Analyzed: 30-Aug-2011 1014 by 93	1	**mg/l** Batch: W37245	
Total Dissolved Solids SM 2540C	Prep: 26-Aug-2011 1432 by 290	**640** Analyzed: 29-Aug-2011 1326 by 290	10	**mg/l** Batch: W37221	
Calcium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**75** Analyzed: 31-Aug-2011 1052 by 270	0.1	**mg/l** Batch: S30746	
Magnesium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**3.6** Analyzed: 31-Aug-2011 1052 by 270	0.03	**mg/l** Batch: S30746	
Potassium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**27** Analyzed: 31-Aug-2011 1052 by 270	1	**mg/l** Batch: S30746	
Sodium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**120** Analyzed: 31-Aug-2011 1448 by 270	10	**mg/l** Batch: S30746	D Dil: 10
Chloride EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**200** Analyzed: 25-Aug-2011 1918 by 07	2	**mg/l** Batch: S30745	D Dil: 10
Sulfate EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**84** Analyzed: 25-Aug-2011 1918 by 07	2	**mg/l** Batch: S30745	D Dil: 10

AIC No. 150522-2
Sample Identification: TB-1 08/24/2011 0940

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**140** Analyzed: 30-Aug-2011 1014 by 93	1	**mg/l** Batch: W37245	
Total Dissolved Solids SM 2540C	Prep: 26-Aug-2011 1432 by 290	**230** Analyzed: 29-Aug-2011 1326 by 290	10	**mg/l** Batch: W37221	
Calcium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**59** Analyzed: 31-Aug-2011 1056 by 270	0.1	**mg/l** Batch: S30746	
Magnesium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**5.6** Analyzed: 31-Aug-2011 1056 by 270	0.03	**mg/l** Batch: S30746	
Potassium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**3.0** Analyzed: 31-Aug-2011 1056 by 270	1	**mg/l** Batch: S30746	
Sodium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**10** Analyzed: 31-Aug-2011 1056 by 270	1	**mg/l** Batch: S30746	
Chloride EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**22** Analyzed: 25-Aug-2011 2008 by 07	0.2	**mg/l** Batch: S30745	
Sulfate EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**17** Analyzed: 25-Aug-2011 2008 by 07	0.2	**mg/l** Batch: S30745	

AIC No. 150522-3
Sample Identification: TB-2 08/24/2011 1030

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**120** Analyzed: 30-Aug-2011 1014 by 93	1	**mg/l** Batch: W37245	

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Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 150522-3 (Continued)
Sample Identification: TB-2 08/24/2011 1030

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**530**	10	**mg/l**	
SM 2540C Prep: 26-Aug-2011 1432 by 290	Analyzed: 29-Aug-2011 1326 by 290		Batch: W37221	
Calcium	**70**	0.1	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1100 by 270		Batch: S30746	
Magnesium	**4.2**	0.03	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1100 by 270		Batch: S30746	
Potassium	**19**	1	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1100 by 270		Batch: S30746	
Sodium	**76**	1	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1100 by 270		Batch: S30746	
Chloride	**150**	2	**mg/l**	D
EPA 300.0 Prep: 25-Aug-2011 1424 by 07	Analyzed: 25-Aug-2011 2032 by 07		Batch: S30745	Dil: 10
Sulfate	**62**	2	**mg/l**	D
EPA 300.0 Prep: 25-Aug-2011 1424 by 07	Analyzed: 25-Aug-2011 2032 by 07		Batch: S30745	Dil: 10

AIC No. 150522-4
Sample Identification: TB-2D 08/24/2011 1032

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3	**120**	1	**mg/l**	
SM 2320B	Analyzed: 30-Aug-2011 1014 by 93		Batch: W37245	
Total Dissolved Solids	**470**	10	**mg/l**	
SM 2540C Prep: 26-Aug-2011 1432 by 290	Analyzed: 29-Aug-2011 1326 by 290		Batch: W37221	
Calcium	**70**	0.1	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1104 by 270		Batch: S30746	
Magnesium	**4.2**	0.03	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1104 by 270		Batch: S30746	
Potassium	**19**	1	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1104 by 270		Batch: S30746	
Sodium	**76**	1	**mg/l**	
EPA 200.7 Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1104 by 270		Batch: S30746	
Chloride	**150**	2	**mg/l**	D
EPA 300.0 Prep: 25-Aug-2011 1424 by 07	Analyzed: 25-Aug-2011 2212 by 07		Batch: S30745	Dil: 10
Sulfate	**62**	2	**mg/l**	D
EPA 300.0 Prep: 25-Aug-2011 1424 by 07	Analyzed: 25-Aug-2011 2212 by 07		Batch: S30745	Dil: 10

AIC No. 150522-5
Sample Identification: HC-2 08/24/2011 1050

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3	**100**	1	**mg/l**	
SM 2320B	Analyzed: 30-Aug-2011 1014 by 93		Batch: W37245	

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ANALYTICAL RESULTS

AIC No. 150522-5 (Continued)
Sample Identification: HC-2 08/24/2011 1050

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C	Prep: 26-Aug-2011 1432 by 290	**340** Analyzed: 29-Aug-2011 1326 by 290	10	**mg/l** Batch: W37221	
Calcium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**60** Analyzed: 31-Aug-2011 1108 by 270	0.1	**mg/l** Batch: S30746	
Magnesium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**4.0** Analyzed: 31-Aug-2011 1108 by 270	0.03	**mg/l** Batch: S30746	
Potassium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**10** Analyzed: 31-Aug-2011 1108 by 270	1	**mg/l** Batch: S30746	
Sodium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**41** Analyzed: 31-Aug-2011 1108 by 270	1	**mg/l** Batch: S30746	
Chloride EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**83** Analyzed: 25-Aug-2011 2301 by 07	2	**mg/l** Batch: S30745	D Dil: 10
Sulfate EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**41** Analyzed: 25-Aug-2011 2326 by 07	0.2	**mg/l** Batch: S30745	

AIC No. 150522-6
Sample Identification: HC-1 08/24/2011 1115

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**94** Analyzed: 30-Aug-2011 1014 by 93	1	**mg/l** Batch: W37245	
Total Dissolved Solids SM 2540C	Prep: 26-Aug-2011 1432 by 290	**120** Analyzed: 29-Aug-2011 1326 by 290	10	**mg/l** Batch: W37221	
Calcium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**38** Analyzed: 31-Aug-2011 1112 by 270	0.1	**mg/l** Batch: S30746	
Magnesium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**3.2** Analyzed: 31-Aug-2011 1112 by 270	0.03	**mg/l** Batch: S30746	
Potassium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**2.5** Analyzed: 31-Aug-2011 1112 by 270	1	**mg/l** Batch: S30746	
Sodium EPA 200.7	Prep: 25-Aug-2011 1351 by 271	**4.4** Analyzed: 31-Aug-2011 1112 by 270	1	**mg/l** Batch: S30746	
Chloride EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**7.4** Analyzed: 25-Aug-2011 2351 by 07	0.2	**mg/l** Batch: S30745	
Sulfate EPA 300.0	Prep: 25-Aug-2011 1424 by 07	**13** Analyzed: 25-Aug-2011 2351 by 07	0.2	**mg/l** Batch: S30745	

AIC No. 150522-7
Sample Identification: WEC-1 08/24/2011 1200

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**52** Analyzed: 30-Aug-2011 1014 by 93	1	**mg/l** Batch: W37245	

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ANALYTICAL RESULTS

AIC No. 150522-7 (Continued)
Sample Identification: WEC-1 08/24/2011 1200

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**100**	10	**mg/l**	
SM 2540C	Prep: 26-Aug-2011 1432 by 290	Analyzed: 29-Aug-2011 1326 by 290		Batch: W37221	
Calcium		**20**	0.1	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1115 by 270		Batch: S30746	
Magnesium		**2.5**	0.03	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1115 by 270		Batch: S30746	
Potassium		**2.4**	1	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1115 by 270		Batch: S30746	
Sodium		**2.9**	1	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1115 by 270		Batch: S30746	
Chloride		**3.7**	0.2	**mg/l**	
EPA 300.0	Prep: 25-Aug-2011 1424 by 07	Analyzed: 26-Aug-2011 0016 by 07		Batch: S30745	
Sulfate		**7.2**	0.2	**mg/l**	
EPA 300.0	Prep: 25-Aug-2011 1424 by 07	Analyzed: 26-Aug-2011 0016 by 07		Batch: S30745	

AIC No. 150522-8
Sample Identification: WEC-2 08/24/2011 1315

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**72**	1	**mg/l**	
SM 2320B		Analyzed: 30-Aug-2011 1014 by 93		Batch: W37245	
Total Dissolved Solids		**150**	10	**mg/l**	
SM 2540C	Prep: 26-Aug-2011 1432 by 290	Analyzed: 29-Aug-2011 1326 by 290		Batch: W37221	
Calcium		**31**	0.1	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1130 by 270		Batch: S30746	
Magnesium		**2.5**	0.03	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1130 by 270		Batch: S30746	
Potassium		**3.0**	1	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1130 by 270		Batch: S30746	
Sodium		**7.5**	1	**mg/l**	
EPA 200.7	Prep: 25-Aug-2011 1351 by 271	Analyzed: 31-Aug-2011 1130 by 270		Batch: S30746	
Chloride		**14**	0.2	**mg/l**	
EPA 300.0	Prep: 25-Aug-2011 1424 by 07	Analyzed: 26-Aug-2011 0041 by 07		Batch: S30745	
Sulfate		**10**	0.2	**mg/l**	
EPA 300.0	Prep: 25-Aug-2011 1424 by 07	Analyzed: 26-Aug-2011 0041 by 07		Batch: S30745	

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Bryant, AR 72022

DUPLICATE RESULTS

Analyte		AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids		150504-1	270 mg/l			26Aug11 1432 by 290	29Aug11 1326 by 290		
	Batch: W37221	Duplicate	280 mg/l	4.31	10.0	26Aug11 1432 by 290	29Aug11 1326 by 290		
Total Dissolved Solids		150522-1	640 mg/l			26Aug11 1432 by 290	29Aug11 1326 by 290		
	Batch: W37221	Duplicate	630 mg/l	1.82	10.0	26Aug11 1432 by 290	29Aug11 1326 by 290		
Alkalinity as CaCO3		150522-1	110 mg/l				30Aug11 1014 by 93		
	Batch: W37245	Duplicate	110 mg/l	0.525	20.0		30Aug11 1014 by 93		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	10 mg/l	104	85.0-115			S30746	25Aug11 1351 by 271	31Aug11 0957 by 270		
Magnesium	10 mg/l	103	85.0-115			S30746	25Aug11 1351 by 271	31Aug11 0957 by 270		
Potassium	10 mg/l	103	85.0-115			S30746	25Aug11 1351 by 271	31Aug11 0957 by 270		
Sodium	10 mg/l	105	85.0-115			S30746	25Aug11 1351 by 271	31Aug11 0957 by 270		
Chloride	20 mg/l	97.7	90.0-110			S30745	25Aug11 1027 by 07	25Aug11 1445 by 07		
Sulfate	20 mg/l	94.7	90.0-110			S30745	25Aug11 1027 by 07	25Aug11 1445 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	150520-1	10 mg/l	-	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1000 by 270		X
	150520-1	10 mg/l	-	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1003 by 270		X
	Relative Percent Difference:		3.23	20.0	S30746				
Magnesium	150520-1	10 mg/l	93.5	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1000 by 270		
	150520-1	10 mg/l	101	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1003 by 270		
	Relative Percent Difference:		2.68	20.0	S30746				
Potassium	150520-1	10 mg/l	100	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1000 by 270		
	150520-1	10 mg/l	103	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1003 by 270		
	Relative Percent Difference:		1.50	20.0	S30746				
Sodium	150520-1	10 mg/l	94.1	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1000 by 270		
	150520-1	10 mg/l	100	75.0-125	S30746	25Aug11 1351 by 271	31Aug11 1003 by 270		
	Relative Percent Difference:		1.52	20.0	S30746				
Sulfate	150499-1	20 mg/l	94.8	80.0-120	S30745	25Aug11 1027 by 07	25Aug11 1510 by 07		
	150499-1	20 mg/l	95.1	80.0-120	S30745	25Aug11 1027 by 07	25Aug11 1534 by 07		
	Relative Percent Difference:		0.257	10.0	S30745				

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219 Brown Lane
Bryant, AR 72022

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Alkalinity as CaCO3	< 1 mg/l	1	1	W37245-1		30Aug11 1014 by 93	
Total Dissolved Solids	< 10 mg/l	10	10	W37221-1	26Aug11 1432 by 290	29Aug11 1326 by 290	
Calcium	< 0.1 mg/l	0.1	0.1	S30746-1	25Aug11 1351 by 271	31Aug11 0954 by 270	
Magnesium	< 0.03 mg/l	0.03	0.03	S30746-1	25Aug11 1351 by 271	31Aug11 0954 by 270	
Potassium	< 1 mg/l	1	1	S30746-1	25Aug11 1351 by 271	31Aug11 0954 by 270	
Sodium	< 1 mg/l	1	1	S30746-1	25Aug11 1351 by 271	31Aug11 0954 by 270	
Chloride	< 0.2 mg/l	0.2	0.2	S30745-1	25Aug11 1027 by 07	25Aug11 1420 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S30745-1	25Aug11 1027 by 07	25Aug11 1420 by 07	

GBMc

219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

150522

CLIENT INFORMATION		BILLING INFORMATION		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Company:	GBMc & Associates	Bill To:	GBMc & Associates	
Project Name/No.:		Company:		
Send Report To:	Greg Phillips	Address:	219 Brown Lane	
Address:	219 Brown Lane		Bryant, AR 72022	Parameters for Analysis/Methods
	Bryant, AR 72022	Phone No.:	(501) 847-7077	
Phone/Fax No.:	(501) 847-7077	Fax No.:	(501) 847-7943	

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Cl, SO_4, TDS, Alk, T	Ca, Mg, K, Na								
1	001		08/24/2011	0930	W	2	Grab	1	1								
2	TB-1		08/24/2011	0940	W	2	Grab	\	\								
3	TB-2		08/24/2011	1030	W	2	Grab	\	\								
4	TB-2D		08/24/2011	1032	W	2	Grab	\	\								
5	HC-2		08/24/2011	1050	W	2	Grab	\	\								
6	HC-1		08/24/2011	1115	W	2	Grab	\	\								
7	WEC-1		08/24/2011	1200	W	2	Grab	\	\								
8	WEC-2		08/24/2011	1315	W	2	Grab	\	\								
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I	I, N								

Sampler(s): GLP / GDS

Shipment Method: GBMc Delivery

Turnaround Time Required: NORMAL

COC Completed by: Geoff Smith Date: 08/25/2011 Time: 0913

COC Checked by: Date: 8/25/11 Time: 0915

Relinquished by: Geoff Smith Date: 08/25/2011 Time: 1011

Received by: ________ Date: ________ Time: ________

Relinquished by: ________ Date: ________ Time: ________

Received in lab by: Date: 8-25-11 Time: 1011

LABORATORY USE ONLY: **Samples Received On Ice?:** [✓ **YES**] **or** **NO** **Sample Temperature:** 2°c

V1.2 08/25/11

AMERICAN INTERPLEX CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on September 15, 2011. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on September 15, 2011

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
151099-1	WEC-2 9-14-11 1032	14-Sep-2011 1032	
151099-2	WEC-2 D 9-14-11 1033	14-Sep-2011 1033	
151099-3	WEC-1 9-14-11 1140	14-Sep-2011 1140	
151099-4	HC-2 9/14/11 1240	14-Sep-2011 1240	
151099-5	HC-1 9-14-11 1305	14-Sep-2011 1305	
151099-6	TB-2 9-14-11 1330	14-Sep-2011 1330	
151099-7	TB-1 9-14-11 1345	14-Sep-2011 1345	
151099-8	001 9-14-11 1400	14-Sep-2011 1400	

Qualifiers:

D	Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 151099-1
Sample Identification: WEC-2 9-14-11 1032

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**230**	10	**mg/l**	
SM 2540C Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride	**42**	0.2	**mg/l**	
EPA 300.0 Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 2116 by 07		Batch: S30880	

AIC No. 151099-2
Sample Identification: WEC-2 D 9-14-11 1033

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**240**	10	**mg/l**	
SM 2540C Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride	**43**	0.2	**mg/l**	
EPA 300.0 Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 2142 by 07		Batch: S30880	

AIC No. 151099-3
Sample Identification: WEC-1 9-14-11 1140

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**100**	10	**mg/l**	
SM 2540C Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride	**3.6**	0.2	**mg/l**	
EPA 300.0 Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 2208 by 07		Batch: S30880	

AIC No. 151099-4
Sample Identification: HC-2 9/14/11 1240

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**610**	10	**mg/l**	
SM 2540C Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride	**180**	2	**mg/l**	D
EPA 300.0 Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 1907 by 07		Batch: S30880	Dil: 10

AIC No. 151099-5
Sample Identification: HC-1 9-14-11 1305

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**210**	10	**mg/l**	
SM 2540C Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride	**9.5**	0.2	**mg/l**	
EPA 300.0 Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 2300 by 07		Batch: S30880	

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ANALYTICAL RESULTS

AIC No. 151099-6
Sample Identification: TB-2 9-14-11 1330

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**680**	10	**mg/l**	
SM 2540C	Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride		**200**	2	**mg/l**	D
EPA 300.0	Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 1959 by 07		Batch: S30880	Dil: 10

AIC No. 151099-7
Sample Identification: TB-1 9-14-11 1345

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**220**	10	**mg/l**	
SM 2540C	Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride		**27**	0.2	**mg/l**	
EPA 300.0	Prep: 15-Sep-2011 1115 by 07	Analyzed: 16-Sep-2011 0109 by 07		Batch: S30880	

AIC No. 151099-8
Sample Identification: 001 9-14-11 1400

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**730**	10	**mg/l**	
SM 2540C	Prep: 19-Sep-2011 1459 by 290	Analyzed: 20-Sep-2011 1314 by 290		Batch: W37449	
Chloride		**230**	2	**mg/l**	D
EPA 300.0	Prep: 15-Sep-2011 1115 by 07	Analyzed: 15-Sep-2011 2050 by 07		Batch: S30880	Dil: 10

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DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	151006-1	100 mg/l			19Sep11 1459 by 290	20Sep11 1314 by 290		
Batch: W37449	Duplicate	92 mg/l	8.88	10.0	19Sep11 1500 by 290	20Sep11 1314 by 290		
Total Dissolved Solids	151070-1	1000 mg/l			19Sep11 1459 by 290	20Sep11 1314 by 290		
Batch: W37449	Duplicate	1000 mg/l	1.45	10.0	19Sep11 1500 by 290	20Sep11 1314 by 290		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	104	90.0-110			S30880	15Sep11 1116 by 07	15Sep11 1449 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	151087-1	20 mg/l	102	80.0-120	S30880	15Sep11 1116 by 07	15Sep11 1514 by 07		
	151087-1	20 mg/l	103	80.0-120	S30880	15Sep11 1116 by 07	15Sep11 1540 by 07		
	Relative Percent Difference:		0.0488	10.0	S30880				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W37449-1	19Sep11 1500 by 290	20Sep11 1314 by 290	
Chloride	< 0.2 mg/l	0.2	0.2	S30880-1	15Sep11 1116 by 07	15Sep11 1423 by 07	

GBM^c & Associates
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

151099

Client/BILLING Information	
Client:	
Company:	GBMC & Associates
Address:	219 Brown Lane
	Bryant, AR 72022
Phone No.:	(501) 847-7077
Fax No.:	(501) 847-7943

SPECIAL INSTRUCTIONS/PRECAUTIONS: email results to Greg phillips @ gphillips@gbmcassoc.com

Project Name / Number:

Parameters for Analysis/Methods

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Chloride TDS
1	WEC-2	War Eagle creek 2	9/14/11	1032	W	1	G	X
2	WEC-2 D	War Eagle creek 2 D		1033		1	G	X
3	WEC-1	War Eagle Creek 1		1140		1	G	X
4	HC-2	Holman Creek 2		1240		1	G	X
5	HC-1	Holman Creek 1		1305		1	G	X
6	TB-2	Town Branch 2		1330		1	G	X
7	TB-1	Town Branch 1		1345		1	G	X
8	001	outfall 001		1400		1	G	X
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I

Sampler(s): RHW / GDS

Shipment Method: GBMc Delivery

Turnaround Time Required: Normal

COC Completed by: Date: 9/15/11 Time: 0810

COC Checked by: GD Smith Date: 09/15/2011 Time: 0820

Relinquished by: GD Smith Date: 09/15/2011 Time: 0925

Received by: Date: 9-15-11 Time: 0925

Relinquished by:____ Date:____ Time:____

Received in lab by:____ Date:____ Time:____

LABORATORY USE ONLY: Samples Received On Ice? [✓ YES] or NO Sample Temperature: 2°C

V1.2 03/31/11

AMERICAN INTERPLEX CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on October 14, 2011. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

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ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
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Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on October 14, 2011

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
151850-1	TB-1 10/12/11 1805	12-Oct-2011 1805	
151850-2	TB-2 10/12/11 1745	12-Oct-2011 1745	
151850-3	HC-1 10/12/11 1710	12-Oct-2011 1710	
151850-4	HC-2 10/12/11 1730	12-Oct-2011 1730	
151850-5	WEC-1 10/13/11 1625	13-Oct-2011 1625	
151850-6	WEC-2 10/13/11 1250	13-Oct-2011 1250	
151850-7	WEC-1D 10/13/11 1627	13-Oct-2011 1627	
151850-8	001 10/12/11 1755	12-Oct-2011 1755	

Qualifiers:

D Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

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ANALYTICAL RESULTS

AIC No. 151850-1
Sample Identification: TB-1 10/12/11 1805

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**110** Analyzed: 19-Oct-2011 0857 by 93	1	**mg/l** Batch: W37725	
Total Dissolved Solids SM 2540C Prep: 18-Oct-2011 1501 by 290	**180** Analyzed: 20-Oct-2011 1450 by 290	10	**mg/l** Batch: W37719	
Calcium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**45** Analyzed: 20-Oct-2011 1522 by 297	0.1	**mg/l** Batch: S31066	
Magnesium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**4.5** Analyzed: 20-Oct-2011 1522 by 297	0.03	**mg/l** Batch: S31066	
Potassium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**2.8** Analyzed: 20-Oct-2011 1522 by 297	1	**mg/l** Batch: S31066	
Sodium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**9.4** Analyzed: 20-Oct-2011 1522 by 297	1	**mg/l** Batch: S31066	
Chloride EPA 300.0 Prep: 14-Oct-2011 1652 by 07	**18** Analyzed: 15-Oct-2011 1150 by 07	0.2	**mg/l** Batch: S31065	
Sulfate EPA 300.0 Prep: 14-Oct-2011 1652 by 07	**14** Analyzed: 15-Oct-2011 1150 by 07	0.2	**mg/l** Batch: S31065	

AIC No. 151850-2
Sample Identification: TB-2 10/12/11 1745

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**130** Analyzed: 19-Oct-2011 0857 by 93	1	**mg/l** Batch: W37725	
Total Dissolved Solids SM 2540C Prep: 18-Oct-2011 1501 by 290	**620** Analyzed: 20-Oct-2011 1450 by 290	10	**mg/l** Batch: W37719	
Calcium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**64** Analyzed: 20-Oct-2011 1526 by 297	0.1	**mg/l** Batch: S31066	
Magnesium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**3.6** Analyzed: 20-Oct-2011 1526 by 297	0.03	**mg/l** Batch: S31066	
Potassium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**17** Analyzed: 20-Oct-2011 1526 by 297	1	**mg/l** Batch: S31066	
Sodium EPA 200.7 Prep: 17-Oct-2011 0828 by 271	**79** Analyzed: 20-Oct-2011 1526 by 297	1	**mg/l** Batch: S31066	
Chloride EPA 300.0 Prep: 14-Oct-2011 1652 by 07	**130** Analyzed: 17-Oct-2011 2240 by 07	2	**mg/l** Batch: S31065	D Dil: 10
Sulfate EPA 300.0 Prep: 14-Oct-2011 1652 by 07	**50** Analyzed: 15-Oct-2011 1216 by 07	0.2	**mg/l** Batch: S31065	

AIC No. 151850-3
Sample Identification: HC-1 10/12/11 1710

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**120** Analyzed: 19-Oct-2011 0857 by 93	1	**mg/l** Batch: W37725	

ANALYTICAL RESULTS

AIC No. 151850-3 (Continued)
Sample Identification: HC-1 10/12/11 1710

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**270**	10	**mg/l**	
SM 2540C	Prep: 18-Oct-2011 1501 by 290	Analyzed: 20-Oct-2011 1450 by 290		Batch: W37719	
Calcium		**50**	0.1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1530 by 297		Batch: S31066	
Magnesium		**4.0**	0.03	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1530 by 297		Batch: S31066	
Potassium		**2.8**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1530 by 297		Batch: S31066	
Sodium		**5.0**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1530 by 297		Batch: S31066	
Chloride		**8.8**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1242 by 07		Batch: S31065	
Sulfate		**16**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1242 by 07		Batch: S31065	

AIC No. 151850-4
Sample Identification: HC-2 10/12/11 1730

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**120**	1	**mg/l**	
SM 2320B		Analyzed: 19-Oct-2011 0857 by 93		Batch: W37725	
Total Dissolved Solids		**620**	10	**mg/l**	
SM 2540C	Prep: 18-Oct-2011 1501 by 290	Analyzed: 20-Oct-2011 1450 by 290		Batch: W37719	
Calcium		**55**	0.1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1555 by 297		Batch: S31066	
Magnesium		**3.6**	0.03	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1555 by 297		Batch: S31066	
Potassium		**12**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1555 by 297		Batch: S31066	
Sodium		**50**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1555 by 297		Batch: S31066	
Chloride		**87**	2	**mg/l**	D
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 17-Oct-2011 2306 by 07		Batch: S31065	Dil: 10
Sulfate		**44**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1308 by 07		Batch: S31065	

AIC No. 151850-5
Sample Identification: WEC-1 10/13/11 1625

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**73**	1	**mg/l**	
SM 2320B		Analyzed: 19-Oct-2011 0857 by 93		Batch: W37725	

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Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 151850-5 (Continued)
Sample Identification: WEC-1 10/13/11 1625

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**270**	10	**mg/l**	
SM 2540C Prep: 18-Oct-2011 1501 by 290	Analyzed: 20-Oct-2011 1450 by 290		Batch: W37719	
Calcium	**26**	0.1	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1559 by 297		Batch: S31066	
Magnesium	**2.9**	0.03	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1559 by 297		Batch: S31066	
Potassium	**2.1**	1	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1559 by 297		Batch: S31066	
Sodium	**3.2**	1	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1559 by 297		Batch: S31066	
Chloride	**4.6**	0.2	**mg/l**	
EPA 300.0 Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1124 by 07		Batch: S31065	
Sulfate	**9.4**	0.2	**mg/l**	
EPA 300.0 Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1124 by 07		Batch: S31065	

AIC No. 151850-6
Sample Identification: WEC-2 10/13/11 1250

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3	**100**	1	**mg/l**	
SM 2320B	Analyzed: 19-Oct-2011 0857 by 93		Batch: W37725	
Total Dissolved Solids	**230**	10	**mg/l**	
SM 2540C Prep: 18-Oct-2011 1501 by 290	Analyzed: 20-Oct-2011 1450 by 290		Batch: W37719	
Calcium	**46**	0.1	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1603 by 297		Batch: S31066	
Magnesium	**2.9**	0.03	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1603 by 297		Batch: S31066	
Potassium	**4.1**	1	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1603 by 297		Batch: S31066	
Sodium	**16**	1	**mg/l**	
EPA 200.7 Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1603 by 297		Batch: S31066	
Chloride	**35**	0.2	**mg/l**	
EPA 300.0 Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1333 by 07		Batch: S31065	
Sulfate	**19**	0.2	**mg/l**	
EPA 300.0 Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1333 by 07		Batch: S31065	

AIC No. 151850-7
Sample Identification: WEC-1D 10/13/11 1627

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3	**72**	1	**mg/l**	
SM 2320B	Analyzed: 19-Oct-2011 0857 by 93		Batch: W37725	

GBMc & Associates, Inc.
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Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 151850-7 (Continued)
Sample Identification: WEC-1D 10/13/11 1627

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**100**	10	**mg/l**	
SM 2540C	Prep: 18-Oct-2011 1501 by 290	Analyzed: 20-Oct-2011 1450 by 290		Batch: W37719	
Calcium		**27**	0.1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1607 by 297		Batch: S31066	
Magnesium		**3.0**	0.03	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1607 by 297		Batch: S31066	
Potassium		**2.2**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1607 by 297		Batch: S31066	
Sodium		**3.3**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1607 by 297		Batch: S31066	
Chloride		**4.6**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1451 by 07		Batch: S31065	
Sulfate		**9.4**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1451 by 07		Batch: S31065	

AIC No. 151850-8
Sample Identification: 001 10/12/11 1755

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**130**	1	**mg/l**	
SM 2320B		Analyzed: 19-Oct-2011 0857 by 93		Batch: W37725	
Total Dissolved Solids		**710**	10	**mg/l**	
SM 2540C	Prep: 18-Oct-2011 1501 by 290	Analyzed: 20-Oct-2011 1450 by 290		Batch: W37719	
Calcium		**73**	0.1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1610 by 297		Batch: S31066	
Magnesium		**2.8**	0.03	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1610 by 297		Batch: S31066	
Potassium		**26**	1	**mg/l**	
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 20-Oct-2011 1610 by 297		Batch: S31066	
Sodium		**150**	10	**mg/l**	D
EPA 200.7	Prep: 17-Oct-2011 0828 by 271	Analyzed: 21-Oct-2011 1106 by 297		Batch: S31066	Dil: 10
Chloride		**22**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1517 by 07		Batch: S31065	
Sulfate		**7.5**	0.2	**mg/l**	
EPA 300.0	Prep: 14-Oct-2011 1652 by 07	Analyzed: 15-Oct-2011 1517 by 07		Batch: S31065	

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DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	151850-1	180 mg/l			18Oct11 1501 by 290	20Oct11 1450 by 290		
Batch: W37719	Duplicate	170 mg/l	6.27	10.0	18Oct11 1502 by 290	20Oct11 1450 by 290		
Total Dissolved Solids	151850-2	620 mg/l			18Oct11 1501 by 290	20Oct11 1450 by 290		
Batch: W37719	Duplicate	660 mg/l	6.09	10.0	18Oct11 1502 by 290	20Oct11 1450 by 290		
Alkalinity as CaCO3	151922-4	3300 mg/l				19Oct11 0857 by 93		
Batch: W37725	Duplicate	3200 mg/l	1.23	20.0		19Oct11 0859 by 93		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	10 mg/l	105	85.0-115			S31066	17Oct11 0828 by 271	20Oct11 1508 by 297		
Magnesium	10 mg/l	103	85.0-115			S31066	17Oct11 0828 by 271	20Oct11 1508 by 297		
Potassium	10 mg/l	104	85.0-115			S31066	17Oct11 0828 by 271	20Oct11 1508 by 297		
Sodium	10 mg/l	106	85.0-115			S31066	17Oct11 0828 by 271	20Oct11 1508 by 297		
Chloride	20 mg/l	101	90.0-110			S31065	14Oct11 1653 by 07	15Oct11 1007 by 07		
Sulfate	20 mg/l	101	90.0-110			S31065	14Oct11 1653 by 07	15Oct11 1007 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	151851-1	10 mg/l	106	75.0-125	S31066	17Oct11 0828 by 271	20Oct11 1511 by 297		
	151851-1	10 mg/l	107	75.0-125	S31066	17Oct11 0828 by 271	20Oct11 1514 by 297		
	Relative Percent Difference:		0.538	20.0	S31066				
Magnesium	151851-1	10 mg/l	75.6	75.0-125	S31066	17Oct11 0828 by 271	20Oct11 1511 by 297		
	151851-1	10 mg/l	86.7	75.0-125	S31066	17Oct11 0828 by 271	20Oct11 1514 by 297		
	Relative Percent Difference:		1.34	20.0	S31066				
Potassium	151851-1	10 mg/l	84.6	75.0-125	S31066	17Oct11 0828 by 271	20Oct11 1511 by 297		
	151851-1	10 mg/l	97.9	75.0-125	S31066	17Oct11 0828 by 271	20Oct11 1514 by 297		
	Relative Percent Difference:		1.75	20.0	S31066				
Chloride	151850-5	20 mg/l	106	80.0-120	S31065	14Oct11 1653 by 07	15Oct11 1033 by 07		
	151850-5	20 mg/l	106	80.0-120	S31065	14Oct11 1653 by 07	15Oct11 1058 by 07		
	Relative Percent Difference:		0.190	10.0	S31065				
Sulfate	151850-5	20 mg/l	108	80.0-120	S31065	14Oct11 1653 by 07	15Oct11 1033 by 07		
	151850-5	20 mg/l	109	80.0-120	S31065	14Oct11 1653 by 07	15Oct11 1058 by 07		
	Relative Percent Difference:		0.920	10.0	S31065				

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219 Brown Lane
Bryant, AR 72022

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Alkalinity as CaCO3	< 1 mg/l	1	1	W37725-1		19Oct11 0857 by 93	
Total Dissolved Solids	< 10 mg/l	10	10	W37719-1	18Oct11 1502 by 290	20Oct11 1450 by 290	
Calcium	< 0.1 mg/l	0.1	0.1	S31066-1	17Oct11 0828 by 271	20Oct11 1504 by 297	
Magnesium	< 0.03 mg/l	0.03	0.03	S31066-1	17Oct11 0828 by 271	20Oct11 1504 by 297	
Potassium	< 1 mg/l	1	1	S31066-1	17Oct11 0828 by 271	20Oct11 1504 by 297	
Sodium	< 1 mg/l	1	1	S31066-1	17Oct11 0828 by 271	20Oct11 1504 by 297	
Chloride	< 0.2 mg/l	0.2	0.2	S31065-1	14Oct11 1653 by 07	15Oct11 0941 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S31065-1	14Oct11 1653 by 07	15Oct11 0941 by 07	

GBMᶜ & Associates
Strategic Environmental Services
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

1S1850

CLIENT INFORMATION		BILLING INFORMATION		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Company:	GBMᶜ & Associates	Bill To:	SAME	
Project Name/No.:	4450-11-075	Company:		
Send Report To:	Greg Phillips	Address:		
Address:	219 Brown Ln.			Parameters for Analysis/Methods
	Bryant, AR 72022	Phone No.:		
Phone/Fax No.:	501-847-7077	Fax No.:		

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Chloride Sulfate TDS	Alkalinity	Calcium Magnesium	Potassium Sodium						
1	TB-1		10/12/11	1805	W	2	G	X	X	X	X						
2	TB-2		10/12/11	1745	W	2	G	X	X	X	X						
3	HC-1		10/12/11	1710	W	2	G	X	X	X	X						
4	HC-2		10/12/11	1730	W	2	G	X	X	X	X						
5	WEC-1		10/13/11	1625	W	2	G	X	X	X	X						
6	WEC-2		10/13/11	1250	W	2	G	X	X	X	X						
7	WEC-1d		10/13/11	1627	W	2	G	X			X						
8	DO1		10/12/11	1755	W	2	G	X	X	X	X						
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I	I	IN	IN						

Sampler(s): GLP/GDS
Shipment Method: GBMᶜ deliv.
Turnaround Time Required: NORMAL

COC Completed by: [illegible] Date: 10/14/11 Time: 1030
COC Checked by: [illegible] Date: ~~[illegible]~~ 10/14/2011 GDS Time: 1031
Relinquished by: [illegible] Date: 10/14/11 Time: 1040
Received by: GD [illegible] Date: 10/14/2011 Time: 1041
Relinquished by: GD [illegible] Date: 10/14/2011 Time: 1247
Received in lab by: [illegible] Date: 10-14-11 Time: 1248

LABORATORY USE ONLY: Samples Received On Ice? [✓ YES] or NO
Sample Temperature: 2°C

V1.2 07/07/09

AMERICAN INTERPLEX
CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Russell McLaren
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on November 18, 2011. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Russell McLaren
rmclaren@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on November 18, 2011

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
152926-1	WEC-1 War Eagle Creek (u/s) 11/17/2011 1155	17-Nov-2011 1155	
152926-2	WEC-2 War Eagle Creek (d/s) 11/17/2011 1120	17-Nov-2011 1120	
152926-3	WEC-2 Dup War Eagle Creek (d/s) 11/17/2011 1125	17-Nov-2011 1125	
152926-4	HC-1 Holman Creek (u/s) 11/17/2011 1225	17-Nov-2011 1225	
152926-5	HC-2 Holman Creek (d/s) 11/17/2011 1250	17-Nov-2011 1250	
152926-6	TB-1 Town Branch (u/s) 11/17/2011 1310	17-Nov-2011 1310	
152926-7	TB-2 Town Branch (d/s) 11/17/2011 1330	17-Nov-2011 1330	
152926-8	001 Outfall 001 11/17/2011 1320	17-Nov-2011 1320	

Qualifiers:

D Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

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219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 152926-1
Sample Identification: WEC-1 War Eagle Creek (u/s) 11/17/2011 1155

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**110**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**10**	0.2	**mg/l**	
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2007 by 07		Batch: S31262	

AIC No. 152926-2
Sample Identification: WEC-2 War Eagle Creek (d/s) 11/17/2011 1120

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**110**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**7.0**	0.2	**mg/l**	
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2033 by 07		Batch: S31262	

AIC No. 152926-3
Sample Identification: WEC-2 Dup War Eagle Creek (d/s) 11/17/2011 1125

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**110**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**7.0**	0.2	**mg/l**	
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2059 by 07		Batch: S31262	

AIC No. 152926-4
Sample Identification: HC-1 Holman Creek (u/s) 11/17/2011 1225

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**250**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**7.7**	0.2	**mg/l**	
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2124 by 07		Batch: S31262	

AIC No. 152926-5
Sample Identification: HC-2 Holman Creek (d/s) 11/17/2011 1250

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**180**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**27**	0.2	**mg/l**	
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2150 by 07		Batch: S31262	

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ANALYTICAL RESULTS

AIC No. 152926-6
Sample Identification: TB-1 Town Branch (u/s) 11/17/2011 1310

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**210**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**20**	0.2	**mg/l**	
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2216 by 07		Batch: S31262	

AIC No. 152926-7
Sample Identification: TB-2 Town Branch (d/s) 11/17/2011 1330

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**270**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**80**	2	**mg/l**	D
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 21-Nov-2011 1020 by 07		Batch: S31262	Dil: 10

AIC No. 152926-8
Sample Identification: 001 Outfall 001 11/17/2011 1320

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**430**	10	**mg/l**	
SM 2540C	Prep: 22-Nov-2011 1729 by 258	Analyzed: 23-Nov-2011 1537 by 258		Batch: W38148	
Chloride		**130**	2	**mg/l**	D
EPA 300.0	Prep: 18-Nov-2011 1359 by 07	Analyzed: 18-Nov-2011 2308 by 07		Batch: S31262	Dil: 10

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Bryant, AR 72022

DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	152945-1	2000 mg/l			22Nov11 1729 by 258	23Nov11 1537 by 258		
Batch: W38148	Duplicate	2100 mg/l	1.55	10.0	22Nov11 1729 by 258	23Nov11 1537 by 258		
Total Dissolved Solids	153002-5	1900 mg/l			22Nov11 1729 by 258	23Nov11 1537 by 258		
Batch: W38148	Duplicate	1800 mg/l	6.51	10.0	22Nov11 1729 by 258	23Nov11 1537 by 258		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	105	90.0-110			S31262	18Nov11 0906 by 07	18Nov11 1351 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	152906-1	20 mg/l	102	80.0-120	S31262	18Nov11 0906 by 07	18Nov11 1541 by 07		
	152906-1	20 mg/l	102	80.0-120	S31262	18Nov11 0906 by 07	18Nov11 1609 by 07		
	Relative Percent Difference:		0.349	10.0	S31262				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W38148-1	22Nov11 1729 by 258	23Nov11 1537 by 258	
Chloride	< 0.2 mg/l	0.2	0.2	S31262-1	18Nov11 0906 by 07	18Nov11 1325 by 07	

152926

GBM^c & Associates

219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

Client/Billing Information		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Client:		
Company:	GBM^c & Associates	
Address:	219 Brown Lane	
	Bryant, AR 72022	Project Name / Number:
Phone No.:	501-847-7077	
Fax No.:	501-847-7943	

Parameters for Analysis/Methods

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Chloride, TDS									
1	WEC-1	War Eagle Creek (u/s)	11/17/2011	1155	W	1	Grab	X									
2	WEC-2	War Eagle Creek (d/s)	11/17/2011	1120	W	1	Grab	X									
3	WEC-2 Dup	War Eagle Creek (d/s)	11/17/2011	1125	W	1	Grab	X									
4	HC-1	Holman Creek (u/s)	11/17/2011	1225	W	1	Grab	X									
5	HC-2	Holman Creek (d/s)	11/17/2011	1250	W	1	Grab	X									
6	TB-1	Town Branch (u/s)	11/17/2011	1310	W	1	Grab	X									
7	TB-2	Town Branch (d/s)	11/17/2011	1330	W	1	Grab	X									
8	001	Outfall 001	11/17/2011	1320	W	1	Grab	X									
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I									

Sampler(s): GDS/RHW
Shipment Method: GBM^c Delivery
Turnaround Time Required: Normal

COC Completed by: Date: 11/18/2011 Time: 0905
COC Checked by: Date: 11/18/11 Time: 0910

Relinquished by Date: 11/18/2011 Time: 1005
Received by: Date: Time:

Relinquished by: Date: Time:
Received in lab by: Date: 11-18-11 Time: 1005

LABORATORY USE ONLY: Samples Received On Ice?: [✓ YES] or NO
Sample Temperature: 2 °C

V1.2 11/18/11

AMERICAN INTERPLEX CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on December 9, 2011. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

Steve Bradford

Steve Bradford
Deputy Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on December 9, 2011
4450-11-075

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
153425-1	TB-1 12/8/11 1205	08-Dec-2011 1205	
153425-2	TB-1 D 12/8/11 1210	08-Dec-2011 1210	
153425-3	001 12/8/11 1230	08-Dec-2011 1230	
153425-4	TB-2 12/8/11 1240	08-Dec-2011 1240	
153425-5	HC-2 12/8/11 1255	08-Dec-2011 1255	
153425-6	WEC-2 12/8/11 1315	08-Dec-2011 1315	
153425-7	WEC-1 12/8/11 1345	08-Dec-2011 1345	
153425-8	HC-1 12/8/11 1415	08-Dec-2011 1415	

Qualifiers:

D	Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 153425-1
Sample Identification: TB-1 12/8/11 1205

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**170**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**12**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1542 by 07		Batch: S31373	

AIC No. 153425-2
Sample Identification: TB-1 D 12/8/11 1210

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**160**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**12**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1606 by 07		Batch: S31373	

AIC No. 153425-3
Sample Identification: 001 12/8/11 1230

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**430**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**110**	2	**mg/l**	D
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1631 by 07		Batch: S31373	Dil: 10

AIC No. 153425-4
Sample Identification: TB-2 12/8/11 1240

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**250**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**42**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1840 by 07		Batch: S31373	

AIC No. 153425-5
Sample Identification: HC-2 12/8/11 1255

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**150**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**16**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1906 by 07		Batch: S31373	

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Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 153425-6
Sample Identification: WEC-2 12/8/11 1315

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**80**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**4.6**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1932 by 07		Batch: S31373	

AIC No. 153425-7
Sample Identification: WEC-1 12/8/11 1345

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**70**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**3.4**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 1958 by 07		Batch: S31373	

AIC No. 153425-8
Sample Identification: HC-1 12/8/11 1415

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**79**	10	**mg/l**	
SM 2540C	Prep: 12-Dec-2011 1459 by 290	Analyzed: 13-Dec-2011 1537 by 290		Batch: W38318	
Chloride		**5.7**	0.2	**mg/l**	
EPA 300.0	Prep: 09-Dec-2011 1314 by 07	Analyzed: 09-Dec-2011 2024 by 07		Batch: S31373	

