EXHIBIT F

USE ATTAINABILITY ANALYSIS FOR DISSOLVED MINERALS IN LITTLE AND RED RIVERS HEMPSTEAD & LITTLE RIVER COUNTIES, ARKANSAS

ftn Associates Ltd.
water resources / environmental consultants

SOUTHWESTERN ELECTRIC POWER COMPANY
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REVISED
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SOUTHWESTERN ELECTRIC POWER COMPANY
USE ATTAINABILITY ANALYSIS FOR
DISSOLVED MINERALS IN
LITTLE AND RED RIVERS
HEMPSTEAD & LITTLE RIVER COUNTIES, ARKANSAS

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EXECUTIVE SUMMARY

ES.1 Background

Southwestern Electric Power Company (SWEPCO) discharges wastewater from the John W. Turk, Jr. Power Plant to the Little River under the facility's National Pollutant Discharge Elimination System (NPDES) permit (No. AR0051136), which includes effluent limitations at Outfall 001 for total dissolved solids (TDS).

The current Arkansas water quality criterion for TDS in the Red River from its confluence with the Little River to the AR-LA state line (500 mg/L) does not account for natural sources of minerals in the Red River in Texas and Oklahoma (see Section 2.3.2). The TDS criterion for this reach of the Red River is lower than the upstream TDS criterion of 850 mg/L above the confluence of the Red River with the Little River and the downstream TDS criterion of 780 mg/L in Louisiana; therefore, the Arkansas TDS criterion is spatially inconsistent (Figure ES.1).

Under a typical permit scenario, the dissolved minerals criteria for the Little River would be used to calculate the effluent limitations for dissolved minerals at Outfall 001. However, because the TDS criterion for the Red River downstream of the confluence with the Little River to the AR-LA state line is exceeded at times (due to natural sources), this reach of the Red River was included on the 2008 303(d) list of impaired waterbodies, which is the most current 303(d) list approved by EPA. A consequence of this 303(d) listing is that the "end-of-pipe" TDS limit that the SWEPCO plant must meet at Outfall 001 is the Red River's current criterion of 500 mg/L. This TDS permit limit adversely impacts the operations at the SWEPCO plant despite the fact that it can be demonstrated that the facility's discharge from Outfall 001 at full operation will have virtually no effect on the concentrations of dissolved minerals in the Red River.

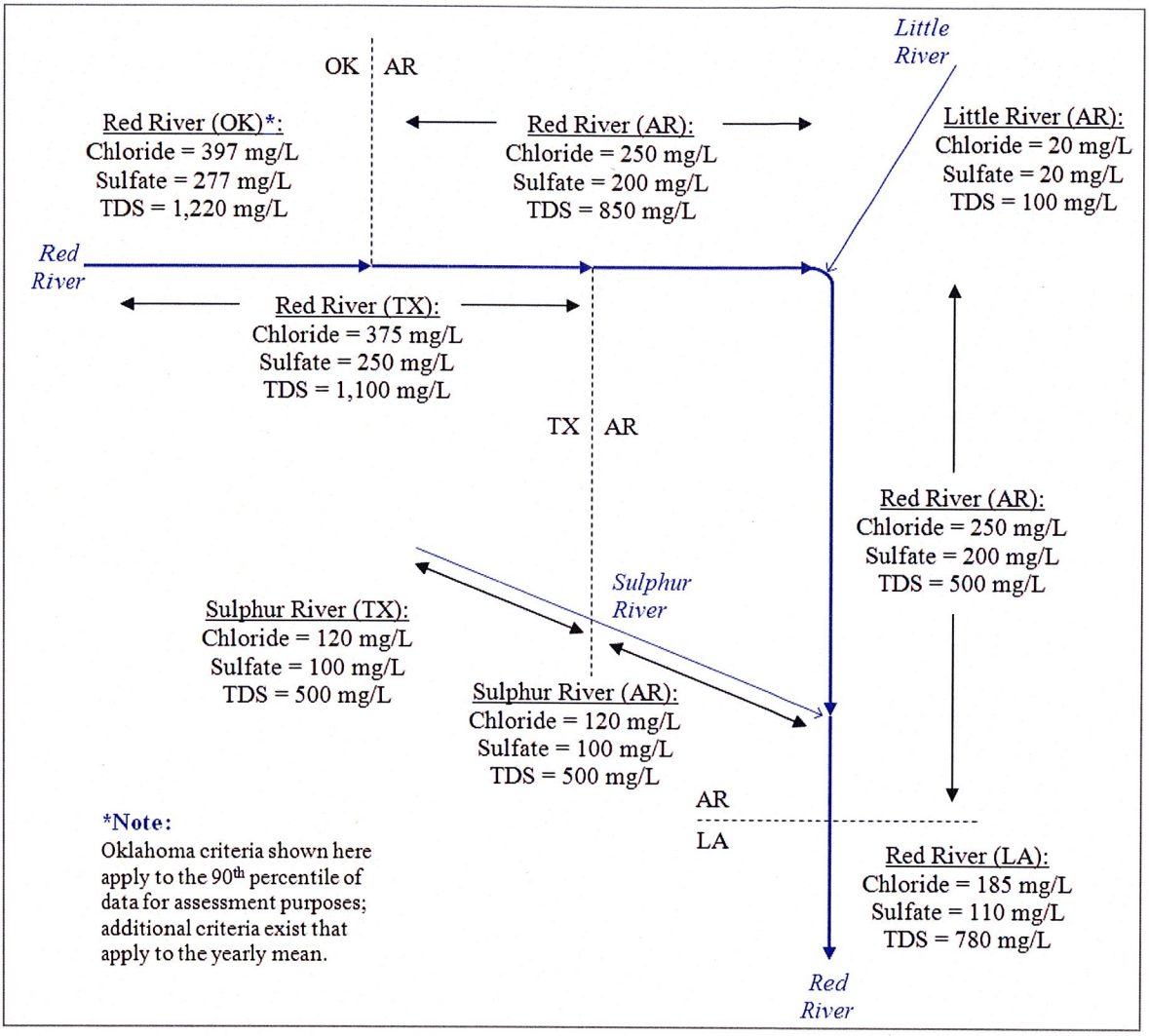


Figure ES.1. Summary of dissolved minerals criteria in the Red River system.

ES.2 Objectives

To justify modification of Arkansas water quality standards (designated uses or water quality criteria), it is necessary to determine whether existing and attainable uses of these waterbodies can be protected with less stringent, site-specific criteria. To show that the proposed criteria are protective of the existing and attainable designated uses of the receiving streams, it must be demonstrated that measured and predicted concentrations of dissolved minerals will not limit aquatic life or impair other existing or attainable uses.

The UAA study reported herein was conducted with the following objectives:

1. Evaluate existing and attainable uses in the receiving streams downstream of the discharge (Little River and Red River);
2. Evaluate whether the current water quality in the Red River supports existing and attainable designated uses;
3. Evaluate whether the current water quality in the Little River supports existing and attainable designated uses;
4. Evaluate whether the projected increase in TDS concentration in the Little River will protect existing and attainable designated uses; and
5. Evaluate options for permit compliance, including treatment, alternative discharge locations, and site-specific minerals criteria.

It was anticipated that the UAA study would reveal the following:

1. Neither treatment nor a pipeline to an alternative discharge location would represent a feasible option for complying with anticipated permit limits when compared to developing revised criteria that are protective of existing and attainable designated uses,
2. Current mineral concentrations in the Little River and Red River are primarily due to naturally occurring upstream sources, and
3. Current concentrations of dissolved minerals in the Red River and the proposed TDS criterion in the Little River would support existing and attainable uses in each receiving stream.

These findings would support modified water quality criteria for TDS in the Little River from Millwood Lake to the Red River and in the Red River from the confluence with the Little River to the AR-LA state line while protecting existing and attainable uses.

ES.3 Water Quality Evaluation

TDS Sources to the Little River

ADEQ monitoring stations exist on the major tributaries of Millwood Lake, which include the Little River, Cossatot River, Saline River, and Mine Creek. The Little River provides 72% of the lake inflow, the Cossatot River 11%, the Saline River 5%, and Mine Creek 2% (FTN 1994). Although TDS concentrations in Mine Creek are significantly higher than the other

streams, the Mine Creek inflow provides only approximately 2 mg/L of TDS based on a flow-weighted mean inflow TDS concentration of 54.8 mg/L for the four major tributaries (54.8 mg/L including Mine Creek and 52.2 mg/L without Mine Creek).

TDS Sources to the Red River in Arkansas

A comparison of flows and chloride + sulfate loads at Denison Dam versus Index shows that the Denison Dam discharge accounts for 41% and 76% of the flow and chloride + sulfate loading, respectively, at Index (Table ES.1). The upper Red River basin (upstream of Lake Texoma) in Texas and Oklahoma is known to contain elevated levels of salinity that are caused primarily by input from natural salt springs in tributaries to the Red River (Baldys et al. 1996, Keller et al. 1988). These springs and seeps typically yield low volumes of water but very high concentrations of chloride, ranging from several hundred milligrams per liter to about 190,000 mg/L (US Geological Survey [USGS] 1961). Elevated concentrations of dissolved solids (particularly sulfate and chloride) are a typical feature in most streams of the Red River basin under low-flow conditions. These elevated concentrations are primarily due to presence of saltwater springs, seeps, and gypsum outcrops (TNRCC 2002). Other sources of TDS include brine disposal areas and oilfield intrusions from the East Fork of the Little Wichita River. These sources have been corrected although some sources due to antiquated oilfield activities are thought to still occur in eastern portions of the Little Wichita River, Texas (Red River Authority 2013). Information could not be located that would allow an estimation of the proportion of the total TDS load to the Red River that is due to these oil-extraction activities, but the references cited herein clearly indicate that the overwhelming portion of TDS inputs to the Red River in Texas and Oklahoma is from natural sources.

Table ES.1. Summary of average flows and daily chloride + sulfate loading at Denison Dam and Index, AR, for October 31, 2007, through November 30, 2011.

Statistic	Denison Dam	Index
Average flow (cfs)	4,801	11,665
Average Chloride + Sulfate Concentration (mg/L)	561	305
Average Daily Chloride + Sulfate Load (Kg/day)	6,591,887	8,705,151
Proportion of Index Flow from Denison Dam	0.41	
Proportion of Index Chloride + Sulfate Loading from Denison	0.76	

ES.4 Threatened and Endangered Species

Small numbers of Ouachita rock pocketbook (*Arkansia wheeleri*) have been documented in the upper reach of the Little River below Millwood Lake, but no live *A. wheeleri* have been collected from the lower reach, extending from a short distance above the SWEPCO plant's intake downstream past the discharge location to the confluence of Little River with the Red River (see Section 2.4). *A. wheeleri* has never been documented in the Red River downstream from the confluence with the Little River. Suitable habitat and water quality to support *A. wheeleri* is not present in the described reaches of these waterbodies due to construction of the Millwood Lake on the Little River, which resulted in changes in flow, water temperature, and sedimentation. Additionally, although the rabbitsfoot, *Quadrula cylindrica,* is known from some streams in southwest Arkansas, including the Little River upstream of Millwood Lake, it has not been documented in either the Little River downstream of the Millwood Lake dam or the Red River (personal communication, Chris Davidson, USFWS, 2013).

The federally listed Interior Least Tern (*Sterna antillarum athalassos*) is known from a large sandbar at the confluence of the Red River and the Little River below Millwood Lake. Many aquatic species are particularly vulnerable to changes in flow and water temperature, but these parameters do not impact terrestrial species such as the Interior Least Tern.

ES.5 Use Analysis

Little River

Primary and secondary contact recreation, domestic water supply, agricultural water supply, and industrial water supply uses for the Little River are existing and attainable uses based on the UAA study and literature reviews.

The combined collections from the present study and USGS sampling during 2009 and 2013 provide strong evidence that the existing mineral conditions support a fish community that represents the expected subset of the ichthyofauna of the Little River basin. "Tolerant" and "moderately tolerant" species dominate this community with few "intolerant" fish species present, which indicates that a slight increase in TDS concentrations will not adversely affect the

fish community. These findings suggest that the designated fisheries use in the Little River is currently attained and will still be attained with the proposed TDS criterion.

TDS concentrations in the Little River under optimal plant operating conditions are projected to exceed the existing site-specific criterion of 100 mg/L. Results and analysis of field survey data indicate that the existing and projected mineral concentrations will support and not impair the fisheries use based on the following evidence:

1. This system represents an impacted system due to the presence of the dam for Millwood Lake (see Section 2.4);
2. The projected change in downstream mineral concentrations represents a modest increase in absolute concentrations over existing conditions;
3. The predominance of tolerant and moderately tolerant fish species in the Little River below the dam on Millwood Lake indicates a fish community that should be relatively insensitive to modest changes in TDS concentrations; and
4. The toxic TDS threshold (1,744 mg/L; see Section 4.0) exceeds projected downstream mineral concentrations by more than an order of magnitude.

Red River

Primary and secondary contact recreation, agricultural water supply, and industrial water supply uses for the Red River are existing and attainable uses based on the UAA study and literature reviews.

Fisheries

Buchanan et al. (2003) demonstrated a high level of fisheries use attainment in the Red River in Arkansas based on fish populations. In general, mineral concentrations were higher during the Buchanan et al. study than during the period of time since their survey ended. This finding shows that existing mineral concentrations in the Red River will support at least the level of fisheries use attainment shown during the Buchanan et al. survey. Therefore, the current mineral regime in the Red River, including the reach downstream of the mouth of the Little River, will support the attainable fisheries designated use in the Red River.

Domestic Water Supply

The domestic water supply use for the reach of the Red River between the OK-AR state line and the Little River confluence has been removed based on a previous study (AquAeTer 1994) that showed the use to be neither an existing nor attainable use due to naturally occurring elevated dissolved minerals concentrations that exceed secondary drinking water standards. Similarly, the reach of the Red River from the Little River confluence to the AR-LA state line can also be expected to exceed secondary drinking water standards due to the same factors. Figure ES.2 shows that the Red River TDS concentrations at Fulton (downstream of the Little River) frequently exceeded the secondary drinking water standard of 500 mg/L during the POR after November 28, 1975, and documents that the domestic water supply use is not attainable in the reach of the Red River downstream of the Little River. TDS concentrations at Index (from Legacy STORET and USGS) from June 1959 through July 2013 (Figure ES.3) show that the Red River TDS concentrations at Index (upstream of the Little River) frequently exceeded the secondary drinking water standard of 500 mg/L during the POR before and after November 28, 1975.

Because the monitoring station at Index is upstream of the station at Fulton, it is concluded that TDS concentrations at Fulton exceeded the secondary drinking water standard of 500 mg/L TDS prior to November 28, 1975, as well. Coordination was performed with the Arkansas Department of Health and the Arkansas Natural Resource Commission to confirm that the stream is not used as an existing domestic water supply. Therefore, the domestic water supply use is neither an existing nor attainable use in the Red River downstream of the mouth of the Little River. This analysis supports the removal of the domestic water supply use for the Red River downstream of the mouth of the Little River per the provisions of 40 CFR 131.10(g)(a).

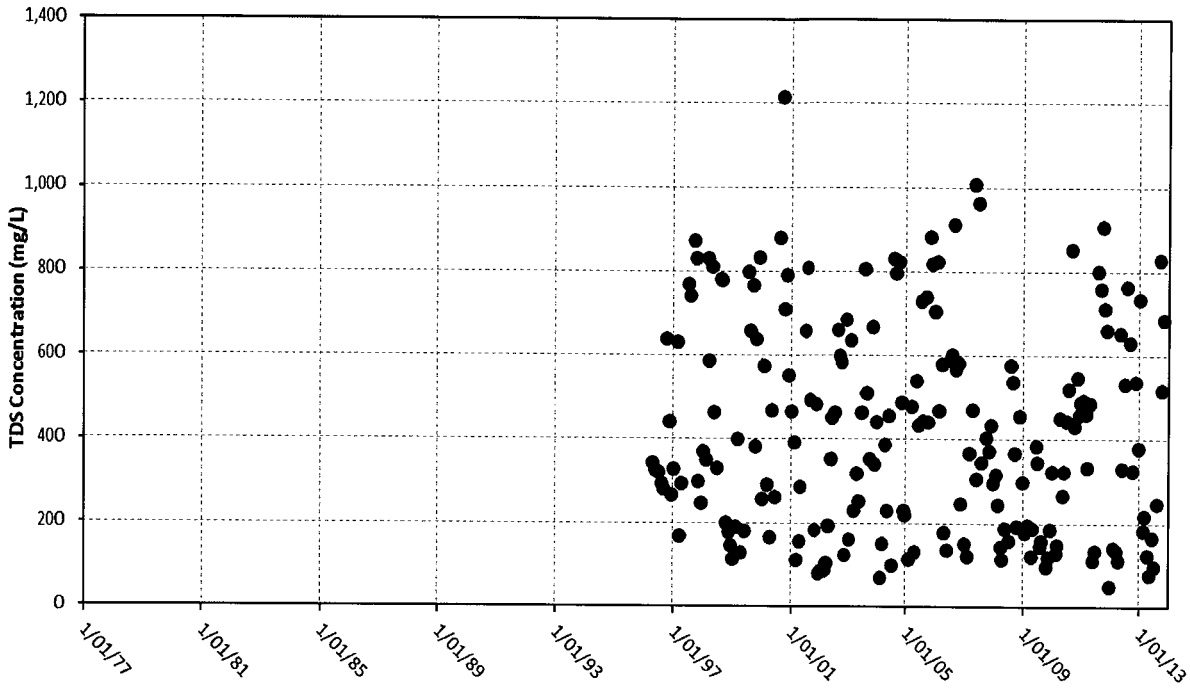


Figure ES.2. Time-series plot of TDS concentrations in the Red River near Fulton, AR.

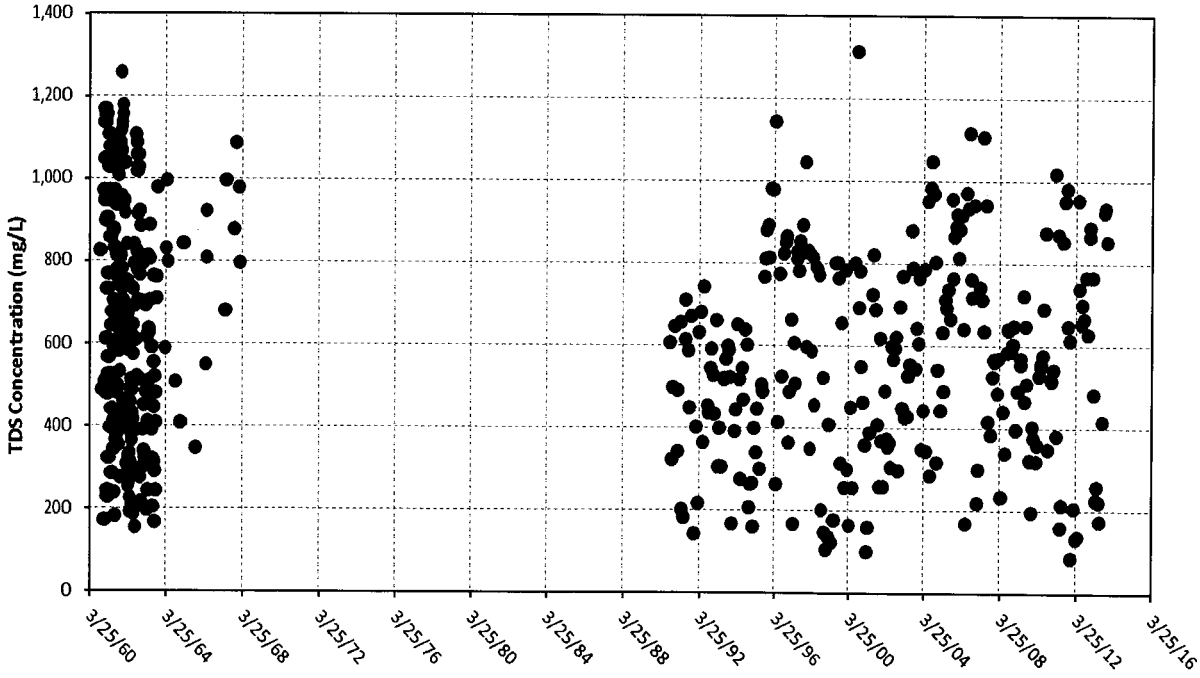


Figure ES.3. Time-series plot of TDS concentrations in the Red River near Index, AR.

ES.6 Alternatives Evaluation

Four alternatives that have been reviewed for other UAAs include the following:

1. Distillation treatment,
2. Treatment using a constructed wetland,
3. Pumping the wastewater to a larger stream that holds the potential for dilution of the minerals, and
4. Reverse osmosis (RO) treatment of the wastewater.

Based on preliminary screening of these four options, the use of RO for feedwater with an initial concentration of 30,000 mg/L or less is generally preferable to the use of distillation processes. In any case, there are no economic benefits with the distillation technology compared to the RO process. Therefore, RO will be evaluated for this application.

Constructed wetlands can be dismissed as an option for this facility. Constructed wetlands can only be used to reduce sulfate, which results in the production of bicarbonate in place of sulfate (Hedin et al. 1989). Although a constructed wetland could, in principle, reduce sulfate in the discharge from this facility, the resulting TDS concentration would not be decreased (due to the replacement of the sulfate ions with bicarbonate ions) and no net benefit would be obtained. TDS is the only concern for this evaluation.

Given these considerations, there are two basic alternatives for achieving compliance with the existing Arkansas water quality criteria for the Little River and Red River:

1. RO treatment to remove or reduce dissolved minerals; and
2. Pumping the SWEPCO effluent to a larger river that holds the potential for dilution of the minerals.

Given the location of the SWEPCO plant in west Arkansas, there is not a river in the vicinity that could be used as dilution to completely avoid a change in the water quality standards. The Red River downstream of the Little River has a TDS criterion of 500 mg/L. However, the expected concentration of TDS in the effluent from this facility would not meet the

Red River TDS criterion and would still require the completion of a UAA or the installation of partial RO treatment.

The following three options are the options that have been identified to achieve compliance with the existing water quality standards:

1. RO Treatment/Discharge to Little River at Current Effluent Limits;
2. RO Treatment/Discharge to Little River at Future Effluent Limits; and
3. RO Treatment/Discharge to Red River.

These options were compared with the option for implementing revised site-specific criteria for dissolved minerals in the Little River and/or the Red River. Table ES.2 summarizes the estimated costs with each option for this facility.

Table ES.2. Summary of costs for various options to attain compliance with permit limits.

Option Description	Estimated Capital Cost	Estimated Annual Operating Cost	Disposal Cost
Option 1 – RO Treatment/Discharge to Little River (current limits)	$5.1 million	$0.31 million	$2.35 million
Option 2 –RO Treatment/Discharge to Little River (future effluent limits)	$6.9 million	$0.42 million	$3.5 million
Option 3 – RO Treatment/Discharge to Red River	$5.7 million	$0.32 million	$2.35 million
Direct Discharge to Little River (Site-Specific TDS Criterion)	<$400,000	NA	NA

The information presented in this section indicates that the most cost-effective option is direct discharge. Implementing this option, however, will require modified TDS criteria in the Little River and Red River, the current receiving streams.

ES.7 Proposed TDS Criteria

Little River

The proposed TDS criterion for the Little River is based on a weight-of-evidence approach utilizing a mass balance, the current TDS criterion for streams in the Gulf Coastal Plain ecoregion (APCEC 2011), and an aquatic life evaluation to assess whether the proposed criterion is protective of the fisheries designated use in the Little River.

A mass balance was prepared in order to estimate a proposed TDS criterion that would (1) allow SWEPCO to operate the facility efficiently and (2) reflect naturally occurring elevated TDS concentrations in the Little River, while still protecting the existing and attainable designated uses of the stream. TDS data collected upstream of SWEPCO by FTN and SWEPCO personnel during October 2010 through October 2013 showed values exceeding the current site-specific TDS criterion (100 mg/L) approximately 10% of the time. Based on the factors above, a TDS criterion of 136.1 mg/L would be necessary in the Little River to reflect the naturally occurring mineral regime and to allow SWEPCO to operate efficiently. The proposed TDS criterion for the Little River is 138 mg/L and is derived from the ecoregion reference stream values listed in Regulation No. 2.511(B) (APCEC 2011). Per §2.511(B), the TDS value of 138 mg/L is calculated by multiplying the ecoregion reference values for chloride (14 mg/L) and sulfate (31 mg/L) by one-third and adding those products to the ecoregion reference value for TDS (123 mg/L). A TDS criterion greater than 138 mg/L would be classified as a "significant modification" from the ecoregion reference stream value for TDS as described in Regulation No. 2.511(B). The model results showed that TDS concentrations in the Little River under optimal plant operating conditions are projected to exceed the existing site-specific criterion of 100 mg/L but should remain below 138 mg/L under critical low-flow conditions.

An aquatic life evaluation was performed to evaluate whether the proposed criterion would be protective of existing and attainable uses in the Little River. Field sampling showed that the species composition of the existing fish community in the Little Red River below the Millwood Lake dam was a subset of ecoregion fish species that would be expected given the available habitat in the Little River and the habitat requirements, habits, and zoogeography of the

ecoregion pool of species. Tolerant and moderately tolerant fish species that should be relatively insensitive to modest changes in TDS dominated the existing fish community.

Spiked toxicity tests were also performed to evaluate the effects of elevated minerals concentrations on aquatic life in the Little River. The test estimated the toxic threshold of minerals by simulating the mixture of the SWEPCO plant effluent and the Little River at the critical flow (26% effluent) and spiking the mixture with salts to mimic elevated minerals concentrations. The calculated toxic threshold for TDS was 1,744 mg/L (see Section 4.0), which exceeds projected downstream TDS concentrations by more than an order of magnitude. These results indicate that the threshold for toxicity due to minerals (as TDS, sulfate, and chloride) is well above anticipated mineral concentrations at the critical dilution of 26%.

This criterion is being proposed not just for the portion of the Little River downstream of SWEPCO, but for the Little River from the Millwood Lake dam to the confluence with the Red River. The revised TDS criterion is needed upstream of SWEPCO because (a) the revised criterion reflects current naturally occurring conditions in the Gulf Coastal Plain ecoregion and (b) that portion of the Little River could be listed as impaired in the future if the criterion is not changed.

Red River

The proposed TDS criterion for the Red River is based on a weight-of-evidence approach utilizing current and historical TDS concentrations in the Red River upstream and downstream of the confluence with the Little River, steady-state mass balance modeling, and an aquatic life evaluation to assess whether the proposed criterion is protective of the fisheries designated use in the Red River.

A mass balance was prepared in order to estimate a proposed TDS criterion for the Red River that would reflect naturally occurring elevated TDS concentrations in the Red River, while still protecting the existing and attainable designated uses of the stream. In order for the modeling to be an appropriate representation of the existing instream mineral regime, the predicted concentrations for critical conditions should be no higher than the 95th percentile of long-term monitoring data. The 95th percentile TDS concentration for the Red River downstream

of the Little River (based on long-term monitoring data at the station near Garland [RED0045] during April 1996 through October 2013) was 860 mg/L. The period of record of April 1996 through October 2013 was selected because it reflects the most complete set of monitoring data that reflected long-term variability.

Based on the factors above, a TDS criterion of 860 mg/L is proposed for the Red River from the Little River to the AR-LA state line. The proposed site-specific TDS criterion maintains existing water quality standards in Louisiana (Section 5.0). In previous UAAs, proposed criteria for dissolved minerals are often decreasing in the downstream direction due to dilution along the length of the stream. However, there is little dilution to the Red River between the Little River and the AR-LA state line during 7Q10 conditions. The predicted TDS concentrations in the Red River did not decrease much from just downstream of the Little River (about 859 mg/L) to the AR-LA state line (about 843 mg/L). Therefore, the same TDS criterion is proposed for the entire distance of the Red River from the Little River to the AR-LA state line.

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1.0 INTRODUCTION

1.1 Background & Overview

Southwestern Electric Power Company (SWEPCO) discharges wastewater from the John W. Turk, Jr. Power Plant to the Little River approximately 2 miles upstream of its confluence with the Red River, near Fulton, Arkansas (Figure 1.1). The facility's National Pollutant Discharge Elimination System (NPDES) permit (No. AR0051136) includes effluent limitations at Outfall 001 for total dissolved solids (TDS). This evaluation considered TDS levels in the Little River from downstream of the dam for Millwood Lake to the confluence with the Red River and in the Red River from its confluence with the Little River to the Arkansas-Louisiana state line and immediately downstream into Louisiana.

The current Arkansas water quality criterion for TDS in the Red River from its confluence with the Little River to the AR-LA state line (500 mg/L) does not account for natural sources of minerals in the Red River in Texas and Oklahoma (see Section 2.3.2). The TDS criterion for this reach of the Red River is lower than the upstream TDS criterion of 850 mg/L above the confluence of the Red River with the Little River and the downstream TDS criterion of 780 mg/L in Louisiana; therefore, the TDS criterion is geographically inconsistent (see Figure 1.2).

Under a typical permit scenario, the dissolved minerals criteria for the Little River would be used to calculate the effluent limitations for dissolved minerals at Outfall 001. However, because the TDS criterion for the Red River downstream of the confluence with the Little River to the AR-LA state line is exceeded at times (due to natural sources), this reach of the Red River was included on the 2008 303(d) list of impaired waterbodies. A consequence of this 303(d) listing is that the "end-of-pipe" TDS limit that the SWEPCO plant must meet at Outfall 001 is the Red River's current criterion of 500 mg/L. This TDS permit limit adversely impacts the operations at the SWEPCO plant despite the fact that it can be demonstrated that the facility's discharge from Outfall 001 at full operation will have virtually no effect on the concentrations of dissolved minerals in the Red River (Section 5.0).

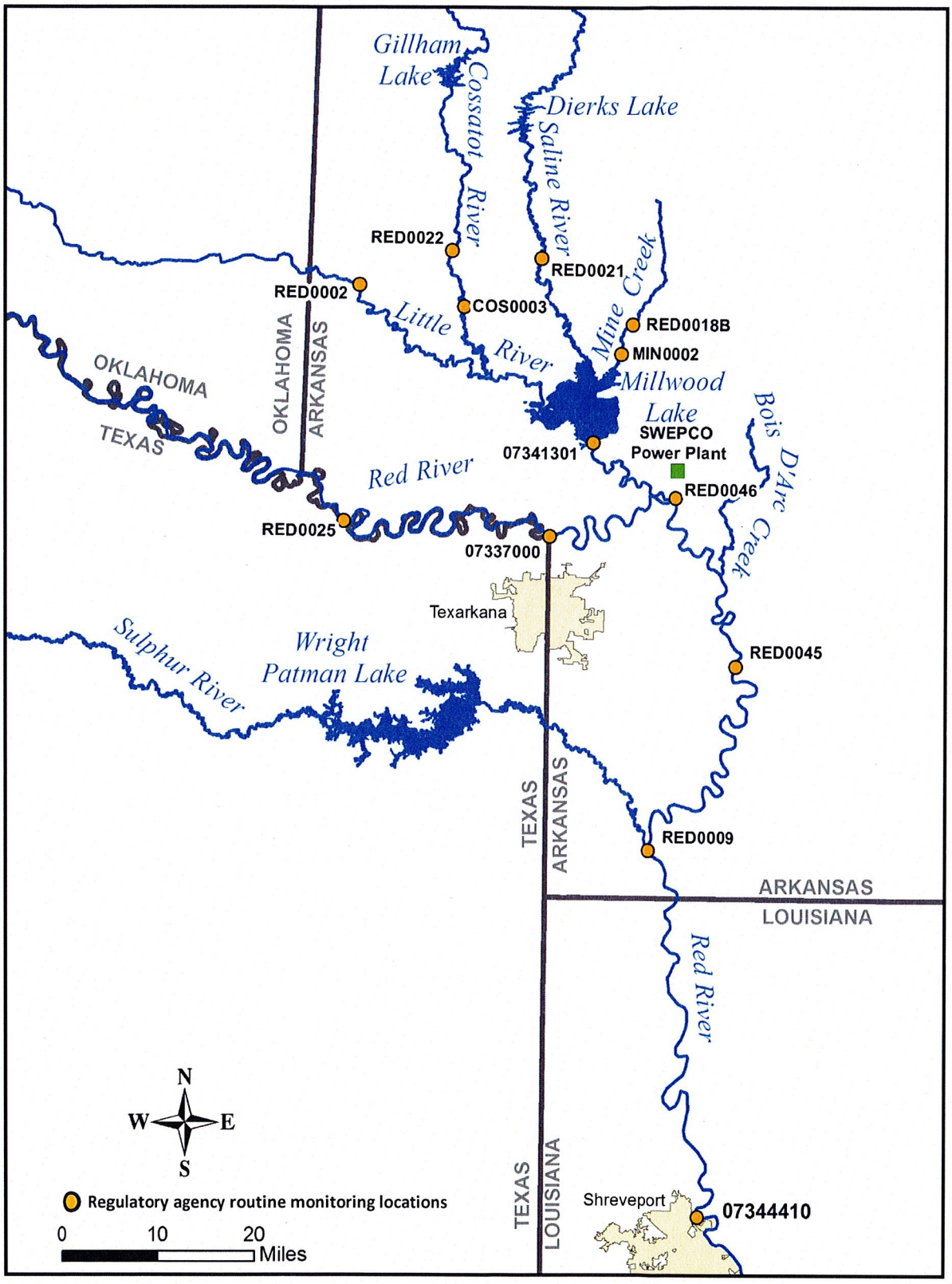


Figure 1.1. Red River, Little River, and selected tributaries in Arkansas.

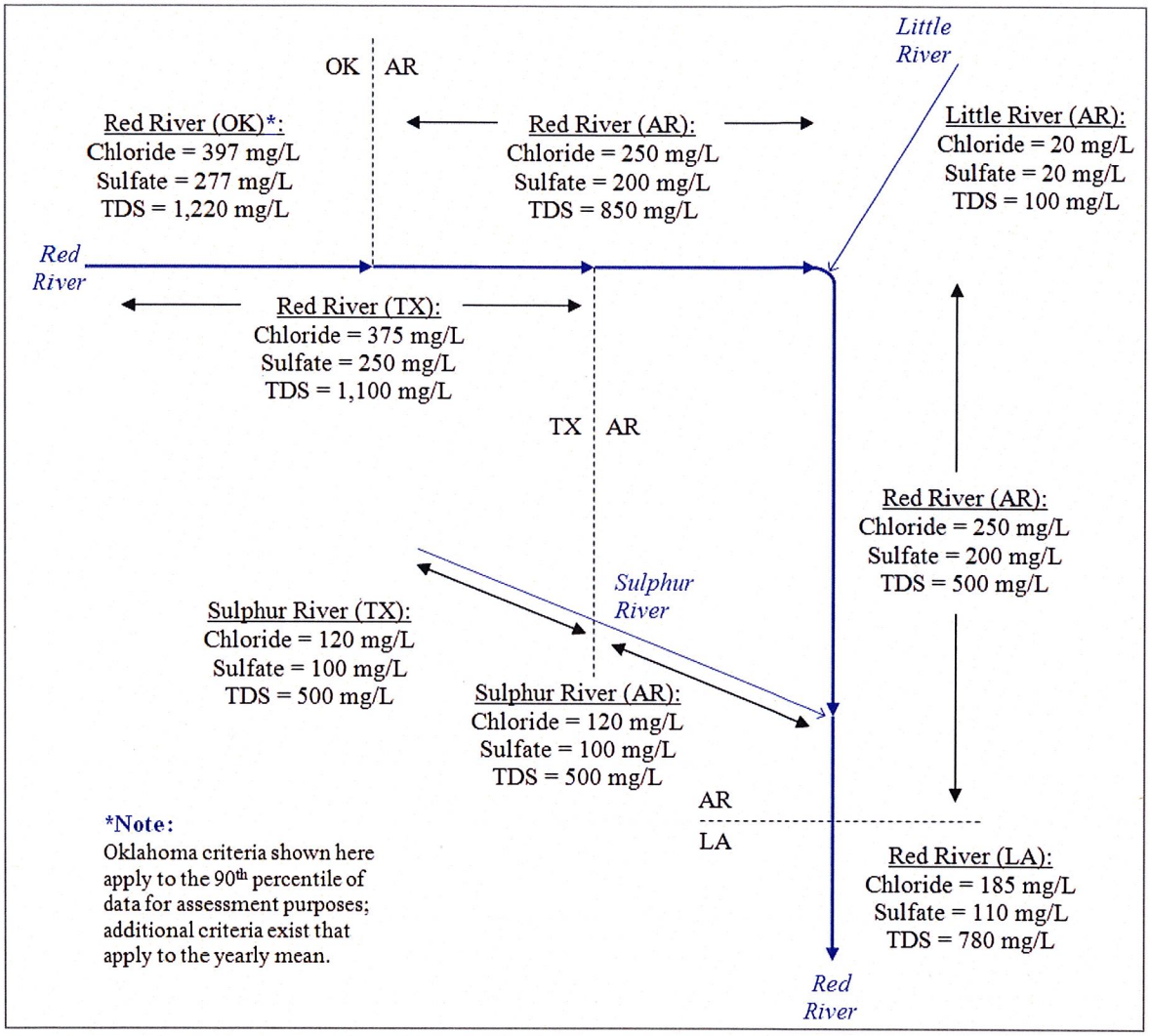


Figure 1.2. Summary of dissolved minerals criteria in the Red River system.

For example, the combined total of the 7Q10 flows for the Red River and Little River is over 400 times as large as the SWEPCO effluent flow rate (design flow); therefore, in order for the discharge to change the TDS concentration of the Red River downstream of the Little River by 1 mg/L, the effluent TDS concentration would have to change by about 400 mg/L.

The TDS criterion in this reach of the Red River should be revised to reflect the naturally occurring minerals concentrations, thus allowing this stretch of the Red River to be removed from the 303(d) list of impaired waterbodies. Addressing the TDS criterion will then allow for

the subsequent revision of the existing effluent limitations for TDS in the SWEPCO facility's NPDES permit.

It should be noted that the use attainability analysis (UAA) study plan submitted to ADEQ in May 2013 (and revised July 2013) did not include assessment of potential revised minerals criteria for the Little River. The primary historical water quality data set that was available before this study to describe Little River water quality was based on water quality sampling performed by the United States Geological Survey (USGS) at USGS gage 07341301 (Figure 1.1) from November 1967 to August 1995 that included TDS, sulfate, and chloride. These data were used to represent water quality in the Little River upstream of the SWEPCO facility by ADEQ in preparing the facility's current NPDES permit. The median and 95th percentile concentrations from the historical water quality data are provided in Table 1.1.

Table 1.1. Median and 95th percentile concentrations of historical data from USGS gage 07341301 on the Little River for the period from November 1967 to August 1995.

Parameter	Median Concentration (mg/L)	95th Percentile Concentration (mg/L)	Count
TDS	50	77	53
Sulfate	5.2	9.6	81
Chloride	4.55	8.57	80

Water quality data to describe dissolved minerals in the Little River were collected by SWEPCO and as part of the UAA efforts beginning in October 2010 and continuing through January 2014. The median and 95th percentile concentrations from the water quality data collected as part of this UAA study are provided in Table 1.2.

Table 1.2. Median and 95th percentile concentrations of data collected by SWEPCO from the Little River from October 2010 to October 2013 as part of this study.

Parameter	Median Concentration (mg/L)	95th Percentile Concentration (mg/L)	Count
TDS	63	105	56
Sulfate	6.0	8.0	51
Chloride	5.0	8.5	51

More in-depth discussions of the upstream data and the sampling locations are provided in Sections 3.0 and 5.0. However, naturally occurring exceedances of the current site-specific TDS criterion of 100 mg/L for the Little River are occurring at times upstream of the SWEPCO discharge. Based on these data, there is little to no assimilative capacity for TDS in the Little River at times (absent the SWEPCO facility's discharge) due to naturally occurring upstream sources of dissolved minerals. Data collected during this study show that background TDS concentrations exceed the criterion approximately 10% of the time, indicating that the Little River is likely to be listed as impaired for TDS on a future 303(d) list, which could result in a permit limitation for the SWEPCO plant equal to the current Little River TDS criterion of 100 mg/L. This scenario could limit the plant's ability to operate. Therefore, the UAA study objectives were modified to evaluate a potential TDS criterion change to the Little River (see Section 1.2).

1.2 Objectives

The UAA study reported herein was conducted with the following objectives:

1. Evaluate existing and attainable uses in the receiving streams downstream of the discharge (Little River and Red River);
2. Evaluate whether the current water quality in the Red River supports existing and attainable designated uses;
3. Evaluate whether the current water quality in the Little River supports existing and attainable designated uses;
4. Evaluate whether the projected increase in TDS concentration in the Little River would be protective of existing and attainable designated uses; and
5. Evaluate options for permit compliance, including treatment, alternative discharge locations, and site-specific minerals criteria.

1.3 Approach

To justify modification of Arkansas water quality standards (designated uses or water quality criteria), it is necessary to determine whether existing and attainable uses of these waterbodies can be protected with less stringent, site-specific criteria. To show that the proposed criteria are protective of the existing and attainable designated uses of the receiving streams, it

must be demonstrated that measured and predicted concentrations of dissolved minerals will not limit aquatic life or impair other existing or attainable uses. The UAA process included development of a UAA study plan, which was submitted to ADEQ in March 2013. ADEQ provided comments on the plan in May 2013, and the revised plan was submitted in July 2013. ADEQ indicated conceptual agreement with the proposed UAA approach. Development of the UAA approach followed applicable guidance in the following documents:

1. The US Environmental Protection Agency (EPA) *Water Quality Standards Handbook: Second Edition* (EPA 1994);
2. The EPA Technical Support Document for Waterbody Surveys and Assessments for Conducting UAAs (EPA 1983);
3. The Water Environment Research Foundation's (WERF) reports "Suggested Framework for Conducting UAAs and Interpreting Results" (WERF 1997a) and "A Comprehensive UAA Technical Reference" (WERF 1997b);
4. The State of Arkansas Continuing Planning Process document (ADEQ 2000);
5. APCEC Regulation No. 2, including §2.306 (2011); and
6. 40 CFR 131.10(a) through (k).

The proposal for changes to APCEC Regulation No. 2 is in accordance with §2.306 of Regulation No. 2 (APCEC 2011). The proposal for changes to APCEC Regulation No. 2 is also in accordance with the applicable sections of 40 CFR 131.10 including:

1. 40 CFR 131.10(b): In designating uses of a waterbody and the appropriate criteria for those uses, the state shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters.
2. 40 CFR 131.10(e): Prior to adding or removing any use, or establishing sub-categories of a use, the state shall provide notice and an opportunity for a public hearing under Section 131.20(b) of this regulation.
3. 40 CFR 131.10(g): States may remove a designated use which is not an existing use, as defined in Section 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because:

a. Naturally occurring pollutant concentrations prevent the attainment of the use;[1]

b. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met;

c. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;

d. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use;

e. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

f. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.[1]

1.4 Economic Impact on Local Area

In accordance with page IX-7 of the Arkansas CPP ("Administrative Guidance Document" section), a petition to increase dissolved minerals concentrations above existing conditions must demonstrate to ADEQ that the facility will have a sufficient impact on the economy of the area or is essential to the promotion of the public interest, and that approval of the petition will accommodate important economic or social development in the stream segment area (item 3b). Page IX-17 of the CPP ("Justification Required for Substantial and Widespread Economic and Social Impact") lists the suggested information to be included in order to demonstrate substantial widespread economic and social impacts that justify the site-specific criteria.

[1] Applicable to this study.

Items 1, 3, and 4 of the list on page IX-17 of the CPP will be discussed in Section 7.0. Items 5 through 9 of the list on page IX-17 of the CPP are addressed in an economic impact study prepared on behalf of SWEPCO during construction of the facility. The study, titled *Economic Impact of the Construction and Operation of the John W. Turk, Jr. Power Plant*, is included as Appendix A. The study demonstrated that the SWEPCO facility would provide approximately 154 new jobs (direct and indirect) totaling more than $7 million in annual salaries. The facility also serves as a major contributor to the local tax base, contributing more than $11.2 million annually in property taxes, of which $9.7 million is distributed to local school districts (the revenue is primarily designated to go to the Mineral Springs Saratoga School District but is also dispersed to other school districts in the county). For comparison, a financial statement from the end of the 2008 fiscal year for the Mineral Springs Saratoga School District showed revenue from all categories amounting to approximately $5.8 million (Appendix A). Thus the property tax revenue provided by SWEPCO from the school district millage tax alone is approximately twice the annual amount received by the school district in revenue from other sources.

1.5 Facility Process Description

Discharges at Outfall 001 are from a wastewater pond containing primarily cooling tower blowdown and previously monitored internal waste streams from a process water pond. The design flow for this discharge is 2.16 million gallons per day (MGD), which is equivalent to 3.34 cubic feet per second (cfs). Current permit limits (i.e., based on the Red River TDS criterion) prevent the SWEPCO plant from operating as designed (i.e., running up to ten cycles of concentration with regard to the cooling water system); due to the TDS "impairment" in the Red River, the SWEPCO discharge must have a TDS concentration equal to the instream criterion in the Red River of 500 mg/L in order to not contribute to the impairment. Operation of the cooling water system at intended optimum design results in less use of makeup water from the Little River and also more efficient use of water treatment chemicals.

2.0 BACKGROUND

2.1 NPDES Permit

SWEPCO discharges wastewater to the Little River via Outfall 001 under the authority of NPDES Permit No. AR0051136 (effective November 1, 2012). The permit includes a monthly average effluent limit for TDS of 500 mg/L.

2.2 Receiving Stream Water Quality Standards

Designated uses and dissolved minerals criteria for the Little River and Red River in Arkansas are summarized in Table 2.1. Note that based on a previous use attainability analysis (AquAeTer 1994), the segment of the Red River upstream of its confluence with the Little River to the AR-OK state line does not have a domestic water supply designated use.

Table 2.1. Summary of designated uses and dissolved minerals criteria for the Red River in Arkansas and the Little River below Millwood Lake.

Stream Reach	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Designated Uses[1,2]
Little River downstream of Millwood Lake (reaches 11140109-001 and -006)	20	20	100	Primary contact recreation, secondary contact recreation, domestic water supply, industrial water supply, agricultural water supply, fisheries
Red River from OK-AR state line to Little River (reaches 11140106-001, -003, -005, and -025)	250	200	850	Primary contact recreation, secondary contact recreation, industrial water supply, agricultural water supply, fisheries
Red River from Little River to AR-LA state line (reaches 11140201-003, -004, -005, -007, and -011)	250	200	500	Primary contact recreation, secondary contact recreation, domestic water supply, industrial water supply, agricultural water supply, fisheries

Notes:
1. As listed for the Gulf Coastal Plain ecoregion in APCEC Regulation No. 2 (2011).
2. The domestic water supply designated use for the reaches of the Red River between the AR-OK state line and the confluence with the Little River was removed based on a previous UAA (AquAeTer 1994).

2.3 Existing Water Quality and Impairments

2.3.1 Little River

2.3.1.1 TDS Sources to the Little River

An evaluation of existing data upstream of Millwood Lake was performed to identify potential recent sources of TDS that might explain the increased TDS values in samples collected from the Little River downstream of the dam on Millwood Lake. The major tributaries of Millwood Lake include the Little River, Cossatot River, Saline River, and Mine Creek (Figure 1.1) (FTN 1994). The Little River provides 72% of the lake inflow, the Cossatot River 11%, the Saline River 5%, and Mine Creek 2% (FTN 1994). ADEQ monitoring stations exist on these major tributaries (Figure 1.1). Table 2.2 provides summary information for TDS data (provided in full in Appendix B) from these monitoring stations.

Table 2.2. Summary statistics of TDS data from ADEQ monitoring stations on major tributaries to Millwood Lake.

	TDS (mg/L)			
Statistic	**Little River (RED0002)**	**Cossatot River (RED0022/COS0003)**	**Saline River (RED0021)**	**Mine Creek (RED0018B/MIN0002)**
Minimum	10	13	8	56
Maximum	113	85	152	510
Average	54	40	54	167
90^{th} percentile	73	52	74	361
95^{th} percentile	81	58	82	404
Period of Record	September 1990-January 2000	January 1991-July 2013/ July 1991-August 2002	January 1991-July 2013	May 1997-July 2013/ July 1991-August 2002

Figures 2.1 through 2.4 provide time-series plots of TDS data from these ADEQ monitoring stations on the tributaries upstream of Millwood Lake. Overall, there is no clear evidence of significant changes in TDS levels in any of the streams. Linear trend lines on each TDS plot show an increase in the Little River, declines in the Saline and Cossatot rivers, and no apparent change in Mine Creek. Although TDS concentrations in Mine Creek are significantly higher than the other streams, the Mine Creek inflow provides only approximately 3 mg/L of TDS based on a flow-weighted mean inflow TDS concentration of 54.8 mg/L for the four major tributaries (54.8 mg/L including Mine Creek and 52.2 mg/L without Mine Creek).

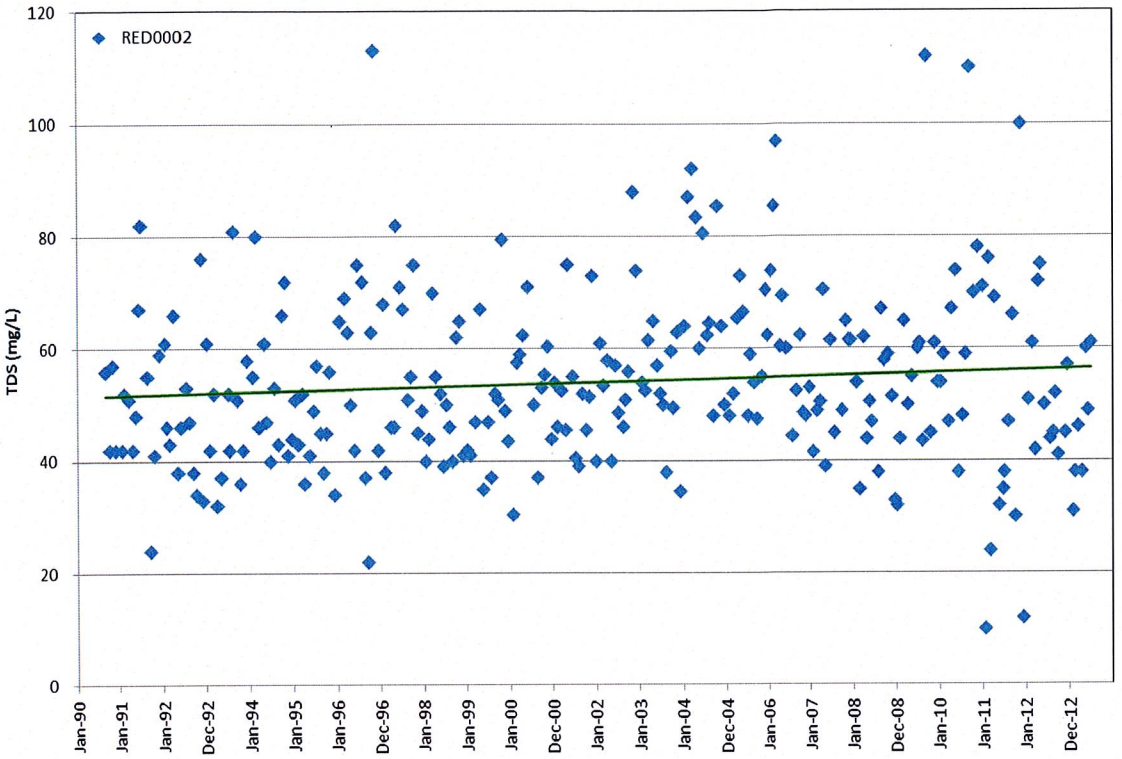


Figure 2.1. TDS time-series data from ADEQ station on Little River (RED0002).

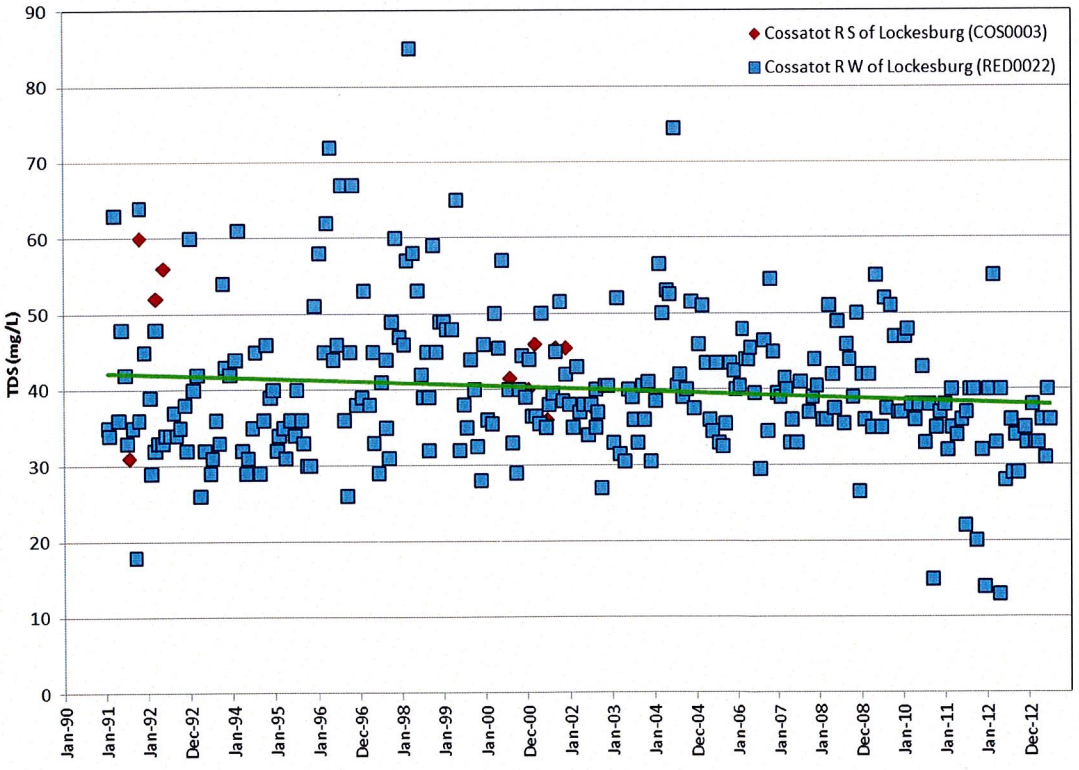


Figure 2.2. TDS time-series data from ADEQ stations on Cossatot River (COS0003/RED0022).

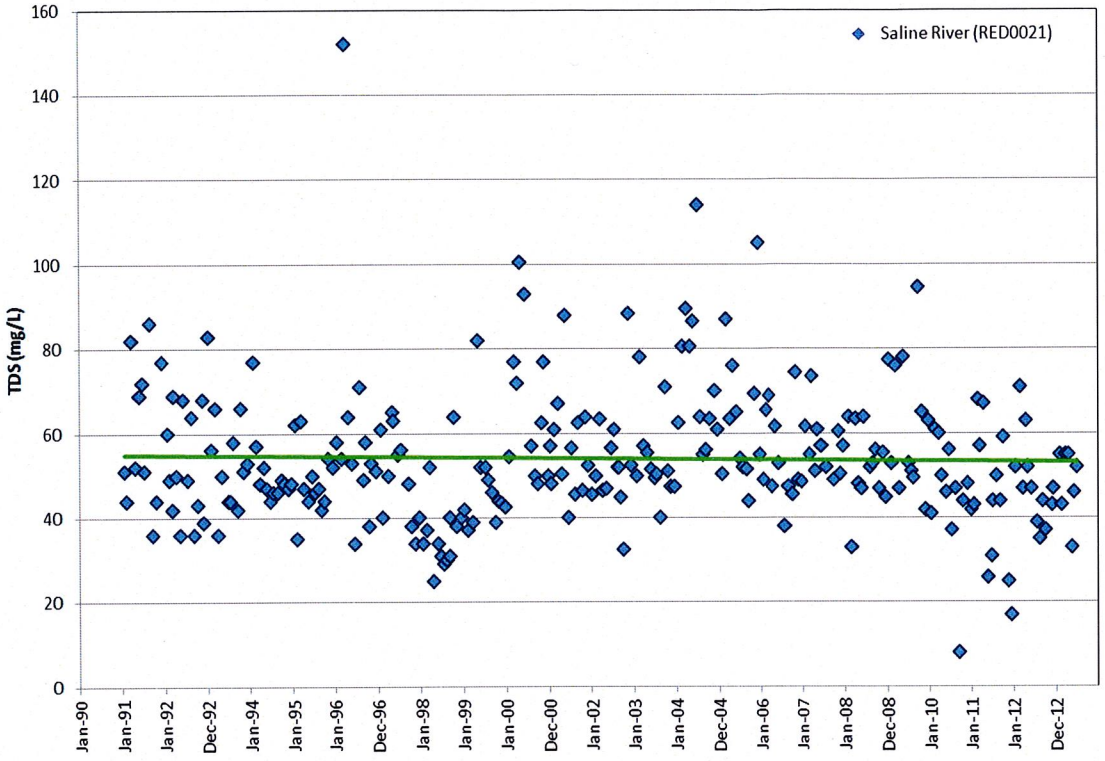


Figure 2.3. TDS time-series data from ADEQ station on Saline River (RED0021).