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Bryant, AR 72022

DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	153356-1	1300 mg/l			12Dec11 1459 by 290	13Dec11 1537 by 290		
Batch: W38318	Duplicate	1300 mg/l	0.770	10.0	12Dec11 1459 by 290	13Dec11 1537 by 290		
Total Dissolved Solids	153429-4	170 mg/l			12Dec11 1459 by 290	13Dec11 1537 by 290		
Batch: W38318	Duplicate	760 mg/l	0.784	10.0	12Dec11 1459 by 290	13Dec11 1537 by 290		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	99.3	90.0-110			S31373	09Dec11 1315 by 07	09Dec11 1407 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	153425-1	20 mg/l	96.3	80.0-120	S31373	09Dec11 1315 by 07	09Dec11 1431 by 07		
	153425-1	20 mg/l	98.2	80.0-120	S31373	09Dec11 1315 by 07	09Dec11 1455 by 07		
	Relative Percent Difference:		1.81	10.0	S31373				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W38318-1	12Dec11 1459 by 290	13Dec11 1537 by 290	
Chloride	< 0.2 mg/l	0.2	0.2	S31373-1	09Dec11 1315 by 07	09Dec11 1343 by 07	

GBM^c & Associates
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

153425

Client/BILLING Information		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Client:		
Company:	GBM^c & Associates	Email results to Greg phillips @ gphillips@gbmcassoc.com
Address:	219 Brown Lane	
	Bryant, AR 72022	**Project Name / Number:**
Phone No.:	501-847-7077	4450-11-015
Fax No.:	501-847-7943	

Parameters for Analysis/Methods

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	TDS, Cl									
1	TB-1		12/8/11	1205	W	1	G	X									
2	TB-1 D			1210		1		X									
3	001			1230		1		X									
4	TB-2			1240		1		X									
5	HC-2			1255		1		X									
6	WEC-2			1315		1		X									
7	WEC-1			1345		1		X									
8	HC-1			1415		1		X									
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I									

Sampler(s): RHW / GDS
Shipment Method: GBMc Delivery
Turnaround Time Required: Normal

COC Completed by:	Date: 12/9/11	Time: 0850	COC Checked by:	Date: 12/09/2011	Time: 0855
Relinquished by:	Date: 12/9/11	Time: 1011	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received in lab by:	Date: 12-9-11	Time: 1011

LABORATORY USE ONLY: **Samples Received On Ice?:** [✓ **YES**] **or NO** **Sample Temperature:** 2°C

V1.2 12/09/11

AMERICAN INTERPLEX
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LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on January 19, 2012. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:
Eight (8) water sample(s) received on January 19, 2012
4450-11-075

Receipt Details:
A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
154499-1	001 1/18/12 1345	18-Jan-2012 1345	
154499-2	WEC-2 1/18/12 1125	18-Jan-2012 1125	
154499-3	WEC-1 1/18/12 1205	18-Jan-2012 1205	
154499-4	WEC-1 Dup 1/18/12 1210	18-Jan-2012 1210	
154499-5	TB-1 1/18/12 1350	18-Jan-2012 1350	
154499-6	TB-2 1/18/12 1330	18-Jan-2012 1330	
154499-7	HC-1 1/18/12 1310	18-Jan-2012 1310	
154499-8	HC-2 1/18/12 1245	18-Jan-2012 1245	

Qualifiers:

D	Result is from a secondary dilution factor

References:
"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

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219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 154499-1
Sample Identification: 001 1/18/12 1345

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 20-Jan-2012 1401 by 285	**550** Analyzed: 22-Jan-2012 1637 by 285	10	**mg/l** Batch: W38715	
Chloride EPA 300.0 Prep: 19-Jan-2012 1456 by 07	**170** Analyzed: 19-Jan-2012 1901 by 07	2	**mg/l** Batch: S31630	D Dil: 10

AIC No. 154499-2
Sample Identification: WEC-2 1/18/12 1125

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 20-Jan-2012 1401 by 285	**94** Analyzed: 22-Jan-2012 1637 by 285	10	**mg/l** Batch: W38715	
Chloride EPA 300.0 Prep: 19-Jan-2012 1456 by 07	**6.6** Analyzed: 19-Jan-2012 1948 by 07	0.2	**mg/l** Batch: S31630	

AIC No. 154499-3
Sample Identification: WEC-1 1/18/12 1205

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 20-Jan-2012 1401 by 285	**58** Analyzed: 23-Jan-2012 1313 by 258	10	**mg/l** Batch: W38715	
Chloride EPA 300.0 Prep: 19-Jan-2012 1456 by 07	**3.7** Analyzed: 19-Jan-2012 2012 by 07	0.2	**mg/l** Batch: S31630	

AIC No. 154499-4
Sample Identification: WEC-1 Dup 1/18/12 1210

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 20-Jan-2012 1401 by 285	**56** Analyzed: 22-Jan-2012 1637 by 285	10	**mg/l** Batch: W38715	
Chloride EPA 300.0 Prep: 19-Jan-2012 1456 by 07	**3.8** Analyzed: 19-Jan-2012 2036 by 07	0.2	**mg/l** Batch: S31630	

AIC No. 154499-5
Sample Identification: TB-1 1/18/12 1350

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 20-Jan-2012 1401 by 285	**170** Analyzed: 22-Jan-2012 1637 by 285	10	**mg/l** Batch: W38715	
Chloride EPA 300.0 Prep: 19-Jan-2012 1456 by 07	**17** Analyzed: 19-Jan-2012 2147 by 07	0.2	**mg/l** Batch: S31630	

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ANALYTICAL RESULTS

AIC No. 154499-6
Sample Identification: TB-2 1/18/12 1330

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**380**	10	**mg/l**	
SM 2540C	Prep: 20-Jan-2012 1401 by 285	Analyzed: 22-Jan-2012 1637 by 285		Batch: W38715	
Chloride		**100**	2	**mg/l**	D
EPA 300.0	Prep: 19-Jan-2012 1456 by 07	Analyzed: 20-Jan-2012 0910 by 07		Batch: S31630	Dil: 10

AIC No. 154499-7
Sample Identification: HC-1 1/18/12 1310

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**100**	10	**mg/l**	
SM 2540C	Prep: 20-Jan-2012 1401 by 285	Analyzed: 22-Jan-2012 1637 by 285		Batch: W38715	
Chloride		**6.6**	0.2	**mg/l**	
EPA 300.0	Prep: 19-Jan-2012 1456 by 07	Analyzed: 19-Jan-2012 2235 by 07		Batch: S31630	

AIC No. 154499-8
Sample Identification: HC-2 1/18/12 1245

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**210**	10	**mg/l**	
SM 2540C	Prep: 20-Jan-2012 1401 by 285	Analyzed: 22-Jan-2012 1637 by 285		Batch: W38715	
Chloride		**38**	0.2	**mg/l**	
EPA 300.0	Prep: 19-Jan-2012 1456 by 07	Analyzed: 19-Jan-2012 2259 by 07		Batch: S31630	

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DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	154494-1	160 mg/l			20Jan12 1401 by 285	22Jan12 1637 by 285		
Batch: W38715	Duplicate	150 mg/l	3.87	10.0	20Jan12 1401 by 285	22Jan12 1637 by 285		
Total Dissolved Solids	154499-1	550 mg/l			20Jan12 1401 by 285	22Jan12 1637 by 285		
Batch: W38715	Duplicate	540 mg/l	1.09	10.0	20Jan12 1401 by 285	22Jan12 1637 by 285		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	108	90.0-110			S31630	19Jan12 1420 by 07	19Jan12 1442 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	154516-8	20 mg/l	110	80.0-120	S31630	19Jan12 1420 by 07	19Jan12 1506 by 07		
	154516-8	20 mg/l	105	80.0-120	S31630	19Jan12 1420 by 07	19Jan12 1530 by 07		
	Relative Percent Difference:		2.89	10.0	S31630				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W38715-1	20Jan12 1401 by 285	22Jan12 1637 by 285	
Chloride	< 0.2 mg/l	0.2	0.2	S31630-1	19Jan12 1417 by 07	19Jan12 1418 by 07	

154499

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219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

Client/BILLING Information		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Client:		
Company:	GBM^c & Associates	Email results to Greg phillips @ gphillips@gbmcassoc.com
Address:	219 Brown Lane	
	Bryant, AR 72022	Project Name / Number:
Phone No.:	501-847-7077	4450-11-075
Fax No.:	501-847-7943	

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	CL, TDS									
1	001		1/18/12	1315	W	1	G	x									
2	WEC-2			1125	W	1		x									
3	WEC-1			1205	W	1		x									
4	WEC-1 dup			1210	W	1		x									
5	TB-1			1350	W	1		x									
6	TB-2			1330	W	1		x									
7	HC-1			1310	W	1		x									
8	HC-2			1245	W	1		x									
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I									

Parameters for Analysis/Methods

Sampler(s): RHW/GLP
Shipment Method: GBMc Delivery
Turnaround Time Required: Normal

COC Completed by: Peter Walt... Date: 1/19/12 Time: 0836
COC Checked by: Date: 1/19/12 Time: 0840

Relinquished by: Date: 1/19/12 Time: 0915
Received by: ______ Date: ______ Time: ______

Relinquished by: ______ Date: ______ Time: ______
Received in lab by: Date: 1-19-12 Time: 0915

LABORATORY USE ONLY: Samples Received On Ice?: [✓ YES] or NO   Sample Temperature: 2°C

V1.2 10/21/11

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LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on February 17, 2012. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:
Eight (8) water sample(s) received on February 17, 2012

Receipt Details:
A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
155373-1	WEC-2 2/16/12 1040	16-Feb-2012 1040	
155373-2	WEC-1 2/16/12 1120	16-Feb-2012 1120	
155373-3	HC-1 2/16/12 1155	16-Feb-2012 1155	
155373-4	HC-2 2/16/12 1220	16-Feb-2012 1220	
155373-5	TB-2 2/16/12 1240	16-Feb-2012 1240	
155373-6	TB-1 2/16/12 1255	16-Feb-2012 1255	
155373-7	001 2/16/12 1305	16-Feb-2012 1305	
155373-8	WEC-1D 2/16/12 1120	16-Feb-2012 1120	

Notes:
155373-8: Not listed on chain of custody

Qualifiers:

D	Result is from a secondary dilution factor

References:
"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 155373-1
Sample Identification: WEC-2 2/16/12 1040

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**72**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**3.5**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 17-Feb-2012 1757 by 07		Batch: S31839	

AIC No. 155373-2
Sample Identification: WEC-1 2/16/12 1120

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**88**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**3.4**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 20-Feb-2012 0958 by 07		Batch: S31839	

AIC No. 155373-3
Sample Identification: HC-1 2/16/12 1155

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**100**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**15**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 17-Feb-2012 1844 by 07		Batch: S31839	

AIC No. 155373-4
Sample Identification: HC-2 2/16/12 1220

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**140**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**4.9**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 17-Feb-2012 1908 by 07		Batch: S31839	

AIC No. 155373-5
Sample Identification: TB-2 2/16/12 1240

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**240**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**41**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 20-Feb-2012 1046 by 07		Batch: S31839	

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 155373-6
Sample Identification: TB-1 2/16/12 1255

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**150**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**12**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 17-Feb-2012 2107 by 07		Batch: S31839	

AIC No. 155373-7
Sample Identification: 001 2/16/12 1305

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**480**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**140**	2	**mg/l**	D
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 17-Feb-2012 2131 by 07		Batch: S31839	Dil: 10

AIC No. 155373-8
Sample Identification: WEC-1D 2/16/12 1120

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**82**	10	**mg/l**	
SM 2540C	Prep: 20-Feb-2012 0924 by 285	Analyzed: 22-Feb-2012 0841 by 285		Batch: W38995	
Chloride		**3.5**	0.2	**mg/l**	
EPA 300.0	Prep: 17-Feb-2012 1416 by 07	Analyzed: 20-Feb-2012 1022 by 07		Batch: S31839	

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	155367-1	150 mg/l			20Feb12 0924 by 285	22Feb12 0841 by 285		
Batch: W38995	Duplicate	150 mg/l	1.97	10.0	20Feb12 0924 by 285	22Feb12 0841 by 285		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	106	90.0-110			S31839	17Feb12 1416 by 07	17Feb12 1450 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	155353-1	20 mg/l	106	80.0-120	S31839	17Feb12 1416 by 07	17Feb12 1621 by 07		
	155353-1	20 mg/l	103	80.0-120	S31839	17Feb12 1416 by 07	17Feb12 1645 by 07		
	Relative Percent Difference:		3.14	10.0	S31839				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W38995-1	20Feb12 0924 by 285	22Feb12 0841 by 285	
Chloride	< 0.2 mg/l	0.2	0.2	S31839-1	17Feb12 1416 by 07	17Feb12 1426 by 07	

GBM^c & Associates
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

155373

Client/BILLING Information	
Client:	
Company:	GBM^c & Associates
Address:	219 Brown Lane
	Bryant, AR 72022
Phone No.:	501-847-7077
Fax No.:	501-847-7943

SPECIAL INSTRUCTIONS/PRECAUTIONS:
Email results to Greg Phillips @
gphillips@gbmcassoc.com

Project Name / Number:

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Parameters for Analysis/Methods									
								Cl, TDS									
1	WEC-2		2/16/12	1040	W	1	G	X									
2	WEC-1			1120	W	1	G	X									
3	HC-1			1155	W	1	G	X									
4	HC-2			1222	W	1	G	X									
5	TB-2			1240	W	1	G	X									
6	TB-1			1255	W	1	G	X									
7	001			1306	W	1	G	X									
8																	

Preservative (Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)

Sampler(s): RHW/JBB
Shipment Method: GBMc Delivery
Turnaround Time Required: Normal

COC Completed by: Date: 2/17/12 Time: 0800
COC Checked by: Date: 2-17-12 Time: 0800

Relinquished by: Date: 2/17/12 Time: 0930
Received by: ________ Date: ______ Time: ______

Relinquished by: ________ Date: ______ Time: ______
Received in lab by: Date: 2-17-12 Time: 0930

LABORATORY USE ONLY: **Samples Received On Ice?:** [✓ **YES**] **or** **NO** **Sample Temperature:** 2°c

V1.2 12/09/11

AMERICAN INTERPLEX CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on March 29, 2012. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on March 29, 2012
City of Huntsville
4450-11-075

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
156533-1	TB-1 27MAR12 1300	27-Mar-2012 1300	
156533-2	HC-2 27MAR12 1410	27-Mar-2012 1410	
156533-3	WEC-1 27MAR12 1605	27-Mar-2012 1605	
156533-4	001 27MAR12 1245	27-Mar-2012 1245	
156533-5	WEC-2 27MAR12 1530	27-Mar-2012 1530	
156533-6	HC-1 27MAR12 1435	27-Mar-2012 1435	
156533-7	TB-2D 27MAR12 1346	27-Mar-2012 1346	
156533-8	TB-2 27MAR12 1345	27-Mar-2012 1345	

Qualifiers:

D Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 156533-1
Sample Identification: TB-1 27MAR12 1300

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**160**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**7.6**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2040 by 07		Batch: S32133	

AIC No. 156533-2
Sample Identification: HC-2 27MAR12 1410

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**130**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**10**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2106 by 07		Batch: S32133	

AIC No. 156533-3
Sample Identification: WEC-1 27MAR12 1605

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**64**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**1.9**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2132 by 07		Batch: S32133	

AIC No. 156533-4
Sample Identification: 001 27MAR12 1245

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**400**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**82**	2	**mg/l**	D
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2158 by 07		Batch: S32133	Dil: 10

AIC No. 156533-5
Sample Identification: WEC-2 27MAR12 1530

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**82**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**2.9**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2223 by 07		Batch: S32133	

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ANALYTICAL RESULTS

AIC No. 156533-6
Sample Identification: HC-1 27MAR12 1435

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**90**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**3.4**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2249 by 07		Batch: S32133	

AIC No. 156533-7
Sample Identification: TB-2D 27MAR12 1346

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**220**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**30**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 29-Mar-2012 2315 by 07		Batch: S32133	

AIC No. 156533-8
Sample Identification: TB-2 27MAR12 1345

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**220**	10	**mg/l**	
SM 2540C	Prep: 02-Apr-2012 1155 by 285	Analyzed: 03-Apr-2012 1433 by 285		Batch: W39416	
Chloride		**30**	0.2	**mg/l**	
EPA 300.0	Prep: 29-Mar-2012 1316 by 07	Analyzed: 30-Mar-2012 0033 by 07		Batch: S32133	

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DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	156533-1	160 mg/l			02Apr12 1155 by 285	03Apr12 1433 by 285		
Batch: W39416	Duplicate	160 mg/l	2.77	10.0	02Apr12 1155 by 285	03Apr12 1433 by 285		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	94.5	90.0-110			S32133	29Mar12 0848 by 07	29Mar12 1439 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	156517-1	20 mg/l	101	80.0-120	S32133	29Mar12 0848 by 07	29Mar12 1504 by 07		
	156517-1	20 mg/l	98.5	80.0-120	S32133	29Mar12 0848 by 07	29Mar12 1530 by 07		
	Relative Percent Difference:		2.57	10.0	S32133				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W39416-1	02Apr12 1155 by 285	03Apr12 1433 by 285	
Chloride	< 0.2 mg/l	0.2	0.2	S32133-1	29Mar12 0848 by 07	29Mar12 1413 by 07	

156533

GBMc & Associates
Strategic Environmental Services
219 Brown Ln.
Bryant, AR 72022

(501) 847-7077 Fax (501) 847-7943

Chain of Custody

CLIENT INFORMATION

Company: GBMC + Associates
Project Name/No.: City of Huntsville 4450-11-075
Send Report To: GBMC + Associates
Address: 219 Brown Lane
Bryant, AR 72022
Phone/Fax No.: 501-847-7077

BILLING INFORMATION

Bill To:
Company: GBMC + Associates
Address: 219 Brown Lane
Bryant, AR 72022
Phone No.: 501-847-7077
Fax No.: 501-847-7943

SPECIAL INSTRUCTIONS/PRECAUTIONS:

E-mail results to Greg Phillips at GBMC + Associates gphillips@gbmcassoc.com

Parameters for Analysis/Methods

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Cl TDS									
1	TB-1		27Mar12	1300	W	1	Grab	X									
2	HC-2		27Mar12	1410	W	1	Grab	X									
3	WEC-1		27Mar12	1605	W	1	Grab	X									
4	001		27Mar12	1245	W	1	Grab	X									
5	WEC-2		27Mar12	1530	W	1	Grab	X									
6	HC-1		27Mar12	1435	W	1	Grab	X									
7	TB-2D		27Mar12	1346	W	1	Grab	X									
8	TB-2		27Mar12	1345	W	1	Grab	X									
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I									

Sampler(s): GLP/ENJ
Shipment Method: GBMC Delivery
Turnaround Time Required: Normal

COC Completed by: Nicki Jensen Date: 29Mar12 Time: 900
COC Checked by: Date: 3/29/12 Time: 0905

Relinquished by: Nicki Jensen Date: 29Mar12 Time: 945
Received by: Date: 3-29-12 Time: 0945

Relinquished by:____ Date:____ Time:____
Received in lab by:____ Date:____ Time:____

LABORATORY USE ONLY: Samples Received On Ice?: [✓ YES] or NO
Sample Temperature: 2

V1.2 07/07/09

AMERICAN INTERPLEX CORPORATION
LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on April 13, 2012. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

John Overbey
Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on April 13, 2012
4450-11-075
Huntsville

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
156934-1	HC-2 4/10/12 0930	10-Apr-2012 0930	
156934-2	HC-1 4/10/12 1115	10-Apr-2012 1115	
156934-3	TB-1 4/10/12 1355	10-Apr-2012 1355	
156934-4	001 4/10/12 1430	10-Apr-2012 1430	
156934-5	TB-2 4/10/12 1555	10-Apr-2012 1555	
156934-6	WEC-2 4/10/12 1730	10-Apr-2012 1730	
156934-7	WEC-1 4/10/12 1705	10-Apr-2012 1705	
156934-8	WEC-2d 4/10/12 1735	10-Apr-2012 1735	

Qualifiers:

D	Result is from a secondary dilution factor
X	Spiking level is invalid due to the high concentration of analyte in the spiked sample

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

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ANALYTICAL RESULTS

AIC No. 156934-1
Sample Identification: HC-2 4/10/12 0930

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**100** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	
Total Dissolved Solids SM 2540C	Prep: 17-Apr-2012 0806 by 285	**220** Analyzed: 18-Apr-2012 1340 by 285	10	**mg/l** Batch: W39557	
Calcium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**27** Analyzed: 13-Apr-2012 2009 by 270	0.1	**mg/l** Batch: S32235	
Magnesium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**2.7** Analyzed: 13-Apr-2012 2009 by 270	0.03	**mg/l** Batch: S32235	
Potassium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**1.9** Analyzed: 13-Apr-2012 2009 by 270	1	**mg/l** Batch: S32235	
Sodium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**3.4** Analyzed: 13-Apr-2012 2009 by 270	1	**mg/l** Batch: S32235	
Chloride EPA 300.0	Prep: 12-Apr-2012 1629 by 07	**32** Analyzed: 17-Apr-2012 0533 by 07	0.2	**mg/l** Batch: S32231	
Sulfate EPA 300.0	Prep: 12-Apr-2012 1629 by 07	**28** Analyzed: 17-Apr-2012 0533 by 07	0.2	**mg/l** Batch: S32231	

AIC No. 156934-2
Sample Identification: HC-1 4/10/12 1115

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**70** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	
Total Dissolved Solids SM 2540C	Prep: 17-Apr-2012 0806 by 285	**98** Analyzed: 18-Apr-2012 1340 by 285	10	**mg/l** Batch: W39557	
Calcium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**42** Analyzed: 13-Apr-2012 2012 by 270	0.1	**mg/l** Batch: S32235	
Magnesium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**3.6** Analyzed: 13-Apr-2012 2012 by 270	0.03	**mg/l** Batch: S32235	
Potassium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**5.3** Analyzed: 13-Apr-2012 2012 by 270	1	**mg/l** Batch: S32235	
Sodium EPA 200.7	Prep: 12-Apr-2012 1447 by 297	**20** Analyzed: 13-Apr-2012 2012 by 270	1	**mg/l** Batch: S32235	
Chloride EPA 300.0	Prep: 12-Apr-2012 1629 by 07	**4.7** Analyzed: 17-Apr-2012 0559 by 07	0.2	**mg/l** Batch: S32231	
Sulfate EPA 300.0	Prep: 12-Apr-2012 1629 by 07	**11** Analyzed: 17-Apr-2012 0559 by 07	0.2	**mg/l** Batch: S32231	

AIC No. 156934-3
Sample Identification: TB-1 4/10/12 1355

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B		**130** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	

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ANALYTICAL RESULTS

AIC No. 156934-3 (Continued)
Sample Identification: TB-1 4/10/12 1355

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 17-Apr-2012 0806 by 285	**190** Analyzed: 18-Apr-2012 1340 by 285	10	**mg/l** Batch: W39557	
Calcium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**49** Analyzed: 13-Apr-2012 2015 by 270	0.1	**mg/l** Batch: S32235	
Magnesium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**4.3** Analyzed: 13-Apr-2012 2015 by 270	0.03	**mg/l** Batch: S32235	
Potassium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**2.0** Analyzed: 13-Apr-2012 2015 by 270	1	**mg/l** Batch: S32235	
Sodium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**7.2** Analyzed: 13-Apr-2012 2015 by 270	1	**mg/l** Batch: S32235	
Chloride EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**13** Analyzed: 17-Apr-2012 0624 by 07	0.2	**mg/l** Batch: S32231	
Sulfate EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**15** Analyzed: 17-Apr-2012 0624 by 07	0.2	**mg/l** Batch: S32231	

AIC No. 156934-4
Sample Identification: 001 4/10/12 1430

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**100** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	
Total Dissolved Solids SM 2540C Prep: 17-Apr-2012 0806 by 285	**500** Analyzed: 18-Apr-2012 1340 by 285	10	**mg/l** Batch: W39557	
Calcium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**61** Analyzed: 13-Apr-2012 2019 by 270	0.1	**mg/l** Batch: S32235	
Magnesium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**3.8** Analyzed: 13-Apr-2012 2019 by 270	0.03	**mg/l** Batch: S32235	
Potassium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**23** Analyzed: 13-Apr-2012 2019 by 270	1	**mg/l** Batch: S32235	
Sodium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**110** Analyzed: 16-Apr-2012 1123 by 270	1	**mg/l** Batch: S32235	
Chloride EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**140** Analyzed: 17-Apr-2012 0650 by 07	2	**mg/l** Batch: S32231	D Dil: 10
Sulfate EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**83** Analyzed: 17-Apr-2012 0650 by 07	2	**mg/l** Batch: S32231	D Dil: 10

AIC No. 156934-5
Sample Identification: TB-2 4/10/12 1555

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**110** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	

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ANALYTICAL RESULTS

AIC No. 156934-5 (Continued)
Sample Identification: TB-2 4/10/12 1555

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids SM 2540C Prep: 17-Apr-2012 0806 by 285	**420** Analyzed: 18-Apr-2012 1340 by 285	10	**mg/l** Batch: W39557	
Calcium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**56** Analyzed: 13-Apr-2012 2023 by 270	0.1	**mg/l** Batch: S32235	
Magnesium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**4.1** Analyzed: 13-Apr-2012 2023 by 270	0.03	**mg/l** Batch: S32235	
Potassium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**13** Analyzed: 13-Apr-2012 2023 by 270	1	**mg/l** Batch: S32235	
Sodium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**54** Analyzed: 13-Apr-2012 2023 by 270	1	**mg/l** Batch: S32235	
Chloride EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**79** Analyzed: 17-Apr-2012 0948 by 07	2	**mg/l** Batch: S32231	D Dil: 10
Sulfate EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**52** Analyzed: 17-Apr-2012 0948 by 07	2	**mg/l** Batch: S32231	D Dil: 10

AIC No. 156934-6
Sample Identification: WEC-2 4/10/12 1730

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**64** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	
Total Dissolved Solids SM 2540C Prep: 17-Apr-2012 0806 by 285	**110** Analyzed: 18-Apr-2012 1340 by 285	10	**mg/l** Batch: W39557	
Calcium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**24** Analyzed: 13-Apr-2012 2026 by 270	0.1	**mg/l** Batch: S32235	
Magnesium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**2.0** Analyzed: 13-Apr-2012 2026 by 270	0.03	**mg/l** Batch: S32235	
Potassium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**1.9** Analyzed: 13-Apr-2012 2026 by 270	1	**mg/l** Batch: S32235	
Sodium EPA 200.7 Prep: 12-Apr-2012 1447 by 297	**4.1** Analyzed: 13-Apr-2012 2026 by 270	1	**mg/l** Batch: S32235	
Chloride EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**6.0** Analyzed: 17-Apr-2012 0742 by 07	0.2	**mg/l** Batch: S32231	
Sulfate EPA 300.0 Prep: 12-Apr-2012 1629 by 07	**8.2** Analyzed: 17-Apr-2012 0742 by 07	0.2	**mg/l** Batch: S32231	

AIC No. 156934-7
Sample Identification: WEC-1 4/10/12 1705

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320B	**47** Analyzed: 17-Apr-2012 0920 by 93	1	**mg/l** Batch: W39559	

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ANALYTICAL RESULTS

AIC No. 156934-7 (Continued)
Sample Identification: WEC-1 4/10/12 1705

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**72**	10	**mg/l**	
SM 2540C Prep: 17-Apr-2012 0806 by 285	Analyzed: 18-Apr-2012 1340 by 285		Batch: W39557	
Calcium	**17**	0.1	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2030 by 270		Batch: S32235	
Magnesium	**2.0**	0.03	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2030 by 270		Batch: S32235	
Potassium	**1.5**	1	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2030 by 270		Batch: S32235	
Sodium	**2.1**	1	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2030 by 270		Batch: S32235	
Chloride	**2.5**	0.2	**mg/l**	
EPA 300.0 Prep: 12-Apr-2012 1629 by 07	Analyzed: 17-Apr-2012 0808 by 07		Batch: S32231	
Sulfate	**6.3**	0.2	**mg/l**	
EPA 300.0 Prep: 12-Apr-2012 1629 by 07	Analyzed: 17-Apr-2012 0808 by 07		Batch: S32231	

AIC No. 156934-8
Sample Identification: WEC-2d 4/10/12 1735

Analyte	Result	RL	Units	Qualifier
Alkalinity as CaCO3	**63**	1	**mg/l**	
SM 2320B	Analyzed: 17-Apr-2012 0920 by 93		Batch: W39559	
Total Dissolved Solids	**100**	10	**mg/l**	
SM 2540C Prep: 17-Apr-2012 0806 by 285	Analyzed: 18-Apr-2012 1340 by 285		Batch: W39557	
Calcium	**24**	0.1	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2033 by 270		Batch: S32235	
Magnesium	**2.1**	0.03	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2033 by 270		Batch: S32235	
Potassium	**1.9**	1	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2033 by 270		Batch: S32235	
Sodium	**4.2**	1	**mg/l**	
EPA 200.7 Prep: 12-Apr-2012 1447 by 297	Analyzed: 13-Apr-2012 2033 by 270		Batch: S32235	
Chloride	**6.2**	0.2	**mg/l**	
EPA 300.0 Prep: 12-Apr-2012 1629 by 07	Analyzed: 17-Apr-2012 0834 by 07		Batch: S32231	
Sulfate	**8.8**	0.2	**mg/l**	
EPA 300.0 Prep: 12-Apr-2012 1629 by 07	Analyzed: 17-Apr-2012 0834 by 07		Batch: S32231	

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DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	156905-1	480 mg/l			17Apr12 0806 by 285	18Apr12 1340 by 285		
Batch: W39557	Duplicate	480 mg/l	0.105	10.0	17Apr12 0806 by 285	18Apr12 1340 by 285		
Alkalinity as CaCO3	156880-1	350 mg/l				17Apr12 0920 by 93		
Batch: W39559	Duplicate	350 mg/l	0.462	20.0		17Apr12 0920 by 93		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	10 mg/l	106	85.0-115			S32235	12Apr12 1448 by 297	13Apr12 1937 by 270		
Magnesium	10 mg/l	105	85.0-115			S32235	12Apr12 1448 by 297	13Apr12 1937 by 270		
Potassium	10 mg/l	104	85.0-115			S32235	12Apr12 1448 by 297	13Apr12 1937 by 270		
Sodium	10 mg/l	102	85.0-115			S32235	12Apr12 1448 by 297	13Apr12 1937 by 270		
Chloride	20 mg/l	94.4	90.0-110			S32231	12Apr12 0915 by 07	12Apr12 1511 by 07		
Sulfate	20 mg/l	94.1	90.0-110			S32231	12Apr12 0915 by 07	12Apr12 1511 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	156879-1	10 mg/l	103	75.0-125	S32235	12Apr12 1448 by 297	13Apr12 1939 by 270		
	156879-1	10 mg/l	104	75.0-125	S32235	12Apr12 1448 by 297	13Apr12 1942 by 270		
	Relative Percent Difference:		0.706	20.0	S32235				
Magnesium	156879-1	10 mg/l	-	75.0-125	S32235	12Apr12 1448 by 297	16Apr12 1058 by 270	10	X
	156879-1	10 mg/l	-	75.0-125	S32235	12Apr12 1448 by 297	16Apr12 1103 by 270	10	X
	Relative Percent Difference:		0.570	20.0	S32235				D
Potassium	156879-1	10 mg/l	99.0	75.0-125	S32235	12Apr12 1448 by 297	13Apr12 1939 by 270		
	156879-1	10 mg/l	106	75.0-125	S32235	12Apr12 1448 by 297	13Apr12 1942 by 270		
	Relative Percent Difference:		1.11	20.0	S32235				
Sodium	156879-1	10 mg/l	-	75.0-125	S32235	12Apr12 1448 by 297	16Apr12 1058 by 270	10	X
	156879-1	10 mg/l	-	75.0-125	S32235	12Apr12 1448 by 297	16Apr12 1103 by 270	10	X
	Relative Percent Difference:		1.73	20.0	S32235				D
Chloride	156893-1	20 mg/l	94.1	80.0-120	S32231	12Apr12 0915 by 07	12Apr12 1536 by 07		
	156893-1	20 mg/l	96.6	80.0-120	S32231	12Apr12 0915 by 07	12Apr12 1602 by 07		
	Relative Percent Difference:		2.22	10.0	S32231				
Sulfate	156893-1	20 mg/l	88.0	80.0-120	S32231	12Apr12 0915 by 07	12Apr12 1536 by 07		
	156893-1	20 mg/l	94.6	80.0-120	S32231	12Apr12 0915 by 07	12Apr12 1602 by 07		
	Relative Percent Difference:		4.14	10.0	S32231				

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219 Brown Lane
Bryant, AR 72022

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Alkalinity as CaCO3	< 1 mg/l	1	1	W39559-1		17Apr12 0920 by 93	
Total Dissolved Solids	< 10 mg/l	10	10	W39557-1	17Apr12 0806 by 285	18Apr12 1340 by 285	
Calcium	< 0.1 mg/l	0.1	0.1	S32235-1	12Apr12 1448 by 297	13Apr12 1933 by 270	
Magnesium	< 0.03 mg/l	0.03	0.03	S32235-1	12Apr12 1448 by 297	13Apr12 1933 by 270	
Potassium	< 1 mg/l	1	1	S32235-1	12Apr12 1448 by 297	13Apr12 1933 by 270	
Sodium	< 1 mg/l	1	1	S32235-1	12Apr12 1448 by 297	13Apr12 1933 by 270	
Chloride	< 0.2 mg/l	0.2	0.2	S32231-1	12Apr12 0915 by 07	12Apr12 1445 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S32231-1	12Apr12 0915 by 07	12Apr12 1445 by 07	

156934

GBMc & Associates
Strategic Environmental Services
219 Brown Ln.
Bryant, AR 72022

(501) 847-7077 Fax (501) 847-7943

Chain of Custody

156918 GEH177
4-13-12

CLIENT INFORMATION		BILLING INFORMATION		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Company:	GBMc & Assoc.	Bill To:	SAME	
Project Name/No.:	Huntsville - 4450-11-075	Company:		
Send Report To:	Greg Phillips	Address:		
Address:	219 Brown Ln.			Parameters for Analysis/Methods
	Bryant, AR 72022	Phone No.:		
Phone/Fax No.:	501-847-7077/7943	Fax No.:		

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	CL, TDS, S04, Total Alk.	CA, MG, NA, K								
1	HC-2		4/10/12	0930	W	2	G	X	X								
2	HC-1		4/10/12	1115	W	2		X	X								
3	TB-1		4/10/12	1355	W	2		X	X								
4	001		4/10/12	1430	W	2		X	X								
5	TB-2		4/10/12	1555	W	2		X	X								
6	WFC-2		4/10/12	1730	W	2		X	X								
7	WFC-1		4/10/12	1705	W	2		X	X								
8	WFC-2d		4/11/12	1735	W	2	G	X	X								
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I	I, N								

Sampler(s): GLP/RHW/ENJ
Shipment Method: GBMc delivery
Turnaround Time Required: NORMAL

COC Completed by: Date: 4/12/12 Time: 10:55
COC Checked by: Date: 4.12.12 Time: 1134

Relinquished by: Date: 4/12/12 Time: 1335
Received by: Date: Time:

Relinquished by: Date: Time:
Received in lab by: Date: 4-12-12 Time: 1335

LABORATORY USE ONLY: Samples Received On Ice?: [✓ YES] or NO Sample Temperature: 2°C

V1.2 07/07/09

AMERICAN INTERPLEX
CORPORATION
LABORATORIES

1972 2012

May 17, 2012
Control No. 157683

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on May 10, 2012. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

Steve Bradford

Steve Bradford
Deputy Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Eight (8) water sample(s) received on May 10, 2012

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
157683-1	WEC-2 5/9/12 1135	09-May-2012 1135	
157683-2	WEC-2D 5/9/12 1140	09-May-2012 1140	
157683-3	WEC-1 5/9/12 1215	09-May-2012 1215	
157683-4	HC-1 5/9/12 1240	09-May-2012 1240	
157683-5	HC-2 5/9/12 1315	09-May-2012 1315	
157683-6	TB-2 5/9/12 1330	09-May-2012 1330	
157683-7	001 5/9/12 1345	09-May-2012 1345	
157683-8	TB-1 5/9/12 1450	09-May-2012 1450	

Qualifiers:

D	Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 157683-1
Sample Identification: WEC-2 5/9/12 1135

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**160**	10	**mg/l**	
SM 2540C	Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride		**15**	0.2	**mg/l**	
EPA 300.0	Prep: 10-May-2012 1906 by 270	Analyzed: 15-May-2012 2021 by 07		Batch: S32411	

AIC No. 157683-2
Sample Identification: WEC-2D 5/9/12 1140

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**150**	10	**mg/l**	
SM 2540C	Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride		**15**	0.2	**mg/l**	
EPA 300.0	Prep: 10-May-2012 1906 by 270	Analyzed: 15-May-2012 2047 by 07		Batch: S32411	

AIC No. 157683-3
Sample Identification: WEC-1 5/9/12 1215

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**93**	10	**mg/l**	
SM 2540C	Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride		**3.1**	0.2	**mg/l**	
EPA 300.0	Prep: 10-May-2012 1906 by 270	Analyzed: 15-May-2012 2113 by 07		Batch: S32411	

AIC No. 157683-4
Sample Identification: HC-1 5/9/12 1240

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**140**	10	**mg/l**	
SM 2540C	Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride		**5.9**	0.2	**mg/l**	
EPA 300.0	Prep: 10-May-2012 1906 by 270	Analyzed: 15-May-2012 2139 by 07		Batch: S32411	

AIC No. 157683-5
Sample Identification: HC-2 5/9/12 1315

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**370**	10	**mg/l**	
SM 2540C	Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride		**92**	2	**mg/l**	D
EPA 300.0	Prep: 10-May-2012 1906 by 270	Analyzed: 11-May-2012 1819 by 07		Batch: S32411	Dil: 10

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 157683-6
Sample Identification: TB-2 5/9/12 1330

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**540**	10	**mg/l**	
SM 2540C Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride	**150**	2	**mg/l**	D
EPA 300.0 Prep: 10-May-2012 1906 by 270	Analyzed: 11-May-2012 1844 by 07		Batch: S32411	Dil: 10

AIC No. 157683-7
Sample Identification: 001 5/9/12 1345

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**710**	10	**mg/l**	
SM 2540C Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride	**230**	20	**mg/l**	D
EPA 300.0 Prep: 10-May-2012 1906 by 270	Analyzed: 11-May-2012 1910 by 07		Batch: S32411	Dil: 100

AIC No. 157683-8
Sample Identification: TB-1 5/9/12 1450

Analyte	Result	RL	Units	Qualifier
Total Dissolved Solids	**210**	10	**mg/l**	
SM 2540C Prep: 15-May-2012 1111 by 285	Analyzed: 16-May-2012 1053 by 285		Batch: W39844	
Chloride	**19**	2	**mg/l**	D
EPA 300.0 Prep: 10-May-2012 1906 by 270	Analyzed: 11-May-2012 1936 by 07		Batch: S32411	Dil: 10

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219 Brown Lane
Bryant, AR 72022

DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	157683-1	160 mg/l			15May12 1111 by 285	16May12 1053 by 285		
Batch: W39844	Duplicate	140 mg/l	8.05	10.0	15May12 1111 by 285	16May12 1053 by 285		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	95.3	90.0-110			S32411	10May12 1906 by 270	11May12 1426 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	157683-1	20 mg/l	97.0	80.0-120	S32411	10May12 1906 by 270	11May12 1452 by 07		
	157683-1	20 mg/l	97.7	80.0-120	S32411	10May12 1906 by 270	11May12 1518 by 07		
	Relative Percent Difference:		0.646	10.0	S32411				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W39844-1	15May12 1111 by 285	16May12 1053 by 285	
Chloride	< 0.2 mg/l	0.2	0.2	S32411-1	10May12 1906 by 270	11May12 1400 by 07	

157683

GBM^c & Associates
Strategic Environmental Services
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

CLIENT INFORMATION

Company: GBMc & Associates
Project Name/No.:
Send Report To: Greg phillips
Address: 219 Brown Lane
Bryant, AR 72022
Phone/Fax No.:

BILLING INFORMATION

Bill To:
Company: Same
Address:
Phone No:
Fax No.:

SPECIAL INSTRUCTIONS/PRECAUTIONS:

Email results to Greg phillips @ gbmcassoc.com

Parameters for Analysis/Methods

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Chloride	TDS								
1	WEC-2		5/9/12	1135	W	1	G	X	X								
2	WEC-2D			1140		1		X	X								
3	WEC-1			1215		1		X	X								
4	HC-1			1240		1		X	X								
5	HC-2			1315		1		X	X								
6	TB-2			1330		1		X	X								
7	001			1345		1		X	X								
8	TB-1			1450		1		X	X								
	Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)															

Sampler(s): RHW / ENJ
Shipment Method: Delivery
Turnaround Time Required: Normal

COC Completed by: Date: 5/10/12 Time: 0825
COC Checked by: Date: 5/10/12 Time: 0920
Relinquished by: Date: 5/10/12 Time: 1100
Received by: ________ Date: ________ Time: ________
Relinquished by: ________ Date: ________ Time: ________
Received in lab by: Date: 5-10-12 Time: 1100

LABORATORY USE ONLY: Samples Received On Ice?: [✓ YES] or NO Sample Temperature: 2 C

V1.2 04/26/12

AMERICAN INTERPLEX
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LABORATORIES

GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
219 Brown Lane
Bryant, AR 72022

This report contains the analytical results and supporting information for samples submitted on June 22, 2012. Attached please find a copy of the Chain of Custody and/or other documents received. Note that any remaining sample will be discarded two weeks from the original report date unless other arrangements are made.

This report is intended for the sole use of the client listed above. Assessment of the data requires access to the entire document.

This report has been reviewed by the Laboratory Director or a qualified designee.

Steve Bradford

Steve Bradford
Deputy Laboratory Director

This document has been distributed to the following:

PDF cc: GBMc & Associates, Inc.
ATTN: Mr. Greg Phillips
gphillips@gbmcassoc.com

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE INFORMATION

Project Description:

Nine (9) water sample(s) received on June 22, 2012
City of Huntsville

Receipt Details:

A Chain of Custody was provided. The samples were delivered in one (1) ice chest.

Each sample container was checked for proper labeling, including date and time sampled. Sample containers were reviewed for proper type, adequate volume, integrity, temperature, preservation, and holding times. Any exceptions are noted below:

Sample Identification:

Laboratory ID	Client Sample ID	Sampled Date/Time	Notes
158819-1	HC-1 21JUN12 1320	21-Jun-2012 1320	
158819-2	HC-1-2 21JUN12 1325	21-Jun-2012 1325	
158819-3	HC-2 21JUN12 1305	21-Jun-2012 1305	
158819-4	WEC-1 21JUN12 1150	21-Jun-2012 1150	
158819-5	WEC-2 21JUN12 1045	21-Jun-2012 1045	
158819-6	001 21JUN12 1210	21-Jun-2012 1210	
158819-7	TB-1 21JUN12 1220	21-Jun-2012 1220	
158819-8	TB-2 21JUN12 1230	21-Jun-2012 1230	
158819-9	Field Blank		1

Notes:

1. Sample label was incomplete in regard to date/time of sampling

Qualifiers:

D Result is from a secondary dilution factor

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.
"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 158819-1
Sample Identification: HC-1 21JUN12 1320

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**190**	10	**mg/l**	
SM 2540C	Prep: 25-Jun-2012 1410 by 302	Analyzed: 27-Jun-2012 0812 by 302		Batch: W40236	
Chloride		**10**	0.2	**mg/l**	
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1253 by 07		Batch: S32629	

AIC No. 158819-2
Sample Identification: HC-1-2 21JUN12 1325

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**180**	10	**mg/l**	
SM 2540C	Prep: 25-Jun-2012 1410 by 302	Analyzed: 27-Jun-2012 0812 by 302		Batch: W40236	
Chloride		**11**	0.2	**mg/l**	
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1318 by 07		Batch: S32629	

AIC No. 158819-3
Sample Identification: HC-2 21JUN12 1305

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**510**	10	**mg/l**	
SM 2540C	Prep: 25-Jun-2012 1410 by 302	Analyzed: 27-Jun-2012 0812 by 302		Batch: W40236	
Chloride		**180**	2	**mg/l**	D
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1343 by 07		Batch: S32629	Dil: 10

AIC No. 158819-4
Sample Identification: WEC-1 21JUN12 1150

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**110**	10	**mg/l**	
SM 2540C	Prep: 25-Jun-2012 1410 by 302	Analyzed: 27-Jun-2012 0812 by 302		Batch: W40236	
Chloride		**4.1**	0.2	**mg/l**	
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1407 by 07		Batch: S32629	

AIC No. 158819-5
Sample Identification: WEC-2 21JUN12 1045

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**200**	10	**mg/l**	
SM 2540C	Prep: 25-Jun-2012 1410 by 302	Analyzed: 27-Jun-2012 0812 by 302		Batch: W40236	
Chloride		**36**	0.2	**mg/l**	
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1432 by 07		Batch: S32629	

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 158819-6
Sample Identification: 001 21JUN12 1210

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**650**	10	**mg/l**	
SM 2540C	Prep: 27-Jun-2012 1100 by 302	Analyzed: 28-Jun-2012 1354 by 302		Batch: W40266	
Chloride		**210**	2	**mg/l**	D
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1457 by 07		Batch: S32629	Dil: 10

AIC No. 158819-7
Sample Identification: TB-1 21JUN12 1220

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**220**	10	**mg/l**	
SM 2540C	Prep: 27-Jun-2012 1100 by 302	Analyzed: 28-Jun-2012 1354 by 302		Batch: W40266	
Chloride		**24**	0.2	**mg/l**	
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1612 by 07		Batch: S32629	

AIC No. 158819-8
Sample Identification: TB-2 21JUN12 1230

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**570**	10	**mg/l**	
SM 2540C	Prep: 27-Jun-2012 1100 by 302	Analyzed: 28-Jun-2012 1354 by 302		Batch: W40266	
Chloride		**190**	2	**mg/l**	D
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1636 by 07		Batch: S32629	Dil: 10

AIC No. 158819-9
Sample Identification: Field Blank

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**< 10**	10	**mg/l**	
SM 2540C	Prep: 27-Jun-2012 1100 by 302	Analyzed: 28-Jun-2012 1354 by 302		Batch: W40266	
Chloride		**< 0.2**	0.2	**mg/l**	
EPA 300.0	Prep: 22-Jun-2012 1012 by 07	Analyzed: 22-Jun-2012 1753 by 07		Batch: S32629	

GBMc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

DUPLICATE RESULTS

Analyte	AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
Total Dissolved Solids	158760-1	900 mg/l			25Jun12 1410 by 302	27Jun12 0812 by 302		
Batch: W40236	Duplicate	890 mg/l	0.560	10.0	25Jun12 1410 by 302	27Jun12 0812 by 302		
Total Dissolved Solids	158772-1	63000 mg/l			25Jun12 1410 by 302	27Jun12 0812 by 302		
Batch: W40236	Duplicate	62000 mg/l	0.958	10.0	25Jun12 1410 by 302	27Jun12 0812 by 302		
Total Dissolved Solids	158819-6	650 mg/l			27Jun12 1100 by 302	28Jun12 1354 by 302		
Batch: W40266	Duplicate	630 mg/l	3.99	10.0	27Jun12 1100 by 302	28Jun12 1354 by 302		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	20 mg/l	104	90.0-110			S32629	22Jun12 1013 by 07	22Jun12 1138 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Chloride	158819-1	20 mg/l	113	80.0-120	S32629	22Jun12 1013 by 07	22Jun12 1203 by 07		
	158819-1	20 mg/l	111	80.0-120	S32629	22Jun12 1013 by 07	22Jun12 1228 by 07		
	Relative Percent Difference:		1.39	10.0	S32629				

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Total Dissolved Solids	< 10 mg/l	10	10	W40236-1	25Jun12 1410 by 302	27Jun12 0812 by 302	
Total Dissolved Solids	< 10 mg/l	10	10	W40266-1	27Jun12 1100 by 302	28Jun12 1354 by 302	
Chloride	< 0.2 mg/l	0.2	0.2	S32629-1	22Jun12 1013 by 07	22Jun12 1114 by 07	

GBM^c & Associates

219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

15 8819

Client/BILLING Information		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Client:		Please e-mail Greg Phillips gphillips@gbmcassoc.com
Company:	GBM^c & Associates	with results
Address:	219 Brown Lane	
	Bryant, AR 72022	**Project Name / Number:**
Phone No.:	501-847-7077	City of Huntsville
Fax No.:	501-847-7943	

Parameters for Analysis/Methods

	Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Cl, TDS
1	HC-1	Holman Creek	21Jun12	1320	W	1	G	X
2	HC-1-2	Holman Creek	21Jun12	1325	W	1	G	X
3	HC-2	Holman Creek	21Jun12	1305	W	1	G	X
4	WEC-1	War Eagle Creek	21Jun12	1150	W	1	G	X
5	WEC-2	War Eagle Creek	21Jun12	1045	W	1	G	X
6	001	Outfall 001	21Jun12	1210	W	1	G	X
7	TB-1	Town Branch	21Jun12	1220	W	1	G	X
8	TB-2	Town Branch	21Jun12	1230	W	1	G	X
9								

Preservative (Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)

Sampler(s): ENJ/KMB

Shipment Method: Delivered

Turnaround Time Required: Normal

COC Completed by: Nicki Jensen Date: 22Jun12 Time: 830

COC Checked by: Kevin Botdorff Date: 6-22-12 Time: 0835

Relinquished by: Kevin Botdorff Date: 6-22-12 Time: 0924

Received by: ____ Date: ____ Time: ____

Relinquished by: ____ Date: ____ Time: ____

Received in lab by: Date: 6-22-12 Time: 0924

LABORATORY USE ONLY: **Samples Received On Ice?: YES or NO** **Sample Temperature:** ____

V1.2 06/22/12

Appendix C

Whole Effluent Toxicity

A1:AH29Outfall 001 City of Huntsville Toxicity Summary (7-day chronic tox

	Ceriodaphnia dubia (Water Flea)							Pimephales promelas (Fathead Minnow)							WET Chemistry (Maximum values)							Min.					
Date Test initated	Survival Control (%)	Survival 100%	Survival NOEC	Repro. Control	Repro. 100%	Repro. NOEC	Pass/Fail (Lethal/ Sublethal)	Survival Control (%)	Survival 100%	Survival NOEC	Growth Control	Growth 100%	Growth NOEC	Pass/Fail (Lethal/ Sublethal)	Residual Chlorine**	Hardness (Max)	Alkalinity	Sp. Cond. (us/cm)	NH3-N**	pH (Max)	Temp °C	D.O. (Min)	TDS (mg/L) (via SC)***	TDS (mg/L) (from DMR)	Max TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2/3/2009	100	100	100	23.5	25.7	100.0	Pass	97.5	100	100	0.535	0.552	100	Pass	*0.025*	78	36	580	0.63	7.3	25	7.9	377		377		
4/28/2009	100	100	100	20.1	8.2	75.0	Fail (Subleth)	97.5	92.5	100	0.413	0.411	100	Pass	0.06	200	96	1000	*0.05*	7.9	25	7.8	650		650		
7/15/2009	Control Failure Resulted in an Invalid Test						NA	100	97.5	100	0.643	0.629	100	Pass	*0.025*	86	64	310	*0.05*	8.0	25	7.9	201.5				
8/18/2009	100	100	100	15.7	11.7	100.0	Pass	Repeated test for Ceriodaphnia						NA	*0.025*	180	77	890	1.70	7.8	25	7.7	578.5		578.5		
10/27/2009	100	100	100	16.9	23.2	100.0	Pass	100	95	100	0.432	0.496	100	Pass	*0.025*	120	42	460	0.16	7.8	25	7.9	299		299		
2/2/2010	Control Failure Resulted in an Invalid Test						NA	100	100	100	0.585	0.576	100	Pass	0.07	140	52	660	2.80	7.5	25	7.6	429	569	569		
3/16/2010*	100	100	100	17.5	16.9	100.0	Pass	Repeated test for Ceriodaphnia						NA	0.07	110	100	690	0.35	8.2	25	7.7	448.5	582	582		
4/20/2010	100	100	100	20.7	13.0	42.0	Fail (Subleth)	97.5	97.5	100	0.665	0.663	100	Pass	*0.025*	180	110	900	3.10	7.8	25	7.5	585	727	727		
7/27/2010	100	100	100	21.0	21.3	100.0	Pass	100	100	100	0.61	0.662	100	Pass	*0.025*	240	72	1000	1.50	7.6	25	8.0	650	807	807		
10/26/2010	100	100	100	21.7	18.9	100.0	Pass	100	97.5	100	0.451	0.495	100	Pass	0.05	170	72	700	3.90	7.5	25	7.8	455	648	648	210	53
3/1/2011	100	90	100	20.6	23.8	100.0	Pass	100	90	100	0.616	0.546	100	Pass	0.06	220	89	640	0.23	8.0	25	8.0	416	760	760	360	56
5/17/2011	90	100	100	14.9	15.2	100.0	Pass	95	92.5	100	0.409	0.568	100	Pass	*0.05*	180	68	860	0.10	8.0	25	7.4	559	933	933	370	43
8/16/2011	80	100	100	14.0	17.1	100.0	Pass	100	97.5	100	0.467	0.424	100	Pass	*0.025*	220	130	720	2.20	8.4	25	7.4	468	495	495	185	26
11/15/2011	100	100	100	24.4	19.7	100.0	Pass	95	97.5	100	0.528	0.647	100	Pass	*0.05*	170	45	660	0.39	7.4	25	7.4	429	430	430	130	52
1/31/2012	Control Failure Resulted in an Invalid Test						NA	97.5	77.5	100	0.459	0.378	100	Pass	*0.05*	160	90	560	3.80	8.0	25	7.5	364	480	480	140	49
2/28/2012*	100	100	100	18.6	18.5	100.0	Pass	Repeated test for Ceriodaphnia						NA	*0.05*	220	110	1300	0.80	8.0	25	7.2	845	878	878	300	60
5/1/2012	100	90	100	22.4	18.2	100.0	Pass	100	92.5	100	0.363	0.295	100	Pass	*0.05*	250	110	1100	0.38	8.0	25	7.5	715	659	715	240	16
N	14	14	14	14	14	14	--	14	14	14	14	14	14	--	17	17	17	17	17	17	17	17	17	12	16	8	8
AVE	97.9	98.6	100.0	19.4	18.0	94.1	--	98.6	94.8	100.0	0.5	0.5	100.0	--	0.0	172.0	80.2	766.5	1.3	7.8	25.0	7.7	498.2	664.0	620.5	241.9	44.4
MIN	80	90	100	14	8.2	42	--	95	77.5	100	0.363	0.295	100	--	0.025	78	36	310	0.05	7.3	25	7.2	201.5	430	299	130	16
MAX	100	100	100	24.4	25.7	100	--	100	100	100	0.665	0.663	100	--	0.07	250	130	1300	3.9	8.4	25	8	845	933	933	370	60
STD DEV	5.8	3.6	0.0	3.2	4.8	16.4	--	1.9	5.9	0.0	0.1	0.1	0.0	--	0.0	51.6	27.3	247.2	1.4	0.3	0.0	0.2	160.7	161.0	179.0	93.3	15.5
90%TILE	100	100	100	23.17	23.62	100	--	100	100	100	0.6349	0.6575	100	--	0.064	228	110	1040	3.38	8.08	25	7.94	676	870.9	842.5	363	57.2

* Repeated test after prior month control failure

** Values shown in italics for Chlorine and NH3-N are at 1/2 detection limit as data reported by laboratory was < detection

*** Estimated based upon specific conductance

Appendix D

Habitat Data

Habitat Characterization Summary Table Fall 2011- City of Huntsville, AR (Holman Ck, Town Branch, & War Eagle Ck)

Observation	Study Locations					
	HC-1	**HC-2**	**TB-1**	**TB-2**	**WEC-1**	**WEC-2**
Date	10/12/2011	10/12/2011	10/11/2011	10/11/2011	10/13/2011	10/13/2011
General Stream Characteristics:						
Total Habitat Reach Length, ft	1224	1280	600	800	1300	1900
Average Bankfull Width, ft	61.2	64	30	40	71	93.4
Average Bankfull Depth, ft[1]	0.9	2.5	1.6	1.8	2.7	1.85
Average Velocity, fps	0.05	0.17	0.27	0.13	0.37	0.45
Flow, cfs	0.07	2.9	0.82	2.5	4.3	10.8
Morphology Regime						
% Riffle	36	28	25	38	22	15
% Run	26	33	33	38	23	6
% Pool	39	38	43	23	54	79
Depth and Width Regime						
Average Riffle Thalwag Depth, ft.	0.9	0.7	0.5	0.7	0.9	0.7
Average Riffle Overall Depth, ft.	0.4	0.5	0.3	0.5	0.4	0.4
Average Riffle Wetted Width, ft	9.2	24.9	14.3	14.7	18.3	38.8
Average Run Thalwag Depth, ft.	1.0	1.4	0.8	1.3	1.8	1.0
Average Run Overall Depth, ft.	0.6	0.9	0.5	0.7	1.4	0.6
Average Run Wetted Width, ft	13.0	43.4	10.0	28.7	30.0	37.5
Average Pool Thalwag Depth, ft.	2.7	2.7	1.3	2.8	2.0	3.8
Average Pool Overall Depth, ft.	1.8	1.8	0.8	1.7	1.4	2.5
Average Pool Wetted Width, ft	24.8	41.2	--	22.0	65.0	88.7
In-Stream Habitat (Percent Stable Habitat)						
Epifaunal Substrate, Macroinvertebrates	68	68	55	72	68	50.5
In-Stream Cover, Fish	71	72	59	76	72	67
Substrate Characterization (Dominate Substrate)						
Riffle	Coarse Gravel	Coarse Gravel	Boulder	Cobble	Coarse Gravel	Coarse Gravel
Run	Coarse Gravel	Coarse Gravel	Boulder	Cobble/Fine Gravel	Coarse Gravel	Coarse Gravel
Pool	Coarse Gravel	Coarse Gravel	Bedrock	Cobble	Coarse Gravel	Coarse Gravel
Embeddedness						
% Embeddedness	30	48	35	33	25	27
Sediment Deposition						
Average Percent of Bottom Affected	8	20	14	9	20	53
Aquatic Macrophytes and Periphyton (Percent Coverage)						
Average Riffle Macrophytes	0	3	2	1	15	10
Average Riffle Periphyton	81	75	70	70	75	66
Average Run Macrophytes	3	5	1	4	14	8
Average Run Periphyton	74	68	68	57	63	75
Average Pool Macrophytes	3	5	2	2	7	5
Average Pool Periphyton	70	53	75	72	41	32
Canopy Cover (Percent Stream Shading)						
Stream Shading	20	33	55	61	32	22
Bank Stability and Slope						
Average Left Bank Stability	8	5	5	7	6	5
Average Left Bank Slope (degrees)	42	70	59	49	75	76
Average Right Bank Stability	4	6	5	7	6	6

Habitat Characterization Summary Table Fall 2011- City of Huntsville, AR (Holman Ck, Town Branch, & War Eagle Ck)

	Study Locations					
Observation	**HC-1**	**HC-2**	**TB-1**	**TB-2**	**WEC-1**	**WEC-2**
Date	10/12/2011	10/12/2011	10/11/2011	10/11/2011	10/13/2011	10/13/2011
Average Right Bank Slope (degrees)	77	70	60	49	59	69
Bank Vegetative Protection						
Average Left Bank Protection (percent)	77	70	54	72	76	77
Average Right Bank Protection (percent)	50	79	53	75	72	74
Riparian Vegetative Zone Width						
Average Left Bank Riparian Width, meters	7	2	4	8	2	3
Average Right Bank Riparian Width, meters	2	7	3	3	9	7
Land-Use Stream Impacts						
Impacts	Pasture-minor	Pasture-minor	Industrial & Urban-moderate	Cattle-minor	Cattle-moderate/Urban-minor	Pasture-minor

Habitat Characterization Summary Table Spring 2012 - City of Huntsville, AR (Holman Ck, Town Branch, & War Eagle Ck)

	Study Locations					
Observation	**HC-1**	**HC-2**	**TB-1**	**TB-2**	**WEC-1**	**WEC-2**
Date	4/10/2012	4/10/2012	4/10/2012	4/10/2012	4/11/2012	4/11/2012
General Stream Characteristics:						
Total Habitat Reach Length, ft	1564	1196	600	850	1300	1900
Average Bankfull Width, ft	78.2	59.8	30	40	71	93.4
Average Bankfull Depth, ft[1]	2.05	3.2	1.6	1.8	2.7	1.85
Average Velocity, fps	0.09	0.60	0.50	0.20	0.76	0.7
Flow, cfs	3.74	7.70	1.88	2.68	61.4	72.3
Morphology Regime						
% Riffle	40	27	47	51	8	13
% Run	33	26	25	17	15	16
% Pool	28	47	28	32	77	72
Depth and Width Regime						
Average Riffle Thalwag Depth, ft.	0.7	0.6	0.7	0.7	1.5	1.4
Average Riffle Overall Depth, ft.	0.4	0.4	0.4	0.5	1.0	0.9
Average Riffle Wetted Width, ft	15.6	20.7	15.0	14.8	25.3	35.6
Average Run Thalwag Depth, ft.	1.0	1.1	1.2	0.7	1.9	1.9
Average Run Overall Depth, ft.	0.5	0.7	0.7	0.4	1.4	1.1
Average Run Wetted Width, ft	19.0	23.9	13.4	21.3	47.0	39.4
Average Pool Thalwag Depth, ft.	2.7	3.0	1.5	1.9	4.7	4.7
Average Pool Overall Depth, ft.	1.4	1.8	1.0	1.1	3.5	2.9
Average Pool Wetted Width, ft	26.0	26.6	18.6	19.6	74.4	50.9
In-Stream Habitat (Percent Stable Habitat)						
Epifaunal Substrate, Macroinvertebrates	69	64	50	55	33	34.5
In-Stream Cover, Fish	62	59	52	57	46	48
Substrate Characterization (Dominate Substrate)						
Riffle	Cobble	Coarse Gravel	Boulder	Cobble	Coarse Gravel	Coarse Gravel
Run	Cobble	Coarse Gravel	Cobble	Fine Gravel	Coarse Gravel	Coarse Gravel
Pool	Coarse Gravel	Coarse Gravel	Boulder	Cobble	Coarse Gravel/Silt,Clay	Coarse Gravel/Sand
Embeddedness						
% Embeddedness	13	11	18	25	13	10
Sediment Deposition						
Average Percent of Bottom Affected	5	10	19	10	26	25
Aquatic Macrophytes and Periphyton (Percent Coverage)						
Average Riffle Macrophytes	0	0	0	0	10	3
Average Riffle Periphyton	58	62	56	65	65	47
Average Run Macrophytes	0	0	0	0	4	5
Average Run Periphyton	49	45	61	35	55	50
Average Pool Macrophytes	0	0	0	0	1	0
Average Pool Periphyton	43	24	43	30	10	6
Canopy Cover (Percent Stream Shading)						
Stream Shading	30	55	51	60	35	25
Bank Stability and Slope						
Average Left Bank Stability	8	7	7	9	6	7

Habitat Characterization Summary Table Spring 2012 - City of Huntsville, AR (Holman Ck, Town Branch, & War Eagle Ck)

Observation	**Study Locations**					
	HC-1	**HC-2**	**TB-1**	**TB-2**	**WEC-1**	**WEC-2**
Date	4/10/2012	4/10/2012	4/10/2012	4/10/2012	4/11/2012	4/11/2012
Average Left Bank Slope (degrees)	37	54	54	45	68	72
Average Right Bank Stability	6	7	6	8	8	6
Average Right Bank Slope (degrees)	56	62	54	43	72	61
Bank Vegetative Protection						
Average Left Bank Protection (percent)	74	75	53	80	61	65
Average Right Bank Protection (percent)	53	74	54	71	73	71
Riparian Vegetative Zone Width						
Average Left Bank Riparian Width, meters	6	3	3	7	2	8
Average Right Bank Riparian Width, meters	3	10	3	2	2	5
Land-Use Stream Impacts						
Impacts	Cattle-moderate/Bridge-minor	Cattle-moderate	Industrial & Urban- moderate	Cattle-minor	Cattle-moderate/Industrial-minor	Cattle-minor

Appendix E

Macroinvertebrate Data

Macroinvertebrates identified from WEC-1, WEC-2, TB-1, TB-2, HC-1, and HC-2 subsamples collected in War Eagle Creek in Madison County, AR during the fall of 2011.

Taxa/Station I.D.	Biotic Index*	Trophic Group	Station Sampled in Fall 2011					
			WEC-1	WEC-2	TB-1	TB-2	HC-1	HC-2
TURBELLARIA								
Planariidae	8	GC	0	0	0	0	0	0
COLLEMBOLA								
Isotomidae	-	GC	0	2	0	1	0	9
ANNELIDA								
Hirudinea	7.8	PR	1	0	0	0	1	0
Oligochaeta	9.2	GC	3	1	1	2	4	9
GASTROPODA								
Ancylidae	6	SC	0	2	0	0	0	0
Physa	9.1	SC	18	53	1	9	2	52
Planorbidae	---	SC	0	2	0	0	1	0
BIVALVIA								
Sphaeriidae	7.7	FC	8	37	1	5	0	7
CRUSTACEA								
Amphipoda	7.9	GC	6	2	0	1	29	2
Cambaridae	6	GC	0	1	1	1	2	0
Isopoda	7.7	GC	0	0	0	0	2	0
EPHEMEROPTERA								
Anthopotamus	3.6	FC	1	0	0	0	0	1
Baetis	6	GC	12	57	41	98	37	137
Americaenis	7.6	GC	0	2	0	0	0	0
Caenis	7.6	GC	216	325	77	13	60	17
Callibaetis	9.3	GC	0	4	0	4	0	0
Choroterpes	2	GC	0	0	0	0	6	0
Isonychia	3.8	FC	0	1	0	0	4	0
Stenacron	7.1	GC	0	0	0	0	1	0
Stenonema	3.4	SC	20	76	10	0	82	6
Tricorythodes	5.4	GC	5	50	0	0	4	26
ODONATA								
Aeshnidae	8	PR	0	0	0	1	0	0
Argia	8.7	PR	4	2	7	20	0	8
Arigomphus	6.4	PR	0	0	1	0	0	0
Basiaeschna	7.7	PR	0	1	0	0	0	0
Calopteryx	8.3	PR	0	0	1	0	0	1
Enallagma	9	PR	5	4	0	2	2	6

Taxa/Station I.D.	Biotic Index*	Trophic Group	Station Sampled in Fall 2011					
			WEC-1	WEC-2	TB-1	TB-2	HC-1	HC-2
Gomphus	6.2	PR	2	0	0	0	0	1
Hetaerina	6.2	PR	0	6	0	1	0	0
Ischnura	9.4	PR	0	0	0	3	0	0
Lanthus	2.7	PR	0	0	0	2	4	0
Macromia	6.7	PR	0	0	0	0	0	1
Progomphus	8.7	PR	1	0	6	4	0	1
PLECOPTERA								
Neoperla	1.6	PR	16	9	0	0	0	3
Perlidae	1	PR	0	0	0	0	9	0
Zealeuctra	0	SH	0	0	0	0	1	0
HEMIPTERA								
Corixidae	6	PR	0	0	0	1	0	0
Rheumatobates	6.4	PR	0	0	0	0	0	1
Saldidae	10	PR	0	0	0	1	0	0
MEGALOPTERA								
Corydalus	5.6	PR	2	3	0	0	1	1
TRICHOPTERA								
Branchycentrus	3.5	GC	1	0	0	0	0	1
Chematopsyche	6.6	FC	243	99	70	366	10	82
Chimarra	2.8	FC	2	6	26	152	3	7
Helicopsyche	0	SC	0	0	2	0	0	0
Hydropsyche	4	FC	0	0	6	6	1	0
Hydroptila	6.2	SC	0	0	1	0	0	0
Polycentropus	3.5	PR	0	0	0	0	3	0
COLEOPTERA								
Ancyronyx (larvae)	6.9	SC	1	0	0	0	0	0
Ancyronyx (adult)	6.9	SC	1	3	0	0	0	0
Dubiraphia (larvae)	6.4	GC	3	5	0	0	0	0
Dubiraphia (adult)	6.4	GC	1	1	0	0	0	0
Ectopria	4.3	SC	0	0	1	0	0	0
Helichus	5.4	SC	0	21	0	0	1	0
Macronychus (larvae)	4.7	SH	0	2	0	0	0	1
Macronychus (adult)	4.7	SH	0	0	0	0	0	3
Peltodytes	8.5	SH	1	0	0	0	0	0
Psephenus	2.5	SC	1	2	16	4	52	16
Stenelmis (larvae)	5.4	SC	22	29	17	22	5	61
Stenelmis (adult)	5.4	GC	4	4	1	12	0	4

Taxa/Station I.D.	Biotic Index*	Trophic Group	Station Sampled in Fall 2011					
			WEC-1	WEC-2	TB-1	TB-2	HC-1	HC-2
Tropisternus	9.8	PR	0	0	0	0	0	4
DIPTERA								
Ceratopogonidae	5.6	PR	0	0	1	0	4	3
Chironomini	8	GC	244	108	66	80	32	9
Ortholadiinae	8	GC	108	21	17	82	82	4
Tanypodinae	8	PR	12	10	11	43	15	1
Nemotelus	-	-	0	0	1	1	0	4
Diptera Sp.1	---	GC	0	0	0	0	1	0
Hemerodromia	6	PR	0	0	0	0	1	0
Forcipomyia	6	SC	0	0	0	0	4	0
Prosimulium	2.6	FC	0	0	1	4	0	2
Psychoda	9.9	GC	0	0	0	0	0	1
Simulium	4.4	FC	19	15	7	0	2	0
Tabanidae	8	PR	0	0	2	0	1	2
Tipula	7.7	SH	2	0	2	3	0	1
Total Abundance:			985	966	395	944	469	495

**All B.I. values are from Sarver 2001 (MDNR) or EPA RBA doc. (1999) and values are either family/genus/species specific or the highest value represented for that family/genus if specifics are unavailable.*

Macroinvertebrates identified from WEC-1, WEC-2, TB-1, TB-2, HC-1, and HC-2 subsamples collected in War Eagle Creek in Madison County, AR during the spring of 2012.

Taxa/Station I.D.	Biotic Index*	Trophic Group	Station Sampled in Spring 2012					
			WEC-1	**WEC-2**	**TB-1**	**TB-2**	**HC-1**	**HC-2**
COLLEMBOLA								
Isotomidae	-	GC	0	1	0	0	0	1
ANNELIDA								
Hirudinea	7.8	PR	0	1	0	29	0	0
Oligochaeta	9.2	GC	5	7	8	28	5	9
GASTROPODA								
Physa	9.1	SC	3	27	12	54	1	8
Planorbidae	---	SC	0	1	0	0	0	1
BIVALVIA								
Sphaeriidae	7.7	FC	3	3	0	0	0	0
CRUSTACEA								
Amphipoda	7.9	GC	1	2	0	0	0	0
Cambaridae	6	GC	3	2	7	0	4	2
Isopoda	7.7	GC	0	0	2	0	8	4
EPHEMEROPTERA								
Baetis	6	GC	47	26	86	18	238	178
Caenis	7.6	GC	18	42	77	42	30	43
Callibaetis	9.3	GC	7	6	2	0	0	1
Leptophlebia	6.4	GC	3	6	0	0	4	1
Stenonema	3.4	SC	15	15	2	0	8	14
Tricorythodes	5.4	GC	8	11	0	1	0	10
ODONATA								
Argia	8.7	PR	0	0	3	6	0	0
Calopteryx	8.3	PR	0	0	2	1	0	3
Enallagma	9	PR	3	4	8	8	1	9
Hagenius	4	PR	0	0	1	1	0	0
Hetaerina	6.2	PR	0	0	1	0	0	0
Ischnura	9.4	PR	2	2	0	4	0	0
Ladona	---	PR	0	0	0	2	0	0
Macromia	6.7	PR	0	0	1	0	0	0
Progomphus	8.7	PR	0	1	0	0	0	0
Stylogomphus	4.8	PR	0	0	1	1	0	0
PLECOPTERA								
Amphinemura	3.4	SH	0	0	0	0	4	0
Attaneuria	2.75	PR	10	4	0	0	3	2

Taxa/Station I.D.	Biotic Index*	Trophic Group	Station Sampled in Spring 2012					
			WEC-1	**WEC-2**	**TB-1**	**TB-2**	**HC-1**	**HC-2**
Haploperla	1.3	PR	0	0	0	0	2	2
Isoperla	2	PR	0	0	0	0	8	0
Neoperla	1.6	PR	2	5	0	0	21	1
Perlesta	0	PR	1	5	0	0	4	4
Zealeuctra	0	SH	0	0	1	0	0	1
MEGALOPTERA								
Corydalus	5.6	PR	4	0	0	0	0	0
Sialis	7.5	PR	0	0	0	0	1	1
TRICHOPTERA								
Chematopsyche	6.6	FC	38	25	208	82	29	244
Chimarra	2.8	FC	2	5	13	18	7	2
Helicopsyche	0	SC	0	0	2	0	0	0
Hydropsyche	4	FC	1	0	9	27	0	0
Hydroptila	6.2	SC	2	0	0	0	3	0
Orthotrichia	7.2	GC	0	0	1	0	0	0
Polycentropus	3.5	PR	0	0	0	0	1	0
COLEOPTERA								
Ancyronyx (larvae)	6.9	SC	0	3	0	0	0	0
Ancyronyx (adult)	6.9	SC	0	3	0	0	0	0
Dubiraphia (larvae)	6.4	GC	0	1	0	0	0	0
Dubiraphia (adult)	6.4	GC	0	2	0	0	0	0
Macronychus (larvae)	4.7	SH	1	0	0	0	0	2
Macronychus (adult)	4.7	SH	0	0	0	0	0	0
Psephenus	2.5	SC	1	0	11	2	24	6
Stenelmis (larvae)	5.4	SC	9	6	8	5	8	20
Stenelmis (adult)	5.4	GC	0	2	13	3	1	2
DIPTERA								
Ceratopogonidae	5.6	PR	1	1	0	0	5	0
Chironomini	8	GC	158	130	230	105	161	208
Ortholadiinae	8	GC	66	47	117	96	86	39
Tanypodinae	8	PR	3	13	41	8	23	7
Culicidae	---	GC	0	0	0	0	0	1
Prosimulium	2.6	FC	0	0	55	0	0	2
Psychoda	9.9	GC	0	0	0	0	4	1
Simulium	4.4	FC	36	48	10	22	56	77
Tipula	7.7	SH	1	0	2	1	2	1
Total Abundance:			454	457	934	564	752	907

**All B.I. values are from Sarver 2001 (MDNR) or EPA RBA doc. (1999) and values are either family/genus/species specific or the highest value represented for that family/genus if specifics are unavailable*

Appendix F

Macroinvertebrate Analysis (Equations)

Hilsenhoff Biotic Index (HBI):

$$HBI = \frac{\sum n_i \times a_i}{N};$$

n = number of specimens in taxa i
a = tolerance value of taxa i
N = total number of specimens in sample

Quantitative Similarity Index (QSI):

$$QSI= \sum \min (pia, pib)$$

pia= The relative abundance of species i at station A (upstream)

pib = The relative abundance of species i at station B (downstream)

Indicator Assemblage Index (IAI):

$$IAI= 0.5 (\%EPTb / \%EPTa + \%CAa / \%Cab)$$

0.5= constant

% EPTb= Total relative abundance of ephemeropterans, plecopterans, and trichopterans at station B (downstream)

% EPTa= Total relative abundance of ephemeropterans, plecopterans, and trichopterans at station A (upstream)

%CAa= Total relative abundaces of Chironomids and annelids at Station A (upstream)

%CAb= Total relative abundaces of Chironomids and annelids at Station B (downstream)

Appendix G

Fish Data

FISH COMMUNITY BIOCRITERIA

Ozark Highlands Streams (All Watersheds)

METRIC	5	3	1
% Sensitive Individuals	>31	31 - 20	<20
% Cyprinidae (Minnows)	48 – 64	39 – 47 or 65 – 73	<39 or >73
% Ictaluridae (Catfishes)	>2[1]	1 - 2[1]	<1 or >3% bullheads
% Centrarchidae (Sunfishes)	4 - 15[2]	<4 or 15 - 20[2]	>20 or >2% Green sunfish
% Percidae (Darters)	>11	5 – 11	<5
% Primary Feeders	<42	42 – 49	>49
% "Key" Individuals	>23	23 – 16	<16
Diversity	>2.77	2.77 – 2.37	<2.37
# Species	>(wtrshd*0.034)+16.45	>(wtrshd*0.034)+16.45 to (wtrshd*0.034)+12.26	<(wtrshd*0.034)+12.26

[1] no more than 3% bullheads
[2] no more than 2% Green sunfish
*if a raw metric score is zero, score as zero, except for Primary Feeders

Total Score

37-45	Mostly Similar
25-36	Generally Similar
13-24	Somewhat Similar
12-0	Not Similar

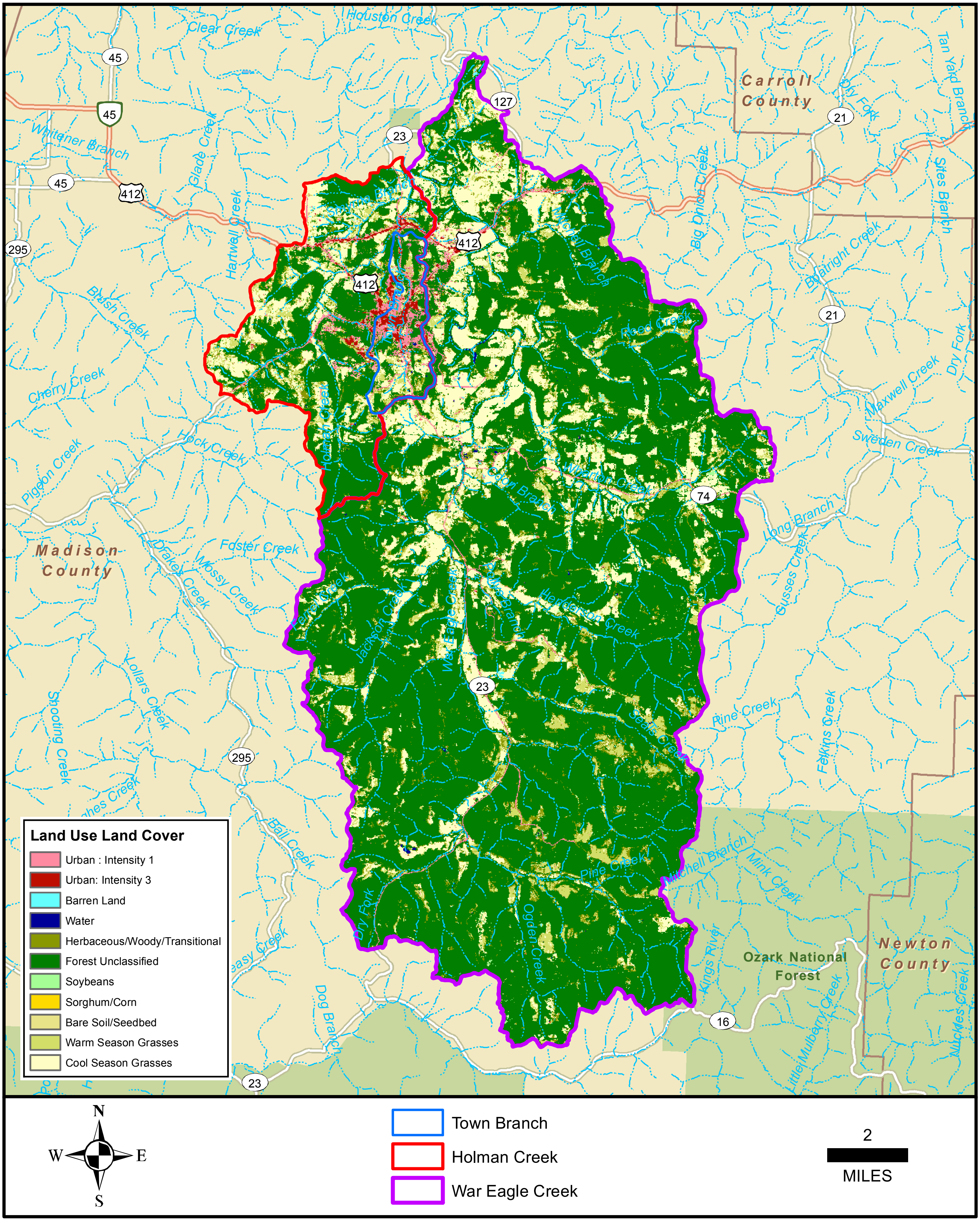
Raw fish numbers for stations of the Town Branch, Holman Creek, and War Eagle Creek in Fall 2011.

Scientific Name	Common Name	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
PETROMYZONTIDAE							
Ichthyomyzon spp.		0	0	0	0	1	0
CYPRINIDAE							
Campostoma anomalum	central stoneroller	237	219	176	49	47	12
Cyprinella whipplei	steelcolor shiner	0	1	0	17	25	5
Luxilus pilsbryi[1]	duskystripe shiner	35	39	39	87	16	5
Luxilus chrysocephalus	striped shiner	21	5	0	0	0	0
Notropis boops	bigeye shiner	0	0	0	2	4	0
Notropis atherinoides	emerald shiner	0	0	0	0	0	3
Notropis nubilis[2]	ozark minnow	251	138	20	65	20	5
Notropis telescopus	telescope shiner	0	0	0	1	0	0
Phoxinus erythrogster[2]	southern redbelly dace	0	0	9	0	0	0
Pimehpales notatus	bluntnose minnow	13	11	8	12	12	3
Semotilus atromaculatus	creek chub	5	0	9	0	0	0
CATOSTOMIDAE							
Hypentelium nigricans[1]	northern hog sucker	0	2	4	3	2	3
Moxostoma duquesnei	black redhorse	0	0	0	2	0	1
Moxostoma erythrurm	golden redhorse	0	0	0	0	0	2
FUNDULIDAE							
Fundulus olivaceus	blackspotted topminnow	0	0	2	2	4	1
Fundulus catenatus	northern studfish	16	6	18	0	0	0
POECILIIDAE							
Gambusia affinis	mosquitofish	0	0	0	0	1	0
ICTALURIDAE							
Noturus exilis[1]	slender madtom	8	10	12	7	1	0
Noturus albater[2]	ozark madtom	0	0	0	0	2	14
Ameiurus natalis	yellow bullhead	3	7	1	5	1	0
CENTRARCHIDAE							
Ambloplites constellatus[1]	ozark bass	0	0	0	1	3	4
Lepomis cyanellus	green sunfish	12	7	4	8	23	4
Lepomis gulosus	warmouth	0	0	0	0	0	2
Lepomis macrochirus	bluegill sunfish	1	3	0	1	1	3
Lepomis megalotis	longear sunfish	37	53	42	94	199	72
Micropterus salmoides	largemouth bass	0	0	1	0	0	1
Micropterus dolomieu[1]	smallmouth bass	1	1	0	0	0	0
Micropterus punctulatus	spotted bass	0	0	0	0	6	7

Scientific Name	Common Name	TB-1	TB-2	HC-1	HC-2	WEC-1	WEC-2
PERCIDAE							
Etheostoma blennioides	greenside darter	1	0	3	3	10	7
Etheostoma caeruleum[1]	rainbow darter	42	31	55	48	54	50
Etheostoma juliae	yoke darter	0	0	0	0	8	87
Etheostoma punctulatum	stippled darter	0	0	1	0	0	0
Etheostoma stigmaeum	speckled darter	0	0	0	0	3	2
Etheostoma zonale	banded darter	0	0	0	0	7	22
Percina caproides	Logperch	0	0	0	1	1	0
COTTIDAE							
Cottus carolinae[2]	banded sculpin	7	7	4	0	2	24
Total Fish Collected		690	540	408	408	453	339

Appendix H

Land-Use Analysis


Land Use Land Cover
Urban : Intensity 1
Urban: Intensity 3
Barren Land
Water
Herbaceous/Woody/Transitional
Forest Unclassified
Soybeans
Sorghum/Corn
Bare Soil/Seedbed
Warm Season Grasses
Cool Season Grasses
Town Branch
Holman Creek
War Eagle Creek
N
W
E
S
2
MILES
Carroll County
Madison County
Newton County
Ozark National Forest
Clear Creek
Houston Creek
Whitener Branch
Glade Creek
Hartwell Creek
Brush Creek
Cherry Creek
Pigeon Creek
Hock Creek
Holman Creek
Drakes Creek
Mossy Creek
Foster Creek
Lollars Creek
Shooting Creek
Ball Creek
Dog Branch
Big Dinon Creek
Boatright Creek
Reed Creek
Wharton Creek
Maxwell Creek
Sweden Creek
Long Branch
Gusses Creek
Henderson Creek
Jackson Creek
War Eagle Creek
Pine Creek
Felkins Creek
Mitchell Branch
Mink Creek
Kings River
Little Mulberry Creek
Ogden Creek
Dry Fork
Sites Branch
Tan Yard Branch
45
412
295
23
127
21
74
16

Appendix I

Data Used for 95th Percentile Calculations

TB-2 Town Branch Downstream from Huntsville's Outfall
All Data Collected by GBMc

Date	Location	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	TB-2	250	40	900
8/24/2011	TB-2	150	62.0	530
9/14/2011	TB-2	200	--	680
10/12/2011	TB-2	130	50.0	620
11/17/2011	TB-2	80	--	270
12/8/2011	TB-2	42	--	250
1/18/2012	TB-2	100	--	380
2/16/2012	TB-2	41	--	240
3/27/2012	TB-2	30	--	220
4/10/2012	TB-2	79	52	420
5/9/2012	TB-2	150	--	540
6/21/2012	TB-2	190	--	570
	Minimum	30	40	220
	Maximum	250	62	900
	Average	120	51	468
	St Dev	70	9	210
	95th	223	61	779
	N	12	4	12

WEC-2 War Eagle Creek Downstream from Holman
All Data Collected by GBMc

Date	Location	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	WEC-2	22.0	7.2	270.0
8/24/2011	WEC-2	14.0	10.0	150.0
9/14/2011	WEC-2	42.0	--	230.0
10/13/2011	WEC-2	35.0	19.0	230.0
11/17/2011	WEC-2	7.0	--	110.0
12/8/2011	WEC-2	4.6	--	80.0
1/18/2012	WEC-2	6.6	--	94.0
2/16/2012	WEC-2	3.5	--	72.0
3/27/2012	WEC-2	2.9	--	82.0
4/10/2012	WEC-2	6.0	8.2	110.0
5/9/2012	WEC-2	15.0	--	160.0
6/21/2012	WEC-2	36.0	--	200.0
	Minimum	3	7	72
	Maximum	42	19	270
	Average	16	11	149
	St Dev	14	5	69
	95th	39	18	248
	N	12	4	12

HC-2 Holman Creek Station Downstream from Town Branch
ADEQ WHI0070 + GBMc Data
Data shown in red are from the GBMc Study