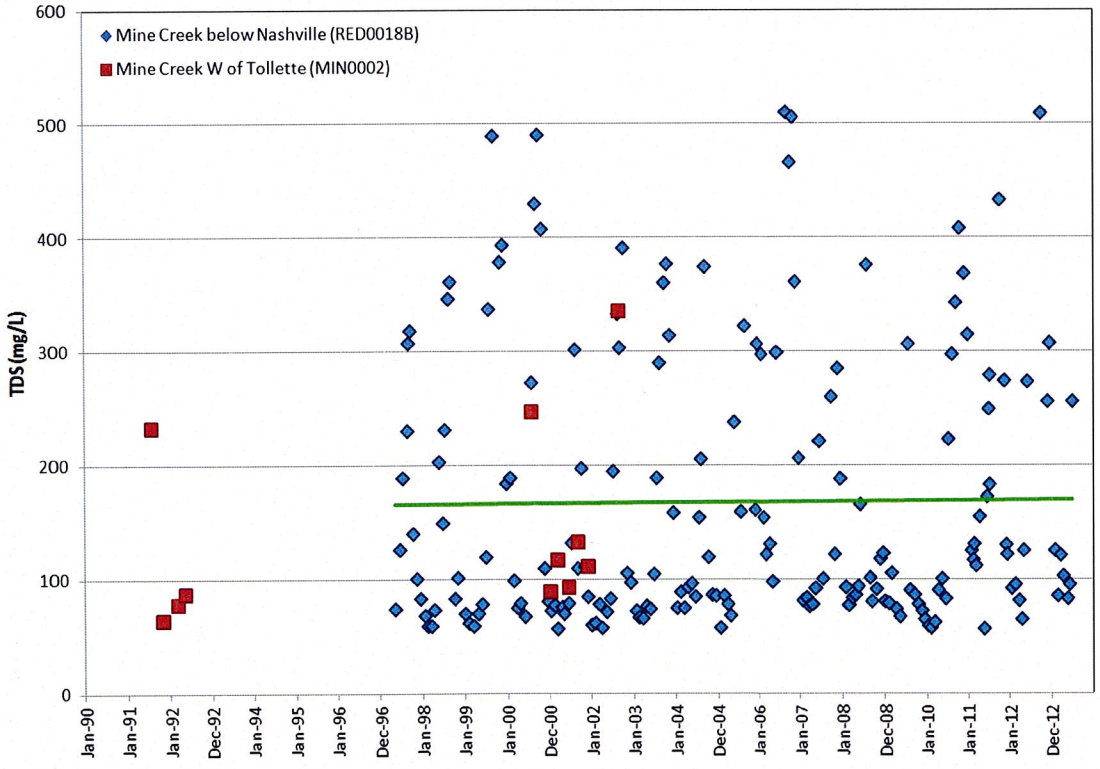


Figure 2.4. TDS time-series data from ADEQ stations on Mine Creek (RED0018B/MIN0002).

The increase in TDS downstream of Millwood Lake is discussed further in Section 5.0.

2.3.1.2 Water Quality Impairments for Minerals in the Little River

Neither ADEQ nor EPA considers the Little River downstream of Millwood Lake as impaired at this time, nor is it included on any 303(d) list. This stream is classified by ADEQ as "unassessed" due to a lack of data for water quality (including minerals).

2.3.2 Red River

The Red River in Arkansas has concentrations of dissolved minerals (chloride, sulfate, and TDS) that are higher than concentrations in streams that originate within southwest Arkansas.

2.3.2.1 TDS Sources to the Red River in Arkansas

TDS loads in the Red River when it enters Arkansas can be evaluated by analyzing loading at the USGS monitoring station at Index, AR (Figure 2.5). This loading was compared to mineral loads originating from the discharge at Denison Dam (which forms Lake Texoma), located approximately 250 river miles upstream of Index. Although flow and mineral records at these locations extend back into the 1950s and 1940s, the period of record (POR) chosen for this analysis was from 1997 through 2011. This POR provided the most readily available pairings of flow and mineral concentrations and includes the effects of the Red River Chloride Control Project that the US Army Corps of Engineers (USACE) has implemented. There were very few overlapping records that included TDS measurements at both locations. Accordingly, this evaluation used chloride + sulfate concentrations as a surrogate for minerals because those parameters provided the most complete data set. The paired flow and chloride/sulfate data used for this analysis are provided in their entirety in Appendix C. Average daily flows at both locations (Index and Denison Dam) as well as the chloride and sulfate data for the POR can be provided in electronic format upon request.

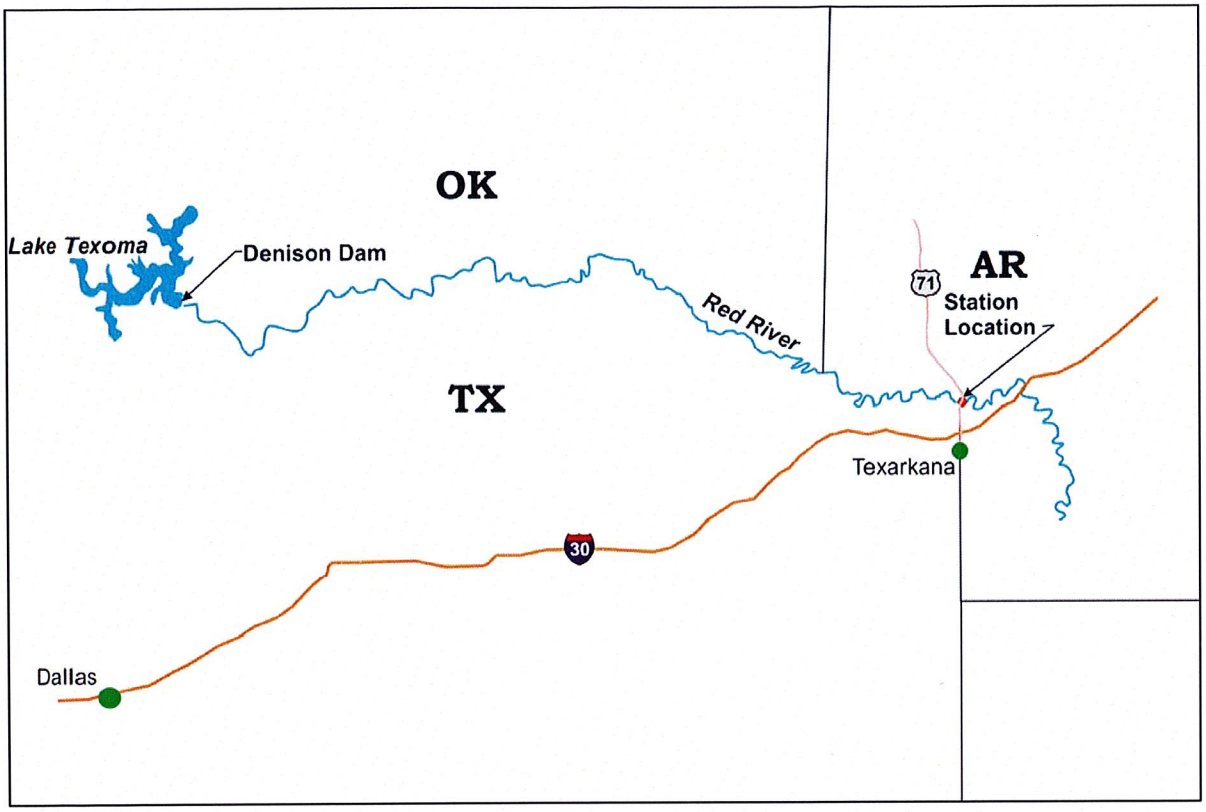


Figure 2.5. Location of the USGS monitoring location at Index, Arkansas, relative to Denison Dam and Lake Texoma.

TDS loads, as indicated by the sum of chloride and sulfate loads, were calculated as the product of the average daily flow and average daily chloride + sulfate concentration with appropriate unit adjustments. This approach assumes that the flows present at the time chloride/sulfate samples were taken are representative of the POR flows. A comparison between flows on sampling days and POR flows is presented in Table 2.3, which shows that summary statistics (e.g., mean, percentiles, coefficient of variation) for flows are similar for the chloride/sulfate sampling days versus the POR. This comparison indicates that chloride/sulfate data set is not biased with respect to flow for the POR and that average chloride + sulfate concentrations are representative of existing conditions at both locations. A comparison of flows and chloride + sulfate loads at Denison Dam versus Index shows that the Denison Dam discharge

accounts for 41% and 76% of the flow and chloride + sulfate loading, respectively at Index (Table 2.4).

Table 2.3. Comparison of selected summary statistics for flows on the chloride and sulfate sampling dates versus the POR (1997-2011) for the Denison Dam discharge and Index, AR.

Summary Statistic		Flow at Index (cfs)		Flow at Denison Dam (cfs)	
		Sampling Dates	POR	Sampling Dates	POR
Percentile	10th	1,930	1,810	233	166
	25th	3,180	2,770	1,356	1,092
	50th	4,960	5,280	2,589	2,684
	75th	11,150	12,675	6,281	5,743
	90th	33,400	32,550	12,113	11,389
Mean		11,534	11,665	5,346	4,801
% Coefficient of Variation		137	133	128	133
Number of Values		91	4,646	147	4,918

Table 2.4. Summary of average flows and daily chloride + sulfate loading at Denison Dam and Index, AR, for October 31, 2007, through November 30, 2011.

Statistic	Denison Dam	Index
Average flow (cfs)	4,801	11,665
Average Chloride + Sulfate Concentration (mg/L)	561	305
Average Daily Chloride + Sulfate Load (Kg/day)	6,591,887	8,705,151
Proportion of Index Flow from Denison Dam	0.41	
Proportion of Index Chloride + Sulfate Loading from Denison	0.76	

2.3.2.2 TDS Sources to the Upper Red River (Oklahoma, Texas)

The upper Red River basin (upstream of Lake Texoma) in Texas and Oklahoma is known to contain elevated levels of salinity that are caused primarily by input from natural salt springs in tributaries to the Red River (Baldys et al. 1996, Keller et al. 1988). These springs and seeps typically yield low volumes of water but very high concentrations of chloride, ranging from several hundred milligrams per liter to about 190,000 mg/L (US Geological Survey

[USGS] 1961). Elevated concentrations of dissolved solids (particularly sulfate and chloride) are a typical feature in most streams of the Red River Basin under low-flow conditions. These elevated concentrations are primarily due to presence of saltwater springs, seeps, and gypsum outcrops (TNRCC 2002).

Over the last five decades, considerable work has been done to limit the amount of dissolved minerals from these springs and seeps that enters the Red River. USACE began evaluating the feasibility of salt removal from 10 salt-spring areas in the Red River Basin starting in 1957. USACE selected eight source areas for installation of structural controls to reduce salt loads reaching the mainstem of the Red River (Keller et al. 1988, USACE 2010). Several water-control structures (South Wichita River, Truscott Brine Lake, Bateman pump station and Truscott Brine Lake, Estelline Springs) have been completed to reduce TDS inputs to the Red River (USGS Fact Sheet: http://pubs.usgs.gov/fs/fs-170-97/FS_170-97.htm).

Even with these efforts, dissolved minerals concentrations in the Red River in Oklahoma are still much higher in the upper part of the watershed than in Arkansas. Median values of specific conductivity (an indication of how much dissolved minerals are in the water) during 1997 and 1998 show values upstream of Lake Texoma that are three to four times as high as values at Index, AR (USGS 2003). As shown in Table 2.5, there is a general decrease in dissolved mineral concentrations in the Red River from the upper parts of the watershed to Arkansas.

Table 2.5. Spatial trend of specific conductivity in the Red River.

Monitoring Site	River Miles Upstream of Index, AR	Median Specific Conductivity (µS/cm)
Red River near Terral, OK	387	4,765
Red River near Gainesville, TX	306	3,740
Red River at Denison Dam	240	1,795
Red River near Bonham, TX	209	1,934
Red River at Arthur City, TX	148	1,053
Red River near DeKalb, TX	72	1,170
Red River at Index, AR	0	998

Other sources of TDS include brine disposal areas and oilfield intrusions from the East Fork of the Little Wichita River. These sources have been corrected although some sources due to antiquated oilfield activities are thought to still occur in eastern portions of the Little Wichita River, Texas (Red River Authority 2013). Information could not be located that would allow an estimation of the proportion of the total TDS load to the Red River that is due to these oil-extraction activities but the references cited herein clearly indicate that the overwhelming portion of TDS inputs to the Red River in Texas and Oklahoma is from natural sources.

2.3.2.3 Water Quality Impairments for Minerals in the Red River

TDS concentrations in the reach of the Red River between the confluence with the Little River and the AR-LA state line have historically exceeded the existing TDS criterion of 500 mg/L frequently enough to cause the Red River to be classified as impaired for TDS on the 2008 303(d) list of impaired waterbodies (the current EPA-approved 303(d) list), as well as the draft 2010 and 2012 303(d) lists for Arkansas. Table 2.6 summarizes the impairment listings for the Red River.

The upstream criteria for the Red River in Texas and Oklahoma reflect the elevated ambient mineral concentrations that are due to inputs from salt springs and seeps from the arid and semi-arid headwater regions.

Table 2.6 shows that the Red River is not considered to be impaired upstream of Arkansas (in Oklahoma and Texas) or downstream of Arkansas (in Louisiana). This is partly due to different assessment procedures that are used in other states. For example, Louisiana does not consider a stream to be impaired for dissolved minerals unless 30% of the observed data exceed the water quality standard. In comparison, ADEQ assesses the Red River for dissolved minerals using a 10% threshold rather than 30%. Oklahoma and Texas also use less-stringent assessment procedures for dissolved minerals than Arkansas, and the criteria in their water quality standards are less stringent than the criteria in Arkansas's standards (see Table 2.6).

Table 2.6. Dissolved minerals criteria and impairments for the Red River.

Reach	Applicable Criteria for Chloride / Sulfate / TDS (mg/L)	Impairments on 303(d) Lists for2008 through 2012
Upstream of OK-AR state line	OK: 397 / 277 / 1,220* TX: 375 / 250 / 1,100	none
From OK-AR state line to US Hwy 71 north of Texarkana (Index, AR)	TX: 375 / 250 / 1,100 AR: 250 / 200 / 850	Chloride (2008, 2010, 2012) Sulfate (2008, 2010, 2012) TDS (2008, 2010, 2012)
From US Hwy 71 (Index, AR) to mouth of Little River	AR: 250 / 200 / 850	Chloride (2008, 2010, 2012) Sulfate (2008, 2010, 2012) TDS (2008, 2010, 2012)
From mouth of Little River to mouth of Bois D'Arc Creek near Miller / Lafayette county line	AR: 250 / 200 / 500	Chloride (2008) TDS (2008, 2010, 2012)
From mouth of Bois D'Arc Creek to mouth of Sulphur River	AR: 250 / 200 / 500	Chloride (2008, 2010) Sulfate (2008) TDS (2008, 2010, 2012)
From mouth of Sulphur River to AR-LA state line	AR: 250 / 200 / 500	TDS (2008, 2010, 2012)
Downstream of AR-LA state line	LA: 185 / 110 / 780	none

*Note: The criteria shown here from Oklahoma Water Quality Standards are "sample standards," which are applied for assessment purposes with an allowable exceedance rate of 10%. Oklahoma has additional criteria for dissolved minerals that are "yearly mean standards," which are compared to annual averages of observed data for assessment purposes.

It is also notable from Table 2.6 that the Red River immediately downstream of the Little River was impaired for chloride only on the 2008 303(d) list for Arkansas. The 2010 and 2012 303(d) lists were based on more recent data, which did not indicate an impairment for chloride in the Red River immediately downstream of the Little River. In recent years, ADEQ has been adamant that permitting decisions and calculations must be based on the most recent 303(d) list that has been approved by EPA Region 6. The Arkansas 303(d) lists for 2010 and 2012 have not yet been approved by EPA. Therefore, ADEQ develops permit limits using the 2008 303(d) list, which includes the chloride impairment in the Red River immediately downstream of the Little River. If EPA Region 6 approves the 2010 303(d) list for Arkansas, ADEQ can re-calculate the facility permit limits for chloride and sulfate for a discharge going into a non-impaired stream.

2.4 Threatened and Endangered Species

2.4.1 Threatened and Endangered Aquatic Species

The Ouachita rock pocketbook (*Arkansia wheeleri*) was federally listed by the US Fish and Wildlife Service (USFWS) throughout its range in Arkansas and Oklahoma as an endangered species in 1991, under protection of the Endangered Species Act (Federal Register 1991). Small numbers of *A. wheeleri* have been documented in the upper reach of the Little River below Millwood Lake, but no live *A. wheeleri* have been collected from the lower reach, extending from a short distance above the SWEPCO plant's intake downstream past the discharge location to the confluence of Little River with the Red River (personal communication, Chris Davidson, USFWS, 2013).

No other aquatic threatened and endangered (T&E) species are documented for the channel of the Little River downstream of the dam below Millwood Lake or in the Red River downstream of the confluence with the Little River. USFWS recently listed another mussel species, rabbitsfoot (*Quadrula cylindrica cylindrica*) as threatened (Federal Register 2013). That species is known from some streams in southwest Arkansas, including the Little River upstream of Millwood Lake, but it has not been documented in the Little River downstream of Millwood Lake or the Red River (personal communication, Chris Davidson, USFWS, 2013).

Millwood Lake was impounded in 1966 at the point of confluence of the Little River and Saline River. The surface area of the lake at the top of the conservation pool is 29,200 acres (11,800 ha), and its shoreline length at the top of the conservation pool is 65 miles (105 km). Therefore, this impoundment was large enough to cause major changes in water quality following its construction, which is thought to have resulted in adverse impacts to *A. wheeleri* and its habitat both above and below the dam.

Mussel authorities are in general agreement that dam construction on rivers results in adverse impacts to populations of most mussel species. Dams fragment rivers, isolate populations, block movement of host fish species, and change physical habitats. Changes in flow, water temperature, and sedimentation are commonplace and of particular concern. As filter feeders on microscopic forms of aquatic life, mussels are susceptible to mortality due to smothering by silt and also due to high sediment loads in the water. High turbidity levels

typically result in reduction or prevention of filter feeding and respiration by mussels when their valves are closed to avoid silt intake. At sub-lethal levels, excessive silt interferes with feeding and metabolism in general, causing mussels to divert more energy in sorting silt particles from food, which can result in starvation and adverse impacts to, if not extirpation of, mussel populations.

Prior to the Millwood Lake impoundment, it is thought that a population of *A. wheeleri* existed in the Little River from the AR-OK state line to near the confluence of Little River with the Red River. Surveys for the species in the Little River of Arkansas, however, apparently were not conducted until well after impoundment. Seagraves was the first to conduct surveys downstream of Millwood Lake (Seagraves 2006). Seagraves recovered mussels from three locations on the Little River downstream from Millwood Lake; all three sites were upstream from the SWEPCO intake. Seagraves found two young mussels at the first site, two gravid females from the second site, and two dead shells at the third site.

URS, under contract to American Electric Power, conducted follow-up mussel surveys in the Little River prior to construction of the SWEPCO facility (URS 2007). The URS surveys were conducted during March and May of 2007 in the vicinity of the proposed water intake and outfall locations for the plant, which were located several miles below the river reach where the Seagraves surveys were conducted. The URS survey did not document the presence of *A. wheeleri*.

Cold water discharges from dams have been reported to result in slow growth and inhibited reproduction in mussels (Harman 1974; Heinricher and Layzer 1999). Millwood Lake, however, is shallow and remains essentially isothermal throughout the year. As a result, the dam below Millwood Lake does not have a cold hypolimnetic release and should not affect downstream mussel populations through the release of cold water.

To summarize the potential for project issues related to T&E mussels, while small numbers of *A. wheeleri* have been documented in the upper reaches of the Little River below Millwood Lake, no live *A. wheeleri* have been collected from the lower reach of the Little River, extending from a short distance above the SWEPCO plant's intake downstream past the discharge location to the confluence of Little River with the Red River. Likewise, the occurrence

of *A. wheeleri* has never been documented in the Red River downstream from the confluence with the Little River. Suitable habitat and water quality to support *A. wheeleri* is not present in the described reaches of these waterbodies. Additionally, although *Q. cylindrica* is known from some streams in southwest Arkansas, including the Little River upstream of Millwood Lake, it has not been documented in either the Little River downstream of the Millwood Lake dam or the Red River (personal communication, Chris Davidson, USFWS, 2013).

2.4.2 Threatened and Endangered Terrestrial Species

Existence of the federally listed Interior Least Tern (*Sterna antillarum athalassos*) is known from a large sandbar at the confluence of the Red River and the Little River below Millwood Lake. Nesting colonies of this species have been observed there, and at scattered downstream localities on the Red River, for a number of years. This species is not aquatic but is found on terrestrial habitats associated with certain major stream channels. Successful nesting for this bird species occurs when predators are absent and when flood waters occur outside the nesting season. Many aquatic species are particularly vulnerable to changes in flow and water temperature, but these parameters do not impact terrestrial species such as the Interior Least Tern.

3.0 FIELD SURVEY

3.1 Overview

Biological evaluations to address the effects of pollutants such as minerals typically rely on comparisons of communities upstream versus downstream of a point source discharge and/or comparisons of reference streams versus communities downstream of a point source discharge. In this case, however, the Millwood Lake dam and Denison Dam, rather than the discharge, dominate the mineral regimes of the Little River (Section 2.3.1) and Red River (Section 2.3.2), respectively. Other sections of this report have demonstrated the following:

1. Dissolved minerals in the target reaches are primarily due to natural upstream sources that cause mineral concentrations in the Little River below the dam on Millwood Lake and the Red River below the mouth of the Little River to exceed the current mineral criteria (Sections 2.3.1 and 2.3.2);
2. The discharge will have negligible effect on the future mineral regime of the Red River (Section 5.0); and
3. The discharge can have a slight effect on the mineral regime in the Little River under low-flow conditions (Section 5.0).

Therefore, this evaluation is unique because the instream criteria exceedances have little or nothing to do with a point source that is not able to meet existing criteria. In the case of the Red River, the criteria exceedances are wholly due to upstream background concentrations. In the case of the Little River, existing mineral concentrations are also at or near the existing site-specific criteria without influence from the plant.

In addition, although ADEQ has developed data sets that characterize least-disturbed streams in the Gulf Coastal Plain ecoregion, these streams do not represent appropriate reference conditions because their size, physical habitat, and background water quality are not directly comparable to the Red River or the segment of the Little River below the dam on Millwood Lake. Accordingly, alternative approaches for assessing the attainment of the fisheries use in the Little River and Red River were used for this evaluation.

3.1.1 Little River

The evaluation of attainable aquatic life (fisheries) uses in the Little River downstream of Millwood Lake included a field survey of benthic macroinvertebrates, fish, and habitat upstream and downstream of the SWEPCO outfall during the mid-summer through early fall seasons (July through October 2013) when maximum mineral concentrations are likely to occur. The objectives of the data analysis were as follows:

1. Compare the biota in the downstream versus upstream reaches to assess potential effects of the current discharge on Little River,
2. Document the level of fisheries use attainment under existing mineral conditions, and
3. Assess whether the projected increase in TDS concentrations due to future plant operations would be expected to adversely affect the biological communities and impair the designated fisheries use.

3.1.1.1 Benthic Macroinvertebrates

Due to the difficulty of effective sampling sand/silt substrates in deep water, benthic macroinvertebrates were sampled by (1) deployment of Hester-Dendy (HD) artificial samplers, and (2) collection of woody debris (WD) substrate.

Benthic communities present on WD should provide an adequate assessment of attainable benthic communities in the Little River below the dam on Millwood Lake because WD is a dominant epifaunal habitat type in that reach of the Little River. Communities present on HD samplers can be thought of as artificial analogues of WD communities representing early colonization stages while the communities present on WD represent later, more mature stages of colonization.

The potential for adverse effects due to increased mineral concentrations was also evaluated using toxicity tests that simulated increased mineral concentrations in the Little River (see Section 4.0). A finding that the threshold for toxicity due to minerals is well above projected mineral concentrations will provide further evidence that projected mineral concentrations will support designated uses.

3.1.1.2 Fish

Fish sampling was conducted using a boat-mounted electroshocker. This sampling gear is biased towards larger fish and will tend to under-sample small and/or benthic fishes. The fish assemblage was assessed by evaluating the distribution of tolerance classes among species collected.

3.1.2 Red River

The objective of the evaluation of the Red River fisheries use was to determine whether the existing mineral regime, which will experience negligible change due to the discharge, supports the designated fisheries use as indicated by fish populations. The approach was to characterize the existing fish communities and evaluate whether those existing communities, which by definition are supported by the existing mineral regime, indicate attainment of the fisheries designated use. This evaluation relied on the following sources of information:

1. The historical record of mineral concentrations in the Red River as indicated available ADEQ monitoring data from ambient monitoring stations near Index, Fulton, and Garland (ADEQ monitoring stations RED0025, RED0046, and RED0045, respectively); and
2. An extensive sampling survey and historical data review of fish populations in the Arkansas portion of the Red River conducted by Buchanan et al. (2003) (Appendix D).

The extensive sampling conducted by Buchanan et al. (2003) showed that the Red River in Arkansas during 1995 through 2001 supported a high level of fisheries use attainment based on the existing fish populations. A finding that existing mineral concentrations are comparable to (or improved from) those present during the Buchanan et al. study will document that existing mineral concentrations support the fisheries designated use and that site-specific minerals criteria based on existing conditions will support the fisheries designated use.

3.2 Water Quality Evaluation: Little River

3.2.1 Water Quality Evaluation Methods: Little River

FTN and SWEPCO personnel monitored the current mineral regime in the Little River below the dam on Millwood Lake with routine collection of 57 grab samples at 1- to 4-week intervals between October 12, 2011, and October 17, 2013. Samples were collected from a depth of approximately 0.3 m in front of the Arkansas Game and Fish Commission boat access, approximately 1.5 miles downstream of the dam on Millwood Lake (Figure 3.1, LR-0). FTN and SWEPCO personnel conducted their monitoring programs independently (i.e., there was no coordination between the two programs with regards to sampling date), and water quality samples collected by FTN and SWEPCO were analyzed by separate laboratories. Samples from both programs were analyzed for chloride (EPA Method 300.0), sulfate (EPA Method 300.0) and TDS (Standard Methods 2540C).

3.2.2 Water Quality Evaluation Results: Little River

Results of monitoring are provided in Section 5.0, which presents the derivation of values for site-specific minerals criteria.

3.3 Physical Habitat Evaluation: Little River

3.3.1 Physical Habitat Evaluation Methods: Little River

Habitat characterization followed low-gradient stream habitat assessment procedures per Barbour et al. (1999). The characterization included visual evaluation of physical habitat and a scoring methodology that allowed a rough comparison of habitat quality among sites. Field forms used for the habitat assessment were taken directly from Barbour et al.

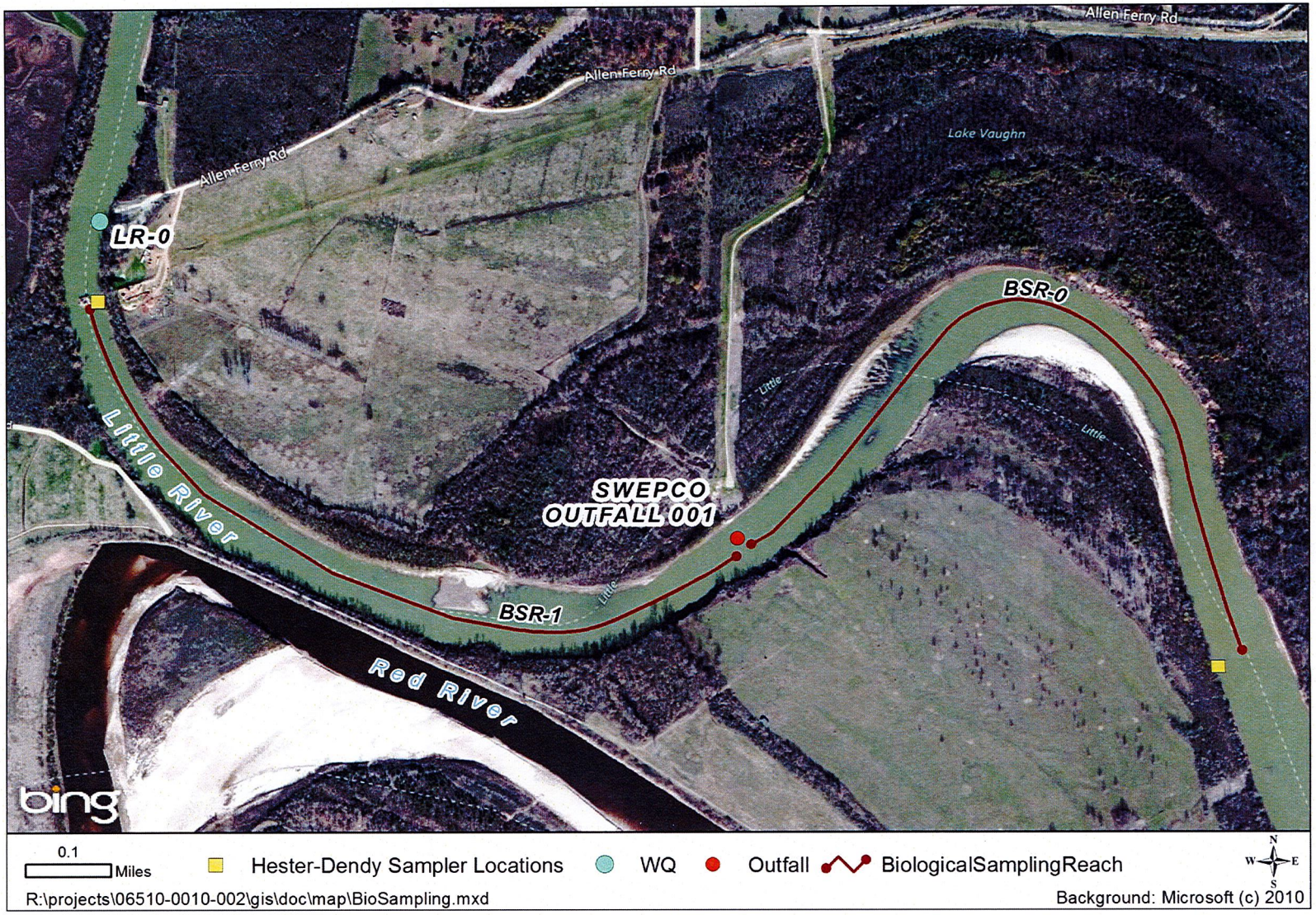


Figure 3.1. Location of the water quality station, HD samplers, and biological sampling reaches (WD collection and fish sampling) on the Little River below the dam on Millwood Lake.

The habitat characterization included the following physical variables:

1. Canopy cover;
2. Substrate type;
3. Sediment characteristics;
4. Dominant aquatic vegetation;
5. Proportion of reach with aquatic vegetation;
6. Pool/riffle ratio;
7. Average depth, width, current velocity;
8. Dominant riparian vegetation; and
9. Watershed features.

Scored habitat variables included the following:

1. Epifaunal substrate/available cover,
2. Pool substrate characterization,
3. Pool variability,
4. Sediment deposition,
5. Channel flow status,
6. Channel alteration,
7. Channel sinuosity,
8. Bank stability,
9. Vegetative protection, and
10. Riparian vegetative zone width.

Assessment of physical and habitat characteristics was performed in reaches upstream and downstream of the discharge during the August 22, 2013, fish sampling event.

3.3.2 Physical Habitat Evaluation Results: Little River

Complete habitat forms are provided in Appendix E. Local land use was primarily pasture and forest. Trees and grasses dominated all riparian zones. Aquatic vegetation was

absent. Stream morphology was 100% deep pool with no canopy, slow current, high turbidity, abundant woody debris, and substrate likely comprised almost entirely of sand (one area in the upstream reach was observed to be comprised of gravel). Within the shallow areas near the shoreline, the substrate odors were normal and no oils were observed. Presence of organic substrate components were not observed due to the depth and turbidity of the water. Scored habitat variables (Table 3.1) indicate relative habitat quality of the upstream versus downstream reaches. Although somewhat subjective, these evaluations are useful for assessing general tends and relationships and detecting large differences in habitat.

Table 3.1. Summary of habitat evaluation performed August 22, 2013.

Category	Upstream	Downstream	Difference Between Upstream and Downstream Locations
Epifaunal Substrate/Available Cover	17	15	2
Pool Substrate Characterization	10	10	0
Pool Variability	15	15	0
Sediment Deposition	17	15	2
Channel Flow Status	18	17	1
Channel Alteration	20	20	0
Channel Sinuosity	6	8	2
Bank Stability	9/7	5/9	4/2
Vegetative Protection	9/5	10/7	1/2
Riparian Vegetative Zone Width	8/2	10/5	2/3
Total Habitat Score	143	146	3

3.3.3 Physical Habitat Evaluation Discussion and Conclusions: Little River

Variability in total habitat scores can be due to small consistent differences among most or all parameters or due to large differences among a few. In general, differences in total habitat scores of approximately 20 points or more can be considered to indicate an actual difference in habitat quality.

Habitat scores indicated very similar habitat in the two biological sampling reaches of the Little River during the August 22, 2013, survey. These habitat assessments indicated deep,

low-velocity pools with epifaunal substrates made up entirely of silt/sand and woody. Woody debris habitats are generally the most available habitat type in lowland systems (ADEQ 2012).

For the purpose of interpreting variability in benthic communities based on habitat quality, the abundance and diversity of benthic macroinvertebrates and fish is expected to follow the same general pattern as habitat quality. Large deviations from this expectation indicate other limiting factors such as water quality. Habitats containing gravel/cobble substrates, which are generally associated with higher diversity, benthic macroinvertebrates were absent. Therefore, the expected macroinvertebrate communities should show relatively low taxa richness and high levels of dominance by tolerant taxa.

3.4 Fisheries Evaluation in the Little River Below Millwood Lake

3.4.1 Benthic Macroinvertebrate Community Evaluation Methods

3.4.1.1 Macroinvertebrate Sample Collection and Processing

One collection effort consisted of deploying HD samplers from July 19 and August 29, 2013. Three replicate samplers were placed approximately one mile upstream of Outfall 001 and three samplers were placed approximately one mile downstream of the outfall (Figure 3.1). Each sampler consisted of 14 round, 75-mm-diameter, 3-mm-thick plates variably separated by nylon spacers and held together with an eyebolt and wingnut. The total surface area of each sampler was approximately 0.4 m^2.

Each sampler was deployed approximately 0.3 m below the water surface by suspending the sampler in parallel orientation from a buoy. The samplers were collected after colonization by gently lifting each sampler out of the water, enclosing it in a plastic bag, and immediately preserving it with 70% ethanol.

Each sampler was cleaned in the laboratory by placing the sampler and the contents of the plastic bag into a sorting tray. The sampler was disassembled and all obvious invertebrates were removed. The surfaces of all sampler parts were then gently scrubbed with a plastic bristle scrub brush in the sorting tray.

A second collection effort (October 22, 2013) focused on WD habitats. At each site (Figure 3.1), a total of 20 submerged sticks with dimensions of 30 cm by 2.3 cm (approximately

0.49 square meter) were collected throughout the entire reach by cutting out sections of the WD below the water surface using limb loppers. The 20 WD pieces were placed into a single plastic bag and immediately preserved with 70% ethanol.

Each sample was cleaned in the laboratory by emptying the plastic bag of its liquid contents into a sorting tray and gently rinsing each WD over the sorting tray using a rinsing bottle. Any loose bark was removed and rinsed over the sorting tray along with the uncovered area of the WD. Once all WD pieces were rinsed into the sorting tray, the plastic bag was rinsed into the sorting tray until all debris was removed. After all WD pieces and the plastic bag were thoroughly rinsed, the WDs were returned to the plastic bag and preserved with 70% ethanol.

Samples from the HD artificial substrates and WD collections were sorted in the laboratory by rinsing the pooled sample in a 500-micron sieve and dispensing the entire sample onto a Caton grid. All organisms were sorted from randomly selected grids until a minimum of 270 organisms were collected. If the whole sample was sorted and the number of organisms fell short of 270, then the whole sample was used. Sorted organisms were transferred to 70% ethanol in glass vials. To assure thorough removal of specimens from the sample, the sorted residue was retained and examined by a second biological technician. If the second sorting produced fewer than 10% of the number of organisms found in the initial sorting, the sorting of that sample was considered complete. If the second sorting produced more than 10% of the number of organisms found in the initial sorting, the sample was resorted until the 10% goal was reached.

Taxonomic identifications were carried out to the lowest practical taxon according to Merritt and Cummins (1996), Thorp and Covich (2001) and Houston (1980). In general, macroinvertebrates were identified to genus except for bivalve mollusks, gastropods, dipteran larvae, and decapod shrimp, which were identified to family. A voucher collection of invertebrate taxa collected at the sites was retained for further reference. Taxonomic identifications in the voucher collection were verified by a second taxonomist and identification discrepancies were resolved.

3.4.1.2 Macroinvertebrate Data Analysis

Field observations indicated that most of the available instream substrate suitable for invertebrate colonization was in the form of woody debris. However, unlike the evaluation of the fish community, there is no readily available data set to be used to develop a list of expected macroinvertebrate taxa for these types of substrates for the Little River. An attempt was made to assess the susceptibility of the existing benthic macroinvertebrate community to a slight increase in TDS. Tolerance indicator values (TIVs) for specific conductance for various invertebrate taxa provided in Carlisle et al. 2007 were reviewed. However, too few of the taxa listed in Carlisle et al. 2007 were present in the data set for this study to allow for a meaningful evaluation of ion tolerance. Accordingly, the benthic data presented herein provide a description of the presently attained fisheries use and a baseline for future studies.

3.4.2 Fish Community Evaluation Methods

3.4.2.1 Fish Sample Collection and Processing

Fish sampling was conducted using a boat-mounted electroshocker on August 22, 2013. Each sampling reach (Figure 3.1) was divided into four sub-reaches:

1. Right bank of the upper half of the sampling reach,
2. Left bank of the upper half of the sampling reach,
3. Right bank of the lower half of the sampling reach, and
4. Left bank of the lower half of the sampling reach.

The electroshocker was operated along the entirety of the shoreline within each sampling sub-reach. One sampling pass was performed on each sub-reach. All fish were placed in an aerated live well upon capture. At the end of the sampling of each sub-reach, all fish were identified to species, measured (total length in inch classes), and counted. After processing, all live fish were returned to the river. Individuals not positively identified in the field were killed, preserved in formalin, and identified in the laboratory.

3.4.2.2 Fish Data Analysis

Fish data were first assessed to determine if there were impacts due to the discharge under current conditions by evaluating differences in total species richness, relative abundance, diversity, and similarity measures between upstream and downstream reaches.

A percent similarity index (Renkonen 1938) and Morisita's index (Morisita 1962) were used to quantify similarity between upstream versus downstream communities and between the pooled species list versus the reference list. The percent similarity index is calculated by standardizing species abundances in each assemblage as percentages and calculating the percent similarity, P, between assemblages j and k, as follows:

$$P_{jk} = \sum_{minimum}(p_{ki}, p_{ji}),$$

where p_{ji} and p_{ki} are the relative abundances of species i in assemblage j and k, respectively, and minimum indicates the smallest of the two relative abundances used in the summation. The percent similarity index varies from 0% to 100%, with 0% indicating no species in common and 100% indicating identical species composition.

The present level of fisheries use attainment was evaluated by pooling all FTN fish data collected in August 2013 with data collected by USGS on June 23, 2009, and August 15, 2013, within the immediate vicinity of the upstream sampling reach. The species list of the pooled data set was then compared to a reference list of species expected to be present based on information from the literature as described below.

If the taxa richness and types species present represent a significant subset of species known to occur in the Little River basin (accounting for factors such as rarity, available habitat, and gear selectivity), then the existing mineral conditions can be said to support the fishery use.

Morisita's index uses the number of individuals (whole numbers) per species. The similarity, C, between assemblages j and k is calculated as follows:

$$C_{jk} = \frac{2\sum X_{ij}X_{jk}}{(\lambda_j+\lambda_k)N_jN_k},$$

Where:

$$\lambda_j = \frac{\sum[X_{ij}(X_{ij}-1)]}{N_j(N_j-1)} \quad \text{and} \quad \lambda_k = \frac{\sum[X_{ik}(X_{ik}-1)]}{N_k(N_k-1)}.$$

The number of individuals of species *i* is given by X_{ij} and X_{ik}, and N_j and N_k are the total number of individuals in assemblage *j* and *k*, respectively. Morisita's index varies from 0 to 1, with 0 indicating no species in common, and 1 indicating identical species composition.

A preliminary reference list of species was compiled by tabulating all fish species shown to inhabit the Little River basin based on species distribution maps and descriptions in Robison and Buchanan (1988). The preliminary reference list was then modified to compile the final reference list by removing species that would not be expected to occur in the habitats of the Little River below Millwood Lake. For example, species preferring headwater streams or fast-flowing water over cobble substrates were removed from the preliminary list. This evaluation was based on habitat preference information provided in Robison and Buchanan (1988). The final reference list of species was then compared to the pooled list obtained from the 2013 sampling. Differences in the number of Little River basin fish species in the pooled species list versus the number of Little River basin fish species in the reference list were statistically analyzed with a chi-square (X^2) test.

Differences between the final reference and pooled lists were evaluated to determine if the differences could be attributed to factors such as habitat preferences, seasonality, rarity or gear selectivity.

3.4.3 Fisheries Evaluation Results

3.4.3.1 Benthic Macroinvertebrates

Invertebrate communities found on the HD and WD substrates are summarized in Table 3.2. Macroinvertebrate data are presented in their entirety in Appendix F.

Table 3.2. Summary of macroinvertebrate communities in the Little River upstream and downstream of the plant discharge from artificial substrates (HD samplers from three locations upstream and downstream) and in situ WD.

Metric	Hester-Dendy								Woody Debris	
	Upstream				Downstream					
	A	B	C	All	A	B	C	All	Upstream	Downstream
Total unique taxa	8	8	7	8	9	8	7	11	4	4
Proportion Chironomidae	0.74	0.84	0.75	0.77	0.83	0.74	0.75	0.77	0.97	0.82
EPT index	0.13	0.12	0.24	0.16	0.11	0.24	0.23	0.19	0.02	0.07
EPT/Chironomidae	0.16	0.14	0.31	0.20	0.13	0.31	0.29	0.24	0.02	0.01

Visual examination of Table 3.2 indicates very similar values for the selected metrics among the different HD replicates and between upstream and downstream locations for both substrate types. Accordingly, for purposes of comparison and discussion, the upstream and downstream data sets were pooled for both substrate types and are summarized in Table 3.3.

Table 3.3. Summary of pooled macroinvertebrate data from both substrate types.

Metric	Hester-Dendy	Woody Debris
Total Unique Taxa	11	6
Proportion Chironomidae	0.77	0.89
EPT index	0.18	0.05
EPT/Chironomidae	0.22	0.02

As shown in Table 3.3, Chironomidae dominated the assemblages on both substrate types. However, the WD substrates contained extremely large numbers of encased Chironomid pupae that could not be removed from the substrate or the casings without destroying the specimens. The Chironomidae counts presented herein for the WD substrates include only individuals that were not encased. Therefore Chironomidae almost completely dominated the WD substrates. In contrast, EPT taxa (only Ephemeroptera and Trichoptera in this case) comprised a significant portion of the HD community. This difference is also reflected in the higher taxa richness on the HD substrates.

3.4.3.2 Fish

Upstream Versus Downstream

The fish communities upstream and downstream were very similar with respect to relative abundance (Table 3.4). Percent similarity between the two sites was calculated at 81.3%. Morisita's similarity index was calculated at 0.96.

Final Reference Versus Pooled Species Lists

The preliminary and final reference lists and supporting information are provided in Appendix G. The final reference and pooled lists are presented in Table 3.5. The pooled list contained 37 of the 52 (71%) of the species found in the reference list. Two additional species were present in the pooled list but were not present on the final reference list. Of the 15 species that were in the reference list but not on the pooled list, three species could be considered rare in this system (American eel, *Anguilla rostrata*; paddlefish, *Polydon spatula*; blackspotted topminnow[2], *Fudulus olivaceus*) and six species are likely to be difficult to capture in deep waters using electrofishing techniques due to their benthic or parasitic habits (shovelnose sturgeon, *Scaphirhynchus platorynchus*; blue sucker, *Cycleptus elongatus*[3]; spotted sucker, *Minytrema melanops*; scaly sand darter, *Ammocrypta clara*; western sand darter, *A. vivax*; chestnut lamprey, *Icthyomyzon castaneus*). Of the remaining four species, one species (grass carp, *Ctenopharyngodon idella*) is introduced, two species (skipjack herring , *Alosa chrysochloris*; striped bass, *Morone saxatilus*) are known to tolerate brackish waters, and one species (green sunfish, *Lepomis cyanellus*) is known to tolerate a wide range habitat and water quality and is probably actually present in the study reaches but escaped capture. The two remaining species that were on the pooled list but not on the reference list were the ghost shiner (*Notropis buchanani*) and the yellow bass (*Morone mississippiensis*).

This analysis shows that based on presence/absence of species, the fish community indicated by the pooled species list closely resembles expectations based on zoogeography, habitat preferences, and gear selectivity.

[2] Intolerant of high turbidity.
[3] Also can be considered rare.

Table 3.4. Summary of fish collections (as percent relative abundance) conducted August 22, 2013.

Species	Sampling Location	
	Upstream	Downstream
Lepisosteus oculatus	0.2	0.7
Lepisosteus osseus	0.5	0.4
Lepisosteus platostomus	0.5	0.3
Amia calva	0.1	0.1
Dorosoma cepedianum	19.0	8.8
Dorosoma petenense	44.0	39.7
Cyprinella lutrensis	0.7	4.5
Cyprinella venusta	4.1	3.5
Cyprinus carpio	0.1	0.1
Hybognathus nuchalis	0.0	0.1
Notropis atherinoides	0.2	0.3
Notropis potteri	3.5	8.9
Pimephales vigilax	6.5	6.9
Carpiodes carpio	6.8	13.3
Ictiobus bubalus	2.3	2.7
Ictiobus cyprinellus	0.5	0.2
Ictalurus furcatus	0.6	1.0
Ictalurus punctatus	0.0	0.2
Noturus nocturnus	0.1	0.0
Pylodictis olivaris	0.5	0.1
Fundulus notatus	0.1	0.1
Gambusia affinis	0.0	0.1
Menidia beryllina	0.3	0.0
Lepomis macrochirus	0.5	0.8
Lepomis megalotis	5.7	3.9
Micropterus punctulatus	0.0	0.3
Micropterus salmoides	1.9	1.6
Pomoxis annularis	0.1	0.1
Percina caprodes	0.6	0.6
*Percina sciera**	0.0	0.1
Percina shumardi	0.1	0.0
Aplodinotus grunniens	0.7	0.8
Total Taxa	**27**	**29**
Total Number	**1,039**	**1,165**
Morisita's Similarity	**0.96**	
Percent Similarity	**81.3%**	

*Typical Gulf Coastal ecoregion indicator species

Table 3.5. Final reference and pooled species lists.

Scientific name	Common name	Final Reference	Pooled
Petromyzontidae	**Lampreys**		
Ichthyomyzon castaneus	chestnut lamprey	Y	N
Ichthyomyzon gagei	southern brook lamprey	N	N
Acipenseridae	**Sturgeons**		
Scaphirhynchus platorynchus	shovelnose sturgeon	Y	N
Polyodontidae	**Paddlefishes**		
Polyodon spathula	paddlefish	Y	N
Lepisosteidae	**Gars**		
Atractosteus spatula	alligator gar	Y	Y
Lepisosteus oculatus	spotted gar	Y	Y
Lepisosteus osseus	longnose gar	Y	Y
Lepisosteus platostomus	shortnose gar	Y	Y
Amiidae	**Bowfins**		
Amia calva	bowfin	Y	Y
Angullidae	**Freshwater Eels**		
Anguilla rostrata	American eel	Y	N
Clupeidae	**Herrings**		
Alosa chrysochloris	skipjack herring	Y	N
Dorosoma cepedianum	gizzard shad	Y	Y
Dorosoma petenense	threadfin shad	Y	Y
Hiodontidae	**Mooneyes**		
Hiodon alosoides	goldeye	N	N
Esocidae	**Pikes**		
Esox americanus	redfin pickerel	N	N
Esox lucius	northern pike	N	N
Esox niger	chain pickerel	N	N
Cyprinidae	**Minnows and Carps**		
Campostoma anomalum	central stoneroller	N	N
Ctenopharyngodon idella	grass carp	Y	N
Cyprinella lutrensis	red shiner	Y	Y
Cyprinella venusta	blacktail shiner	Y	Y
Cyprinella whipplei	steelcolor shiner	N	N
Cyprinus carpio	common carp	Y	Y
Hybognathus nuchalis	Mississippi silvery minnow	Y	Y
Hybopsis amnis	pallid shiner	N	N
Luxilus chrysocephalus	striped shiner	N	N
Lythrurus fumeus	ribbon shiner	N	N
Lythrurus snelsoni	Ouachita mountain shiner	N	N
Lythrurus umbratilis	redfin shiner	N	Y

Table 3.5. Final reference and pooled species lists (continued).

Scientific name	Common name	Final Reference	Pooled
Macrhybopsis aestivalis	speckled chub	N	N
Macrhybopsis storeriana	silver chub	N	N
Notemigonus crysoleucas	golden shiner	N	N
Notropis atherinoides	emerald shiner	Y	Y
Notropis atrocaudalis	blackspot shiner	N	N
Notropis boops	bigeye shiner	N	N
Notropis buchanani	ghost shiner	Y	N
Notropis chalybaeus	ironcolor shiner	N	N
Notropis maculatus	taillight shiner	N	N
Notropis ortenburgeri	Kiamichi shiner	N	N
Notropis potteri	chub shiner	Y	Y
Notropis rubellus	rosyface shiner	N	N
Notropis shumardi	silverband shiner	N	Y
Notropis texanus	weed shiner	N	N
Opsopoeodus emiliae	pugnose minnow	N	N
Phenacobius mirabilis	suckermouth minnow	N	Y
Pimephales notatus	bluntnose minnow	N	N
Pimephales promelas	fathead minnow	N	N
Pimephales tenellus	slim minnow	N	N
Pimephales vigilax	bullhead minnow	Y	Y
Pteronotropis hubbsi	bluehead shiner	N	N
Semotilus atromaculatus	creek chub	N	N
Catostomidae	**Suckers**		
Carpiodes carpio	river carpsucker	Y	Y
Cycleptus elongatus	blue sucker	Y	N
Erimyzon oblongus	creek chubsucker	N	N
Erimyzon sucetta	lake chubsucker	N	N
Ictiobus bubalus	smallmouth buffalo	Y	Y
Ictiobus cyprinellus	bigmouth buffalo	Y	Y
Ictiobus niger	black buffalo	N	N
Minytrema melanops	spotted sucker	Y	N
Moxostoma carinatum	river redhorse	N	N
Moxostoma duquesnii	black redhorse	N	N
Moxostoma erythrurum	golden redhorse	N	N
Ictaluridae	**Bullhead Catfishes**		
Ameiurus melas	black bullhead	N	N
Ameiurus natalis	yellow bullhead	N	N
Ameiurus nebulosus	brown bullhead	N	N
Ictalurus furcatus	blue catfish	Y	Y

Table 3.5. Final reference and pooled species lists (continued).

Scientific name	Common name	Final Reference	Pooled
Ictalurus punctatus	channel catfish	Y	Y
Noturus eleutherus	mountain madtom	N	N
Noturus gyrinus	tadpole madtom	N	N
Noturus nocturnus	freckled madtom	Y	Y
Pylodictis olivaris	flathead catfish	Y	Y
Aphredoderidae	**Pirate Perches**		
Aphredoderus sayanus	pirate perch	N	N
Fundulidae	**Killifishes**		
Fundulus blairae	Blair's starhead topminnow	N	N
Fundulus catenatus	northern studfish	N	N
Fundulus chrysotus	golden topminnow	N	N
Fundulus notatus	blackstripe topminnow	Y	Y
Fundulus olivaceus	blackspotted topminnow	Y	N
Poeciliidae	**Livebearers**		
Gambusia affinis	mosquitofish	Y	Y
Atherinidae	**Silversides**		
Labidesthes sicculus	brook silverside	Y	Y
Menidia beryllina	inland silverside	Y	Y
Moronidae	**Temperate Basses**		
Morone chrysops	white bass	Y	Y
Morone mississippiensis	yellow bass	Y	N
Morone saxatilis	striped bass	Y	N
Centrarchidae	**Sunfishes**		
Ambloplites ariommus	shadow bass	N	N
Lepomis cyanellus	green sunfish	Y	N
Lepomis gulosus	warmouth	N	N
Lepomis humilis	orangespotted sunfish	Y	Y
Lepomis macrochirus	bluegill	Y	Y
Lepomis marginatus	dollar sunfish	N	N
Lepomis megalotis	longear sunfish	Y	Y
Lepomis microlophus	redear sunfish	Y	Y
Lepomis punctatus	spotted sunfish	N	N
Lepomis symmetricus	bantam sunfish	N	N
Micropterus dolomieu	smallmouth bass	N	N
Micropterus punctulatus	spotted bass	Y	Y
Micropterus salmoides	largemouth bass	Y	Y
Pomoxis annularis	white crappie	Y	Y
Pomoxis nigromaculatus	black crappie	N	N

Table 3.5. Final reference and pooled species lists (continued).

Scientific name	Common name	Final Reference	Pooled
Elassomatidae	**Pygmy Sunfishes**		
Elassoma zonatum	banded pygmy sunfish	N	N
Percidae	**Perches**		
Ammocrypta clara	western sand darter	Y	N
Ammocrypta vivax	scaly sand darter	Y	N
Crystallaria asprella	crystal darter	N	N
Etheostoma chlorosomum	bluntnose darter	N	N
Etheostoma collettei	creole darter	N	N
Etheostoma fusiforme	swamp darter	N	N
Etheostoma gracile	slough darter	N	N
Etheostoma histrio	Harlequin darter	N	N
Etheostoma nigrum	Johnny darter	N	N
Etheostoma parvipinne	goldstripe darter	N	N
Etheostoma proeliare	cypress darter	N	N
Etheostoma radiosum	orangebelly darter	N	N
Etheostoma spectabile	orangethroat darter	N	N
Etheostoma stigmaeum	speckled darter	N	N
Etheostoma whipplei	redfin darter	N	N
Percina caprodes	logperch	Y	Y
Percina copelandi	channel darter	N	N
Percina pantherina	leopard darter	N	N
Percina phoxocephala	slenderhead darter	N	N
Percina sciera	dusky dater	Y	Y
Percina shumardi	river darter	Y	Y
Sciaenidae	**Drums**		
Aplodinotus grunniens	freshwater drum	Y	Y

Tolerance Classes of Species in Pooled List

To evaluate the potential impacts of the projected slight increase in mineral concentrations to the Little River fish community downstream of the dam on Millwood Lake, the distribution of ion tolerance classes (tolerant, moderate, intolerant) based on Meador and Carlisle (2007) was evaluated for the pooled list. The results of this analysis are provided in Table 3.6. A total of 29 species in the pooled list were included in the classification provided by Meador and Carlisle (2007). Only one species (green sunfish, *L. cyanellus*[4]) of the 15 species in the final reference list that was not present in the pooled was also listed in Meador and Carlisle (2007). A total of 23 of 27 species in the pooled list are classified as "tolerant" or "moderately tolerant" in Meador and Carlisle (2007), which indicates a fish community that is relatively insensitive to moderate changes in TDS (as indicated by specific conductance).

The pooled fish list was further analyzed to evaluate the distribution of those species classified as intolerant and those for which ion tolerance values were not available in Meador and Carlisle (2003). Information presented in Buchanan et al. (2003) was examined to determine if these species were part of the Red River ichthyofauna. TDS concentrations in the Red River range well above the anticipated TDS concentrations in the Little River due to the operation of the SWEPCO plant (see Section 5 of this document). The presence of these species in the Red River would strongly indicate that the modest increases of TDS in the Little River due to the operation of the SWEPCO plant would support those species in the Little River. Information summarized in Table 3.7 indicates that all except one of the species classified as intolerant or lacking ion tolerance information in Meador and Carlisle (2003) are found in the Red River. This information strongly indicates that the proposed TDS concentration in the Little River will support those species.

Table 3.6. Distribution of tolerance classes (per Meador and Carlisle 2007) among species within the pooled species list.

Expected/Observed	Intolerant	Moderately Tolerant	Tolerant
Fish species expected	5	11	15
Fish species in pooled list	4	10	13

[4] Classified as "tolerant."

Table 3.7. Comparison of fish species classified as "intolerant" from Table 3.7 and not having ion tolerance values in Meador and Carlisle (2007) with their presence in the Red River.

Species	Common Name	Included in Meador & Carlisle (2007)?	Classified as Intolerant in Meador & Carlisle (2007)?	Presence in Red River*
Dorosoma petenense	threadfin shad	Yes	Yes	A
Labidesthes sicculus	brook silversides	Yes	Yes	U
Lepomis macrochirus	bluegill	Yes	Yes	C
Pomoxis annularis	white crappie	Yes	Yes	C
Minytrema melanops	spotted sucker	Yes	Yes	R
Atractosteus spatula	alligator gar	No	NA	R
Cyprinella venusta	blacktail shiner	No	NA	U
Hybognathus nuchalis	Mississippi silvery minnow	No	NA	U
Ictalurus furcatus	blue catfish	No	NA	A
Ictiobus cyprinellus	bigmouth buffalo	No	NA	U
Menidia beryllina	inland silverside	No	NA	A
Notropis potteri	chub shiner	No	NA	A
Noturus nocturnus	freckled madtom	No	NA	U
Percina sciera	dusky dater	No	NA	U
Percina shumardi	river darter	No	NA	U
Lythrurus umbratilis	redfin shiner	No	NA	NC
Notropis shumardi	silverband shiner	No	NA	C

Note: A = abundant (greater than 700 individuals in greater than 60 samples)
C = common (100 to 700 individuals in 25 to 59 samples)
U = uncommon (11 to 99 individuals in 5 to 24 samples)
R = rare (1 to 10 individuals in 1 to 4 samples)
NC = not collected

Ecoregion Key and Indicator Species

The presence and absence of ecoregion key and indicator species per APCEC (2011) is summarized in Table 3.8. Of three key and indicator species expected to be present based on habitat preferences, one species was present in the pooled list. One species not expected to be present (redfin shiner) was present in the pooled list.

Table 3.8. Typical Gulf Coastal Plain ecoregion fish species.

Species Type	Species	Expected in Lower Little River	Present in Pooled List
Key Species	Redfin shiner (*Lythrurus umbratilus*)	N	Y
	Spotted sucker (*Minytrema melanops*)	Y	N
	Yellow bullhead (*Ameiurus melas*)	N	N
	Warmouth (*Lepomis gulosus*)	N	N
	Slough darter (*Etheostoma gracile*)	N	N
	Grass pickerel (*Esox americanus*)	Y	N
Indicator species	Pirate perch (*Aphredoderus sayanus*)	N	N
	Flier (*Centrarchus macropterus*)*	N	N
	Spotted sunfish (*Lepomis punctatus*)	N	N
	Dusky darter (*Percina sciera*)	Y	Y
	Creek chubsucker (*Semotilus atromaculatus*)	N	N
	Banded pygmy sunfish (*Elassoma zonatum*)	N	N

*Not present in Little River basin per Robison and Buchanan (1988).

3.4.4 Discussion and Conclusions

Evaluation of the fish community demonstrated similar fish communities upstream and downstream of the discharge in the Little River. The combined collections from the present study and USGS sampling during 2009 and 2013 provide strong evidence that the existing mineral conditions support a fish community that represents the expected subset of the ichthyofauna of the Little River basin. "Tolerant" and "moderately tolerant" species dominate this community with few "intolerant" fish species present. Ecoregion key and indicator species are generally not expected to be present in the reach of the Little River due to the habitat preferences of those species. The low numbers of key and indicator species present in the pooled list (two species) is a reflection of this expectation. These findings suggest that the attainable designated fisheries use, as indicated by the fish community, is currently attained and is not adversely affected by the existing minerals regime. These findings also suggest that the designated fisheries use in the Little River is currently attained. Evaluation of the mineral tolerances of the existing fish community indicate that the distribution of mineral (TDS) tolerances among the fish taxa present closely matches that of the expected community and that the existing fish community. This finding also indicates a fish community that can be expected to be relatively insensitive to

moderate changes in TDS (as indicated by specific conductance). Fish species that were classified as intolerant to TDS or for which data in Meador and Carlisle (2007) were lacking can be shown to be present in the Red River, which has substantially higher TDS than will be experienced in the Little River due to the operation of the SWEPCO plant. Therefore, the anticipated increase in TDS due to the operation of the SWEPCO plant will support the designated fisheries use, as indicated by the fish community, in the Little River downstream of the Millwood Lake dam.

The macroinvertebrate communities on the HD and WD substrates provide a description of the presently attainable fisheries use and a baseline for future studies.

TDS concentrations under optimal plant operating conditions are projected to exceed the existing site-specific TDS criterion of 100 mg/L, but remain below the value that would represent a "significant modification" of water quality in the Gulf Coastal ecoregion (138 mg/L per §2.511(B) of Regulation No. 2, APCEC 2011). The following weight of evidence supports the conclusion the projected mineral regime and recommended criterion change will support and not impair the designated fisheries use:

1. This system represents an impacted system due to the presence of the dam (see Section 2.4);
2. The species composition of the existing fish community matches expectations based on geography, habitat preferences, and gear selectivity;
3. The projected change in downstream TDS concentrations represents a modest increase in absolute TDS concentrations over existing conditions;
4. The predominance of tolerant and moderately tolerant fish species in the Little River below the dam on Millwood Lake indicates biological communities that should be relatively insensitive to modest increases in TDS due to the operation of the SWEPCO plant; and
5. The toxic threshold for TDS (1,744 mg/L; see Section 4.0) exceeds projected downstream TDS concentrations by more than an order of magnitude.

Based on these observations, the projected increase in TDS concentrations is expected to support and not impair the designated fisheries use.

3.5 Fisheries Evaluation in the Red River

The objective of the evaluation of the Red River fisheries use was to determine whether the existing mineral regime, which will not change due to the discharge, supports the designated fisheries use as indicated by fish populations. The approach was to characterize the existing fish communities and evaluate whether those existing communities, which, by definition, are supported by the existing mineral regime, indicate attainment of the fisheries designated use. This evaluation relied on the following two sources of information:

1. The historical record of mineral concentrations in the Red River as indicated available ADEQ monitoring data from ambient monitoring stations near Index, Fulton, and Garland (ADEQ monitoring stations RED0025, RED0046, and RED0045, respectively) (Figure 1.1); and
2. An extensive sampling survey and historical data review of fish populations in the Arkansas portion of the Red River conducted by Buchanan et al. (2003) (Appendix D).

Buchanan et al. (2003), which is provided in its entirety in Appendix D, sampled 96 locations using a variety of gear and methods on the main stem of the Red River from 1995 through 2001. Buchanan et al. (2003) found that the Arkansas segment of the Red River "has high species richness." They reported that the Arkansas segment of the Red River contains only 11% of the entire river length but holds approximately 67% of the fishes known to inhabit the entire Red River. The results of this survey strongly suggest that mineral conditions present during 1995 through 2001 supported a high level of fisheries use attainment.

Summary statistics for TDS from the study period (1995 through 2001) versus the post-study period (2002 through 2013) are provided in Table 3.9. Visual examination of Table 3.9 indicates that mineral concentrations, as indicated by TDS, were, in general, higher during the Buchanan et al. study than during the period of time since their survey ended. This finding shows that existing mineral concentrations in the Red River will support at least the level of fisheries use attainment shown during the Buchanan et al. survey. Therefore, site-specific mineral criteria that reflect existing conditions will support the attainable fisheries designated use in the Red River.

Table 3.9. Summary of TDS concentrations at three monitoring stations during and after the fish survey performed by Buchanan et al. (2003).

Summary Statistic		TDS at Index (mg/L)		TDS at Fulton (mg/L)		TDS at Garland (mg/L)	
		Study Period	Post-Study Period	Study Period	Post-Study Period	Study Period	Post-Study Period
Percentile	10	427	243	168	123	157	156
	25	632	422	266	184	216	248
	50	720	575	393	382	464	438
	75	912	753	686	579	660	624
	90	1128	905	813	765	802	751
Number of Values		37	70	63	141	63	138
Period of Record		9/20/1995 – 10/21/2001	1/16/2002 – 7/11/2013	4/2/1996 – 12/11/2001	1/2/2002 – 10/22/2013	4/2/1996 – 12/11/2001	1/2/2002 – 10/22/2013

3.6 Biological Evaluation: Summary and Conclusions

3.6.1 Little River

Evaluation of the biological data demonstrated similar fish and benthic macroinvertebrate communities upstream and downstream of the discharge. Therefore, the current discharge is not having discernible adverse effects on the attainment of the designated fisheries use.

The combined collections from the present study and USGS sampling during 2009 and 2013 provide strong evidence that the existing mineral conditions support a fish community that represents the expected subset of the ichthyofauna of the Little River basin. "Tolerant" and "moderately tolerant" species dominate this community with few "intolerant" fish species present, which indicates that a slight increase in TDS concentrations will not adversely affect the fish community.

These findings suggest that the fisheries designated use is currently attained and will not be adversely affected by projected future mineral concentrations.

3.6.2 Red River

Buchanan et al. (2003) demonstrated a high level of fisheries use attainment in the Red River in Arkansas based on fish populations. In general, mineral concentrations were higher during the Buchanan et al. study than during the period of time since their survey ended. This finding shows that existing mineral concentrations in the Red River will support at least the level of fisheries use attainment shown during the Buchanan et al. survey. Therefore, the current

mineral regime in the Red River, including the reach downstream of the mouth of the Little River, will support the attainable fisheries designated use in the Red River.

4.0 TOXICITY ANALYSIS

This section addresses the potential toxicity of elevated mineral concentrations in the Little River due to the discharge. The approach to this evaluation consisted of the following:

1. Evaluate results of whole effluent toxicity (WET) tests conducted as part of routine NPDES biomonitoring to determine if the results indicate any episodes of toxicity that could be attributed to elevated mineral concentrations, and
2. Estimate the toxic threshold of minerals in a mixture of plant effluent and receiving stream spiked with mineral salts to mimic elevated concentrations of minerals.

4.1 Evaluation of Routine WET Testing

A review of all NPDES DMR submittals for routine quarterly WET testing for Outfall 001 indicated no episodes of lethal or sub-lethal toxicity to either *Pimephales promelas* or *Ceriodaphnia dubia* since the effective date (November 1, 2012) of the NPDES permit.

4.2 Spiked Effluent Testing

The objective of this testing was to evaluate the toxic threshold for TDS, sulfate, and chloride in water that simulates the mixture of the SWEPCO plant effluent and the Little River at the critical flow (26% effluent). The approach was to evaluate chronic toxicity to *C. dubia* per EPA (2002) in a series of increasing TDS concentrations in the effluent/receiving stream matrix to identify a threshold for chronic toxicity to *C. dubia.* This threshold sets an upper limit for site-specific mineral criteria because a discharge that is toxic due to mineral concentrations must be avoided.

4.2.1 Methods

A detailed protocol for conducting this test is provided in Appendix H. This protocol describes the selection of target ion concentrations, preparation of test exposures, and additional test measurements. In general, the test was conducted as follows:

1. Target ions and their ratios were selected based on samples of the effluent and receiving stream;
2. Inorganic salts were added to a mixture of 26% effluent plus 74% receiving stream in amounts calculated to produce a solution that was six times the concentration of the TDS (as sulfate, chloride, sodium, magnesium, and calcium ions) in the mixture;
3. This spiked mixture was then used to prepare test exposures by serially diluting the spiked mixture with unspiked mixture using a dilution factor of 0.75;
4. Concentrations of selected ions were measured analytically to verify exposure concentrations and to use in the endpoint calculations; and
5. The no-observed-effect concentration (NOEC) and the concentration inhibiting reproduction by 25% relative to the control (IC25) were calculated for TDS, sulfate, and chloride relative to the performance of the unspiked mixture.

4.2.2 Results

Results of analyses of selected ions in selected test exposures are presented in Table 4.1. Toxicity test results are presented in Table 4.2. Laboratory reports are provided in Appendix I. Average neonate production (and the percent coefficient of variation) and percent survival in the laboratory controls (Table 4.2) indicate satisfactory control performance per EPA (2002). Measurements of in situ test parameters (dissolved oxygen, pH; Table 4.3) indicated that test organism performance (survival and reproduction) was not affected by confounding factors. Measured mineral concentrations in selected test exposures indicated correct preparation of test exposures. Both survival and reproduction showed a monotonically decreasing dose response. Based on these characteristics of test performance, the test results provide a valid estimate of the toxic threshold for dissolved minerals in the matrix of effluent and Little River water.

Table 4.1. Measured concentrations of selected ions in selected test exposures.

% Spiked Mixture	Analyte	Day 1	Day 3	Day 6	Mean
0	Total Alkalinity	140	150	140	143
	TDS	570	630	570	590
	Chloride	78	83	78	80
	Sulfate	130	140	140	137
	Hardness	149	160	160	156
6.25	Total Alkalinity	210	210	210	210
	TDS	990	1,200	960	1,050
	Chloride	140	150	140	143
	Sulfate	310	330	310	317
	Hardness	150	150	150	150
12.5*	Total Alkalinity	335	344	335	338
	TDS	1,249	1,301	1,249	1,266
	Chloride	170	174	170	171
	Sulfate	426	435	435	432
	Hardness	207	216	216	213
25	Total Alkalinity	380	400	400	393
	TDS	2,100	2,400	2,100	2,200
	Chloride	290	310	270	290
	Sulfate	680	690	910	760
	Hardness	150	150	150	150
50*	Total Alkalinity	920	NM	NM	920
	TDS	3,285	NM	NM	3,285
	Chloride	690	NM	NM	690
	Sulfate	1,289	NM	NM	1,289
	Hardness	370	NM	NM	370
100	Total Alkalinity	1,700	NM	NM	1,700
	TDS	6,000	NM	NM	6,000
	Chloride	810	NM	NM	810
	Sulfate	2,500	NM	NM	2,500
	Hardness	610	NM	NM	610

* Concentrations calculated based on measured concentrations and proportion of spike and unspiked mixture used to prepare exposure solution. All units are mg/L. Hardness and total alkalinity reported as mg/L as $CaCO_3$. NM=not measured.

Table 4.2. Summary of toxicity test results and endpoints.

Percent Spiked Mixture	% Survival (n = 10)		Mean Number of Neonates	% CV	Average Mineral Concentration (mg/L)		
	48 hrs	7 days			TDS	Chloride	Sulfate
Unspiked Mixture	100	100	17.3	11.6	590	80	137
6.25	100	100	15.9	13.4	1,050	143	317
12.5	100	90	14.1	42.9	1,266	171	432
25	90	90	11.9*	40.9	2,200	290	760
50	0	0	0**	NA	3,285	690	1,289
100	0	0	0**	NA	6,000	810	2,500
Laboratory Control	100	100	18.2	12.9	NM	NM	NM
Estimated Endpoint Values (mg/L)				IC25	1,744	232	600
				NOEC	1,260	171	432

* Mean number of neonates significantly less than unspiked mixture ($P < 0.05$).
** Survival significantly less than unspiked mixture ($P < 0.05$).
% CV = percent coefficient of variation.

Table 4.3. Summary of in situ test measurements.

Exposure	pH (su)					
	Initial			Final		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Unspiked mix	7.6	7.9	8.2	8.0	8.3	8.5
6.25	7.8	8.2	8.5	8.3	8.5	8.7
12.5	8.3	8.5	8.6	8.5	8.6	8.8
25	8.6	8.7	8.8	8.7	8.8	8.9
50	8.9	8.9	9.0	9.0	9.0	9.0
100	9.0	9.0	9.0	9.0	9.1	9.2
Exposure	DO (mg/L)					
	Initial			Final		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Unspiked mix	7.0	7.7	8.7	7.1	7.9	8.5
6.25	7.0	7.4	7.7	7.1	8.4	7.8
12.5	7.0	7.5	7.8	7.2	7.9	8.4
25	6.9	7.4	7.7	7.1	7.8	8.4
50	7.1	7.5	7.9	7.9	7.9	7.9
100	7.2	7.4	7.6	8.1	8.1	8.1

4.2.3 Conclusions

The calculated IC25 values (1,744 mg/L for TDS; 232 mg/L for sulfate; and 600 mg/L for chloride) indicate that toxicity due to minerals in WET testing would not be expected at the critical dilution (26%) until effluent TDS values reached approximately 6,976 mg/L. These results indicate that the threshold for toxicity due to minerals (as TDS, sulfate, and chloride) is well above anticipated mineral concentrations at the critical dilution of 26%. Accordingly, there is a large margin of safety associated with mineral discharges from the plant with respect to compliance with NPDES WET testing.

5.0 MASS BALANCE MODELING

5.1 Model Description

Steady-state mass balance calculations/models were used to estimate TDS concentrations during critical conditions in the Little River downstream of SWEPCO and in the Red River downstream of the Little River. The Little River concentrations were calculated in a mass balance spreadsheet (Table J.1 in Appendix J), while the Red River concentrations were calculated using the same LA-QUAL model that was used for the total maximum daily loads (TMDLs) that were developed for dissolved minerals in the Red River (FTN 2012). The TMDLs were approved by EPA Region 6 in October 2012.

The LA-QUAL model calculates instream concentrations in the Red River from the OK-AR state line to the AR-LA state line, and in McKinney Bayou and the Sulphur River (tributaries that enter the Red River approximately 65 to 70 miles downstream of the Little River). A schematic diagram of the LA-QUAL model is included as Figure J.1 in Appendix J.

5.2 Critical Flow Conditions

Instream TDS concentrations in the Red River were modeled for two critical flow conditions: 7Q10 and harmonic mean flow. Regulation 2.106 of the Arkansas water quality standards (APCEC 2011; the latest version that is currently approved by EPA) specifies 7Q10 (referred to as "Q7-10" in the standards) as the critical flow for meeting dissolved mineral criteria in streams such as the Little River and Red River that have site-specific criteria that are listed in Regulation No. 2.511 without an asterisk. Harmonic mean flow is the critical flow for meeting chloride, sulfate, and TDS criteria in Louisiana according to Section 1115.C.8 of the Louisiana water quality standards (LDEQ 2012).

Calculations and model results for 7Q10 flow conditions were used to develop proposed criteria for the Little River, and for the Red River between the Little River and the AR-LA state line. The results for harmonic mean flow conditions were used to confirm that the proposed criteria in Arkansas will still allow the Louisiana criterion for TDS in the Red River (780 mg/L) to be maintained.

5.3 Model Inputs for Flows

Flow balances for the Red River are shown in Appendix J (Table J.2 for 7Q10 flow conditions and Tables J.3 through J.5 for harmonic mean flow conditions). The flow balances include the model headwater flow (the Red River at the OK-AR state line), inflow from the Little River upstream of SWEPCO Outfall 001, inflow from specific tributaries and point sources, and diffuse inflow (inflow from surface and subsurface sources distributed along the length of each reach). Calculations used to estimate headwater flow, tributary flow, and diffuse flow are documented in Appendix J.

For the 7Q10 simulation, the flows in the LA-QUAL model were the same as in the 2012 TMDL report with minor corrections and updates described by the four bullets at the bottom of Table J.2. The flow balance for 7Q10 conditions is summarized in Table 5.1.

For harmonic mean conditions, flows were calculated in a manner that was consistent with the flow balance for 7Q10 conditions. Details of the flow balance calculations for harmonic mean conditions are included in Tables J.3 through J.5. The flow balance for harmonic mean conditions is summarized in Table 5.2.

5.4 Model Inputs for TDS

TDS concentrations for ambient inflows (headwaters, tributaries, and diffuse inflow) were estimated based on observed data; these model input values are summarized in Table 5.3. TDS concentrations for point sources were estimated primarily from effluent data or from the 2012 TMDL; these model input values are summarized in Table 5.4. The same input values for TDS concentrations were used for both 7Q10 conditions and harmonic mean conditions.

Table 5.1. Summary of flows used in mass balance for 7Q10 conditions.

Reach	Flow (cfs) from:				Total Flow at Downstream End of Reach (cfs)
	Upstream Reach	Specific Tributaries	Diffuse Inflow	Point Sources	
Red River from OK-AR state line to Little River:					
Red River 11140106-025	1,146 (upstream end of model)	0	3.25	0	1,149.25
Red River 11140106-005	1,149.25	0	2.32	0	1,151.57
Red River 11140106-003	1,151.57	3.69 (Walnut Bayou)	0.58	0	1,155.84
Red River 11140106-001	1,155.84	0	5.29	87.264 (Domtar) + 1.702 (City of Ashdown)	1,250.10
Little River from Millwood Lake dam to Red River:					
Little River	130.15 (just upstream of SWEPCO)	0	0	3.342 (SWEPCO)	133.49
Red River from Little River to AR-LA state line:					
Red River 11140201-011	1,250.10 (Red River) + 133.49 (Little River)	0	1.40	0.077 (City of Fulton) + 0.650 (Tyson River Valley Animal Food)	1,385.72
Red River 11140201-007	1,385.72	1.24 (Bois D'Arc Creek)	1.29	0.116 (City of Garland) + 0.155 (Chieftain Sand)	1,388.52
Red River 11140201-005	1,388.52	0	2.97	0	1,391.49
Red River 11140201-004	1,391.49	1.372 (McKinney Bayou)	0.41	0.004 (Pollution Management) + 1.47 (N. Texarkana)	1,394.75
Red River 11140201-003	1,394.75	23.46 (Sulphur River)	0.33	0 (Int'l Paper)	1,418.54

Table 5.2. Summary of flows used in mass balance for harmonic mean conditions.

Reach	Flow (cfs) from:				Total Flow at Downstream End of Reach (cfs)
	Upstream Reach	Specific Tributaries	Diffuse Inflow	Point Sources	
Red River from OK-AR state line to Little River:					
Red River 11140106-025	4,209.35 (upstream end of model)	0	11.95	0	4,221.30
Red River 11140106-005	4,221.30	0	8.50	0	4,229.80
Red River 11140106-003	4,229.80	13.56 (Walnut Bayou)	2.13	0	4,245.49
Red River 11140106-001	4,245.49	0	19.44	87.264 (Domtar) + 1.702 (City of Ashdown)	4,353.90
Little River from Millwood Lake dam to Red River:					
Little River	1,156.31 (just upstream of SWEPCO)	0	0	3.342 (SWEPCO)	1,159.65
Red River from Little River to AR-LA state line:					
Red River 11140201-011	4,353.90 (Red River) + 1,159.65 (Little River)	0	13.91	0.077 (City of Fulton) + 0.650 (Tyson River Valley Animal Food)	5,528.19
Red River 11140201-007	5,528.19	79.92 (Bois D'Arc Creek)	12.82	0.116 (City of Garland) + 0.155 (Chieftain Sand)	5,621.20
Red River 11140201-005	5,621.20	0	29.46	0	5,650.66
Red River 11140201-004	5,650.66	91.276* (McKinney Bayou)	4.09	0.004 (Pollution Management) + 1.47 (N. Texarkana)	5,747.50
Red River 11140201-003	5,747.50	728.88* (Sulphur River)	3.27	293.5 (Int'l Paper)	6,773.15

* See Tables J.3 – J.5 for details concerning ambient flows for McKinney Bayou and Sulphur River.

Table 5.3. TDS concentrations for ambient inflow in mass balance.

Inflow	TDS Concentration (mg/L)	Data Source / Comment for TDS
Red River at OK-AR state line	891	90th percentile of ADEQ data at RED0025 (Red River south of Foreman)
Diffuse inflow to Red River between OK-AR state line and Little River	296.6	Same as 2012 TMDL – average of ADEQ data at RED0064 (Walnut Bayou near Foreman)
Walnut Bayou (tributary to Red River)	296.6	Same as 2012 TMDL – average of ADEQ data at RED0064 (Walnut Bayou near Foreman)
Little River upstream of SWEPCO	98	90th percentile of data collected by SWEPCO and FTN in Little River upstream of SWEPCO during October 2010 through October 2013
Diffuse inflow to Red River between Little River and AR-LA state line	183.5	Same as 2012 TMDL – average of ADEQ data at UWBDK02 (Bois D'Arc Creek)
Bois D'Arc Creek (tributary to Red River)	183.5	Same as 2012 TMDL – average of ADEQ data at UWBDK02 (Bois D'Arc Creek)
Headwater and diffuse inflow for McKinney Bayou (tributary to Red River)	296.6	Same as 2012 TMDL – average of ADEQ data at RED0064 (Walnut Bayou near Foreman)
Sulphur River (tributary to Red River) at TX-AR state line	145.5	Same as 2012 TMDL – average of Texas Commission on Environmental Quality (TCEQ) measurements from Sulphur River at Highway 59 bridge (TCEQ station 10212)
Diffuse inflow to Sulphur River	219	Same as 2012 TMDL – average of ADEQ data at RED0004A (Days Creek southeast of Texarkana)
Days Creek (tributary to Sulphur River)	219	Same as 2012 TMDL – average of ADEQ data at RED0004A (Days Creek southeast of Texarkana)

Table 5.4. TDS concentrations for point sources in mass balance.

Facility	Flow (MGD)	TDS Concentration (mg/L)	Data Source / Comment for TDS
Domtar	56.4	1,638	95th percentile of quarterly discharge monitoring report (DMR) data from 4th quarter 2008 through 3rd quarter 2013
City of Ashdown	1.1	540	Same as 2012 TMDL
SWEPCO	2.16	1,620	Recent estimate by SWEPCO personnel of effluent TDS concentration based on an intake concentration of 98 mg/L (90th percentile of values in Little River upstream of SWEPCO) and full operation of the facility with cycling of cooling water as designed
City of Fulton	0.05	500	Same as 2012 TMDL
Tyson River Valley Animal Food	0.42	2,000	95th percentile of monthly effluent data from August 2008 through September 2013
City of Garland	0.075	500	Same as 2012 TMDL
Chieftain Sand	0.1	500	Same as 2012 TMDL
Pollution Management (discharges to McKinney Bayou)	0.003	480	Same as 2012 TMDL
North Texarkana WWTP (discharges to McKinney Bayou)	0.95	480	Same as 2012 TMDL
International Paper Texarkana (discharges to Sulphur River)	0 for 7Q10; 189.7 for harmonic mean	855	Maximum effluent concentration that will allow current TDS criterion to be maintained in Sulphur River in Arkansas with discharge at 100% of upstream flow

5.5 Model Results for 7Q10 Conditions

The TDS concentrations predicted by the model for 7Q10 conditions are summarized and compared with statistics for long-term monitoring data in Table 5.5. Detailed model output for 7Q10 conditions is shown in Appendix K. In order for the modeling to be an appropriate representation of the existing instream mineral regime, the predicted concentrations for critical conditions should be no higher than the 95th percentile of long-term monitoring data. For the Little River, this comparison cannot be made because there are no long-term monitoring data that have been collected downstream of SWEPCO's discharge. For the Red River, the predicted TDS concentrations were less than the 95th percentile of observed values for each of the long-term monitoring stations except RED0046 (Red River at Fulton) and RED0009 (Red River near Doddridge) (see Figure 1.1 for locations of monitoring stations).

Neither the RED0046 data nor the RED0009 data were considered to be a good representation of well-mixed concentrations in the Red River. Both the RED0046 station and the RED0009 station are located in places where the Red River does not appear to be laterally well-mixed due to significant tributary inflows a short distance upstream of each station. Lateral gradients at these monitoring stations are likely created by inflows from the Little River (RED0046) and the Sulphur River (RED0009). In some instances, these lateral gradients can be observed from aerial photographs. According to a station description report from EPA's Legacy STORET web site, the RED0046 station is sampled at a railroad bridge pier on the east side of the river (i.e., the left bank), which is the same side of the river that the Little River enters. The RED0009 station is sampled at a boat ramp on the west side of the river, which is the same side of the river that the Sulphur River enters. Therefore, both the RED0046 data and the RED0009 data are likely measuring a disproportionate percentage of tributary water that has not mixed completely with the entire flow of the Red River. Both tributaries (especially the Little River) contribute water that typically has TDS concentrations much lower than concentrations in the Red River. Therefore, the data at these two stations appear to be underestimating the TDS concentrations in the Red River and should not be used for comparison with predicted TDS values from the mass balance modeling.

Table 5.5. Predicted TDS values for 7Q10 conditions and comparison to observed values.

Reach	Range of Predicted TDS Concentrations (mg/L)	Statistics from Long-Term Monitoring Data (mg/L)
Red River from OK-AR state line to Little River:		
Red River 11140106-025	891.0 at upstream end, 889.3 at downstream end	--
Red River 11140106-005	889.3 at upstream end, 888.1 at downstream end	891 = 90th percentile 958 = 95th percentile (based on data for Red River south of Foreman [RED0025] during September 1990 – October 2013)
Red River 11140106-003	886.2 at upstream end, 885.9 at downstream end	--
Red River 11140106-001	885.9 at upstream end, 938.3 immediately below Domtar, 935.5 at downstream end	933 = 90th percentile 1,047 = 95th percentile (based on data for Red River at Index (07337000) during August 1990 – July 2013)
Little River from Millwood Lake dam to Red River:		
Little River	136.1 below SWEPCO	No long-term data exist downstream of SWEPCO
Red River from Little River to AR-LA state line:		
Red River 11140201-011	856.5 at upstream end, 858.6 immediately below Tyson River Valley Animal Food, 858.3 at downstream end	804 = 90th percentile 834 = 95th percentile (based on data for Red River at Fulton [RED0046] during April 1996 through October 2013)
Red River 11140201-007	857.7 at upstream end, 857.0 at downstream end	778 = 90th percentile 860 = 95th percentile (based on data for Red River near Garland [RED0045] during April 1996 through October 2013)
Red River 11140201-005	857.0 at upstream end, 855.5 at downstream end	--
Red River 11140201-004	854.6 at upstream end, 854.4 at downstream end	--
Red River 11140201-003	843.2 at upstream end, 843.1 at downstream end	657 = 90th percentile 770 = 95th percentile (based on data for Red River near Doddridge [RED0009] during September 1990 through October 2013)

Because the predicted TDS concentrations were less than the 95th percentile of long-term monitoring data at stations with representative data, the model results were considered appropriate values for proposed criteria.

5.6 Model Results for Harmonic Mean Conditions

As mentioned above, the reason for simulating harmonic mean conditions was to confirm that proposed TDS criteria for the Red River in Arkansas would allow the Louisiana criterion for TDS in the Red River to be maintained under critical conditions. For the harmonic mean simulation (which used the same input TDS concentrations as the 7Q10 simulation), the predicted TDS concentration at the AR-LA state line was 661 mg/L, which is well below the Louisiana criterion for TDS in the Red River (780 mg/L). Therefore, proposed criteria based on the mass balance modeling for this study will be protective of the Louisiana criterion for TDS in the Red River.

Detailed model output for harmonic mean conditions is shown in Appendix L.

5.7 Proposed Criteria

Based on the mass balance calculations and LA-QUAL model results described above, as well as the weight of evidence discussed throughout this UAA report, the following TDS criteria are proposed:

- 138 mg/L for the Little River from Millwood Lake dam to the Red River, and
- 860 mg/L for the Red River from the Little River to the AR-LA state line.

A value greater than 138 mg/L is the TDS concentration that would be classified as a "significant modification" from the Gulf Coastal Plain ecoregion reference stream TDS value of 123 mg/L as described in Regulation No. 2.511(B) (APCEC 2011). The Little River mass budget calculations showed that the expected TDS concentrations in the Little River under critical conditions should be less than 138 mg/L (Table J.1). This criterion is being proposed not just for the portion of the Little River downstream of SWEPCO, but for the Little River from the Millwood Lake dam to the confluence with the Red River. The revised TDS criterion is needed

upstream of SWEPCO because that portion of the stream could be listed as impaired in the future if the criterion is not changed. TDS data collected upstream of SWEPCO by FTN and SWEPCO personnel during October 2010 through October 2013 showed values exceeding the current criterion (100 mg/L) approximately 10% of the time.

For the Red River, the value of 860 mg/L is the proposed TDS criterion for the entire distance from the Little River to the AR-LA state line. In previous UAAs, proposed criteria for dissolved minerals are often decreasing in the downstream direction due to dilution along the length of the stream. However, there is little dilution to the Red River between the Little River and the AR-LA state line during 7Q10 conditions. The predicted TDS concentrations in the Red River for 7Q10 conditions did not decrease much from just downstream of the Little River (about 859 mg/L) to the AR-LA state line (about 843 mg/L). Therefore, the same TDS criterion is proposed for the entire distance of the Red River from the Little River to the AR-LA state line.

6.0 DESIGNATED USES

This section evaluates the designated uses in the Little River and the Red River in the presence of the SWEPCO plant discharge.

6.1 Little River

6.1.1 Primary and Secondary Contact Recreation

Mineral content of surface water is not typically a relevant parameter used to consider the attainability of contact recreation uses. Therefore, current TDS concentrations should have no effect on the attainability of these uses.

6.1.2 Domestic Water Supply

The Little River is designated as a domestic water supply, and the designated use is also an existing use. The City of Hope water supply withdrawal point is located on the Little River downstream of the Millwood Lake dam and upstream of the SWEPCO plant cooling water intake (see Figure 1.1).

6.1.3 Industrial Water Supply

Current TDS concentrations do not affect the attainability of this use.

6.1.4 Agricultural Water Supply: Crops

The most commonly used guideline for salinity tolerance of crops is Ayers and Westcot (1985). In this document, yield potentials for a number of crops are associated with soil and water salinity values measured as electrical conductance. Salinity values associated with yield potentials for cotton, soybeans, and rice are summarized in Table 6.1. The water salinity (ECw) values reported in Ayers and Westcot (1985) have been calculated from the soil salinity (ECe) values reported (ECw = ECe/1.5). TDS values shown in Table 6.1 were calculated from the conductivity values (TDS = 650*conductivity). The highest calculated TDS value in the Little River (see Section 5.0) is less than 138 mg/L, which indicates that no adverse effects would be

expected related to crop productivity if the Little River water was used for crop irrigation. The US Salinity Laboratory (US Department of Agriculture, Agricultural Research Services) has calculated linear regressions of irrigation water salinity (measured as the conductivity) to relative rice yield measurements based on experiments conducted in the late 1990s (Zeng and Shannon 2000). These relationships are based on the response of rice to sodium chloride (NaCl) solutions of various strengths that were used for irrigation in the experiments. Table 6.2 shows irrigation water conductivities for relative yields of grain weight per panicle and grain weight per plant that correspond to the yield potentials that are shown in Table 6.1. These values were calculated using Zeng and Shannon's (2000) linear regression equations. TDS values in Table 6.2 are calculated using the same equation as Table 6.1 values. The linear regression relationships developed by the US Salinity Laboratory indicate that a TDS concentration (due primarily to NaCl) of 1,000 mg/L could reduce rice productivity by approximately 10%. Tacker et al. (2001) also report that irrigation water with conductivity greater than 1.2 dS/m (approximately 780 mg/L TDS) is borderline for use on rice. The University of Arkansas Cooperative Extension Service reports that TDS levels greater than 770 parts per million (ppm) in irrigation water for rice are cause for concern.

Table 6.1. Influence of soil salinity (ECe) and irrigation water salinity (ECw) on crop tolerance and yield potential of selected crops (Ayers and Westcot 1985).

Crop	Parameter	100% yield		90% yield		75% yield		50% yield		0% yield	
		ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw
Cotton	Cond, dS/m	7.7	5.1	9.6	6.4	13	8.4	17	12	27	18
	TDS, mg/L	--	3,315	--	4,160	--	5,460	--	7,800	--	11,700
Rice	Cond, dS/m	3	2	3.8	2.6	5.1	3.4	7.2	4.8	11	7.6
	TDS, mg/L	--	1,300	--	1,690	--	2,210	--	3,120	--	4,940
Soybean	Cond, dS/m	5	3.3	5.5	3.7	6.3	4.2	7.5	5	10.	6.7
	TDS, mg/L	--	2,145	--	2,405	--	2,730	--	3,250	--	4,355

Table 6.2. Irrigation water salinity for selected relative rice yield measurements calculated using US Salinity Laboratory linear regression equations (Zeng and Shannon 2000).

Yield Measurement	Parameter	Percent Yield				
		100	90	75	50	0
Grain weight per panicle [(a)]	Conductance (dS/m)	0.49	1.71	3.54	6.59	12.68
	TDS (mg/L)	317	1,110	2,299	4,280	8,244
Grain weight per plant [(b)]	Conductance (dS/m)	0.46	1.52	3.12	5.78	11.10
	TDS (mg/L)	297	989	2,026	3,755	7,212

Notes:
(a) ECw = (1.040 – relative yield)/0.082, r^2=0.87
(b) ECw = (1.043 – relative yield)/0.094, r^2=0.83

This information indicates that the Little River downstream from the SWEPCO outfall is suitable for irrigation, so the existing or proposed TDS criteria will not affect the attainability of the agricultural water supply use.

6.1.5 Agricultural Water Supply: Livestock

There are no published guidelines for salinity/TDS in pasture irrigation water (personal communication, Bryce Baldridge, University of Arkansas Extension Agent, Lawrence County, University of Arkansas Extension Service, Walnut Ridge, Arkansas). However, field observations indicate that at least some of the land adjacent to the Little River is used as cattle pasture. This information indicates that these aspects of the agricultural water supply use are currently attained in the Little River.

6.1.6 Fisheries

Attainability of the fisheries designated use is addressed in Section 3.0 of this document.

6.2 Red River

6.2.1 Primary and Secondary Contact Recreation

Mineral content of surface water is not typically a relevant parameter used to consider the attainability of contact recreation uses. Therefore, current TDS concentrations should have no effect on the attainability of these uses.

6.2.2 Domestic Water Supply

The domestic water supply use for the reach of the Red River between the OK-AR state line and the Little River confluence has been removed based on a previous study (AquAeTer 1994) that showed the use to be neither an existing nor attainable use due to naturally occurring elevated dissolved minerals concentrations (see Section 2) that exceed secondary drinking water standards. Similarly, the reach of the Red River from the Little River confluence to the AR-LA state line can also be expected to exceed secondary drinking water standards due to the same factors. Figure 6.1 shows that the Red River TDS concentrations at Fulton (downstream of the mouth of the Little River) frequently exceeded the secondary drinking water standard of 500 mg/L during the POR after November 28, 1975, and documents that the domestic water supply use is not attainable in the reach of the Red River downstream of the Little River. TDS concentrations at Index (from Legacy STORET and USGS) from June 1959 through July 2013 (Figure 6.2) show that the Red River TDS concentrations at Index (upstream of the mouth of the Little River) frequently exceeded the secondary drinking water standard of 500 mg/L during the POR before and after November 28, 1975. Since the monitoring station at Index is upstream of the station at Fulton, it is safe to conclude that TDS concentrations at Fulton exceeded the secondary drinking water standard for TDS of 500 mg/L prior to November 28, 1975, as well. Coordination was performed with the Arkansas Department of Health and the Arkansas Natural Resource Commission to confirm that the stream is not used as an existing domestic water supply (see Appendix M). Therefore, the domestic water supply use is neither an existing nor attainable use in the Red River downstream of the mouth of the Little River.

This analysis supports the removal of the domestic water supply use for the Red River downstream of the mouth of the Little River per the provisions of 40 CFR 131.10(g)(a).

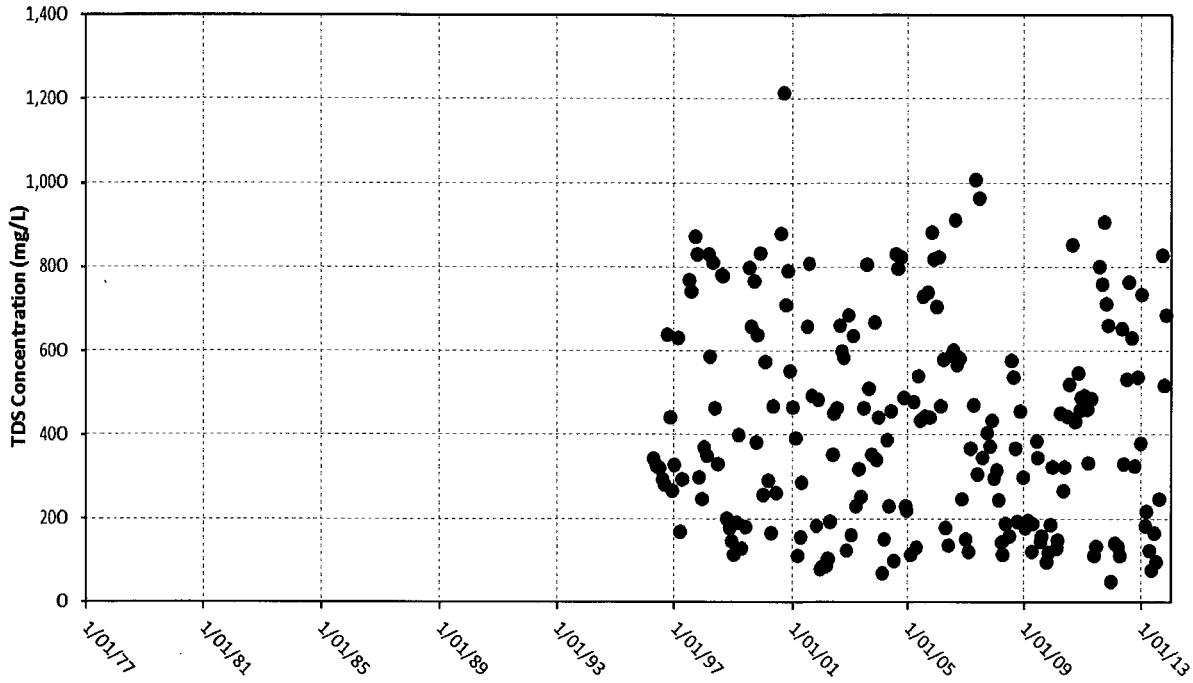


Figure 6.1. Time-series plot of TDS concentrations in the Red River near Fulton, AR.

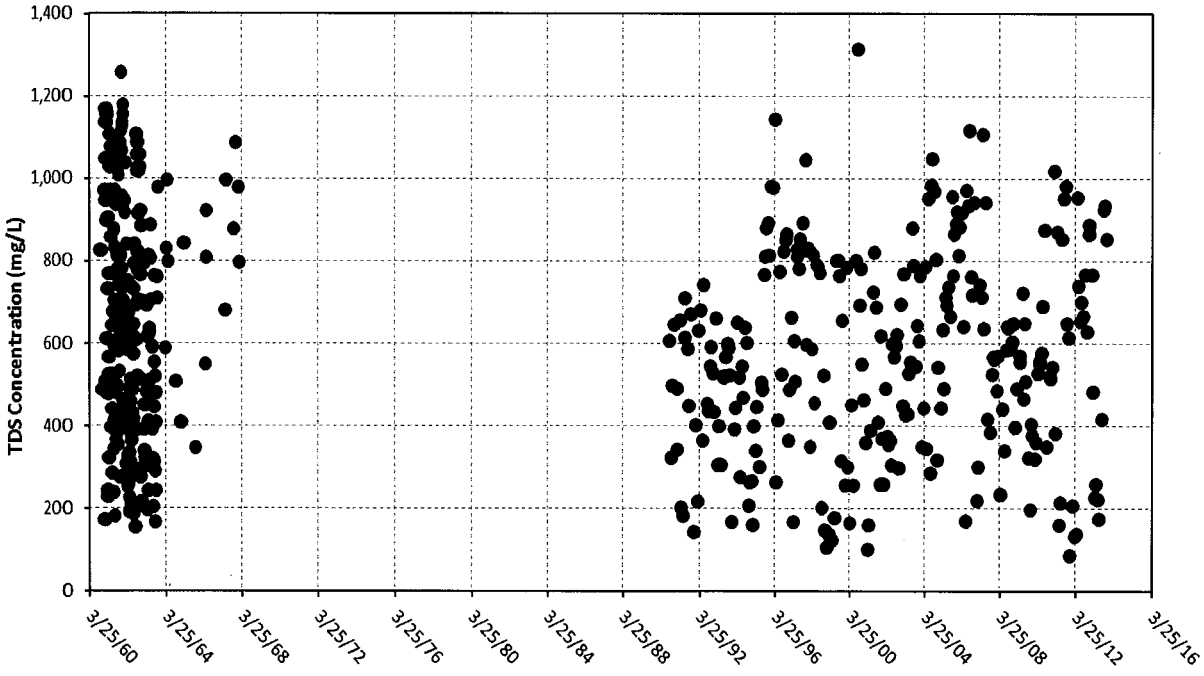


Figure 6.2. Time-series plot of TDS concentrations in the Red River near Index, AR.

6.2.3 Industrial Water Supply

Current TDS concentrations do not affect the attainability of this use.

6.2.4 Agricultural Water Supply: Crops

Section 6.1.4 introduces data on salinity tolerance of crops. Salinity values associated with yield potentials for cotton, soybeans, and rice are summarized in Table 6.1. The average TDS concentration for the Red River (860 mg/L; see Section 5.0) is below the calculated irrigation water TDS values summarized in Table 6.1, thus indicating that effluent TDS would not be expected to negatively affect crop productivity. Table 6.2 shows irrigation water conductivities for relative yields of grain weight per panicle and grain weight per plant that correspond to the yield potentials that are shown in Table 6.1.

The minerals levels in the Red River are principally due to upstream sources in Oklahoma and Texas (Section 2.3.2). As discussed in Section 1.1, the SWEPCO effluent will have a negligible effect on these existing concentrations. The data from the Ayers and Westcot study (1985) suggest that Red River TDS values should not affect crops if the water was used for irrigation. However, the data from Zeng and Shannon (2000), Tacker et al. (2001), and the University of Arkansas Cooperative Extension Service suggest that the Red River water may not be suitable for rice crop irrigation. However, the discharge itself will not affect the attainability of this use.

6.2.5 Agricultural Water Supply: Livestock

There are no published guidelines for salinity/TDS in pasture irrigation water (personal communication, Bryce Baldridge, University of Arkansas Extension Agent, Lawrence County, University of Arkansas Extension Service, Walnut Ridge, Arkansas). However, field observations indicate that at least some of the land adjacent to the Red River is used as cattle pasture. This information indicates that these aspects of the agricultural water supply use are currently attained in the Red River.

6.2.6 Fisheries

Attainability of the fisheries designated use is addressed in Section 3.0 of this document.

6.3 Conclusions

All the designated uses for the Little River appear to be both existing and attainable uses based on the UAA study and the literature review to evaluate potential agricultural water supply uses.

Upstream, naturally occurring sources of minerals to the Red River technically preclude the designated domestic water supply use from becoming an attainable use. Research shows that the use of the Red River water for rice irrigation may or may not fully support this specific agricultural use. All other designated uses (i.e., primary and secondary contact recreation, industrial water supply, agricultural water supply for livestock and other crops) are existing and attainable based on this study and information available from the literature.

The attainability of the fisheries designated uses for both the Little River and Red River is discussed in Section 3.0.

7.0 ALTERNATIVES EVALUATION

UAA guidance and the Arkansas CPP (page IX-7, items 3a and 3c) require that a petition to increase dissolved minerals concentrations above existing conditions must include an evaluation of alternatives to the direct discharge of the water. These alternatives are evaluated for technical and economic considerations. Based on a number of similar evaluations in previous UAAs, the alternatives for management of effluents with elevated dissolved minerals are limited. Four alternatives that have been reviewed for other UAAs include the following:

1. Distillation treatment,
2. Treatment using a constructed wetland,
3. Pumping the wastewater to a larger stream that holds the potential for dilution of the minerals, and
4. Reverse osmosis (RO) treatment of the wastewater.

FTN has completed this current evaluation of alternatives based on previous experience, information from published literature, and from data provided by the facility.

Based on preliminary screening of these four options, the use of RO for feedwater with an initial concentration of 30,000 mg/L or less is generally preferable to the use of distillation processes. In any case, there are no economic benefits with the distillation technology compared to the RO process. Therefore, RO will be evaluated for this application.

Constructed wetlands can be dismissed as an option for this facility. Constructed wetlands can only be used to reduce sulfate, which results in the production of bicarbonate in place of sulfate (Hedin et al. 1989). Although a constructed wetland could, in principle, reduce sulfate in the discharge from this facility, the resulting TDS concentration would not be decreased (due to the replacement of the sulfate ions with bicarbonate ions) and no net benefit would be obtained. TDS is the only concern for this evaluation.

Given these considerations, there are two basic alternatives for achieving compliance with the existing Arkansas water quality criteria for the Little River and Red River:

1. RO treatment to remove or reduce dissolved minerals, and
2. Pumping the SWEPCO effluent to a larger river that holds the potential for dilution of the minerals.

Given the location of the SWEPCO plant in west Arkansas, there is not a river in the vicinity that could be used as dilution to completely avoid a change in the water quality standards. The Red River downstream of the Little River has a TDS criterion of 500 mg/L. However, the expected concentration of TDS in the effluent from this facility would not meet the Red River TDS criterion and would still require the completion of a UAA or the installation of partial RO treatment. The latter alternative will be considered as part of the following evaluation.

With the above considerations, it has been determined there are three variations of the alternatives listed above (in addition to the option of direct discharge to the Little River with the approval of a site-specific TDS criterion) that could be used depending on the specific effluent limitations that are currently in effect or that could be implemented.

Option 1: RO Treatment/Discharge to Little River at Current Effluent Limits

The current effluent limitation for TDS in the Little River is 500 mg/L. A single-stage RO treatment system is capable of treating the water to below 100 mg/L. Thus, a system could be installed to treat a portion of the flow with some blending to achieve the 500-mg/L value.

Option 2: RO Treatment/Discharge to Little River at Future Effluent Limits

It is anticipated that the TDS criterion for the Little River, and thus the effluent limitations in future NPDES permits for the SWEPCO plant, could be lowered to 100 mg/L. This would require that all of the effluent be treated through an RO system.

Option 3: RO Treatment/Discharge to Red River

The third alternative would be to route the effluent to the Red River and apply RO to meet the current 500-mg/L TDS criterion with the SWEPCO plant operating under design conditions. This option could potentially become feasible if the water quality criterion for TDS in the Little River were lowered and if full treatment (Option 2) was not feasible. In this case, due to the 500-mg/L effluent limitation for TDS that would be required for a direct discharge to the Red River, only a portion of the effluent would need to be treated with RO. In terms of treatment, this option is similar to Option 1. However, an extension of the pipeline that currently transports the SWEPCO effluent to the Little River via Outfall 001 would have to be constructed.

These three options are the only ones that have been identified to achieve compliance with the existing water quality standards. These options will be compared with the option for implementing revised site-specific criteria for dissolved minerals in the Little River and/or the Red River.

7.1 TDS Treatment Through Reverse Osmosis

7.1.1 Technical Considerations

Wastewater technologies, such as conventional precipitation, can efficiently remove the heavy metals from wastewater to meet the effluent requirements. However, these systems do not remove dissolved compounds like sulfate and TDS. As a result, the effluent flow from the treatment plant is limited by the dilution of the flow in the receiving stream to reduce these constituents to acceptable concentrations.

RO is an advanced water/wastewater treatment process capable of removing dissolved contaminants such as TDS, sulfate, and chloride. While technically not a filtration process, the contaminants are removed as highly pressurized feed water flows across a membrane, with a portion of the flow, identified as "permeate," going through the membrane. The rest of the feed is called "concentrate" or "reject" because it carries off the concentrated contaminants rejected by the membrane. The concentrate volume depends on many factors and can vary between 10% to 40% of the feed. Depending on the size of the pores in the membrane, the process results in different classes of separation. For the removal of dissolved solids, a membrane capable of

rejecting elemental-sized particles must be utilized. Thus, reverse osmosis membrane systems are the only filtration-type system that can reduce dissolved solids.

Based on the information available from equipment manufacturers, RO is a possible alternative treatment for effluent to meet the limits for TDS. The permeate from a system of this type generally has a TDS value below 100 mg/L. This is considered a high-quality water and would meet downstream Arkansas water quality criteria in the process.

The cost of installing a RO membrane system, as well as the cost of operation (i.e., electricity, membrane cleaning, etc.) is high. The costs of operation (primarily for pumping to achieve the high necessary pressure) and maintenance are also high. The most common maintenance problem involves the tendency for membrane fouling when applied to concentrated waste streams.

Despite the comparatively high initial and maintenance costs of RO, the disposal of the concentrated brine generated by this process is a more significant issue. Unless there is a convenient location for the disposal of brine (e.g., the ocean), this factor alone often discourages the selection of RO (or distillation processes) for applications involving pollution control. RO separates the dissolved parameters from the water but does not chemically alter their state to other non-polluting compounds. Thus, the concentrate, or brine, requires disposal by other methods.

A review of the options available for disposal of the brine solution is an important part of the overall alternatives analysis. Based on past experience, the options for disposal include the following:

1. Solidification and disposal onsite,
2. Transport offsite for stabilization prior to landfilling,
3. Transport offsite to a municipal or industrial wastewater treatment system with a large river or seawater outfall, and
4. Transport offsite to a deep-well injection facility.

The waste brine solution is not considered a hazardous waste in Arkansas. However, the land application or the discharge to a surface waterbody of the brine solution in the quantities

that would be generated at this facility is not considered a viable alternative due to permitting issues. Given the mass of constituents involved, neither land application or direct discharge of brine is likely to be approved by the regulatory agencies without significant treatment (again, using RO or distillation).

Establishing an onsite disposal unit is also problematic from an environmental permitting viewpoint, as will be discussed below. For the remaining alternatives, transportation is a critical factor.

7.1.1.1 Stabilization/Landfill

The concentrate could be stabilized onsite, using a cementitious element such as Portland cement or fly ash. This would require the construction of a mixing facility, purchase of the cementitious agent, crews, and equipment to mix the waste solution, regulatory authority to dispose of the waste onsite, and engineering support for selection and operation of a disposal area. The critical and unknown costs for this option are the mixing ratio for the waste solution/stabilization agent, and any required environmental protection controls for the disposal area. The mixing ratio determines the tonnage necessary for purchase of the stabilizing agent. Final disposal could be achieved with an existing local landfill or the permitting and installation of a landfill by the facility. A landfill of this type would require liners and caps, and would be subject to stringent regulatory oversight.

Some commercial landfill operations currently offer dewatering capability through a stabilization process, similar to that described above. There is a minimum amount of regulatory approval required by the generator when the waste is removed to a commercial offsite facility.

7.1.1.2 Offsite Treatment/Discharge

The wastewater could be transported offsite by truck to an industrial or municipal wastewater treatment facility. It would be necessary to provide waste profile information to each facility to obtain cost information. For treatment and discharge, the treatment facility would need to be located at a site with capabilities for discharging to a large waterbody. The critical cost component would be the cost of transportation and the cost per disposal on a per-gallon basis.

7.1.1.3 Deep-Well Disposal

Most of the saltwater brine generated in Arkansas, whether from the brine industry in south Arkansas or water from the gas- and/or oil-drilling operations, is disposed in deep-well injection sites. There are many commercial operations operating in the state for this purpose.

7.1.2 Economic Considerations

The evaluation of costs for the different options involves establishing a set of criteria for treatment and flow rates. The initial wastewater analysis and the design flow requirements are primary considerations in the sizing and cost of the equipment. In general, the criteria and flow are the same with each option unless the goal of the option changes the basic assumptions. For instance, with Option 1, an effluent limit for TDS of 500 mg/L must be achieved while with Option 2 the goal would be to achieve 100 mg/L. With each option analyzed below, the flow and criteria are described. Calculations are made based on these data and assumptions.

Since each option includes RO, certain general statements and assumptions about RO are applicable to all three options.

For each option, the cost information is based upon a single-pass, three-stage RO system, capable of concentrating the reject water to about 1/100 of its original volume. The concentrate could be stored in an onsite holding tank.

The capital costs of installing an RO treatment system have been estimated by USACE (1998) to range from $1.44 to $2.13 per gallon per day. This is for a single-stage RO unit. For a three-stage RO unit, designed to concentrate the reject water, it is estimated that the costs would increase by a factor of 1.5. The costs were developed by USACE (1998) for a typical brackish water application in Florida. These values are widely cited in the literature, and although dated, are still considered adequate for a comparison of alternatives. Over this time period (since the mid-1990s), the cost of RO membranes has been reduced. However, the cost of ancillary equipment (i.e., equipment housing, pumping, piping) has increased. Therefore, the costs are considered valid for the intended use. For purposes of this discussion, the costs for installing an RO system are estimated at $3.20 per gallon per day. USACE further estimated the operating

costs of an RO system (less the costs of brine disposal) at about $0.001 per gallon for a large-scale treatment system (USACE 1998).

For comparison, a study by the Texas Water Development Board (TWDB) has also estimated the costs of capital and operating costs (Arroyo and Shirazi 2012). Based on a review of various utilities and consultants, the TWDB examined six brackish groundwater desalination plants completed in the period from 2002 to 2012 and arrived at the following conclusions:

- Capital cost range from $2.03 to $3.91 per gallon per day of installed capacity; and
- Operation and maintenance costs range from $0.53 to $1.16 per 1,000 gallons of water ($0.00053 to $0.00116 per gallon).

These costs from the TWBD study (Arroyo and Shirazi 2012) are similar in value with the numbers based on the USACE study (USACE 1998).

The above costs are based on generic estimates. However, these estimates provide a method for comparison between the different alternatives that are available. As stated above, the costs of disposal of the concentrate actually becomes the controlling factor with each option.

As discussed above, there are several alternatives for the disposal of brine solutions. However, because the disposal of brine (as generated by the gas- and oil-drilling businesses) is a common problem in Arkansas, it is considered appropriate to estimate the cost of brine disposal based on experience from that business.

Much of the water generated from gas-well fracturing operations or oil drilling, particularly in west Arkansas, is currently hauled to deep-well disposal facilities in south Arkansas, north Louisiana or Oklahoma. The cost of brine disposal in a commercial deep well, not including transportation to the site, is estimated to vary between $0.15 and $0.25 per gallon (personal communication, Doug Melton, Southwestern Energy Company, 2013). Some of the closest commercial disposal wells, known to be available to accept brine of this type, are located in Columbia County in south Arkansas. This location would represent a hauling distance of about 100 miles round trip. Given this distance, the cost per 5,000-gallon tanker to load, haul,

and unload is estimated at $400, or $0.08 per gallon. A total cost of $0.28 per gallon will be used for disposal of brine in the following economic evaluation.

7.1.2.1 Option 1: RO Treatment/Discharge to Little River at Current Effluent Limits

As discussed above, this option would involve treatment of the wastewater to a discharge limit of 500 mg/L. A single-stage, reverse osmosis treatment system is capable of treating the wastewater down to below 100 mg/L. A system could be installed to treat a portion of the flow with some blending to always achieve the 500 mg/L concentration value.

A set of conditions was chosen to provide a basis for sizing equipment and estimating operating costs under this scenario. Pumps and piping that are associated with the RO process would be required along with controls, building, utilities, etc.

The basic assumptions used in the analysis of costs for Option 1 are shown below. Additional calculations used to develop this information are included in Appendix N:

1. An initial design flow of approximately 2.16 mgd (1,500 gallons per minute [gpm]) is the basis for sizing the RO system (ADEQ 2012). To achieve the 500 mg/L TDS limitation, only a portion of the flow would require treatment. This has been calculated to be 1.6 mgd. Using the USACE (1998) data, the estimated capital cost of the treatment system would be approximately $5.1 million.
2. An average flow rate of 1.04 mgd is the basis for calculating operating costs. This is based on the percentage of the average flow that will require treatment. The annual costs of operation, not including disposal of brine, is estimated to be $0.31 million.
3. To reduce the amount of brine requiring disposal, the system will consist of a minimum of three RO units in series (the latter two units operating on the reject water from the previous unit). Each pass will have a reject rate of 30%.
4. Approximately 8.4 million gallons per year at about 5% solids will be generated as brine solution reject from the RO treatment system. This brine solution will require disposal. As noted previously, this cost is based on data for commercial deep well injection. The annual costs associated with disposal would be about $2.35 million.