Date	Chloride (mg/l)	Sulfate (mg/l)	TDS (mg/l)
4/7/2009	22.1	11.6	149
5/19/2009	29.8	13.5	181
6/23/2009	85	18	336
7/21/2009	43.7	20.9	247
8/10/2009	62.2	19.7	246
9/15/2009	77.5	25.6	342
10/13/2009	5.42	6.94	118
11/2/2009	14.6	13	128
12/1/2009	25.8	19.6	182
1/12/2010	37.8	21.7	212
2/23/2010	12.6	12.8	129
3/16/2010	24.3	21.2	168
4/13/2010	26.8	17.1	166
5/4/2010	35.5	24.3	215
6/16/2010	90.2	34.8	324
7/20/2010	16.5	30.5	354
8/10/2010	265	39.8	790
9/21/2010	43.9	26.3	252
10/26/2010	108	35.2	365
11/21/2010	121	40.1	461
12/28/2010	78.1	36.8	337
1/25/2011	94.7	42.5	370
2/22/2011	37	25.8	219
3/29/2011	44.1	24.4	213
4/26/2011	4.69	7.32	64
5/17/2011	35.2	17.1	191
6/14/2011	95.4	22.7	292
7/7/2011	150	27	630
7/18/2011	168	31.9	505
8/16/2011	28.4	23	216
8/20/2011	96.3	42.4	368
8/24/2011	83	41	340
9/14/2011	180	--	610
10/12/2011	87	44	620
10/18/2011	99.1	45.6	332
11/15/2011	26.9	24.4	186
11/17/2011	27	--	180
12/8/2011	16	--	150
12/12/2011	20.1	18.7	158
1/18/2012	38	--	210
1/30/2012	12.8	14	119
2/16/2012	5	--	140
2/28/2012	38.2	21	185
3/27/2012	9.7	12.7	120
3/27/2012	10	--	130
4/10/2012	32	28	220
4/23/2012	59.8	36.9	272
5/1/2012	87.5	37.5	341
5/9/2012	92	--	370
6/21/2012	180	--	510
6/26/2012	170	58.6	566
7/24/2012	270	61.4	738

Date	Chloride (mg/l)	Sulfate (mg/l)	TDS (mg/l)
8/28/2012	219	58.3	622
9/24/2012	174	47.6	524
10/23/2012	117	33.1	416
11/13/2012	114	46.9	414
12/10/2012	65.9	35.5	292
1/15/2013	40.4	35.8	243
2/4/2013	37.2	27.9	217
3/25/2013	17.1	17.3	134
4/23/2013	20.2	15.2	147
5/28/2013	28.4	15.1	198
6/25/2013	114	30.6	395
7/29/2013	94.9	37.9	369
8/13/2013	13.7	15.7	164
9/24/2013	134	34.3	457
10/22/2013	56.2	26	277
11/18/2013	86.4	35	364
12/16/2013	21.3	17.2	164
1/28/2014	50.2	24.6	226
2/10/2014	43.2	24.1	216
3/11/2014	25.4	16.9	143
4/8/2014	8.4	9.88	105
5/13/2014	18.3	15	152
6/3/2014	40.4	20	219
Minimum	5	7	64
Maximum	270	61	790
Average	68	27	290
St Dev	60	13	160
95th	180	47	621
N	75	67	75

Final Criteria Calculations

TB-2 Town Branch Downstream from Huntsville's Outfall

All Data Collected by GBMc

Date	Location	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	TB-2	250	40	900
8/24/2011	TB-2	150	62.0	530
9/14/2011	TB-2	200	--	680
10/12/2011	TB-2	130	50.0	620
11/17/2011	TB-2	80	--	270
12/8/2011	TB-2	42	--	250
1/18/2012	TB-2	100	--	380
2/16/2012	TB-2	41	--	240
3/27/2012	TB-2	30	--	220
4/10/2012	TB-2	79	52	420
5/9/2012	TB-2	150	--	540
6/21/2012	TB-2	190	--	570
	95th	**223**	**61**	**779**
	N	12	4	12

Final Criteria Calculations

WEC-2 War Eagle Creek Downstream from Holman

All Data Collected by GBMc

Date	Location	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
7/7/2011	WEC-2	22.0	7.2	270.0
8/24/2011	WEC-2	14.0	10.0	150.0
9/14/2011	WEC-2	42.0	--	230.0
10/13/2011	WEC-2	35.0	19.0	230.0
11/17/2011	WEC-2	7.0	--	110.0
12/8/2011	WEC-2	4.6	9.4	80.0
1/18/2012	WEC-2	6.6	--	94.0
2/16/2012	WEC-2	3.5	--	72.0
3/27/2012	WEC-2	2.9	--	82.0
4/10/2012	WEC-2	6.0	8.2	110.0
5/9/2012	WEC-2	15.0	--	160.0
6/21/2012	WEC-2	36.0	--	200.0
	95th	39	17	248
	N	12	5	12

Final Criteria Calculations

HC-2 Holman Creek Station Downstream from Town Branch

ADEQ WHI0070 + GBMc Data

Data shown in red are from the GBMc Study

Date	Chloride (mg/l)	Date Sampled	Sulfate (mg/l)	Date Sampled	TDS (mg/l)
4/7/2009	22.1	4/7/2009	11.6	4/7/2009	149
5/19/2009	29.8	5/19/2009	13.5	5/19/2009	181
6/23/2009	85	6/23/2009	18	6/23/2009	336
7/21/2009	43.7	7/21/2009	20.9	7/21/2009	247
8/10/2009	62.2	8/10/2009	19.7	8/10/2009	246
9/15/2009	77.5	9/15/2009	25.6	9/15/2009	342
10/13/2009	5.42	10/13/2009	6.94	10/13/2009	118
11/2/2009	14.6	11/2/2009	13	11/2/2009	128
12/1/2009	25.8	12/1/2009	19.6	12/1/2009	182
1/12/2010	37.8	1/12/2010	21.7	1/12/2010	212
2/23/2010	12.6	2/23/2010	12.8	2/23/2010	129
3/16/2010	24.3	3/16/2010	21.2	3/16/2010	168
4/13/2010	26.8	4/13/2010	17.1	4/13/2010	166
5/4/2010	35.5	5/4/2010	24.3	5/4/2010	215
6/16/2010	90.2	6/16/2010	34.8	6/16/2010	324
7/20/2010	16.5	7/20/2010	30.5	7/20/2010	354
8/10/2010	265	8/10/2010	39.8	8/10/2010	790
9/21/2010	43.9	9/21/2010	26.3	9/21/2010	252
10/26/2010	108	10/26/2010	35.2	10/26/2010	365
11/21/2010	121	11/21/2010	40.1	11/21/2010	461
12/28/2010	78.1	12/28/2010	36.8	12/28/2010	337
1/25/2011	94.7	1/25/2011	42.5	1/25/2011	370
2/22/2011	37	2/22/2011	25.8	2/22/2011	219
3/29/2011	44.1	3/29/2011	24.4	3/29/2011	213
4/26/2011	4.69	4/26/2011	7.32	4/26/2011	64
5/17/2011	35.2	5/17/2011	17.1	5/17/2011	191
6/14/2011	95.4	6/14/2011	22.7	6/14/2011	292
7/7/2011	150	7/7/2011	27	7/7/2011	630
7/18/2011	168	7/18/2011	31.9	7/18/2011	505
8/16/2011	28.4	8/16/2011	23	8/16/2011	216
8/20/2011	96.3	8/20/2011	42.4	8/20/2011	368
8/24/2011	83	8/24/2011	41	8/24/2011	340
9/14/2011	180	10/12/2011	44	9/14/2011	610
10/12/2011	87	10/18/2011	45.6	10/12/2011	620
10/18/2011	99.1	11/15/2011	24.4	10/18/2011	332
11/15/2011	26.9	12/12/2011	18.7	11/15/2011	186
11/17/2011	27	1/30/2012	14	11/17/2011	180
12/8/2011	16	2/28/2012	21	12/8/2011	150
12/12/2011	20.1	3/27/2012	12.7	12/12/2011	158
1/18/2012	38	4/10/2012	28	1/18/2012	210
1/30/2012	12.8	4/23/2012	36.9	1/30/2012	119

2/16/2012	5
2/28/2012	38.2
3/27/2012	9.7
3/27/2012	10
4/10/2012	32
4/23/2012	59.8
5/1/2012	87.5
5/9/2012	92
6/21/2012	180
6/26/2012	170
7/24/2012	270
8/28/2012	219
9/24/2012	174
10/23/2012	117
11/13/2012	114
12/10/2012	65.9
1/15/2013	40.4
2/4/2013	37.2
3/25/2013	17.1
4/23/2013	20.2
5/28/2013	28.4
6/25/2013	114
7/29/2013	94.9
8/13/2013	13.7
9/24/2013	134
10/22/2013	56.2
11/18/2013	86.4
12/16/2013	21.3
1/28/2014	50.2
2/10/2014	43.2
3/11/2014	25.4
4/8/2014	8.4
5/13/2014	18.3
6/3/2014	40.4
Minimum	**5**
Maximum	270
Average	68
St Dev	60
95th	180
N	75

5/1/2012	37.5
6/26/2012	58.6
7/24/2012	61.4
8/28/2012	58.3
9/24/2012	47.6
10/23/2012	33.1
11/13/2012	46.9
12/10/2012	35.5
1/15/2013	35.8
2/4/2013	27.9
3/25/2013	17.3
4/23/2013	15.2
5/28/2013	15.1
6/25/2013	30.6
7/29/2013	37.9
8/13/2013	15.7
9/24/2013	34.3
10/22/2013	26
11/18/2013	35
12/16/2013	17.2
1/28/2014	24.6
2/10/2014	24.1
3/11/2014	16.9
4/8/2014	9.88
5/13/2014	15
6/3/2014	20
Minimum	**7**
Maximum	**61**
Average	27
St Dev	13
95th	51
N	67

2/16/2012	140
2/28/2012	185
3/27/2012	120
3/27/2012	130
4/10/2012	220
4/23/2012	272
5/1/2012	341
5/9/2012	370
6/21/2012	510
6/26/2012	566
7/24/2012	738
8/28/2012	622
9/24/2012	524
10/23/2012	416
11/13/2012	414
12/10/2012	292
1/15/2013	243
2/4/2013	217
3/25/2013	134
4/23/2013	147
5/28/2013	198
6/25/2013	395
7/29/2013	369
8/13/2013	164
9/24/2013	457
10/22/2013	277
11/18/2013	364
12/16/2013	164
1/28/2014	226
2/10/2014	216
3/11/2014	143
4/8/2014	105
5/13/2014	152
6/3/2014	219
Minimum	**64**
Maximum	790
Average	290
St Dev	160
95th	621
N	75

Appendix J

Alternatives Analysis

Butterball-Huntsville
Dissolved Minerals Treatment Cost Estimate

BASIS: 1.01 MGD Filtration/Reverse Osmosis/Concentrated Reject Crystallization
Ground storage tanks
Max/Avg Effluent TDS = 1300/922mg/l
Discharge limit TDS = 500 mg/l

Reject flow= 0.27 MGD

ITEM	
CAPITAL	TOTAL ($000)
UF+Carbon+RO	$13,764
Storage tanks	$1,250
Evaporative crystallization system	$15,833
TOTAL CAPITAL	**$30,847**
ANNUAL OPERATING	TOTAL ($000)
Filtration	$250
RO	$1,974
CRYSTALLIZATION	$824
EQUIP REPLACEMENT	$1,542
TOTAL OPERATING	**$4,590**

PROCESS FLOW: 24HR EMER STG+UF+8HR STORAGE+CARBON+24HR STORAGE+RO+REJECT STORAGE 40HR+(1)250GPM BRINE CONC+(1)20GPM CRYSTALLIZ

City of Huntsville, Arkansas

Supplemental Report:

Feasibility of Treatment Alternatives for Total Dissolved Solids and Chloride

October 21, 2013

GBMc & Associates
Strategic Environmental Services

Supplemental Report: Feasibility of Treatment Alternatives for Total Dissolved Solids and Chloride

Prepared for:

City of Huntsville, Arkansas
P.O. Box 430
Huntsville, AR 72740

Prepared by:

GBM^c & Associates
219 Brown Lane
Bryant, AR 72022

Registered Professional Engineer
Charles Daniel Campbell
No.6857

10/21/13

GBM^C & Associates, Inc.
No. 570

October 21, 2013

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APPENDICES

1.0 INTRODUCTION

The City of Huntsville has conducted additional review of the feasibility of treatment alternatives pursuant to Commission Minute Order No. 13-23 regarding the removal of dissolved solids (minerals) from the effluent of its current waste water treatment system. The scope of the review included emerging technologies that have not been proved beyond the laboratory or pilot scale levels. However, only technologies demonstrated to perform at the full scale flow and loading of the City of Huntsville's wastewater treatment facility were considered for further cost evaluation.

This report summarizes three treatment options identified by the review. The three technologies determined to be capable of removal of minerals at discharged flows and concentrations are: reverse osmosis (RO), electrodialysis (ED), and capacitive deionization technology (CDT). Reverse osmosis and a particular implementation of electrodialysis, electrodialysis reversal (EDR) are the most commonly used technologies for removal of TDS at the concentrations present in the City of Huntsville's effluent. CDT is a newer, up-and-coming technology that has not yet been widely adopted.

For each of the three treatment technologies further evaluated, an estimate of the capital construction cost plus annual operation/maintenance cost was developed using published reports and/or engineering estimation resources.

2.0 REVERSE OSMOSIS

For the reverse osmosis treatment, a treatment train consisting of: twenty-four hour emergency storage followed by ultrafiltration, eight hour storage, carbon filtration, twenty-four hour storage, reverse osmosis, forty hour reject storage, brine concentration, and finally brine crystallization was analyzed.

The emergency storage is required to prevent the release of partially treated effluent in the event of a failure in the system. Intermediate storage allows for equipment maintenance, filter and membrane replacement, and routine scheduled treatment interruptions.

Reverse osmosis utilizes a membrane to filter solutes from solution. Organics, oil and grease, and other particulates must be removed to reduce membrane fouling. To that end, ultrafiltration and carbon filtration are used to prolong membrane life. This also reduces loss of membrane function from chemical attack, which is the result of reactions from chemicals used in cleaning and regenerating a fouled membrane.

In the reverse osmosis step, enough pressure is applied to the untreated water to overcome osmotic pressure and force the water through a membrane. The membrane prevents the passage of solutes, resulting in water with greatly reduced TDS loads. Reverse osmosis membranes are sensitive to scaling and fouling. They can be regenerated to a large degree by cleaning, but as mentioned previously, cleaning chemicals are a source of chemical attack that reduces membrane life. These membranes are also susceptible to creep, performing less efficiently over time as the membrane is slowly deformed by the pressures applied to the system.

In the final steps, the concentrated brine reject solution from reverse osmosis is sent to an evaporator to reduce the volume of water in the reject solution through a vapor-compression process. That process prepares the now extremely concentrated reject for the crystallization step where the brine is heated and swirled in a vortex where some brine evaporates, leading to the formation of crystals. A small stream carries these to a filter press where final dewatering to 20% moisture content results in a filter cake that can then be disposed of.

2.1 Capital Cost Estimate

The total capital cost for reverse osmosis treatment is estimated to be $30.8 million. This includes $13.7 million for pretreatment and RO treatment, $1.25 million for storage tanks, and $15.8 million for the evaporative crystallization system. These costs include permitting, engineering, and site and structural work. These costs were developed using information from GE Power and Water's technical papers and "Perry's Chemical Engineering Handbook" and prices were adjusted using Implicit Price Deflator data from the Federal Reserve Bank of St. Louis.

2.2 Operation/Maintenance Costs

The total annual operating cost associated with reverse osmosis treatment is estimated to be $4.59 million. This includes $250,000 per year for costs associated with filtration, $1.97 million per year for costs involving the reverse osmosis treatment step, $824,000 per year for costs associated with the evaporative crystallization step, and $1.54 million per year for equipment replacement. Included in calculating these costs were: energy usage, labor, maintenance equipment, and disposal of solid salts generated. These costs were likewise developed using information from GE Power and Water's technical papers and "Perry's Chemical Engineering Handbook" and prices were adjusted using Implicit Price Deflator data from the Federal Reserve Bank of St. Louis.

3.0 ELECTRODIALYSIS

For the electrodialysis treatment, a treatment train similar to reverse osmosis is required: twenty-four hour emergency storage, followed by ultrafiltration, eight hour storage, carbon filtration, twenty-four hour storage, electrodialysis, forty hour reject storage, brine concentration, and finally brine crystallization.

The storage components of the treatment train are required for the same reasons discussed for reverse osmosis: to ensure safety in the event of system failure and to allow components to be taken offline for maintenance, cleaning, membrane replacement, etc.

Since electrodialysis is a membrane-based technology, it too requires pretreatment using filtration, for the same reasons as reverse osmosis. One of the main advantages of electrodialysis reversal (EDR) is that due to the nature of the technology, EDR membranes are much less susceptible to fouling and scaling.

Electrodialysis reversal is another membrane-based separation technology that acts on ionic species. With this technology, the feed water is run through a chamber with an electrical potential created by charged electrodes. The chamber is divided into cells by alternatingly charged ion-exchange membranes. Each membrane is highly selective, passing only cations or only anions. Cations are passed to an adjacent cell through the first membrane they encounter as they travel toward the cathode, while anions are passed through to an opposite cell adjacent to that which the feed water originally entered by the first membrane they encounter on their way toward the anode. Each specie, however, is blocked from entering subsequent cells by either an anion-exchange or cation-exchange membrane, respectively. These cells concentrate ions, reducing the TDS of the water fed into the initial cell. In the reversal stage of the process, the polarity of the electrode is reversed, and the diluate cells become concentrate cells. This helps regenerate the membranes, leading a large reduction in scaling and fouling. This also prolongs membrane life by reducing cleaning requirements.

The final steps are the same as for reverse osmosis: the concentrated brine reject solution from electrodialysis is sent to an evaporator to reduce the volume of water in the reject solution through a vapor-compression process. That process prepares the now extremely concentrated reject for the crystallization step where the brine is heated and swirled in a vortex where some brine evaporates, leading to the formation of crystals. A small stream carries these to a filter press where final dewatering to 20% moisture content results in a filter cake that can then be disposed of.

3.1 Capital Cost Estimate

The total capital cost for electrodialysis treatment is estimated to be $22 million. This includes $4.88 million for pretreatment and ED treatment, $1.25 million for storage tanks, and $15.8 million for the evaporative crystallization system. These costs include permitting, engineering, and site and structural work. These costs were developed using information from GE Power and Water's technical papers and "Perry's Chemical Engineering Handbook" and prices were adjusted using Implicit Price Deflator data from the Federal Reserve Bank of St. Louis.

3.2 Operation/Maintenance Costs

The total annual operating cost associated with electrodialysis treatment is estimated to be $2.89 million. This includes $250,000 per year for costs associated with filtration, $268,000 per year for costs involving the electrodialysis treatment step, $824,000 per year for costs associated with the evaporative crystallization step, and $1.54 million per year for equipment replacement. Included in calculating these costs were: energy usage, labor, maintenance equipment, and disposal of solid salts generated. These costs were developed using information from GE Power and Water's technical papers and "Perry's Chemical Engineering Handbook" and prices were adjusted using Implicit Price Deflator data from the Federal Reserve Bank of St. Louis.

4.0 CAPACITIVE DEIONIZATION TECHNOLOGY

Like the previous two technologies, capacitive deionization technology begins with a treatment train that uses twenty-four hour emergency storage, followed by ultrafiltration, eight hour storage, carbon filtration, and twenty-four hour storage. This is followed by the capacitive deionization step and then continues with forty hour reject storage, brine concentration, and finally brine crystallization.

The storage used with this technology serves the same functions discussed in the previous two treatment technologies.

With this technology, feed water is run through carbon-aerogel electrodes, a foam material consisting of countless pores. Organics and other suspended solids must be removed for the system to work properly. The filtration pretreatment steps effectively prepare the water for CDT treatment.

Capacitive deionization technology consists of passing water through carbon-aerogel electrodes, which are kept at a potential difference of about one volt. Ionic species in the water are induced to move toward their respective electrodes, and adsorb to their surfaces. The electrodes are made of a special air-filled foam that exhibits ideal properties for this application due to their high electrical conductivity, high specific surface area, and controllable pore-size distribution. Adsorbed ions are desorbed from the surface of the electrodes by eliminating the charge on the electrodes between treatment cycles. The ions are then flushed from the system in what becomes the reject water. When the treatment cycle begins again, the electrodes' polarity is reversed, further regenerating their capacity and reducing or eliminating scaling. The major drawback is that large volumes of reject water are generated when flushing previously adsorbed ions from the highly porous electrodes.

As with the previous two treatment systems, the concentrated brine reject solution from capacitive deionization is sent to an evaporator to reduce the volume of water in the reject solution through a vapor-compression process. That process prepares the now extremely concentrated reject for the crystallization step where the brine is heated and swirled in a vortex where some brine evaporates, leading to the formation of crystals. A small stream carries these to a filter press where final dewatering to 20% moisture content results in a filter cake that can then be then disposed of.

4.1 Capital Cost Estimate

The total capital cost for capacitive deionization technology treatment is estimated to be $58.5 million. This includes $25.6 million for pretreatment and CDT treatment, $1.25 million for storage tanks, and $31.7 million for the evaporative crystallization system. These costs include permitting, engineering, and site and structural work. These costs were developed using information published in the U.S. Department of the Interior Bureau of Reclamation's "Reclamation: Managing Water in the West" journal and prices were adjusted using Implicit Price Deflator data from the Federal Reserve Bank of St. Louis.

4.2 Operation/Maintenance Costs

The total annual operating cost associated with capacitive deionization technology treatment is estimated to be $4.42 million. This includes $250,000 per year for costs associated with filtration, $983,000 per year for costs involving the capacitive deionization technology treatment step, $1.65 million per year for costs associated with the evaporative crystallization step, and $1.54 million per year for equipment replacement. Included in calculating these costs were: energy usage, labor, maintenance equipment, and disposal of solid salts generated. These costs were developed using information published in the U.S. Department of the Interior Bureau of Reclamation's "Reclamation: Managing Water in the West" journal and prices were adjusted using Implicit Price Deflator data from the Federal Reserve Bank of St. Louis.

5.0 SUMMARY & CONCLUSION

A supplemental review of treatment alternatives for dissolved minerals removal from water and wastewater was undertaken at the request of the Arkansas Pollution Control and Ecology Commission. This review identified a number of articles describing treatment methods (Appendix B). However, only technologies demonstrated to perform at the full scale flow and loading of the City of Huntsville's wastewater treatment facility were considered for evaluation. Consideration of experimental or academic technologies not yet proven would be speculative and contrary to accepted engineering practices.

The costs associated with the three technologies reviewed are summarized in Table 1 below. Each of the treatment technologies reviewed are technically viable options for reducing TDS, however, the estimated costs for each technology are not feasible for the City.

These costs would jeopardize the continued operation of the Butterball Facility, the largest employer in Madison County. The consequence of the loss of the Butterball Facility would likely prove to be disastrous for the City of Huntsville, Madison County and the surrounding northwest Arkansas community. This region relies heavily on the economic impact of the Butterball facility. The facility employs almost 700 citizens and provides them an annual payroll of more than $22,000,000. It also acts as a critical client/customer to a number of local businesses and pays more than $138,000 in local property taxes.

Table 1. Associated costs for each of the three treatment technologies reviewed.

Treatment Technology	Capital Cost (Million $)	Annual O/M Cost (Million $)
Reverse Osmosis	30.1	4.6
Electrodialysis	22.0	2.9
CDT	58.5	4.4

6.0 SOURCES

Apte Sagar. S., Apte Shruti S., Kore, V. S., Kore, S. V. "Chloride Removal from Wastewater by Biosorption with the Plant Biomass". Universal Journal of Environmental Research and Technology Volume 1, Issue 4: 416-422. (2011). 7 Oct 2013.

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"DOWEX Ion Exchange Resins: Water Conditioning Manual." Dow Water Solutions. n.d. Web. 7 Oct 2013.

Drewes, J.E., Xu, Pei, Wang, Gary. "Multibeneficial use of produced water through high-pressure treatment and capacitive deionization technology." Reclamation: Managing Water in the West. Program Report No. 133 (2009). Print.

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Jacobson, Kyle S., Drew David M., He Zhen. "Efficient salt removal in a continuously operated upflow microbial desalination cell with an air cathode". Bioresource Technology, Volume 102, Issue 1, Pages 376-380. (2011). Print.

Kameda, T., Miyano, Y., Yoshioka, T., Uchida M., Okuwaki, A. "New Treatment Methods for Waste Water Containing Chloride Ion Using Magnesium–Aluminum Oxide" Chemistry Letters 2000, Chemical Society of Japan. 1136-1137. (2000). Web. 7 Oct 2013.

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Perry, Robert H. and Green, Don W. *Perry's Chemical Engineering Handbook*. 7th ed. New York: McGraw Hill, 1997. Print.

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"Power Purge Deioinization Systems High Efficiency DI." Remco Engineering. n.d. Web. 7 Oct 2013.

Water Treatment Solutions. Lenntech, 2013. Web. 7 Oct 2013.

Yu, J.T., Lue, S.J. “Desalination of high NaCl wastewater using electrodialysis”. Department of Chemical and Materials Engineering, Chang Gung University. Web. 7 Oct 2013.

Appendix A

Cost Calculations

1.0 REVERSE OSMOSIS CALCULATIONS (PERRY'S CHEMICAL ENGINEERING HANDBOOK)

Reverse Osmosis and Pretreatment Costs

FROM PERRY'S P.22-52			Implicit Price Deflator			
6 MGD 38 g/l 45% conversion 6 train system			1996	83.159	1995	92.103
NEED 1.25 MGD, 3.4 g/l 95% conversion			2006	103.231	2012Q4	114.46
assume 1 train system, 35% of cost	1996	0.35	inflation adj			
	base	adj	2006	2012Q4		
ITEM	$000	$000	$000			
UF+ Carbon filter			3000			
Membranes+housings installed	3600	$1,260	$1,564.12	$2,152.86		
process equip	13700	$4,795	$5,952.36	$8,192.83		
site work	500	$175	$217.24	$299.01		
structural	1850	$648	$803.79	$1,106.33		
permitting	25	$9	$10.86	$14.95		
Engr	3341	$1,169	$1,451.59	$1,997.97		
TOT CAP		$8,056	**$13,000**	**$13,764**		
OPERATING						
elec	1976.875	$692	$858.91	$1,182.20		
consum+chem	187	$65	$81.25	$111.83		
Maint	482	$169	$209.42	$288.24		
labor	265	$93	$115.14	$158.47		
membrane repl	390	$137	$169.45	$233.23		
TOT OP		$1,155	**$1,434**	**$1,974**		

Reject Treatment

RO REJECT TREATMENT				
Per Bill Heinz, VP GE Treatment 425-828-2400x1330				
Trt train consists of (2) 250 GPM Brine Concentrator, then (1) 20 GPM Crystallizer				
includes solids conveyor		0.6	Butterball assume half capacity, 60% of cost	
	2006			2012Q4
CAPITAL	$ (000)			
Brine Conc.	$9,100	$5,460		$6,053.91
Crystallizer	$4,900	$2,940		$3,259.80
Installation	$9,800	$5,880		$6,519.60
TOTAL	$23,800	$14,280		$15,833

Total RO Costs

CAPITAL	TOTAL ($000)
UF+Carbon+RO	$13,764
Storage tanks	$1,250
Evaporative crystallization system	$15,833
TOTAL CAPITAL	**$30,847**
ANNUAL OPERATING	TOTAL ($000)
Filtration	$250
RO	$1,974
CRYSTALLIZATION	$824
EQUIP REPLACEMENT	$1,542
TOTAL OPERATING	**$4,590**

2.0 ELECTRODIALYSIS CALCULATIONS (PERRY'S CHEMICAL ENGINEERING HANDBOOK)

ED Step Operating Costs (in 1993 dollars)
1 MGD = 3823.036 m^3/day
Basis: 1000 m^3 product water

$66	Membrane-replacement cost (assuming seven-year life)
32	Plant power
16	Filters and pretreatment chemicals
11	Labor
8	Maintenance
133	Total

Convert ED step per 1000 m^3 to annual operating costs (1993 Dollars)

$$1\,MGD * \frac{3785.184\ \frac{m^3}{day}}{1\,MGD} * \frac{\$133}{1000\,m^3} * \frac{365\ days}{1\ year} = \$183751.76$$

Covert ED step Operating Costs in 1993 dollars to 2013 dollars

$$\$183751.76 \div \frac{\$79.28}{\$115.51} = \$267724.08$$

Convert UF + Carbon Filter Capital Costs from 2006 dollars to 2013 dollars

$$\$3000000 \div \frac{\$103.23}{\$115.51} = \$3356834$$

ED Capital Costs from Perry's: given typical plant at 4700 m^3/day built in 1993 capital costs were $1210000 these costs scale by the 0.7 power. Covert to 1 MGD (3785.184 m^3/day).

$$\$1210000 * \left(\frac{3785.184\ m^3/day}{4700\ m^3/day}\right)^{0.7} = \$1039866.93$$

Covert ED Capital Costs from 1993 to 2013 dollars

$$\$\mathbf{1039866.93} \div \frac{\$\mathbf{79.28}}{\$\mathbf{115.51}} = \$\mathbf{1515059}$$

According to literature, the reject from ED is similar to RO, so use same process separate water and salts. Pretreatment uses the same process as the other technologies.

Total ED Costs

CAPITAL	**TOTAL ($000)**
UF+Carbon+Electrodialysis	$4,871
Storage tanks	$1,250
Evaporative crystallization system	$15,833
TOTAL CAPITAL	**$21,954**
ANNUAL OPERATING	TOTAL ($000)
Filtration	$250
RO	$268
CRYSTALLIZATION	$824
EQUIP REPLACEMENT	$1,542
TOTAL OPERATING	**$2,884**

3.0 Capacitive Deionization Technology Calculations (Reclamation: Managing Water in the West. Program Report No. 133)

Basis

Plant life		20 years
Interest rate		10%
Capacity	Product	1.0 MGD
Capital	Including initial module cost plus supporting equipment	$1000/module
Module replacement	10 year module lifetime	$770/module
Energy cost	Purchased from off-site	$0.06/kwh

Annual Costs Given

Initial Capital ($ per year)	Replace modules ($ per year)	Labor ($ per year)	Energy ($ per year)	Total costs ($ per year)	Total costs ($ per 1000 gallons product)
2612044	868406	38400	76650	3595500	

Convert UF + Carbon Filter Capital Costs from 2006 dollars to 2013 dollars

$$\$3000000 \div \frac{\$103.23}{\$115.51} = \$3356834$$

CDT step Capital Costs Series Present Worth (P/A, *i*, n)

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

$$P = \$2612044\left[\frac{(1+0.1)^{20} - 1}{0.1(1+0.1)^{20}}\right] = \$\ 22{,}237{,}803.03$$

Reject Treatment

Reject flow at 33% water recovery. Reject 0.667 MGD
Using same process as RO to treat reject, scale up processes.
Determine number of 250 gpm brine concentrators needed

$$\frac{666667 gal}{day} * \frac{1\ day}{24\ hr} * \frac{1\ hr}{60\ min} * \frac{1\ concentrator}{250\ gpm} = 1.85$$

Double RO reject capital and operating costs

Total CDT Costs

CAPITAL	TOTAL ($000)
UF+Carbon+RO	$25,595
Storage tanks	$1,250
Evaporative crystallization system	$31,667
TOTAL CAPITAL	**$58,511**
ANNUAL OPERATING	TOTAL ($000)
Filtration	$250
CDT	$983
CRYSTALLIZATION	$1,648
EQUIP REPLACEMENT	$1,542
TOTAL OPERATING	**$4,424**

Appendix B

City of Huntsville Research Information

City of Huntsville Research Information

Desalination System Targets Fracking Wastewater
http://www.treehugger.com/clean-technology/new-low-cost-desalination-system-targets-fracking-wastewater.html

Different Applied Methods - to Reduce Salt Freight in Tannery Effluent
http://www.tfl.com/web/files/reductionsaltfreighttanneryeffluent.pdf

Desalination of high NaCl wastewater using electro dialysis
http://research.cgu.edu.tw/ezfiles/14/1014/img/651/98-B-32.pdf

Efficient Salt removal in a continuously operated upflow microbial desalination cell with an air cathode
https://pantherfile.uwm.edu/zhenhe/www/papers/Efficient%20salt%20removal%20in%20a%20continuously%20operated%20UMDC.pdf

Chloride Removal from Wastewater by Biosorption with the Plant Biomass
http://www.environmentaljournal.org/1-4/ujert-1-4-4.pdf

New Treatment Methods for Waste Water Containing Chloride Ion Using Magnesium-Aluminum Oxide
http://ir.library.tohoku.ac.jp/re/bitstream/10097/51573/1/29_1136.pdf

Dealkalization By Anion Exchange
http://www.resintech.com/Uploads/resintech/Documents/TDS/Dealkalization%20by%20Anion%20Exchange.pdf

Deionization Systems High Efficiency DI - http://www.remco.com/di.htm
Reverse Osmosis and Utlrafiltration Systems - http://www.remco.com/di.htm

Helpful Document -
http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0885/0901b80380885879.pdf?filepath=liquidseps/pdfs/noreg/177-01766.pdf&fromPage=GetDoc

ECON MVC Evaporator - http://www.evaporator.com/reverse-osmosis-reject

Continuous microfiltration pretreatment to reverse osmosis
http://www.sciencedirect.com/science/article/pii/S001191640100248X

MCDI System – Desalination of a thermal power plant wastewater by membrane capacitive deionization
http://www.sciencedirect.com/science/article/pii/S0011916406004279

TDS Removal using Roughing Filters
http://astonjournals.com/manuscripts/Vol2010/CSJ-6_Vol2010.pdf

Removal of TDS and BOD via Adsorption
http://www.ipcbee.com/vol41/034-ICEBB2012-R034.pdf

Extraction by electodialysis study on TDS removal
http://www.lenntech.com/abstracts/2717/study-on-tds-removal-from-polymer-flooding-wastewater-in-crude-oil-extraction.html

Solar-heated hollow fiber membrane distillation system
http://www.lenntech.com/abstracts/78/feasibility-research-of-potable-water-production-via-solar-heated-hollow-fiber-membrane-distillation.html

www.lenntech.com has an excellent database of scholarly articles related to this research
www.desalination.com is another related website that could be useful

Appendix K

USGS Report

Prepared in cooperation with the City of Fayetteville, Arkansas, and Beaver Water District

Ambient Conditions and Fate and Transport Simulations of Dissolved Solids, Chloride, and Sulfate in Beaver Lake, Arkansas, 2006–10

Scientific Investigations Report 2013–5019

U.S. Department of the Interior
U.S. Geological Survey

Cover:
Photo by Robert Morgan, Beaver Water District.

Ambient Conditions and Fate and Transport Simulations of Dissolved Solids, Chloride, and Sulfate in Beaver Lake, Arkansas, 2006–10

By W. Reed Green

Prepared in cooperation with the City of Fayetteville, Arkansas,
and Beaver Water District

Scientific Investigations Report 2013–5019

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Area	
square kilometer (km^2)	247.1	acre
	Volume	
cubic meter (m^3)	6.290	barrel (petroleum, 1 barrel = 42 gal)
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	2.113	pint (pt)
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
cubic meter (m^3)	0.0002642	million gallons (Mgal)
liter (L)	61.02	cubic inch (in^3)
cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic meter (m^3)	1.308	cubic yard (yd^3)
	Flow rate	
cubic meter per second (m^3/s)	70.07	acre-foot per day (acre-ft/d)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 1929)

Altitude, as used in this report, refers to distance above the vertical datum.

Ambient Conditions and Fate and Transport Simulations of Dissolved Solids, Chloride, and Sulfate in Beaver Lake, Arkansas, 2006–10

By W. Reed Green

Abstract

Beaver Lake is a large, deep-storage reservoir located in the upper White River Basin in northwestern Arkansas, and was completed in 1963 for the purposes of flood control, hydroelectric power, and water supply. Beaver Lake is affected by point and nonpoint sources of minerals, nutrients, and sediments. The City of Fayetteville discharges about half of its sewage effluent into the White River immediately upstream from the backwater of the reservoir. The City of West Fork discharges its sewage effluent into the West Fork of the White River, and the City of Huntsville discharges its sewage effluent into a tributary of War Eagle Creek.

A study was conducted to describe the ambient conditions and fate and transport of dissolved solids, chloride, and sulfate concentrations in Beaver Lake. Dissolved solids, chloride, and sulfate are components of wastewater discharged into Beaver Lake and a major concern of the drinking water utilities that use Beaver Lake as their source. A two-dimensional model of hydrodynamics and water quality was calibrated to include simulations of dissolved solids, chloride, and sulfate for the period January 2006 through December 2010. Estimated daily dissolved solids, chloride, and sulfate loads were increased in the White River and War Eagle Creek tributaries, individually and the two tributaries together, by 1.2, 1.5, 2.0, 5.0, and 10.0 times the baseline conditions to examine fate and transport of these constituents through time at seven locations (segments) in the reservoir, from upstream to downstream in Beaver Lake.

Fifteen dissolved solids, chloride, and sulfate fate and transport scenarios were compared to the baseline simulation at each of the seven downstream locations in the reservoir, both 2 meters (m) below the surface and 2 m above the bottom. Concentrations were greater in the reservoir at model segments closer to where the tributaries entered the reservoir. Concentrations resulting from the increase in loading became more diluted farther downstream from the source. Differences in concentrations between the baseline condition and the 1.2, 1.5, and 2.0 times baseline concentration scenarios were smaller than the differences in the 5.0 and 10.0 times baseline concentration scenarios. The results for both the 2 m below the surface and 2 m above the bottom were similar, with the exception of concentrations resulting from the increased loading factors (5.0 and 10.0 times), where concentrations 2 m above the bottom were consistently greater than those 2 m below the surface at most segments.

Introduction

Beaver Lake is a large, deep-storage reservoir located in the upper White River Basin in northwestern Arkansas. The reservoir was completed in 1963 for the purposes of flood control, hydroelectric power, and water supply. In addition, the reservoir is used for fish and wildlife habitat, recreation, and waste assimilation.

Beaver Lake is affected by point and nonpoint sources of minerals, nutrients, and sediments. The City of Fayetteville discharges about half of its sewage effluent into the White River immediately upstream from the backwater of the reservoir. The City of West Fork discharges its sewage effluent into the West Fork of the White River, and the City of Huntsville discharges its sewage effluent into a tributary of War Eagle Creek. Water-quality constituents like dissolved solids (DS), chloride (Cl), sulfate (SO_4), nutrients, sediment, pathogenic bacteria, and others enter Beaver Lake through its tributaries and around its shoreline and through precipitation on the pool.

In 2006, a study was conducted by Galloway and Green (2006) that analyzed ambient water-quality conditions. In Galloway and Green (2006), a two-dimensional model of hydrodynamics and water-quality characteristics was developed and calibrated for the period 2001 through 2003. For the present study, conducted by the U.S. Geological Survey (USGS) in cooperation with the City of Fayetteville and Beaver Water District (BWD), their model was modified and recalibrated to examine ambient conditions of DS, Cl, and SO_4 and fate and transport of these compounds and elements in Beaver Lake from January 2006 through December 2010.

Purpose and Scope

The purpose of this report is to describe the ambient conditions and fate and transport of DS, Cl, and SO_4 concentrations in Beaver Lake. DS, Cl, and SO_4 are components of wastewater discharged into Beaver Lake and a major concern of the drinking water utilities that use Beaver Lake as their source. A previously developed CE-QUAL-W2 two-dimensional model of hydrodynamics and water quality in Beaver Lake (Galloway and Green, 2006) was modified and recalibrated to include simulations of DS, Cl, and SO_4 for the period of January 2006 through December 2010. Estimated daily DS, Cl, and SO_4 loads were increased in the White River and War Eagle Creek tributaries, individually and the two tributaries together, by 1.2, 1.5, 2.0, 5.0, and 10.0 times the baseline conditions to examine fate and transport of these constituents through time at seven locations in the reservoir, from upstream to downstream in Beaver Lake.

Description of Study Area

Beaver Lake (fig. 1) was impounded in 1963 on the White River, is located northeast of the City of Fayetteville, Ark., and near Eureka Springs, Ark., and had reached conservation capacity in 1968 (Haggard and Green, 2002). The conservation capacity of the reservoir is the storage capacity used for hydroelectric power, water supply, fish and wildlife habitat, and recreation (U.S. Army Corps of Engineers, 1997). The main inflows into Beaver Lake are the White River, Richland Creek, and War Eagle Creek (fig. 1). Several smaller tributaries also flow into the reservoir. The reservoir has a drainage area of 3,087 square kilometers (km^2) at the Beaver Lake dam. Beaver Lake contains 2,040 million cubic meters (m^3) of water at the top of the current conservation pool (341.4 meters (m) above NGVD of 1929) and the surface area is 114 km^2 (Haggard and Green, 2002). The length of the reservoir is 80 kilometers (km) from the White River at the Highway 45 bridge to the Beaver Lake dam. The depth of the reservoir at the dam at conservation pool elevation is 60 m, and the average depth throughout the reservoir is 18 m (Haggard and Green, 2002).

The USGS in cooperation with BWD has monitored water quality in Beaver Lake since 2001. Currently, water-quality samples are collected at seven lake sites (L1–L5, L9, and L10) and three tributary inflow sites (S1–S3) (table 1, fig. 1). Continuous streamflow data are also collected at S1, S2, and S3 and used to calculate constituent loading into Beaver Lake.

Methods

This section describes the methods of data collection and analysis used to describe the ambient DS, Cl, and SO_4 conditions in Beaver Lake used in this report. Streamflow and water-quality samples were collected at three tributaries to Beaver Lake from January 2006 through December 2010. Annual DS, Cl, and SO_4 loads were estimated from streamflow and water-quality data at these three sites. Water-quality samples were also collected at seven fixed sites along the downstream gradient in the reservoir during the same time period.

Streamflow

Stream stage was measured continuously at White River near Fayetteville (site S1), Richland Creek at Goshen (site S2), and War Eagle Creek near Hindsville (site S3) (table 1 and fig. 1). Stage and instantaneous discharge were measured to compute the continuous streamflow from stage-discharge rating curves by using methods described by Rantz and others (1982). Outflow data from Beaver Lake were provided by the U.S. Army Corps of Engineers (USACE), Little Rock District, for the period January 2006 through December 2010.

Water-Quality Sampling

Water-quality data were collected from January 2006 through December 2010 at five fixed sites along the downstream gradient of Beaver Lake. Sample sites in the lake were located along the original stream channel, the deepest location within the lake cross section. Samples were collected six times annually at White River at Goshen (site L1), at Beaver Lake at Highway 412 bridge near Sonora (site L2), near Beaver Lake near Lowell (site L3), at Beaver Lake at Highway 12 bridge near Rogers (site L4), and Beaver Lake near Eureka Springs (site L5) (table 1 and fig.1). Samples were collected six times annually at War Eagle Creek above White River near Lowell (site L9) from October 2007 through December 2010 and monthly (12 times annually) at Beaver Lake downstream from Hickory Creek landing near Springdale (site L10) from August 2008 through December 2010.

Water-quality samples were collected at lake sites by using a peristaltic pump and weighted hose to collect samples 2 m below the water surface when isothermal and well-mixed conditions were present. During thermal stratification, samples were collected at 2 m below the water surface to represent the epilimnion (near surface), at various depths in the metalimnion (middle depth) depending on the depth of the thermocline, and at 2 m above the reservoir bottom to represent the hypolimnion (near bottom). Water-quality samples were analyzed for concentrations of DS (analytically determined by weighing residue after drying at 180 degrees Celsius (°C), not the sum of individual constituents), Cl, and SO_4. All sample analyses were conducted at the USGS National Water Quality Laboratory according to USGS procedures (Fishman, 1993). Field measurements of water temperature were also recorded at various depths at the time of sample collection.

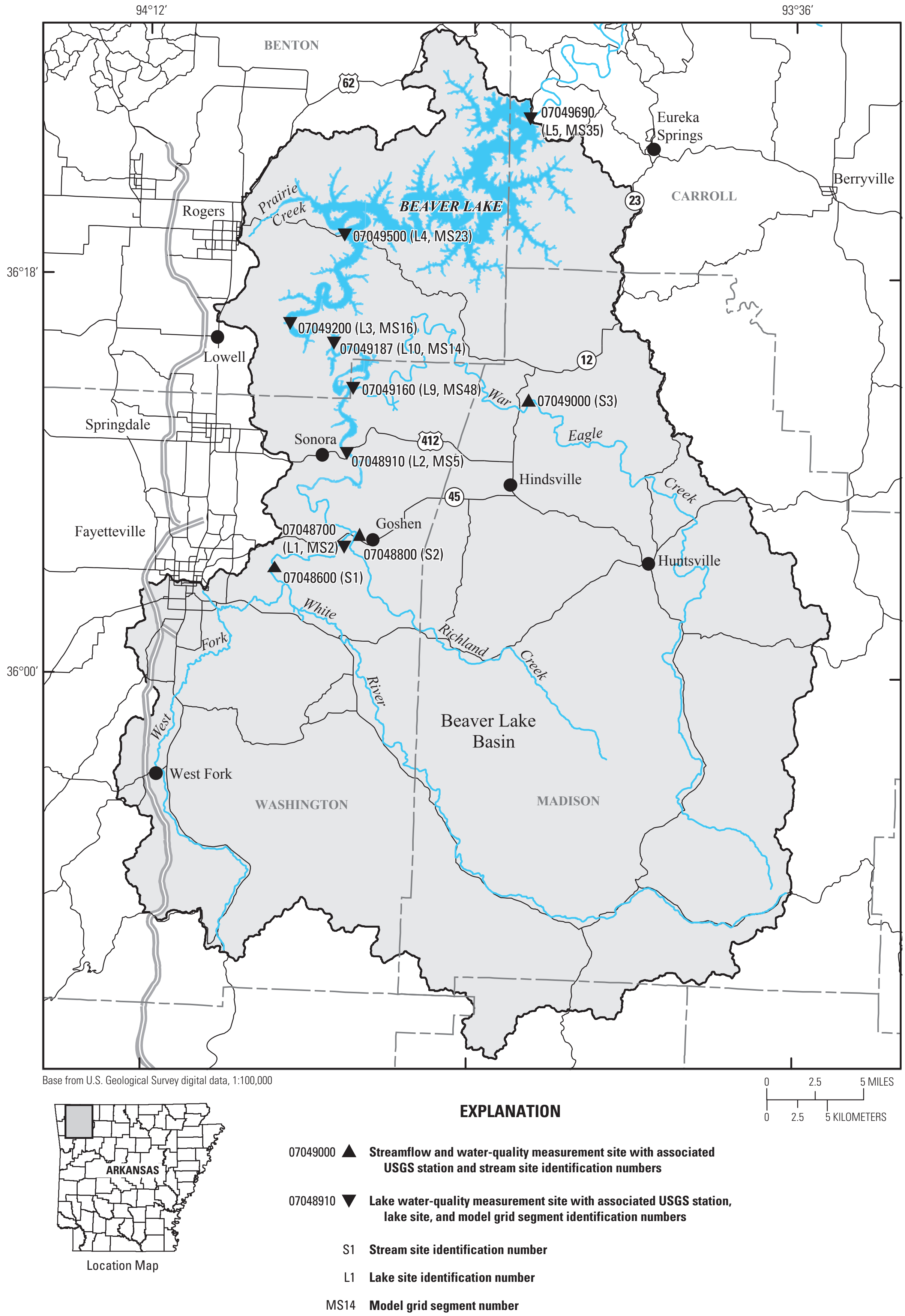

Figure 1. Beaver Lake study area, Arkansas, with locations of water-quality sampling sites.

Table 1. Streamflow and water-quality sites for Beaver Lake, Arkansas

Site identification number (fig. 1)	U.S. Geological Survey station number	Model grid segment (fig. 2)	Station name	Station type	Latitude (degree,minute, second)	Longitude (degree, minute, second)
S1	07048600	—	White River near Fayetteville	Streamflow, water quality	36°04′23″	94°04′52″
S2	07048800	—	Richland Creek at Goshen	Streamflow, water quality	36°06′15″	94°00′28″
S3	07049000	—	War Eagle Creek near Hindsville	Streamflow, water quality	36°12′00″	93°51′18″
L1	07048700	2	White River near Goshen	Water quality	36°06′21″	94°00′41″
L2	07048910	5	Beaver Lake at Highway 412 bridge near Sonora	Water quality	36°10′00″	94°00′26″
L3	07049200	16	Beaver Lake near Lowell	Water quality	36°15′33″	94°04′08″
L4	07049500	23	Beaver Lake at Highway 12 bridge near Rogers	Water quality	36°19′56″	94°01′08″
L5	07049690	35	Beaver Lake near Eureka Springs	Water quality	36°25′15″	93°50′50″
L9	07049160	48	War Eagle Creek above White River near Lowell	Water quality	36°13′24″	94°00′38″
L10	07049187	14	Beaver Lake downstream from Hickory Creek landing near Springdale	Water quality	36°15′01″	94°01′35″

Water-quality samples also were collected from three fixed inflow sites: White River near Fayetteville (site S1), Richland Creek at Goshen (site S2), and War Eagle Creek near Hindsville (site S3) (table 1, fig. 1). Water-quality samples were collected following equal-width increment methods by using depth-integrated samplers and processed by using protocols described in Wilde and Radke (1998) and Wilde and others (1998a, 1998b, 1998c, 1999a, and 1999b). Water-quality samples were analyzed for concentrations of DS, Cl, and SO_4. Field measurements including water temperature were collected with each sample. Water-quality samples were collected six times annually and during selected surface-runoff events.

Constituent Loads

DS, Cl, and SO_4 loads were estimated for the three main inflows to Beaver Lake: the White River near Fayetteville (site S1), Richland Creek at Goshen (site S2), and War Eagle Creek near Hindsville (site S3) (fig. 1). Constituent load (L) is a function of the volumetric rate of water passing a point in the stream (Q) and the constituent concentration within the water (C). Regression methods used to estimate constituent loads use the natural logarithm (ln) transformed relation between Q and C to estimate daily load (L) of the constituent. The regression method can account for nonnormal data distributions, seasonal and long-term cycles, censored data, biases associated with using logarithmic transformations, and serial correlations of the residuals (Cohn, 1995). The regression method uses discrete water-quality samples often collected over several years and a daily streamflow hydrograph. The relations between natural logarithmic-transformed L (QC) and Q were used:

$$ln\,(L) = \beta_0 + \beta_1\, ln\,(Q) \qquad (1)$$

where

ln is natural logarithm;

L is constituent load, in kilograms per day (kg/d);

β_o is regression constant, dimensionless;

β_1 is a regression coefficient, dimensionless; and

Q is daily streamflow, in cubic meters per second (m^3/s).

Transformation of the results of the model from logarithmic space to real space was accomplished by using two methods: an adjusted maximum likelihood estimator (AMLE) and a least absolute deviation (LAD) (Cohn and others, 1992). The AMLE method was used if the constituent had censored values, and the LAD method was used to transform the results if no censored values were included in the data or if outliers in the residuals were present. The S-LOADEST computer program (Runkel and others, 2004) was used to estimate daily loads for 2006 through 2010.

Data Analysis

The resulting measured streamflow, water-quality (DS, Cl, and SO_4 concentrations—inflow and lake samples), and S-LOADEST loading rates were analyzed and summarized by using several graphical techniques for data collected from January 2006 through December 2010. Time-series plots were used to describe inflow and outflow. Boxplots and time-series plots were used to compare concentrations of DS, Cl, and SO_4 among sites. Boxplots, scatter plots, line plots, and bar charts were used to describe model simulation results.

Model Implementation

A two-dimensional, laterally averaged, hydrodynamic and water-quality model using CE-QUAL-W2 Version 3.1 (Cole and Wells, 2003) had been developed for Beaver Lake and calibrated on the basis of vertical profiles of temperature and dissolved oxygen, and water-quality constituent concentrations were collected at various depths at four sites in the reservoir from April 2001 to April 2003 (Galloway and Green, 2006). This Beaver Lake CE-QUAL-W2 model had simulated water-surface elevation and vertical and longitudinal gradients in water-quality constituents. The model had included routines for 18 state variables in addition to temperature and dissolved oxygen, including any number of inorganic suspended solids groups, phytoplankton groups, nitrogen and phosphorus species, dissolved and particulate organic matter, total inorganic carbon, and organic sediment. Additionally, CE-QUAL-W2 had the capability of computing more than 60 derived variables from the state variables (Cole and Wells, 2003); however, for the purposes of this report, only water temperature, DS, Cl, and SO_4 were simulated. DS, Cl, and SO_4 were considered to be conservative constituents and changed concentration only through advection and dilution, as a conservative tracer might be expected to behave.

Implementation of the CE-QUAL-W2 model for Beaver Lake included development of the computational grid, specification of boundary and initial conditions, and preliminary selection of model parameter values. Model development and associated assumptions in the selection of boundary and initial conditions are described and model parameters are listed in the “Boundary and Initial Conditions” and “Model Parameters” sections.

Computational Grid

The computational grid used by Galloway and Green (2006) and used in this study provides the geometric scheme that numerically represents the space and volume of Beaver Lake. The grid extends 80 km from the upstream boundary (White River at the Highway 45 bridge) to the Beaver Lake dam (figs. 1 and 2). The grid originally was developed by Haggard and Green (2002) to simulate the hydrodynamics and distribution of temperature and dissolved oxygen in Beaver Lake for calendar years 1994 and 1995. Thirty-five computational segments exist along the main stem branch of the White River and 12 computational segments are in War Eagle Creek branch in Beaver Lake. In addition, four other downstream branches are modeled with three computational segments each. Volumes of the smaller embayments not included in the computational grid were added to associated main stem segments so that reservoir volume was preserved. Each segment was divided vertically into 1-m layers. Tributaries were linked geometrically to the segment they enter and allow for the application of inflow without affecting the geometry. Two tributaries were included in the model at the most upstream segment. One tributary was used to simulate the discharge from the Fayetteville wastewater-treatment plant (WWTP) at the upstream segment although WWTP discharge concentrations were not included for the purposes of this study; DS, Cl and SO_4 concentration data in WWTP discharge were limited and uncertain. A second tributary was used to simulate the inflow from Richland Creek, and a third to simulate the inflow from Prairie Creek (fig. 1). Model grid segments 2, 5, 14, 16, 23, 35, and 48 (fig. 2) relate to water-quality monitoring sites L1, L2, L10, L3, L4, L5, and L9, respectively (table 1).

Boundary and Initial Conditions

Hydraulic and Thermal Boundary Conditions

Daily reservoir inflow data (upstream hydraulic boundaries) used in the model were obtained from streamflow-gaging station data on the three main inflows (White River, Richland Creek, and War Eagle Creek) and were estimated for the three smaller ungaged branches and the tributary, Prairie Creek. The mean daily streamflow recorded for War Eagle Creek near Hindsville (site S3, upstream from L9) was used to estimate the streamflow for the three ungaged branches and tributary, based on the ratio between the drainage area for War Eagle Creek at site S3 and the drainage areas of the three ungaged branches and tributary.

The downstream hydraulic boundary for the Beaver Lake model consisted of the outflow from Beaver Lake dam. The USACE produced hourly outflow data by using stage-discharge relations and hourly power generation records for the period of January 2006 through December 2010 (U.S. Army Corps of Engineers, written commun., 2011). The release structure (penstock) was simulated as a point release, and the middle of the penstock was located at an elevation of 302.2 m above NGVD of 1929, model layer 45 (fig. 2).

Hydraulic boundary conditions also included water withdrawal by four public water-supply districts (Beaver Water District, Carroll-Boone County Water District, Madison County Water District, and Benton-Washington County Water District). Annualized mean daily withdrawal rates for each water-supply district were applied (Terrance W. Holland, U.S. Geological Survey, written commun., 2011).

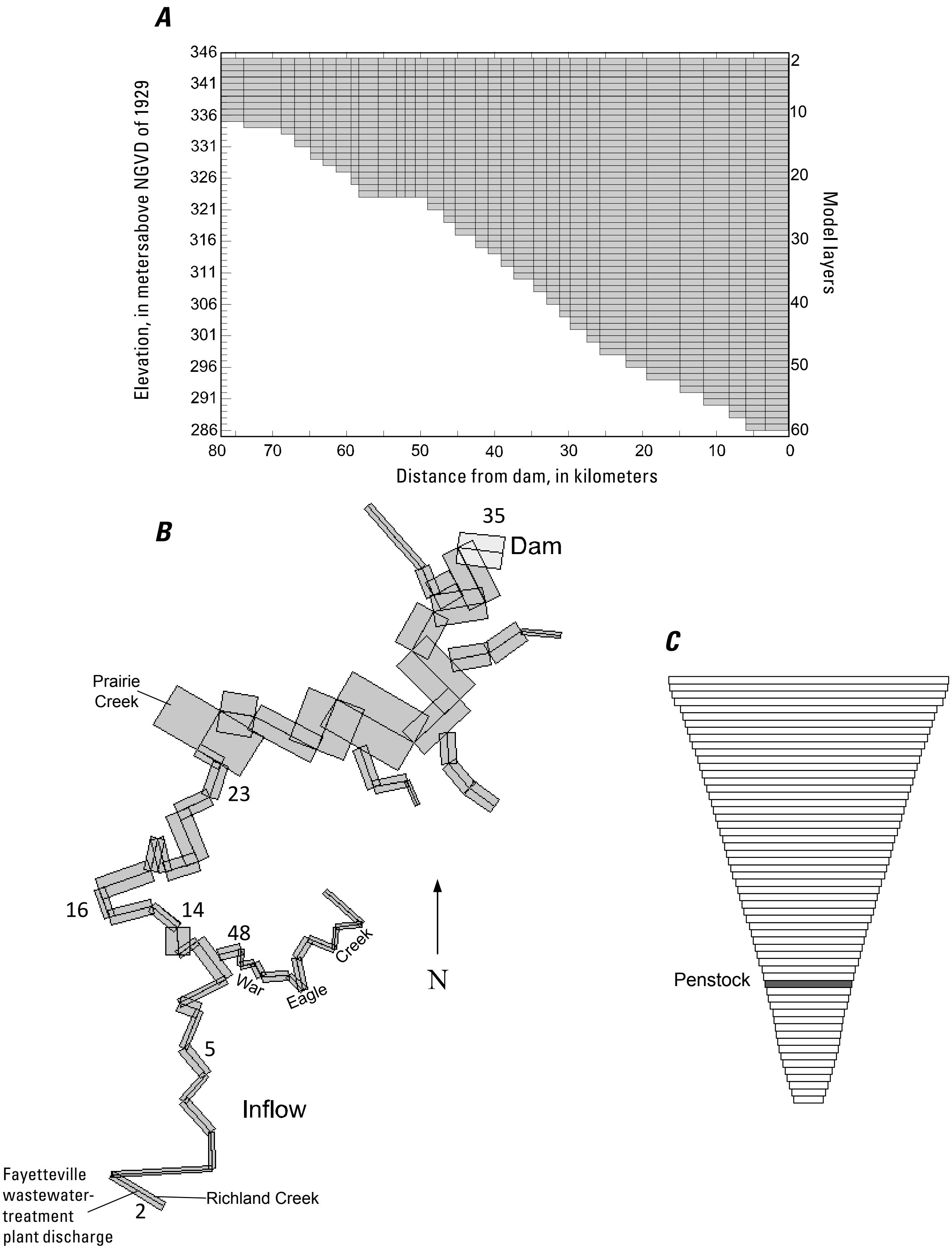

Figure 2. Side view (*A*), top view (*B*), and face view from the dam (*C*) of the computational grid of Beaver Lake, Arkansas, used in the CE-QUAL-W2 model.

Hydraulic boundary conditions at the water surface included evaporation, wind stress, and surface heat exchange. Meteorological data required for these computations were measured hourly at a weather station southwest of Rogers (fig. 1) (National Climatic Data Center, Asheville, North Carolina, written commun., 2011).

Hourly inflow water temperatures were estimated from air temperature in the meteorological data by using the Marciano and Harbeck (1954) method and from periodic measurements at the three main inflow sites (White River, Richland Creek, and War Eagle Creek). Water temperatures for the three smaller branches and Prairie Creek were estimated only from air temperature.

Dissolved Solids, Chloride, and Sulfate Boundary Conditions

Chemical boundary conditions were estimated daily, by dividing daily S-LOADEST loads (kg/d) by the daily mean streamflow (m^3/s) to provide a daily mean concentration (mg/L) for each of the main inflow sites. Daily mean streamflow was used to calculate daily mean concentrations from daily S-LOADEST loads because it probably more accurately reflected the variation in constituent concentrations compared to using discrete concentrations as input, where the model linearly interpolates daily concentrations between sample collection dates.

Initial Conditions

Initial water-surface elevation, water temperature, and DS, Cl, and SO_4 concentrations for each model segment are required at the start of a model simulation. Initial water-surface elevations were set to the measured value (337.0 m above NGVD of 1929) on January 1, 2006. At this time, Beaver Lake was assumed to be in isothermal conditions throughout the entire reservoir with an initial water temperature of 6 °C. Initial DS, Cl, and SO_4 concentrations also were assumed to be uniform and were set at 80, 4.0, and 9.0 mg/L, respectively.

Model Parameters

Parameters are used to describe the physical and chemical processes that are not explicitly modeled and to provide the chemical kinetic rate information. Many parameters cannot be measured directly and often are adjusted during the model calibration process until simulated values, for example, water temperature, dissolved oxygen, and others, agree with measured observations. Most of the hydrodynamic and thermal processes are modeled in CE-QUAL-W2, which results in very few adjustable hydraulic and thermal parameters. There are many chemical and biological rate coefficients required for the application of CE-QUAL-W2, which were all temporally constant (table 2). Many of the coefficients were based on suggested values given as default values for CE-QUAL-W2, and others were based on other model applications (Bales and others, 2001; Haggard and Green, 2002; Galloway and Green, 2002 and 2003; Green and others, 2003; Sullivan and Rounds, 2005).

Model Calibration and Testing

Successful model application requires model calibration that includes comparing simulated results with measured reservoir conditions. The Beaver Lake model calibration was completed by adjusting parameters for the 5-year period from January 2006 through December 2010. Calibration was achieved generally by calibrating the water balance first and then the thermodynamics.

Two statistics were used to compare simulated and measured water temperature and DS, Cl, and SO_4 concentrations. The absolute mean error (AME) indicated the average difference between simulated and measured values and was computed by equation 2:

$$AME = \frac{\Sigma\left|\text{simulated value} - \text{measured value}\right|}{\text{number of observations}} \qquad (2)$$

Table 2. Parameters and values used in the CE-QUAL-W2 model of Beaver Lake, January 2006 to December 2010.

Parameter description	Values	Units
Coefficient of bottom heat exchange	0.3	watts/square meter/ second
Sediment temperature	20.0	degrees Celsius
Wind-sheltering coefficient	0.7	dimensionless
Horizontal eddy viscosity	1.0	square meters /second
Horizontal eddy diffusivity	1.0	square meters/second
Light extinction coefficient for pure water	0.35	1/meter
Fraction of incident solar radiation absorbed at water surface	0.32	dimensionless

An AME of 1.5 °C, for example, means that the average difference between simulated temperatures and measured temperature is 1.5 °C.

The root mean square error (RMSE) indicated the spread of how far simulated values deviated from the measured values and was computed by equation 3:

$$RMSE = \sqrt{\frac{\Sigma\,(\text{simulated value} - \text{measured value})^2}{\text{number of observations}}} \qquad (3)$$

An RMSE of 1.5 °C, for example, means that the simulated temperatures are within 1.5 °C of the measured temperatures about 67 percent of the time.

Water Balance

Simulated water-surface elevations in Beaver Lake were adjusted to the measured water-surface elevation near the dam for the model period of January 2006 through December 2010 (fig. 3). The simulated water-surface elevations were corrected to the measured values by adjusting the unmeasured inflow into the lake that had been distributed to all the segments within a branch. Inflow was added or subtracted so that the simulated water-surface elevation reflected the measured water-surface elevation, therefore accounting for unmeasured inflow and groundwater interaction in Beaver Lake. By correcting the distributed inflow, the temperature and water quality could be calibrated without the uncertainty incurred with having differences between simulated and measured water-surface elevations.

Sensitivity Analysis

A sensitivity analysis is the determination of the effects of small changes in the calibrated model parameters and input on model results. A complete sensitivity analysis for the Beaver Lake model was not conducted. Testing of how changes in different parameters affect the hydrodynamics, temperature, and water quality, however, was conducted as part of the model development and calibration. Results from the model development and calibration runs plus information from previous model studies (Bales and others, 2001; Haggard and Green, 2002; Galloway and Green, 2002, 2003; Green and others, 2003; Sullivan and Rounds, 2005) were used to identify several parameters for partial evaluation in the sensitivity analysis.

The sensitivity of simulated water temperature and water quality was assessed with changes in the wind-sheltering coefficient and light-extinction coefficient (for pure water). Simulated vertical profiles of water temperature, at 1-m depth intervals, were compared with measured water-temperature profiles.

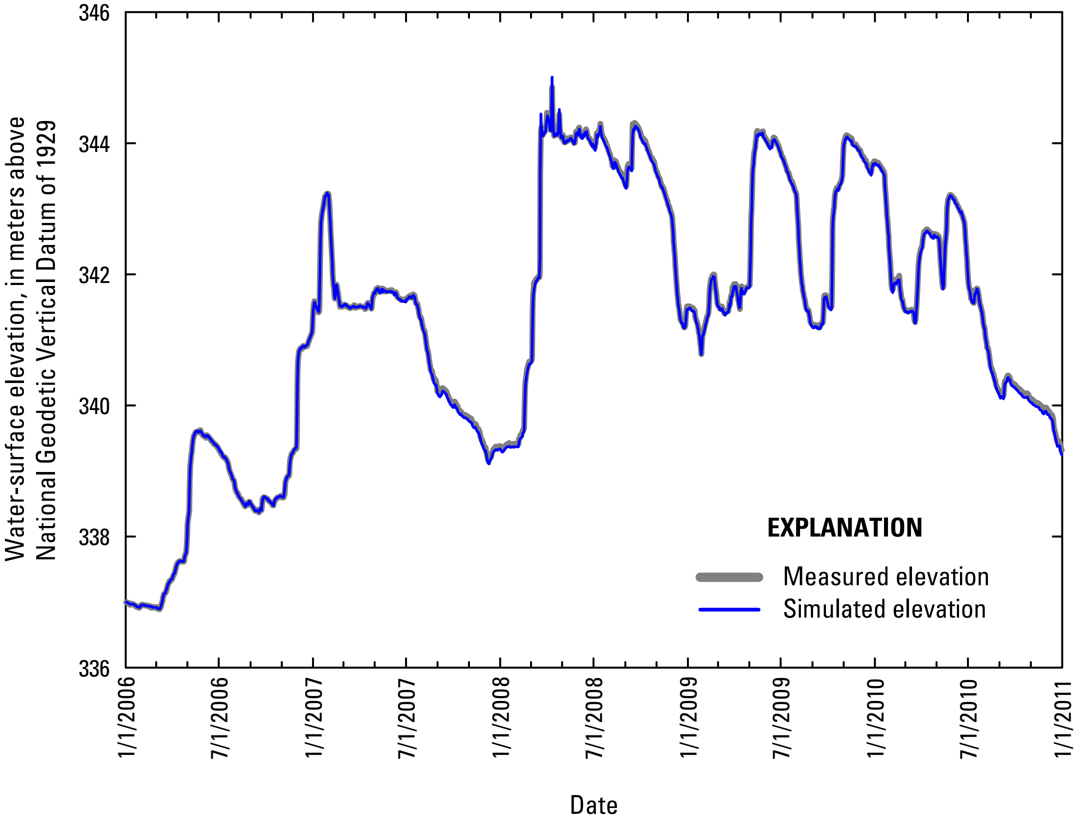

Figure 3. Simulated and measured water-surface elevations near Beaver Lake dam, Arkansas, January 2006 through December 2010.

Water temperature in the Beaver Lake model was the most sensitive to wind speed (wind-sheltering coefficient, table 2). The wind speed, adjusted by using the wind-sheltering coefficient, affects the amount of mixing in the reservoir, which can change the depth of the thermocline and increase or decrease the evaporative cooling.

Sensitivity analysis of DS, Cl, and SO_4 was not conducted. These water-quality constituents were considered conservative and only changed concentration through advection and dilution, as a conservative tracer might be expected to behave.

Model Limitations

The accuracy of the Beaver Lake model was limited by the simplification of the complexities of the hydrodynamics within the reservoir, by spatial and temporal discretization effects, and by assumptions made in the formulation of the governing equations. Model accuracy also was limited by segment size, boundary conditions, accuracy of calibration, and parameter sensitivity. Moreover, model accuracy was limited by the availability of data and by the interpolations and extrapolations that were inherent in using data in a model. Although a model might be calibrated, calibration parameter values are generally not necessarily unique in yielding acceptable values for the selected water-quality constituents and reservoir water-surface elevation.

Another limitation of the Beaver Lake model was that it is a two-dimensional representation of a three-dimensional water body. The governing equations are laterally and vertically averaged within layers. Although the model may have accurately represented vertical and longitudinal processes within the reservoir, processes that occur laterally, or from shoreline to shoreline perpendicular to the downstream axis, may not have been properly represented.

Ambient Conditions of Dissolved Solids, Chloride, and Sulfate in Beaver Lake

This section describes the ambient hydrologic and water-quality conditions for Beaver Lake from January 2006 through December 2010. Streamflow in the three major tributaries, outflow at Beaver Lake dam, and pool elevation for Beaver Lake are described for the period. In addition, water-quality conditions for the three major tributaries and for seven sites on Beaver Lake are described for January 2006 through December 2010. These data were retrieved and are still available from the USGS National Water Quality Information System Web site: http://waterdata.usgs.gov/ar/nwis/qw/.

Hydrologic Conditions

Streamflow varied substantially from January 2006 through December 2010 for the three major tributaries that provide inflow to Beaver Lake (fig. 4). The White River is the main inflow into Beaver Lake, and approximately 34 percent of the drainage area at Beaver Lake dam is above the streamflow-gaging station near Fayetteville (site S1, fig. 1). The daily mean streamflow for the White River ranged from 0.01 to 1,215 m^3/s for the period of January 2006 through December 2010. Mean daily streamflow for the period was 16.3 m^3/s. The drainage area of Richland Creek above the gaging station at Goshen (site S2, fig. 1) composes 12 percent of the drainage area at Beaver Lake dam. The daily mean streamflow for Richland Creek ranged from 0.003 to 957 m^3/s for the period of January 2006 through December 2010, with a mean daily streamflow of 6.06 m^3/s for the period. War Eagle Creek at the gaging station near Hindsville (site S3, fig. 1) has a drainage area that composes 22 percent of the drainage area at Beaver Lake dam. The daily mean streamflow for War Eagle Creek ranged from 0.312 to 767 m^3/s for the period of January 2006 through December 2010, with a mean daily streamflow of 9.90 m^3/s for the period.

The outflow from Beaver Lake also varied substantially for the period of January 2006 through December 2010 (fig. 4). Outflow discharge at Beaver Lake dam ranged from 1.76 m^3/s to 2,254 m^3/s, with a mean outflow discharge of 35.3 m^3/s for the period. Four public water-supply withdrawals also are located on Beaver Lake near the dam.

The water-surface elevation for Beaver Lake varied according to changes in the inflow and outflow for the reservoir (fig. 3). Water-surface elevation started off low in January 2006 reaching a minimum elevation March 7, 2006, at 336.9 m above NGVD of 1929 and remained below the top of conservation pool (341.4 m above NGVD of 1929) for most of 2006. Water-surface elevation reached a maximum elevation of 344.9 m above NGVD of 1929 on April 11, 2008.

Water-Quality Conditions

Water quality has been monitored in Beaver Lake by the USGS in cooperation with Beaver Water District since 2001. Water-quality samples are collected from both high-flow events and base flow to characterize conditions within the entire hydrograph. Samples are collected in the reservoir at sites positioned along the downstream gradient. Vertical samples are collected within the water column when the lake is thermally stratified in the epilimnion, metalimnion, and hypolimnion. When the lake is not thermally stratified, only one sample (epilimnion) is collected. Both inflow and reservoir samples are analyzed for a number of constituents, DS, Cl, and SO_4, included.

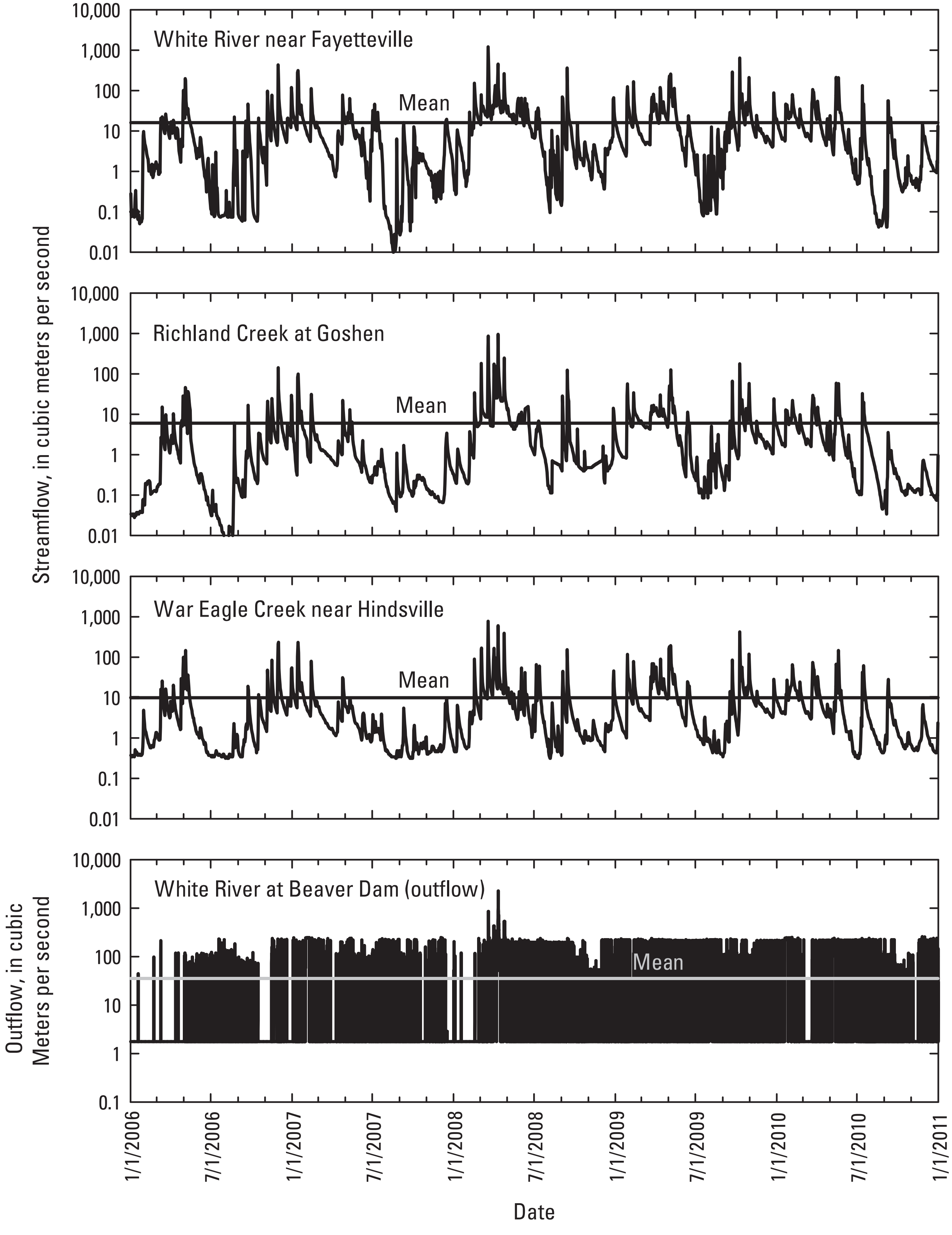

Figure 4. Mean daily streamflow for White River (site S1), Richland Creek (site S2), and War Eagle Creek (site S3), and hourly outflow at Beaver Lake dam.

Inflow Water Quality

Water-quality samples were collected at the three main inflows to Beaver Lake: the White River near Fayetteville (site S1), Richland Creek at Goshen (site S2), and War Eagle Creek near Hindsville (site S3) (fig. 1). Measured DS, Cl, and SO_4 concentrations varied among the tributaries because of differences in land use and contributions from point sources. DS concentrations were greater at Richland Creek and War Eagle Creek than White River (fig. 5). The median DS concentrations at White River, Richland Creek, and War Eagle Creek were 72, 96, and 109 mg/L, respectively. Cl concentrations were greater at War Eagle Creek than Richland Creek and White River (fig. 5). The median Cl concentrations at White River, Richland Creek, and War Eagle Creek were 3.1, 4.1, and 6.9 mg/L, respectively. The median SO_4 concentration was greater at White River and Richland Creek than War Eagle Creek (fig. 5). The median SO_4 concentrations at White River, Richland Creek, and War Eagle Creek were 10.6, 9.5, and 5.8 mg/L, respectively.

The inflow of DS, Cl, and SO_4 input from groundwater into Beaver Lake was not considered in this study. Groundwater inflow through the bottom of the reservoir was not considered a boundary condition in the model and therefore not simulated. Tributary base flow into Beaver Lake was considered to be dominated by groundwater; therefore, groundwater inflow was indirectly accounted for in tributary loading.

Reservoir Water Quality

Water-quality samples were collected at the seven sites in Beaver Lake: White River near Goshen (site L1), Beaver Lake at Highway 412 bridge near Sonora (site L2), Beaver Lake near Lowell (site L3), Beaver Lake at Highway 12 bridge near Rogers (site L4), Beaver Lake near Eureka Springs (site L5), War Eagle Creek above White River near Lowell (site L9), and Beaver Lake downstream from Hickory Creek landing near Springdale (site L10) (table 1, fig. 1). Concentrations of DS, Cl, and SO_4 were analyzed from samples collected 1 m below the surface at White River near Goshen (site L1) and 1 m above the bottom, when the water column was thermally stratified. When the water column was isothermal, one sample was collected 1 m below the surface. Samples were collected 2 m below the surface and 2 m above the reservoir bottom at the other six sampling sites. When the water column was isothermal, one sample was collected 2 m below the surface.

Measured DS, Cl, and SO_4 concentrations varied among lake sites relative to their downstream distance from the tributary point of entry to Beaver Lake (fig. 6). DS, Cl, and SO_4 concentrations were most variable at the upper end of the reservoir, White River near Goshen (site L1). The City of Fayetteville discharges wastewater into the White River, upstream from site L1 near Goshen and downstream from White River near Fayetteville (site S1). Although the variability in DS concentrations was greatest at White River near Goshen (site L1), the greatest median value (98 mg/L) occurred at War Eagle Creek above White River near Lowell (site L9), followed by Beaver Lake at Highway 412 bridge near Sonora (site L2, 93 mg/L) and Beaver Lake downstream from Hickory Creek landing near Springdale (site L10, 91 mg/L). Variability and median concentrations for both Cl (5.4 mg/L) and SO_4 (13.0 mg/L) were greatest at White River near Goshen (site L1) and generally decreased the farther downstream the site was located.

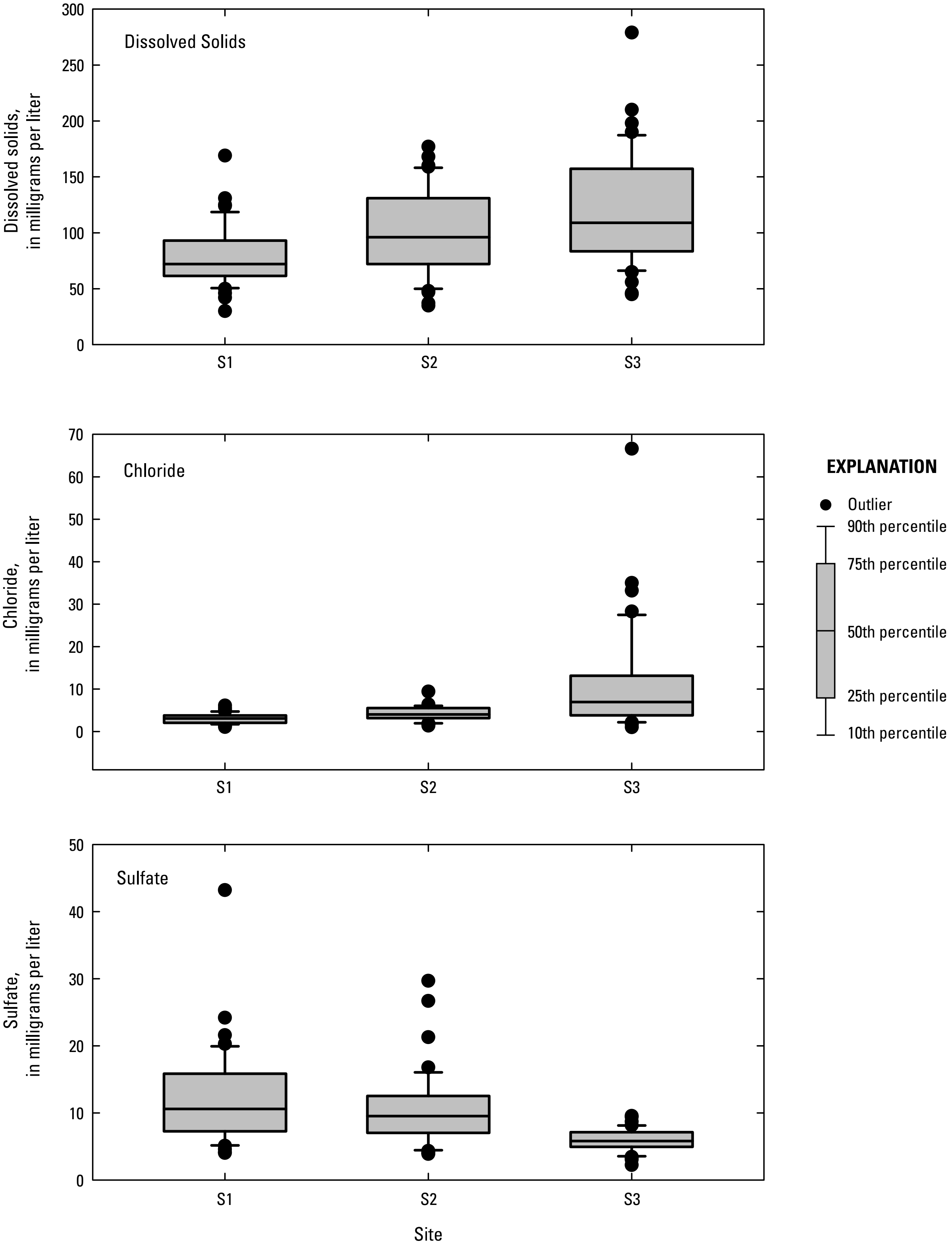

Figure 5. Distribution of dissolved solids, chloride, and sulfate concentrations for White River (site S1), Richland Creek (site S2), and War Eagle Creek (site S3), 2006–10.

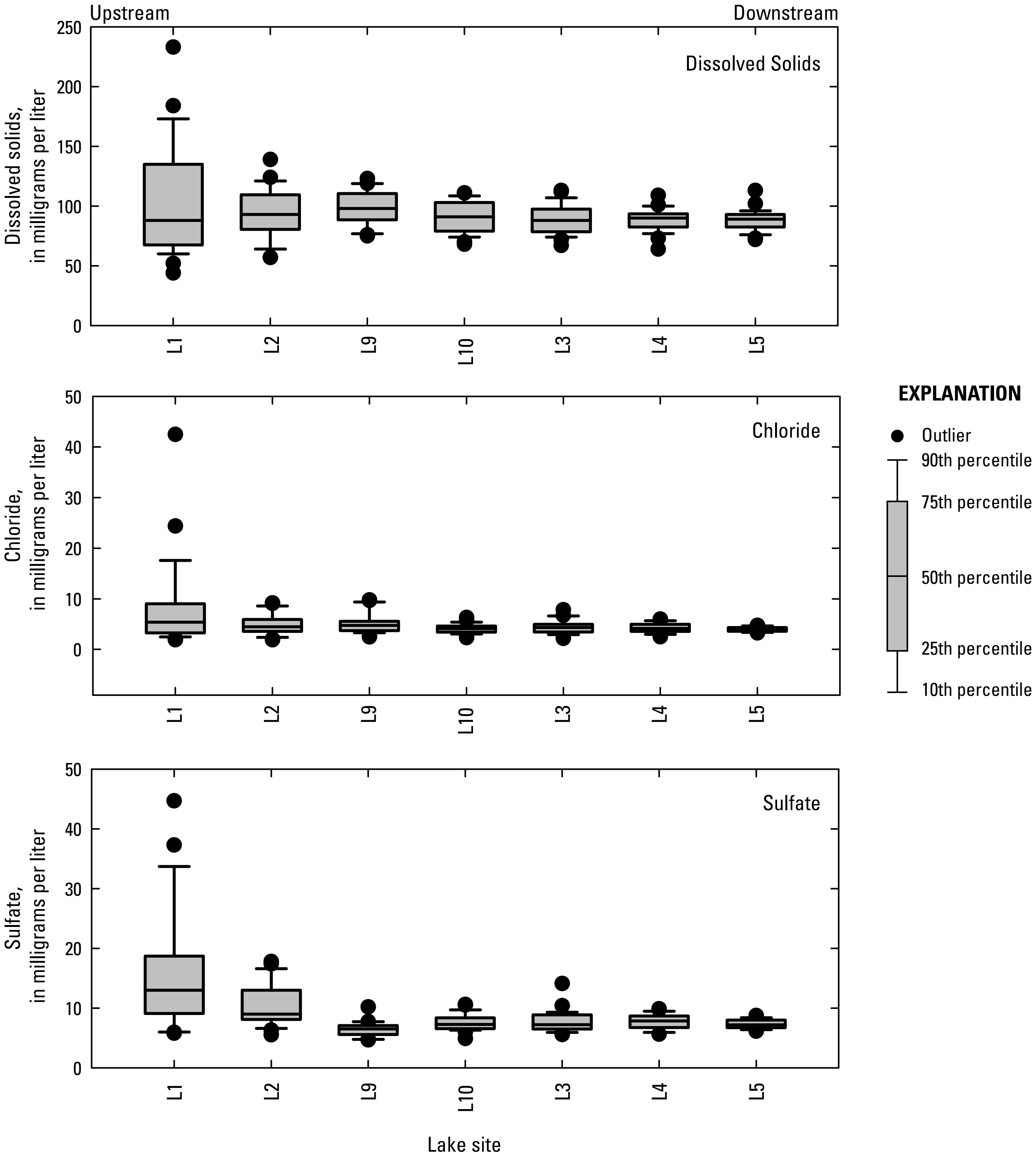

Figure 6. Distribution of dissolved solids, chloride, and sulfate concentrations 2 meters (m) below the surface at lake sites L1–L5, L9, and L10, 2006–10.

Dissolved Solids, Chloride, and Sulfate Fate and Transport Simulations

Inflow Loads and Concentrations

Estimated daily DS, Cl, and SO_4 concentrations in the Beaver Lake model were determined by dividing daily S-LOADEST loads by daily discharge and converting to milligrams per liter. S-LOADEST daily concentrations were similar to measured instantaneous concentrations at all three inflow tributaries (figs. 7–9, table 3). In general, estimated mean daily concentrations followed the seasonal (high-flow/low-flow) cycles of instantaneous measured concentrations.

Reservoir Hydrodynamics

Simulated water temperatures in Beaver Lake were compared to 197 depth profiles of temperature measured at seven sites on Beaver Lake (fig. 1). Temperatures were adjusted to the measured values for the model period, January 2006 through December 2010.