5. The treated effluent will be discharged to the Little River through the existing outfall.

7.1.2.2 Option 2: RO Treatment/Discharge to Little River at Future Effluent Limits

As discussed in Section 1.1, it is anticipated that the TDS criterion in the Little River, and thus the effluent limitations in future NPDES permits for the SWEPCO plant, could be lowered to 100 mg/L. This would require that all of the effluent be treated through an RO system if it continues to be discharged to the Little River, in order to achieve an effluent limit of 100 mg/L for TDS.

The basic assumptions used in the analysis of costs for Option 2 are shown below. Additional calculations used to develop this information are included in Appendix N:

1. An initial design flow of approximately 2.16 mgd (1,500 gpm) is the basis for sizing the RO system (ADEQ 2012). Using the USACE data (1998), the estimated capital cost of the treatment system would be approximately $6.9 million.
2. An average flow rate of 1.44 mgd is the basis for calculating operating costs. The annual costs of operation, not including disposal of brine, is estimated to be $0.42 million.
3. The system will consist of three RO units in series to minimize brine production. Each pass will have a reject rate of 30%.
4. Approximately 12.6 million gallons per year at about 5% solids will be generated as brine solution reject from the RO treatment system. This brine solution will require disposal. As noted previously, this cost is based on data for commercial deep well injection. The annual costs associated with disposal would be about $3.5 million.
5. The treated effluent will be discharged to the Little River through the existing outfall.

7.1.2.3 Option 3: RO Treatment/Discharge to Red River

The third alternative would be to route the discharge to the Red River and apply RO to meet the 500-mg/L TDS criterion. This option could potentially become feasible if the TDS criterion is changed in the Little River. With this situation, only a portion of the wastewater would require treatment through RO, thus reducing the capital and operating costs. In terms of

treatment requirements, the option is identical to Option 1. This option does require the construction of a pipeline extension from the SWEPCO outfall in the Little River to a point on the Red River.

The estimated cost of building a pipeline from the discharge outfall to a new outfall on the Red River is estimated to be about $640,000, including the purchase of right-of-way. The cost of pumping and maintenance would add another $10,000 annually to the cost of this option. Additional calculations used to develop the economic information are included in Appendix N.

Including the cost of the pipeline, the overall capital cost is estimated at $5.7 million. The operating cost is estimated at $0.32 million and the cost of disposal is estimated to be $2.35 million.

7.2 Direct Discharge with Site-Specific Criteria

Any capital and operating costs associated with the direct discharge option (e.g., effluent monitoring) would also be required in the other options, and therefore were not added to the cost estimates. The cost of implementation of the direct discharge option is estimated to be less than $400,000; this estimate accounts for the cost of the UAA study as well as consulting and legal expenses to support the rule-making process to modify the TDS criterion in the Little River and Red River and to remove the domestic drinking water supply use in the Red River.

7.3 Summary of Costs

Table 7.1 summarizes the estimated costs with each option for this facility. Additional information regarding the cost of the various alternatives is included in Appendix N.

Table 7.1. Summary of costs for various options to attain compliance with permit limits.

Option Description	Estimated Capital Cost	Estimated Annual Operating Cost	Disposal Cost
Option 1 – RO Treatment; Discharge to Little River (current limits)	$5.1 million	$0.31 million	$2.35 million
Option 2 –RO Treatment/Discharge to Little River (future effluent limits)	$6.9 million	$0.42 million	$3.5 million
Option 3 - RO Treatment/Discharge to Red River	$5.7 million	$0.32 million	$2.35 million
Direct Discharge to Little River (Site-Specific TDS Criterion)	<$400,000	NA	NA

7.4 Conclusions

The information presented in this section indicates that the most cost-effective option is direct discharge. Implementing this option, however, will require modified TDS criteria in the Little River and Red River, the current receiving streams.

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APPENDIX A

Economic Impact Study

ECONOMIC IMPACT

OF THE

CONSTRUCTION AND OPERATION

OF THE

JOHN W. TURK, JR. POWER PLANT

Prepared for:

SOUTHWESTERN ELECTRIC POWER COMPANY

Prepared by:

Dr. Richard Ford

and

Dr. Phillip Taylor

April 2011

In 2008, Southwestern Electric Power Company, a unit of American Electric Power Company, began construction of a new power generating plant in Hempstead County, Arkansas at a location about five miles north of Fulton. They have named the new facility the John W. Turk, Jr. Power Plant and the company's current plans call for construction to be completed and operations of the plant to begin at some point prior to the end of 2012. This economic impact analysis was prepared at the request of representatives of the company.

The economic impact (direct and indirect) of a new project can be expressed in terms of one or all of the following: the impact of the dollars flowing to suppliers of goods and services for both the construction and continued operations of the new facility; new jobs as a result of the construction and operations of the facility; and the increase in earnings associated with the new jobs, as well as changes to the public sector tax revenues. The economic impacts themselves are area specific. That is, they are estimated for a specified area such as a state, a region or a county. While the economic impacts are not time specific, for construction they are generally assumed to occur over the period of construction and for ongoing operations they are generally assumed to occur annually.

It is assumed that most of the materials and equipment needed for constructing and equipping the generating facility will come from outside the area that is nearby the facility. Similarly, the plant's primary raw material for operation purposes will be coal and that it, too, will come from outside the nearby area. As a result of these assumptions and the sources of the plant's coal supply, the following economic impact analysis is confined to new jobs and increased earnings associated with the construction and operations of the facility, along with the increases in state, county and school district tax revenues[1]. However it should be noted that positive economic impacts will accrue to the state and nation beyond those enjoyed in Hempstead and Miller Counties as a result of the construction of this plant even though they are not

[1] The increased earnings resulting from new jobs may result in an increase in income and sales tax collections. However, these quantities are not included in the economic impact calculations.

accounted for in this report.

The number of employees that will be directly engaged in both construction and continued operations are those provided by the company. Similarly, employee earnings, the cost for construction and the value of the land have been provided by the company. The economic multipliers used to determine the indirect effects of the increase in jobs and earnings are based on the 2002 Benchmark Input-Output Table for the nation and 2007 regional data[2] (e.g., the most current data available for this application.) The economic multipliers applied to construction jobs and employee earnings are those for the construction industry that are produced by the Aggregation Model Generator. The economic multipliers applied to the continued operations jobs and earnings are those for Electric Power Generation, Transmission and Distribution sector that are produced by the Detailed Industry Generator. The economic multipliers were developed using a regional definition of Hempstead and Miller Counties of Arkansas.

DEFINED ECONOMIC IMPACT REGION

The new power generating plant is being constructed a relatively short distance northwest of Fulton, Arkansas. Fulton is located just north of Interstate 30 at the western edge of Hempstead County. Miller County is contiguous with Hempstead County in the vicinity of Fulton. Texarkana is the closest major location for shopping, health care and other personal services along Interstate 30 to the southwest of Fulton and is the county seat of Miller County. Hope is the nearest location for shopping, health care and other personal services along Interstate 30 to the northeast of Fulton. Since Hope is also the county seat of Hempstead County it is also the location for government services for county residents and businesses. As a result of these and other factors, it seems reasonable to believe that Hempstead and Miller Counties will be the primary economic impact area of the new power generating plant.

[2] Regional Input-Output Modeling System (RIMSII), Regional Product Division, Bureau of Economic Analysis, U.S. Department of Commerce

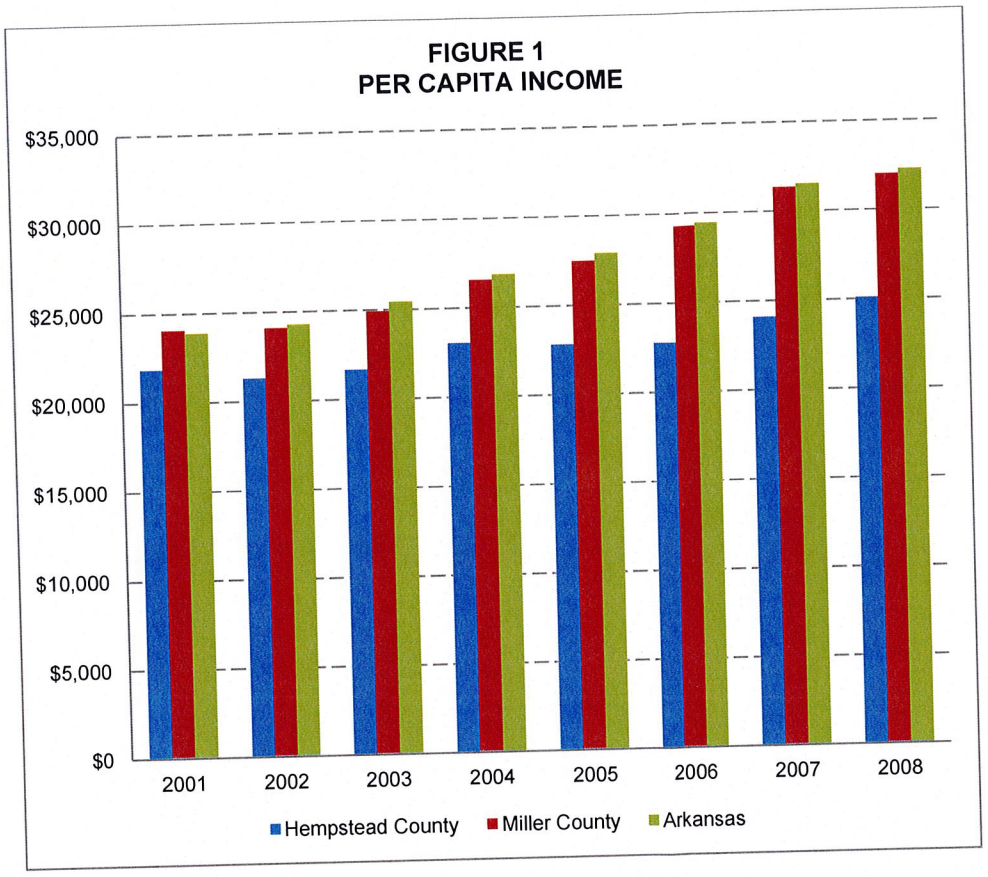
In 2010, the population of Hempstead County was 22,609 and that of Miller County was 43,462. Over the period from 2000 to 2010, Hempstead County lost an average of approximately 98 residents per year, while Miller County gained approximately 302 per year. The population of Fulton fell from 245 to 201 between 2000 and 2010. In 2010, the population of Hope (Hempstead County) was 10,095. Like the county, Hope lost population between the two census years. Texarkana (Miller County) had a population of 29,919 in 2010, as compared to its 2000 population of 26,899, or about a 1.069 % average annual growth rate.

The most recent per capita income data currently available is for 2008 and that information is provided in Table 1 and illustrated graphically in Figure 1. In 2008, the per capita income in Hempstead County ranked 64th among the 75 Arkansas counties and was less than 78% of the average for the state. The per capita income of Miller County is similar in size to that of the state. The per capita income of the two counties taken together was $29,603 in 2008 or $2,654 less than the per capita income for the state in that year.

TABLE 1
PER CAPITA INCOME[3]

Year	Counties		Arkansas
	Hempstead	Miller	
2001	$21,874	$24,057	$23,870
2002	$21,295	$24,088	$24,273
2003	$21,672	$24,916	$25,434
2004	$23,054	$26,563	$26,846
2005	$22,828	$27,488	$27,908
2006	$22,790	$29,293	$29,459
2007	$24,095	$31,328	$31,517
2008	$25,093	$31,994	$32,257

[3] The source of Per Capita Income is the Bureau of Economic Analysis, U.S. Department of Commerce



The data in Table 2 show that Personal Income in Hempstead County grew by approximately 13% in nominal dollars between 2001 and 2008 (the latest year for which data are available), while that of Miller County increased by about 42% in terms of nominal dollars. Together the two counties experienced Personal Income growth of almost 32% over the seven-year period from 2001 to 2008. In that time period the Personal Income of residents of Hempstead County declined each year from 34.3% of the combined Personal Incomes of the two counties in 2001 to 29.4% on their combined total in 2008.

TABLE 2
PERSONAL INCOME[4]
(thousands of dollars)

Year	Counties		
	Hempstead	Miller	Combined
2001	$509,881	$977,607	$1,487,488
2002	$495,078	$987,282	$1,482,360
2003	$502,505	$1,032,784	$1,535,289
2004	$532,618	$1,111,953	$1,644,571
2005	$527,138	$1,162,593	$1,689,731
2006	$528,013	$1,254,085	$1,782,098
2007	$559,292	$1,343,998	$1,903,290
2008	$576,363	$1,386,171	$1,962,534

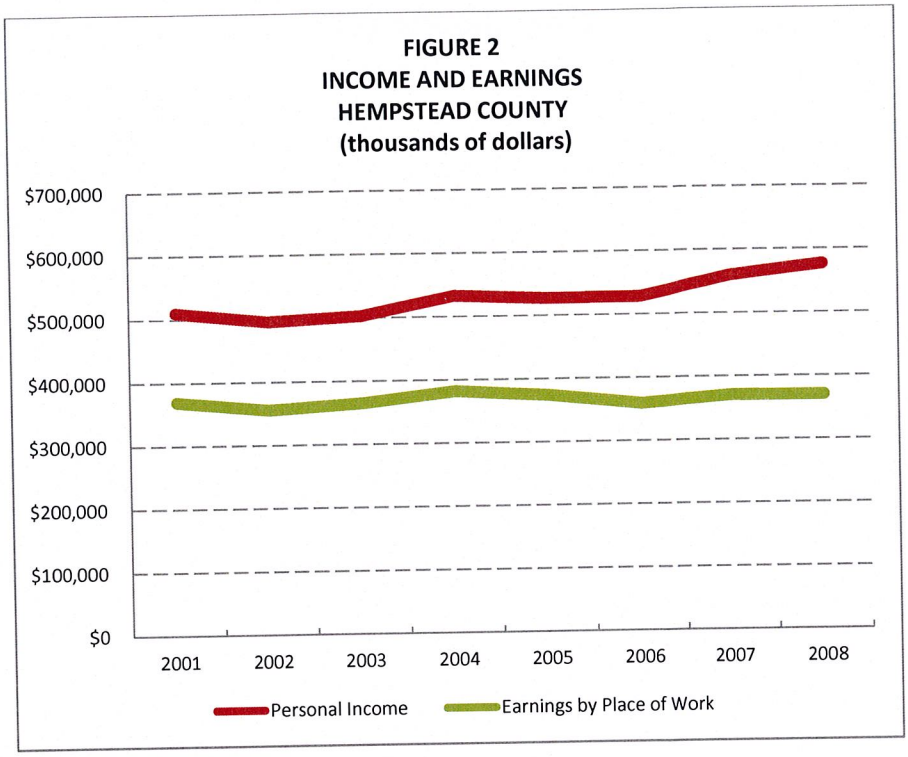
The earnings of the people working in the two counties for each year from 2001 to 2008 are shown in Table 3. In nominal dollars, total earnings of those working in the two counties increased by approximately $158 million from 2001 to 2008, or about $22.6 million per year.

Over the period from 2001 to 2008, the Personal Income of Hempstead County residents increased by about $67 million, or less than $10 million per year. However, the earnings of individuals working in the county changed very little in nominal terms over that period as is shown in Table 3 and reflected in Figure 2.

TABLE 3
EARNINGS BY PLACE OF WORK
(thousands of dollars)

Year	Counties		
	Hempstead	Miller	Combined
2001	$369,012	$624,602	$993,614
2002	$355,586	$640,306	$995,892
2003	$364,838	$670,260	$1,035,098
2004	$381,953	$721,653	$1,103,606
2005	$373,721	$716,737	$1,090,458
2006	$358,735	$774,743	$1,133,478
2007	$370,118	$800,618	$1,170,736
2008	$369,842	$782,137	$1,151,979

[4] The source of Personal Income is the Bureau of Economic Analysis, U.S. Department of Commerce

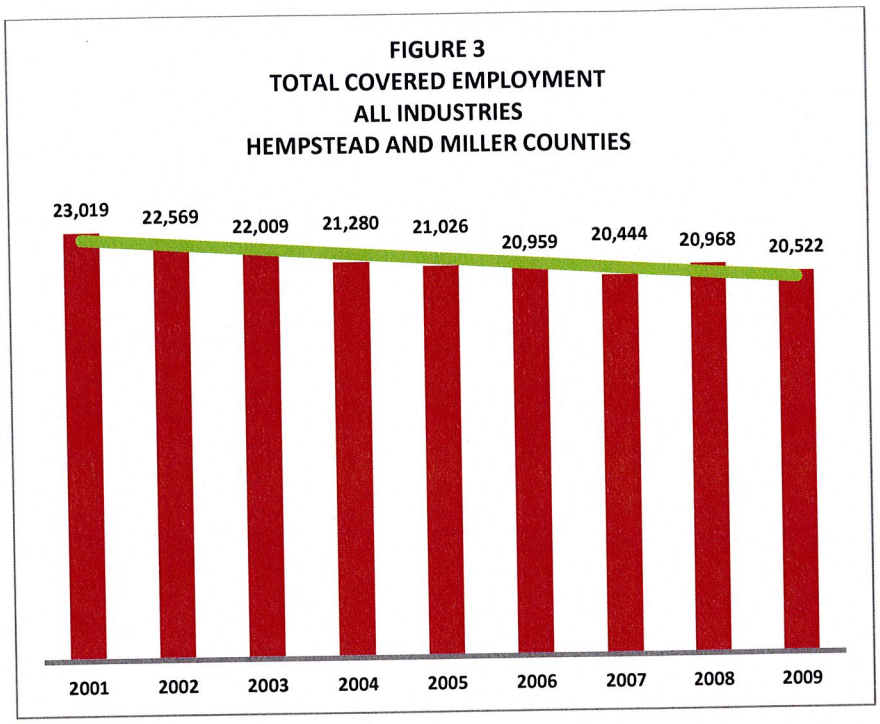


Total covered employment in the two counties declined each year from 2001 to 2007. As shown in Table 4, with the nation in a recession, total covered employment in the two counties increased in 2008, and then declined by 446 jobs in 2009. Over the eight years, the number of jobs in the two counties experienced a downward trend[5] with an average loss of 304 jobs per year. The employment data are shown in Table 4 and Figure 3. (The trend is shown in green in Figure 3.)

TABLE 4
HEMPSTEAD AND MILLER COUNTIES[6]

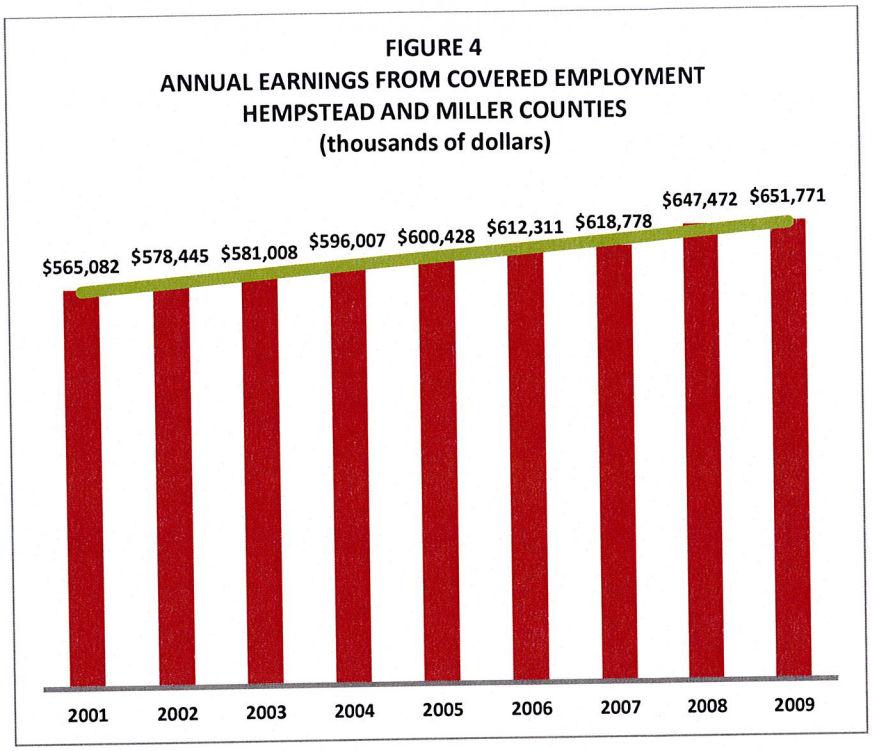
	Covered Employment	
	Total Employment All Industries	Total Wages (1,000)
2001	23,019	$565,082
2002	22,569	$578,445
2003	22,009	$581,008
2004	21,280	$596,007
2005	21,026	$600,428
2006	20,959	$612,311
2007	20,444	$618,778
2008	20,968	$647,472
2009	20,522	$651,771

[5] The adjusted R^2 for the trend equation is 0.82 and the slope has a p-value of 0.00047.
[6] The source of the covered employment data is the Bureau of Labor Statistics, U.S. Department of Labor



The combined total wages in covered employment in the two counties increased each year between 2001 and 2009. They experienced a positive trend with an average increase of $10.761 million per year[7] in nominal dollars. The increases in total wages in covered employment in Hempstead County were relatively small until 2009 when they registered growth of over $18.7 million while they declined by more than $14.4 million in Miller County in that year. Figure 4 displays the annual earnings for the two counties, with the trend shown in green.

[7] The adjusted R^2 for the trend equation is 0.96 and the slope has a p-value of 0.0000026.



As reflected in Figure 5, covered employment in construction in Hempstead County increased by 188 jobs between 2007 and 2008 and increased again by 434 jobs between 2008 and 2009. In other words, without the increase in construction jobs, covered employment in the county would have declined by 428 jobs in 2008 and by 339 jobs in 2009.

Figure 6 shows the level of total nominal dollar wages in covered construction employment in Hempstead County between 2001 and 2009. Earnings from construction jobs increased by $9.204 million in 2008 and by $25.011 million in 2009. Had these increases not occurred, earnings from covered employment in Hempstead County would have been $6.427 million less in 2008 and $6.262 less is 2009. Thus, the increase in earnings from construction jobs in Hempstead County more than accounted for the growth in earnings from covered employment in both counties in 2009.

FIGURE 5
EMPLOYMENT IN THE CONSTRUCTION INDUSTRY
HEMPSTEAD COUNTY

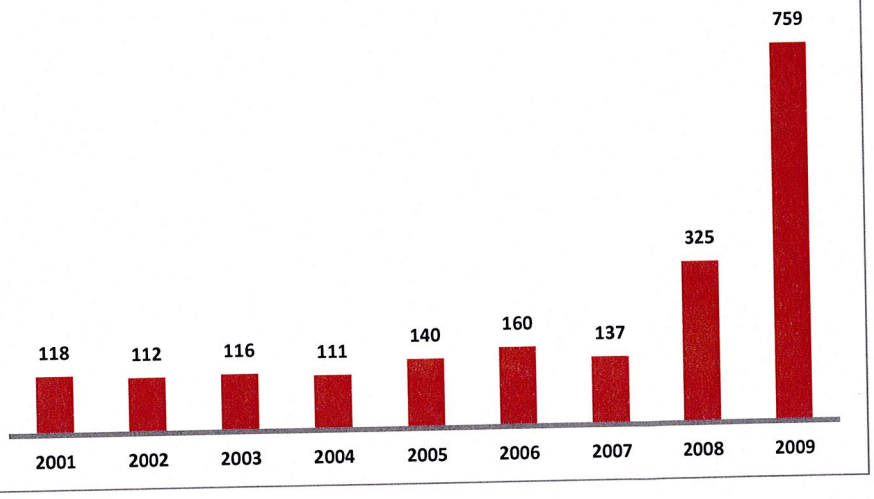
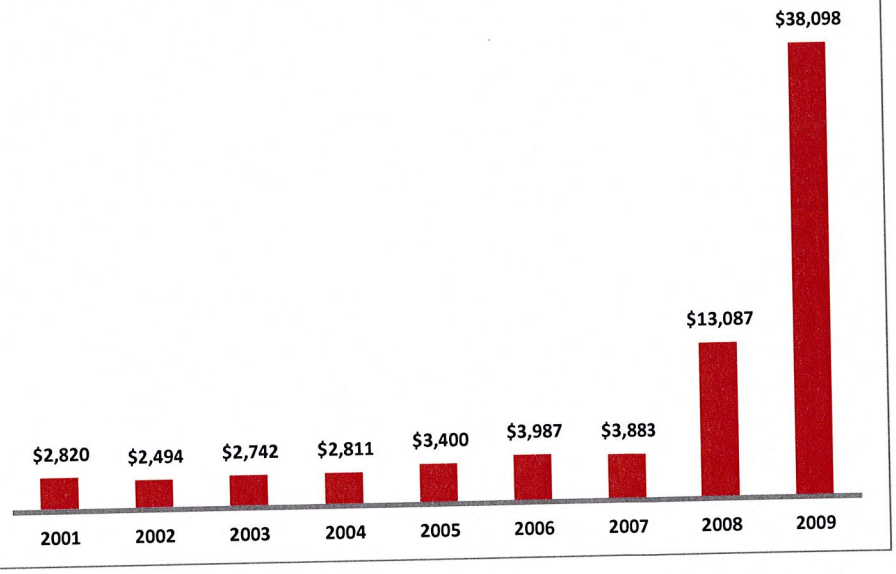


FIGURE 6
ANNUAL EARNINGS IN THE CONSTRUCTION INDUSTRY
HEMPSTEAD COUNTY
(thousands of dollars)



Disclosure rules prohibit the reporting of nonresidential employment and earnings in covered employment in Hempstead County except for a few years. The most recent year for which data are available is 2005. In that year, the number of covered

nonresidential construction jobs in Hempstead County was 10, and the earnings associated with those jobs were $254,000.

THE ECONOMIC IMPACT OF THE CONSTRUCTION OF THE GENERATING PLANT

It is currently estimated that 1,600 workers will be employed during the construction of the generating plant and that these workers will earn $695,300,000. The output of the RIMSII model shows that one new indirect job will be created for every 5.9 new workers employed in construction in the two-county area. The model also indicates that the earnings of the construction workers will result in an additional $116,623,690 being paid across all industries to households in Hempstead and Miller Counties.

TABLE 5
TEMPORARY EMPLOYMENT FROM PLANT CONSTRUCTION

Total Temporary Direct Jobs	RIMSII Multiplier	Total New Temporary Indirect Jobs	Total New Temporary Jobs
1,600	1.1691	271	1,871

TABLE 6
TEMPORARY EARNINGS FROM PLANT CONSTRUCTION

Total Temporary Direct Earnings	RIMSII Multiplier	Total Temporary Indirect Earnings	Total Temporary Earnings
$695,300,000	1.1673	$116,323,690	$811,623,690

THE ECONOMIC IMPACT OF THE OPERATION OF THE GENERATING PLANT

In order to operate the generating facility, Southwestern Electric Power Company will employ 109 people in the categories set forth in Table 7. When the plant begins operations, the 109 new employees will have total annual salaries of $6,364,160. The 109 new employees will result in the creation of 45 additional jobs elsewhere in the defined economic impact area. When the indirect earnings are included, the earnings of the new employees will result in households in the two counties having a total of

$7,420,611 in new earnings from across all industries. The details of the new jobs and earnings creation are provided in Tables 8 and 9.

TABLE 7
PERMANENT EMPLOYMENT AND EARNINGS

Categories of Employees	Number of Employees	Wage Rate	Annual Salary per Employee	Total New Annual Direct Salaries
Plant Operations	85	$26 per hour	$54,080	$4,596,800
Administrative	3	$14 per hour	$29,120	$87,360
Management	21	$80,000 per year	$80,000	$1,680,000
Total	109			$6,364,160

TABLE 8
PERMANENT DIRECT AND INDIRECT EMPLOYMENT FROM PLANT OPERATION

Total New Direct Jobs	RIMSII Multiplier	Total New Indirect Jobs	Total New Jobs
109	1.4122	45	154

TABLE 9
DIRECT AND INDIRECT EARNINGS FROM PLANT OPERATIONS

Total New Annual Direct Salaries	RIMSII Multiplier	Total New Annual Indirect Salaries	Total New Annual Salaries
$6,364,160	1.1660	$1,056,451	$7,420,611

IMPACT OF CONSTRUCTION AND OPERATIONS ON GOVERNMENTAL UNITS

The cost of materials for constructing the plant, as well as the equipment for its operations, is subject to the sales and use taxes levied in Arkansas and Hempstead County. As noted in Table 10, the current estimate for these two items is almost $725 million. Thus, when the Turk plant is ready to begin operations based on its current estimated cost its construction will have increased Arkansas' sales and use tax revenue by almost $43.5 million and that for Hempstead County in excess of $19.9 million.

TABLE 10
SALES TAXES COLLECTED FROM PLANT CONSTRUCTION AND EQUIPMENT

Sales and Use Tax Jurisdiction	Sales and Use Tax Rates	Construction Materials and Equipment Cost	Sales and Use Tax Collections
State	6.00%	$724,700,000	$43,482,000
County	2.75%	$724,700,000	$19,929,250
Total			$63,411,250

Once in operation, the Turk plant will go on the property tax role of taxing units in Hempstead County. The currently prevailing (2011) property tax rates for Hempstead County and the Mineral Spring Saratoga School District in which the Turk plant is located are provided in Table 11.

TABLE 11
COUNTY TAX MILLAGES

Category	Millage
County General	3.0
County Road	1.2
County Library	1.0
County Total	5.2
Mineral Springs Saratoga School District	34.0

It is estimated that the total project cost will be $1.432 billion and that the plant will have an assessed value for purposes of property taxes of $286.4 million. With those values, the construction of the Turk plant will result in annual payments of $11,226,880 in property taxes by Southwestern Electric Power Company to taxing units in Hempstead County. Over 85% of that amount ($9,737,600) will accrue to the Mineral Springs Saratoga School District in Hempstead County. Of the portion collected for the County, almost $860,000 per year will go to the County General Fund; almost $345,000 per year will be for the construction and maintenance of roads; and over $286,000 per year will be added to the County Library budget.

TABLE 12
ANNUAL PROPERTY TAXES

Item	Project Cost	Value for Property Taxes	County Property Tax Per Year	School District Property Tax Per Year	Total Property Tax Per Year
Land	$12,000,000	$2,400,000	$12,480	$81,600	$94,080
Building and Equipment	$1,420,000,000	$284,000,000	$1,476,800	$9,656,000	$11,132,800
Total	$1,432,000,000	$286,400,000	$1,489,280	$9,737,600	$11,226,880

TABLE 13
ANNUAL EXPECTED REVENUE FROM TAXES

Taxing Jurisdiction	Type of Tax	Year of Construction	Subsequent Years Assuming No Change
Hempstead County			
	Sales and Use Tax	$19,929,250	
	Property Tax		$1,489,280
School District			
	Property Tax		$9,737,600
State of Arkansas			
	Sales and Use Tax	$43,482,000	

SUMMARY

The direct and indirect economic impacts for the Hempstead and Miller county area for both the construction and operation of the John W. Turk Power Plant are restated in Tables 14 and 15.

TABLE 14
TEMPORARY ECONOMIC IMPACTS OF THE JOHN W.TURK POWER PLANT CONSTRUCTION

Total New Temporary Indirect Jobs	271
Total New Temporary Jobs	1871
Total Temporary Indirect Earnings	$116,323,690
Total Temporary Earnings	$811,623,690

TABLE 15
ONGOING ECONOMIC IMPACTS OF THE JOHN W. TURK POWER PLANT OPTERATION

Total New Indirect Jobs	45
Total New Jobs	154
Total New Annual Indirect Salaries	$1,056,451
Total New Annual Salaries	$7,420,611

The economic impact area for this study, Hempstead and Miller counties, are not among the most economically robust of the state. However, as the preceding text and tables show, mixed progress has been made within these counties during the study period. Although population increased for the two-county area between 2000 and 2010,

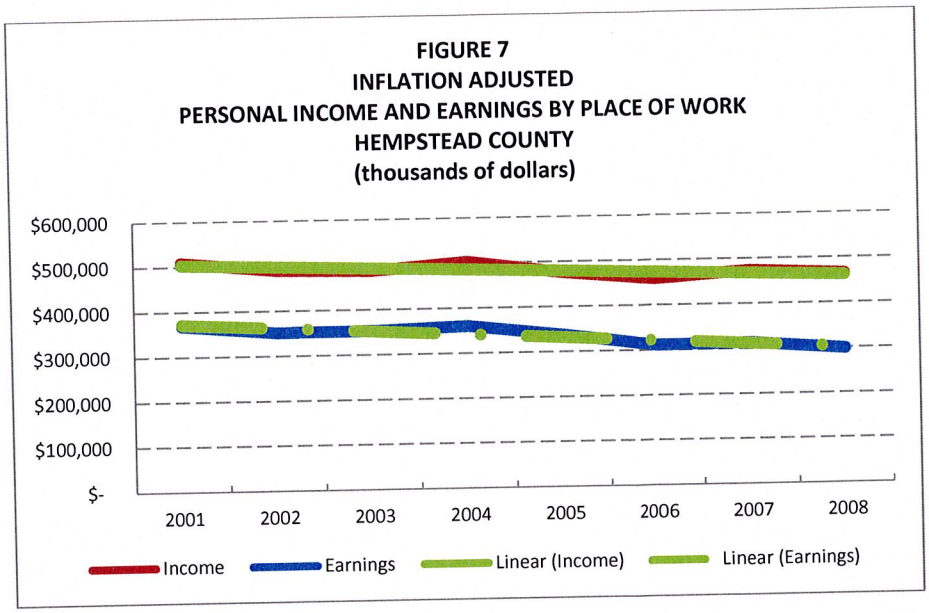
the population of Hempstead Count (the site of the Turk plant) actually declined. Personal Income for each county increased between 2001 and 2008, with increases of 13.0%, 41.8%, and 31.9% for Hempstead County, Miller County, and the combined area respectively. However these percentage increases were recorded in nominal dollar terms while the rate of inflation estimated using the appropriate Consumer Price Index (CPI)[8] over a similar period was 23.7%. Therefore, the inflation adjusted Personal Income increases over the seven years are -10.7%, 18.0%, and 8.2%, respectively.

When earnings by place of work are viewed in terms of inflation adjusted dollars, those for Hempstead County declined 23.5% between 2001 and 2008. Over that same period, the earnings of those working in Miller County had a real dollar increase of less than 1.5%.

Figure 7 presents the inflation adjusted Personal Income and Earnings by Place of work for Hempstead County. The trend of each series is displayed in green and reflects the average annual change in the given economic measures. As shown in the graph, the Personal Income of the residents of Hempstead County declined by an average of almost $6 million per year in real dollar terms[9] between 2001 and 2009, while the Earnings by Place of Residence decreased by an average of $9.9 million real

[8] Consumer Price Index for the South – Size: Class D, All items, Series ID: CUURD300SAD
[9] The adjusted R^2 for the Personal Income trend equation is 0.63 and the slope has a p-value of 0.011393.

dollars per year[10] over the same period of time. This yields a picture of an area in want of economic development, which the Turk plant will contribute toward.



One statistic not cited above is the percent of the population in Hempstead County with a college degree. In 2000 the number was 11.0% and by 2010 the number had increased to 12.7%. In comparison the similar statistic for the State of Arkansas and the U.S. is 16.7% and 24.4 % for 2009. When in operation the Turk plant will employ 109 employees, some of which will be college educated. These new professional positions have the potential to further impact Hempstead County through the ripple effect of bringing similar jobs to the area. It seems reasonable to conclude that some of the induced employment may also be individuals who have earned college degrees. Moreover, it is unknowable at this time what role models and what mentor relationships this increase in professional employment will have on the community;

[10] The adjusted R^2 for the Earnings by Place of Residence trend equation is 0.85 and the slope has a p-value of 0.000692.

however, it is generally accepted that increasing the education level of the Arkansas workforce is a key political component and goal of many Arkansas leaders.

The operations of the Turk plant will have a positive impact on the local tax base. As has been previously stated the total that will be paid annually by the Turk plant for school mileage tax is $9,737,600. For perspective consider the figures in Table 16. The sum of all categories of revenue for the Mineral Springs Saratoga School District for 2008 was $5,758,357. With this kind of increased tax base, even if the local school district was required to 'turn back' all of its State Assistance funding, there would still be a $6,034,451 increase in the Mineral Springs Saratoga School District budget; which amounts to a doubling of the schools district's revenue.

TABLE 16
EXTRACT FROM A FINANCIAL STATEMENT OF
MINERAL SPRINGS SARATOGA SCHOOL DISTRICT NO. 3
(year ending June 30, 2008)

	General	Special Revenue	Other Aggregate
Property Taxes	$1,055,853		
State Assistance	$3,700,505	$2,644	
Federal Assistance	$4,707	$790,461	
Activity Revenues	$79,437		
Meal Sales		$51,198	
Investment Income	$20,717		$7,804
Other Revenue	$37,984	$7,047	
Total revenues	$4,899,203	$851,350	$7,804

It is understood that the county has taken action to disperse this "tax-windfall" over more than one school district in the county which doesn't diminish the importance of the economic impact the Turk plant will have on the area. Economically, it is difficult to find anything other than positive effects that the Turk plant will have on Hempstead and Miller counties.

APPENDIX B

Historical TDS Data from ADEQ Monitoring Stations

Appendix B.1. ADEQ historical monitoring data for dissolved minerals at RED0002.

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1990/09/04	Chloride	Dissolved	10.95
RED0002	1990/10/02	Chloride	Dissolved	5.82
RED0002	1990/10/30	Chloride	Dissolved	11.3
RED0002	1990/11/27	Chloride	Dissolved	2.24
RED0002	1991/01/22	Chloride	Dissolved	2.98
RED0002	1991/02/05	Chloride	Dissolved	3.31
RED0002	1991/03/19	Chloride	Dissolved	6.96
RED0002	1991/04/23	Chloride	Dissolved	2.9
RED0002	1991/05/21	Chloride	Dissolved	3.51
RED0002	1991/06/18	Chloride	Dissolved	R
RED0002	1991/07/02	Chloride	Dissolved	18.2
RED0002	1991/08/20	Chloride	Dissolved	8.96
RED0002	1991/12/03	Chloride	Dissolved	2.68
RED0002	1992/01/21	Chloride	Dissolved	5.88
RED0002	1992/02/04	Chloride	Dissolved	6.73
RED0002	1992/03/03	Chloride	Dissolved	3.84
RED0002	1992/04/07	Chloride	Dissolved	12.5
RED0002	1992/05/05	Chloride	Dissolved	2.92
RED0002	1992/06/02	Chloride	Dissolved	4.23
RED0002	1992/07/14	Chloride	Dissolved	7.6
RED0002	1992/08/11	Chloride	Dissolved	2.93
RED0002	1992/09/08	Chloride	Dissolved	3.3
RED0002	1992/10/06	Chloride	Dissolved	2.71
RED0002	1992/11/17	Chloride	Dissolved	11.9
RED0002	1992/12/01	Chloride	Dissolved	2.79
RED0002	1993/01/05	Chloride	Dissolved	3.13
RED0002	1993/02/02	Chloride	Dissolved	4.11
RED0002	1993/03/02	Chloride	Dissolved	3.5
RED0002	1993/03/30	Chloride	Dissolved	2.69
RED0002	1993/05/03	Chloride	Dissolved	2.37
RED0002	1993/06/28	Chloride	Dissolved	9.06
RED0002	1993/07/12	Chloride	Dissolved	7.07
RED0002	1993/08/10	Chloride	Dissolved	21.2
RED0002	1993/09/14	Chloride	Dissolved	9.86
RED0002	1993/10/12	Chloride	Dissolved	3.07
RED0002	1993/11/02	Chloride	Dissolved	2.23
RED0002	1993/12/07	Chloride	Dissolved	2.56
RED0002	1994/01/25	Chloride	Dissolved	4.43
RED0002	1994/02/22	Chloride	Dissolved	6.22
RED0002	1994/03/22	Chloride	Dissolved	5.75
RED0002	1994/04/26	Chloride	Dissolved	10.3
RED0002	1994/05/17	Chloride	Dissolved	3
RED0002	1994/06/21	Chloride	Dissolved	3.76
RED0002	1994/07/19	Chloride	Dissolved	2.83

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1994/08/23	Chloride	Dissolved	7.13
RED0002	1994/09/27	Chloride	Dissolved	14.6
RED0002	1994/10/25	Chloride	Dissolved	5.9
RED0002	1994/11/21	Chloride	Dissolved	2.47
RED0002	1994/12/20	Chloride	Dissolved	2.69
RED0002	1995/01/17	Chloride	Dissolved	3.232
RED0002	1995/02/06	Chloride	Dissolved	3.245
RED0002	1995/03/14	Chloride	Dissolved	6.693
RED0002	1995/04/04	Chloride	Dissolved	4.325
RED0002	1995/05/16	Chloride	Dissolved	2.143
RED0002	1995/06/19	Chloride	Dissolved	6.205
RED0002	1995/07/11	Chloride	Dissolved	11.579
RED0002	1995/08/15	Chloride	Dissolved	9.697
RED0002	1995/09/05	Chloride	Dissolved	5.343
RED0002	1995/10/03	Chloride	Dissolved	8.322
RED0002	1995/10/31	Chloride	Dissolved	12.515
RED0002	1995/12/12	Chloride	Dissolved	2.987
RED0002	1996/01/16	Chloride	Dissolved	4.029
RED0002	1996/02/27	Chloride	Dissolved	7.149
RED0002	1996/03/26	Chloride	Dissolved	3.984
RED0002	1996/04/23	Chloride	Dissolved	2.976
RED0002	1996/05/21	Chloride	Dissolved	2.876
RED0002	1996/06/18	Chloride	Dissolved	4.365
RED0002	1996/07/30	Chloride	Dissolved	3.143
RED0002	1996/08/27	Chloride	Dissolved	2.678
RED0002	1996/09/17	Chloride	Dissolved	2.381
RED0002	1996/10/15	Chloride	Dissolved	5.914
RED0002	1996/11/05	Chloride	Dissolved	4.291
RED0002	1996/12/10	Chloride	Dissolved	2.493
RED0002	1997/01/21	Chloride	Dissolved	8.756
RED0002	1997/02/11	Chloride	Dissolved	2.854
RED0002	1997/04/01	Chloride	Dissolved	3.71
RED0002	1997/04/29	Chloride	Dissolved	2.808
RED0002	1997/05/12	Chloride	Dissolved	12.043
RED0002	1997/06/16	Chloride	Dissolved	17.249R
RED0002	1997/07/14	Chloride	Dissolved	10.3
RED0002	1997/08/25	Chloride	Dissolved	10.1
RED0002	1997/09/15	Chloride	Dissolved	10.2
RED0002	1997/10/14	Chloride	Dissolved	6
RED0002	1997/11/12	Chloride	Dissolved	4.546
RED0002	1997/12/16	Chloride	Dissolved	4.591
RED0002	1998/01/20	Chloride	Dissolved	2.797
RED0002	1998/02/17	Chloride	Dissolved	3.472
RED0002	1998/03/17	Chloride	Dissolved	3.97
RED0002	1998/04/14	Chloride	Dissolved	12.223
RED0002	1998/05/26	Chloride	Dissolved	10.1

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1998/06/23	Chloride	Dissolved	4.102
RED0002	1998/07/14	Chloride	Dissolved	10.8
RED0002	1998/08/11	Chloride	Dissolved	9.13
RED0002	1998/09/01	Chloride	Dissolved	6.22
RED0002	1998/10/06	Chloride	Dissolved	3.67
RED0002	1998/11/03	Chloride	Dissolved	12.2
RED0002	1998/12/08	Chloride	Dissolved	2.62
RED0002	1999/01/05	Chloride	Dissolved	3.1
RED0002	1999/02/02	Chloride	Dissolved	2.52
RED0002	1999/03/16	Chloride	Dissolved	2.6
RED0002	1999/04/27	Chloride	Dissolved	7.32
RED0002	1999/05/25	Chloride	Dissolved	2.89
RED0002	1999/06/29	Chloride	Dissolved	3.69
RED0002	1999/07/27	Chloride	Dissolved	4.1
RED0002	1999/08/31	Chloride	Dissolved	9.36
RED0002	1999/09/28	Chloride	Dissolved	13.4
RED0002	1999/10/26	Chloride	Dissolved	25.3
RED0002	1999/11/22	Chloride	Dissolved	14.57
RED0002	1999/12/20	Chloride	Dissolved	3.5
RED0002	2000/01/25	Chloride	Dissolved	9.58
RED0002	2000/02/29	Chloride	Dissolved	4.08
RED0002	2000/03/27	Chloride	Dissolved	7.57
RED0002	2000/04/24	Chloride	Dissolved	7.32
RED0002	2000/05/30	Chloride	Dissolved	6.06
RED0002	2000/06/19	Chloride	Dissolved	2.54
RED0002	2000/07/25	Chloride	Dissolved	9.34
RED0002	2000/08/28	Chloride	Dissolved	6.03
RED0002	2000/09/26	Chloride	Dissolved	11.6
RED0002	2000/10/24	Chloride	Dissolved	13.26
RED0002	2000/11/14	Chloride	Dissolved	3.1
RED0002	2000/12/19	Chloride	Dissolved	3.81
RED0002	2001/01/16	Chloride	Dissolved	3.45
RED0002	2001/02/13	Chloride	Dissolved	3.8
RED0002	2001/03/13	Chloride	Dissolved	2.55
RED0002	2001/04/17	Chloride	Dissolved	2.75
RED0002	2001/05/08	Chloride	Dissolved	15.66
RED0002	2001/06/12	Chloride	Dissolved	10.45
RED0002	2001/07/10	Chloride	Dissolved	4.44
RED0002	2001/08/07	Chloride	Dissolved	4.47
RED0002	2001/09/04	Chloride	Dissolved	10.7
RED0002	2001/10/09	Chloride	Dissolved	7.3
RED0002	2001/11/06	Chloride	Dissolved	10.87
RED0002	2001/12/04	Chloride	Dissolved	9.36
RED0002	2002/01/02	Chloride	Dissolved	2.01
RED0002	2002/02/04	Chloride	Dissolved	2.6
RED0002	2002/03/05	Chloride	Dissolved	4.12

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2002/04/02	Chloride	Dissolved	2.6
RED0002	2002/05/07	Chloride	Dissolved	3.81
RED0002	2002/06/11	Chloride	Dissolved	4.06
RED0002	2002/07/09	Chloride	Dissolved	7.5
RED0002	2002/08/13	Chloride	Dissolved	7.32
RED0002	2002/09/03	Chloride	Dissolved	8.92
RED0002	2002/10/01	Chloride	Dissolved	16.4
RED0002	2002/11/05	Chloride	Dissolved	8.75
RED0002	2002/12/03	Chloride	Dissolved	16
RED0002	2003/01/21	Chloride	Dissolved	10.7
RED0002	2003/02/18	Chloride	Dissolved	4.52
RED0002	2003/03/18	Chloride	Dissolved	10.5
RED0002	2003/04/22	Chloride	Dissolved	15.1
RED0002	2003/05/27	Chloride	Dissolved	9.06
RED0002	2003/06/24	Chloride	Dissolved	5.29
RED0002	2003/07/15	Chloride	Dissolved	9.46
RED0002	2003/08/12	Chloride	Dissolved	7.51
RED0002	2003/09/23	Chloride	Dissolved	8.27
RED0002	2003/10/14	Chloride	Dissolved	9.28
RED0002	2003/11/12	Chloride	Dissolved	10.9
RED0002	2003/12/09	Chloride	Dissolved	5.35
RED0002	2004/01/13	Chloride	Dissolved	11.6
RED0002	2004/02/17	Chloride	Dissolved	4.6
RED0002	2004/03/16	Chloride	Dissolved	7.94
RED0002	2004/04/20	Chloride	Dissolved	14.7
RED0002	2004/05/18	Chloride	Dissolved	6.97
RED0002	2004/06/22	Chloride	Dissolved	2.97
RED0002	2004/07/20	Chloride	Dissolved	12
RED0002	2004/08/10	Chloride	Dissolved	8.39
RED0002	2004/09/07	Chloride	Dissolved	9.68
RED0002	2004/10/12	Chloride	Dissolved	16.1
RED0002	2004/11/16	Chloride	Dissolved	7.56
RED0002	2004/12/14	Chloride	Dissolved	3.93
RED0002	2005/01/25	Chloride	Dissolved	2.16
RED0002	2005/02/22	Chloride	Dissolved	4.21
RED0002	2005/03/29	Chloride	Dissolved	4.19
RED0002	2005/04/26	Chloride	Dissolved	14.2
RED0002	2005/05/24	Chloride	Dissolved	15
RED0002	2005/06/28	Chloride	Dissolved	11.5
RED0002	2005/07/19	Chloride	Dissolved	9.81
RED0002	2005/08/23	Chloride	Dissolved	9.63
RED0002	2005/09/13	Chloride	Dissolved	6.55
RED0002	2005/10/25	Chloride	Dissolved	7.65
RED0002	2005/11/29	Chloride	Dissolved	18
RED0002	2005/12/13	Chloride	Dissolved	14.3
RED0002	2006/01/17	Chloride	Dissolved	21.8

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2006/02/14	Chloride	Dissolved	19
RED0002	2006/03/07	Chloride	Dissolved	19.8
RED0002	2006/04/11	Chloride	Dissolved	7.83
RED0002	2006/05/02	Chloride	Dissolved	2.89
RED0002	2006/06/06	Chloride	Dissolved	11.9
RED0002	2006/07/25	Chloride	Dissolved	7.08
RED0002	2006/08/29	Chloride	Dissolved	7.94
RED0002	2006/09/26	Chloride	Dissolved	13.8
RED0002	2006/10/24	Chloride	Dissolved	3.69
RED0002	2006/11/14	Chloride	Dissolved	4.15
RED0002	2006/12/18	Chloride	Dissolved	5.95
RED0002	2007/01/23	Chloride	Dissolved	2.54
RED0002	2007/02/27	Chloride	Dissolved	5.09
RED0002	2007/03/20	Chloride	Dissolved	7.82
RED0002	2007/04/17	Chloride	Dissolved	14.7
RED0002	2007/05/08	Chloride	Dissolved	2.52
RED0002	2007/06/12	Chloride	Dissolved	8.91
RED0002	2007/07/17	Chloride	Dissolved	2.29
RED0002	2007/09/25	Chloride	Dissolved	4.9
RED0002	2007/10/30	Chloride	Dissolved	12.1
RED0002	2007/11/19	Chloride	Dissolved	8.22
RED0002	2007/12/11	Chloride	Dissolved	13
RED0002	2008/01/29	Chloride	Dissolved	8.16
RED0002	2008/02/26	Chloride	Dissolved	3.17
RED0002	2008/03/25	Chloride	Dissolved	2.67
RED0002	2008/04/22	Chloride	Dissolved	1.99
RED0002	2008/05/13	Chloride	Dissolved	2.65
RED0002	2008/06/03	Chloride	Dissolved	6.23
RED0002	2008/07/29	Chloride	Dissolved	4.07
RED0002	2008/08/26	Chloride	Dissolved	5.54
RED0002	2008/09/16	Chloride	Dissolved	4.24
RED0002	2008/10/21	Chloride	Dissolved	9.71
RED0002	2008/11/24	Chloride	Dissolved	8.9
RED0002	2008/12/17	Chloride	Dissolved	6.69
RED0002	2009/01/06	Chloride	Dissolved	3.43
RED0002	2009/02/03	Chloride	Dissolved	5.26
RED0002	2009/03/03	Chloride	Dissolved	13.2
RED0002	2009/04/07	Chloride	Dissolved	6.15
RED0002	2009/05/12	Chloride	Dissolved	1.53
RED0002	2009/06/30	Chloride	Dissolved	15.4
RED0002	2009/07/21	Chloride	Dissolved	16.3
RED0002	2009/08/11	Chloride	Dissolved	4.43
RED0002	2009/09/15	Chloride	Dissolved	18.8
RED0002	2009/10/20	Chloride	Dissolved	2.18
RED0002	2009/11/23	Chloride	Dissolved	7.03
RED0002	2009/12/15	Chloride	Dissolved	5.36

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2010/01/12	Chloride	Dissolved	6.66
RED0002	2010/02/09	Chloride	Dissolved	2.22
RED0002	2010/03/16	Chloride	Dissolved	5.44
RED0002	2010/04/13	Chloride	Dissolved	11.7
RED0002	2010/05/18	Chloride	Dissolved	9.26
RED0002	2010/06/15	Chloride	Dissolved	3.72
RED0002	2010/07/13	Chloride	Dissolved	7.28
RED0002	2010/08/10	Chloride	Dissolved	8.44
RED0002	2010/09/14	Chloride	Dissolved	39.7
RED0002	2010/10/19	Chloride	Dissolved	18.9
RED0002	2010/11/22	Chloride	Dissolved	21.7
RED0002	2010/12/28	Chloride	Dissolved	17.3
RED0002	2011/01/25	Chloride	Dissolved	2.78
RED0002	2011/02/22	Chloride	Dissolved	10.7
RED0002	2011/03/08	Chloride	Dissolved	5.98
RED0002	2011/04/12	Chloride	Dissolved	11.2
RED0002	2011/05/24	Chloride	Dissolved	2.64
RED0002	2011/06/28	Chloride	Dissolved	12.8
RED0002	2011/07/05	Chloride	Dissolved	10.8
RED0002	2011/08/02	Chloride	Dissolved	3.62
RED0002	2011/09/06	Chloride	Dissolved	10.4
RED0002	2011/10/04	Chloride	Dissolved	10.4
RED0002	2011/11/15	Chloride	Dissolved	35.1
RED0002	2011/12/12	Chloride	Dissolved	2.43
RED0002	2012/01/17	Chloride	Dissolved	4.06
RED0002	2012/02/21	Chloride	Dissolved	4.47
RED0002	2012/03/20	Chloride	Dissolved	2.89
RED0002	2012/04/17	Chloride	Dissolved	11.3
RED0002	2012/05/01	Chloride	Dissolved	18.2
RED0002	2012/06/05	Chloride	Dissolved	14.4
RED0002	2012/07/24	Chloride	Dissolved	7.61
RED0002	2012/08/14	Chloride	Dissolved	10.2
RED0002	2012/09/04	Chloride	Dissolved	11.5
RED0002	2012/10/02	Chloride	Dissolved	9.47
RED0002	2012/11/27	Chloride	Dissolved	12.5
RED0002	2012/12/10	Chloride	Dissolved	17.3
RED0002	2013/01/29	Chloride	Dissolved	3.41
RED0002	2013/02/19	Chloride	Dissolved	4.19
RED0002	2013/03/19	Chloride	Dissolved	4.49
RED0002	2013/04/16	Chloride	Dissolved	2.33
RED0002	2013/05/21	Chloride	Dissolved	4.3
RED0002	2013/06/04	Chloride	Dissolved	1.72
RED0002	2013/07/01	Chloride	Dissolved	8.45

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1990/09/04	Sulfate	Dissolved	6
RED0002	1990/10/02	Sulfate	Dissolved	31
RED0002	1990/10/30	Sulfate	Dissolved	2
RED0002	1990/11/27	Sulfate	Dissolved	4
RED0002	1991/01/22	Sulfate	Dissolved	7
RED0002	1991/02/05	Sulfate	Dissolved	5
RED0002	1991/03/19	Sulfate	Dissolved	4
RED0002	1991/04/23	Sulfate	Dissolved	4
RED0002	1991/05/21	Sulfate	Dissolved	5
RED0002	1991/06/18	Sulfate	Dissolved	5
RED0002	1991/07/02	Sulfate	Dissolved	5
RED0002	1991/08/20	Sulfate	Dissolved	4
RED0002	1991/12/03	Sulfate	Dissolved	8.58
RED0002	1992/01/21	Sulfate	Dissolved	6.9
RED0002	1992/02/04	Sulfate	Dissolved	4.08
RED0002	1992/03/03	Sulfate	Dissolved	4.58
RED0002	1992/04/07	Sulfate	Dissolved	8.5
RED0002	1992/05/05	Sulfate	Dissolved	3.12
RED0002	1992/06/02	Sulfate	Dissolved	4.5
RED0002	1992/07/14	Sulfate	Dissolved	4.62
RED0002	1992/08/11	Sulfate	Dissolved	4.08
RED0002	1992/09/08	Sulfate	Dissolved	5.83
RED0002	1992/10/06	Sulfate	Dissolved	2.04
RED0002	1992/11/17	Sulfate	Dissolved	4
RED0002	1992/12/01	Sulfate	Dissolved	5.58
RED0002	1993/01/05	Sulfate	Dissolved	7.33
RED0002	1993/02/02	Sulfate	Dissolved	8.4
RED0002	1993/03/02	Sulfate	Dissolved	6.87
RED0002	1993/03/30	Sulfate	Dissolved	5.83
RED0002	1993/05/03	Sulfate	Dissolved	6.33
RED0002	1993/06/28	Sulfate	Dissolved	3.96
RED0002	1993/07/12	Sulfate	Dissolved	4.08
RED0002	1993/08/10	Sulfate	Dissolved	5.08
RED0002	1993/09/14	Sulfate	Dissolved	4.5
RED0002	1993/10/12	Sulfate	Dissolved	4.79
RED0002	1993/11/02	Sulfate	Dissolved	3.46
RED0002	1993/12/07	Sulfate	Dissolved	6.5
RED0002	1994/01/25	Sulfate	Dissolved	7.34
RED0002	1994/02/22	Sulfate	Dissolved	7.1
RED0002	1994/03/22	Sulfate	Dissolved	5.2
RED0002	1994/04/26	Sulfate	Dissolved	7.2
RED0002	1994/05/17	Sulfate	Dissolved	3.7
RED0002	1994/06/21	Sulfate	Dissolved	6.6
RED0002	1994/07/19	Sulfate	Dissolved	<1
RED0002	1994/08/23	Sulfate	Dissolved	4.4
RED0002	1994/09/27	Sulfate	Dissolved	7.8

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1994/10/25	Sulfate	Dissolved	7.5
RED0002	1994/11/21	Sulfate	Dissolved	6.6
RED0002	1994/12/20	Sulfate	Dissolved	4.23
RED0002	1995/01/17	Sulfate	Dissolved	9.6
RED0002	1995/02/06	Sulfate	Dissolved	1.9
RED0002	1995/03/14	Sulfate	Dissolved	6.4
RED0002	1995/04/04	Sulfate	Dissolved	<1.0
RED0002	1995/05/16	Sulfate	Dissolved	6.9
RED0002	1995/06/19	Sulfate	Dissolved	5.3
RED0002	1995/07/11	Sulfate	Dissolved	2.3
RED0002	1995/08/15	Sulfate	Dissolved	1.4
RED0002	1995/09/05	Sulfate	Dissolved	5.2
RED0002	1995/10/03	Sulfate	Dissolved	5.8
RED0002	1995/10/31	Sulfate	Dissolved	5.9
RED0002	1995/12/12	Sulfate	Dissolved	4.8
RED0002	1996/01/16	Sulfate	Dissolved	22.5
RED0002	1996/02/27	Sulfate	Dissolved	16
RED0002	1996/03/26	Sulfate	Dissolved	9.7
RED0002	1996/04/23	Sulfate	Dissolved	6.8
RED0002	1996/05/21	Sulfate	Dissolved	7.6
RED0002	1996/06/18	Sulfate	Dissolved	26.1
RED0002	1996/07/30	Sulfate	Dissolved	25.9
RED0002	1996/08/27	Sulfate	Dissolved	7.8
RED0002	1996/09/17	Sulfate	Dissolved	<1.0
RED0002	1996/10/15	Sulfate	Dissolved	8.2
RED0002	1996/11/05	Sulfate	Dissolved	53.4
RED0002	1996/12/10	Sulfate	Dissolved	7.4
RED0002	1997/01/21	Sulfate	Dissolved	9.3
RED0002	1997/02/11	Sulfate	Dissolved	5.8
RED0002	1997/04/01	Sulfate	Dissolved	6.3
RED0002	1997/04/29	Sulfate	Dissolved	3.5
RED0002	1997/05/12	Sulfate	Dissolved	8.1
RED0002	1997/06/16	Sulfate	Dissolved	9.4
RED0002	1997/07/14	Sulfate	Dissolved	6
RED0002	1997/08/25	Sulfate	Dissolved	3.84
RED0002	1997/09/15	Sulfate	Dissolved	5.51
RED0002	1997/10/14	Sulfate	Dissolved	7.29
RED0002	1997/11/12	Sulfate	Dissolved	4.37
RED0002	1997/12/16	Sulfate	Dissolved	4.583
RED0002	1998/01/20	Sulfate	Dissolved	3.297
RED0002	1998/02/17	Sulfate	Dissolved	4.003
RED0002	1998/03/17	Sulfate	Dissolved	7.24
RED0002	1998/04/14	Sulfate	Dissolved	5.29
RED0002	1998/05/26	Sulfate	Dissolved	4.18
RED0002	1998/06/23	Sulfate	Dissolved	3.992
RED0002	1998/07/14	Sulfate	Dissolved	3.8

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1998/08/11	Sulfate	Dissolved	4.14
RED0002	1998/09/01	Sulfate	Dissolved	4.6
RED0002	1998/10/06	Sulfate	Dissolved	4.46
RED0002	1998/11/03	Sulfate	Dissolved	5.83
RED0002	1998/12/08	Sulfate	Dissolved	4
RED0002	1999/01/05	Sulfate	Dissolved	4.74
RED0002	1999/02/02	Sulfate	Dissolved	4.19
RED0002	1999/03/16	Sulfate	Dissolved	4.65
RED0002	1999/04/27	Sulfate	Dissolved	4.88
RED0002	1999/05/25	Sulfate	Dissolved	4.07
RED0002	1999/06/29	Sulfate	Dissolved	3.57
RED0002	1999/07/27	Sulfate	Dissolved	4.31
RED0002	1999/08/31	Sulfate	Dissolved	4.2
RED0002	1999/09/28	Sulfate	Dissolved	5.42
RED0002	1999/10/26	Sulfate	Dissolved	6.69
RED0002	1999/11/22	Sulfate	Dissolved	5.24
RED0002	1999/12/20	Sulfate	Dissolved	4.48
RED0002	2000/01/25	Sulfate	Dissolved	5.58
RED0002	2000/02/29	Sulfate	Dissolved	6.01
RED0002	2000/03/27	Sulfate	Dissolved	6.65
RED0002	2000/04/24	Sulfate	Dissolved	5.69
RED0002	2000/05/30	Sulfate	Dissolved	4.81
RED0002	2000/06/19	Sulfate	Dissolved	3.69
RED0002	2000/07/25	Sulfate	Dissolved	3.94
RED0002	2000/08/28	Sulfate	Dissolved	3.5
RED0002	2000/09/26	Sulfate	Dissolved	5.2
RED0002	2000/10/24	Sulfate	Dissolved	4.88
RED0002	2000/11/14	Sulfate	Dissolved	5.11
RED0002	2000/12/19	Sulfate	Dissolved	5.1
RED0002	2001/01/16	Sulfate	Dissolved	4.73
RED0002	2001/02/13	Sulfate	Dissolved	4.4
RED0002	2001/03/13	Sulfate	Dissolved	4.46
RED0002	2001/04/17	Sulfate	Dissolved	4.14
RED0002	2001/05/08	Sulfate	Dissolved	6.05
RED0002	2001/06/12	Sulfate	Dissolved	4.33
RED0002	2001/07/10	Sulfate	Dissolved	3.65
RED0002	2001/08/07	Sulfate	Dissolved	3.54
RED0002	2001/09/04	Sulfate	Dissolved	4.32
RED0002	2001/10/09	Sulfate	Dissolved	4.2
RED0002	2001/11/06	Sulfate	Dissolved	4.3
RED0002	2001/12/04	Sulfate	Dissolved	6.34
RED0002	2002/01/02	Sulfate	Dissolved	3.56
RED0002	2002/02/04	Sulfate	Dissolved	4.36
RED0002	2002/03/05	Sulfate	Dissolved	4.51
RED0002	2002/04/02	Sulfate	Dissolved	4.73
RED0002	2002/05/07	Sulfate	Dissolved	3.86

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2002/06/11	Sulfate	Dissolved	3.45
RED0002	2002/07/09	Sulfate	Dissolved	4.15
RED0002	2002/08/13	Sulfate	Dissolved	4.33
RED0002	2002/09/03	Sulfate	Dissolved	4.9
RED0002	2002/10/01	Sulfate	Dissolved	5.54
RED0002	2002/11/05	Sulfate	Dissolved	8.66
RED0002	2002/12/03	Sulfate	Dissolved	6.84
RED0002	2003/01/21	Sulfate	Dissolved	6.33
RED0002	2003/02/18	Sulfate	Dissolved	7.15
RED0002	2003/03/18	Sulfate	Dissolved	6.64
RED0002	2003/04/22	Sulfate	Dissolved	6.33
RED0002	2003/05/27	Sulfate	Dissolved	5.17
RED0002	2003/06/24	Sulfate	Dissolved	4.48
RED0002	2003/07/15	Sulfate	Dissolved	5.26
RED0002	2003/08/12	Sulfate	Dissolved	4.16
RED0002	2003/09/23	Sulfate	Dissolved	4.79
RED0002	2003/10/14	Sulfate	Dissolved	4.8
RED0002	2003/11/12	Sulfate	Dissolved	5.66
RED0002	2003/12/09	Sulfate	Dissolved	4.08
RED0002	2004/01/13	Sulfate	Dissolved	6.38
RED0002	2004/02/17	Sulfate	Dissolved	7.32
RED0002	2004/03/16	Sulfate	Dissolved	8.97
RED0002	2004/04/20	Sulfate	Dissolved	6.63
RED0002	2004/05/18	Sulfate	Dissolved	5.08
RED0002	2004/06/22	Sulfate	Dissolved	3.8
RED0002	2004/07/20	Sulfate	Dissolved	4.09
RED0002	2004/08/10	Sulfate	Dissolved	4.26
RED0002	2004/09/07	Sulfate	Dissolved	4.88
RED0002	2004/10/12	Sulfate	Dissolved	17.7
RED0002	2004/11/16	Sulfate	Dissolved	4.77
RED0002	2004/12/14	Sulfate	Dissolved	5.08
RED0002	2005/01/25	Sulfate	Dissolved	3.94
RED0002	2005/02/22	Sulfate	Dissolved	4.66
RED0002	2005/03/29	Sulfate	Dissolved	5.6
RED0002	2005/04/26	Sulfate	Dissolved	5.5
RED0002	2005/05/24	Sulfate	Dissolved	5.27
RED0002	2005/06/28	Sulfate	Dissolved	3.96
RED0002	2005/07/19	Sulfate	Dissolved	5.27
RED0002	2005/08/23	Sulfate	Dissolved	4.43
RED0002	2005/09/13	Sulfate	Dissolved	4.47
RED0002	2005/10/25	Sulfate	Dissolved	4.94
RED0002	2005/11/29	Sulfate	Dissolved	9.22
RED0002	2005/12/13	Sulfate	Dissolved	6.68
RED0002	2006/01/17	Sulfate	Dissolved	10.5
RED0002	2006/02/14	Sulfate	Dissolved	9.17
RED0002	2006/03/07	Sulfate	Dissolved	9.79

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2006/04/11	Sulfate	Dissolved	5.98
RED0002	2006/05/02	Sulfate	Dissolved	4.71
RED0002	2006/06/06	Sulfate	Dissolved	4.62
RED0002	2006/07/25	Sulfate	Dissolved	4
RED0002	2006/08/29	Sulfate	Dissolved	4.85
RED0002	2006/09/26	Sulfate	Dissolved	5.73
RED0002	2006/10/24	Sulfate	Dissolved	3.9
RED0002	2006/11/14	Sulfate	Dissolved	5.09
RED0002	2006/12/18	Sulfate	Dissolved	5.46
RED0002	2007/01/23	Sulfate	Dissolved	4.5
RED0002	2007/02/27	Sulfate	Dissolved	5.42
RED0002	2007/03/20	Sulfate	Dissolved	5.2
RED0002	2007/04/17	Sulfate	Dissolved	7.13
RED0002	2007/05/08	Sulfate	Dissolved	4.2
RED0002	2007/06/12	Sulfate	Dissolved	4.75
RED0002	2007/07/17	Sulfate	Dissolved	3.49
RED0002	2007/09/25	Sulfate	Dissolved	3.26
RED0002	2007/10/30	Sulfate	Dissolved	4.5
RED0002	2007/11/19	Sulfate	Dissolved	4.21
RED0002	2007/12/11	Sulfate	Dissolved	4.95
RED0002	2008/01/29	Sulfate	Dissolved	5.42
RED0002	2008/02/26	Sulfate	Dissolved	4.6
RED0002	2008/03/25	Sulfate	Dissolved	4.1
RED0002	2008/04/22	Sulfate	Dissolved	3.48
RED0002	2008/05/13	Sulfate	Dissolved	3.52
RED0002	2008/06/03	Sulfate	Dissolved	3.65
RED0002	2008/07/29	Sulfate	Dissolved	3.34
RED0002	2008/08/26	Sulfate	Dissolved	5.23
RED0002	2008/09/16	Sulfate	Dissolved	3.67
RED0002	2008/10/21	Sulfate	Dissolved	4.53
RED0002	2008/11/24	Sulfate	Dissolved	4.48
RED0002	2008/12/17	Sulfate	Dissolved	4.44
RED0002	2009/01/06	Sulfate	Dissolved	3.73
RED0002	2009/02/03	Sulfate	Dissolved	4.55
RED0002	2009/03/03	Sulfate	Dissolved	6.26
RED0002	2009/04/07	Sulfate	Dissolved	5.19
RED0002	2009/05/12	Sulfate	Dissolved	2.72
RED0002	2009/06/30	Sulfate	Dissolved	3.67
RED0002	2009/07/21	Sulfate	Dissolved	4.03
RED0002	2009/08/11	Sulfate	Dissolved	3.25
RED0002	2009/09/15	Sulfate	Dissolved	6.27
RED0002	2009/10/20	Sulfate	Dissolved	3.32
RED0002	2009/11/23	Sulfate	Dissolved	4.79
RED0002	2009/12/15	Sulfate	Dissolved	4.79
RED0002	2010/01/12	Sulfate	Dissolved	4.92
RED0002	2010/02/09	Sulfate	Dissolved	3.86

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2010/03/16	Sulfate	Dissolved	4.95
RED0002	2010/04/13	Sulfate	Dissolved	5.87
RED0002	2010/05/18	Sulfate	Dissolved	5.56
RED0002	2010/06/15	Sulfate	Dissolved	4.08
RED0002	2010/07/13	Sulfate	Dissolved	4.12
RED0002	2010/08/10	Sulfate	Dissolved	3.51
RED0002	2010/09/14	Sulfate	Dissolved	7.05
RED0002	2010/10/19	Sulfate	Dissolved	7
RED0002	2010/11/22	Sulfate	Dissolved	6.16
RED0002	2010/12/28	Sulfate	Dissolved	6.04
RED0002	2011/01/25	Sulfate	Dissolved	3.68
RED0002	2011/02/22	Sulfate	Dissolved	7.26
RED0002	2011/03/08	Sulfate	Dissolved	6.02
RED0002	2011/04/12	Sulfate	Dissolved	5.59
RED0002	2011/05/24	Sulfate	Dissolved	4.06
RED0002	2011/06/28	Sulfate	Dissolved	5.1
RED0002	2011/07/05	Sulfate	Dissolved	4.88
RED0002	2011/08/02	Sulfate	Dissolved	3.36
RED0002	2011/09/06	Sulfate	Dissolved	4.72
RED0002	2011/10/04	Sulfate	Dissolved	5.11
RED0002	2011/11/15	Sulfate	Dissolved	6.59
RED0002	2011/12/12	Sulfate	Dissolved	3.81
RED0002	2012/01/17	Sulfate	Dissolved	5.16
RED0002	2012/02/21	Sulfate	Dissolved	5.74
RED0002	2012/03/20	Sulfate	Dissolved	4.12
RED0002	2012/04/17	Sulfate	Dissolved	5.21
RED0002	2012/05/01	Sulfate	Dissolved	6.23
RED0002	2012/06/05	Sulfate	Dissolved	4.94
RED0002	2012/07/24	Sulfate	Dissolved	4.11
RED0002	2012/08/14	Sulfate	Dissolved	4.29
RED0002	2012/09/04	Sulfate	Dissolved	4.73
RED0002	2012/10/02	Sulfate	Dissolved	4.42
RED0002	2012/11/27	Sulfate	Dissolved	5.08
RED0002	2012/12/10	Sulfate	Dissolved	6.13
RED0002	2013/01/29	Sulfate	Dissolved	3.85
RED0002	2013/02/19	Sulfate	Dissolved	5.07
RED0002	2013/03/19	Sulfate	Dissolved	5.57
RED0002	2013/04/16	Sulfate	Dissolved	3.82
RED0002	2013/05/21	Sulfate	Dissolved	5.03
RED0002	2013/06/04	Sulfate	Dissolved	3.15
RED0002	2013/07/01	Sulfate	Dissolved	3.95

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1990/09/04	TDS	Total	56
RED0002	1990/10/02	TDS	Total	42
RED0002	1990/10/30	TDS	Total	57
RED0002	1990/11/27	TDS	Total	42
RED0002	1991/01/22	TDS	Total	42
RED0002	1991/02/05	TDS	Total	52
RED0002	1991/03/19	TDS	Total	51
RED0002	1991/04/23	TDS	Total	42
RED0002	1991/05/21	TDS	Total	48
RED0002	1991/06/18	TDS	Total	67
RED0002	1991/07/02	TDS	Total	82
RED0002	1991/08/20	TDS	Total	55
RED0002	1991/09/17	TDS	Total	24
RED0002	1991/10/15	TDS	Total	41
RED0002	1991/12/03	TDS	Total	59
RED0002	1992/01/21	TDS	Total	61
RED0002	1992/02/04	TDS	Total	46
RED0002	1992/03/03	TDS	Total	43
RED0002	1992/04/07	TDS	Total	66
RED0002	1992/05/05	TDS	Total	38
RED0002	1992/06/02	TDS	Total	46
RED0002	1992/07/14	TDS	Total	53
RED0002	1992/08/11	TDS	Total	47
RED0002	1992/09/08	TDS	Total	38
RED0002	1992/10/06	TDS	Total	34
RED0002	1992/11/17	TDS	Total	76
RED0002	1992/12/01	TDS	Total	33
RED0002	1993/01/05	TDS	Total	61
RED0002	1993/02/02	TDS	Total	42
RED0002	1993/03/02	TDS	Total	52
RED0002	1993/03/30	TDS	Total	32
RED0002	1993/05/03	TDS	Total	37
RED0002	1993/06/28	TDS	Total	52
RED0002	1993/07/12	TDS	Total	42
RED0002	1993/08/10	TDS	Total	81
RED0002	1993/09/14	TDS	Total	51
RED0002	1993/10/12	TDS	Total	36
RED0002	1993/11/02	TDS	Total	42
RED0002	1993/12/07	TDS	Total	58
RED0002	1994/01/25	TDS	Total	55
RED0002	1994/02/22	TDS	Total	80
RED0002	1994/03/22	TDS	Total	46
RED0002	1994/04/26	TDS	Total	61
RED0002	1994/05/17	TDS	Total	47
RED0002	1994/06/21	TDS	Total	40
RED0002	1994/07/19	TDS	Total	53

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1994/08/23	TDS	Total	43
RED0002	1994/09/27	TDS	Total	66
RED0002	1994/10/25	TDS	Total	72
RED0002	1994/11/21	TDS	Total	41
RED0002	1994/12/20	TDS	Total	44
RED0002	1995/01/17	TDS	Total	51
RED0002	1995/02/06	TDS	Total	43
RED0002	1995/03/14	TDS	Total	52
RED0002	1995/04/04	TDS	Total	36
RED0002	1995/05/16	TDS	Total	41
RED0002	1995/06/19	TDS	Total	49
RED0002	1995/07/11	TDS	Total	57
RED0002	1995/08/15	TDS	Total	45
RED0002	1995/09/05	TDS	Total	38
RED0002	1995/10/03	TDS	Total	45
RED0002	1995/10/31	TDS	Total	56
RED0002	1995/12/12	TDS	Total	34
RED0002	1996/01/16	TDS	Total	65
RED0002	1996/02/27	TDS	Total	69
RED0002	1996/03/26	TDS	Total	63
RED0002	1996/04/23	TDS	Total	50
RED0002	1996/05/21	TDS	Total	42
RED0002	1996/06/18	TDS	Total	75
RED0002	1996/07/30	TDS	Total	72
RED0002	1996/08/27	TDS	Total	37
RED0002	1996/09/17	TDS	Total	22
RED0002	1996/10/15	TDS	Total	63
RED0002	1996/11/05	TDS	Total	113
RED0002	1996/12/10	TDS	Total	42
RED0002	1997/01/21	TDS	Total	68
RED0002	1997/02/11	TDS	Total	38
RED0002	1997/04/01	TDS	Total	46
RED0002	1997/04/29	TDS	Total	46
RED0002	1997/05/12	TDS	Total	82
RED0002	1997/06/16	TDS	Total	71
RED0002	1997/07/14	TDS	Total	67
RED0002	1997/08/25	TDS	Total	51
RED0002	1997/09/15	TDS	Total	55
RED0002	1997/10/14	TDS	Total	75
RED0002	1997/11/12	TDS	Total	45
RED0002	1997/12/16	TDS	Total	49
RED0002	1998/01/20	TDS	Total	40
RED0002	1998/02/17	TDS	Total	44
RED0002	1998/03/17	TDS	Total	70
RED0002	1998/04/14	TDS	Total	55
RED0002	1998/05/26	TDS	Total	52

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	1998/06/23	TDS	Total	39
RED0002	1998/07/14	TDS	Total	50
RED0002	1998/08/11	TDS	Total	46
RED0002	1998/09/01	TDS	Total	40
RED0002	1998/10/06	TDS	Total	62
RED0002	1998/11/03	TDS	Total	65
RED0002	1998/12/08	TDS	Total	41
RED0002	1999/01/05	TDS	Total	42
RED0002	1999/02/02	TDS	Total	41
RED0002	1999/03/16	TDS	Total	47
RED0002	1999/04/27	TDS	Total	67
RED0002	1999/05/25	TDS	Total	35
RED0002	1999/06/29	TDS	Total	47
RED0002	1999/07/27	TDS	Total	37
RED0002	1999/08/31	TDS	Total	52
RED0002	1999/09/28	TDS	Total	51
RED0002	1999/10/26	TDS	Total	79.5
RED0002	1999/11/22	TDS	Total	49
RED0002	1999/12/20	TDS	Total	43.5
RED0002	2000/01/25	TDS	Total	30.5
RED0002	2000/02/29	TDS	Total	57.5
RED0002	2000/03/27	TDS	Total	59
RED0002	2000/04/24	TDS	Total	62.5
RED0002	2000/05/30	TDS	Total	71
RED0002	2000/07/25	TDS	Total	50
RED0002	2000/08/28	TDS	Total	37
RED0002	2000/09/26	TDS	Total	53
RED0002	2000/10/24	TDS	Total	55.5
RED0002	2000/11/14	TDS	Total	60.5
RED0002	2000/12/19	TDS	Total	44
RED0002	2001/01/16	TDS	Total	54
RED0002	2001/02/13	TDS	Total	46
RED0002	2001/03/13	TDS	Total	52.5
RED0002	2001/04/17	TDS	Total	45.5
RED0002	2001/05/08	TDS	Total	75
RED0002	2001/06/12	TDS	Total	55
RED0002	2001/07/10	TDS	Total	40.5
RED0002	2001/08/07	TDS	Total	39
RED0002	2001/09/04	TDS	Total	52
RED0002	2001/10/09	TDS	Total	45.5
RED0002	2001/11/06	TDS	Total	51.5
RED0002	2001/12/04	TDS	Total	73
RED0002	2002/01/02	TDS	Total	40
RED0002	2002/02/04	TDS	Total	61
RED0002	2002/03/05	TDS	Total	53.5
RED0002	2002/04/02	TDS	Total	58

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2002/05/07	TDS	Total	40
RED0002	2002/06/11	TDS	Total	57
RED0002	2002/07/09	TDS	Total	48.5
RED0002	2002/08/13	TDS	Total	46
RED0002	2002/09/03	TDS	Total	51
RED0002	2002/10/01	TDS	Total	56
RED0002	2002/11/05	TDS	Total	88
RED0002	2002/12/03	TDS	Total	74
RED0002	2003/01/21	TDS	Total	54
RED0002	2003/02/18	TDS	Total	52.5
RED0002	2003/03/18	TDS	Total	61.5
RED0002	2003/04/22	TDS	Total	65
RED0002	2003/05/27	TDS	Total	57
RED0002	2003/06/24	TDS	Total	52
RED0002	2003/07/15	TDS	Total	50
RED0002	2003/08/12	TDS	Total	38
RED0002	2003/09/23	TDS	Total	59.5
RED0002	2003/10/14	TDS	Total	49.5
RED0002	2003/11/12	TDS	Total	63
RED0002	2003/12/09	TDS	Total	34.5
RED0002	2004/01/13	TDS	Total	64
RED0002	2004/02/17	TDS	Total	87
RED0002	2004/03/16	TDS	Total	92
RED0002	2004/04/20	TDS	Total	83.5
RED0002	2004/05/18	TDS	Total	60
RED0002	2004/06/22	TDS	Total	80.5
RED0002	2004/07/20	TDS	Total	62.5
RED0002	2004/08/10	TDS	Total	64.5
RED0002	2004/09/07	TDS	Total	48
RED0002	2004/10/12	TDS	Total	85.5
RED0002	2004/11/16	TDS	Total	64
RED0002	2004/12/14	TDS	Total	50
RED0002	2005/01/25	TDS	Total	48
RED0002	2005/02/22	TDS	Total	52
RED0002	2005/03/29	TDS	Total	65.5
RED0002	2005/04/26	TDS	Total	73
RED0002	2005/05/24	TDS	Total	66.5
RED0002	2005/06/28	TDS	Total	48
RED0002	2005/07/19	TDS	Total	59
RED0002	2005/08/23	TDS	Total	54
RED0002	2005/09/13	TDS	Total	47.5
RED0002	2005/10/25	TDS	Total	55
RED0002	2005/11/29	TDS	Total	70.5
RED0002	2005/12/13	TDS	Total	62.5
RED0002	2006/01/17	TDS	Total	74
RED0002	2006/02/14	TDS	Total	85.5

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2006/03/07	TDS	Total	97
RED0002	2006/04/11	TDS	Total	60.5
RED0002	2006/05/02	TDS	Total	69.5
RED0002	2006/06/06	TDS	Total	60
RED0002	2006/07/25	TDS	Total	44.5
RED0002	2006/08/29	TDS	Total	52.5
RED0002	2006/09/26	TDS	Total	62.5
RED0002	2006/10/24	TDS	Total	48.5
RED0002	2006/11/14	TDS	Total	48
RED0002	2006/12/18	TDS	Total	53
RED0002	2007/01/23	TDS	Total	41.5
RED0002	2007/02/27	TDS	Total	49
RED0002	2007/03/20	TDS	Total	50.5
RED0002	2007/04/17	TDS	Total	70.5
RED0002	2007/05/08	TDS	Total	39
RED0002	2007/06/12	TDS	Total	61.5
RED0002	2007/07/17	TDS	Total	45
RED0002	2007/09/25	TDS	Total	49
RED0002	2007/10/30	TDS	Total	65
RED0002	2007/11/19	TDS	Total	61.5
RED0002	2007/12/11	TDS	Total	61.5
RED0002	2008/01/29	TDS	Total	54
RED0002	2008/02/26	TDS	Total	35
RED0002	2008/03/25	TDS	Total	62
RED0002	2008/04/22	TDS	Total	44
RED0002	2008/05/13	TDS	Total	50.5
RED0002	2008/06/03	TDS	Total	47
RED0002	2008/07/29	TDS	Total	38
RED0002	2008/08/26	TDS	Total	67
RED0002	2008/09/16	TDS	Total	58
RED0002	2008/10/21	TDS	Total	59
RED0002	2008/11/24	TDS	Total	51.5
RED0002	2008/12/17	TDS	Total	33
RED0002	2009/01/06	TDS	Total	32
RED0002	2009/02/03	TDS	Total	44
RED0002	2009/03/03	TDS	Total	65
RED0002	2009/04/07	TDS	Total	50
RED0002	2009/05/12	TDS	Total	55
RED0002	2009/06/30	TDS	Total	60
RED0002	2009/07/21	TDS	Total	61
RED0002	2009/08/11	TDS	Total	43.5
RED0002	2009/09/15	TDS	Total	112
RED0002	2009/10/20	TDS	Total	45
RED0002	2009/11/23	TDS	Total	61
RED0002	2009/12/15	TDS	Total	54
RED0002	2010/01/12	TDS	Total	54

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0002	2010/02/09	TDS	Total	59
RED0002	2010/03/16	TDS	Total	47
RED0002	2010/04/13	TDS	Total	67
RED0002	2010/05/18	TDS	Total	74
RED0002	2010/06/15	TDS	Total	38
RED0002	2010/07/13	TDS	Total	48
RED0002	2010/08/10	TDS	Total	59
RED0002	2010/09/14	TDS	Total	110
RED0002	2010/10/19	TDS	Total	70
RED0002	2010/11/22	TDS	Total	78
RED0002	2010/12/28	TDS	Total	71
RED0002	2011/01/25	TDS	Total	10
RED0002	2011/02/22	TDS	Total	76
RED0002	2011/03/08	TDS	Total	24
RED0002	2011/04/12	TDS	Total	69
RED0002	2011/05/24	TDS	Total	32
RED0002	2011/06/28	TDS	Total	35
RED0002	2011/07/05	TDS	Total	38
RED0002	2011/08/02	TDS	Total	47
RED0002	2011/09/06	TDS	Total	66
RED0002	2011/10/04	TDS	Total	30
RED0002	2011/11/15	TDS	Total	100
RED0002	2011/12/12	TDS	Total	12
RED0002	2012/01/17	TDS	Total	51
RED0002	2012/02/21	TDS	Total	61
RED0002	2012/03/20	TDS	Total	42
RED0002	2012/04/17	TDS	Total	72
RED0002	2012/05/01	TDS	Total	75
RED0002	2012/06/05	TDS	Total	50
RED0002	2012/07/24	TDS	Total	44
RED0002	2012/08/14	TDS	Total	45
RED0002	2012/09/04	TDS	Total	52
RED0002	2012/10/02	TDS	Total	41
RED0002	2012/11/27	TDS	Total	45
RED0002	2012/12/10	TDS	Total	57
RED0002	2013/01/29	TDS	Total	31
RED0002	2013/02/19	TDS	Total	38
RED0002	2013/03/19	TDS	Total	46
RED0002	2013/04/16	TDS	Total	38
RED0002	2013/05/21	TDS	Total	60
RED0002	2013/06/04	TDS	Total	49
RED0002	2013/07/01	TDS	Total	61

Appendix B.2. ADEQ historical monitoring data for dissolved minerals at RED0022.

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1991/01/22	Chloride	Dissolved	2.24
RED0022	1991/02/05	Chloride	Dissolved	2.81
RED0022	1991/03/19	Chloride	Dissolved	3.8
RED0022	1991/04/23	Chloride	Dissolved	2.57
RED0022	1991/05/21	Chloride	Dissolved	3.59
RED0022	1991/06/18	Chloride	Dissolved	R
RED0022	1991/07/02	Chloride	Dissolved	2.71
RED0022	1991/08/20	Chloride	Dissolved	3.04
RED0022	1991/12/03	Chloride	Dissolved	2.11
RED0022	1992/01/21	Chloride	Dissolved	2.51
RED0022	1992/02/04	Chloride	Dissolved	3.42
RED0022	1992/03/03	Chloride	Dissolved	2.06
RED0022	1992/03/10	Chloride	Dissolved	2.25
RED0022	1992/04/07	Chloride	Dissolved	2.73
RED0022	1992/05/05	Chloride	Dissolved	2
RED0022	1992/06/02	Chloride	Dissolved	2.57
RED0022	1992/07/14	Chloride	Dissolved	2.14
RED0022	1992/08/11	Chloride	Dissolved	2.35
RED0022	1992/09/08	Chloride	Dissolved	2.13
RED0022	1992/10/06	Chloride	Dissolved	2.13
RED0022	1992/11/17	Chloride	Dissolved	2.24
RED0022	1992/12/01	Chloride	Dissolved	2.2
RED0022	1993/01/05	Chloride	Dissolved	2.73
RED0022	1993/02/02	Chloride	Dissolved	2.26
RED0022	1993/03/02	Chloride	Dissolved	2.29
RED0022	1993/03/30	Chloride	Dissolved	2.38
RED0022	1993/05/03	Chloride	Dissolved	1.61
RED0022	1993/06/28	Chloride	Dissolved	2.44
RED0022	1993/07/12	Chloride	Dissolved	2.22
RED0022	1993/08/10	Chloride	Dissolved	2.06
RED0022	1993/09/14	Chloride	Dissolved	1.72
RED0022	1993/10/12	Chloride	Dissolved	2.95
RED0022	1993/11/02	Chloride	Dissolved	1.85
RED0022	1993/12/07	Chloride	Dissolved	2.2
RED0022	1994/01/25	Chloride	Dissolved	2.23
RED0022	1994/02/22	Chloride	Dissolved	4.03
RED0022	1994/03/22	Chloride	Dissolved	2.38
RED0022	1994/04/26	Chloride	Dissolved	2.37
RED0022	1994/05/17	Chloride	Dissolved	2.4
RED0022	1994/06/21	Chloride	Dissolved	2.27
RED0022	1994/07/19	Chloride	Dissolved	2.38
RED0022	1994/08/23	Chloride	Dissolved	2.32
RED0022	1994/09/27	Chloride	Dissolved	2.47
RED0022	1994/10/25	Chloride	Dissolved	3.32

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1994/11/21	Chloride	Dissolved	2.26
RED0022	1994/12/20	Chloride	Dissolved	2.42
RED0022	1995/01/17	Chloride	Dissolved	2.433
RED0022	1995/02/06	Chloride	Dissolved	2.369
RED0022	1995/03/14	Chloride	Dissolved	2.925
RED0022	1995/04/04	Chloride	Dissolved	2.803
RED0022	1995/05/16	Chloride	Dissolved	1.654
RED0022	1995/06/20	Chloride	Dissolved	2.749
RED0022	1995/07/11	Chloride	Dissolved	1.874
RED0022	1995/08/15	Chloride	Dissolved	2.452
RED0022	1995/09/05	Chloride	Dissolved	2.331
RED0022	1995/10/03	Chloride	Dissolved	2.514
RED0022	1995/10/31	Chloride	Dissolved	2.273
RED0022	1995/12/12	Chloride	Dissolved	3.103
RED0022	1996/01/16	Chloride	Dissolved	4.534
RED0022	1996/02/27	Chloride	Dissolved	2.366
RED0022	1996/03/26	Chloride	Dissolved	4.458
RED0022	1996/04/23	Chloride	Dissolved	4.06
RED0022	1996/05/21	Chloride	Dissolved	3.529
RED0022	1996/06/18	Chloride	Dissolved	3.807
RED0022	1996/07/30	Chloride	Dissolved	2.939
RED0022	1996/08/27	Chloride	Dissolved	2.588
RED0022	1996/09/17	Chloride	Dissolved	2.37
RED0022	1996/10/15	Chloride	Dissolved	2.752
RED0022	1996/11/05	Chloride	Dissolved	5.293
RED0022	1996/12/10	Chloride	Dissolved	2.078
RED0022	1997/01/21	Chloride	Dissolved	2.706
RED0022	1997/02/11	Chloride	Dissolved	3.523
RED0022	1997/04/01	Chloride	Dissolved	2.305
RED0022	1997/04/29	Chloride	Dissolved	2.503
RED0022	1997/05/12	Chloride	Dissolved	1.94
RED0022	1997/06/16	Chloride	Dissolved	2.562R
RED0022	1997/07/14	Chloride	Dissolved	2.821
RED0022	1997/08/25	Chloride	Dissolved	2.38
RED0022	1997/08/25	Chloride	Dissolved	2.71
RED0022	1997/09/15	Chloride	Dissolved	2.34
RED0022	1997/10/14	Chloride	Dissolved	3.19
RED0022	1997/11/12	Chloride	Dissolved	4.123
RED0022	1997/12/16	Chloride	Dissolved	3.276
RED0022	1998/01/20	Chloride	Dissolved	2.977
RED0022	1998/02/17	Chloride	Dissolved	3.256
RED0022	1998/03/17	Chloride	Dissolved	2.8
RED0022	1998/04/14	Chloride	Dissolved	4.442
RED0022	1998/05/26	Chloride	Dissolved	3.18
RED0022	1998/06/23	Chloride	Dissolved	2.196
RED0022	1998/07/14	Chloride	Dissolved	2.61

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1998/08/11	Chloride	Dissolved	3.26
RED0022	1998/09/01	Chloride	Dissolved	2.27
RED0022	1998/09/01	Chloride	Dissolved	3
RED0022	1998/10/06	Chloride	Dissolved	2.91
RED0022	1998/11/03	Chloride	Dissolved	3.81
RED0022	1998/12/08	Chloride	Dissolved	2.6
RED0022	1999/01/05	Chloride	Dissolved	2.88
RED0022	1999/02/02	Chloride	Dissolved	2.67
RED0022	1999/03/16	Chloride	Dissolved	2.62
RED0022	1999/04/27	Chloride	Dissolved	2.48
RED0022	1999/05/25	Chloride	Dissolved	2.27
RED0022	1999/06/29	Chloride	Dissolved	1.59
RED0022	1999/07/27	Chloride	Dissolved	2.13
RED0022	1999/08/31	Chloride	Dissolved	1.71
RED0022	1999/09/28	Chloride	Dissolved	1.97
RED0022	1999/10/26	Chloride	Dissolved	2.19
RED0022	1999/11/22	Chloride	Dissolved	2.3
RED0022	1999/12/20	Chloride	Dissolved	2.46
RED0022	2000/01/25	Chloride	Dissolved	2.18
RED0022	2000/02/29	Chloride	Dissolved	1.91
RED0022	2000/03/27	Chloride	Dissolved	2.3
RED0022	2000/04/24	Chloride	Dissolved	2.67
RED0022	2000/05/30	Chloride	Dissolved	2.73
RED0022	2000/06/19	Chloride	Dissolved	1.95
RED0022	2000/07/25	Chloride	Dissolved	2.84
RED0022	2000/08/28	Chloride	Dissolved	2.55
RED0022	2000/09/26	Chloride	Dissolved	2.08
RED0022	2000/10/24	Chloride	Dissolved	2.25
RED0022	2000/11/14	Chloride	Dissolved	2.07
RED0022	2000/12/19	Chloride	Dissolved	2.29
RED0022	2001/01/16	Chloride	Dissolved	1.86
RED0022	2001/02/13	Chloride	Dissolved	2.29
RED0022	2001/03/13	Chloride	Dissolved	1.6
RED0022	2001/04/17	Chloride	Dissolved	1.79
RED0022	2001/05/08	Chloride	Dissolved	2.34
RED0022	2001/06/12	Chloride	Dissolved	2.11
RED0022	2001/07/10	Chloride	Dissolved	2.27
RED0022	2001/08/07	Chloride	Dissolved	2.06
RED0022	2001/09/04	Chloride	Dissolved	2.17
RED0022	2001/10/09	Chloride	Dissolved	2.81
RED0022	2001/11/06	Chloride	Dissolved	2.3
RED0022	2001/12/04	Chloride	Dissolved	1.97
RED0022	2002/01/02	Chloride	Dissolved	1.55
RED0022	2002/02/04	Chloride	Dissolved	1.67
RED0022	2002/03/05	Chloride	Dissolved	2.04
RED0022	2002/04/02	Chloride	Dissolved	1.77

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2002/05/07	Chloride	Dissolved	2.08
RED0022	2002/06/11	Chloride	Dissolved	1.64
RED0022	2002/07/09	Chloride	Dissolved	2.29
RED0022	2002/08/13	Chloride	Dissolved	1.94
RED0022	2002/08/20	Chloride	Dissolved	1.88
RED0022	2002/09/03	Chloride	Dissolved	1.88
RED0022	2002/10/01	Chloride	Dissolved	2.32
RED0022	2002/11/05	Chloride	Dissolved	2.77
RED0022	2002/12/03	Chloride	Dissolved	2.35
RED0022	2003/01/21	Chloride	Dissolved	2.38
RED0022	2003/02/18	Chloride	Dissolved	2.66
RED0022	2003/03/18	Chloride	Dissolved	2.16
RED0022	2003/04/22	Chloride	Dissolved	2.54
RED0022	2003/05/27	Chloride	Dissolved	1.94
RED0022	2003/06/24	Chloride	Dissolved	1.53
RED0022	2003/07/15	Chloride	Dissolved	2.27
RED0022	2003/08/12	Chloride	Dissolved	1.96
RED0022	2003/09/23	Chloride	Dissolved	2.32
RED0022	2003/10/14	Chloride	Dissolved	2.33
RED0022	2003/11/12	Chloride	Dissolved	1.91
RED0022	2003/12/09	Chloride	Dissolved	2.03
RED0022	2004/01/13	Chloride	Dissolved	2.39
RED0022	2004/02/17	Chloride	Dissolved	1.77
RED0022	2004/03/16	Chloride	Dissolved	2.29
RED0022	2004/04/20	Chloride	Dissolved	2.87
RED0022	2004/05/18	Chloride	Dissolved	2.09
RED0022	2004/06/22	Chloride	Dissolved	2.07
RED0022	2004/07/20	Chloride	Dissolved	2.4
RED0022	2004/08/10	Chloride	Dissolved	2.37
RED0022	2004/09/07	Chloride	Dissolved	2.31
RED0022	2004/10/12	Chloride	Dissolved	2.44
RED0022	2004/11/16	Chloride	Dissolved	2.05
RED0022	2004/12/14	Chloride	Dissolved	1.98
RED0022	2005/01/25	Chloride	Dissolved	1.72
RED0022	2005/02/22	Chloride	Dissolved	2.56
RED0022	2005/03/29	Chloride	Dissolved	1.83
RED0022	2005/04/26	Chloride	Dissolved	2.27
RED0022	2005/05/24	Chloride	Dissolved	2.69
RED0022	2005/06/28	Chloride	Dissolved	2.59
RED0022	2005/07/19	Chloride	Dissolved	2.2
RED0022	2005/08/23	Chloride	Dissolved	2.2
RED0022	2005/09/13	Chloride	Dissolved	2.26
RED0022	2005/10/25	Chloride	Dissolved	2.31
RED0022	2005/11/29	Chloride	Dissolved	2.72
RED0022	2005/12/13	Chloride	Dissolved	2.81
RED0022	2006/01/17	Chloride	Dissolved	2.56

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2006/02/14	Chloride	Dissolved	2.3
RED0022	2006/03/07	Chloride	Dissolved	2.26
RED0022	2006/04/11	Chloride	Dissolved	1.81
RED0022	2006/05/02	Chloride	Dissolved	1.6
RED0022	2006/06/06	Chloride	Dissolved	2.62
RED0022	2006/07/25	Chloride	Dissolved	2.32
RED0022	2006/08/29	Chloride	Dissolved	2.11
RED0022	2006/09/26	Chloride	Dissolved	2.12
RED0022	2006/10/24	Chloride	Dissolved	2.77
RED0022	2006/11/14	Chloride	Dissolved	2.25
RED0022	2006/12/18	Chloride	Dissolved	2.89
RED0022	2007/01/23	Chloride	Dissolved	1.76
RED0022	2007/02/27	Chloride	Dissolved	2.48
RED0022	2007/03/20	Chloride	Dissolved	2.91
RED0022	2007/04/17	Chloride	Dissolved	2.03
RED0022	2007/05/08	Chloride	Dissolved	1.75
RED0022	2007/06/12	Chloride	Dissolved	2.35
RED0022	2007/07/17	Chloride	Dissolved	1.84
RED0022	2007/09/25	Chloride	Dissolved	2.58
RED0022	2007/10/30	Chloride	Dissolved	2.1
RED0022	2007/11/19	Chloride	Dissolved	2.77
RED0022	2007/12/11	Chloride	Dissolved	2.42
RED0022	2008/01/29	Chloride	Dissolved	2.95
RED0022	2008/02/26	Chloride	Dissolved	2.02
RED0022	2008/03/25	Chloride	Dissolved	1.62
RED0022	2008/04/22	Chloride	Dissolved	1.4
RED0022	2008/05/13	Chloride	Dissolved	1.68
RED0022	2008/06/03	Chloride	Dissolved	2.84
RED0022	2008/07/29	Chloride	Dissolved	2.3
RED0022	2008/08/26	Chloride	Dissolved	1.71
RED0022	2008/09/16	Chloride	Dissolved	1.52
RED0022	2008/10/21	Chloride	Dissolved	2.16
RED0022	2008/11/24	Chloride	Dissolved	2.76
RED0022	2008/12/17	Chloride	Dissolved	2.87
RED0022	2009/01/06	Chloride	Dissolved	2.91
RED0022	2009/02/03	Chloride	Dissolved	2.14
RED0022	2009/03/03	Chloride	Dissolved	2.7
RED0022	2009/04/07	Chloride	Dissolved	2.28
RED0022	2009/05/12	Chloride	Dissolved	2.09
RED0022	2009/06/30	Chloride	Dissolved	2.78
RED0022	2009/07/21	Chloride	Dissolved	2.42
RED0022	2009/08/11	Chloride	Dissolved	1.93
RED0022	2009/09/15	Chloride	Dissolved	2.86
RED0022	2009/10/20	Chloride	Dissolved	1.81
RED0022	2009/11/23	Chloride	Dissolved	2.13
RED0022	2009/12/15	Chloride	Dissolved	2.03

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2010/01/12	Chloride	Dissolved	3.75
RED0022	2010/02/09	Chloride	Dissolved	1.59
RED0022	2010/03/16	Chloride	Dissolved	2.06
RED0022	2010/04/13	Chloride	Dissolved	2.3
RED0022	2010/05/18	Chloride	Dissolved	1.74
RED0022	2010/06/15	Chloride	Dissolved	1.59
RED0022	2010/07/13	Chloride	Dissolved	2.32
RED0022	2010/08/10	Chloride	Dissolved	2.09
RED0022	2010/09/14	Chloride	Dissolved	2.04
RED0022	2010/10/19	Chloride	Dissolved	2.08
RED0022	2010/11/22	Chloride	Dissolved	2.08
RED0022	2010/12/28	Chloride	Dissolved	2.35
RED0022	2011/01/25	Chloride	Dissolved	2.99
RED0022	2011/02/22	Chloride	Dissolved	2.49
RED0022	2011/03/08	Chloride	Dissolved	2.32
RED0022	2011/04/12	Chloride	Dissolved	2.9
RED0022	2011/05/24	Chloride	Dissolved	1.95
RED0022	2011/06/28	Chloride	Dissolved	2.46
RED0022	2011/07/05	Chloride	Dissolved	2.34
RED0022	2011/08/02	Chloride	Dissolved	2.72
RED0022	2011/09/06	Chloride	Dissolved	2.31
RED0022	2011/10/04	Chloride	Dissolved	2.25
RED0022	2011/11/15	Chloride	Dissolved	2.77
RED0022	2011/12/12	Chloride	Dissolved	2.05
RED0022	2012/01/17	Chloride	Dissolved	2.84
RED0022	2012/02/21	Chloride	Dissolved	2.53
RED0022	2012/03/20	Chloride	Dissolved	2.01
RED0022	2012/04/17	Chloride	Dissolved	2.32
RED0022	2012/05/01	Chloride	Dissolved	2.99
RED0022	2012/06/05	Chloride	Dissolved	2.73
RED0022	2012/07/24	Chloride	Dissolved	2.22
RED0022	2012/08/14	Chloride	Dissolved	2.14
RED0022	2012/09/04	Chloride	Dissolved	2.17
RED0022	2012/10/02	Chloride	Dissolved	2.26
RED0022	2012/11/27	Chloride	Dissolved	2.61
RED0022	2012/12/10	Chloride	Dissolved	2.53
RED0022	2013/01/29	Chloride	Dissolved	2.83
RED0022	2013/02/19	Chloride	Dissolved	2.65
RED0022	2013/03/19	Chloride	Dissolved	2.33
RED0022	2013/04/16	Chloride	Dissolved	1.98
RED0022	2013/05/21	Chloride	Dissolved	2.01
RED0022	2013/06/04	Chloride	Dissolved	1.13
RED0022	2013/07/01	Chloride	Dissolved	2.52

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1991/01/22	Sulfate	Dissolved	4
RED0022	1991/02/05	Sulfate	Dissolved	4
RED0022	1991/03/19	Sulfate	Dissolved	4
RED0022	1991/04/23	Sulfate	Dissolved	4
RED0022	1991/05/21	Sulfate	Dissolved	3
RED0022	1991/06/18	Sulfate	Dissolved	3
RED0022	1991/07/02	Sulfate	Dissolved	3
RED0022	1991/08/20	Sulfate	Dissolved	2
RED0022	1991/12/03	Sulfate	Dissolved	6.12
RED0022	1992/01/21	Sulfate	Dissolved	3.56
RED0022	1992/02/04	Sulfate	Dissolved	2.42
RED0022	1992/03/03	Sulfate	Dissolved	2.29
RED0022	1992/03/10	Sulfate	Dissolved	6.79
RED0022	1992/04/07	Sulfate	Dissolved	4.62
RED0022	1992/05/05	Sulfate	Dissolved	3.12
RED0022	1992/06/02	Sulfate	Dissolved	3.12
RED0022	1992/07/14	Sulfate	Dissolved	3.21
RED0022	1992/08/11	Sulfate	Dissolved	2.04
RED0022	1992/09/08	Sulfate	Dissolved	3.96
RED0022	1992/10/06	Sulfate	Dissolved	2.04
RED0022	1992/11/17	Sulfate	Dissolved	<1
RED0022	1992/12/01	Sulfate	Dissolved	3.96
RED0022	1993/01/05	Sulfate	Dissolved	5.79
RED0022	1993/02/02	Sulfate	Dissolved	8.4
RED0022	1993/03/02	Sulfate	Dissolved	3.71
RED0022	1993/03/30	Sulfate	Dissolved	4.08
RED0022	1993/05/03	Sulfate	Dissolved	3.46
RED0022	1993/06/28	Sulfate	Dissolved	1.5
RED0022	1993/07/12	Sulfate	Dissolved	2.67
RED0022	1993/08/10	Sulfate	Dissolved	2.04
RED0022	1993/09/14	Sulfate	Dissolved	2.25
RED0022	1993/10/12	Sulfate	Dissolved	7.33
RED0022	1993/11/02	Sulfate	Dissolved	3.46
RED0022	1993/12/07	Sulfate	Dissolved	5.08
RED0022	1994/01/25	Sulfate	Dissolved	5.44
RED0022	1994/02/22	Sulfate	Dissolved	7.1
RED0022	1994/03/22	Sulfate	Dissolved	3.7
RED0022	1994/04/26	Sulfate	Dissolved	3.8
RED0022	1994/05/17	Sulfate	Dissolved	2.6
RED0022	1994/06/21	Sulfate	Dissolved	6.6
RED0022	1994/07/19	Sulfate	Dissolved	2.1
RED0022	1994/08/23	Sulfate	Dissolved	3.4
RED0022	1994/09/27	Sulfate	Dissolved	4.3
RED0022	1994/10/25	Sulfate	Dissolved	6.3
RED0022	1994/11/21	Sulfate	Dissolved	5.5
RED0022	1994/12/20	Sulfate	Dissolved	3.24

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1995/01/17	Sulfate	Dissolved	6.8
RED0022	1995/02/06	Sulfate	Dissolved	1.9
RED0022	1995/03/14	Sulfate	Dissolved	5
RED0022	1995/04/04	Sulfate	Dissolved	1.3
RED0022	1995/05/16	Sulfate	Dissolved	6.9
RED0022	1995/06/20	Sulfate	Dissolved	4.1
RED0022	1995/07/11	Sulfate	Dissolved	3.5
RED0022	1995/08/15	Sulfate	Dissolved	1.4
RED0022	1995/09/05	Sulfate	Dissolved	4
RED0022	1995/10/03	Sulfate	Dissolved	4.5
RED0022	1995/10/31	Sulfate	Dissolved	2.3
RED0022	1995/12/12	Sulfate	Dissolved	6.1
RED0022	1996/01/16	Sulfate	Dissolved	17.3
RED0022	1996/02/27	Sulfate	Dissolved	4.7
RED0022	1996/03/26	Sulfate	Dissolved	10.9
RED0022	1996/04/23	Sulfate	Dissolved	7.9
RED0022	1996/05/21	Sulfate	Dissolved	3.4
RED0022	1996/06/18	Sulfate	Dissolved	4
RED0022	1996/07/30	Sulfate	Dissolved	25.1
RED0022	1996/08/27	Sulfate	Dissolved	7.8
RED0022	1996/09/17	Sulfate	Dissolved	<1.0
RED0022	1996/10/15	Sulfate	Dissolved	8.2
RED0022	1996/11/05	Sulfate	Dissolved	8.2
RED0022	1996/12/10	Sulfate	Dissolved	7.4
RED0022	1997/01/21	Sulfate	Dissolved	4.9
RED0022	1997/02/11	Sulfate	Dissolved	5.8
RED0022	1997/04/01	Sulfate	Dissolved	4
RED0022	1997/04/29	Sulfate	Dissolved	3.5
RED0022	1997/05/12	Sulfate	Dissolved	4
RED0022	1997/06/16	Sulfate	Dissolved	9.4
RED0022	1997/07/14	Sulfate	Dissolved	2
RED0022	1997/08/25	Sulfate	Dissolved	3.22
RED0022	1997/08/25	Sulfate	Dissolved	3.03
RED0022	1997/09/15	Sulfate	Dissolved	4
RED0022	1997/10/14	Sulfate	Dissolved	3.66
RED0022	1997/11/12	Sulfate	Dissolved	5.101
RED0022	1997/12/16	Sulfate	Dissolved	4.863
RED0022	1998/01/20	Sulfate	Dissolved	3.762
RED0022	1998/02/17	Sulfate	Dissolved	7.509
RED0022	1998/03/17	Sulfate	Dissolved	7.58
RED0022	1998/04/14	Sulfate	Dissolved	8.525
RED0022	1998/05/26	Sulfate	Dissolved	4.12
RED0022	1998/06/23	Sulfate	Dissolved	3.835
RED0022	1998/07/14	Sulfate	Dissolved	2.79
RED0022	1998/08/11	Sulfate	Dissolved	3.62
RED0022	1998/09/01	Sulfate	Dissolved	4.2

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1998/09/01	Sulfate	Dissolved	4.23
RED0022	1998/10/06	Sulfate	Dissolved	4.11
RED0022	1998/11/03	Sulfate	Dissolved	4.41
RED0022	1998/12/08	Sulfate	Dissolved	2.99
RED0022	1999/01/05	Sulfate	Dissolved	5.11
RED0022	1999/02/02	Sulfate	Dissolved	5.03
RED0022	1999/03/16	Sulfate	Dissolved	5.35
RED0022	1999/04/27	Sulfate	Dissolved	3.5
RED0022	1999/05/25	Sulfate	Dissolved	3.64
RED0022	1999/06/29	Sulfate	Dissolved	3.02
RED0022	1999/07/27	Sulfate	Dissolved	3.44
RED0022	1999/08/31	Sulfate	Dissolved	2.4
RED0022	1999/09/28	Sulfate	Dissolved	2.37
RED0022	1999/10/26	Sulfate	Dissolved	3.31
RED0022	1999/11/22	Sulfate	Dissolved	3.46
RED0022	1999/12/20	Sulfate	Dissolved	4.87
RED0022	2000/01/25	Sulfate	Dissolved	4.41
RED0022	2000/02/29	Sulfate	Dissolved	4.36
RED0022	2000/03/27	Sulfate	Dissolved	4.58
RED0022	2000/04/24	Sulfate	Dissolved	4.07
RED0022	2000/05/30	Sulfate	Dissolved	3.46
RED0022	2000/06/19	Sulfate	Dissolved	3.04
RED0022	2000/07/25	Sulfate	Dissolved	3.99
RED0022	2000/08/28	Sulfate	Dissolved	3.68
RED0022	2000/09/26	Sulfate	Dissolved	3.23
RED0022	2000/10/24	Sulfate	Dissolved	3.02
RED0022	2000/11/14	Sulfate	Dissolved	3.64
RED0022	2000/12/19	Sulfate	Dissolved	3.99
RED0022	2001/01/16	Sulfate	Dissolved	3.95
RED0022	2001/02/13	Sulfate	Dissolved	3.99
RED0022	2001/03/13	Sulfate	Dissolved	3.58
RED0022	2001/04/17	Sulfate	Dissolved	3.76
RED0022	2001/05/08	Sulfate	Dissolved	3.47
RED0022	2001/06/12	Sulfate	Dissolved	3.33
RED0022	2001/07/10	Sulfate	Dissolved	3.41
RED0022	2001/08/07	Sulfate	Dissolved	3.28
RED0022	2001/09/04	Sulfate	Dissolved	3.2
RED0022	2001/10/09	Sulfate	Dissolved	4.1
RED0022	2001/11/06	Sulfate	Dissolved	3.45
RED0022	2001/12/04	Sulfate	Dissolved	3.86
RED0022	2002/01/02	Sulfate	Dissolved	3.67
RED0022	2002/02/04	Sulfate	Dissolved	3.74
RED0022	2002/03/05	Sulfate	Dissolved	4.08
RED0022	2002/04/02	Sulfate	Dissolved	3.97
RED0022	2002/05/07	Sulfate	Dissolved	3.46
RED0022	2002/06/11	Sulfate	Dissolved	3.25

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2002/07/09	Sulfate	Dissolved	3.55
RED0022	2002/08/13	Sulfate	Dissolved	3.51
RED0022	2002/08/20	Sulfate	Dissolved	3.07
RED0022	2002/09/03	Sulfate	Dissolved	3.8
RED0022	2002/10/01	Sulfate	Dissolved	3.9
RED0022	2002/11/05	Sulfate	Dissolved	4.53
RED0022	2002/12/03	Sulfate	Dissolved	4.27
RED0022	2003/01/21	Sulfate	Dissolved	4.79
RED0022	2003/02/18	Sulfate	Dissolved	5.67
RED0022	2003/03/18	Sulfate	Dissolved	4.24
RED0022	2003/04/22	Sulfate	Dissolved	3.97
RED0022	2003/05/27	Sulfate	Dissolved	3.86
RED0022	2003/06/24	Sulfate	Dissolved	3.67
RED0022	2003/07/15	Sulfate	Dissolved	3.91
RED0022	2003/08/12	Sulfate	Dissolved	3.76
RED0022	2003/09/23	Sulfate	Dissolved	3.52
RED0022	2003/10/14	Sulfate	Dissolved	3.29
RED0022	2003/11/12	Sulfate	Dissolved	3.78
RED0022	2003/12/09	Sulfate	Dissolved	3.84
RED0022	2004/01/13	Sulfate	Dissolved	4.21
RED0022	2004/02/17	Sulfate	Dissolved	3.93
RED0022	2004/03/16	Sulfate	Dissolved	4
RED0022	2004/04/20	Sulfate	Dissolved	4.26
RED0022	2004/05/18	Sulfate	Dissolved	3.78
RED0022	2004/06/22	Sulfate	Dissolved	2.61
RED0022	2004/07/20	Sulfate	Dissolved	3.3
RED0022	2004/08/10	Sulfate	Dissolved	3.75
RED0022	2004/09/07	Sulfate	Dissolved	3.6
RED0022	2004/10/12	Sulfate	Dissolved	3.68
RED0022	2004/11/16	Sulfate	Dissolved	3.79
RED0022	2004/12/14	Sulfate	Dissolved	3.78
RED0022	2005/01/25	Sulfate	Dissolved	3.81
RED0022	2005/02/22	Sulfate	Dissolved	4.2
RED0022	2005/03/29	Sulfate	Dissolved	3.59
RED0022	2005/04/26	Sulfate	Dissolved	3.59
RED0022	2005/05/24	Sulfate	Dissolved	3.81
RED0022	2005/06/28	Sulfate	Dissolved	3.6
RED0022	2005/07/19	Sulfate	Dissolved	3.48
RED0022	2005/08/23	Sulfate	Dissolved	3.43
RED0022	2005/09/13	Sulfate	Dissolved	3.2
RED0022	2005/10/25	Sulfate	Dissolved	3.77
RED0022	2005/11/29	Sulfate	Dissolved	4.56
RED0022	2005/12/13	Sulfate	Dissolved	4.91
RED0022	2006/01/17	Sulfate	Dissolved	5.4
RED0022	2006/02/14	Sulfate	Dissolved	5.63
RED0022	2006/03/07	Sulfate	Dissolved	5.61