Simulated temperatures compared reasonably well with measured temperatures (fig. 10), and differences varied spatially in Beaver Lake for January 2006 through December 2010. Differences in temperature between simulated and measured values decreased from site L2 (segment 5) to site L5 (segment 35). The AME ranged from 1.75 °C at site L5 to 2.68 °C at L2, and the RMSE ranged from 2.22 °C at site L5 to 3.35 °C at site L2 from January 2006 through December 2010 (table 4). Among all the sites, the greatest differences between measured and simulated data occurred in the upstream part of the reservoir, which is the most dynamic part of the reservoir. The upstream part of the reservoir is the shallowest section of Beaver Lake and has more riverine characteristics than the deep downstream part of the reservoir. The upstream part also receives most of the inflow to the reservoir, which creates more dynamic conditions. The greatest differences between simulated and measured temperatures at any given site generally occurred in simulating the location of the thermocline. Higher wind speeds result in more mixing, resulting in a deeper thermocline and lower surface temperatures, whereas lower wind speeds result in a shallower thermocline and higher surface temperatures. Differences in the thermocline depth between the simulated and measured vertical profiles resulted in high temperature errors because of the rapid change and differences in water temperature with depth.

Dissolved Solids, Chloride, and Sulfate Concentrations

Simulated DS, Cl, and SO_4 concentrations in model segments 2, 5, 48, 14, 16, 23, and 35 matched well with measured concentrations at lake sites L1, L2, L9, L10, L3, L4, and L5, respectively (figs. 11–16). The greatest differences between measured and simulated DS, Cl, and SO_4 concentrations occurred at the upstream sites on the White River main stem in Beaver Lake: White River near Goshen (site L1, model segment 2) and Beaver Lake at Highway 412 (site L2, model segment 5). The higher measured concentrations likely resulted from wastewater discharges upstream from station L1 that were not included in the model input, based on the measured and simulated increases in DS, Cl, and SO_4 concentrations between White River near Fayetteville (site S1) and White River near Goshen (site L1) (figs. 7–8). Not including sites L1 and L2, the AME for DS for sites L3, L4, L5, L9, and L10 ranged from 7.64 mg/L at site L10 to 11.5 mg/L at L9, and the RMSE ranged from 10.4 mg/L at site L5 to 15.2 mg/L at site L9 from January 2006 through December 2010 (figs. 11–12, table 4). The AME for Cl ranged from 0.224 mg/L at site L5 to 1.20 mg/L at site L9, and the RMSE ranged from 0.286 mg/L at site L5 to 1.37 mg/L at site L9 from January 2006 through December 2010 (figs. 13–14, table 4). The AME for SO_4 ranged from 1.27 mg/L at site L4 to 1.60 mg/L at site L3, and the RMSE ranged from 1.51 mg/L at site L4 to 1.95 mg/L at site L9 from January 2006 through December 2010 (figs. 15–16, table 4).

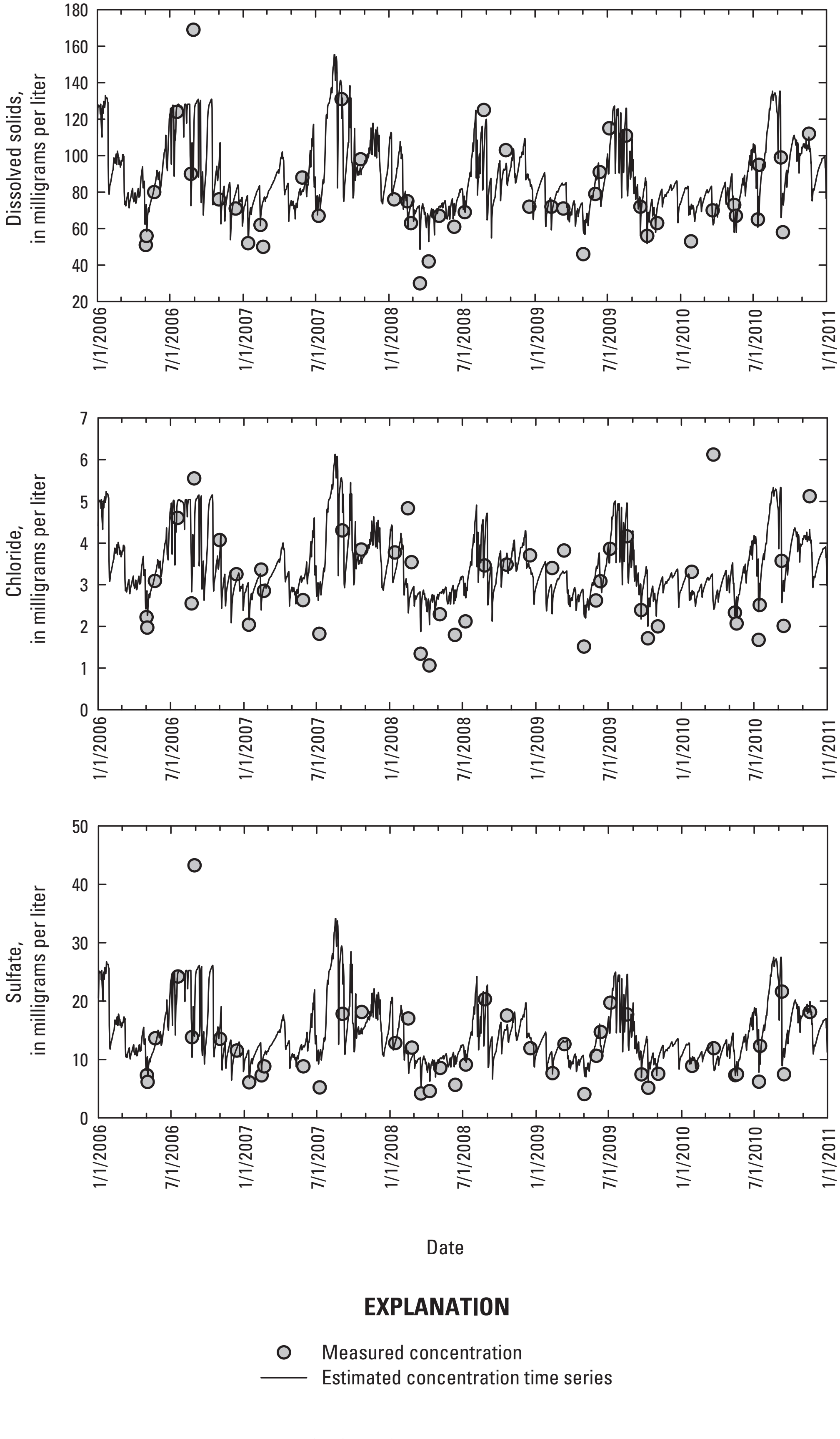

Figure 7. Time-series distributions of measured and S-LOADEST estimated dissolved solids, chloride, and sulfate concentrations at White River (site S1).

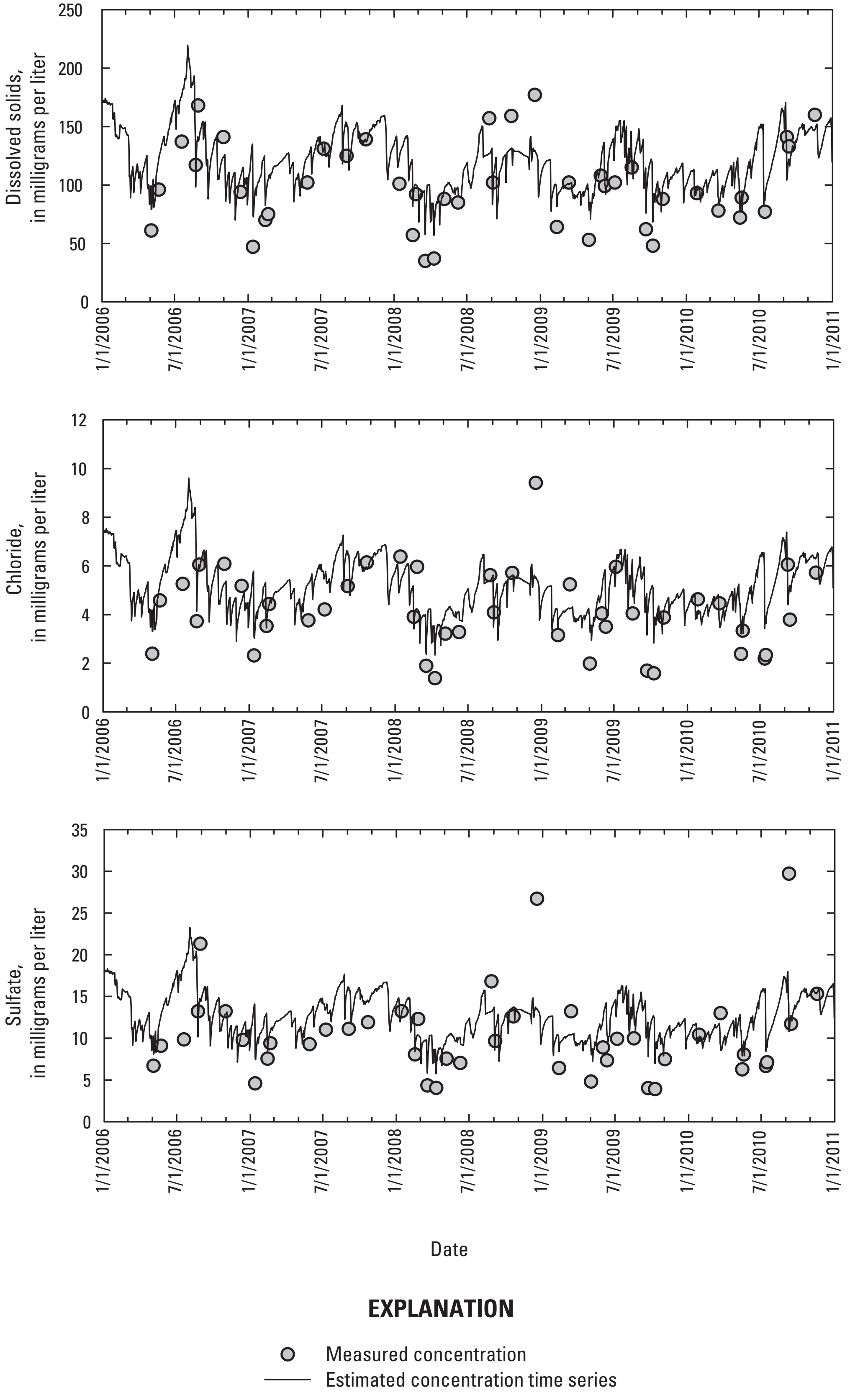

Figure 8. Time-series distributions of measured and S-LOADEST estimated dissolved solids, chloride, and sulfate concentrations at Richland Creek (site S2).

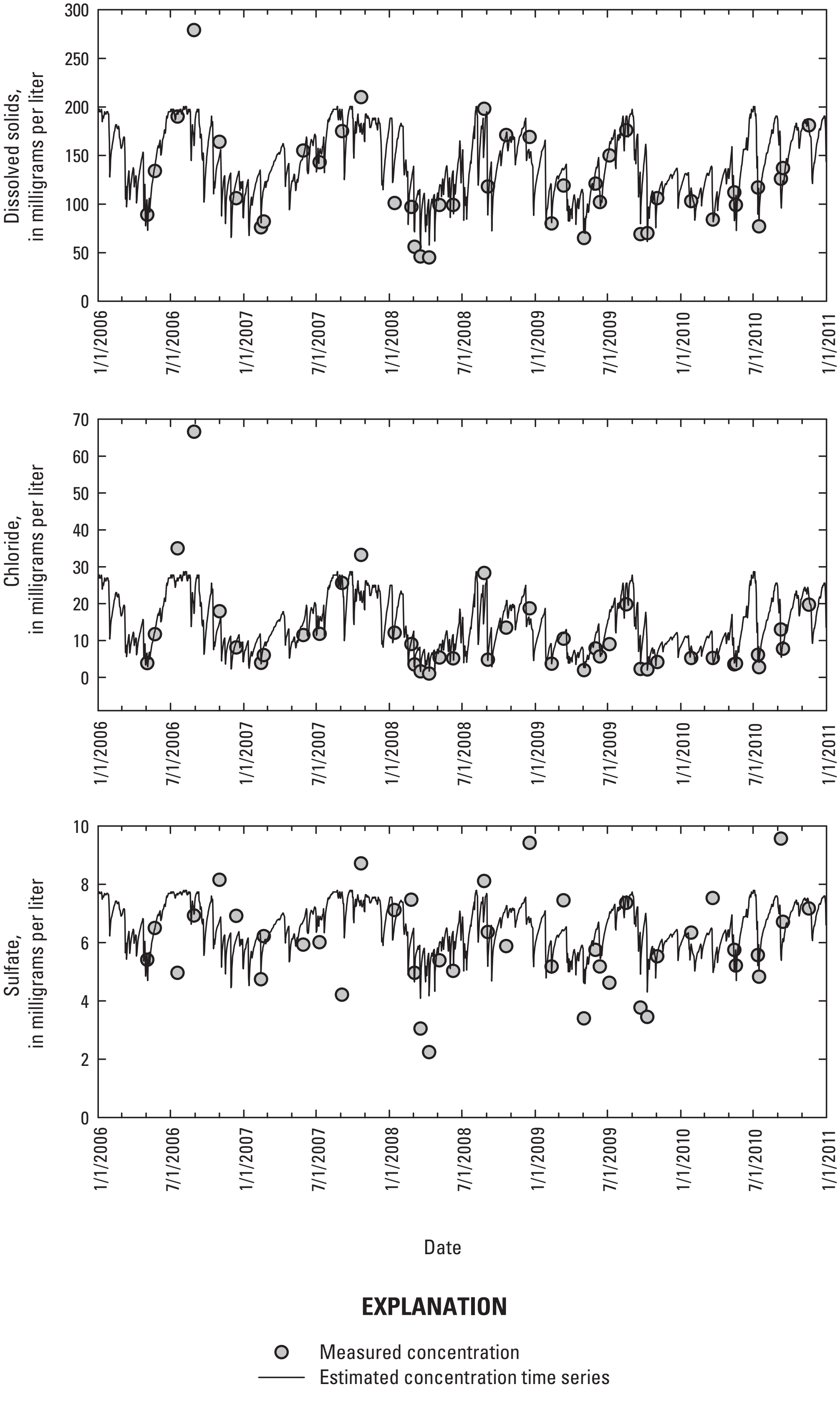

Figure 9. Time-series distributions of measured and S-LOADEST estimated dissolved solids, chloride, and sulfate concentrations at War Eagle Creek (site S3).

Table 3. Statistics measuring error between measured and S-LOADEST estimated dissolved solids, chloride, and sulfate concentrations at White River (S1), Richland Creek (S2), and War Eagle Creek (S3).

[AME, absolute mean error; RMSE, root mean square error; DS, dissolved solid; Cl, chloride; SO_4, sulfate]

	White River (S1)		Richland Creek (S2)		War Eagle Creek (S3)	
Constituent	AME	RMSE	AME	RMSE	AME	RMSE
DS	12.8	18.2	19.2	22.9	17.9	26.1
Cl	0.672	0.919	0.913	1.150	3.994	8.586
SO_4	3.271	5.701	3.123	4.566	2.242	6.912

Dissolved Solids, Chloride, and Sulfate Fate and Transport

Fifteen DS, Cl, and SO_4 fate and transport scenarios were compared to the baseline (calibrated) simulation. Daily DS, Cl, and SO_4 concentrations in the baseline simulation from the White River near Fayetteville (site S1) and War Eagle Creek near Hindsville (site S3) (fig. 1), individually and the two tributaries together, were increased by factors of 1.2, 1.5, 2.0, 5.0, and 10.0 times; flow (discharge) remained unchanged. These scenarios resulted in increased inflow DS, Cl, and SO_4 loading in each tributary by a factor of 1.2, 1.5, 2.0, 5.0, and 10.0 times baseline. It should be noted again that contributions from the City of Fayetteville's WWTP were not included in either the baseline model or any of the loading scenarios. Daily DS, Cl, and SO_4 concentrations in the 15 scenarios were compared to daily baseline concentrations at the seven model segments (2, 5, 48, 14, 16, 23, and 35) corresponding to lake sites L1, L2, L9, L10, L3, L4, and L5, respectively. Daily baseline and scenario concentrations were reported at the seven model segments 2 m below the surface and 2 m above the bottom, corresponding to the depths where water samples were collected. A time-series plot of baseline and scenario results from increasing loading scenarios from White River near Fayetteville (site S1) and War Eagle Creek near Hindsville (site S3), individually and the two tributaries together, for each of the seven model segments at 2 m below the surface was prepared to visualize differences for the period January 2006 through December 2010 (fig. 17*A*–*C*). For all three constituents (DS, Cl, and SO_4), the loads that were increased by factors of 1.2, 1.5, and 2.0 times baseline produced only slightly higher concentrations in the model segments than those in the baseline condition. Much greater separation in concentrations from the baseline condition, at model segments 2, 5, 48, 14, 16, 23, and 35 at 2 m below the surface, occurred when loads were increased by a factor of 5.0 and 10.0 times baseline loads.

Average daily DS, Cl, and SO_4 concentrations, from January 2006 through December 2010, for each constituent for the baseline and each loading scenario at each of the seven model segments both 2 m below the surface and 2 m above the bottom are presented in tables 5–7 and figures 18–26. Concentrations were greater in the reservoir at model segments closer to where the tributaries entered the reservoir: sites L1 and L2 (segments 2 and 5) for increased loads from White River near Fayetteville (site S1) and sites L9 and L10 (segments 48 and 14) for increased loads from War Eagle Creek near Hindsville. Concentrations resulting from the increase in loading became more diluted farther downstream from the source. Differences in concentrations between the baseline condition and the 1.2, 1.5, and 2.0 times baseline concentration scenarios were smaller than the differences in the 5.0 and 10.0 times baseline concentration scenarios. The results for both the 2 m below the surface and 2 m above the bottom were similar, with the exception of concentrations resulting from the increased loading factors (5.0 and 10.0 times), where concentrations 2 m above the bottom were consistently greater than those 2 m below the surface at most segments. During thermal stratification, inflow water temperature often is lower (more dense) than the surface of the reservoir, which causes the inflow to dip below the warmer surface layer into a layer of equal density, carrying DS, CL, and SO_4 with it. During these times, concentrations will be higher in the deeper water than the surface, as shown in the average concentrations at the increased loading rates in tables 5–7 and figures 18–26.

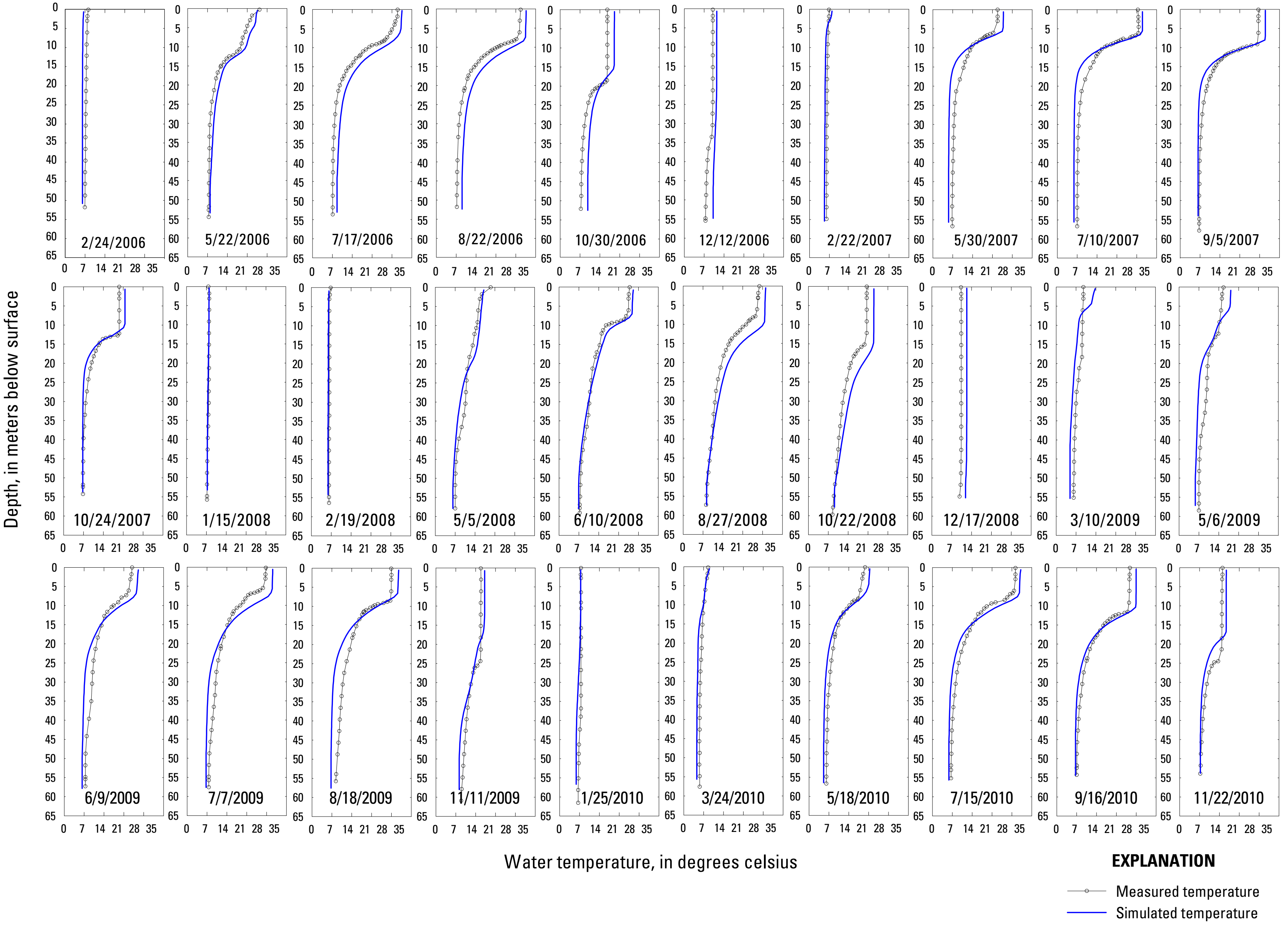

Figure 10. Selected simulated and measured water-temperature profiles for Beaver Lake at Highway 412 bridge near Eureka Springs, Arkansas (site L5, segment 35).

Table 4. CE-QUAL-W2 model calibration evaluation statistics for water temperature, dissolved solids, chloride, and sulfate for Beaver Lake sites, January 2006 through December 2010.

[Difference is simulated minus measured]

Station	Year	Minimum difference	Maximum difference	Mean difference	Absolute mean error	Root mean square error
			Temperature, in degrees Celsius			
L1, White River near Goshen (segment 2)[1]	2006–2010	-4.35	8.95	1.44	2.55	3.04
L2, Beaver Lake at Highway 412 bridge near Sonora (segment 5)[1]	2006–2010	-3.66	9.77	2.15	2.68	3.35
L9, War Eagle Creek above White River near Lowell (segment 48)	2007–2010	-2.74	7.78	2.28	2.62	3.19
L10, Beaver Lake downstream from Hickory Creek Landing near Springdale (segment 14)	2008–2010	-4.47	7.32	1.24	2.04	2.61
L3, Beaver Lake near Lowell (segment 16)	2006–2010	-5.31	6.84	1.35	2.30	2.77
L4, Beaver Lake at Highway 12 bridge near Rogers (segment 23)	2006–2010	-3.06	6.97	1.05	1.92	2.40
L5, Beaver Lake near Eureka Springs (segment 35)	2006–2010	-6.13	7.39	0.76	1.75	2.22
			Dissolved solids, in milligrams per liter			
L1, White River near Goshen (segment 2)[1]	2006–2010	-153	19.8	-24.1	29.2	45.1
L2, Beaver Lake at Highway 412 bridge near Sonora (segment 5)[1]	2006–2010	-74.7	18.3	-17.7	19.3	24.7
L9, War Eagle Creek above White River near Lowell (segment 48)	2007–2010	-50.8	14.8	-5.96	11.5	15.2
L10, Beaver Lake downstream from Hickory Creek landing near Springdale (segment 14)	2008–2010	-27.4	5.97	-5.20	7.64	10.8
L3, Beaver Lake near Lowell (segment 16)	2006–2010	-36.9	18.2	-6.23	10.3	13.3
L4, Beaver Lake at Highway 12 bridge near Rogers (segment 23)	2006–2010	-38.0	12.1	-7.71	9.55	12.5
L5, Beaver Lake near Eureka Springs (segment 35)	2006–2010	-29.1	14.8	-6.11	7.94	10.4
			Chloride, in milligrams per liter			
L1, White River near Goshen (segment 2)[1]	2006–2010	-39.1	0.725	-3.92	4.17	8.13
L2, Beaver Lake at Highway 412 bridge near Sonora (segment 5)[1]	2006–2010	-7.60	1.04	-1.68	1.83	2.60
L9, War Eagle Creek above White River near Lowell (segment 48)	2007–2010	-2.10	2.41	0.80	1.20	1.37
L10, Beaver Lake downstream from Hickory Creek landing near Springdale (segment 14)	2008–2010	-2.35	1.01	0.04	0.65	0.81
L3, Beaver Lake near Lowell (segment 16)	2006–2010	-2.84	1.33	-0.29	0.69	0.93
L4, Beaver Lake at Highway 12 bridge near Rogers (segment 23)	2006–2010	-2.50	0.92	-0.33	0.56	0.74
L5, Beaver Lake near Eureka Springs (segment 35)	2006–2010	-0.82	0.58	-0.01	0.22	0.29

Table 4. CE-QUAL-W2 model calibration evaluation statistics for water temperature, dissolved solids, chloride, and sulfate for Beaver Lake sites, January 2006 through December 2010.—Continued

[Difference is simulated minus measured]

Station	Year	Minimum difference	Maximum difference	Mean difference	Absolute mean error	Root mean square error
Sulfate, in milligrams per liter						
L1, White River near Goshen (segment 2)[1]	2006–2010	-32.6	5.01	-3.36	5.32	8.73
L2, Beaver Lake at Highway 412 bridge near Sonora (segment 5)[1]	2006–2010	-7.24	8.89	0.10	2.49	3.12
L9, War Eagle Creek above White River near Lowell (segment 48)	2007–2010	-1.00	5.26	1.44	1.58	1.95
L10, Beaver Lake downstream from Hickory Creek landing near Springdale (segment 14)	2008–2010	-2.03	2.33	0.916	1.40	1.55
L3, Beaver Lake near Lowell (segment 16)	2006–2010	-3.47	5.87	1.31	1.60	1.93
L4, Beaver Lake at Highway 12 bridge near Rogers (segment 23)	2006–2010	-2.19	4.55	1.10	1.27	1.51
L5, Beaver Lake near Eureka Springs (segment 35)	2006–2010	0.47	2.41	1.54	1.54	1.59

[1] Model simulation does not include dissolved solids, chloride, and sulfate constituents from the Fayetteville, Arkansas, wastewater-treatment plant, which influence measured concentrations.

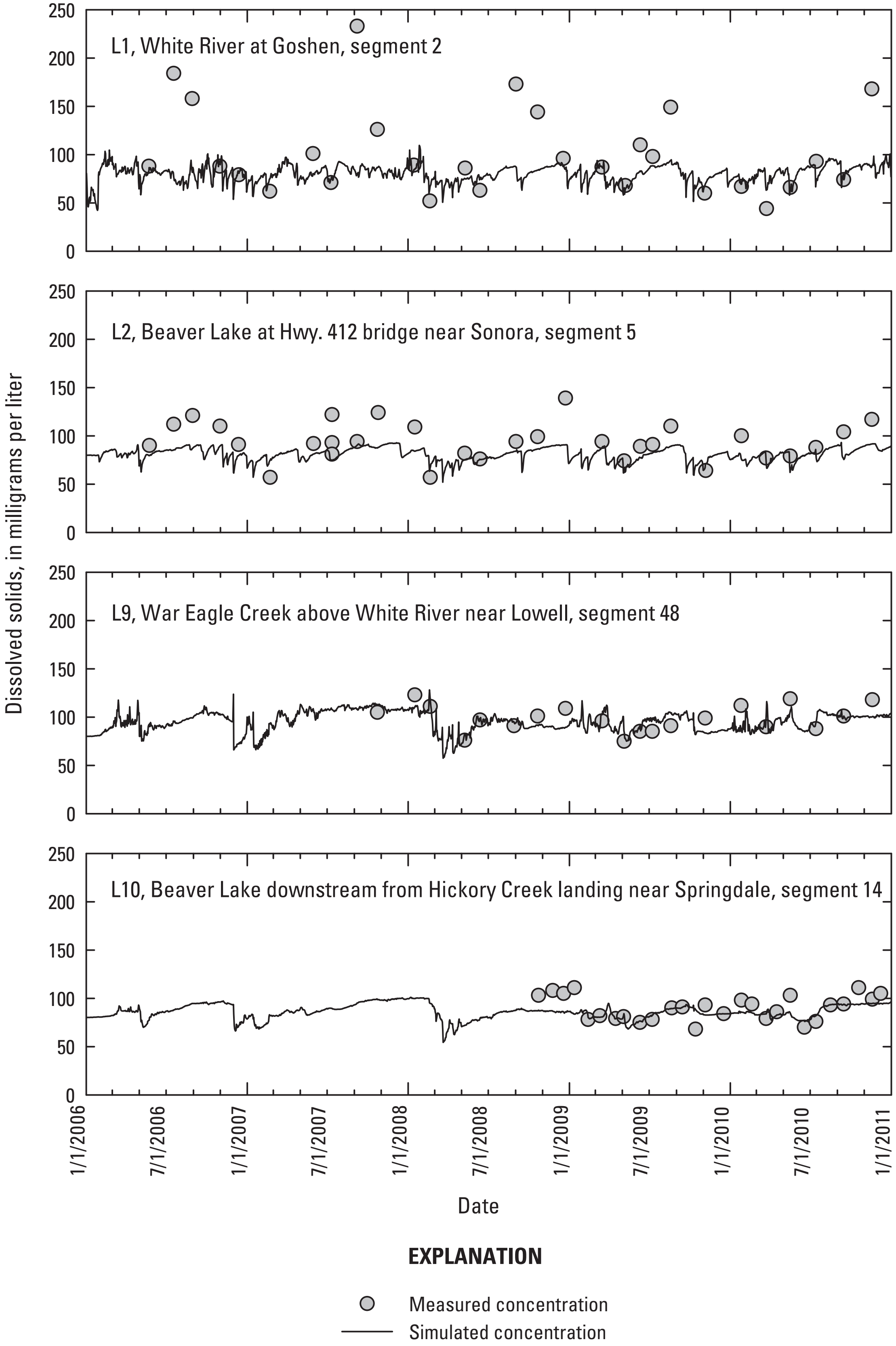

Figure 11. Simulated and measured dissolved solids concentrations 2 meters (m) below the surface in Beaver Lake, Arkansas.

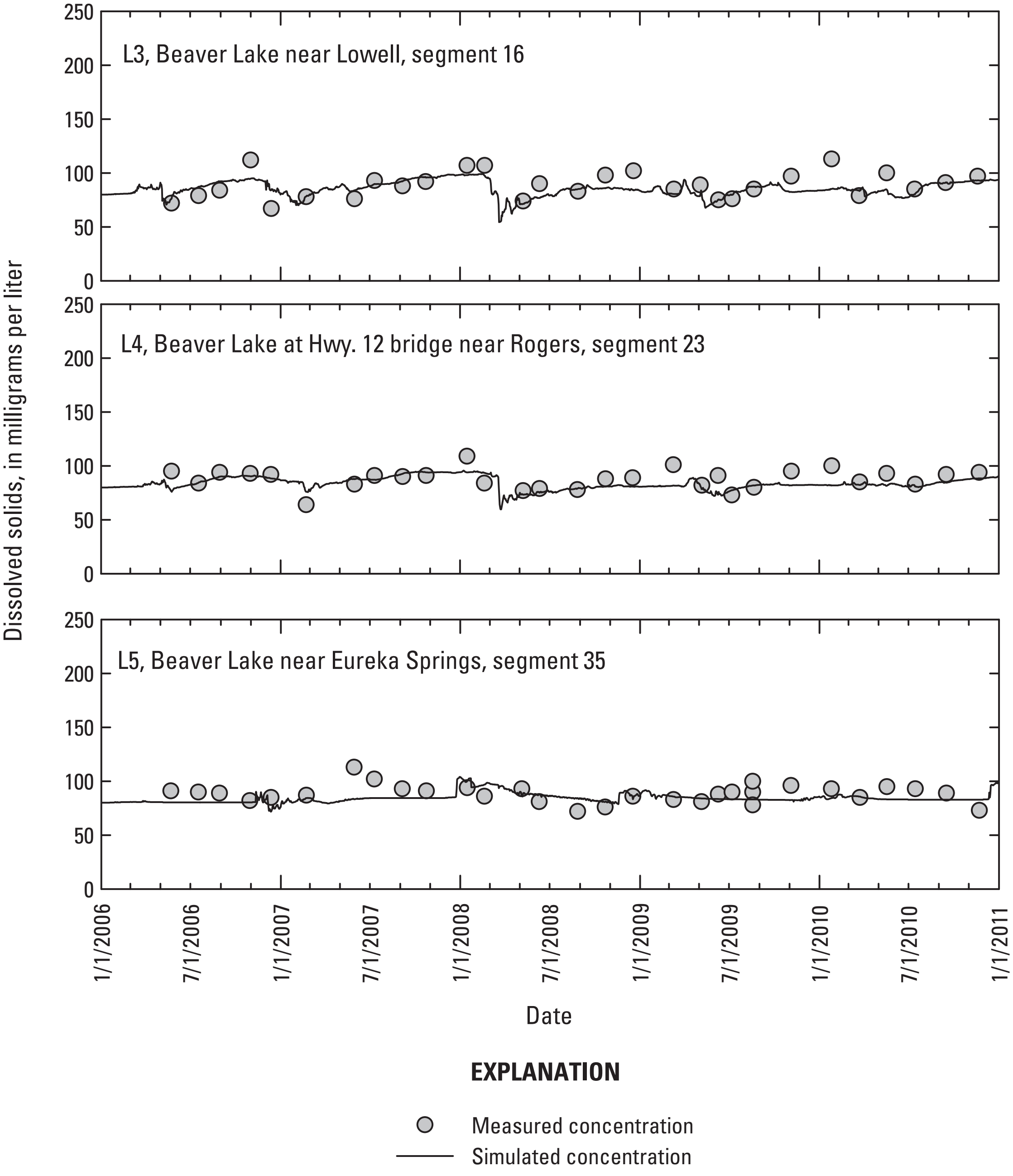

Figure 11. Simulated and measured dissolved solids concentrations 2 meters (m) below the surface in Beaver Lake, Arkansas.—Continued

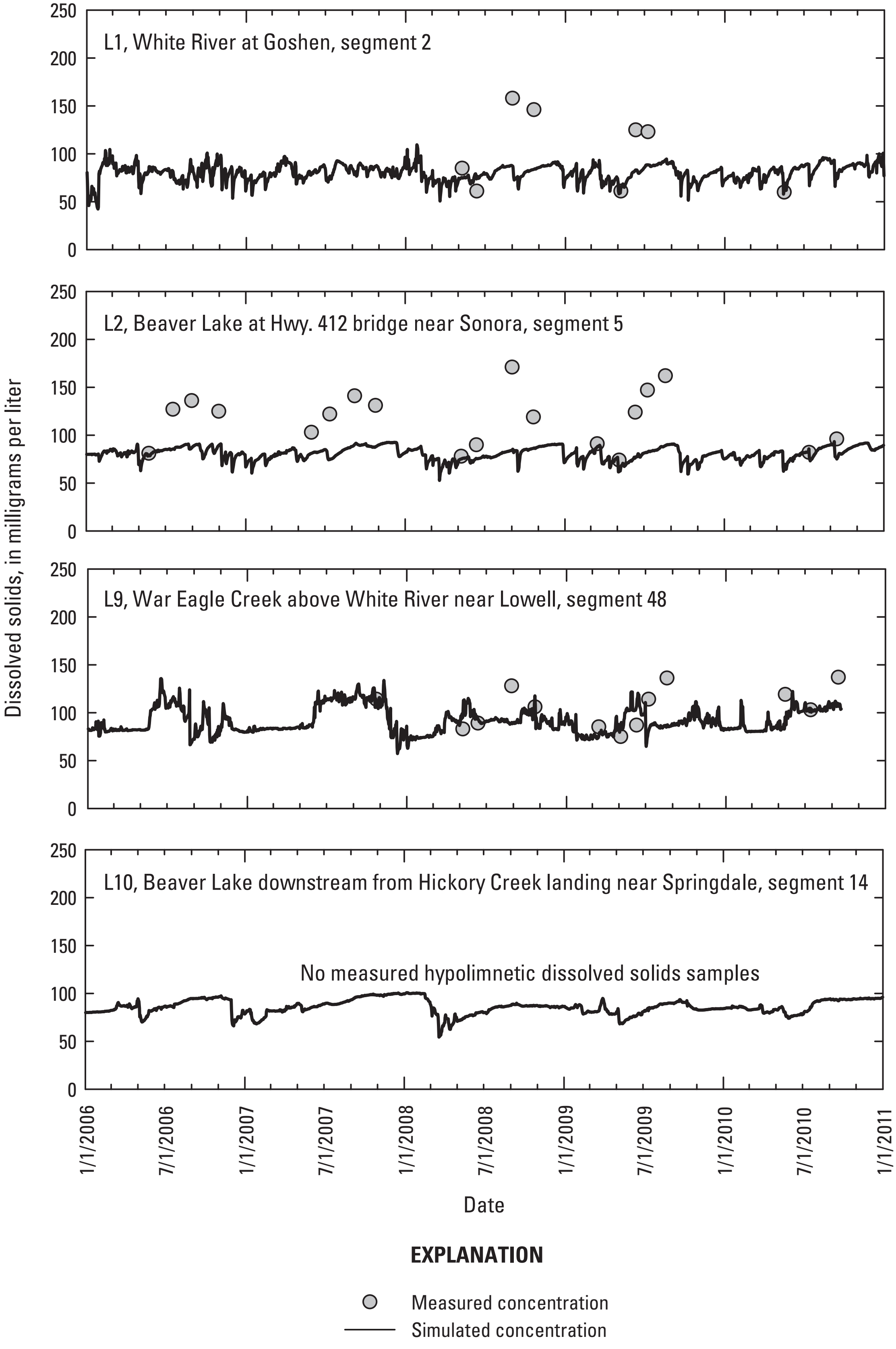

Figure 12. Simulated and measured dissolved solids concentrations 2 meters (m) above the bottom in Beaver Lake, Arkansas.

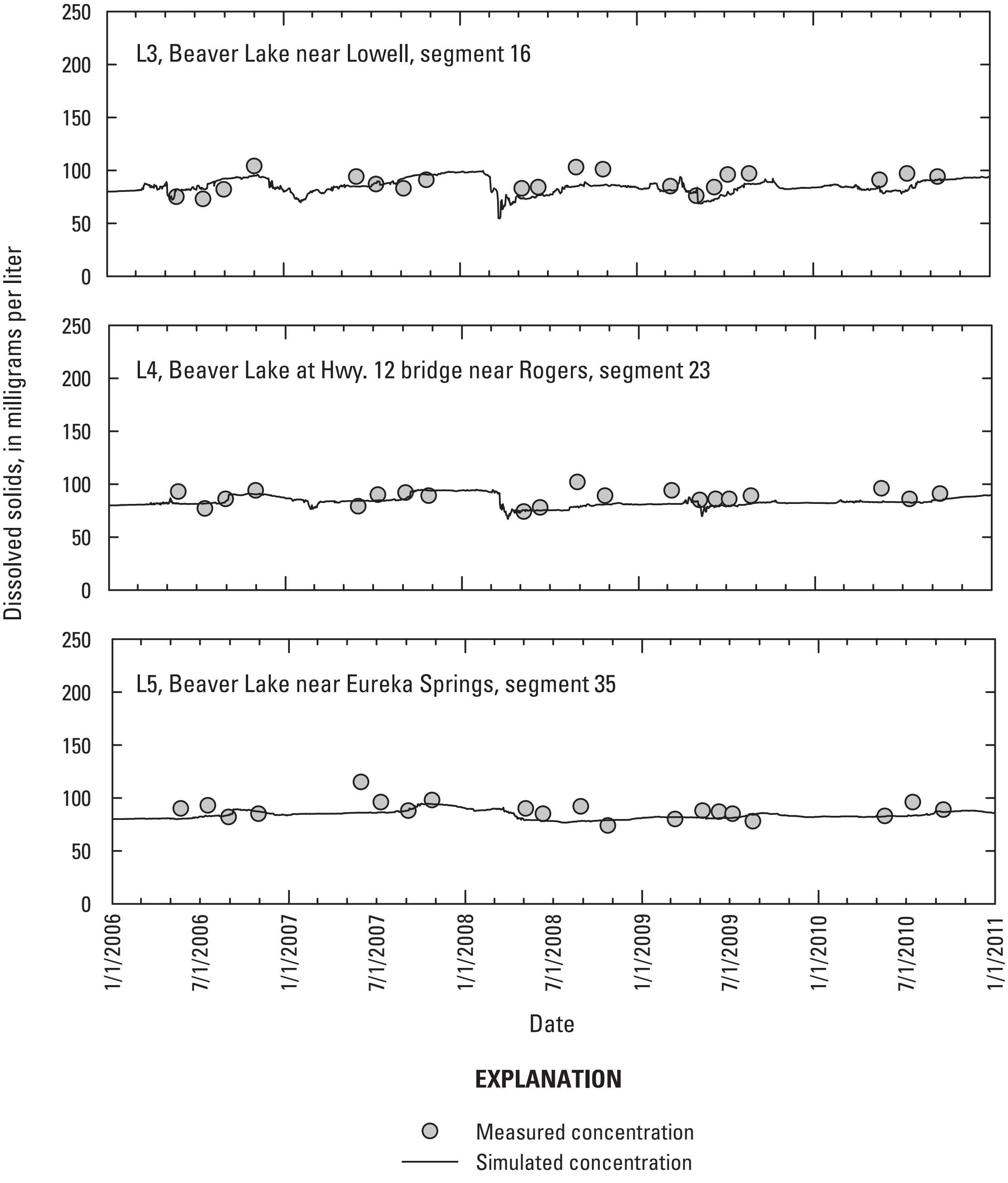

Figure 12. Simulated and measured dissolved solids concentrations 2 meters (m) above the bottom in Beaver Lake, Arkansas.—Continued

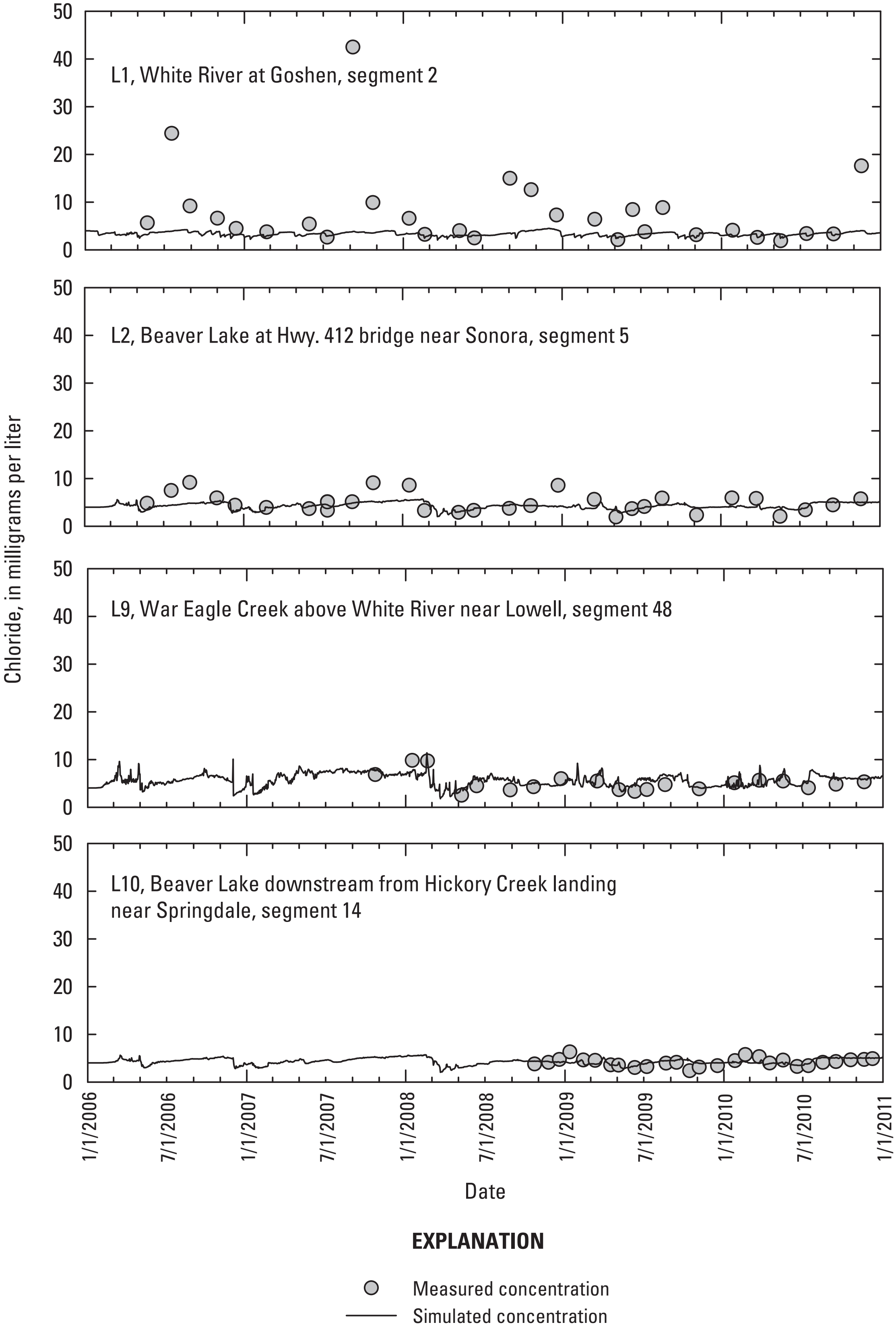

Figure 13. Simulated and measured chloride concentrations 2 meters (m) below the surface in Beaver Lake, Arkansas.