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2006/04/11	Sulfate	Dissolved	4.2
RED0022	2006/05/02	Sulfate	Dissolved	3.88
RED0022	2006/06/06	Sulfate	Dissolved	3.74
RED0022	2006/07/25	Sulfate	Dissolved	3.49
RED0022	2006/08/29	Sulfate	Dissolved	3.68
RED0022	2006/09/26	Sulfate	Dissolved	3.4
RED0022	2006/10/24	Sulfate	Dissolved	4.05
RED0022	2006/11/14	Sulfate	Dissolved	4.14
RED0022	2006/12/18	Sulfate	Dissolved	4.47
RED0022	2007/01/23	Sulfate	Dissolved	3.75
RED0022	2007/02/27	Sulfate	Dissolved	4.75
RED0022	2007/03/20	Sulfate	Dissolved	4.86
RED0022	2007/04/17	Sulfate	Dissolved	4.56
RED0022	2007/05/08	Sulfate	Dissolved	3.83
RED0022	2007/06/12	Sulfate	Dissolved	3.98
RED0022	2007/07/17	Sulfate	Dissolved	3.63
RED0022	2007/09/25	Sulfate	Dissolved	4.04
RED0022	2007/10/30	Sulfate	Dissolved	3.99
RED0022	2007/11/19	Sulfate	Dissolved	4.5
RED0022	2007/12/11	Sulfate	Dissolved	4.72
RED0022	2008/01/29	Sulfate	Dissolved	5.01
RED0022	2008/02/26	Sulfate	Dissolved	4.26
RED0022	2008/03/25	Sulfate	Dissolved	3.69
RED0022	2008/04/22	Sulfate	Dissolved	3.29
RED0022	2008/05/13	Sulfate	Dissolved	3.51
RED0022	2008/06/03	Sulfate	Dissolved	4.1
RED0022	2008/07/29	Sulfate	Dissolved	3.92
RED0022	2008/08/26	Sulfate	Dissolved	3.07
RED0022	2008/09/16	Sulfate	Dissolved	2.93
RED0022	2008/10/21	Sulfate	Dissolved	4.01
RED0022	2008/11/24	Sulfate	Dissolved	4.71
RED0022	2008/12/17	Sulfate	Dissolved	5.18
RED0022	2009/01/06	Sulfate	Dissolved	4.82
RED0022	2009/02/03	Sulfate	Dissolved	4.54
RED0022	2009/03/03	Sulfate	Dissolved	5.08
RED0022	2009/04/07	Sulfate	Dissolved	4.01
RED0022	2009/05/12	Sulfate	Dissolved	3.46
RED0022	2009/06/30	Sulfate	Dissolved	4.06
RED0022	2009/07/21	Sulfate	Dissolved	3.51
RED0022	2009/08/11	Sulfate	Dissolved	3.36
RED0022	2009/09/15	Sulfate	Dissolved	3.82
RED0022	2009/10/20	Sulfate	Dissolved	3.44
RED0022	2009/11/23	Sulfate	Dissolved	3.99
RED0022	2009/12/15	Sulfate	Dissolved	3.88
RED0022	2010/01/12	Sulfate	Dissolved	3.63
RED0022	2010/02/09	Sulfate	Dissolved	3.25

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2010/03/16	Sulfate	Dissolved	4.01
RED0022	2010/04/13	Sulfate	Dissolved	4.02
RED0022	2010/05/18	Sulfate	Dissolved	3.74
RED0022	2010/06/15	Sulfate	Dissolved	3.39
RED0022	2010/07/13	Sulfate	Dissolved	3.57
RED0022	2010/08/10	Sulfate	Dissolved	3.3
RED0022	2010/09/14	Sulfate	Dissolved	3.63
RED0022	2010/10/19	Sulfate	Dissolved	3.93
RED0022	2010/11/22	Sulfate	Dissolved	3.51
RED0022	2010/12/28	Sulfate	Dissolved	3.96
RED0022	2011/01/25	Sulfate	Dissolved	5.18
RED0022	2011/02/22	Sulfate	Dissolved	5.03
RED0022	2011/03/08	Sulfate	Dissolved	4.92
RED0022	2011/04/12	Sulfate	Dissolved	4.72
RED0022	2011/05/24	Sulfate	Dissolved	3.99
RED0022	2011/06/28	Sulfate	Dissolved	4.07
RED0022	2011/07/05	Sulfate	Dissolved	3.93
RED0022	2011/08/02	Sulfate	Dissolved	4.03
RED0022	2011/09/06	Sulfate	Dissolved	3.8
RED0022	2011/10/04	Sulfate	Dissolved	3.82
RED0022	2011/11/15	Sulfate	Dissolved	3.77
RED0022	2011/12/12	Sulfate	Dissolved	3.79
RED0022	2012/01/17	Sulfate	Dissolved	4.54
RED0022	2012/02/21	Sulfate	Dissolved	4.36
RED0022	2012/03/20	Sulfate	Dissolved	3.72
RED0022	2012/04/17	Sulfate	Dissolved	3.55
RED0022	2012/05/01	Sulfate	Dissolved	4.03
RED0022	2012/06/05	Sulfate	Dissolved	3.75
RED0022	2012/07/24	Sulfate	Dissolved	3.58
RED0022	2012/08/14	Sulfate	Dissolved	3.59
RED0022	2012/09/04	Sulfate	Dissolved	3.56
RED0022	2012/10/02	Sulfate	Dissolved	3.77
RED0022	2012/11/27	Sulfate	Dissolved	3.54
RED0022	2012/12/10	Sulfate	Dissolved	3.58
RED0022	2013/01/29	Sulfate	Dissolved	5.05
RED0022	2013/02/19	Sulfate	Dissolved	4.76
RED0022	2013/03/19	Sulfate	Dissolved	4.54
RED0022	2013/04/16	Sulfate	Dissolved	3.99
RED0022	2013/05/21	Sulfate	Dissolved	3.55
RED0022	2013/06/04	Sulfate	Dissolved	2.8
RED0022	2013/07/01	Sulfate	Dissolved	3.29

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1991/01/22	TDS	Total	35
RED0022	1991/02/05	TDS	Total	34
RED0022	1991/03/19	TDS	Total	63
RED0022	1991/04/23	TDS	Total	36
RED0022	1991/05/21	TDS	Total	48
RED0022	1991/06/18	TDS	Total	42
RED0022	1991/07/02	TDS	Total	33
RED0022	1991/08/20	TDS	Total	35
RED0022	1991/09/17	TDS	Total	18
RED0022	1991/10/15	TDS	Total	36
RED0022	1991/10/30	TDS	Total	64
RED0022	1991/12/03	TDS	Total	45
RED0022	1992/01/21	TDS	Total	39
RED0022	1992/02/04	TDS	Total	29
RED0022	1992/03/03	TDS	Total	32
RED0022	1992/03/10	TDS	Total	48
RED0022	1992/04/07	TDS	Total	33
RED0022	1992/05/05	TDS	Total	33
RED0022	1992/06/02	TDS	Total	34
RED0022	1992/07/14	TDS	Total	34
RED0022	1992/08/11	TDS	Total	37
RED0022	1992/09/08	TDS	Total	34
RED0022	1992/10/06	TDS	Total	35
RED0022	1992/11/17	TDS	Total	38
RED0022	1992/12/01	TDS	Total	32
RED0022	1993/01/05	TDS	Total	60
RED0022	1993/02/02	TDS	Total	40
RED0022	1993/03/02	TDS	Total	42
RED0022	1993/03/30	TDS	Total	26
RED0022	1993/05/03	TDS	Total	32
RED0022	1993/06/28	TDS	Total	29
RED0022	1993/07/12	TDS	Total	31
RED0022	1993/08/10	TDS	Total	36
RED0022	1993/09/14	TDS	Total	33
RED0022	1993/10/12	TDS	Total	54
RED0022	1993/11/02	TDS	Total	43
RED0022	1993/12/07	TDS	Total	42
RED0022	1994/01/25	TDS	Total	44
RED0022	1994/02/22	TDS	Total	61
RED0022	1994/03/22	TDS	Total	32
RED0022	1994/04/26	TDS	Total	29
RED0022	1994/05/17	TDS	Total	31
RED0022	1994/06/21	TDS	Total	35
RED0022	1994/07/19	TDS	Total	45
RED0022	1994/08/23	TDS	Total	29
RED0022	1994/09/27	TDS	Total	36

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1994/10/25	TDS	Total	46
RED0022	1994/11/21	TDS	Total	39
RED0022	1994/12/20	TDS	Total	40
RED0022	1995/01/17	TDS	Total	32
RED0022	1995/02/06	TDS	Total	34
RED0022	1995/03/14	TDS	Total	35
RED0022	1995/04/04	TDS	Total	31
RED0022	1995/05/16	TDS	Total	36
RED0022	1995/06/20	TDS	Total	34
RED0022	1995/07/11	TDS	Total	40
RED0022	1995/08/15	TDS	Total	36
RED0022	1995/09/05	TDS	Total	33
RED0022	1995/10/03	TDS	Total	30
RED0022	1995/10/31	TDS	Total	30
RED0022	1995/12/12	TDS	Total	51
RED0022	1996/01/16	TDS	Total	58
RED0022	1996/02/27	TDS	Total	45
RED0022	1996/03/26	TDS	Total	62
RED0022	1996/04/23	TDS	Total	72
RED0022	1996/05/21	TDS	Total	44
RED0022	1996/06/18	TDS	Total	46
RED0022	1996/07/30	TDS	Total	67
RED0022	1996/08/27	TDS	Total	36
RED0022	1996/09/17	TDS	Total	26
RED0022	1996/10/15	TDS	Total	45
RED0022	1996/11/05	TDS	Total	67
RED0022	1996/12/10	TDS	Total	38
RED0022	1997/01/21	TDS	Total	39
RED0022	1997/02/11	TDS	Total	53
RED0022	1997/04/01	TDS	Total	38
RED0022	1997/04/29	TDS	Total	45
RED0022	1997/05/12	TDS	Total	33
RED0022	1997/06/16	TDS	Total	29
RED0022	1997/07/14	TDS	Total	41
RED0022	1997/08/25	TDS	Total	35
RED0022	1997/08/25	TDS	Total	44
RED0022	1997/09/15	TDS	Total	31
RED0022	1997/10/14	TDS	Total	49
RED0022	1997/11/12	TDS	Total	60
RED0022	1997/12/16	TDS	Total	47
RED0022	1998/01/20	TDS	Total	46
RED0022	1998/02/17	TDS	Total	57
RED0022	1998/03/17	TDS	Total	85
RED0022	1998/04/14	TDS	Total	58
RED0022	1998/05/26	TDS	Total	53
RED0022	1998/06/23	TDS	Total	42

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	1998/07/14	TDS	Total	39
RED0022	1998/08/11	TDS	Total	45
RED0022	1998/09/01	TDS	Total	32
RED0022	1998/09/01	TDS	Total	39
RED0022	1998/10/06	TDS	Total	59
RED0022	1998/11/03	TDS	Total	45
RED0022	1998/12/08	TDS	Total	49
RED0022	1999/01/05	TDS	Total	49
RED0022	1999/02/02	TDS	Total	48
RED0022	1999/03/16	TDS	Total	48
RED0022	1999/04/27	TDS	Total	65
RED0022	1999/05/25	TDS	Total	32
RED0022	1999/06/29	TDS	Total	38
RED0022	1999/07/27	TDS	Total	35
RED0022	1999/08/31	TDS	Total	44
RED0022	1999/09/28	TDS	Total	40
RED0022	1999/10/26	TDS	Total	32.5
RED0022	1999/11/22	TDS	Total	28
RED0022	1999/12/20	TDS	Total	46
RED0022	2000/01/25	TDS	Total	36
RED0022	2000/02/29	TDS	Total	35.5
RED0022	2000/03/27	TDS	Total	50
RED0022	2000/04/24	TDS	Total	45.5
RED0022	2000/05/30	TDS	Total	57
RED0022	2000/07/25	TDS	Total	40
RED0022	2000/08/28	TDS	Total	33
RED0022	2000/09/26	TDS	Total	29
RED0022	2000/10/24	TDS	Total	40
RED0022	2000/11/14	TDS	Total	44.5
RED0022	2000/12/19	TDS	Total	39
RED0022	2001/01/16	TDS	Total	44
RED0022	2001/02/13	TDS	Total	36.5
RED0022	2001/03/13	TDS	Total	36.5
RED0022	2001/04/17	TDS	Total	35.5
RED0022	2001/05/08	TDS	Total	50
RED0022	2001/06/12	TDS	Total	35
RED0022	2001/07/10	TDS	Total	38
RED0022	2001/08/07	TDS	Total	39.5
RED0022	2001/09/04	TDS	Total	45
RED0022	2001/10/09	TDS	Total	51.5
RED0022	2001/11/06	TDS	Total	38.5
RED0022	2001/12/04	TDS	Total	42
RED0022	2002/01/02	TDS	Total	38
RED0022	2002/02/04	TDS	Total	35
RED0022	2002/03/05	TDS	Total	43
RED0022	2002/04/02	TDS	Total	37

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2002/05/07	TDS	Total	38
RED0022	2002/06/11	TDS	Total	34
RED0022	2002/07/09	TDS	Total	38
RED0022	2002/08/13	TDS	Total	35
RED0022	2002/08/20	TDS	Total	40
RED0022	2002/09/03	TDS	Total	37
RED0022	2002/10/01	TDS	Total	27
RED0022	2002/11/05	TDS	Total	40.5
RED0022	2002/12/03	TDS	Total	40.5
RED0022	2003/01/21	TDS	Total	33
RED0022	2003/02/18	TDS	Total	52
RED0022	2003/03/18	TDS	Total	31.5
RED0022	2003/04/22	TDS	Total	30.5
RED0022	2003/05/27	TDS	Total	40
RED0022	2003/06/24	TDS	Total	39
RED0022	2003/07/15	TDS	Total	36
RED0022	2003/08/12	TDS	Total	33
RED0022	2003/09/23	TDS	Total	40.5
RED0022	2003/10/14	TDS	Total	36
RED0022	2003/11/12	TDS	Total	41
RED0022	2003/12/09	TDS	Total	30.5
RED0022	2004/01/13	TDS	Total	38.5
RED0022	2004/02/17	TDS	Total	56.5
RED0022	2004/03/16	TDS	Total	50
RED0022	2004/04/20	TDS	Total	53
RED0022	2004/05/18	TDS	Total	52.5
RED0022	2004/06/22	TDS	Total	74.5
RED0022	2004/07/20	TDS	Total	40.5
RED0022	2004/08/10	TDS	Total	42
RED0022	2004/09/07	TDS	Total	39
RED0022	2004/10/12	TDS	Total	40
RED0022	2004/11/16	TDS	Total	51.5
RED0022	2004/12/14	TDS	Total	37.5
RED0022	2005/01/25	TDS	Total	46
RED0022	2005/02/22	TDS	Total	51
RED0022	2005/03/29	TDS	Total	43.5
RED0022	2005/04/26	TDS	Total	36
RED0022	2005/05/24	TDS	Total	34.5
RED0022	2005/06/28	TDS	Total	43.5
RED0022	2005/07/19	TDS	Total	33
RED0022	2005/08/23	TDS	Total	32.5
RED0022	2005/09/13	TDS	Total	35.5
RED0022	2005/10/25	TDS	Total	43.5
RED0022	2005/11/29	TDS	Total	42.5
RED0022	2005/12/13	TDS	Total	40
RED0022	2006/01/17	TDS	Total	40.5

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2006/02/14	TDS	Total	48
RED0022	2006/03/07	TDS	Total	44
RED0022	2006/04/11	TDS	Total	44
RED0022	2006/05/02	TDS	Total	45.5
RED0022	2006/06/06	TDS	Total	39.5
RED0022	2006/07/25	TDS	Total	29.5
RED0022	2006/08/29	TDS	Total	46.5
RED0022	2006/09/26	TDS	Total	34.5
RED0022	2006/10/24	TDS	Total	54.5
RED0022	2006/11/14	TDS	Total	45
RED0022	2006/12/18	TDS	Total	39.5
RED0022	2007/01/23	TDS	Total	39
RED0022	2007/02/27	TDS	Total	41.5
RED0022	2007/03/20	TDS	Total	40
RED0022	2007/04/17	TDS	Total	33
RED0022	2007/05/08	TDS	Total	36
RED0022	2007/06/12	TDS	Total	33
RED0022	2007/07/17	TDS	Total	41
RED0022	2007/09/25	TDS	Total	37
RED0022	2007/10/30	TDS	Total	39
RED0022	2007/11/19	TDS	Total	44
RED0022	2007/12/11	TDS	Total	40.5
RED0022	2008/01/29	TDS	Total	36
RED0022	2008/02/26	TDS	Total	36
RED0022	2008/03/25	TDS	Total	51
RED0022	2008/04/22	TDS	Total	42
RED0022	2008/05/13	TDS	Total	37.5
RED0022	2008/06/03	TDS	Total	49
RED0022	2008/07/29	TDS	Total	35.5
RED0022	2008/08/26	TDS	Total	46
RED0022	2008/09/16	TDS	Total	44
RED0022	2008/10/21	TDS	Total	39
RED0022	2008/11/24	TDS	Total	50
RED0022	2008/12/17	TDS	Total	26.5
RED0022	2009/01/06	TDS	Total	42
RED0022	2009/02/03	TDS	Total	36
RED0022	2009/03/03	TDS	Total	42
RED0022	2009/04/07	TDS	Total	35
RED0022	2009/05/12	TDS	Total	55
RED0022	2009/06/30	TDS	Total	35
RED0022	2009/07/21	TDS	Total	52
RED0022	2009/08/11	TDS	Total	37.5
RED0022	2009/09/15	TDS	Total	51
RED0022	2009/10/20	TDS	Total	47
RED0022	2009/11/23	TDS	Total	37
RED0022	2009/12/15	TDS	Total	37

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0022	2010/01/12	TDS	Total	47
RED0022	2010/02/09	TDS	Total	48
RED0022	2010/03/16	TDS	Total	38
RED0022	2010/04/13	TDS	Total	36
RED0022	2010/05/18	TDS	Total	38
RED0022	2010/06/15	TDS	Total	43
RED0022	2010/07/13	TDS	Total	33
RED0022	2010/08/10	TDS	Total	38
RED0022	2010/09/14	TDS	Total	15
RED0022	2010/10/19	TDS	Total	35
RED0022	2010/11/22	TDS	Total	37
RED0022	2010/12/28	TDS	Total	38
RED0022	2011/01/25	TDS	Total	32
RED0022	2011/02/22	TDS	Total	40
RED0022	2011/03/08	TDS	Total	35
RED0022	2011/04/12	TDS	Total	34
RED0022	2011/05/24	TDS	Total	36
RED0022	2011/06/28	TDS	Total	22
RED0022	2011/07/05	TDS	Total	37
RED0022	2011/08/02	TDS	Total	40
RED0022	2011/09/06	TDS	Total	40
RED0022	2011/10/04	TDS	Total	20
RED0022	2011/11/15	TDS	Total	32
RED0022	2011/12/12	TDS	Total	14
RED0022	2012/01/17	TDS	Total	40
RED0022	2012/02/21	TDS	Total	55
RED0022	2012/03/20	TDS	Total	33
RED0022	2012/04/17	TDS	Total	13
RED0022	2012/05/01	TDS	Total	40
RED0022	2012/06/05	TDS	Total	28
RED0022	2012/07/24	TDS	Total	36
RED0022	2012/08/14	TDS	Total	29
RED0022	2012/09/04	TDS	Total	34
RED0022	2012/10/02	TDS	Total	29
RED0022	2012/11/27	TDS	Total	35
RED0022	2012/12/10	TDS	Total	33
RED0022	2013/01/29	TDS	Total	38
RED0022	2013/02/19	TDS	Total	33
RED0022	2013/03/19	TDS	Total	33
RED0022	2013/04/16	TDS	Total	36
RED0022	2013/05/21	TDS	Total	31
RED0022	2013/06/04	TDS	Total	40
RED0022	2013/07/01	TDS	Total	36

Appendix B.3. ADEQ historical monitoring data for dissolved minerals at COS0003.

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
COS0003	1991/07/23	Chloride	Dissolved	2.21
COS0003	1992/03/10	Chloride	Dissolved	2.6
COS0003	1992/05/12	Chloride	Dissolved	3.45
COS0003	2000/08/01	Chloride	Dissolved	2.77
COS0003	2001/01/08	Chloride	Dissolved	1.9
COS0003	2001/03/12	Chloride	Dissolved	1.95
COS0003	2001/06/18	Chloride	Dissolved	2.66
COS0003	2001/09/04	Chloride	Dissolved	2.5
COS0003	2001/11/27	Chloride	Dissolved	3.32
COS0003	2002/08/20	Chloride	Dissolved	2.1
COS0003	1991/07/23	Sulfate	Dissolved	1
COS0003	1992/03/10	Sulfate	Dissolved	8.62
COS0003	1992/05/12	Sulfate	Dissolved	6.41
COS0003	2000/08/01	Sulfate	Dissolved	3.5
COS0003	2001/01/08	Sulfate	Dissolved	4.01
COS0003	2001/03/12	Sulfate	Dissolved	4.08
COS0003	2001/06/18	Sulfate	Dissolved	3.21
COS0003	2001/09/04	Sulfate	Dissolved	3.33
COS0003	2001/11/27	Sulfate	Dissolved	3.54
COS0003	2002/08/20	Sulfate	Dissolved	3.06
COS0003	1991/07/23	TDS	Total	31
COS0003	1991/10/30	TDS	Total	60
COS0003	1992/03/10	TDS	Total	52
COS0003	1992/05/12	TDS	Total	56
COS0003	2000/08/01	TDS	Total	41.5
COS0003	2001/01/08	TDS	Total	40
COS0003	2001/03/12	TDS	Total	46
COS0003	2001/06/18	TDS	Total	36
COS0003	2001/09/04	TDS	Total	45.5
COS0003	2001/11/27	TDS	Total	45.5
COS0003	2002/08/20	TDS	Total	37

Appendix B.4. ADEQ historical monitoring data for dissolved minerals at RED0021.

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1991/01/22	Chloride	Dissolved	2.66
RED0021	1991/02/05	Chloride	Dissolved	3.13
RED0021	1991/03/19	Chloride	Dissolved	4.95
RED0021	1991/04/23	Chloride	Dissolved	3.15
RED0021	1991/05/21	Chloride	Dissolved	3.6
RED0021	1991/06/18	Chloride	Dissolved	R
RED0021	1991/07/02	Chloride	Dissolved	3.35
RED0021	1991/08/20	Chloride	Dissolved	4.94
RED0021	1991/12/03	Chloride	Dissolved	3.17
RED0021	1992/01/21	Chloride	Dissolved	3.64
RED0021	1992/02/04	Chloride	Dissolved	4.28
RED0021	1992/03/03	Chloride	Dissolved	2.43
RED0021	1992/03/10	Chloride	Dissolved	2.48
RED0021	1992/04/07	Chloride	Dissolved	3.3
RED0021	1992/05/05	Chloride	Dissolved	2.32
RED0021	1992/06/02	Chloride	Dissolved	3.73
RED0021	1992/07/14	Chloride	Dissolved	2.56
RED0021	1992/08/11	Chloride	Dissolved	3.58
RED0021	1992/09/08	Chloride	Dissolved	2.58
RED0021	1992/10/06	Chloride	Dissolved	2.53
RED0021	1992/11/17	Chloride	Dissolved	4.39
RED0021	1992/12/01	Chloride	Dissolved	2.98
RED0021	1993/01/05	Chloride	Dissolved	3.06
RED0021	1993/02/02	Chloride	Dissolved	3.26
RED0021	1993/03/02	Chloride	Dissolved	3.75
RED0021	1993/03/30	Chloride	Dissolved	2.5
RED0021	1993/05/03	Chloride	Dissolved	2.44
RED0021	1993/06/28	Chloride	Dissolved	3.17
RED0021	1993/07/12	Chloride	Dissolved	2.85
RED0021	1993/08/10	Chloride	Dissolved	4.01
RED0021	1993/09/14	Chloride	Dissolved	2.17
RED0021	1993/10/12	Chloride	Dissolved	3.67
RED0021	1993/11/02	Chloride	Dissolved	2.29
RED0021	1993/12/07	Chloride	Dissolved	2.95
RED0021	1994/01/25	Chloride	Dissolved	4.48
RED0021	1994/02/22	Chloride	Dissolved	4.68
RED0021	1994/03/22	Chloride	Dissolved	3.72
RED0021	1994/04/26	Chloride	Dissolved	3.49
RED0021	1994/05/17	Chloride	Dissolved	3.19
RED0021	1994/06/21	Chloride	Dissolved	2.54
RED0021	1994/07/19	Chloride	Dissolved	2.58
RED0021	1994/08/23	Chloride	Dissolved	3.24

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1994/09/27	Chloride	Dissolved	3.24
RED0021	1994/10/25	Chloride	Dissolved	3.28
RED0021	1994/11/21	Chloride	Dissolved	2.86
RED0021	1994/12/20	Chloride	Dissolved	3.16
RED0021	1995/01/17	Chloride	Dissolved	4.31
RED0021	1995/02/06	Chloride	Dissolved	2.765
RED0021	1995/03/14	Chloride	Dissolved	3.83
RED0021	1995/04/04	Chloride	Dissolved	2.866
RED0021	1995/05/16	Chloride	Dissolved	2.302
RED0021	1995/06/20	Chloride	Dissolved	3.037
RED0021	1995/07/11	Chloride	Dissolved	3.004
RED0021	1995/08/15	Chloride	Dissolved	3.228
RED0021	1995/09/05	Chloride	Dissolved	2.511
RED0021	1995/10/03	Chloride	Dissolved	2.943
RED0021	1995/10/31	Chloride	Dissolved	3.262
RED0021	1995/12/12	Chloride	Dissolved	3.684
RED0021	1996/01/16	Chloride	Dissolved	4.673
RED0021	1996/02/27	Chloride	Dissolved	4.689
RED0021	1996/03/26	Chloride	Dissolved	6.288
RED0021	1996/04/23	Chloride	Dissolved	3.452
RED0021	1996/05/21	Chloride	Dissolved	2.467
RED0021	1996/06/18	Chloride	Dissolved	2.676
RED0021	1996/07/30	Chloride	Dissolved	6.708
RED0021	1996/08/27	Chloride	Dissolved	3.325
RED0021	1996/09/17	Chloride	Dissolved	4.579
RED0021	1996/10/15	Chloride	Dissolved	2.491
RED0021	1996/11/05	Chloride	Dissolved	3.197
RED0021	1996/12/10	Chloride	Dissolved	2.836
RED0021	1997/01/21	Chloride	Dissolved	5.369
RED0021	1997/02/11	Chloride	Dissolved	2.601
RED0021	1997/04/01	Chloride	Dissolved	2.58
RED0021	1997/04/29	Chloride	Dissolved	2.799
RED0021	1997/05/12	Chloride	Dissolved	4.342
RED0021	1997/06/16	Chloride	Dissolved	4.200R
RED0021	1997/07/14	Chloride	Dissolved	3.822
RED0021	1997/09/15	Chloride	Dissolved	2.93
RED0021	1997/10/14	Chloride	Dissolved	2.79
RED0021	1997/11/12	Chloride	Dissolved	2.086
RED0021	1997/12/16	Chloride	Dissolved	2.969
RED0021	1998/01/20	Chloride	Dissolved	2.336
RED0021	1998/02/17	Chloride	Dissolved	2.16
RED0021	1998/03/17	Chloride	Dissolved	2.35
RED0021	1998/04/14	Chloride	Dissolved	1.912
RED0021	1998/05/26	Chloride	Dissolved	2.59

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1998/06/23	Chloride	Dissolved	1.738
RED0021	1998/07/14	Chloride	Dissolved	1.8
RED0021	1998/08/11	Chloride	Dissolved	2.12
RED0021	1998/09/01	Chloride	Dissolved	2.83
RED0021	1998/09/01	Chloride	Dissolved	2.38
RED0021	1998/10/06	Chloride	Dissolved	2.7
RED0021	1998/11/03	Chloride	Dissolved	2.67
RED0021	1998/12/08	Chloride	Dissolved	2.17
RED0021	1999/01/05	Chloride	Dissolved	2.2
RED0021	1999/02/02	Chloride	Dissolved	1.83
RED0021	1999/03/16	Chloride	Dissolved	1.71
RED0021	1999/04/27	Chloride	Dissolved	4.01
RED0021	1999/05/25	Chloride	Dissolved	3.18
RED0021	1999/06/29	Chloride	Dissolved	2.64
RED0021	1999/07/27	Chloride	Dissolved	2.9
RED0021	1999/08/31	Chloride	Dissolved	2.7
RED0021	1999/09/28	Chloride	Dissolved	3.16
RED0021	1999/10/26	Chloride	Dissolved	2.8
RED0021	1999/11/22	Chloride	Dissolved	3.37
RED0021	1999/12/20	Chloride	Dissolved	2.45
RED0021	2000/01/25	Chloride	Dissolved	2.91
RED0021	2000/02/29	Chloride	Dissolved	3.36
RED0021	2000/03/27	Chloride	Dissolved	3.07
RED0021	2000/04/24	Chloride	Dissolved	3.25
RED0021	2000/05/30	Chloride	Dissolved	3.32
RED0021	2000/06/19	Chloride	Dissolved	1.74
RED0021	2000/07/25	Chloride	Dissolved	3.9
RED0021	2000/08/28	Chloride	Dissolved	3.47
RED0021	2000/09/26	Chloride	Dissolved	2.96
RED0021	2000/10/24	Chloride	Dissolved	2.87
RED0021	2000/11/14	Chloride	Dissolved	2.67
RED0021	2000/12/19	Chloride	Dissolved	3.72
RED0021	2001/01/08	Chloride	Dissolved	2.77
RED0021	2001/01/16	Chloride	Dissolved	2.71
RED0021	2001/02/13	Chloride	Dissolved	3.91
RED0021	2001/03/13	Chloride	Dissolved	2.09
RED0021	2001/04/17	Chloride	Dissolved	2.59
RED0021	2001/05/08	Chloride	Dissolved	2.78
RED0021	2001/06/12	Chloride	Dissolved	2.27
RED0021	2001/07/10	Chloride	Dissolved	3.23
RED0021	2001/08/07	Chloride	Dissolved	2.62
RED0021	2001/09/04	Chloride	Dissolved	2.32
RED0021	2001/10/09	Chloride	Dissolved	2.42
RED0021	2001/11/06	Chloride	Dissolved	3.62

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2001/12/04	Chloride	Dissolved	2.89
RED0021	2002/01/02	Chloride	Dissolved	2.25
RED0021	2002/02/04	Chloride	Dissolved	2.6
RED0021	2002/03/05	Chloride	Dissolved	3.48
RED0021	2002/04/02	Chloride	Dissolved	2.26
RED0021	2002/05/07	Chloride	Dissolved	2.86
RED0021	2002/06/11	Chloride	Dissolved	2.87
RED0021	2002/07/09	Chloride	Dissolved	3.9
RED0021	2002/08/13	Chloride	Dissolved	2.96
RED0021	2002/08/20	Chloride	Dissolved	2.7
RED0021	2002/09/03	Chloride	Dissolved	2.45
RED0021	2002/10/01	Chloride	Dissolved	2.76
RED0021	2002/11/06	Chloride	Dissolved	6.36
RED0021	2002/12/03	Chloride	Dissolved	3.45
RED0021	2003/01/21	Chloride	Dissolved	4.06
RED0021	2003/02/18	Chloride	Dissolved	3.97
RED0021	2003/03/18	Chloride	Dissolved	3.97
RED0021	2003/04/22	Chloride	Dissolved	3.71
RED0021	2003/05/27	Chloride	Dissolved	2.69
RED0021	2003/06/24	Chloride	Dissolved	2.84
RED0021	2003/07/15	Chloride	Dissolved	3.74
RED0021	2003/08/12	Chloride	Dissolved	2.72
RED0021	2003/09/23	Chloride	Dissolved	2.82
RED0021	2003/10/14	Chloride	Dissolved	2.56
RED0021	2003/11/12	Chloride	Dissolved	2.64
RED0021	2003/12/09	Chloride	Dissolved	2.88
RED0021	2004/01/13	Chloride	Dissolved	3.93
RED0021	2004/02/17	Chloride	Dissolved	3.24
RED0021	2004/03/16	Chloride	Dissolved	3.67
RED0021	2004/04/20	Chloride	Dissolved	5.08
RED0021	2004/05/18	Chloride	Dissolved	4.01
RED0021	2004/06/22	Chloride	Dissolved	2.34
RED0021	2004/07/20	Chloride	Dissolved	3.63
RED0021	2004/08/10	Chloride	Dissolved	3.19
RED0021	2004/09/07	Chloride	Dissolved	3.19
RED0021	2004/10/12	Chloride	Dissolved	3
RED0021	2004/11/16	Chloride	Dissolved	2.97
RED0021	2004/12/14	Chloride	Dissolved	3.76
RED0021	2005/01/25	Chloride	Dissolved	2.43
RED0021	2005/02/22	Chloride	Dissolved	5.6
RED0021	2005/03/29	Chloride	Dissolved	2.82
RED0021	2005/04/26	Chloride	Dissolved	4.65
RED0021	2005/05/24	Chloride	Dissolved	4.11
RED0021	2005/06/28	Chloride	Dissolved	3.04

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2005/07/19	Chloride	Dissolved	2.82
RED0021	2005/08/23	Chloride	Dissolved	2.89
RED0021	2005/09/13	Chloride	Dissolved	2.72
RED0021	2005/10/25	Chloride	Dissolved	3.05
RED0021	2005/11/29	Chloride	Dissolved	3.63
RED0021	2005/12/13	Chloride	Dissolved	3.97
RED0021	2006/01/17	Chloride	Dissolved	3.55
RED0021	2006/02/14	Chloride	Dissolved	4.92
RED0021	2006/03/07	Chloride	Dissolved	6.45
RED0021	2006/04/11	Chloride	Dissolved	3.23
RED0021	2006/05/02	Chloride	Dissolved	2.74
RED0021	2006/06/06	Chloride	Dissolved	3.41
RED0021	2006/07/25	Chloride	Dissolved	2.87
RED0021	2006/08/29	Chloride	Dissolved	2.79
RED0021	2006/09/26	Chloride	Dissolved	3.11
RED0021	2006/10/24	Chloride	Dissolved	9.64
RED0021	2006/11/14	Chloride	Dissolved	3.18
RED0021	2006/12/18	Chloride	Dissolved	4.01
RED0021	2007/01/23	Chloride	Dissolved	2.85
RED0021	2007/02/27	Chloride	Dissolved	3
RED0021	2007/03/20	Chloride	Dissolved	5.36
RED0021	2007/04/17	Chloride	Dissolved	3.54
RED0021	2007/05/08	Chloride	Dissolved	3.15
RED0021	2007/06/12	Chloride	Dissolved	3.24
RED0021	2007/07/17	Chloride	Dissolved	2.77
RED0021	2007/09/25	Chloride	Dissolved	3.4
RED0021	2007/10/30	Chloride	Dissolved	4.45
RED0021	2007/11/19	Chloride	Dissolved	3.72
RED0021	2007/12/11	Chloride	Dissolved	5.63
RED0021	2008/01/29	Chloride	Dissolved	5.79
RED0021	2008/02/26	Chloride	Dissolved	3.41
RED0021	2008/03/25	Chloride	Dissolved	3.08
RED0021	2008/04/22	Chloride	Dissolved	2.2
RED0021	2008/05/13	Chloride	Dissolved	2.1
RED0021	2008/06/03	Chloride	Dissolved	3.42
RED0021	2008/07/29	Chloride	Dissolved	2.84
RED0021	2008/08/26	Chloride	Dissolved	2.54
RED0021	2008/09/16	Chloride	Dissolved	2.34
RED0021	2008/10/21	Chloride	Dissolved	2.99
RED0021	2008/11/24	Chloride	Dissolved	4.2
RED0021	2008/12/17	Chloride	Dissolved	5.4
RED0021	2009/01/06	Chloride	Dissolved	5.41
RED0021	2009/02/03	Chloride	Dissolved	4.25
RED0021	2009/03/03	Chloride	Dissolved	6.04

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2009/04/07	Chloride	Dissolved	4.04
RED0021	2009/05/12	Chloride	Dissolved	1.97
RED0021	2009/06/30	Chloride	Dissolved	3.01
RED0021	2009/07/21	Chloride	Dissolved	2.55
RED0021	2009/08/11	Chloride	Dissolved	2.28
RED0021	2009/09/15	Chloride	Dissolved	3.66
RED0021	2009/10/20	Chloride	Dissolved	2.68
RED0021	2009/11/23	Chloride	Dissolved	2.54
RED0021	2009/12/15	Chloride	Dissolved	3.75
RED0021	2010/01/12	Chloride	Dissolved	3.25
RED0021	2010/02/09	Chloride	Dissolved	1.27
RED0021	2010/03/16	Chloride	Dissolved	3.59
RED0021	2010/04/13	Chloride	Dissolved	3.29
RED0021	2010/05/18	Chloride	Dissolved	2.51
RED0021	2010/06/15	Chloride	Dissolved	2.22
RED0021	2010/07/13	Chloride	Dissolved	2.88
RED0021	2010/08/10	Chloride	Dissolved	2.67
RED0021	2010/09/14	Chloride	Dissolved	2.72
RED0021	2010/10/19	Chloride	Dissolved	2.92
RED0021	2010/11/22	Chloride	Dissolved	3.11
RED0021	2010/12/28	Chloride	Dissolved	2.88
RED0021	2011/01/25	Chloride	Dissolved	4.6
RED0021	2011/02/22	Chloride	Dissolved	6.32
RED0021	2011/03/08	Chloride	Dissolved	5.72
RED0021	2011/04/12	Chloride	Dissolved	4.15
RED0021	2011/05/24	Chloride	Dissolved	2.29
RED0021	2011/06/28	Chloride	Dissolved	3.24
RED0021	2011/07/05	Chloride	Dissolved	2.93
RED0021	2011/08/02	Chloride	Dissolved	2.82
RED0021	2011/09/06	Chloride	Dissolved	2.53
RED0021	2011/10/04	Chloride	Dissolved	2.97
RED0021	2011/11/15	Chloride	Dissolved	3.44
RED0021	2011/12/12	Chloride	Dissolved	2.76
RED0021	2012/01/17	Chloride	Dissolved	3.76
RED0021	2012/02/21	Chloride	Dissolved	3.54
RED0021	2012/03/20	Chloride	Dissolved	3.06
RED0021	2012/04/17	Chloride	Dissolved	3.63
RED0021	2012/05/01	Chloride	Dissolved	4
RED0021	2012/06/05	Chloride	Dissolved	3.23
RED0021	2012/07/24	Chloride	Dissolved	2.84
RED0021	2012/08/14	Chloride	Dissolved	2.76
RED0021	2012/09/04	Chloride	Dissolved	2.86
RED0021	2012/10/02	Chloride	Dissolved	2.95
RED0021	2012/11/27	Chloride	Dissolved	3.25

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2012/12/10	Chloride	Dissolved	3.51
RED0021	2013/01/29	Chloride	Dissolved	4.62
RED0021	2013/02/19	Chloride	Dissolved	4.06
RED0021	2013/03/19	Chloride	Dissolved	4.5
RED0021	2013/04/16	Chloride	Dissolved	3.26
RED0021	2013/05/21	Chloride	Dissolved	2.78
RED0021	2013/06/04	Chloride	Dissolved	2.75
RED0021	2013/07/01	Chloride	Dissolved	3.32

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1991/01/22	Sulfate	Dissolved	6
RED0021	1991/02/05	Sulfate	Dissolved	4
RED0021	1991/03/19	Sulfate	Dissolved	11
RED0021	1991/04/23	Sulfate	Dissolved	7
RED0021	1991/05/21	Sulfate	Dissolved	9
RED0021	1991/06/18	Sulfate	Dissolved	7
RED0021	1991/07/02	Sulfate	Dissolved	5
RED0021	1991/08/20	Sulfate	Dissolved	4
RED0021	1991/12/03	Sulfate	Dissolved	12.4
RED0021	1992/01/21	Sulfate	Dissolved	9.97
RED0021	1992/02/04	Sulfate	Dissolved	7.96
RED0021	1992/03/03	Sulfate	Dissolved	4.58
RED0021	1992/03/10	Sulfate	Dissolved	8.62
RED0021	1992/04/07	Sulfate	Dissolved	9.66
RED0021	1992/05/05	Sulfate	Dissolved	4.5
RED0021	1992/06/02	Sulfate	Dissolved	9.58
RED0021	1992/07/14	Sulfate	Dissolved	6.04
RED0021	1992/08/11	Sulfate	Dissolved	5.87
RED0021	1992/09/08	Sulfate	Dissolved	5.83
RED0021	1992/10/06	Sulfate	Dissolved	2.04
RED0021	1992/11/17	Sulfate	Dissolved	5.66
RED0021	1992/12/01	Sulfate	Dissolved	7.12
RED0021	1993/01/05	Sulfate	Dissolved	8.79
RED0021	1993/02/02	Sulfate	Dissolved	13.2
RED0021	1993/03/02	Sulfate	Dissolved	10.7
RED0021	1993/03/30	Sulfate	Dissolved	7.33
RED0021	1993/05/03	Sulfate	Dissolved	6.33
RED0021	1993/06/28	Sulfate	Dissolved	3.96
RED0021	1993/07/12	Sulfate	Dissolved	2.67
RED0021	1993/08/10	Sulfate	Dissolved	3.71
RED0021	1993/09/14	Sulfate	Dissolved	3.42
RED0021	1993/10/12	Sulfate	Dissolved	11.5
RED0021	1993/11/02	Sulfate	Dissolved	4.58
RED0021	1993/12/07	Sulfate	Dissolved	7.79
RED0021	1994/01/25	Sulfate	Dissolved	14.1
RED0021	1994/02/22	Sulfate	Dissolved	8.1
RED0021	1994/03/22	Sulfate	Dissolved	8.9
RED0021	1994/04/26	Sulfate	Dissolved	9.4
RED0021	1994/05/17	Sulfate	Dissolved	5.9
RED0021	1994/06/21	Sulfate	Dissolved	6.6
RED0021	1994/07/19	Sulfate	Dissolved	2.1
RED0021	1994/08/23	Sulfate	Dissolved	5.4
RED0021	1994/09/27	Sulfate	Dissolved	5.5
RED0021	1994/10/25	Sulfate	Dissolved	6.3

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1994/11/21	Sulfate	Dissolved	5.5
RED0021	1994/12/20	Sulfate	Dissolved	5.13
RED0021	1995/01/17	Sulfate	Dissolved	15
RED0021	1995/02/06	Sulfate	Dissolved	4.9
RED0021	1995/03/14	Sulfate	Dissolved	11.1
RED0021	1995/04/04	Sulfate	Dissolved	5.4
RED0021	1995/05/16	Sulfate	Dissolved	8.1
RED0021	1995/06/20	Sulfate	Dissolved	4.1
RED0021	1995/07/11	Sulfate	Dissolved	8.9
RED0021	1995/08/15	Sulfate	Dissolved	5.3
RED0021	1995/09/05	Sulfate	Dissolved	7.5
RED0021	1995/10/03	Sulfate	Dissolved	8.1
RED0021	1995/10/31	Sulfate	Dissolved	11.3
RED0021	1995/12/12	Sulfate	Dissolved	6.1
RED0021	1996/01/16	Sulfate	Dissolved	17.3
RED0021	1996/02/27	Sulfate	Dissolved	7.5
RED0021	1996/03/26	Sulfate	Dissolved	53.2
RED0021	1996/04/23	Sulfate	Dissolved	7.9
RED0021	1996/05/21	Sulfate	Dissolved	4.9
RED0021	1996/06/18	Sulfate	Dissolved	2.3
RED0021	1996/07/30	Sulfate	Dissolved	5.6
RED0021	1996/08/27	Sulfate	Dissolved	7.8
RED0021	1996/09/17	Sulfate	Dissolved	2.8
RED0021	1996/10/15	Sulfate	Dissolved	5.1
RED0021	1996/11/05	Sulfate	Dissolved	10.1
RED0021	1996/12/10	Sulfate	Dissolved	6.1
RED0021	1997/01/21	Sulfate	Dissolved	10.2
RED0021	1997/02/11	Sulfate	Dissolved	4.7
RED0021	1997/04/01	Sulfate	Dissolved	5.2
RED0021	1997/04/29	Sulfate	Dissolved	7.6
RED0021	1997/05/12	Sulfate	Dissolved	8.1
RED0021	1997/06/16	Sulfate	Dissolved	9.4
RED0021	1997/07/14	Sulfate	Dissolved	5
RED0021	1997/09/15	Sulfate	Dissolved	4.61
RED0021	1997/10/14	Sulfate	Dissolved	3.91
RED0021	1997/11/12	Sulfate	Dissolved	3.496
RED0021	1997/12/16	Sulfate	Dissolved	4.117
RED0021	1998/01/20	Sulfate	Dissolved	3.091
RED0021	1998/02/17	Sulfate	Dissolved	3.255
RED0021	1998/03/17	Sulfate	Dissolved	4.93
RED0021	1998/04/14	Sulfate	Dissolved	3.934
RED0021	1998/05/26	Sulfate	Dissolved	3.55
RED0021	1998/06/23	Sulfate	Dissolved	3.587
RED0021	1998/07/14	Sulfate	Dissolved	2.67

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1998/08/11	Sulfate	Dissolved	3.35
RED0021	1998/09/01	Sulfate	Dissolved	4.17
RED0021	1998/09/01	Sulfate	Dissolved	4.22
RED0021	1998/10/06	Sulfate	Dissolved	3.33
RED0021	1998/11/03	Sulfate	Dissolved	4.3
RED0021	1998/12/08	Sulfate	Dissolved	3.99
RED0021	1999/01/05	Sulfate	Dissolved	4.21
RED0021	1999/02/02	Sulfate	Dissolved	3.83
RED0021	1999/03/16	Sulfate	Dissolved	3.74
RED0021	1999/04/27	Sulfate	Dissolved	6.63
RED0021	1999/05/25	Sulfate	Dissolved	5.45
RED0021	1999/06/29	Sulfate	Dissolved	3.16
RED0021	1999/07/27	Sulfate	Dissolved	3.42
RED0021	1999/08/31	Sulfate	Dissolved	3.32
RED0021	1999/09/28	Sulfate	Dissolved	3.56
RED0021	1999/10/26	Sulfate	Dissolved	3.31
RED0021	1999/11/22	Sulfate	Dissolved	3.21
RED0021	1999/12/20	Sulfate	Dissolved	3.5
RED0021	2000/01/25	Sulfate	Dissolved	4.16
RED0021	2000/02/29	Sulfate	Dissolved	7.59
RED0021	2000/03/27	Sulfate	Dissolved	7.58
RED0021	2000/04/24	Sulfate	Dissolved	12.3
RED0021	2000/05/30	Sulfate	Dissolved	6.44
RED0021	2000/06/19	Sulfate	Dissolved	3.85
RED0021	2000/07/25	Sulfate	Dissolved	4.06
RED0021	2000/08/28	Sulfate	Dissolved	3.51
RED0021	2000/09/26	Sulfate	Dissolved	3.08
RED0021	2000/10/24	Sulfate	Dissolved	2.95
RED0021	2000/11/14	Sulfate	Dissolved	6.62
RED0021	2000/12/19	Sulfate	Dissolved	6.87
RED0021	2001/01/08	Sulfate	Dissolved	4.94
RED0021	2001/01/16	Sulfate	Dissolved	5
RED0021	2001/02/13	Sulfate	Dissolved	8.55
RED0021	2001/03/13	Sulfate	Dissolved	5.81
RED0021	2001/04/17	Sulfate	Dissolved	4.98
RED0021	2001/05/08	Sulfate	Dissolved	10.11
RED0021	2001/06/12	Sulfate	Dissolved	3.53
RED0021	2001/07/10	Sulfate	Dissolved	3.6
RED0021	2001/08/07	Sulfate	Dissolved	2.91
RED0021	2001/09/04	Sulfate	Dissolved	3.09
RED0021	2001/10/09	Sulfate	Dissolved	3.62
RED0021	2001/11/06	Sulfate	Dissolved	3.51
RED0021	2001/12/04	Sulfate	Dissolved	4.52
RED0021	2002/01/02	Sulfate	Dissolved	3.55

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2002/02/04	Sulfate	Dissolved	4.61
RED0021	2002/03/05	Sulfate	Dissolved	7.18
RED0021	2002/04/02	Sulfate	Dissolved	5.06
RED0021	2002/05/07	Sulfate	Dissolved	4.93
RED0021	2002/06/11	Sulfate	Dissolved	5
RED0021	2002/07/09	Sulfate	Dissolved	4.14
RED0021	2002/08/13	Sulfate	Dissolved	3.35
RED0021	2002/08/20	Sulfate	Dissolved	2.67
RED0021	2002/09/03	Sulfate	Dissolved	3.3
RED0021	2002/10/01	Sulfate	Dissolved	4.48
RED0021	2002/11/06	Sulfate	Dissolved	11.5
RED0021	2002/12/03	Sulfate	Dissolved	5.37
RED0021	2003/01/21	Sulfate	Dissolved	8.15
RED0021	2003/02/18	Sulfate	Dissolved	10.4
RED0021	2003/03/18	Sulfate	Dissolved	8.63
RED0021	2003/04/22	Sulfate	Dissolved	7.03
RED0021	2003/05/27	Sulfate	Dissolved	4.56
RED0021	2003/06/24	Sulfate	Dissolved	4.44
RED0021	2003/07/15	Sulfate	Dissolved	3.8
RED0021	2003/08/12	Sulfate	Dissolved	3.71
RED0021	2003/09/23	Sulfate	Dissolved	3.21
RED0021	2003/10/14	Sulfate	Dissolved	2.53
RED0021	2003/11/12	Sulfate	Dissolved	3.59
RED0021	2003/12/09	Sulfate	Dissolved	4.06
RED0021	2004/01/13	Sulfate	Dissolved	6.21
RED0021	2004/02/17	Sulfate	Dissolved	6.83
RED0021	2004/03/16	Sulfate	Dissolved	7.92
RED0021	2004/04/20	Sulfate	Dissolved	11.5
RED0021	2004/05/18	Sulfate	Dissolved	6.52
RED0021	2004/06/22	Sulfate	Dissolved	4.63
RED0021	2004/07/20	Sulfate	Dissolved	3.77
RED0021	2004/08/10	Sulfate	Dissolved	3.59
RED0021	2004/09/07	Sulfate	Dissolved	3.17
RED0021	2004/10/12	Sulfate	Dissolved	2.99
RED0021	2004/11/16	Sulfate	Dissolved	3.88
RED0021	2004/12/14	Sulfate	Dissolved	5.99
RED0021	2005/01/25	Sulfate	Dissolved	3.97
RED0021	2005/02/22	Sulfate	Dissolved	13.9
RED0021	2005/03/29	Sulfate	Dissolved	5.67
RED0021	2005/04/26	Sulfate	Dissolved	7.42
RED0021	2005/05/24	Sulfate	Dissolved	4.77
RED0021	2005/06/28	Sulfate	Dissolved	3.7
RED0021	2005/07/19	Sulfate	Dissolved	3.54
RED0021	2005/08/23	Sulfate	Dissolved	3.38

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2005/09/13	Sulfate	Dissolved	3.05
RED0021	2005/10/25	Sulfate	Dissolved	3.6
RED0021	2005/11/29	Sulfate	Dissolved	10.3
RED0021	2005/12/13	Sulfate	Dissolved	4.1
RED0021	2006/01/17	Sulfate	Dissolved	3.83
RED0021	2006/02/14	Sulfate	Dissolved	6.55
RED0021	2006/03/07	Sulfate	Dissolved	8.18
RED0021	2006/04/11	Sulfate	Dissolved	4.31
RED0021	2006/05/02	Sulfate	Dissolved	4.69
RED0021	2006/06/06	Sulfate	Dissolved	3.42
RED0021	2006/07/25	Sulfate	Dissolved	3
RED0021	2006/08/29	Sulfate	Dissolved	3.21
RED0021	2006/09/26	Sulfate	Dissolved	3.07
RED0021	2006/10/24	Sulfate	Dissolved	4.2
RED0021	2006/11/14	Sulfate	Dissolved	2.69
RED0021	2006/12/18	Sulfate	Dissolved	4.03
RED0021	2007/01/23	Sulfate	Dissolved	5.12
RED0021	2007/02/27	Sulfate	Dissolved	5.33
RED0021	2007/03/20	Sulfate	Dissolved	9.46
RED0021	2007/04/17	Sulfate	Dissolved	5.87
RED0021	2007/05/08	Sulfate	Dissolved	5.4
RED0021	2007/06/12	Sulfate	Dissolved	3.88
RED0021	2007/07/17	Sulfate	Dissolved	3.39
RED0021	2007/09/25	Sulfate	Dissolved	3.23
RED0021	2007/10/30	Sulfate	Dissolved	4.9
RED0021	2007/11/19	Sulfate	Dissolved	3.25
RED0021	2007/12/11	Sulfate	Dissolved	5.98
RED0021	2008/01/29	Sulfate	Dissolved	10.9
RED0021	2008/02/26	Sulfate	Dissolved	4.89
RED0021	2008/03/25	Sulfate	Dissolved	4.65
RED0021	2008/04/22	Sulfate	Dissolved	3.62
RED0021	2008/05/13	Sulfate	Dissolved	3.35
RED0021	2008/06/03	Sulfate	Dissolved	4.6
RED0021	2008/07/29	Sulfate	Dissolved	2.9
RED0021	2008/08/26	Sulfate	Dissolved	3.54
RED0021	2008/09/16	Sulfate	Dissolved	3.89
RED0021	2008/10/21	Sulfate	Dissolved	3.67
RED0021	2008/11/24	Sulfate	Dissolved	5.93
RED0021	2008/12/17	Sulfate	Dissolved	9.66
RED0021	2009/01/06	Sulfate	Dissolved	12.1
RED0021	2009/02/03	Sulfate	Dissolved	7.15
RED0021	2009/03/03	Sulfate	Dissolved	9.7
RED0021	2009/04/07	Sulfate	Dissolved	6.11
RED0021	2009/05/12	Sulfate	Dissolved	4.66

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2009/06/30	Sulfate	Dissolved	3.99
RED0021	2009/07/21	Sulfate	Dissolved	2.76
RED0021	2009/08/11	Sulfate	Dissolved	2.45
RED0021	2009/09/15	Sulfate	Dissolved	11.5
RED0021	2009/10/20	Sulfate	Dissolved	3.76
RED0021	2009/11/23	Sulfate	Dissolved	3.44
RED0021	2009/12/15	Sulfate	Dissolved	7.67
RED0021	2010/01/12	Sulfate	Dissolved	3.85
RED0021	2010/02/09	Sulfate	Dissolved	3.27
RED0021	2010/03/16	Sulfate	Dissolved	8.17
RED0021	2010/04/13	Sulfate	Dissolved	6.25
RED0021	2010/05/18	Sulfate	Dissolved	3.71
RED0021	2010/06/15	Sulfate	Dissolved	3.39
RED0021	2010/07/13	Sulfate	Dissolved	2.96
RED0021	2010/08/10	Sulfate	Dissolved	2.73
RED0021	2010/09/14	Sulfate	Dissolved	3.02
RED0021	2010/10/19	Sulfate	Dissolved	3.1
RED0021	2010/11/22	Sulfate	Dissolved	2.98
RED0021	2010/12/28	Sulfate	Dissolved	2.75
RED0021	2011/01/25	Sulfate	Dissolved	4.38
RED0021	2011/02/22	Sulfate	Dissolved	7.99
RED0021	2011/03/08	Sulfate	Dissolved	10.5
RED0021	2011/04/12	Sulfate	Dissolved	3.91
RED0021	2011/05/24	Sulfate	Dissolved	3.95
RED0021	2011/06/28	Sulfate	Dissolved	3.53
RED0021	2011/07/05	Sulfate	Dissolved	3.29
RED0021	2011/08/02	Sulfate	Dissolved	2.63
RED0021	2011/09/06	Sulfate	Dissolved	2.26
RED0021	2011/10/04	Sulfate	Dissolved	2.54
RED0021	2011/11/15	Sulfate	Dissolved	2.49
RED0021	2011/12/12	Sulfate	Dissolved	3.57
RED0021	2012/01/17	Sulfate	Dissolved	6.6
RED0021	2012/02/21	Sulfate	Dissolved	7.33
RED0021	2012/03/20	Sulfate	Dissolved	5.59
RED0021	2012/04/17	Sulfate	Dissolved	8.41
RED0021	2012/05/01	Sulfate	Dissolved	4.71
RED0021	2012/06/05	Sulfate	Dissolved	3.4
RED0021	2012/07/24	Sulfate	Dissolved	2.68
RED0021	2012/08/14	Sulfate	Dissolved	2.49
RED0021	2012/09/04	Sulfate	Dissolved	2.58
RED0021	2012/10/02	Sulfate	Dissolved	2.54
RED0021	2012/11/27	Sulfate	Dissolved	2.21
RED0021	2012/12/10	Sulfate	Dissolved	2.1
RED0021	2013/01/29	Sulfate	Dissolved	6.45