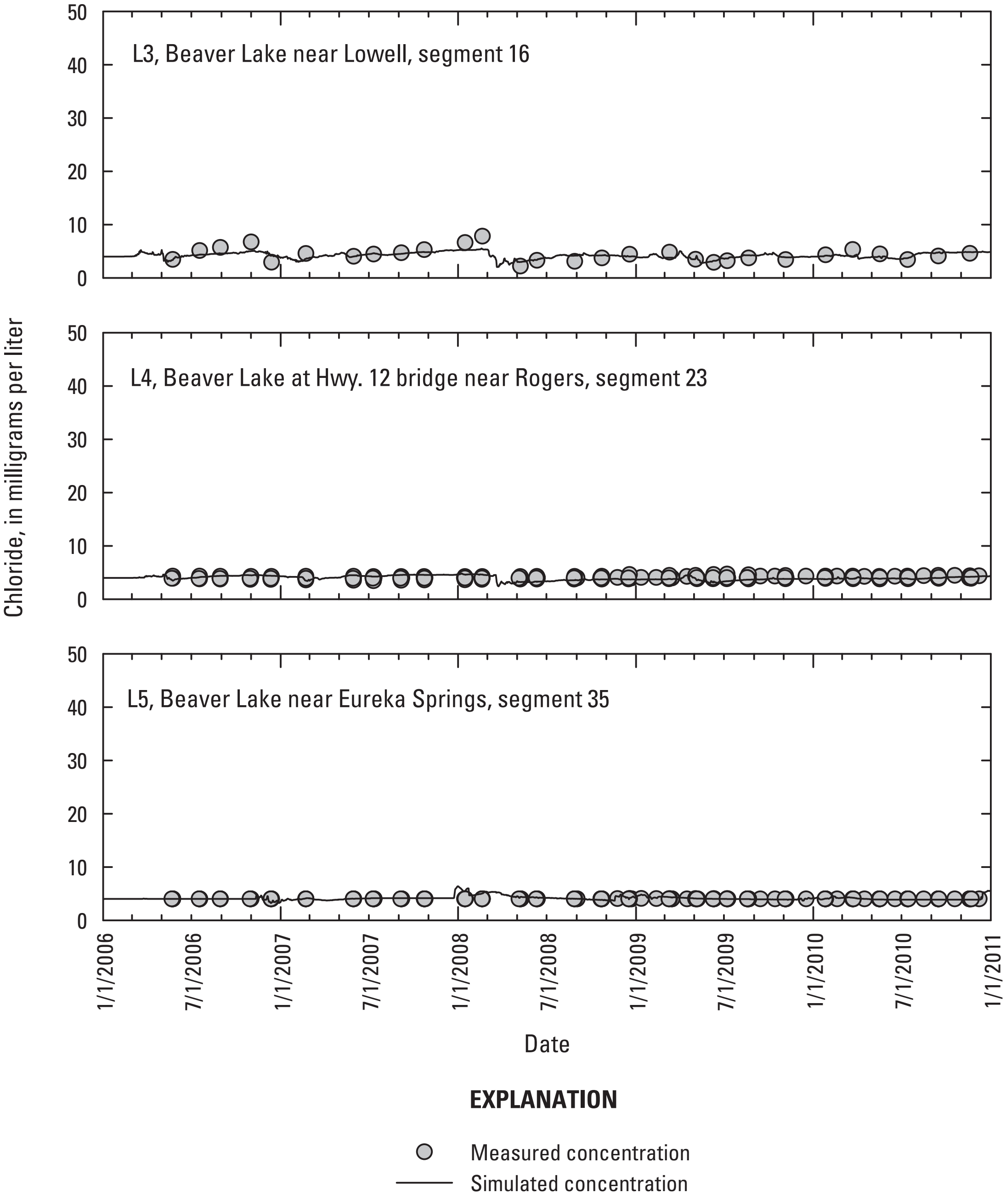

Figure 13. Simulated and measured chloride concentrations 2 meters (m) below the surface in Beaver Lake, Arkansas.—Continued

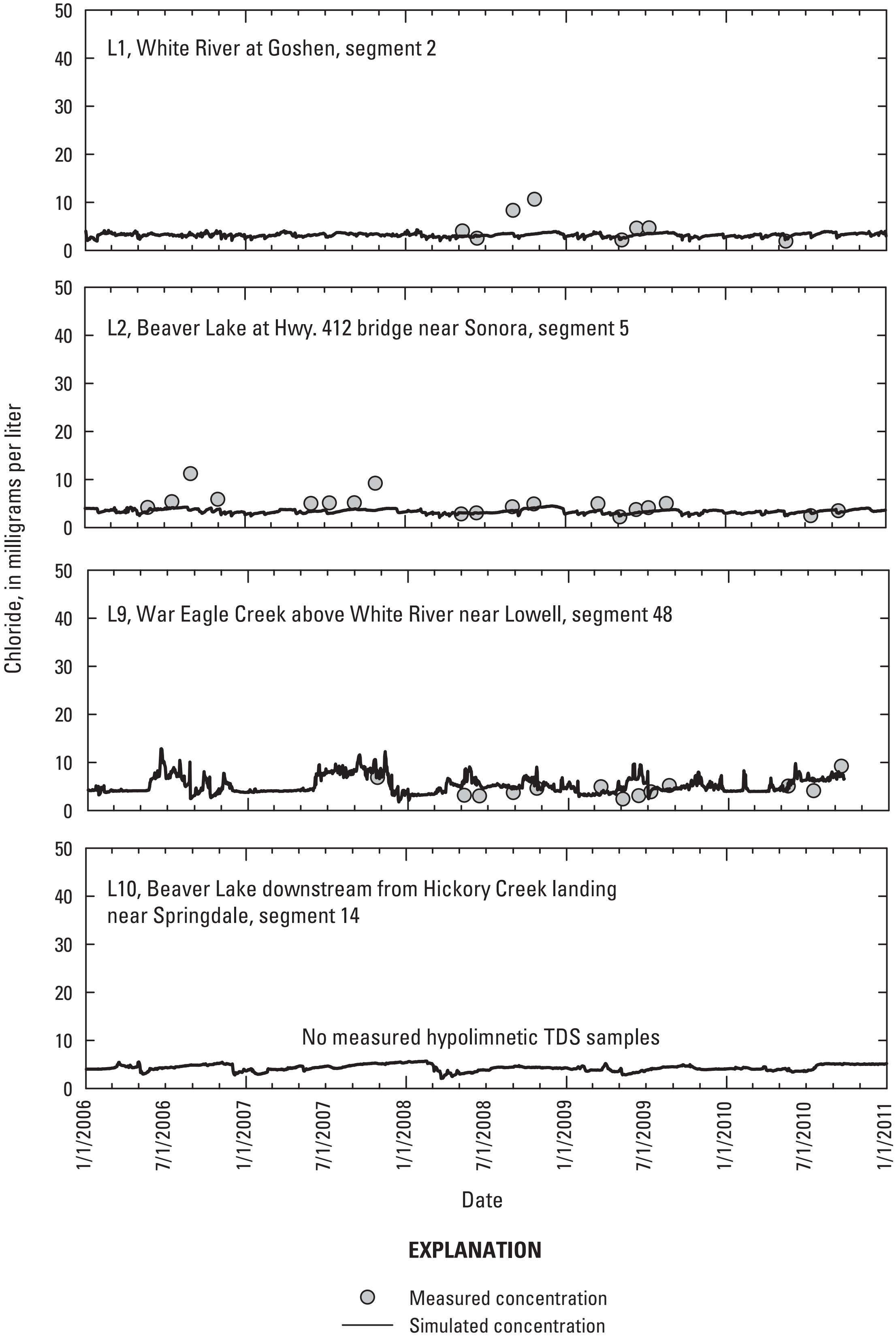

Figure 14. Simulated and measured chloride concentrations 2 meters (m) above the bottom in Beaver Lake, Arkansas.

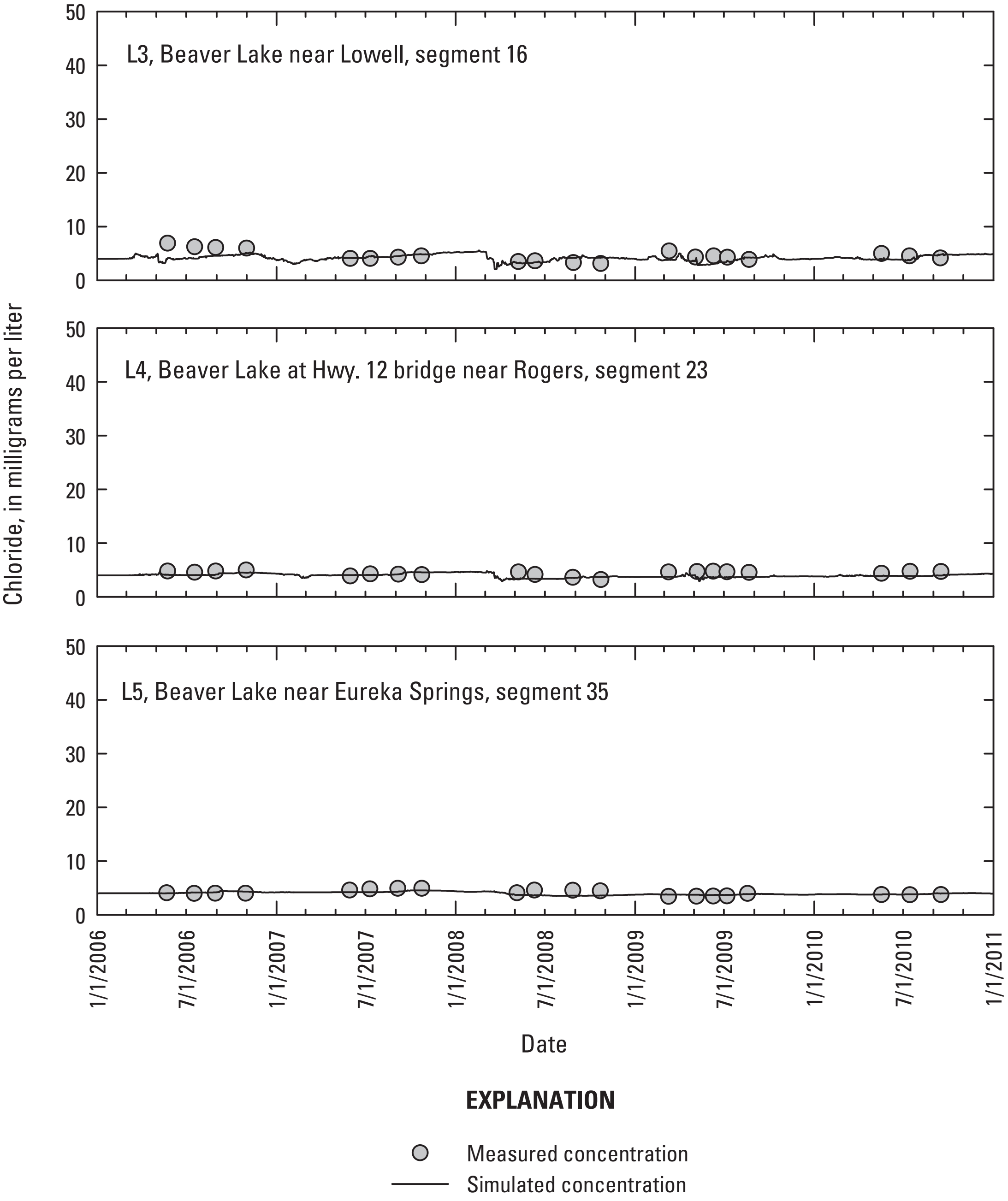

Figure 14. Simulated and measured chloride concentrations 2 meters (m) above the bottom in Beaver Lake, Arkansas.—Continued

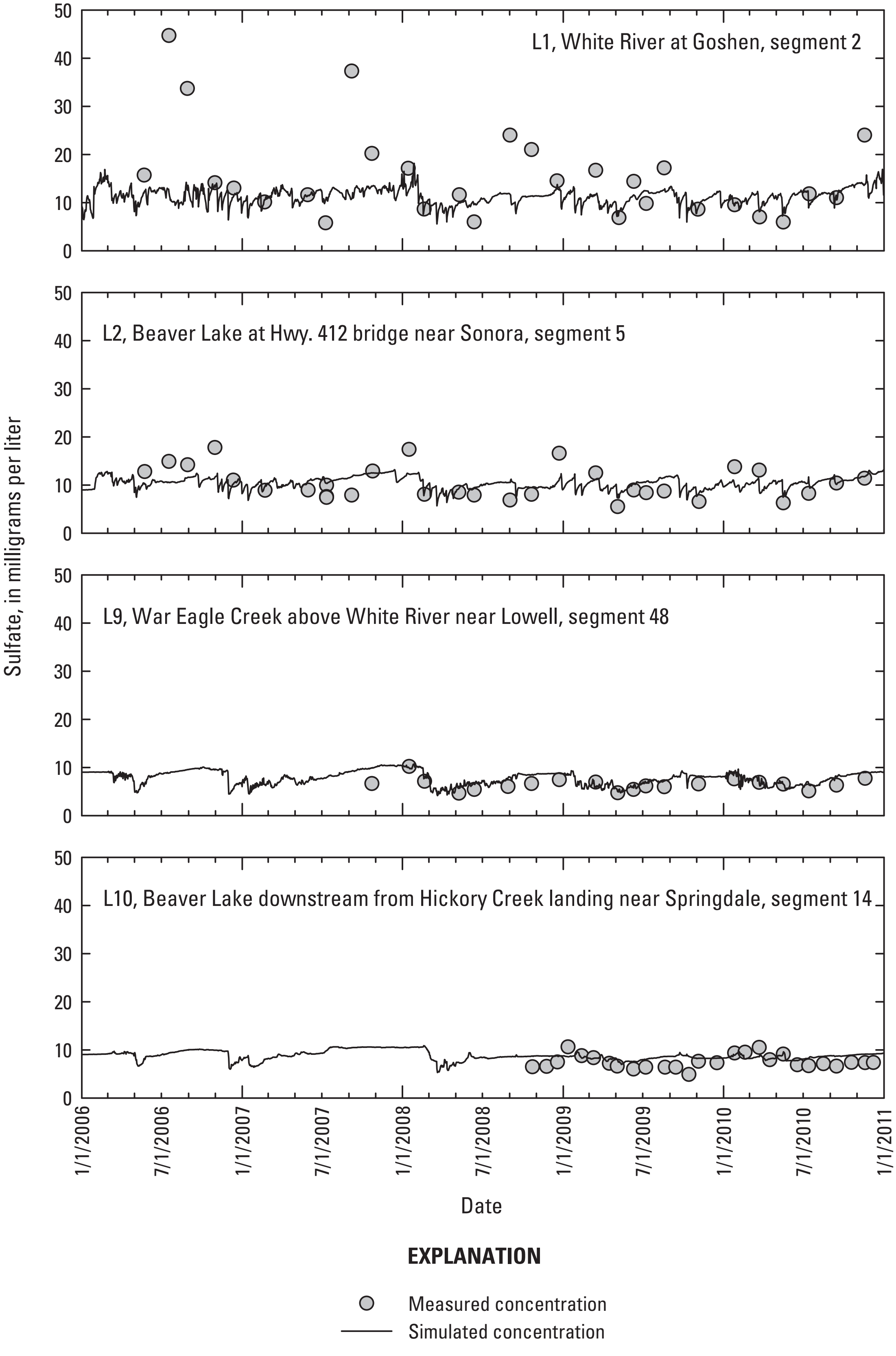

Figure 15. Simulated and measured sulfate concentrations 2 meters (m) below the surface in Beaver Lake, Arkansas.

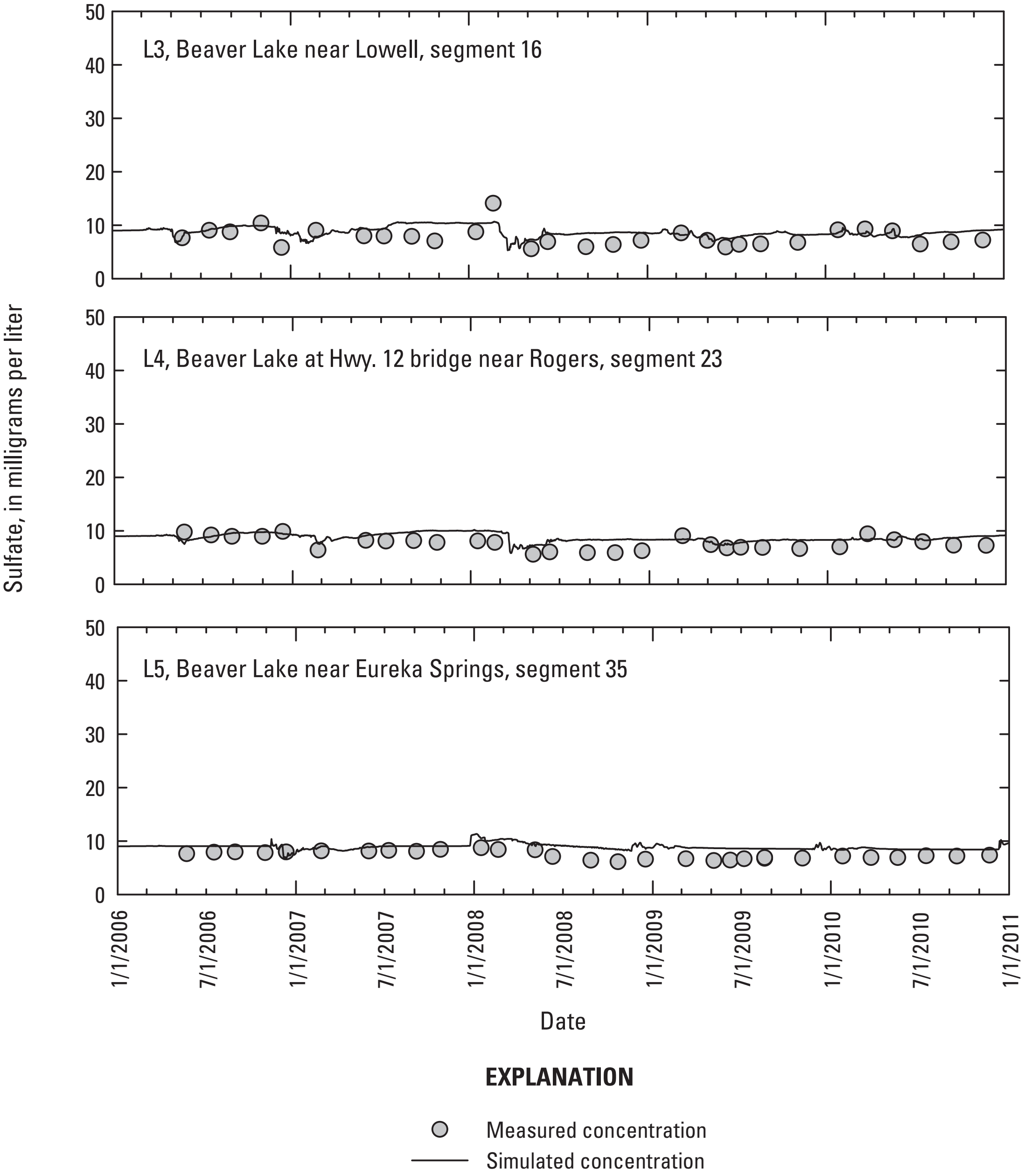

Figure 15. Simulated and measured sulfate concentrations 2 meters (m) below the surface in Beaver Lake, Arkansas.—Continued

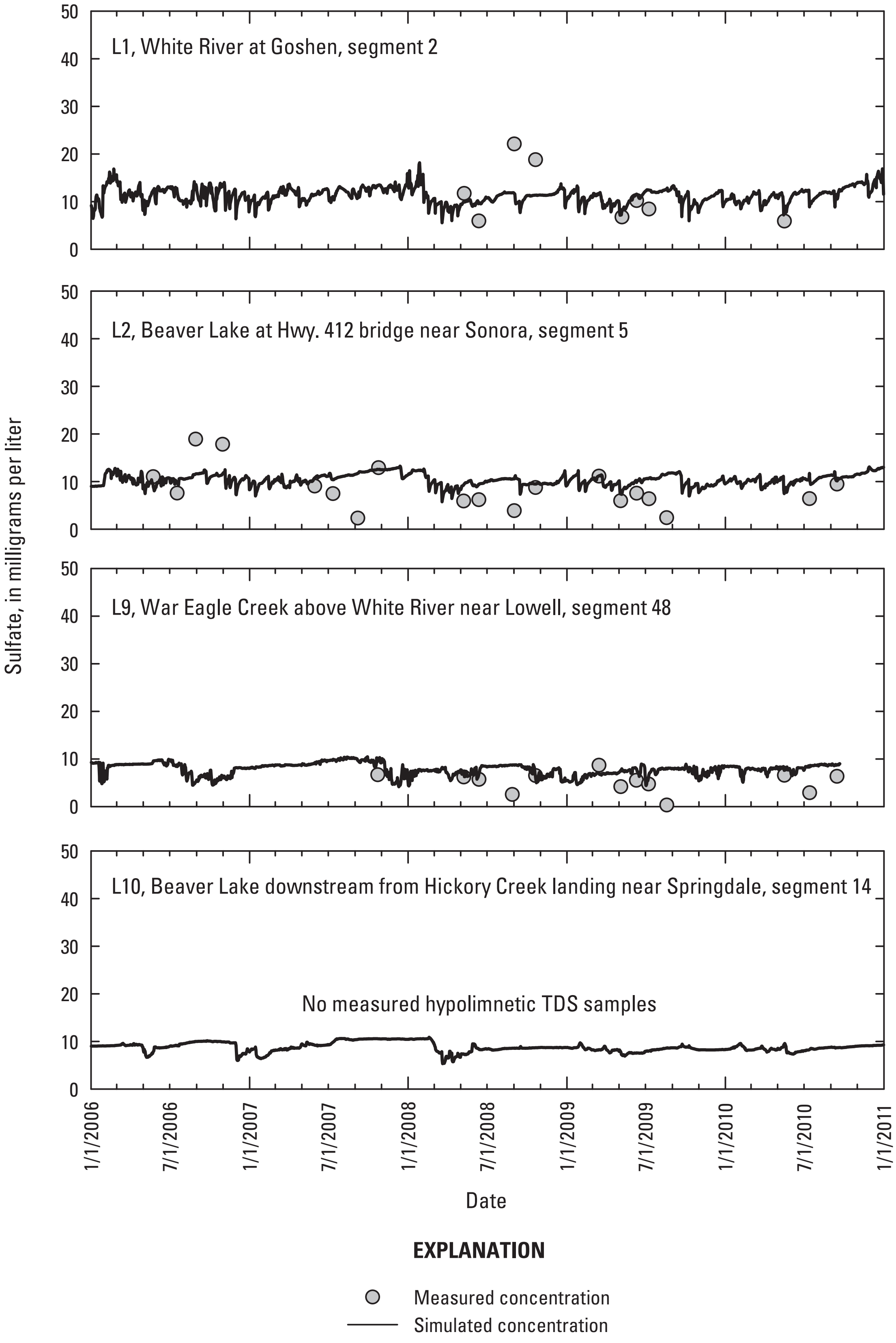

Figure 16. Simulated and measured sulfate concentrations 2 meters (m) above the bottom in Beaver Lake, Arkansas.

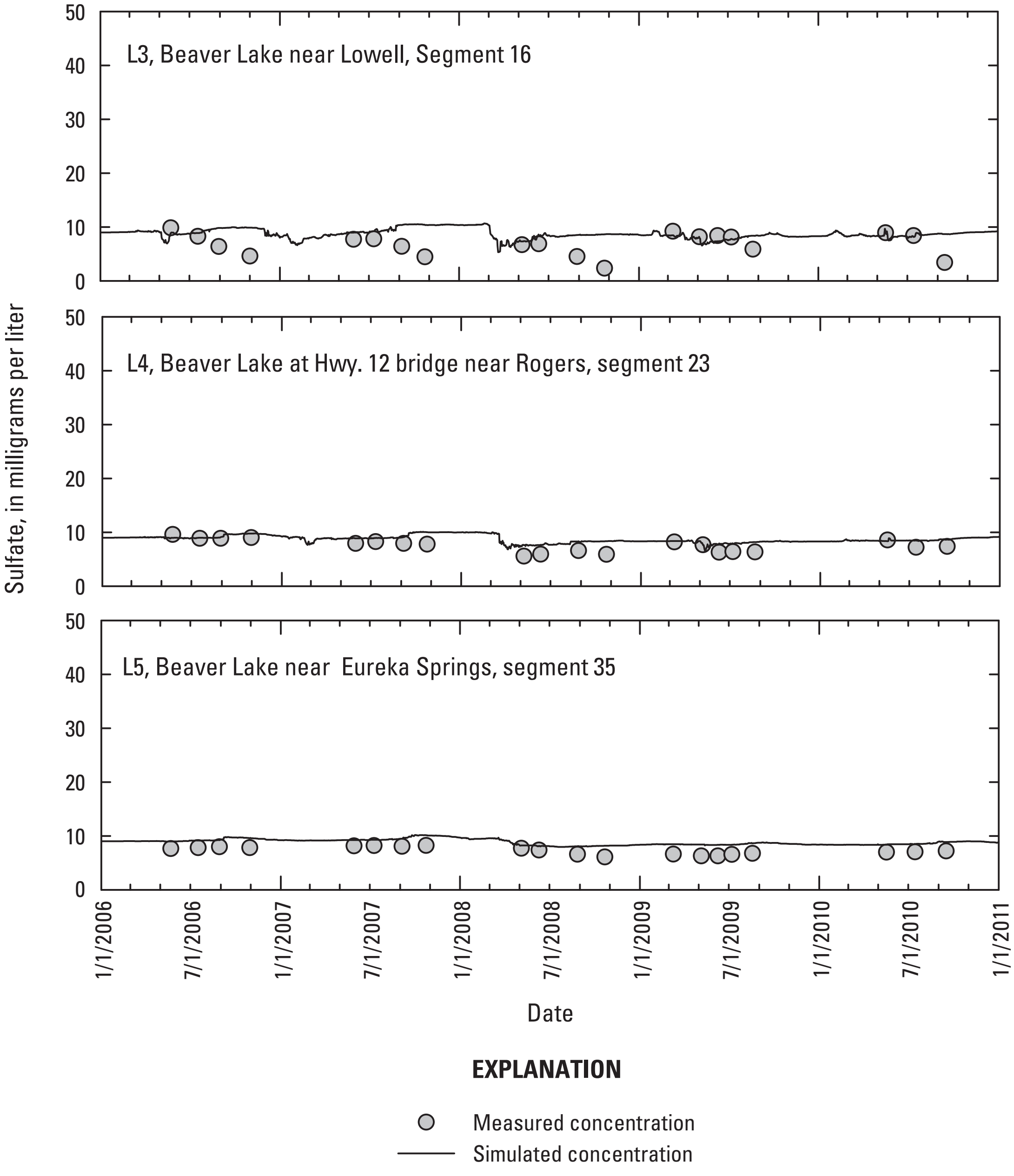

Figure 16. Simulated and measured sulfate concentrations 2 meters (m) above the bottom in Beaver Lake, Arkansas.—Continued

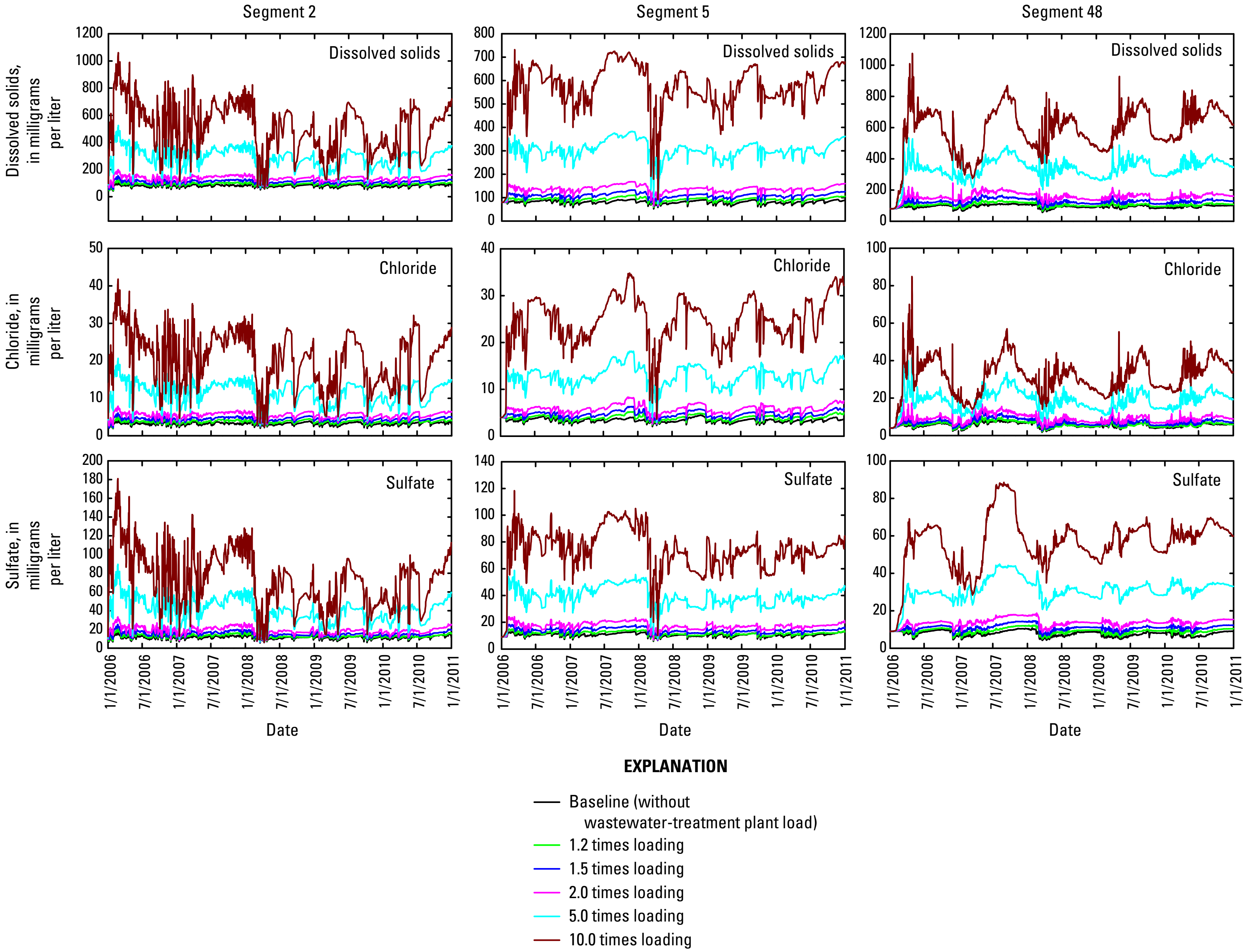

Figure 17. Dissolved solids, chloride, and sulfate concentrations 2 meters (m) below the surface at model segments 2, 5, 48, 14, 16, 23 and 35 from baseline model and increased loading scenarios from both White River near Fayetteville, Arkansas, (site S1) and War Eagle Creek near Hindsville, Ark. (site S3).

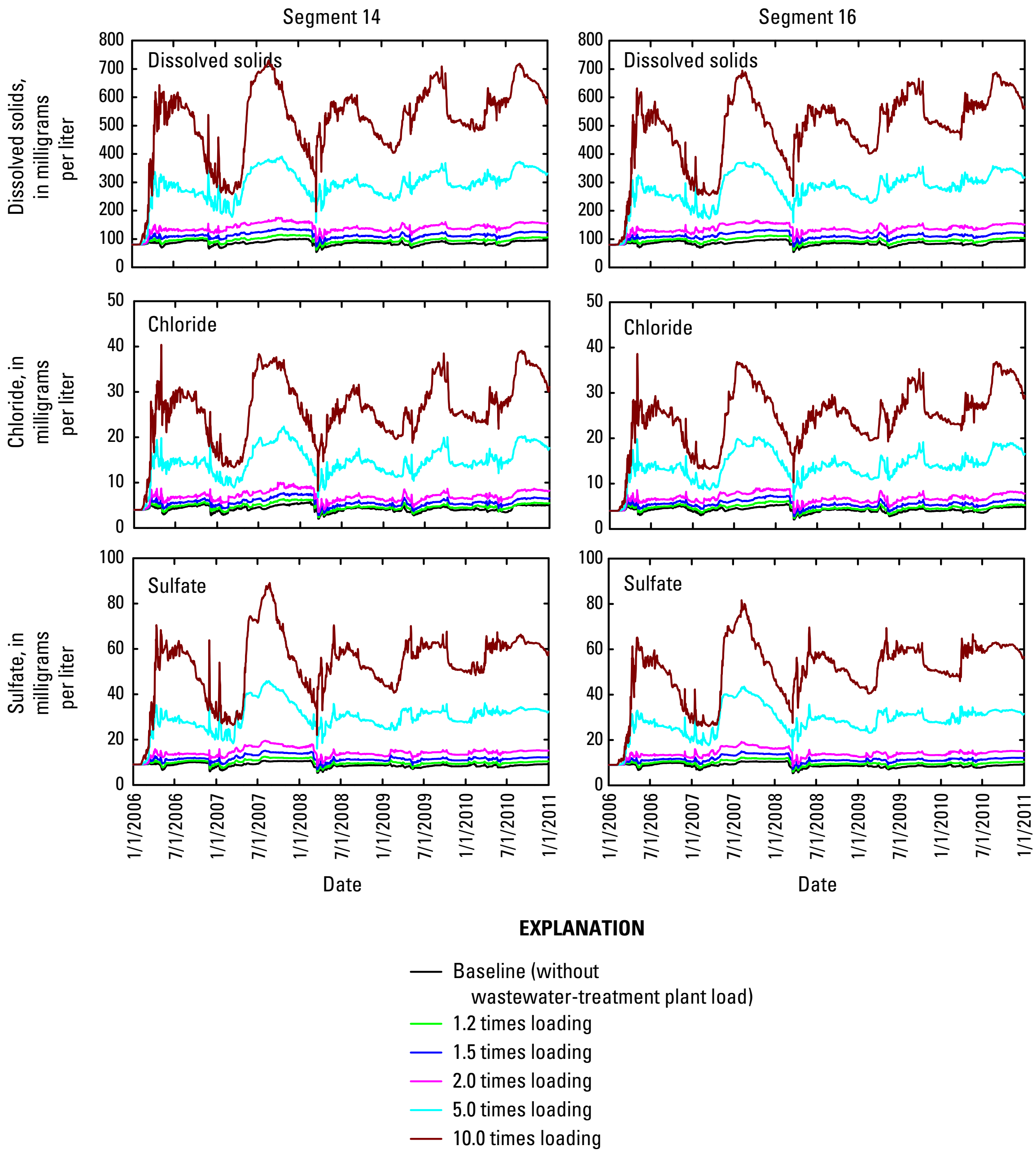

Figure 17. Dissolved solids, chloride, and sulfate concentrations 2 meters (m) below the surface at model segments 2, 5, 48, 14, 16, 23 and 35 from baseline model and increased loading scenarios from both White River near Fayetteville, Arkansas, (site S1) and War Eagle Creek near Hindsville, Ark. (site S3).—Continued

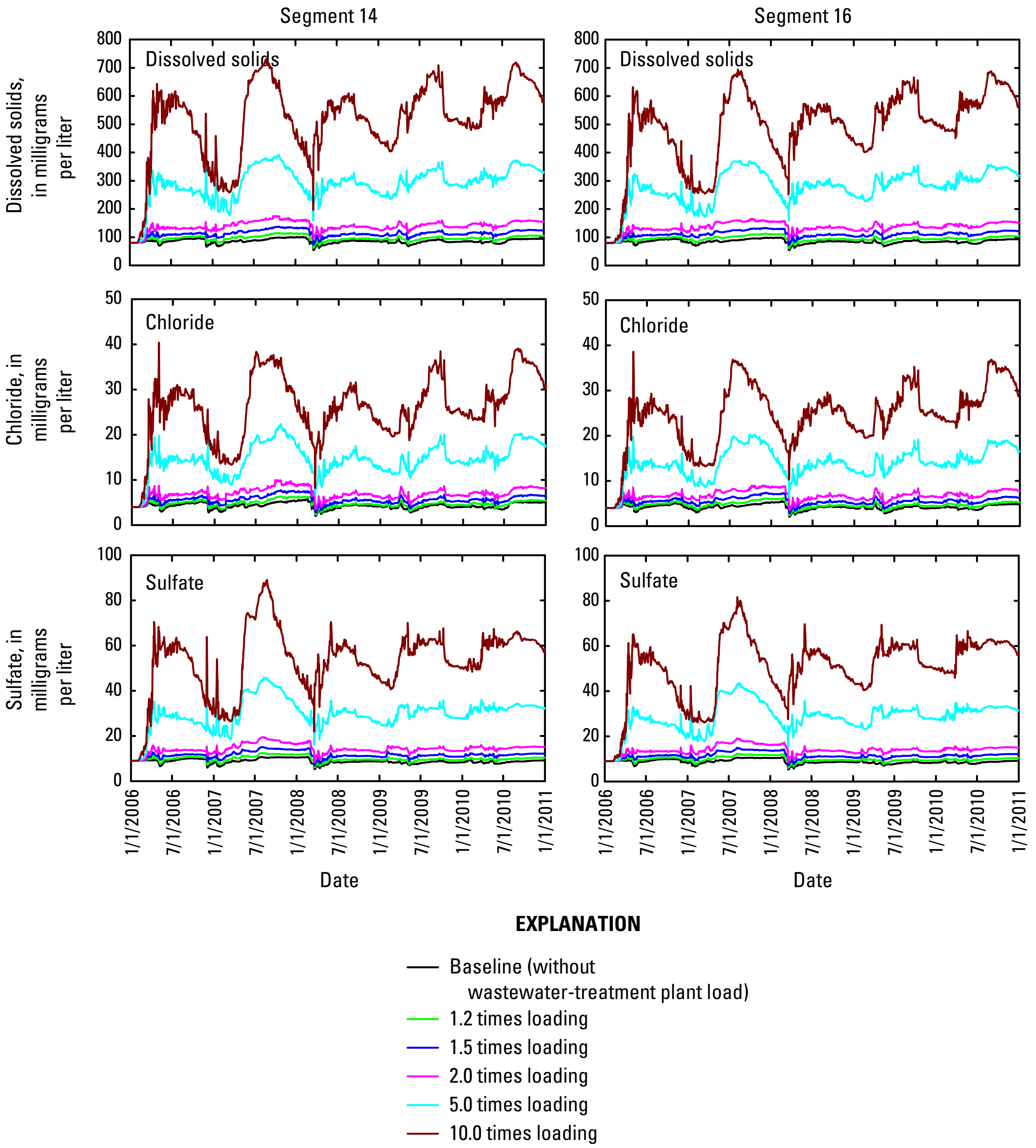

Figure 17. Dissolved solids, chloride, and sulfate concentrations 2 meters (m) below the surface at model segments 2, 5, 48, 14, 16, 23 and 35 from baseline model and increased loading scenarios from both White River near Fayetteville, Arkansas, (site S1) and War Eagle Creek near Hindsville, Ark. (site S3).—Continued

Table 5. Average daily dissolved solids, chloride, and sulfate concentrations for baseline condition and increasing loading factor scenarios from White River near Fayetteville (site S1) only, for the period January 2006 through December 2010, 2 meters (m) below the surface and 2 m above the bottom at model segments 2, 5, 14, 16, 23, and 35 (fig. 2).

[m, meter; x, times]

Loading factor	Segment 2 (site L1)		Segment 5 (site L2)		Segment 14 (site L10)		Segment 16 (site L3)		Segment 23 (site L4)		Segment 35 (site L5)	
	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom
Dissolved solids, in milligrams per liter												
1.0x (baseline)	80.4	85.8	81.0	80.8	86.1	83.1	85.5	83.5	83.9	84.3	84.2	84.2
1.2x	91.7	94.2	90.9	90.0	91.5	88.5	90.9	88.2	88.1	88.1	87.1	87.4
1.5x	108	111	105	103	100	96.5	100	95.4	96	94.4	91.6	92.6
2.0x	134	142	129	126	115	110	137	108	107	105	99.0	101
5.0x	273	337	269	269	197	202	192	193	170	182	142	169
10.0x	485	671	477	524	313	367	304	344	258	327	206	307
Chloride, in milligrams per liter												
1.0x (baseline)	3.22	3.50	3.38	3.48	4.30	4.07	4.22	4.11	4.00	4.14	4.00	4.09
1.2x	3.70	3.86	3.85	3.92	4.46	4.27	4.39	4.27	4.28	4.28	4.12	4.22
1.5x	4.38	4.48	4.43	4.43	4.83	4.57	4.75	4.54	4.47	4.51	4.30	4.43
2.0x	5.36	5.67	5.35	5.28	5.40	5.06	6.80	4.98	4.91	4.89	4.58	4.76
5.0x	10.8	13.3	10.8	10.8	8.63	8.55	8.37	8.19	7.37	7.80	6.26	7.34
10.0x	19.1	26.3	19.0	20.8	13.2	14.9	12.8	14.0	10.80	13.4	8.77	12.6
Sulfate, in milligrams per liter												
1.0x (baseline)	11.3	11.4	10.5	9.87	8.80	8.69	8.79	8.76	8.75	8.88	8.90	8.93
1.2x	12.7	12.6	11.5	11.0	9.63	9.46	9.61	9.41	9.42	9.42	9.29	9.39
1.5x	15.0	15.6	13.6	13.0	10.9	10.6	10.8	10.5	10.4	10.3	9.92	10.1
2.0x	18.7	20.5	17.0	16.2	12.9	12.7	14.1	12.3	12.0	11.9	10.9	11.4
5.0x	39.4	50.2	37.2	37.3	24.3	25.9	23.7	24.5	20.5	22.9	16.8	21.0
10.0x	71.3	101	66.8	74.5	40.3	49.4	39.2	46.1	32.6	43.6	25.7	40.3

Table 6. Average daily dissolved solids, chloride, and sulfate concentrations for baseline condition and increasing loading scenarios from War Eagle Creek (site S3) only, for the period January 2006 through December 2010, 2 meters (m) below the surface and 2 m above the bottom at model segments 48, 5, 14, 16, 23, and 35 (fig. 2).