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2013/02/19	Sulfate	Dissolved	5.77
RED0021	2013/03/19	Sulfate	Dissolved	8.18
RED0021	2013/04/16	Sulfate	Dissolved	5.56
RED0021	2013/05/21	Sulfate	Dissolved	3.84
RED0021	2013/06/04	Sulfate	Dissolved	3.9
RED0021	2013/07/01	Sulfate	Dissolved	3.21

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1991/01/22	TDS	Total	51
RED0021	1991/02/05	TDS	Total	44
RED0021	1991/03/19	TDS	Total	82
RED0021	1991/04/23	TDS	Total	52
RED0021	1991/05/21	TDS	Total	69
RED0021	1991/06/18	TDS	Total	72
RED0021	1991/07/02	TDS	Total	51
RED0021	1991/08/20	TDS	Total	86
RED0021	1991/09/17	TDS	Total	36
RED0021	1991/10/15	TDS	Total	44
RED0021	1991/12/03	TDS	Total	77
RED0021	1992/01/21	TDS	Total	60
RED0021	1992/02/04	TDS	Total	49
RED0021	1992/03/03	TDS	Total	42
RED0021	1992/03/10	TDS	Total	69
RED0021	1992/04/07	TDS	Total	50
RED0021	1992/05/05	TDS	Total	36
RED0021	1992/06/02	TDS	Total	68
RED0021	1992/07/14	TDS	Total	49
RED0021	1992/08/11	TDS	Total	64
RED0021	1992/09/08	TDS	Total	36
RED0021	1992/10/06	TDS	Total	43
RED0021	1992/11/17	TDS	Total	68
RED0021	1992/12/01	TDS	Total	39
RED0021	1993/01/05	TDS	Total	83
RED0021	1993/02/02	TDS	Total	56
RED0021	1993/03/02	TDS	Total	66
RED0021	1993/03/30	TDS	Total	36
RED0021	1993/05/03	TDS	Total	50
RED0021	1993/06/28	TDS	Total	44
RED0021	1993/07/12	TDS	Total	44
RED0021	1993/08/10	TDS	Total	58
RED0021	1993/09/14	TDS	Total	42
RED0021	1993/10/12	TDS	Total	66
RED0021	1993/11/02	TDS	Total	51
RED0021	1993/12/07	TDS	Total	53
RED0021	1994/01/25	TDS	Total	77
RED0021	1994/02/22	TDS	Total	57
RED0021	1994/03/22	TDS	Total	48
RED0021	1994/04/26	TDS	Total	52
RED0021	1994/05/17	TDS	Total	47
RED0021	1994/06/21	TDS	Total	44
RED0021	1994/07/19	TDS	Total	46
RED0021	1994/08/23	TDS	Total	46

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1994/09/27	TDS	Total	49
RED0021	1994/10/25	TDS	Total	48
RED0021	1994/11/21	TDS	Total	47
RED0021	1994/12/20	TDS	Total	48
RED0021	1995/01/17	TDS	Total	62
RED0021	1995/02/06	TDS	Total	35
RED0021	1995/03/14	TDS	Total	63
RED0021	1995/04/04	TDS	Total	47
RED0021	1995/05/16	TDS	Total	44
RED0021	1995/06/20	TDS	Total	50
RED0021	1995/07/11	TDS	Total	46
RED0021	1995/08/15	TDS	Total	47
RED0021	1995/09/05	TDS	Total	42
RED0021	1995/10/03	TDS	Total	44
RED0021	1995/10/31	TDS	Total	54
RED0021	1995/12/12	TDS	Total	52
RED0021	1996/01/16	TDS	Total	58
RED0021	1996/02/27	TDS	Total	54
RED0021	1996/03/26	TDS	Total	152
RED0021	1996/04/23	TDS	Total	64
RED0021	1996/05/21	TDS	Total	53
RED0021	1996/06/18	TDS	Total	34
RED0021	1996/07/30	TDS	Total	71
RED0021	1996/08/27	TDS	Total	49
RED0021	1996/09/17	TDS	Total	58
RED0021	1996/10/15	TDS	Total	38
RED0021	1996/11/05	TDS	Total	53
RED0021	1996/12/10	TDS	Total	51
RED0021	1997/01/21	TDS	Total	61
RED0021	1997/02/11	TDS	Total	40
RED0021	1997/04/01	TDS	Total	50
RED0021	1997/04/29	TDS	Total	65
RED0021	1997/05/12	TDS	Total	63
RED0021	1997/06/16	TDS	Total	55
RED0021	1997/07/14	TDS	Total	56
RED0021	1997/09/15	TDS	Total	48
RED0021	1997/10/14	TDS	Total	38
RED0021	1997/11/12	TDS	Total	34
RED0021	1997/12/16	TDS	Total	40
RED0021	1998/01/20	TDS	Total	34
RED0021	1998/02/17	TDS	Total	37
RED0021	1998/03/17	TDS	Total	52
RED0021	1998/04/14	TDS	Total	25
RED0021	1998/05/26	TDS	Total	34

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	1998/06/23	TDS	Total	31
RED0021	1998/07/14	TDS	Total	29
RED0021	1998/08/11	TDS	Total	30
RED0021	1998/09/01	TDS	Total	40
RED0021	1998/09/01	TDS	Total	31
RED0021	1998/10/06	TDS	Total	64
RED0021	1998/11/03	TDS	Total	38
RED0021	1998/12/08	TDS	Total	40
RED0021	1999/01/05	TDS	Total	42
RED0021	1999/02/02	TDS	Total	37
RED0021	1999/03/16	TDS	Total	39
RED0021	1999/04/27	TDS	Total	82
RED0021	1999/05/25	TDS	Total	52
RED0021	1999/06/29	TDS	Total	52
RED0021	1999/07/27	TDS	Total	49
RED0021	1999/08/31	TDS	Total	46
RED0021	1999/09/28	TDS	Total	39
RED0021	1999/10/26	TDS	Total	44
RED0021	1999/11/22	TDS	Total	43.5
RED0021	1999/12/20	TDS	Total	42.5
RED0021	2000/01/25	TDS	Total	54.5
RED0021	2000/02/29	TDS	Total	77
RED0021	2000/03/27	TDS	Total	72
RED0021	2000/04/24	TDS	Total	100.5
RED0021	2000/05/30	TDS	Total	93
RED0021	2000/07/25	TDS	Total	57
RED0021	2000/08/28	TDS	Total	50
RED0021	2000/09/26	TDS	Total	48
RED0021	2000/10/24	TDS	Total	62.5
RED0021	2000/11/14	TDS	Total	77
RED0021	2000/12/19	TDS	Total	50
RED0021	2001/01/08	TDS	Total	57
RED0021	2001/01/16	TDS	Total	48
RED0021	2001/02/13	TDS	Total	61
RED0021	2001/03/13	TDS	Total	67
RED0021	2001/04/17	TDS	Total	50.5
RED0021	2001/05/08	TDS	Total	88
RED0021	2001/06/12	TDS	Total	40
RED0021	2001/07/10	TDS	Total	56.5
RED0021	2001/08/07	TDS	Total	45.5
RED0021	2001/09/04	TDS	Total	62.5
RED0021	2001/10/09	TDS	Total	46.5
RED0021	2001/11/06	TDS	Total	64
RED0021	2001/12/04	TDS	Total	52.5

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2002/01/02	TDS	Total	45.5
RED0021	2002/02/04	TDS	Total	50
RED0021	2002/03/05	TDS	Total	63.5
RED0021	2002/04/02	TDS	Total	46.5
RED0021	2002/05/07	TDS	Total	47
RED0021	2002/06/11	TDS	Total	56.5
RED0021	2002/07/09	TDS	Total	61
RED0021	2002/08/13	TDS	Total	52
RED0021	2002/08/20	TDS	Total	52
RED0021	2002/09/03	TDS	Total	45
RED0021	2002/10/01	TDS	Total	32.5
RED0021	2002/11/06	TDS	Total	88.5
RED0021	2002/12/03	TDS	Total	52.5
RED0021	2003/01/21	TDS	Total	50
RED0021	2003/02/18	TDS	Total	78
RED0021	2003/03/18	TDS	Total	57
RED0021	2003/04/22	TDS	Total	55.5
RED0021	2003/05/27	TDS	Total	51.5
RED0021	2003/06/24	TDS	Total	49.5
RED0021	2003/07/15	TDS	Total	50.5
RED0021	2003/08/12	TDS	Total	40
RED0021	2003/09/23	TDS	Total	71
RED0021	2003/10/14	TDS	Total	51
RED0021	2003/11/12	TDS	Total	47.5
RED0021	2003/12/09	TDS	Total	47.5
RED0021	2004/01/13	TDS	Total	62.5
RED0021	2004/02/17	TDS	Total	80.5
RED0021	2004/03/16	TDS	Total	89.5
RED0021	2004/04/20	TDS	Total	80.5
RED0021	2004/05/18	TDS	Total	86.5
RED0021	2004/06/22	TDS	Total	114
RED0021	2004/07/20	TDS	Total	64
RED0021	2004/08/10	TDS	Total	55
RED0021	2004/09/07	TDS	Total	56
RED0021	2004/10/12	TDS	Total	63.5
RED0021	2004/11/16	TDS	Total	70
RED0021	2004/12/14	TDS	Total	61
RED0021	2005/01/25	TDS	Total	50.5
RED0021	2005/02/22	TDS	Total	87
RED0021	2005/03/29	TDS	Total	63.5
RED0021	2005/04/26	TDS	Total	76
RED0021	2005/05/24	TDS	Total	65
RED0021	2005/06/28	TDS	Total	54
RED0021	2005/07/19	TDS	Total	52

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2005/08/23	TDS	Total	51.5
RED0021	2005/09/13	TDS	Total	44
RED0021	2005/10/25	TDS	Total	69.5
RED0021	2005/11/29	TDS	Total	105
RED0021	2005/12/13	TDS	Total	55
RED0021	2006/01/17	TDS	Total	49
RED0021	2006/02/14	TDS	Total	65.5
RED0021	2006/03/07	TDS	Total	69
RED0021	2006/04/11	TDS	Total	47.5
RED0021	2006/05/02	TDS	Total	61.5
RED0021	2006/06/06	TDS	Total	53
RED0021	2006/07/25	TDS	Total	38
RED0021	2006/08/29	TDS	Total	47.5
RED0021	2006/09/26	TDS	Total	45.5
RED0021	2006/10/24	TDS	Total	74.5
RED0021	2006/11/14	TDS	Total	49
RED0021	2006/12/18	TDS	Total	48.5
RED0021	2007/01/23	TDS	Total	61.5
RED0021	2007/02/27	TDS	Total	55
RED0021	2007/03/20	TDS	Total	73.5
RED0021	2007/04/17	TDS	Total	51
RED0021	2007/05/08	TDS	Total	61
RED0021	2007/06/12	TDS	Total	57
RED0021	2007/07/17	TDS	Total	52
RED0021	2007/09/25	TDS	Total	49
RED0021	2007/10/30	TDS	Total	60.5
RED0021	2007/11/19	TDS	Total	50.5
RED0021	2007/12/11	TDS	Total	57
RED0021	2008/01/29	TDS	Total	64
RED0021	2008/02/26	TDS	Total	33
RED0021	2008/03/25	TDS	Total	63.5
RED0021	2008/04/22	TDS	Total	48
RED0021	2008/05/13	TDS	Total	47
RED0021	2008/06/03	TDS	Total	64
RED0021	2008/07/29	TDS	Total	52
RED0021	2008/08/26	TDS	Total	53
RED0021	2008/09/16	TDS	Total	56
RED0021	2008/10/21	TDS	Total	47
RED0021	2008/11/24	TDS	Total	55.5
RED0021	2008/12/17	TDS	Total	45
RED0021	2009/01/06	TDS	Total	77.5
RED0021	2009/02/03	TDS	Total	53
RED0021	2009/03/03	TDS	Total	76
RED0021	2009/04/07	TDS	Total	47

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2009/05/12	TDS	Total	78
RED0021	2009/06/30	TDS	Total	53
RED0021	2009/07/21	TDS	Total	51
RED0021	2009/08/11	TDS	Total	49.5
RED0021	2009/09/15	TDS	Total	94.5
RED0021	2009/10/20	TDS	Total	65
RED0021	2009/11/23	TDS	Total	42
RED0021	2009/12/15	TDS	Total	63
RED0021	2010/01/12	TDS	Total	41
RED0021	2010/02/09	TDS	Total	61
RED0021	2010/03/16	TDS	Total	60
RED0021	2010/04/13	TDS	Total	50
RED0021	2010/05/18	TDS	Total	46
RED0021	2010/06/15	TDS	Total	56
RED0021	2010/07/13	TDS	Total	37
RED0021	2010/08/10	TDS	Total	47
RED0021	2010/09/14	TDS	Total	8
RED0021	2010/10/19	TDS	Total	44
RED0021	2010/11/22	TDS	Total	48
RED0021	2010/12/28	TDS	Total	42
RED0021	2011/01/25	TDS	Total	43
RED0021	2011/02/22	TDS	Total	68
RED0021	2011/03/08	TDS	Total	57
RED0021	2011/04/12	TDS	Total	67
RED0021	2011/05/24	TDS	Total	26
RED0021	2011/06/28	TDS	Total	31
RED0021	2011/07/05	TDS	Total	44
RED0021	2011/08/02	TDS	Total	50
RED0021	2011/09/06	TDS	Total	44
RED0021	2011/10/04	TDS	Total	59
RED0021	2011/11/15	TDS	Total	25
RED0021	2011/12/12	TDS	Total	17
RED0021	2012/01/17	TDS	Total	52
RED0021	2012/02/21	TDS	Total	71
RED0021	2012/03/20	TDS	Total	47
RED0021	2012/04/17	TDS	Total	63
RED0021	2012/05/01	TDS	Total	52
RED0021	2012/06/05	TDS	Total	47
RED0021	2012/07/24	TDS	Total	39
RED0021	2012/08/14	TDS	Total	35
RED0021	2012/09/04	TDS	Total	44
RED0021	2012/10/02	TDS	Total	37
RED0021	2012/11/27	TDS	Total	43
RED0021	2012/12/10	TDS	Total	47

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0021	2013/01/29	TDS	Total	55
RED0021	2013/02/19	TDS	Total	43
RED0021	2013/03/19	TDS	Total	55
RED0021	2013/04/16	TDS	Total	55
RED0021	2013/05/21	TDS	Total	33
RED0021	2013/06/04	TDS	Total	46
RED0021	2013/07/01	TDS	Total	52

8
152
54.01476015
73.5
82

Appendix B.5. ADEQ historical monitoring data for dissolved minerals at RED0018B.

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	1997/05/12	Chloride	Dissolved	7.282
RED0018B	1997/06/16	Chloride	Dissolved	11.369R
RED0018B	1997/07/14	Chloride	Dissolved	24.203
RED0018B	1997/08/25	Chloride	Dissolved	33
RED0018B	1997/09/03	Chloride	Dissolved	45.3
RED0018B	1997/09/15	Chloride	Dissolved	47.7
RED0018B	1997/10/14	Chloride	Dissolved	20.9
RED0018B	1997/11/12	Chloride	Dissolved	13.084
RED0018B	1997/12/16	Chloride	Dissolved	9.845
RED0018B	1998/01/20	Chloride	Dissolved	7.256
RED0018B	1998/02/17	Chloride	Dissolved	4.824
RED0018B	1998/03/17	Chloride	Dissolved	3.59
RED0018B	1998/04/14	Chloride	Dissolved	8.585
RED0018B	1998/05/26	Chloride	Dissolved	29.13
RED0018B	1998/06/23	Chloride	Dissolved	22.91
RED0018B	1998/07/14	Chloride	Dissolved	37.1
RED0018B	1998/08/11	Chloride	Dissolved	64.1
RED0018B	1998/09/01	Chloride	Dissolved	59.6
RED0018B	1998/10/06	Chloride	Dissolved	3.61
RED0018B	1998/11/03	Chloride	Dissolved	13.7
RED0018B	1999/01/05	Chloride	Dissolved	6.08
RED0018B	1999/02/02	Chloride	Dissolved	5.49
RED0018B	1999/03/16	Chloride	Dissolved	4.98
RED0018B	1999/04/27	Chloride	Dissolved	4.76
RED0018B	1999/05/25	Chloride	Dissolved	8.73
RED0018B	1999/06/29	Chloride	Dissolved	10.4
RED0018B	1999/07/27	Chloride	Dissolved	52.9
RED0018B	1999/08/31	Chloride	Dissolved	81.5
RED0018B	1999/10/26	Chloride	Dissolved	50.7
RED0018B	1999/11/22	Chloride	Dissolved	55.34
RED0018B	1999/12/20	Chloride	Dissolved	22.77
RED0018B	2000/01/25	Chloride	Dissolved	26.71
RED0018B	2000/02/29	Chloride	Dissolved	10.8
RED0018B	2000/03/27	Chloride	Dissolved	7.52
RED0018B	2000/04/24	Chloride	Dissolved	5.63
RED0018B	2000/05/30	Chloride	Dissolved	5.52
RED0018B	2000/06/19	Chloride	Dissolved	4.7
RED0018B	2000/07/25	Chloride	Dissolved	37.79
RED0018B	2000/08/28	Chloride	Dissolved	61.4
RED0018B	2000/09/26	Chloride	Dissolved	61.6
RED0018B	2000/10/24	Chloride	Dissolved	55.6
RED0018B	2000/11/14	Chloride	Dissolved	10.13
RED0018B	2000/12/19	Chloride	Dissolved	9.97

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2001/01/16	Chloride	Dissolved	7.46
RED0018B	2001/02/13	Chloride	Dissolved	7.87
RED0018B	2001/03/13	Chloride	Dissolved	3.48
RED0018B	2001/04/17	Chloride	Dissolved	6.93
RED0018B	2001/05/08	Chloride	Dissolved	5.7
RED0018B	2001/06/12	Chloride	Dissolved	8.42
RED0018B	2001/07/10	Chloride	Dissolved	14.74
RED0018B	2001/08/07	Chloride	Dissolved	49.24
RED0018B	2001/09/04	Chloride	Dissolved	9.94
RED0018B	2001/10/09	Chloride	Dissolved	24.42
RED0018B	2001/11/06	Chloride	Dissolved	14.91
RED0018B	2001/12/04	Chloride	Dissolved	9.81
RED0018B	2002/01/02	Chloride	Dissolved	5.68
RED0018B	2002/02/04	Chloride	Dissolved	6.1
RED0018B	2002/03/05	Chloride	Dissolved	8.06
RED0018B	2002/04/02	Chloride	Dissolved	4.17
RED0018B	2002/05/07	Chloride	Dissolved	7.25
RED0018B	2002/06/11	Chloride	Dissolved	11.36
RED0018B	2002/07/09	Chloride	Dissolved	32.07
RED0018B	2002/08/13	Chloride	Dissolved	54.44
RED0018B	2002/09/03	Chloride	Dissolved	50.01
RED0018B	2002/10/01	Chloride	Dissolved	58.4
RED0018B	2002/11/05	Chloride	Dissolved	11.5
RED0018B	2002/12/03	Chloride	Dissolved	12.5
RED0018B	2003/01/21	Chloride	Dissolved	8.65
RED0018B	2003/02/18	Chloride	Dissolved	6.68
RED0018B	2003/03/18	Chloride	Dissolved	7.76
RED0018B	2003/04/22	Chloride	Dissolved	7.74
RED0018B	2003/05/27	Chloride	Dissolved	7.12
RED0018B	2003/06/24	Chloride	Dissolved	13.7
RED0018B	2003/07/15	Chloride	Dissolved	28.7
RED0018B	2003/08/12	Chloride	Dissolved	53.3
RED0018B	2003/09/23	Chloride	Dissolved	56.2
RED0018B	2003/10/14	Chloride	Dissolved	55.7
RED0018B	2003/11/12	Chloride	Dissolved	38.2
RED0018B	2003/12/09	Chloride	Dissolved	24
RED0018B	2004/01/13	Chloride	Dissolved	9.57
RED0018B	2004/02/17	Chloride	Dissolved	7.43
RED0018B	2004/03/16	Chloride	Dissolved	7.57
RED0018B	2004/04/20	Chloride	Dissolved	11.8
RED0018B	2004/05/18	Chloride	Dissolved	11.4
RED0018B	2004/06/22	Chloride	Dissolved	6.12
RED0018B	2004/07/20	Chloride	Dissolved	22.6
RED0018B	2004/08/10	Chloride	Dissolved	34.5
RED0018B	2004/09/07	Chloride	Dissolved	51.7

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2004/10/12	Chloride	Dissolved	12.1
RED0018B	2004/11/16	Chloride	Dissolved	9.25
RED0018B	2004/12/14	Chloride	Dissolved	10.2
RED0018B	2005/01/25	Chloride	Dissolved	7.81
RED0018B	2005/02/22	Chloride	Dissolved	8.22
RED0018B	2005/03/29	Chloride	Dissolved	5.38
RED0018B	2005/04/26	Chloride	Dissolved	6.61
RED0018B	2005/05/24	Chloride	Dissolved	31.5
RED0018B	2005/07/19	Chloride	Dissolved	17
RED0018B	2005/08/23	Chloride	Dissolved	41.1
RED0018B	2005/11/29	Chloride	Dissolved	23.1
RED0018B	2005/12/13	Chloride	Dissolved	37.9
RED0018B	2006/01/17	Chloride	Dissolved	37.7
RED0018B	2006/02/14	Chloride	Dissolved	21.5
RED0018B	2006/03/07	Chloride	Dissolved	15
RED0018B	2006/04/11	Chloride	Dissolved	14.3
RED0018B	2006/05/02	Chloride	Dissolved	9.23
RED0018B	2006/06/06	Chloride	Dissolved	35.3
RED0018B	2006/08/29	Chloride	Dissolved	59
RED0018B	2006/09/26	Chloride	Dissolved	58.8
RED0018B	2006/10/24	Chloride	Dissolved	60
RED0018B	2006/11/14	Chloride	Dissolved	45.9
RED0018B	2006/12/18	Chloride	Dissolved	27.1
RED0018B	2007/01/23	Chloride	Dissolved	8.81
RED0018B	2007/02/27	Chloride	Dissolved	10.5
RED0018B	2007/03/20	Chloride	Dissolved	9.31
RED0018B	2007/04/17	Chloride	Dissolved	8.79
RED0018B	2007/05/08	Chloride	Dissolved	9.22
RED0018B	2007/06/12	Chloride	Dissolved	29.2
RED0018B	2007/07/17	Chloride	Dissolved	9.83
RED0018B	2007/09/25	Chloride	Dissolved	37.9
RED0018B	2007/10/30	Chloride	Dissolved	17.7
RED0018B	2007/11/19	Chloride	Dissolved	35.5
RED0018B	2007/12/11	Chloride	Dissolved	26.3
RED0018B	2008/01/29	Chloride	Dissolved	12.6
RED0018B	2008/02/26	Chloride	Dissolved	9.63
RED0018B	2008/03/25	Chloride	Dissolved	8.27
RED0018B	2008/04/22	Chloride	Dissolved	9.4
RED0018B	2008/05/13	Chloride	Dissolved	9.12
RED0018B	2008/06/03	Chloride	Dissolved	20.8
RED0018B	2008/07/29	Chloride	Dissolved	48.9
RED0018B	2008/08/26	Chloride	Dissolved	10.2
RED0018B	2008/09/16	Chloride	Dissolved	6.95
RED0018B	2008/10/21	Chloride	Dissolved	9.5
RED0018B	2008/11/24	Chloride	Dissolved	15.8

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2008/12/17	Chloride	Dissolved	18
RED0018B	2009/01/06	Chloride	Dissolved	6.75
RED0018B	2009/02/03	Chloride	Dissolved	9.86
RED0018B	2009/03/03	Chloride	Dissolved	12.3
RED0018B	2009/04/07	Chloride	Dissolved	8.95
RED0018B	2009/05/12	Chloride	Dissolved	3.34
RED0018B	2009/07/21	Chloride	Dissolved	50.8
RED0018B	2009/08/11	Chloride	Dissolved	10.6
RED0018B	2009/09/15	Chloride	Dissolved	8.14
RED0018B	2009/10/20	Chloride	Dissolved	6.21
RED0018B	2009/11/23	Chloride	Dissolved	8.64
RED0018B	2009/12/15	Chloride	Dissolved	6.79
RED0018B	2010/01/12	Chloride	Dissolved	3.77
RED0018B	2010/02/09	Chloride	Dissolved	2.74
RED0018B	2010/03/16	Chloride	Dissolved	7.75
RED0018B	2010/04/13	Chloride	Dissolved	10.9
RED0018B	2010/05/18	Chloride	Dissolved	13.2
RED0018B	2010/06/15	Chloride	Dissolved	8.59
RED0018B	2010/07/13	Chloride	Dissolved	32.2
RED0018B	2010/08/10	Chloride	Dissolved	46.5
RED0018B	2010/09/14	Chloride	Dissolved	56.4
RED0018B	2010/10/19	Chloride	Dissolved	63.4
RED0018B	2010/11/22	Chloride	Dissolved	44.6
RED0018B	2010/12/28	Chloride	Dissolved	39.5
RED0018B	2011/01/25	Chloride	Dissolved	20.8
RED0018B	2011/02/14	Chloride	Dissolved	19.8
RED0018B	2011/02/22	Chloride	Dissolved	23.6
RED0018B	2011/03/08	Chloride	Dissolved	14.4
RED0018B	2011/04/12	Chloride	Dissolved	20.2
RED0018B	2011/05/24	Chloride	Dissolved	8.72
RED0018B	2011/06/13	Chloride	Dissolved	28.9
RED0018B	2011/06/28	Chloride	Dissolved	60.1
RED0018B	2011/07/05	Chloride	Dissolved	61.7
RED0018B	2011/07/11	Chloride	Dissolved	32
RED0018B	2011/10/04	Chloride	Dissolved	91.2
RED0018B	2011/11/15	Chloride	Dissolved	44.8
RED0018B	2011/11/28	Chloride	Dissolved	13.2
RED0018B	2011/12/12	Chloride	Dissolved	11.3
RED0018B	2012/01/17	Chloride	Dissolved	10.1
RED0018B	2012/02/21	Chloride	Dissolved	8.98
RED0018B	2012/03/20	Chloride	Dissolved	9.03
RED0018B	2012/04/17	Chloride	Dissolved	8.55
RED0018B	2012/05/01	Chloride	Dissolved	16.1
RED0018B	2012/06/05	Chloride	Dissolved	51
RED0018B	2012/10/02	Chloride	Dissolved	89.4

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
REDO018B	2012/11/27	Chloride	Dissolved	52.7
REDO018B	2012/12/10	Chloride	Dissolved	54.4
REDO018B	2013/01/29	Chloride	Dissolved	20.9
REDO018B	2013/02/19	Chloride	Dissolved	13.4
REDO018B	2013/03/19	Chloride	Dissolved	19.1
REDO018B	2013/04/16	Chloride	Dissolved	12.4
REDO018B	2013/05/21	Chloride	Dissolved	10.5
REDO018B	2013/06/04	Chloride	Dissolved	12
REDO018B	2013/07/01	Chloride	Dissolved	42.7

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	1997/05/12	Sulfate	Dissolved	12.6
RED0018B	1997/06/16	Sulfate	Dissolved	19.2
RED0018B	1997/07/14	Sulfate	Dissolved	23
RED0018B	1997/08/25	Sulfate	Dissolved	29.8
RED0018B	1997/09/03	Sulfate	Dissolved	55.8
RED0018B	1997/09/15	Sulfate	Dissolved	47.7
RED0018B	1997/10/14	Sulfate	Dissolved	14.4
RED0018B	1997/11/12	Sulfate	Dissolved	17.933
RED0018B	1997/12/16	Sulfate	Dissolved	12.568
RED0018B	1998/01/20	Sulfate	Dissolved	8.437
RED0018B	1998/02/17	Sulfate	Dissolved	7.739
RED0018B	1998/03/17	Sulfate	Dissolved	7.2
RED0018B	1998/04/14	Sulfate	Dissolved	12.615
RED0018B	1998/05/26	Sulfate	Dissolved	29.14
RED0018B	1998/06/23	Sulfate	Dissolved	18.475
RED0018B	1998/07/14	Sulfate	Dissolved	38.09
RED0018B	1998/08/11	Sulfate	Dissolved	27.3
RED0018B	1998/09/01	Sulfate	Dissolved	65.1
RED0018B	1998/10/06	Sulfate	Dissolved	6.47
RED0018B	1998/11/03	Sulfate	Dissolved	12.2
RED0018B	1999/01/05	Sulfate	Dissolved	8.46
RED0018B	1999/02/02	Sulfate	Dissolved	7.56
RED0018B	1999/03/16	Sulfate	Dissolved	8.39
RED0018B	1999/04/27	Sulfate	Dissolved	7.67
RED0018B	1999/05/25	Sulfate	Dissolved	11.2
RED0018B	1999/06/29	Sulfate	Dissolved	13.5
RED0018B	1999/07/27	Sulfate	Dissolved	71.5
RED0018B	1999/08/31	Sulfate	Dissolved	100
RED0018B	1999/10/26	Sulfate	Dissolved	79.8
RED0018B	1999/11/22	Sulfate	Dissolved	82.14
RED0018B	1999/12/20	Sulfate	Dissolved	41.65
RED0018B	2000/01/25	Sulfate	Dissolved	42.58
RED0018B	2000/02/29	Sulfate	Dissolved	21.2
RED0018B	2000/03/27	Sulfate	Dissolved	11
RED0018B	2000/04/24	Sulfate	Dissolved	7.46
RED0018B	2000/05/30	Sulfate	Dissolved	7.04
RED0018B	2000/06/19	Sulfate	Dissolved	6.46
RED0018B	2000/07/25	Sulfate	Dissolved	51.93
RED0018B	2000/08/28	Sulfate	Dissolved	78.1
RED0018B	2000/09/26	Sulfate	Dissolved	90.5
RED0018B	2000/10/24	Sulfate	Dissolved	111.04
RED0018B	2000/11/14	Sulfate	Dissolved	18.09
RED0018B	2000/12/19	Sulfate	Dissolved	13.6
RED0018B	2001/01/16	Sulfate	Dissolved	10.82
RED0018B	2001/02/13	Sulfate	Dissolved	13.6

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2001/03/13	Sulfate	Dissolved	6.83
RED0018B	2001/04/17	Sulfate	Dissolved	11.78
RED0018B	2001/05/08	Sulfate	Dissolved	8.99
RED0018B	2001/06/12	Sulfate	Dissolved	14.29
RED0018B	2001/07/10	Sulfate	Dissolved	18.06
RED0018B	2001/08/07	Sulfate	Dissolved	41.52
RED0018B	2001/09/04	Sulfate	Dissolved	21.4
RED0018B	2001/10/09	Sulfate	Dissolved	42.83
RED0018B	2001/11/06	Sulfate	Dissolved	17.51
RED0018B	2001/12/04	Sulfate	Dissolved	14.92
RED0018B	2002/01/02	Sulfate	Dissolved	8.74
RED0018B	2002/02/04	Sulfate	Dissolved	8.92
RED0018B	2002/03/05	Sulfate	Dissolved	13.57
RED0018B	2002/04/02	Sulfate	Dissolved	8.46
RED0018B	2002/05/07	Sulfate	Dissolved	11.09
RED0018B	2002/06/11	Sulfate	Dissolved	14.3
RED0018B	2002/07/09	Sulfate	Dissolved	37.3
RED0018B	2002/08/13	Sulfate	Dissolved	56.18
RED0018B	2002/09/03	Sulfate	Dissolved	46.6
RED0018B	2002/10/01	Sulfate	Dissolved	98.6
RED0018B	2002/11/05	Sulfate	Dissolved	28
RED0018B	2002/12/03	Sulfate	Dissolved	18.3
RED0018B	2003/01/21	Sulfate	Dissolved	13.8
RED0018B	2003/02/18	Sulfate	Dissolved	11.1
RED0018B	2003/03/18	Sulfate	Dissolved	12
RED0018B	2003/04/22	Sulfate	Dissolved	10.4
RED0018B	2003/05/27	Sulfate	Dissolved	13.3
RED0018B	2003/06/24	Sulfate	Dissolved	13.7
RED0018B	2003/07/15	Sulfate	Dissolved	26.4
RED0018B	2003/08/12	Sulfate	Dissolved	40.5
RED0018B	2003/09/23	Sulfate	Dissolved	74.4
RED0018B	2003/10/14	Sulfate	Dissolved	89.7
RED0018B	2003/11/12	Sulfate	Dissolved	75.1
RED0018B	2003/12/09	Sulfate	Dissolved	26.3
RED0018B	2004/01/13	Sulfate	Dissolved	11.8
RED0018B	2004/02/17	Sulfate	Dissolved	11.4
RED0018B	2004/03/16	Sulfate	Dissolved	11.4
RED0018B	2004/04/20	Sulfate	Dissolved	14.5
RED0018B	2004/05/18	Sulfate	Dissolved	13.1
RED0018B	2004/06/22	Sulfate	Dissolved	7.47
RED0018B	2004/07/20	Sulfate	Dissolved	15.6
RED0018B	2004/08/10	Sulfate	Dissolved	33.2
RED0018B	2004/09/07	Sulfate	Dissolved	48.2
RED0018B	2004/10/12	Sulfate	Dissolved	23.8
RED0018B	2004/11/16	Sulfate	Dissolved	11.8

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2004/12/14	Sulfate	Dissolved	13.4
RED0018B	2005/01/25	Sulfate	Dissolved	11.4
RED0018B	2005/02/22	Sulfate	Dissolved	10.7
RED0018B	2005/03/29	Sulfate	Dissolved	9
RED0018B	2005/04/26	Sulfate	Dissolved	8.37
RED0018B	2005/05/24	Sulfate	Dissolved	44.3
RED0018B	2005/07/19	Sulfate	Dissolved	37.6
RED0018B	2005/08/23	Sulfate	Dissolved	63.8
RED0018B	2005/11/29	Sulfate	Dissolved	21.9
RED0018B	2005/12/13	Sulfate	Dissolved	65.5
RED0018B	2006/01/17	Sulfate	Dissolved	39.1
RED0018B	2006/02/14	Sulfate	Dissolved	35.3
RED0018B	2006/03/07	Sulfate	Dissolved	21.6
RED0018B	2006/04/11	Sulfate	Dissolved	29.3
RED0018B	2006/05/02	Sulfate	Dissolved	18
RED0018B	2006/06/06	Sulfate	Dissolved	78.2
RED0018B	2006/08/29	Sulfate	Dissolved	120
RED0018B	2006/09/26	Sulfate	Dissolved	104
RED0018B	2006/10/24	Sulfate	Dissolved	137
RED0018B	2006/11/14	Sulfate	Dissolved	85.3
RED0018B	2006/12/18	Sulfate	Dissolved	45
RED0018B	2007/01/23	Sulfate	Dissolved	13.7
RED0018B	2007/02/27	Sulfate	Dissolved	17.9
RED0018B	2007/03/20	Sulfate	Dissolved	13.4
RED0018B	2007/04/17	Sulfate	Dissolved	13.1
RED0018B	2007/05/08	Sulfate	Dissolved	17.1
RED0018B	2007/06/12	Sulfate	Dissolved	50.4
RED0018B	2007/07/17	Sulfate	Dissolved	14.1
RED0018B	2007/09/25	Sulfate	Dissolved	56.6
RED0018B	2007/10/30	Sulfate	Dissolved	18.7
RED0018B	2007/11/19	Sulfate	Dissolved	55.2
RED0018B	2007/12/11	Sulfate	Dissolved	39.5
RED0018B	2008/01/29	Sulfate	Dissolved	23.8
RED0018B	2008/02/26	Sulfate	Dissolved	14.6
RED0018B	2008/03/25	Sulfate	Dissolved	12.8
RED0018B	2008/04/22	Sulfate	Dissolved	14.9
RED0018B	2008/05/13	Sulfate	Dissolved	15.6
RED0018B	2008/06/03	Sulfate	Dissolved	28.2
RED0018B	2008/07/29	Sulfate	Dissolved	113
RED0018B	2008/08/26	Sulfate	Dissolved	16.7
RED0018B	2008/09/16	Sulfate	Dissolved	10.1
RED0018B	2008/10/21	Sulfate	Dissolved	17.6
RED0018B	2008/11/24	Sulfate	Dissolved	18
RED0018B	2008/12/17	Sulfate	Dissolved	30.7
RED0018B	2009/01/06	Sulfate	Dissolved	9.97

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2009/02/03	Sulfate	Dissolved	14.7
RED0018B	2009/03/03	Sulfate	Dissolved	17
RED0018B	2009/04/07	Sulfate	Dissolved	13.2
RED0018B	2009/05/12	Sulfate	Dissolved	5.62
RED0018B	2009/07/21	Sulfate	Dissolved	34.9
RED0018B	2009/08/11	Sulfate	Dissolved	14.2
RED0018B	2009/09/15	Sulfate	Dissolved	11
RED0018B	2009/10/20	Sulfate	Dissolved	9.47
RED0018B	2009/11/23	Sulfate	Dissolved	13.4
RED0018B	2009/12/15	Sulfate	Dissolved	12
RED0018B	2010/01/12	Sulfate	Dissolved	5.96
RED0018B	2010/02/09	Sulfate	Dissolved	5.07
RED0018B	2010/03/16	Sulfate	Dissolved	13.6
RED0018B	2010/04/13	Sulfate	Dissolved	17.4
RED0018B	2010/05/18	Sulfate	Dissolved	17.8
RED0018B	2010/06/15	Sulfate	Dissolved	15.9
RED0018B	2010/07/13	Sulfate	Dissolved	41.3
RED0018B	2010/08/10	Sulfate	Dissolved	48.7
RED0018B	2010/09/14	Sulfate	Dissolved	57.8
RED0018B	2010/10/19	Sulfate	Dissolved	96.9
RED0018B	2010/11/22	Sulfate	Dissolved	74.5
RED0018B	2010/12/28	Sulfate	Dissolved	56.2
RED0018B	2011/01/25	Sulfate	Dissolved	29.2
RED0018B	2011/02/14	Sulfate	Dissolved	22.7
RED0018B	2011/02/22	Sulfate	Dissolved	24.4
RED0018B	2011/03/08	Sulfate	Dissolved	22.4
RED0018B	2011/04/12	Sulfate	Dissolved	25.7
RED0018B	2011/05/24	Sulfate	Dissolved	12.2
RED0018B	2011/06/13	Sulfate	Dissolved	30.7
RED0018B	2011/06/28	Sulfate	Dissolved	41.8
RED0018B	2011/07/05	Sulfate	Dissolved	44
RED0018B	2011/07/11	Sulfate	Dissolved	47.1
RED0018B	2011/10/04	Sulfate	Dissolved	87.9
RED0018B	2011/11/15	Sulfate	Dissolved	64.9
RED0018B	2011/11/28	Sulfate	Dissolved	33.2
RED0018B	2011/12/12	Sulfate	Dissolved	15.7
RED0018B	2012/01/17	Sulfate	Dissolved	14
RED0018B	2012/02/21	Sulfate	Dissolved	11.8
RED0018B	2012/03/20	Sulfate	Dissolved	13
RED0018B	2012/04/17	Sulfate	Dissolved	11.2
RED0018B	2012/05/01	Sulfate	Dissolved	22.3
RED0018B	2012/06/05	Sulfate	Dissolved	54.2
RED0018B	2012/10/02	Sulfate	Dissolved	84.6
RED0018B	2012/11/27	Sulfate	Dissolved	38.8
RED0018B	2012/12/10	Sulfate	Dissolved	65.3

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
REDO018B	2013/01/29	Sulfate	Dissolved	18
REDO018B	2013/02/19	Sulfate	Dissolved	13.3
REDO018B	2013/03/19	Sulfate	Dissolved	21.7
REDO018B	2013/04/16	Sulfate	Dissolved	14.9
REDO018B	2013/05/21	Sulfate	Dissolved	13.4
REDO018B	2013/06/04	Sulfate	Dissolved	12.8
REDO018B	2013/07/01	Sulfate	Dissolved	31.3

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	1997/05/12	TDS	Total	74
RED0018B	1997/06/16	TDS	Total	126
RED0018B	1997/07/14	TDS	Total	189
RED0018B	1997/08/25	TDS	Total	230
RED0018B	1997/09/03	TDS	Total	307
RED0018B	1997/09/15	TDS	Total	318
RED0018B	1997/10/14	TDS	Total	140
RED0018B	1997/11/12	TDS	Total	100
RED0018B	1997/12/16	TDS	Total	83
RED0018B	1998/01/20	TDS	Total	68
RED0018B	1998/02/17	TDS	Total	59
RED0018B	1998/03/17	TDS	Total	59
RED0018B	1998/04/14	TDS	Total	73
RED0018B	1998/05/26	TDS	Total	203
RED0018B	1998/06/23	TDS	Total	149
RED0018B	1998/07/14	TDS	Total	231
RED0018B	1998/08/11	TDS	Total	346
RED0018B	1998/09/01	TDS	Total	361
RED0018B	1998/10/06	TDS	Total	83
RED0018B	1998/11/03	TDS	Total	101
RED0018B	1999/01/05	TDS	Total	70
RED0018B	1999/02/02	TDS	Total	61
RED0018B	1999/03/16	TDS	Total	59
RED0018B	1999/04/27	TDS	Total	70
RED0018B	1999/05/25	TDS	Total	78
RED0018B	1999/06/29	TDS	Total	119
RED0018B	1999/07/27	TDS	Total	337
RED0018B	1999/08/31	TDS	Total	489
RED0018B	1999/10/26	TDS	Total	378
RED0018B	1999/11/22	TDS	Total	393
RED0018B	1999/12/20	TDS	Total	184
RED0018B	2000/01/25	TDS	Total	188.5
RED0018B	2000/02/29	TDS	Total	98.5
RED0018B	2000/03/27	TDS	Total	75
RED0018B	2000/04/24	TDS	Total	78.5
RED0018B	2000/05/30	TDS	Total	67
RED0018B	2000/07/25	TDS	Total	272
RED0018B	2000/08/28	TDS	Total	430
RED0018B	2000/09/26	TDS	Total	490
RED0018B	2000/10/24	TDS	Total	407
RED0018B	2000/11/14	TDS	Total	109.5
RED0018B	2000/12/19	TDS	Total	80.5
RED0018B	2001/01/16	TDS	Total	72
RED0018B	2001/02/13	TDS	Total	77
RED0018B	2001/03/13	TDS	Total	56.5

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2001/04/17	TDS	Total	75.5
RED0018B	2001/05/08	TDS	Total	70
RED0018B	2001/06/12	TDS	Total	79
RED0018B	2001/07/10	TDS	Total	132
RED0018B	2001/08/07	TDS	Total	301.5
RED0018B	2001/09/04	TDS	Total	109.5
RED0018B	2001/10/09	TDS	Total	197
RED0018B	2001/11/06	TDS	Total	111
RED0018B	2001/12/04	TDS	Total	84.5
RED0018B	2002/01/02	TDS	Total	59.5
RED0018B	2002/02/04	TDS	Total	61
RED0018B	2002/03/05	TDS	Total	77.5
RED0018B	2002/04/02	TDS	Total	57
RED0018B	2002/05/07	TDS	Total	71
RED0018B	2002/06/11	TDS	Total	83
RED0018B	2002/07/09	TDS	Total	194.5
RED0018B	2002/08/13	TDS	Total	333
RED0018B	2002/09/03	TDS	Total	303
RED0018B	2002/10/01	TDS	Total	391
RED0018B	2002/11/05	TDS	Total	105
RED0018B	2002/12/03	TDS	Total	97
RED0018B	2003/01/21	TDS	Total	72
RED0018B	2003/02/18	TDS	Total	66.5
RED0018B	2003/03/18	TDS	Total	65.5
RED0018B	2003/04/22	TDS	Total	76.5
RED0018B	2003/05/27	TDS	Total	74
RED0018B	2003/06/24	TDS	Total	104
RED0018B	2003/07/15	TDS	Total	189
RED0018B	2003/08/12	TDS	Total	290
RED0018B	2003/09/23	TDS	Total	360
RED0018B	2003/10/14	TDS	Total	377
RED0018B	2003/11/12	TDS	Total	314
RED0018B	2003/12/09	TDS	Total	158
RED0018B	2004/01/13	TDS	Total	75
RED0018B	2004/02/17	TDS	Total	89
RED0018B	2004/03/16	TDS	Total	75
RED0018B	2004/04/20	TDS	Total	92.5
RED0018B	2004/05/18	TDS	Total	96
RED0018B	2004/06/22	TDS	Total	84.5
RED0018B	2004/07/20	TDS	Total	154
RED0018B	2004/08/10	TDS	Total	205
RED0018B	2004/09/07	TDS	Total	374
RED0018B	2004/10/12	TDS	Total	119
RED0018B	2004/11/16	TDS	Total	86.5
RED0018B	2004/12/14	TDS	Total	85

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2005/01/25	TDS	Total	57.5
RED0018B	2005/02/22	TDS	Total	85
RED0018B	2005/03/29	TDS	Total	77.5
RED0018B	2005/04/26	TDS	Total	68
RED0018B	2005/05/24	TDS	Total	238
RED0018B	2005/07/19	TDS	Total	159
RED0018B	2005/08/23	TDS	Total	322
RED0018B	2005/11/29	TDS	Total	161
RED0018B	2005/12/13	TDS	Total	306
RED0018B	2006/01/17	TDS	Total	297
RED0018B	2006/02/14	TDS	Total	154
RED0018B	2006/03/07	TDS	Total	122
RED0018B	2006/04/11	TDS	Total	131
RED0018B	2006/05/02	TDS	Total	98
RED0018B	2006/06/06	TDS	Total	299
RED0018B	2006/08/29	TDS	Total	510
RED0018B	2006/09/26	TDS	Total	466
RED0018B	2006/10/24	TDS	Total	506
RED0018B	2006/11/14	TDS	Total	361
RED0018B	2006/12/18	TDS	Total	206
RED0018B	2007/01/23	TDS	Total	81
RED0018B	2007/02/27	TDS	Total	83.5
RED0018B	2007/03/20	TDS	Total	76.5
RED0018B	2007/04/17	TDS	Total	77.5
RED0018B	2007/05/08	TDS	Total	92
RED0018B	2007/06/12	TDS	Total	221
RED0018B	2007/07/17	TDS	Total	100
RED0018B	2007/09/25	TDS	Total	260
RED0018B	2007/10/30	TDS	Total	122
RED0018B	2007/11/19	TDS	Total	285
RED0018B	2007/12/11	TDS	Total	188
RED0018B	2008/01/29	TDS	Total	93
RED0018B	2008/02/26	TDS	Total	77
RED0018B	2008/03/25	TDS	Total	84
RED0018B	2008/04/22	TDS	Total	86
RED0018B	2008/05/13	TDS	Total	94
RED0018B	2008/06/03	TDS	Total	166
RED0018B	2008/07/29	TDS	Total	376
RED0018B	2008/08/26	TDS	Total	101
RED0018B	2008/09/16	TDS	Total	80
RED0018B	2008/10/21	TDS	Total	91.5
RED0018B	2008/11/24	TDS	Total	118
RED0018B	2008/12/17	TDS	Total	123
RED0018B	2009/01/06	TDS	Total	80
RED0018B	2009/02/03	TDS	Total	79

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
RED0018B	2009/03/03	TDS	Total	105
RED0018B	2009/04/07	TDS	Total	74
RED0018B	2009/05/12	TDS	Total	67
RED0018B	2009/07/21	TDS	Total	306
RED0018B	2009/08/11	TDS	Total	90
RED0018B	2009/09/15	TDS	Total	86
RED0018B	2009/10/20	TDS	Total	78
RED0018B	2009/11/23	TDS	Total	72
RED0018B	2009/12/15	TDS	Total	65
RED0018B	2010/01/12	TDS	Total	59
RED0018B	2010/02/09	TDS	Total	57
RED0018B	2010/03/16	TDS	Total	62
RED0018B	2010/04/13	TDS	Total	90
RED0018B	2010/05/18	TDS	Total	100
RED0018B	2010/06/15	TDS	Total	83
RED0018B	2010/07/13	TDS	Total	223
RED0018B	2010/08/10	TDS	Total	297
RED0018B	2010/09/14	TDS	Total	343
RED0018B	2010/10/19	TDS	Total	408
RED0018B	2010/11/22	TDS	Total	368
RED0018B	2010/12/28	TDS	Total	315
RED0018B	2011/01/25	TDS	Total	125
RED0018B	2011/02/14	TDS	Total	117
RED0018B	2011/02/22	TDS	Total	131
RED0018B	2011/03/08	TDS	Total	112
RED0018B	2011/04/12	TDS	Total	155
RED0018B	2011/05/24	TDS	Total	56
RED0018B	2011/06/13	TDS	Total	172
RED0018B	2011/06/28	TDS	Total	249
RED0018B	2011/07/05	TDS	Total	279
RED0018B	2011/07/11	TDS	Total	183
RED0018B	2011/10/04	TDS	Total	433
RED0018B	2011/11/15	TDS	Total	274
RED0018B	2011/11/28	TDS	Total	130
RED0018B	2011/12/12	TDS	Total	122
RED0018B	2012/01/17	TDS	Total	92
RED0018B	2012/02/21	TDS	Total	95
RED0018B	2012/03/20	TDS	Total	81
RED0018B	2012/04/17	TDS	Total	65
RED0018B	2012/05/01	TDS	Total	125
RED0018B	2012/06/05	TDS	Total	273
RED0018B	2012/10/02	TDS	Total	509
RED0018B	2012/11/27	TDS	Total	256
RED0018B	2012/12/10	TDS	Total	307
RED0018B	2013/01/29	TDS	Total	125

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
REDO018B	2013/02/19	TDS	Total	85
REDO018B	2013/03/19	TDS	Total	121
REDO018B	2013/04/16	TDS	Total	103
REDO018B	2013/05/21	TDS	Total	83
REDO018B	2013/06/04	TDS	Total	95
REDO018B	2013/07/01	TDS	Total	256

Appendix B.6. ADEQ historical monitoring data for dissolved minerals at MIN0002.

Station	Date Sampled	Parameter	Fraction	Final Result (mg/L)
MIN0002	1991/07/23	Chloride	Dissolved	28
MIN0002	1992/03/10	Chloride	Dissolved	3.24
MIN0002	1992/05/12	Chloride	Dissolved	4.35
MIN0002	2000/08/01	Chloride	Dissolved	35.27
MIN0002	2001/01/08	Chloride	Dissolved	8.37
MIN0002	2001/03/12	Chloride	Dissolved	2.35
MIN0002	2001/06/18	Chloride	Dissolved	10
MIN0002	2001/09/04	Chloride	Dissolved	11
MIN0002	2002/08/20	Chloride	Dissolved	55.65
MIN0002	1991/07/23	Sulfate	Dissolved	93
MIN0002	1992/03/10	Sulfate	Dissolved	10.3
MIN0002	1992/05/12	Sulfate	Dissolved	11.2
MIN0002	2000/08/01	Sulfate	Dissolved	44.94
MIN0002	2001/01/08	Sulfate	Dissolved	16.64
MIN0002	2001/03/12	Sulfate	Dissolved	10.83
MIN0002	2001/06/18	Sulfate	Dissolved	11.3
MIN0002	2001/09/04	Sulfate	Dissolved	27.3
MIN0002	2002/08/20	Sulfate	Dissolved	54.6
MIN0002	1991/07/23	TDS	Total	233
MIN0002	1991/10/30	TDS	Total	64
MIN0002	1992/03/10	TDS	Total	78
MIN0002	1992/05/12	TDS	Total	87
MIN0002	2000/08/01	TDS	Total	247
MIN0002	2001/01/08	TDS	Total	89
MIN0002	2001/03/12	TDS	Total	116.5
MIN0002	2001/06/18	TDS	Total	93
MIN0002	2001/09/04	TDS	Total	132.5
MIN0002	2001/11/27	TDS	Total	111
MIN0002	2002/08/20	TDS	Total	335

APPENDIX C

Mineral and Flow Data from Denison Dam and Index, AR

Table C.1. Dissolved mineral concentrations and flow values at USGS gage at Index, AR from 1997 to 2013.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
1/15/1997	6,190	170	170	702
3/26/1997	17,800	140	160	580
5/21/1997	23,200	220	250	884
7/16/1997	6,660	180	200	768
9/12/1997	3,120	250	290	1,050
11/19/1997	8,630	150	180	650
1/21/1998	54,400	160	220	720
2/25/1998	19,800	170	210	692
4/22/1998	13,000	180	210	778
6/18/1998	4,080	190	200	812
9/1/1998	4,510	220	250	906
11/4/1998	3,610	130	160	602
1/13/1999	4,170	110	130	548
3/11/1999	3,950	150	180	679
6/9/1999	20,400	230	260	912
7/8/1999	22,600	150	160	632
8/24/1999	4,750	280	310	1,140
11/2/1999	1,780	240	260	963
1/5/2000	4,260	240	270	959
3/1/2000	7,410	91	110	420
4/5/2000	10,200	89	100	397
7/12/2000	6,320	180	200	699
9/13/2000	3,240	370	360	1,310
10/18/2000	1,450	130	130	1,020
1/17/2001	19,500	160	170	643
2/28/2001	53,400	63	69	310
5/9/2001	6,840	92	97	432
6/20/2001	6,900	170	160	675
8/29/2001	3,490	190	190	784
10/24/2001	7,940	54	62	260
1/16/2002	5,380	160	170	663
3/5/2002	6,330	140	140	588
4/24/2002	58,300	100	98	405
6/26/2002	3,240	43	60	326
8/22/2002	9,990	150	140	581

Table C.1. Dissolved mineral concentrations and flow values at USGS gage at Index, AR from 1997 to 2013 (continued).

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
10/17/2002	2,390	130	120	554
12/4/2002	3,060	130	140	624
2/5/2003	5,160	220	180	783
4/16/2003	4,130	86	92	463
6/25/2003	4,470	180	150	662
8/27/2003	4,040	270	210	904
10/16/2003	1,930	170	150	718
1/28/2004	6,780	85	75	334
3/17/2004	6,160	80.7	75	348
5/26/2004	3,340	230	200	838
6/16/2004	7,240	59	56	265
8/17/2004	7,050	320	230	1,010
10/27/2004	4,450	238	188	819
1/19/2005	33,400	134	89.3	443
2/23/2005	8,610	186	121	622
5/5/2005	3,630	188	143	718
6/9/2005	2,420	118	100	564
8/3/2005	2,690	232	171	823
10/5/2005	2,420	276	192	877
1/12/2006	1,210	210	205	894
3/1/2006	2,100	233	185	824
4/19/2006	2,050	247	200	898
6/28/2006	2,020	275	213	934
8/1/2006	3,280	288	214	932
11/29/2006	3,420	393	268	1,190
1/25/2007	33,500	63.6	51.2	245
3/1/2007	4,960	151	127	589
5/3/2007	15,200	127	87.8	431
7/19/2007	86,800	117	88.2	432
8/10/2007	54,900	105	81.5	398
10/31/2007	3,310	102	118	545
12/12/2007	3,380	113	148	612
1/17/2008	3,890	90.6	120	518
3/5/2008	22,900	32.9	45.6	217
4/3/2008	37,100	24.6	35.7	186
8/19/2008	4,170	118	150	621

Table C.1. Dissolved mineral concentrations and flow values at USGS gage at Index, AR from 1997 to 2013 (continued).

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
11/5/2008	980	98.5	139	669
1/14/2009	1,960	98.1	112	483
3/25/2009	2,400	88.9	107	480
5/18/2009	54,400	10.1	17.2	154
6/25/2009	9,500	123	130	515
8/26/2009	6,420	186	176	703
11/5/2009	38,700	32	34.3	183
1/25/2010	15,700	53.4	54.3	255
3/11/2010	24,600	115	108	505
5/25/2010	25,100	122	92.5	448
7/21/2010	12,100	292	208	910
9/15/2010	5,070	78.4	68.7	344
11/17/2010	928	98.7	109	569
12/13/2010	1,650	200	176	763
2/22/2011	1,820	237	199	862
4/19/2011	1,090	159	154	713
6/7/2011	2,030	30.6	51.5	277
8/17/2011	1,420	286	232	971
11/30/2011	7,120	17	22.5	132
1/11/2012	2,210	28.1	40.4	228
4/3/2012	30,800	131	99.3	439
6/13/2012	2,380	147	140	606
7/11/2012	1,600	197	175	724
8/1/2012	1,220	114	117	528
11/29/2012		241	219	918
2/7/2013	813	148	170	688

Table C.2. Dissolved mineral concentrations and flow values at Denison Dam from 1997 to 2011.

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)
1/30/1997	ND	280	270
2/18/1997	5,278	340	310
3/18/1997	11,950	238	266
4/22/1997	19,292	248	265
5/21/1997	16,465	267	292
6/17/1997	15,746	272	309
7/23/1997	6,932	263	319
8/7/1997	ND	304	333
9/24/1997	1,139	295	352
10/22/1997	2,687	328	394
11/4/1997	2,507	312	390
12/9/1997	3,255	318	411
1/14/1998	29,077	307	399
2/11/1998	11,646	280	347
3/19/1998	28,325	291	330
4/17/1998	12,358	210	238
5/21/1998	5,303	321	330
6/11/1998	2,376	308	316
7/14/1998	4,277	243	290
8/19/1998	4,473	268	302
9/2/1998	2,313	269	312
10/21/1998	2,227	279	323
11/17/1998	1,695	286	316
12/16/1998	2,100	321	351
1/27/1999	2,148	303	351
2/24/1999	2,096	305	366
3/23/1999	3,594	309	374
4/21/1999	8,090	311	362
5/27/1999	2,859	431	404
6/23/1999	6,157	344	356
7/20/1999	5,391	354	354
8/27/1999	4,398	339	345
9/15/1999	1,216	333	342
10/27/1999	1,621	345	366
11/16/1999	1,250	332	355
12/30/1999	2,800	352	367
1/25/2000	3,241	354	370
2/28/2000	1,855	349	372

Table C.2. Dissolved mineral concentrations and flow values at Denison Dam from 1997 to 2011 (continued).