[m, meter; x, times]

Loading factor	Segment 2 (site L1)		Segment 5 (site L2)		Segment 14 (Site L10)		Segment 16 (site L3)		Segment 23 (site L4)		Segment 35 (site L5)	
	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom
Dissolved solids, in milligrams per liter												
1.0x (baseline)	95.1	90.4	81.0	80.8	86.1	83.1	85.5	83.5	83.9	84.3	84.2	84.2
1.2x	102	97.3	82.6	83.9	90.4	88.0	89.8	87.8	87.8	87.8	86.7	87.0
1.5x	114	110	84.8	87.7	97.8	95.3	96.9	94.6	93.4	93.8	90.7	91.8
2.0x	133	132	88.7	94.8	110	109	108	107	102	105	97.3	101
5.0x	216	255	115	145	173	194	170	186	151	178	134	168
10.0x	309	463	166	262	264	348	259	325	222	296	190	293
Chloride, in milligrams per liter												
1.0x (baseline)	5.64	5.15	3.38	3.48	4.30	4.07	4.22	4.11	4.00	4.14	4.00	4.09
1.2x	5.88	5.49	3.57	3.76	4.56	4.40	4.48	4.40	4.25	4.38	4.17	4.28
1.5x	6.71	6.39	3.72	4.01	5.05	4.90	4.95	4.87	4.61	4.80	4.42	4.61
2.0x	7.96	7.91	3.98	4.48	5.82	5.78	5.69	5.68	5.17	5.53	4.82	5.21
5.0x	13.6	16.5	5.74	7.8	10.1	11.3	9.82	10.8	8.22	10.28	7.12	9.50
10.0x	20.2	31.0	9.12	15.4	16.4	21.3	15.8	19.8	12.7	17.9	10.6	17.2
Sulfate, in milligrams per liter												
1.0x (baseline)	7.79	7.94	10.5	9.87	8.80	8.69	8.79	8.76	8.75	8.88	8.90	8.93
1.2x	8.53	8.51	10.2	9.81	9.08	8.90	9.06	8.93	8.98	9.01	9.03	9.07
1.5x	9.34	9.17	10.3	9.99	9.50	9.26	9.46	9.25	9.31	9.29	9.26	9.32
2.0x	10.5	10.3	10.5	10.3	10.2	9.90	10.1	9.84	9.83	9.81	9.63	9.74
5.0x	15.5	16.9	11.9	12.9	13.7	14.4	13.6	14.0	12.6	13.7	11.7	13.2
10.0x	20.8	28.0	14.6	19.1	18.7	22.8	18.4	21.6	16.6	20.0	14.8	20.0

Table 7. Average daily dissolved solids, chloride, and sulfate concentrations for baseline condition and increasing loading factor scenarios from White River near Fayetteville (site S1) and War Eagle Creek near Hindsville (site S3), for the period January 2006 through December 2010, 2 meters (m) below the surface and 2 m above the bottom at model segments 2, 5, 14, 16, 23, and 35 (fig. 2).

[m, meter; x, times]

Loading factor	Segment 2 (site L1)		Segment 5 (site L2)		Segment 14 (site L10)		Segment 16 (site L3)		Segment 23 (site L4)		Segment 35 (site L5)	
	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom	2 m below surface	2 m above bottom
Dissolved solids, in milligrams per liter												
1.0x (baseline)	80.4	85.8	81.0	80.8	86.1	83.1	85.5	83.5	83.9	84.3	84.2	84.2
1.2x	92.2	94.9	92.3	92.3	96.5	93.0	95.7	92.3	92.5	91.7	89.8	92.2
1.5x	109	112	109	109	113	108	111	106	105	104	98.2	100
2.0x	136	145	136	136	140	132	137	128	125	124	112	118
5.0x	283	347	301	305	289	276	277	266	236	255	191	247
10.0x	512	697	570	607	513	524	489	498	403	465	315	455
Chloride, in milligrams per liter												
1.0x (baseline)	3.22	3.50	3.38	3.48	4.30	4.07	4.22	4.11	4.00	4.14	4.00	4.09
1.2x	3.74	3.91	3.95	4.07	4.80	4.58	4.71	4.56	4.43	4.52	4.28	3.74
1.5x	4.45	4.58	4.67	4.82	5.66	5.36	5.53	5.28	5.07	5.18	4.71	4.95
2.0x	5.51	5.87	5.84	6.04	7.01	6.63	6.80	6.46	6.07	6.20	5.40	5.86
5.0x	11.5	14.0	12.9	13.4	14.6	14.1	13.9	13.6	11.5	13.1	9.33	12.7
10.0x	20.7	28.0	24.6	26.7	25.9	26.5	24.5	25.2	19.8	23.9	15.5	23.4
Sulfate, in milligrams per liter												
1.0x (baseline)	11.3	11.4	10.5	9.87	8.80	8.69	8.79	8.76	8.75	8.88	8.90	8.93
1.2x	12.7	12.6	11.6	11.1	9.92	9.65	9.88	9.59	9.63	9.58	9.45	12.7
1.5x	15.0	15.7	13.8	13.2	11.6	11.1	11.5	10.9	10.9	10.7	10.3	10.5
2.0x	18.8	20.6	17.4	16.6	14.3	13.5	14.1	13.1	13.0	12.6	11.7	12.2
5.0x	40.2	50.5	39.2	38.4	29.8	27.8	28.6	26.3	24.5	25.0	19.6	24.0
10.0x	73.2	102	73.8	77.2	52.9	53.3	50.3	50.2	41.6	46.6	32.2	43.7

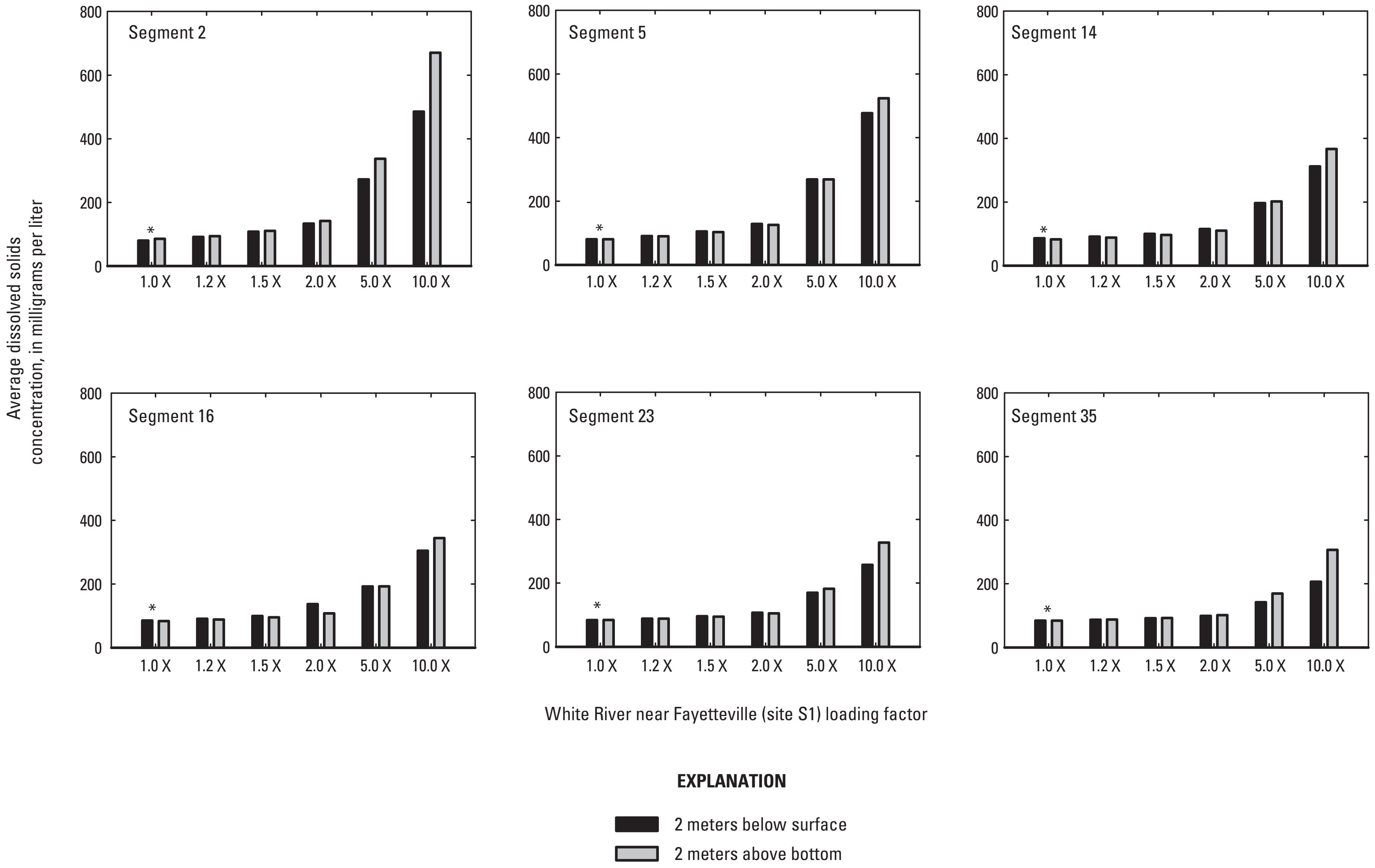

Figure 18. Average daily dissolved solids for the period January 2006 through December 2010 at 2 meters (m) below the surface and 2 m above the bottom at model segments 2, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from White River near Fayetteville, Arkansas, (site S1) only. (* Fayetteville wastewater treatment plant dissolved solids not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

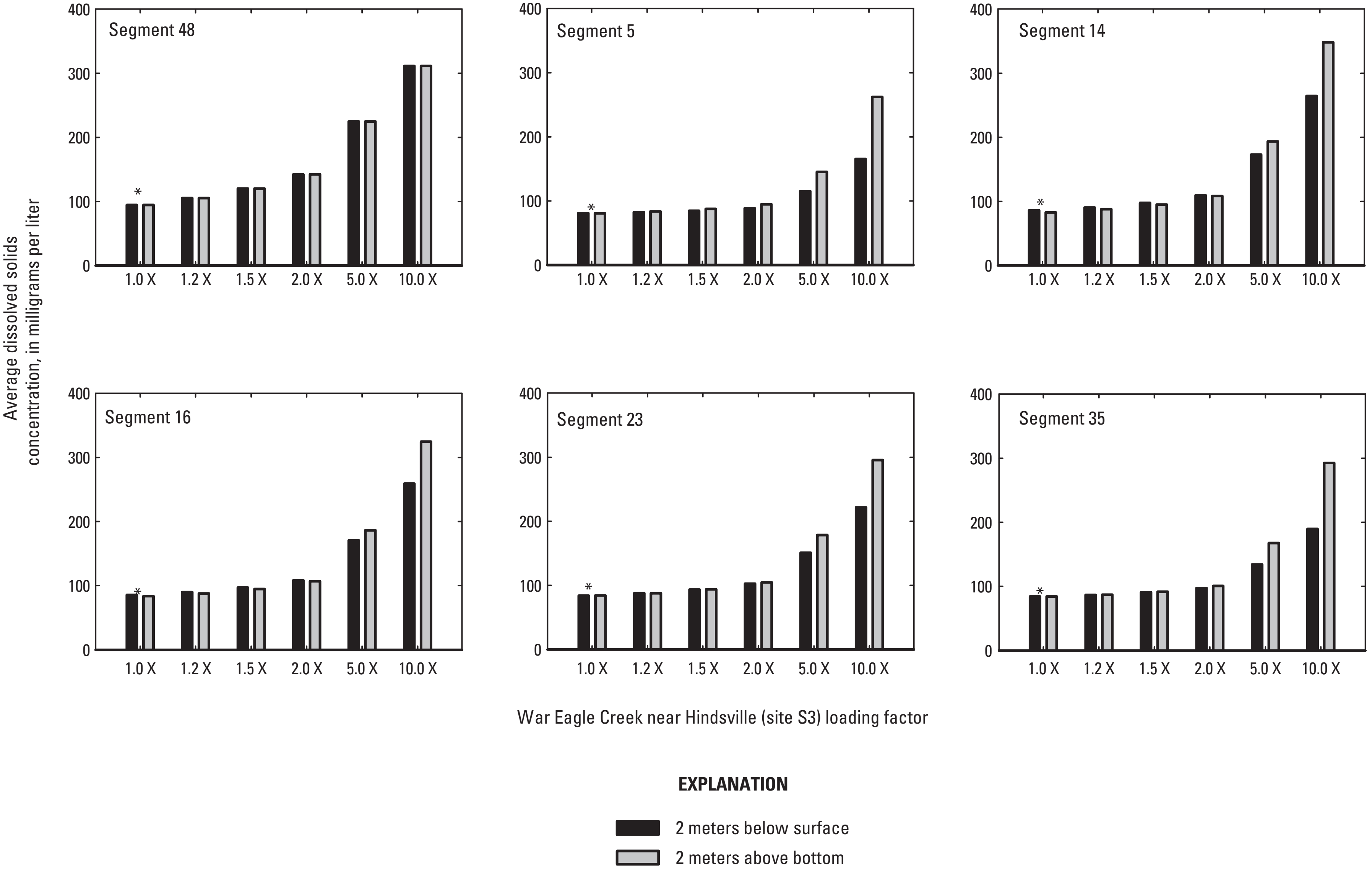

Figure 19. Average daily dissolved solids for the period January 2006 through December 2010 at 2 meters (m) below the surface and 2 m above the bottom at model segments 48, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from War Eagle Creek near Hindsville, Arkansas, (site S3) only. (* Fayetteville wastewater treatment plant dissolved solids not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

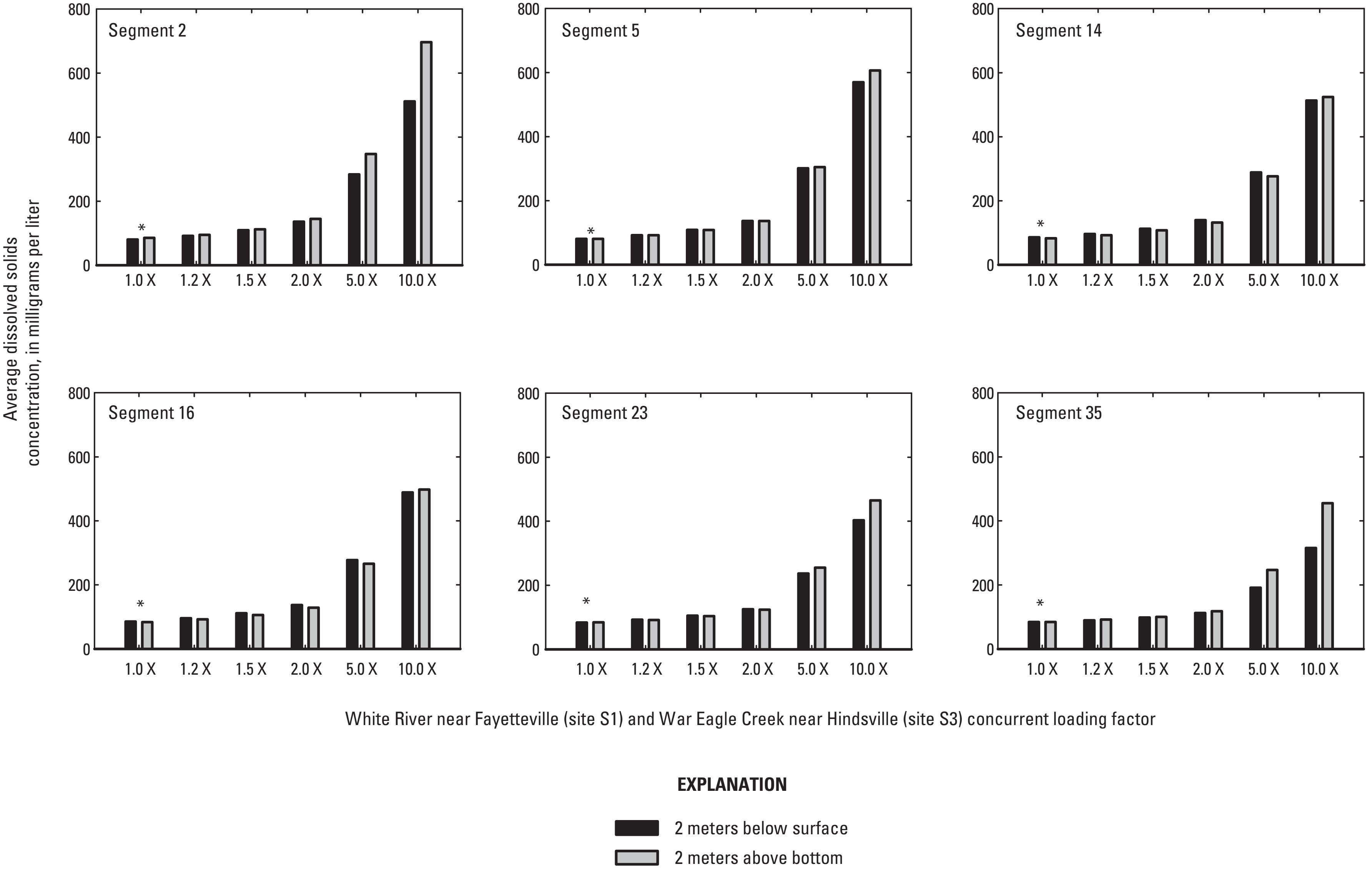

Figure 20. Average daily dissolved solids for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 2, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from both White River near Fayetteville, Arkansas, (site S1) and War Eagle Creek near Hindsville, Ark. (site S3). (* Fayetteville wastewater treatment plant dissolved solids not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

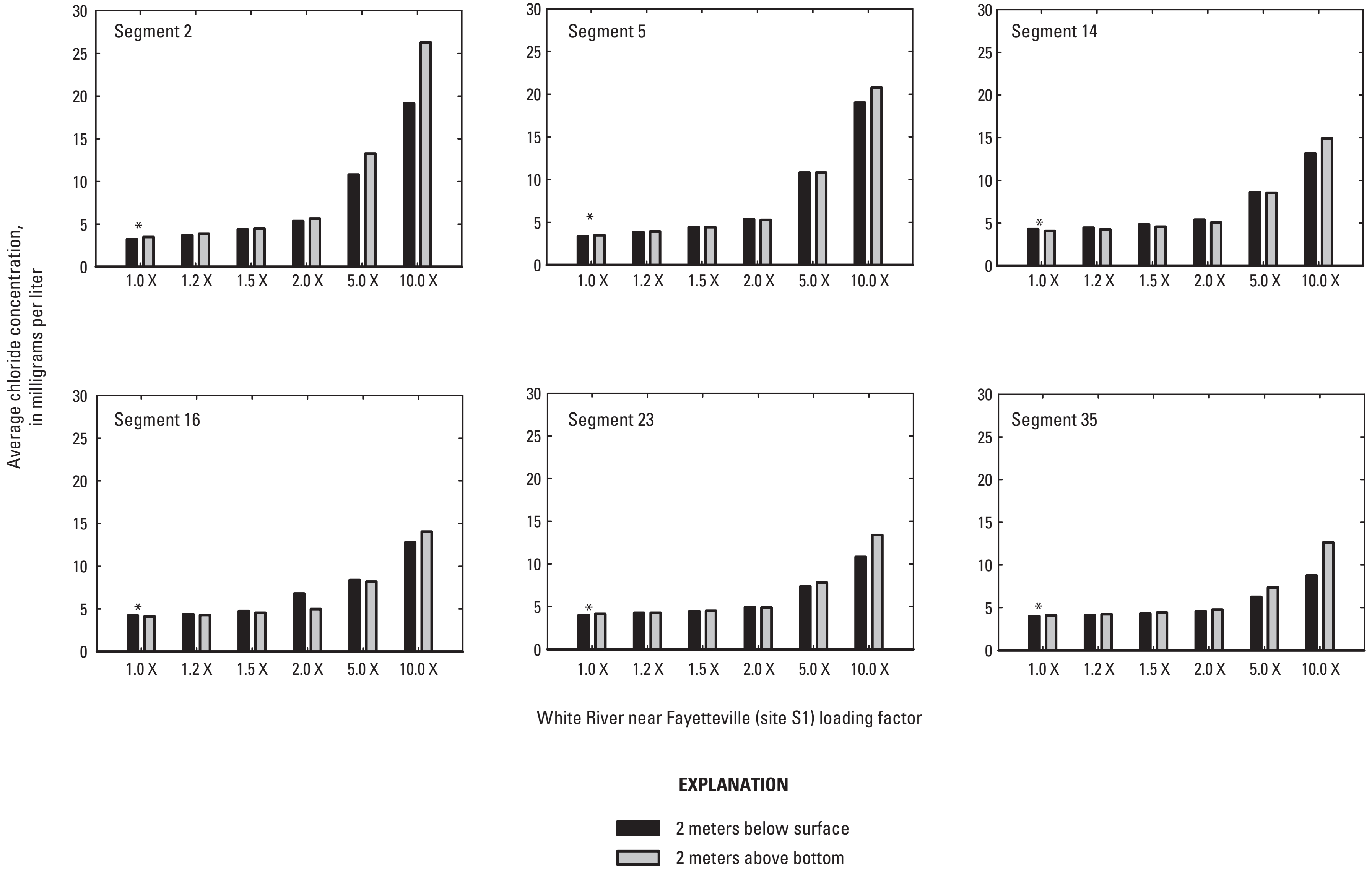

Figure 21. Average daily chloride concentrations for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 2, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from White River near Fayetteville, Arkansas, (site S1) only. (* Fayetteville wastewater treatment plant chloride load not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

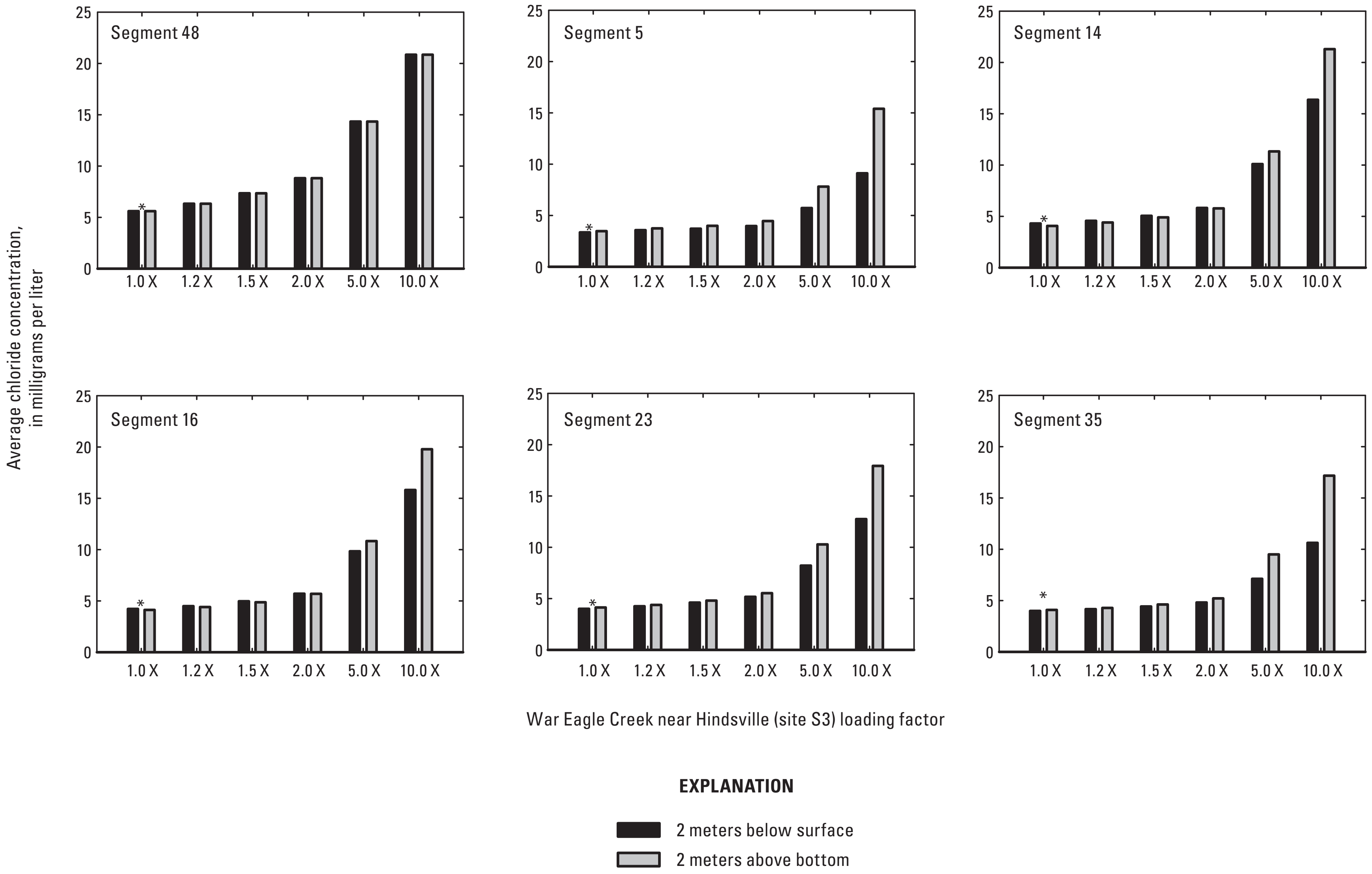

Figure 22. Average daily chloride concentrations for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 48, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from War Eagle Creek near Hindsville, Arkansas, (site S3) only. (* Fayetteville wastewater treatment plant chloride load not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

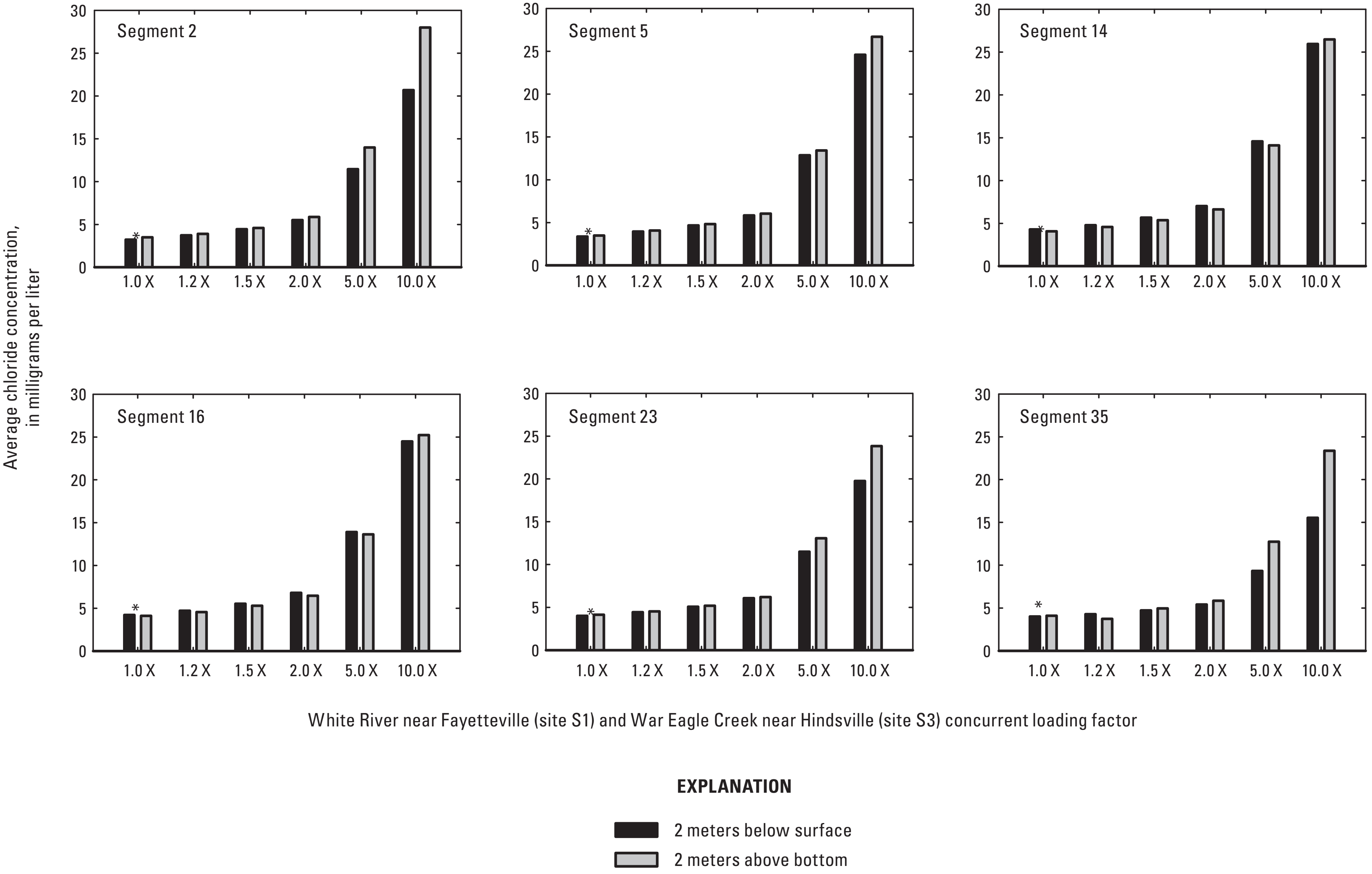

Figure 23. Average daily chloride concentrations for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 2, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from both White River near Fayetteville, Arkansas, (site S1) and War Eagle Creek near Hindsville, Ark. (site S3). (* Fayetteville wastewater treatment plant chloride load not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

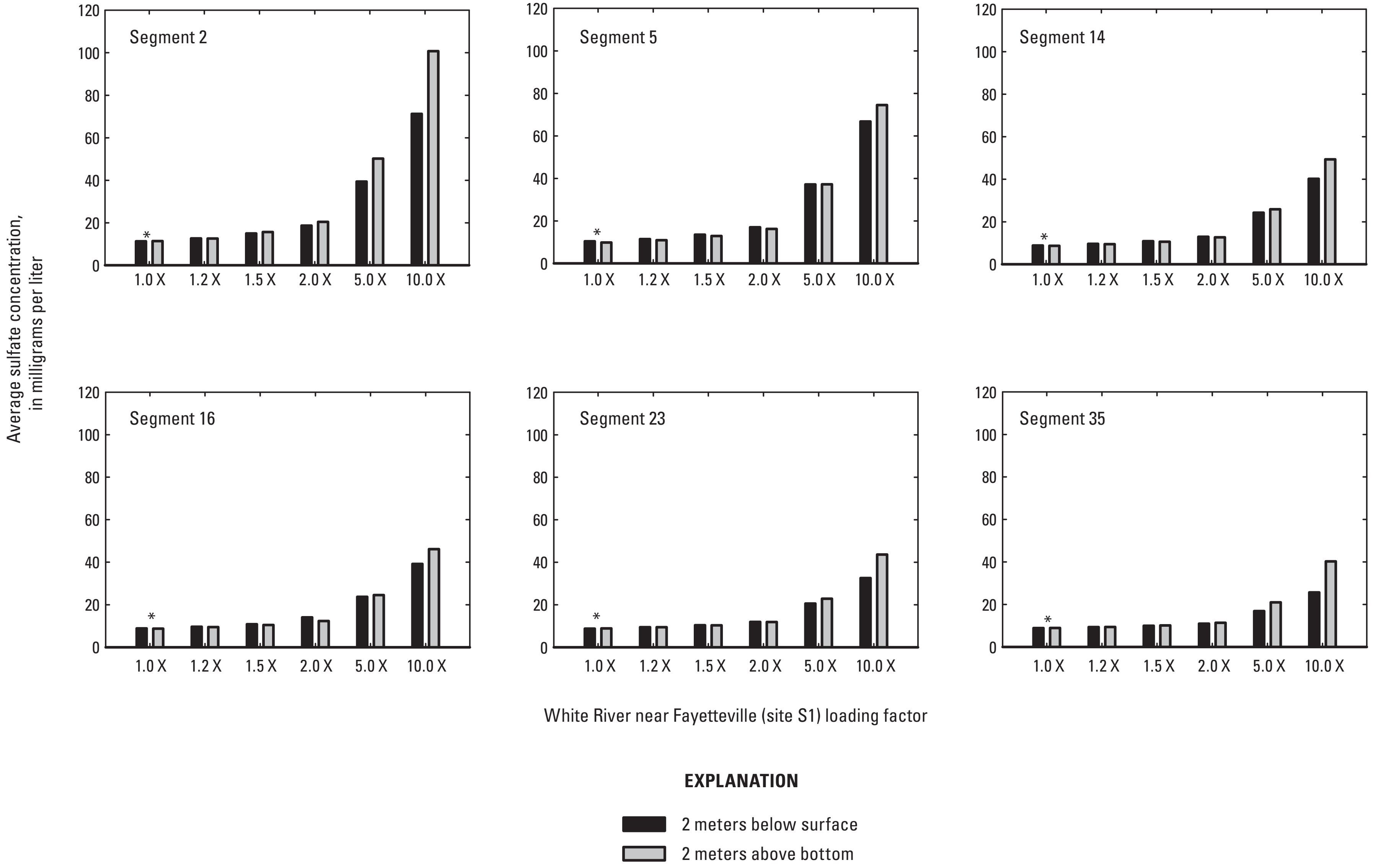

Figure 24. Average daily sulfate concentrations for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 2, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from White River near Fayetteville, Arkansas, (site S1) only. (* Fayetteville wastewater treatment plant sulfate load not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

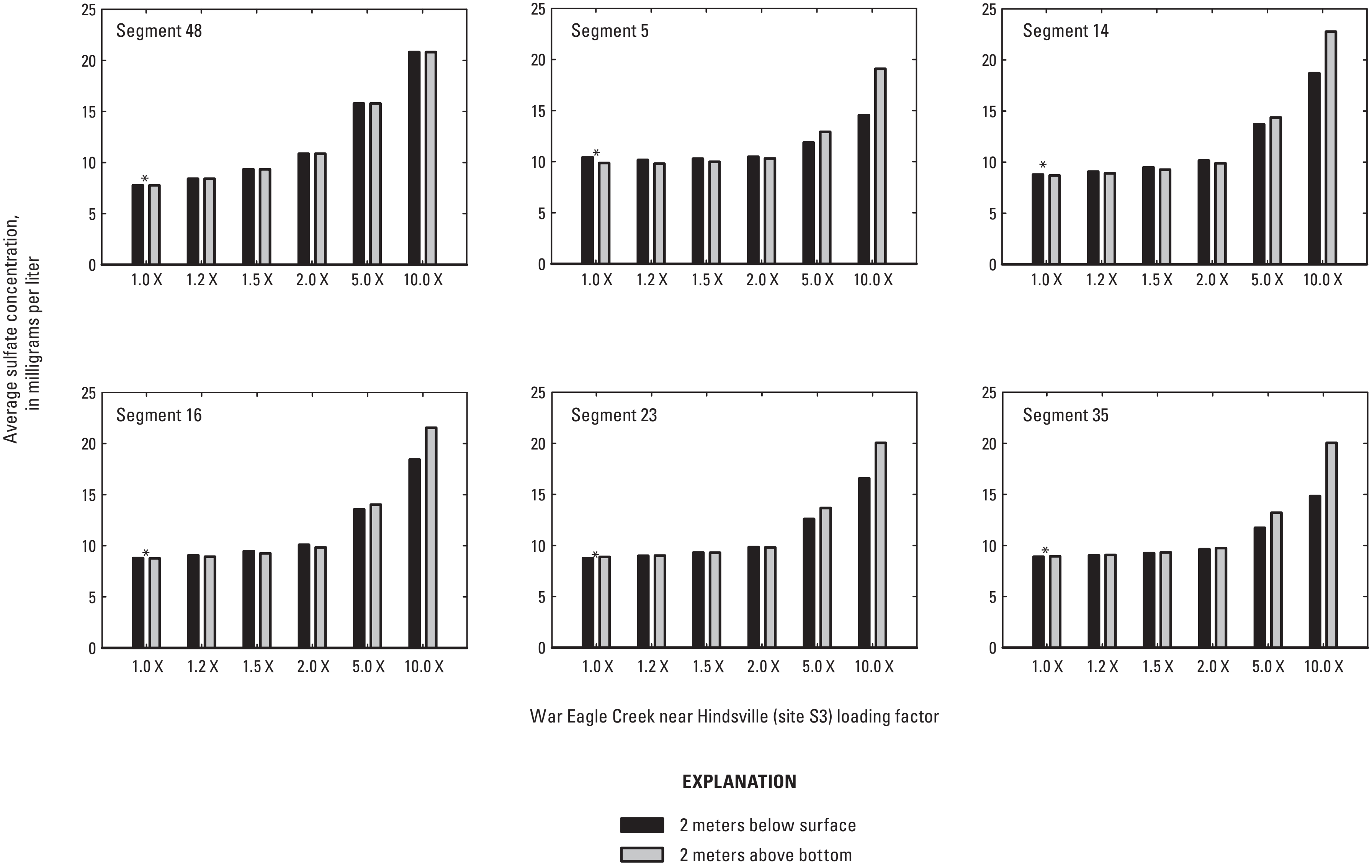

Figure 25. Average daily sulfate concentrations for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 48, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from War Eagle Creek near Hindsville, Arkansas, (site S3) only. (* Fayetteville wastewater treatment plant sulfate load not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

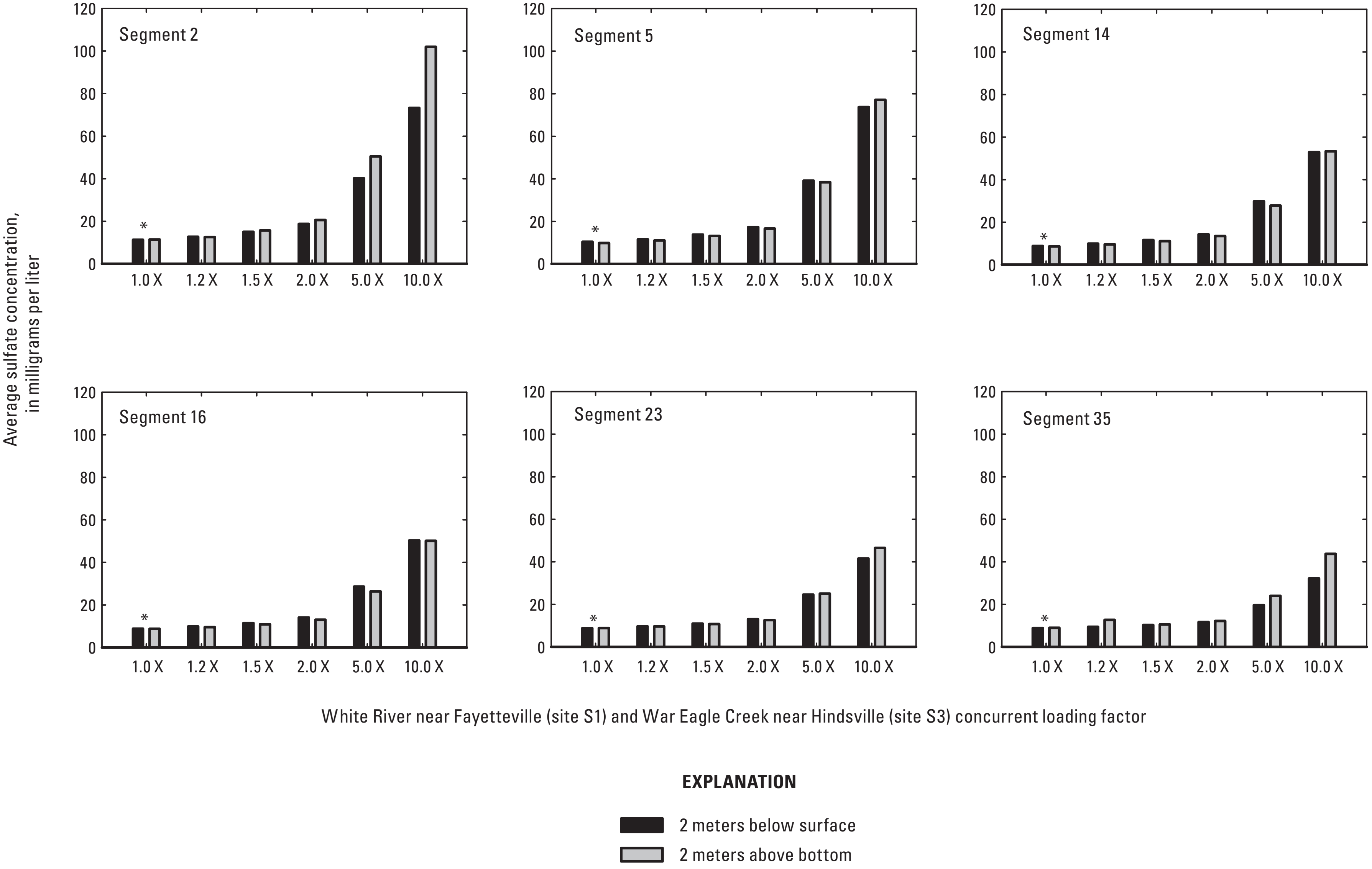

Figure 26. Average daily sulfate concentrations for the period January 2006 through December 2010 at 2 meters below the surface and 2 meters above the bottom at model segments 2, 5, 14, 16, 23, and 35 from baseline model (loading factor 1.0) and increased loading factor scenarios (1.2, 1.5, 2.0, 5.0, and 10.0) from both White River near Fayetteville, Arkansas, (site S1) and War Eagle Creek near Hindsville, Ark. (site S3). (* Fayetteville wastewater treatment plant sulfate load not included in CE-QUAL-W2 baseline calibration or any scenario runs.)

Summary

Beaver Lake is a large, deep-storage reservoir located in the upper White River Basin in northwestern Arkansas, and was completed in 1963 for the purposes of flood control, hydroelectric power, and water supply. In addition, the reservoir is used for fish and wildlife habitat, recreation, and waste assimilation. Beaver Lake is affected by point and nonpoint sources of minerals, nutrients, and sediments. The City of Fayetteville discharges about half of its sewage effluent into the White River immediately upstream from the backwater of the reservoir. The City of West Fork discharges its sewage effluent into the West Fork of the White River, and the City of Huntsville discharges its sewage effluent into a tributary of War Eagle Creek.

The purpose of this report is to describe the ambient conditions and fate and transport of dissolved solids, chloride, and sulfate concentrations in Beaver Lake. Dissolved solids, chloride, and sulfate are components of wastewater discharged into Beaver Lake and a major concern of the drinking water utilities that use Beaver Lake as their source. A two-dimensional model of hydrodynamics and water quality was calibrated to include simulations of dissolved solids, chloride, and sulfate for the period January 2006 through December 2010. Estimated daily dissolved solids, chloride, and sulfate loads were increased in the White River and War Eagle Creek tributaries, individually and the two tributaries together, by 1.2, 1.5, 2.0, 5.0, and 10.0 times the baseline conditions to examine fate and transport of these constituents through time at seven locations in the reservoir, from upstream to downstream in Beaver Lake.

Fifteen dissolved solids, chloride, and sulfate fate and transport scenarios were compared to the baseline simulation at each of the seven downstream locations in the reservoir, both 2 meters (m) below the surface and 2 m above the bottom. Concentrations were greater in the reservoir at model segments closer to where the tributaries entered the reservoir. Concentrations resulting from the increase in loading became more diluted farther downstream from the source. Differences in concentrations between the baseline condition and the 1.2, 1.5, and 2.0 times baseline concentration scenarios were smaller than the differences in the 5.0 and 10.0 times baseline concentration scenarios. The results for both the 2 m below the surface and 2 m above the bottom were similar, with the exception of concentrations resulting from the increased loading factors (5.0 and 10.0 times), where concentrations 2 m above the bottom were consistently greater than those 2 m below the surface at most segments.

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