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)
3/21/2000	38	343	367
4/27/2000	2,514	344	377
5/24/2000	3,153	348	374
6/8/2000	2,683	353	378
7/18/2000	5,760	361	363
8/2/2000	5,759	391	381
9/13/2000	2,979	435	380
10/4/2000	1,092	412	401
11/8/2000	17,817	425	403
12/22/2000	7,450	319	304
1/30/2001	5,529	246	240
2/28/2001	1,486	247	227
3/23/2001	11,279	198	170
4/12/2001	6,179	188	174
5/24/2001	2,585	190	186
6/6/2001	10,963	218	199
7/18/2001	6,922	243	224
8/22/2001	2,711	255	207
9/12/2001	1,444	255	212
10/11/2001	2,284	241	238
11/28/2001	1,085	250	245
12/27/2001	6,989	266	250
1/15/2002	5,838	254	241
2/20/2002	2,386	256	242
3/13/2002	1,141	258	239
4/9/2002	341	261	240
5/8/2002	3,993	221	201
6/13/2002	1,570	412	240
7/17/2002	3,596	568	302
8/15/2002	10,321	215	177
9/17/2002	3,325	231	181
10/9/2002	46	219	171
11/29/2002	1,861	239	190
12/30/2002	1,327	248	192
1/31/2003	2,589	262	198
2/24/2003	7,114	273	203
3/10/2003	1,268	280	204
4/1/2003	795	276	207
5/27/2003	2,381	266	212

Table C.2. Dissolved mineral concentrations and flow values at Denison Dam from 1997 to 2011 (continued).

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)
6/10/2003	386	272	211
7/1/2003	2,606	277	215
8/5/2003	3,988	297	219
9/2/2003	2,941	297	211
10/8/2003	1,773	310	226
11/12/2003	1,874	317	230
12/10/2003	2,528	323	231
1/6/2004	1,908	330	237
2/10/2004	2,207	333	241
3/1/2004	1,448	325	241
4/6/2004	2,260	330	220
5/11/2004	3,064	323	233
6/8/2004	1,917	325	234
7/12/2004	10,846	354	251
8/4/2004	8,536	354	251
9/1/2004	3,165	357	242
10/5/2004	2,338	339	234
11/1/2004	1,685	349	234
12/7/2004	9,186	365	226
1/19/2005	12,371	312	197
2/8/2005	5,866	300	188
3/14/2005	5,933	299	190
4/27/2005	2,985	306	204
5/23/2005	2,529	347	234
6/13/2005	1,385	352	231
7/13/2005	1,773	362	233
8/9/2005	2,489	390	245
9/7/2005	2,252	395	247
10/25/2005	950	400	264
11/30/2005	702	395	261
2/23/2006	1,103	401	267
4/26/2006	1,420	392	273
6/28/2006	61	376	259
8/31/2006	202	386	246
10/31/2006	2,327	419	278
1/31/2007	4,316	460	283
3/13/2007	178	464	293
4/2/2007	11,842	462	289
4/11/2007	11,458	445	277

Table C.2. Dissolved mineral concentrations and flow values at Denison Dam from 1997 to 2011 (continued).

Date	Flow (cfs)	Chloride (mg/L)	Sulfate (mg/L)
4/26/2007	6,381	451	276
5/9/2007	5,964	450	274
6/6/2007	24,313	424	254
6/14/2007	30,721	384	235
7/12/2007	32,475	226	166
8/9/2007	30,071	117	107
8/30/2007	31,788	103	95.1
10/24/2007	2,944	112	136
11/26/2007	267	126	166
12/17/2007	566	129	164
1/9/2008	402	138	177
2/26/2008	435	153	194
3/27/2008	10,700	172	210
4/23/2008	16,200	164	219
5/21/2008	10,200	167	213
6/11/2008	195	160	210
7/24/2008	10,400	176	210
8/28/2008	262	173	191
9/17/2008	172	193	223
9/2/2009	252	222	206
10/5/2009	164	213	193
11/24/2009	598	237	205
2/17/2010	13,700	236	198
3/16/2010	10,600	220	191
5/24/2010	168	307	204
7/12/2010	10,600	322	214
9/30/2010	143	314	223
11/3/2010	164	313	222
1/6/2011	926	344	242
3/14/2011	147	346	241
5/25/2011	143	175	142
7/21/2011	134	353	255
10/27/2011	137	407	282

APPENDIX D

Sampling Survey and Historical Data Review of Fish Populations in the Arkansas Portion of the Red River

Fishes of the Red River in Arkansas

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Abstract

Fishes were collected from Red River mainstem habitats in Arkansas with seines, rotenone, hoop nets, gill nets, and trotlines from 1995 through 2001. Seventy-two species were identified distributed among 17 families, and 15 species were new records for the Red River in Arkansas. Eighty-three species are now historically known from the Arkansas segment of the Red River. Approximately 67% of the fishes known from the entire Red River have been found in the Arkansas segment, which is only 11% of the entire river length. Baseline data on the fish fauna of the Red River is critical for the analysis of potential effects to aquatic systems, and because of the potential for deleterious effects from alteration of aquatic habitats by a proposed project to extend the Red River Navigation System upstream from Shreveport, Louisiana to Index, Arkansas and by desalination projects upstream in Texas.

Introduction

The fish communities of large rivers are the least studied ichthyofaunas of all aquatic habitats in Arkansas. This study was the first comprehensive sampling to determine fish species distribution and abundance within the entire Arkansas segment of the Red River. An up-to-date survey of the fishes of the Red River in Arkansas is especially important because of the proposed construction of a navigation channel from Shreveport, Louisiana through the lower half of the Red River in Arkansas.

Description of the Red River and the Study Area in Arkansas.--The Red River originates in eastern New Mexico and flows easterly across the Texas panhandle, along the boundary between Texas and Oklahoma, through the southwestern corner of Arkansas, and across Louisiana to join the Atchafalaya River near Simmesport, Louisiana. The Red River formerly flowed directly into the Mississippi River, but the flood of 1927 and the subsequent construction of levees diverted the Red River southward into the Atchafalaya River (Douglas, 1974). Today, the Red River is accessible from the Mississippi River through its old channel because part of the Mississippi River flow is diverted through the old channel (11.3 km) into the Atchafalaya River, forming the first segment of the Red River Navigation System.

The Red River is 1,945 km long and drains an area of 179,308 km^2. The Arkansas segment of the river is 217 km long with a drainage area of 11,484 km^2. Compared to the other big rivers in Arkansas (e.g., the Arkansas and Mississippi Rivers), the Red River has been least altered by human activity. A number of anthropogenic alterations, however, have occurred in the Red River upstream and downstream from Arkansas. The upper Red River in Texas and Oklahoma contains salt concentrations approaching that of seawater with decreasing salinities occurring downstream (Matthews, 1998). The Echelle et al. (1972) fish surveys indicated that the species composition of the upper Red River reflected differences in the fish assemblages along the salinity gradient. Those assemblages are currently threatened to be influenced by a project underway to decrease the amount of salt in the Red River by building dams, brine reservoirs, pipelines and pumps on west Texas tributaries that feed the Red River. The natural flow regime has been changed by the construction of Denison Dam, which impounded Lake Texoma on the Red River in Oklahoma, by seven large impoundments in the Little River drainage in Arkansas and Oklahoma, and by several other small impoundments on Red River tributaries in Oklahoma. The lower portion of the Red River in Arkansas downstream from the U.S. Hwy 71 bridge has been modified by manmade levees and numerous areas of revetted banks and wing dikes. Upstream from U.S. Hwy 71 in Arkansas, however, few channel modification structures exist. Downstream from Arkansas, a series of locks and dams maintains a 2.7 m deep navigation channel from the Mississippi River through Old River and the Red River to Shreveport, Louisiana, a distance of approximately 377 km.

Chronological History of Red River Fish Sampling in Arkansas.--The earliest reported scientific collection of fishes from the Arkansas portion of the Red River was by Jordan and Gilbert (1886). During September 1884, David Starr Jordan assisted by Charles H. Gilbert, Joseph Swain, and Seth E. Meek collected fishes "with a fine-meshed seine of large size" from a number of streams in Arkansas, Indian Territory (Oklahoma), and Texas for the U. S. National Museum and the U.S. Fish Commission. The Red River at Fulton, Arkansas was one of their collecting sites. They judged the water to be at its lowest point and referred to the Red River at this site as "singularly barren of fish life"

although they collected 23 species. *Hybognathus nuchalis* was listed as "by far more numerous in individuals than any other species in the river." *Notropis atherinoides*, *Macrhybopsis hyostoma*, and *M. storeriana* were also reported to be rather common or abundant. All 23 species reported by Jordan and Gilbert (1886) were collected from the Red River in the 1990s.

The next reported collections of fishes from the Arkansas segment of the Red River were in 1938 and 1939 by John D. Black (1940), 54 years after Jordan's expedition. Black collected fishes at three mainstem sites and reported 34 currently recognized fish species from those localities, 18 of which had not been reported from the Red River mainstem by Jordan and Gilbert (1886). This increased the number of species known from the Red River in Arkansas to 41. Black's collections included the first known records of the Red River shiner, *Notropis bairdi*, from Arkansas (two adult specimens taken at Spring Bank Ferry, 8 km north of the Louisiana state line on 8 July 1939). Black also reported the only specimens of the plains minnow, *Hybognathus placitus*, ever taken from the Red River in Arkansas (three young and adult specimens collected at Spring Bank Ferry on 8 July 1939).

On 18 August 1940, Reeve M. Bailey and M. E. Davis collected 15 species of fishes from the Red River at Fulton. The results of this collection were not published, but the specimens were deposited in the University of Michigan Museum of Zoology. This collection added three species to the list of fishes known from the Red River in Arkansas, bringing the total known species to 44. The most noteworthy record from this sample was the second (and last known) report of *Notropis bairdi* from Arkansas (three

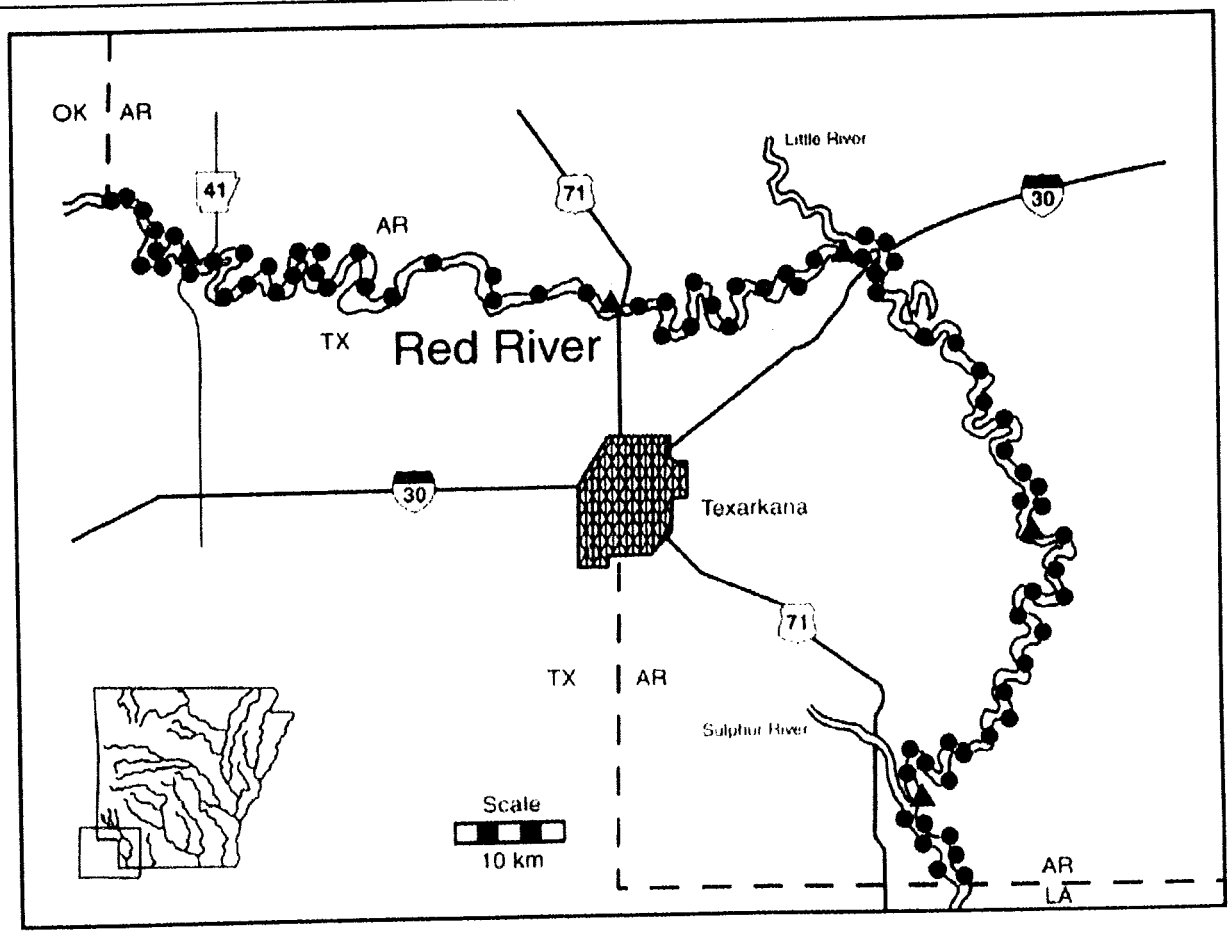


Fig. 1. Red River fish collecting sites in Arkansas, 1995-2001. Solid circles are localities sampled by seine and/or rotenone, solid triangles are localities sampled by hoop nets, gill nets, and/or trotlines. Collecting locales included the following counties in AR: Hempstead, Lafayette, Little River, and Miller.

Table 1. Fish species collected from the Red River in Arkansas, 1995-2001. Status of each species is designated as abundant (A), common (C), uncommon (U), or rare (R).

Species	Status	Collected upstream from Little R. mouth	Collected downstream from Little R. mouth
Scaphirhynchus platorynchus	C	X	X
Polyodon spathula	R		X
Atractosteus spatula	R	X	X
Lepisosteus oculatus	U	X	X
Lepisosteus osseus	A	X	X
Lepisosteus platostomus	U	X	X
Hiodon alosoides	R	X	
Alosa chrysochloris	U	X	X
Dorosoma cepedianum	C	X	X
Dorosoma petenense	A	X	X
*Ctenopharyngodon idella**	R		X
Cyprinella lutrensis	A	X	X
Cyprinella venusta	U	X	X
Cyprinus carpio	U	X	X
Hybognathus nuchalis	U	X	X
Macrhybopsis hyostoma	U	X	X
Macrhybopsis storeriana	A	X	X
Notemigonus crysoleucas	U	X	X
*Notropis amnis**	R		X
Notropis atherinoides	A	X	X
Notropis buchanani	U	X	X
Notropis potteri	A	X	X
Notropis shumardi	C	X	X
Opsopoeodus emiliae	U	X	X
*Phenacobius mirabilis**	R	X	
Pimephales vigilax	A	X	X
Carpiodes carpio	A	X	X
Cycleptus elongatus	A	X	X
Ictiobus bubalus	C	X	X
Ictiobus cyprinellus	U	X	X
*Ictiobus niger**	R	X	
Minytrema melanops	R		X
*Ameiurus natalis**	U	X	X
Ictalurus furcatus	A	X	X
Ictalurus punctatus	C	X	X
Noturus gyrinus	U	X	X
*Noturus nocturnus**	U	X	X
Pylodictis olivaris	C	X	X
Aphredoderus sayanus	U	X	X
*Fundulus blairae**	R		X
Fundulus chrysotus	R	X	X
Fundulus notatus	U	X	X
Fundulus olivaceus	R	X	
Gambusia affinis	C	X	X
*Labidesthes sicculus**	U	X	X
Menidia beryllina	A	X	X

Table 1. Continued

Morone chrysops	A	X	X
Morone mississippiensis	C	X	X
Morone saxatilis	C	X	X
Elassoma zonatum	U	X	X
Lepomis cyanellus	U	X	X
Lepomis gulosus	C	X	X
Lepomis humilis	C	X	X
Lepomis macrochirus	C	X	X
Lepomis megalotis	C	X	X
Lepomis microlophus	U	X	X
Lepomis miniatus	R	X	X
*Lepomis symmetricus**	U	X	X
*Micropterus punctulatus**	U	X	X
Micropterus salmoides	C	X	X
Pomoxis annularis	C	X	X
Pomoxis nigromaculatus	U	X	
Ammocrypta clara	U	X	X
*Etheostoma asprigene**	R	X	X
*Etheostoma chlorosomum**	U	X	
*Etheostoma collettei**	R	X	X
Etheostoma gracile	C	X	X
*Percina macrolepida**	U	X	X
*Percina maculata**	R	X	
Percina sciera	U	X	X
Percina shumardi	U	X	X
Aplodinotus grunniens	A		

* A species first collected from the Arkansas segment of the Red River in this study.

specimens, UMMZ 170013).

Reeves (1953) provided records for the Alabama shad, *Alosa alabamae*, from the Little River of Oklahoma, a Red River tributary. *Alosa alabamae*, an anadromous species, had to ascend the Arkansas portion of the Red River to reach spawning habitat in the Little River of Oklahoma, increasing the known Red River fauna of Arkansas to 45 species.

Buchanan (1973) provided distribution maps showing all known species records and localities for the Red River in Arkansas. This was a summary of all known previous collections, but nine additional species were added to the list of fishes known from the Red River. These nine new species came from Arkansas Game & Fish Commission records of gill netting samples from the Red River in the 1960s and from seine collections at five localities by Buchanan in 1972, bringing the total known fish species in the Red River to 54.

The next, and until now most intensive, fish sampling on the Red River in Arkansas was a survey of the fishes from Index, Arkansas (U.S. Hwy. 71 bridge) to Shreveport, Louisiana by Kelly H. Oliver from December 1978 through July 1979 (Dorris et al., 1979). Oliver sampled 13 mainstem sites in the lower half of the Arkansas portion of the Red River and four mainstem sites in Louisiana. Each site was sampled from one to three times by gill nets, seines, and/or electrofishing; occasional creel censuses were made when local fishermen were encountered. Oliver's field notes and collection site species lists were lost, and it is not possible to precisely determine which fish species were found in the Arkansas portion of the Red River from the data presented in the report (Dorris et al., 1979). Eight species reported by Oliver from the Red River mainstem were possibly misidentified. No voucher specimens of the eight questionable species were available for examination, and those species were not considered as part of the documented Red River fauna. Because 57 of the 58 species reported from the mainstem of the Red River were found in the Arkansas segment of the river, we accept 10 of the species listed by Oliver as new Red River records for Arkansas, bringing the total known mainstem species to 64. All 10 of Oliver's new species records were subsequently confirmed from the Red River by other collectors.

From 1973 to 1987, Robison and Buchanan (1988) made 27 fish collections by seine in the Red River mainstem between the Oklahoma and Louisiana state lines. These collections added four additional species to the known Red River fish fauna of Arkansas, bringing the known species total to 68.

Table 2. Fish species historically known from the Red River in Arkansas but not collected in the 1995-2001 sampling.

Species	Collector and/or author first reporting species
Ichthyomyzon castaneus	Robison and Buchanan (1988)
Amia calva	Bailey, 1940 (Buchanan, 1973)
Anguilla rostrata	Buchanan (1973)
Alosa alabamae	Reeves (1953)
Campostoma anomalum	Oliver (Dorris et al., 1979)
Hybognathus placitus	Black (1940)
Luxilus chrysocephalus	Black (1940)
Notropis bairdi	Black (1940)
Pimephales promelas	Oliver (Dorris et al., 1979)
Ameiurus melas	Black (1940)
Mugil cephalus	Oliver (Dorris et al., 1979)

Methods

Main channel Red River habitats in four counties of Arkansas from the Oklahoma state line to the Louisiana state line were sampled by seines and rotenone from 1995 through 2001 and by gill nets, hoop nets, and trotlines in 1997 and 1998 (Fig. 1). Ninety-one seine and/or rotenone samples were taken in the following four mainstem habitats: main river channel in slow to swift current along point bars and islands, chutes, backwaters adjacent to main channel, and sandbar pools. Seine collections were made with 6 x 1.5 m and 9 x 1.5 m nylon seines of 3.2 mm mesh. Small-scale samples were made with rotenone in areas of little or no current. Sampling time by seine and rotenone averaged 1.0 hour per site and ranged from 0.5 to 2.0 hours. Specimens were preserved in 10% formalin and later transferred to 45% isopropanol. All preserved fishes were identified in the laboratory, and specimens were deposited in the Zoology Collection of the University of Arkansas – Fort Smith.

Five localities in the Arkansas segment of the Red River were sampled with gill nets and hoop nets between March and June 1997, and the three most downstream of those localities were sampled with gill nets and hoop nets between January and July 1998 (Fig. 1), for a total of eight site-samples during the two sampling periods. Each site included a river reach of approximately 8 km. Hoop nets 1.2 m in diameter with 3.8 cm bar mesh were used in deep water, and hoop nets 0.9 m in diameter with 3.8 cm bar mesh were used in shallow water. The hoop nets were checked twice daily, just after sunrise and just before sunset. Experimental gill nets consisting of three 30 m panels one each of 5.1, 7.6, and 10.2 cm monofilament webbing were checked at approximately two-hour intervals. At the two most downstream sampling localities, trotlines baited with golden shiners were used in 1997. A total of 378 hoop net nights, 24 gill net nights, and 8 trotline nights represented approximately 5000 hours of sampling at the five sites.

Present status in the Red River was assigned to each fish species collected in this study (Table 1) based on a combination of habitats sampled, sampling methods used, and number of individuals collected. Species collected mainly by seines and/or rotenone were assigned a status as follows: (1) Abundant – more than 700 specimens collected and the species taken in more than 60 samples, (2) Common – 100-700 specimens collected and taken in 25-59 samples, (3) Uncommon – 11-99 specimens collected and taken in 5-24 samples, and (4) Rare – 1-10 specimens collected and taken in 1-4 samples.

Species taken almost exclusively by hoop nets, gill nets, and trotlines were assigned a status as follows: (1) Abundant – more than 100 specimens collected and taken in seven or eight of the eight site-samples during 1997 and 1998, (2)

Common - 30-99 specimens collected and taken in five or six site-samples, (3) Uncommon - 5-15 specimens collected and taken in three or four site-samples, and (4) Rare - 1-4 specimens collected and taken in one or two site-samples.

Species meeting only one of the two criteria (number of specimens and number of sites) for a given rank in the above two ranking systems were assigned to the next lower ranked category. A few species, which were taken in a variety of habitats and by a variety of methods, were assigned a rank by using a combination of the two previously described ranking systems.

To compare fish species richness and distribution of the Arkansas segment of the Red River with the much longer Red River segments upstream and downstream from Arkansas, several data sources were consulted. Fish distribution records in the Red River upstream from Arkansas were obtained from Hargrave (2000), Miller and Robison (1973), Riggs and Bonn (1959), Sublette et al. (1990), the University of Oklahoma Museum of Natural History, and the Oklahoma Department of Environmental Quality records from Red River fish sampling stations. Fish distribution records in the Red River downstream from Arkansas came from Douglas (1974) and the University of Louisiana at Monroe and Tulane University fish collection databases. Fish species similarity of the Red River segments upstream and downstream from Arkansas was compared with the Arkansas segment by using the index of similarity (S) of Odum (1971), S=2C/A+B, where C is the number of fish species common to two segments being compared, A is the total number of species in one segment, and B is the total number of species in the other stream segment.

Results

Seventy-two fish species and one hybrid combination (38 specimens of *Morone chrysops* x *M. saxatilis*) were collected from the Red River mainstem in Arkansas (Table 1). Fifteen species were new records, bringing the total number of species historically known from the Red River in Arkansas to 83. Prior to this study, 68 fish species were historically reported from the Red River in Arkansas, and 11 of those species were not collected in our 1995-2001 sampling (Table 2). Fish sampling in the Arkansas segment of the Red River in 1999 and 2000 by the U.S. Army Corps of Engineers produced no additional new species records (pers. comm., J. Kilgore, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS).

The species collected in this study were distributed among 17 families. More than 84% of the specimens collected were in the minnow family, Cyprinidae. The four next most abundant families by number of specimens collected were Centrarchidae (5%), Clupeidae (3%), Catostomidae (1.7%), and Atherinopsidae (1.4%). The ten most abundant species in decreasing order of number of specimens collected were as follows: *Notropis atherinoides, N. potteri, Cyprinella lutrensis, Pimephales vigilax, N. shumardi, Lepomis humilis, Dorosoma petenense, Macrhybopsis storeriana, Menidia beryllina,* and *Carpiodes carpio.* Six species represented by only a single specimen each were as follows: *Polyodon spathula, Ctenopharyngodon idella, Phenacobius mirabilis, Ictiobus niger, Fundulus blairae,* and *F. olivaceus.*

In general, the 10 most abundant species were also the most widely distributed species in the study area based on the number of collections in which they were found. Only *N. shumardi* among the 10 most abundant species was not among the 10 most widely distributed species (falling to twelfth most widely distributed). The ten species appearing in the greatest number of collections in decreasing order were as follows: *C. lutrensis, P. vigilax, N. atherinoides, M. beryllina, D. petenense, M. storeriana, D. cepedianum, N. potteri, C. carpio,* and *L. humilis.*

Discussion

The Red River exhibits the well-documented pattern of increasing fish species richness from headwaters to downstream (Horwitz, 1978; Matthews, 1998), and the Arkansas segment of the Red River has high fish species richness. Approximately 124 fish species are historically known from the entire Red River. Eleven percent of the Red River mainstem length and 6.4% of the total Red River drainage area are in Arkansas, and 83 species are historically known from the Arkansas segment. This is approximately 67% of the entire Red River fish fauna, and 58% percent of the mainstem fish fauna was found in this study. Ninety fish species are known from the Red River upstream from Arkansas, and 106 species are known from the Red River downstream from Arkansas. Two species *Etheostoma collettei* and *Percina maculata* have been reported only from the Arkansas segment, 11 species from the Arkansas segment have not been reported upstream from Arkansas, and seven species found in Arkansas have not been reported from the Red River in Louisiana. In this study, the Arkansas segment of the Red River had 61% of the species known from the downstream segment and 68% of the species reported from the upstream reaches. Based on the similarity index (S) of Odum (1971), the fish species composition of the Arkansas segment of the Red River is slightly more similar to the river segment upstream from Arkansas (S=.83) than to the downstream segment (S=.80). Species historically known from the Arkansas segment comprise 80% and 72% of the species reported from the upstream and downstream segments, respectively.

One currently abundant species, *Notropis potteri*, occurs in the Arkansas portion of its range only in the main channel of the Red River. This species occurred throughout the

study reach and was the second most abundant species found with nearly 10,000 specimens collected. A single specimen of *Phenacobius mirabilis* was the first record of that species from the mainstem Red River in Arkansas and was only the second specimen of that species collected in Arkansas in the last 50 years. The bigscale logperch, *Percina macrolepida*, was first reported in Arkansas from the upper portion of the Red River (Buchanan et al., 1996) and was found throughout the Arkansas segment of the Red River in this study.

The blue sucker, *Cycleptus elongatus*, was the most abundant large species caught by hoop nets and was the third most common large species (after *Carpiodes carpio* and *Aplodinotus grunniens*) collected by all methods. The range of *C. elongatus* has drastically declined in recent decades, and it is currently more abundant in the Red River than in any other river in Arkansas. Two specimens of alligator gar, *Atractosteus spatula*, another declining big river fish were collected. Layher (1998) provided additional data on large species collected from the Red River by hoop nets, gill nets, and trotlines.

Eleven species previously reported from the Red River in Arkansas were not found in this study (Table 2). Two of those species, *Campostoma anomalum* and *Luxilus chrysocephalus*, probably are accidentals from tributaries. It is likely that additional Red River floodplain and tributary species could occasionally be taken in future main channel sampling.

Three of the historically reported species not found in our study have probably been extirpated from the Arkansas segment of the Red River. The Alabama shad, *Alosa alabamae*, was reported from the Little River, a Red River tributary in Oklahoma (Reeves, 1953; Miller and Robison, 1973). That anadromous species is no longer able to ascend the Little River to reach its former spawning areas in Oklahoma due to the 1963 construction of Millwood Dam on Little River in Arkansas. *Alosa alabamae* still successfully ascends the lower 55 km of the Red River Navigation System in Louisiana to enter and spawn in the Ouachita River in Arkansas (Buchanan et al., 1999). The plains minnow, *Hybognathus placitus*, and the Red River shiner, *Notropis bairdi*, have not been reported from the Arkansas segment of the Red River in more than 60 years. Both of those primarily Great Plains species are common today in the Red River upstream from Lake Texoma, and small populations of those species persisted into the mid 1990s in the Red River of Oklahoma downstream from Lake Texoma (pers. comm., J. Pigg, Oklahoma Department of Environmental Quality). It is possible that future fish sampling could produce sporadic records of *H. placitus* and *N. bairdi* in the Red River of Arkansas because both species were taken at an Oklahoma Department of Environmental Quality fish sampling site on the Red River near DeKalb, Texas, 18 km upstream from the Arkansas state line as recently as 1995. Unsuccessful attempts were made to collect both species in the Arkansas portion of the Red River near the Oklahoma state line in each year of this study.

Human alteration of the Red River has likely caused the extirpation of *A. alabamae*, *H. placitus*, and *N. bairdi* from the Arkansas segment of that river. Construction of the Red River Navigation System in Louisiana impedes or blocks access of *A. alabamae* to former upstream tributaries of the Red River in Arkansas and Oklahoma, and dams on Little River also block access to former spawning sites. The impoundment of Lake Texoma by Denison Dam on the Red River in Oklahoma in 1944 fragmented the ranges of *H. placitus* and *N. bairdi*, creating a more precarious situation for populations of those species downstream from Denison Dam. Great Plains streams typically experience environmental fluctuations that can lead to the extirpation of local populations of fish species (Luttrell et al., 1999). A species whose range has been fragmented by a dam has little possibility of repopulation if populations above or below the dam are lost. Winston et al. (1991) documented major changes in the fish community in the North Fork of the Red River in Oklahoma, including extirpation of four minnow species following construction of Altus Dam on that river. The small populations of *H. placitus* and *N. bairdi*, known from the Red River in Oklahoma below Denison Dam as recently as the 1990s, have little chance of repopulation from the larger populations of those species upstream from Lake Texoma if they are extirpated.

The mouth of the Little River, just west of Interstate Hwy 30, divides the Arkansas segment of the Red River into two nearly equal parts. The Red River upstream from the Little River mouth, especially upstream from the U.S. Hwy 71 bridge, has been altered very little by manmade structures, whereas the Red River downstream from the Little River mouth has numerous levees, wingdikes, and revetted banks. We found no substantial differences in fish species richness between the upstream (67 species) and downstream (65 species) segments in Arkansas. Seven species were found only in the upstream segment, and five species were found only in the downstream segment (Table 1). Some species found in both river segments in Arkansas were more abundant in one segment based on number of specimens taken and the number of samples in which they occurred. *Macrhybopsis hyostoma*, *Notropis buchanani*, *Labidesthes sicculus*, *Etheostoma asprigene*, and *E. chlorosomum* were more abundant in the upstream segment of the Red River in Arkansas, and *Lepisosteus oculatus*, *Cyprinella venusta*, and *Morone mississippiensis* were more abundant in the downstream segment.

The U.S. Army Corps of Engineers has proposed a project to extend the Red River Navigation System 217 km

upstream from Shreveport, Louisiana to Index, Arkansas near U.S. Highway 71. This project, currently estimated to cost one billion dollars, would require the construction of three to five locks and dams, over 100 dikes, extensive rock revetments, and other channel modification structures. It is not possible to precisely predict the effects of such a project on the fish community of the Red River; however, such a drastic modification of the environment would likely have major impacts on fish species richness, diversity, and distribution. Some species would increase in abundance, while others would decrease or even be extirpated from large sections of the river. This study of the fishes of the Arkansas segment of the Red River should provide a baseline for determining future changes in fish species distribution and abundance.

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APPENDIX E

Habitat Forms

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Little River	LOCATION LR-0	
STATION # _____ RIVERMILE _____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS JMR		
FORM COMPLETED BY JMR	DATE 22 Aug 13 TIME _____ AM PM	REASON FOR SURVEY UAA

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools. 4 unknown	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-27% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. Stream length 0.6 times longer	Channel straight; waterway has been channelized for a long distance.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected. b RB	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. @ 40% erosion LB	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 5 (LB)	Left Bank 10 9	8 7 6	(5) 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. @ 30% if RB a sand bar w/ minimal vegetation	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	(5) 4 3	2 1 0

Total Score 146

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Little River	LOCATION LR-1
STATION # _____ RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS JMR	
FORM COMPLETED BY JMR	DATE 22 AUG 13 TIME _____ AM PM
REASON FOR SURVEY UAA	

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition. 5 unknown	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-27% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 18	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. stream length 0.2 times longer	Channel straight; waterway has been channelized for a long distance.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 (6)	5 4 3 2 1
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected. 4 LB	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. @ 10% erosion RB	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 9 **(LB)**	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 7 **(RB)**	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. @ 30% rip-rap on LB	Less than 50% of the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 9 **(LB)**	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 5 **(RB)**	Right Bank 10 9	8 7 6	(5) 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 8 **(LB)**	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 2 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0

Total Score 143

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME Little River	LOCATION LR-0	
STATION # _____ RIVERMILE _____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS JMR		
FORM COMPLETED BY JMR	DATE 22 AUG 13 TIME _____ AM PM	REASON FOR SURVEY UAA

WEATHER CONDITIONS

Now		Past 24 Hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
30 % ☑	%cloud cover	☐ ____%
☐	clear/sunny	☐

Has there been a heavy rain in the last 7 days? ☐ Yes ☒ No

Air Temperature 95 °F °C

Other _____

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)

STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☒ Mixture of origins
☐ Swamp and bog ☐ Other _____

Catchment Area _____ km^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest ☐ Commercial
☒ Field/Pasture ☐ Industrial
☐ Agricultural ☐ Other _____
☐ Residential

Local Watershed
☐ No evidence ☐ Some potential sources
☒ Obvious sources

Local Watershed Erosion
☐ None ☒ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☒ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous

dominant species present _____

INSTREAM FEATURES

Estimated Reach Length 1 mile

Estimated Stream Width 100 m

Sampling Reach Area _____ m^2

Area in km^2 (m^2x1000) _____ km^2

Estimated Stream Depth unknown m

Surface Velocity (at thalweg) _____ m/sec

Canopy Cover
☒ ~~Partly~~ open ☐ Partly shaded ☐ Shaded

High Water Mark unknown m

Proportion of Reach Represented by Stream Morphology Types
☐ Riffle____% ☐ Run_____%
☒ Pool 100 %

Channelized ☐ Yes ☒ No

Dam Present ☐ Yes ☒ No

LARGE WOODY DEBRIS

LWD _____ m^2 - LWD dominant form of substrate 11-05 JMC

Density of LWD _____ m^2/km^2 (LWD/reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted Floating ☐ Free floating
☐ Floating Algae ☐ Attached Algae

dominant species present _____

Portion of the reach with aquatic vegetation 0 %

WATER QUALITY

Temperature_____°C

Specific Conductance _____

Dissolved Oxygen _____

pH_____

Turbidity _____

WQ Instrument Used _____

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☒ None ☐ Other _____

Turbidity (if not measured)
☐ Clear ☐ Slightly turbid ☒ Turbid
☐ Opaque ☐ Stained ☐ Other_____

SEDIMENT/ SUBSTRATE

Odors
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other _____

Oils
☒ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand
☐ Relict shells ☐ Other _____

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☐ No unknown

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	Sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5" – 10")	unknown	Muck-Mud	Black, very fine organic (FPOM)	unknown
Gravel	2-64 mm (0.1" – 2.5")				
Sand	0.06 – 2mm (gritty)		Marl	Grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	<0.004 mm (slick)				

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME Little River	LOCATION LR - 1
STATION # _____ RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS JMR	
FORM COMPLETED BY JMR	DATE 22 Aug 13 TIME _____ AM PM
	REASON FOR SURVEY UAA

WEATHER CONDITIONS

Now

- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- 30 % ☑ %cloud cover
- ☐ clear/sunny

Past 24 Hours

- ☐
- ☐
- ☐
- ☐ _____%
- ☐

Has there been a heavy rain in the last 7 days?
☐ Yes ☒ No

Air Temperature 95 °F °C

Other_____

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)

STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☒ Mixture of origins
☐ Swamp and bog ☐ Other_____

Catchment Area_____km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
- ☐ Forest
- ☐ Commercial
- ☒ Field/Pasture
- ☐ Industrial
- ☐ Agricultural
- ☐ Other _____
- ☐ Residential

Local Watershed
- ☐ No evidence
- ☒ Some potential sources
- ☐ Obvious sources

Local Watershed Erosion
- ☐ None
- ☒ Moderate
- ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
- ☒ Trees
- ☐ Shrubs
- ☐ Grasses
- ☐ Herbaceous

dominant species present _____

INSTREAM FEATURES

Estimated Reach Length 1 mile

Estimated Stream Width 100 m

Sampling Reach Area _____ m^2

Area in km^2 (m^2x1000) _____ km^2

Estimated Stream Depth unknown m

Surface Velocity (at thalweg) _____ m/sec

Canopy Cover
- ☒ ~~Partly~~ open
- ☐ Partly shaded
- ☐ Shaded

High Water Mark unknown m

Proportion of Reach Represented by Stream Morphology Types
- ☐ Riffle ____ %
- ☐ Run ____ %
- ☒ Pool 100 %

Channelized ☐ Yes ☒ No

Dam Present ☐ Yes ☒ No

LARGE WOODY DEBRIS

LWD _____ m^2 Gravel dominant form of substrate 11-25mm

Density of LWD _____ m^2/km^2 (LWD/reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
- ☐ Rooted emergent
- ☐ Rooted submergent
- ☐ Rooted Floating
- ☐ Free floating
- ☐ Floating Algae
- ☐ Attached Algae

dominant species present _____

Portion of the reach with aquatic vegetation 0 %

WATER QUALITY

Temperature _____ °C

Specific Conductance _____

Dissolved Oxygen _____

pH _____

Turbidity _____

WQ Instrument Used _____

Water Odors
- ☒ Normal/None
- ☐ Sewage
- ☐ Petroleum
- ☐ Chemical
- ☐ Fishy
- ☐ Other _____

Water Surface Oils
- ☐ Slick
- ☐ Sheen
- ☐ Globs
- ☐ Flecks
- ☒ None
- ☐ Other _____

Turbidity (if not measured)
- ☐ Clear
- ☐ Slightly turbid
- ☒ Turbid
- ☐ Opaque
- ☐ Stained
- ☐ Other _____

SEDIMENT/ SUBSTRATE

Odors
- ☒ Normal
- ☐ Sewage
- ☐ Petroleum
- ☐ Chemical
- ☐ Anaerobic
- ☐ None
- ☐ Other _____

Oils
- ☒ Absent
- ☐ Slight
- ☐ Moderate
- ☐ Profuse

Deposits
- ☐ Sludge
- ☐ Sawdust
- ☐ Paper fiber
- ☐ Sand
- ☐ Relict shells
- ☐ Other _____

Looking at stones which are not deeply embedded, are the undersides black in color?
- ☐ Yes
- ☐ No
- unknown

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	Sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5" – 10")	unknown	Muck-Mud	Black, very fine organic (FPOM)	unknown
Gravel	2-64 mm (0.1" – 2.5")				
Sand	0.06 – 2mm (gritty)		Marl	Grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	<0.004 mm (slick)				

APPENDIX F

Macroinvertebrate Data

Table F.1. Invertebrate taxa collected from artificial substrates (Hester-Dendy) and large woody debris in the Little River during late summer 2013.

Class	Order	Family	Genus	Functional Feeding Group	Hester-Dendy						Large Woody Debris	
					Upstream			Downstream				
					A	B	C	A	B	C	Upstream	Downstream
Insecta	Coleoptera	Elmidae	*Stenelmis*	SC	1	1	1	1				
	Diptera	Ceratopogonidae	*Bezzia*	PR	35	8	3	4	2	2	1	35
		Chironomidae		GC	221	253	234	252	224	216	286	260
	Ephemeroptera	Caenidae	*Caenis*	GC	2	1	1	15	10	4		
		Heptageniidae	*Stenacron*	SC	1	4	1	5	11	1		
	Megaloptera	Corydalidae	*Nigronia*	PR	2	2		2	2			
	Odonata	Coenagrionidae	*Argia*	PR	1	1	1	8	2	3		1
		Corduliidae		PR				2		2		
		Gomphidae	*Erpetogomphus*	PR					1			
	Trichoptera										1	
	Trichoptera	Polycentropodidae			2	1	2		3	4		18
	Trichoptera	Polycentropodidae	*Cyrnellus*	FC	33	31	71	13	48	57	6	3
	Trichoptera	Rhyacophilidae	*Rhyacophila*	PR							2	
TOTAL ORGANISMS					298	302	314	302	303	289	296	317

Notes:
FC: Filterer/Collector
GC: Gatherer/Collector
PR: Predator
SC: Scraper

APPENDIX G

Reference Lists and Supporting Information for Fisheries Evaluation

Table G.1. Reference list and collection data for fish evaluation.

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Petromyzontidae	**Lampreys**			
Ichthyomyzon castaneus	chestnut lamprey	Y	N	Confirmed collection in main channel of Little River; found in clear streams of Little River system; could be feeding at time of collection.
Ichthyomyzon gagei	southern brook lamprey	N	N	Found in Little River tributaries; inhabits clear, permanent flowing, small- to medium-sized streams; no known collections in main channel of Little River.
Acipenseridae	**Sturgeons**			
Scaphirhynchus platorynchus	shovelnose sturgeon	Y	N	Confirmed collection in main channel of Little River; especially abundant in the Red River; occupies shallow areas and deep channels of larger rivers, inhabiting sand bars or areas of strong current over sand and gravel substrate; tolerant of high turbidity.
Polyodontidae	**Paddlefishes**			
Polyodon spathula	paddlefish	Y	N	Confirmed collection in main channel of Little River; confined almost entirely to large, low-gradient rivers occupying backwater areas having rich growths of plankton.
Lepisosteidae	**Gars**			
Atractosteus spatula	alligator gar	Y	Y	Confirmed collection in main channel of the Little River; primarily an inhabitant of the sluggish pools and backwaters of large rivers.
Lepisosteus oculatus	spotted gar	Y	Y	Confirmed collection in the main channel of the Little River.
Lepisosteus osseus	longnose gar	Y	Y	Confirmed collection in the main channel of the Little River.
Lepisosteus platostomus	shortnose gar	Y	Y	Confirmed collection in the main channel of the Little River.
Amiidae	**Bowfins**			
Amia calva	bowfin	Y	Y	Confirmed collection in the main channel of the Little River.
Angullidae	**Freshwater Eels**			
Anguilla rostrata	American eel	Y	N	Confirmed collection in the main channel of the Little River.
Clupeidae	**Herrings**			
Alosa chrysochloris	skipjack herring	Y	N	Confirmed collection in the main channel of the Little River; fairly common in the large rivers in Arkansas where it inhabits the open waters, often in swift current; also found in the backwaters; intolerant of continuous high turbidity.
Dorosoma cepedianum	gizzard shad	Y	Y	Confirmed collection in the main channel of the Little River.
Dorosoma petenense	threadfin shad	Y	Y	Confirmed collection in the main channel of the Little River.
Hiodontidae	**Mooneyes**			
Hiodon alosoides	goldeye	N	N	This species has been collected in the main channel of the Red River; occurs in medium-sized to large rivers in Arkansas; prefers moderate to swift current over a firm sand substrate.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Esocidae	**Pikes**			
Esox americanus	redfin pickerel	N	N	Found in Little River tributaries; most often found in quiet waters of small streams having heavy aquatic vegetation or in at least moderately clear water and little current.
Esox lucius	northern pike	N	N	Has been stocked in Lake Millwood; mainly inhabits lakes and marshes and, to a lesser extent, rivers; prefers quiet water with dense aquatic vegetation.
Esox niger	chain pickerel	N	N	Found in Little River tributaries; prefers clear, quiet waters with abundant aquatic vegetation.
Cyprinidae	**Minnows and Carps**			
Campostoma anomalum	central stoneroller	N	N	Found in Little River tributaries; inhabits small, generally clear streams with gravel, rubble, or exposed bedrock substrates.
Ctenopharyngodon idella	grass carp	Y	N	Confirmed collection in the main channel of the Little River; typically an inhabitant of large rivers.
Cyprinella lutrensis	red shiner	Y	Y	Confirmed collection; occupies sluggish streams and large rivers over a wide variety of bottom types and is tolerant of high turbidities and siltation.
Cyprinella venusta	blacktail shiner	Y	Y	Confirmed collection; inhabits medium to large streams and rivers; occurs in moderately clear to very turbid waters.
Cyprinella whipplei	steelcolor shiner	N	N	Found in Little River tributaries; common in large to medium-sized streams with permanent flow, clear water and gravel bottoms; rather intolerant of turbidity and siltation; no confirmed collections in the main channel of the Little River or its tributaries below Lake Millwood.
Cyprinus carpio	common carp	Y	Y	Confirmed collection in the main channel of the Little River; inhabits a wide variety of aquatic habitats, being found in reservoirs, upland streams, and lowland rivers and streams.
Hybognathus nuchalis	Mississippi silvery minnow	Y	Y	Confirmed collection in the main channel of the Little River.
Hybopsis amnis	pallid shiner	N	N	Found in Little River tributaries; preference for medium to large-sized, silty streams and rivers; appears to prefer sand and mud substrates and slow-moving waters.
Luxilus chrysocephalus	striped shiner	N	N	Found in Little River tributaries; seems to prefer small to moderate-sized permanent streams with permanent flow, clear water, and rocky or gravel bottoms.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Lythrurus fumeus	ribbon shiner	N	N	This species has been collected in the main channel of the Red River; found primarily in small to moderate-sized Coastal Plain streams characterized by low to moderate gradient and tannin-stained waters over sand, firm mud, clay, silt, or detritus substrates.
Lythrurus snelsoni	Ouachita mountain shiner	N	N	Confined to the upper portions of the Mountain Fork and Cossatot rivers (Little River system).
Lythrurus umbratilis	redfin shiner	N	Y	Found in Little River tributaries; generally found in relatively clear, warm water streams and most often in sluggish pools lined with water willow over gravel or sand substrates.
Macrhybopsis aestivalis	speckled chub	N	N	Collected in the main channel of the Red River; confined primarily to the larger rivers of the Coastal Plains; inhabits swift flowing waters in large rivers over sandy and gravelly substrates.
Macrhybopsis storeriana	silver chub	N	N	Collected in the main channel of the Red River; inhabits large, sandy-bottomed streams and rivers, but is rarely abundant at most locations in Arkansas; inhabits deep water with moderate to swift current; tolerant of silty turbid streams.
Notemigonus crysoleucas	golden shiner	N	N	Found in Little River tributaries; prefers well-vegetated, standing waters of ponds, reservoirs, lakes, and sloughs and quiet pools of low-gradient streams and small rivers having mud or sand bottoms; Tolerant of turbidity and pollution.
Notropis atherinoides	emerald shiner	Y	Y	Confirmed collection in the main channel of the Little River; inhabits medium to large rivers and streams with clear to turbid waters flowing over sandy substrates.
Notropis atrocaudalis	blackspot shiner	N	N	Restricted to clear smaller streams in the lower reaches of the Little River system and Red River tributaries.
Notropis boops	bigeye shiner	N	N	Found in Little River tributaries; generally avoids the more turbid streams of the Coastal Plain; seems to prefer gravel- and rock-bottomed pools lined with water willow or clear, high-gradient streams and rivers where it is often one of the most abundant fishes.
Notropis buchanani	ghost shiner	Y	N	Collected in the main channel of the Red River; abundant in sluggish streams of the Coastal Plain; generally occupies large, warm, sluggish streams and rivers with high turbidities; is a midwater species frequenting protected backwaters and large pools away from strong currents.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Notropis chalybaeus	ironcolor shiner	N	N	Found in Little River tributaries; frequents acid, tannin-stained, non-turbid, sluggish Coastal Plain streams and rivers of low to moderate gradient with abundant aquatic vegetation over clean sand bottoms.
Notropis maculatus	taillight shiner	N	N	Found in Little River tributaries; occupies shallow, tannin-stained waters of low-gradient streams, sloughs, lakes, including oxbows and swamps of the Coastal Plain, particularly those less disturbed portions; typically collected in backwater areas without currents, over substrates of decomposing vegetation, silt, and soft mud; associated with luxuriant aquatic vegetation.
Notropis ortenburgeri	Kiamichi shiner	N	N	Found in Little River tributaries; inhabits pools over gravel, rubble, or boulder-strewn substrates in small to moderate-sized clear upland streams of moderate gradient.
Notropis potteri	chub shiner	Y	Y	Confirmed collection; rather common in the large, turbid Red River over sand and gravel bottoms along the shore.
Notropis rubellus	rosyface shiner	N	N	Found in Little River tributaries; inhabits clear streams with moderate to high gradient over gravel and rock bottoms, usually in pools with current or in areas just below riffles; intolerant of siltation and turbidity.
Notropis shumardi	silverband shiner	N	Y	Found in the Red River; prefers areas of moderate to swift current in the main channels of large rivers along sand or gravel bars; tolerant of extremely turbid conditions.
Notropis texanus	weed shiner	N	N	Collected in tributary to Red River pre-1960; most abundant in clear lowland streams of small to moderate size with sand and mud bottoms, slight current, and aquatic vegetation.
Opsopoeodus emiliae	pugnose minnow	N	N	Found in Little River tributaries; found primarily in small to moderate-sized Coastal Plain streams characterized by low to moderate gradient and tannin-stained waters over sand, firm mud, clay, silt, or detritus substrates.
Pimephales notatus	bluntnose minnow	N	N	Found in Little River tributaries; generally inhabits medium-sized to large, clear, permanent streams with gravel bottoms and aquatic vegetation; No confirmed collections below Lake Millwood since pre-1960.
Pimephales promelas	fathead minnow	N	N	Probably native to the state only in the headwaters of the Illinois and White rivers on northern Arkansas; widely introduced over the rest of Arkansas (likely baitfish).
Pimephales tenellus	slim minnow	N	N	Found in Little River tributaries pre-1960; frequents midwater to bottom areas of small, clear, gravel-bottomed streams.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Pimephales vigilax	bullhead minnow	Y	Y	Confirmed collection; widespread and abundant in large sluggish streams and rivers with sand and mud bottoms throughout the Coastal Plain; tolerant and turbidity and siltation.
Pteronotropis hubbsi	bluehead shiner	N	N	Found in Little River tributaries; inhabitant of quiet, backwater areas of small to medium sized sluggish streams and oxbow lakes; typically occurs in tannin-stained, heavily vegetated waters over a mud or mixed mud-sand substrate.
Semotilus atromaculatus	creek chub	N	N	Found in Little River tributaries; frequents the smallest clear, gravel-bottomed headwater streams.
Catostomidae	**Suckers**			
Carpiodes carpio	river carpsucker	Y	Y	Confirmed collection; inhabits moderate to large-size streams, rivers, and reservoirs in quiet, sand or silt-bottomed pools of systems with moderate or low gradients; tolerant of turbidity.
Cycleptus elongatus	blue sucker	Y	N	Confirmed collection; restricted to large riverine environments; inhabits bottom on deep, fast-moving rivers.
Erimyzon oblongus	creek chubsucker	N	N	Found in Little River tributaries; prefers small creeks and streams of moderate gradient.
Erimyzon sucetta	lake chubsucker	N	N	Found in Little River watershed; inhabits quiet, heavily vegetated areas of oxbow lakes, sloughs of large rivers, and sluggish stream backwaters of varying clarity over soft bottoms of organic detritus, mud, and sand.
Ictiobus bubalus	smallmouth buffalo	Y	Y	Confirmed collection; widespread, adaptable, and abundant in Arkansas; generally found in large streams and rivers.
Ictiobus cyprinellus	bigmouth buffalo	Y	Y	Confirmed collection; inhabits deep pool regions of large streams, rivers, oxbow lakes and reservoirs; occasionally enters small streams to spawn.
Ictiobus niger	black buffalo	N	N	Confirmed collection; occurs sporadically throughout the state in the larger rivers; Prefers flowing waters and is usually found in small numbers in the stronger currents of large rivers and impoundments; rare to uncommon in the state.
Minytrema melanops	spotted sucker	Y	N	Confirmed collection; prefers clear to slightly turbid warm waters with submerged aquatic vegetation, lots of detritus, and soft substrates; occurs typically in sluggish, somewhat turbid lowland ditches and quiet backwater areas away from the current.
Moxostoma carinatum	river redhorse	N	N	Found in Little River watershed; inhabits pool or swift main channel regions of clear, medium to large-sized upland streams and rivers with gravel or rock bottoms.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Moxostoma duquesnii	black redhorse	N	N	Found in Little River watershed; restricted to streams and rivers of the Ozark-Ouachita uplands; Inhabits clear, medium-sized streams with permanent flow and gravelly or rocky bottoms; intolerant of silty waters.
Moxostoma erythrurum	golden redhorse	N	N	Found in Little River watershed; favors upland streams in the Ozark and Ouachita mountains; inhabits clear, gravel-bottomed streams like the black redhorse but seems to prefer slightly warmer water with less current.
Ictaluridae	**Bullhead Catfishes**			
Ameiurus melas	black bullhead	N	N	Found in Little River watershed; common inhabitants of oxbow lakes, quiet mud-bottomed backwater areas, and pools of small streams away from strong currents.
Ameiurus natalis	yellow bullhead	N	N	Found in Little River watershed; seems to prefer clear, gravel- and rocky-bottomed, permanent streams.
Ameiurus nebulosus	brown bullhead	N	N	Found in Little River watershed; very uncommon in the state; seems to prefer quite, clear waters with moderate to large amounts of aquatic vegetation.
Ictalurus furcatus	blue catfish	Y	Y	Confirmed collection; mainly an inhabitant of the big rivers, where it is most abundant in swift, deep channels; usually found in moderate current over a sandy bottom.
Ictalurus punctatus	channel catfish	Y	Y	Confirmed collection; extremely adaptable; seek out deep pools, submerged logs, and overhanging banks in the major rivers by day and at night feed in riffles and shallow pools.
Noturus eleutherus	mountain madtom	N	N	Found in Little River watershed; chiefly inhabits large, clear, swift to moderately flowing rivers and streams in Arkansas and avoids small creeks; frequently taken in association with dense vegetation and large stone, rock, and gravel bottoms.
Noturus gyrinus	tadpole madtom	N	N	Found in the Little River watershed; prefers clear to moderately turbid quiet water areas of small streams, oxbows and sluggish rivers where organic debris has accumulated, or thick growths of aquatic vegetation over mud and sand bottoms.
Noturus nocturnus	freckled madtom	Y	Y	Confirmed collection; found in the Little River watershed; inhabits low to moderate-gradient, medium to small-size streams with slight to moderate current over gravel or sand bottoms; occurs in clear to moderately turbid waters and adults are found in riffles and pools where accumulation of leaves, twigs and associated debris accumulate.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Pylodictis olivaris	flathead catfish	Y	Y	Confirmed collection; found in a variety of habitats; most abundant in the large sandy-bottomed, turbid rivers of the state where it inhabits deep pools adjacent to strong current, but is also found in moderate to swift currents of these rivers.
Aphredoderidae	**Pirate Perches**			
Aphredoderus sayanus	pirate perch	N	N	Found in Little River watershed; inhabits quiet ponds, oxbow lakes, swamps, ditches, and sluggish mud and sand-bottomed small rivers and streams; locally abundant over soft mud and silt bottoms with thick vegetation and is found in both clear and turbid waters.
Fundulidae	**Killifishes**			
Fundulus blairae	Blair's starhead topminnow	N	N	Found in Little River watershed; found in quiet, heavily vegetated waters of small creeks and swampy backwater overflows of rivers; prefers clear water and a soft mud and detritus bottom.
Fundulus catenatus	northern studfish	N	N	Found in Little River watershed; found in clear mountain streams and rivers of moderate to high gradient and permanent flow; usually found in quiet, shallow waters along the margins of pools having rock and gravel bottoms.
Fundulus chrysotus	golden topminnow	N	N	A lowland species inhabiting oxbow lakes, sluggish areas of creeks, and swampy backwater overflows of rivers; usually found in quiet, shallow water in or near aquatic vegetation over a soft mud and detritus bottom.
Fundulus notatus	blackstripe topminnow	Y	Y	Confirmed collection; found in Little River watershed; found primarily in small to large low-gradient streams of moderate to high turbidity; prefers the quiet backwaters and pool margins and can be found over a variety of bottom types.
Fundulus olivaceus	blackspotted topminnow	Y	N	Confirmed collection; found in a variety of habitats including small headwater creeks to large rivers, impoundments, and oxbow lakes in both mountainous and lowland regions.
Poeciliidae	**Livebearers**			
Gambusia affinis	mosquitofish	Y	Y	Confirmed collection; occurs in a wide variety of habitats, including swamps, ditches, farm ponds, streams, rivers, and lakes.
Atherinidae	**Silversides**			
Labidesthes sicculus	brook silverside	Y	Y	Found in Little River watershed; occurs in streams, lakes, and small rivers - specimens are sometimes taken in the big rivers of the state.
Menidia beryllina	inland silverside	Y	Y	Confirmed collection; inhabits the large rivers of the state.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Moronidae	**Temperate Basses**			
Morone chrysops	white bass	Y	Y	Found in the Little River watershed; most abundant in large rivers and large impoundments; inhabits moderate-sized to large rivers where it is found in both current and backwater areas in clear water over a firm sand or rock bottom; intolerant of continuous high turbidity.
Morone mississippiensis	yellow bass	Y	N	Found in the Little River watershed; a lowland species found primarily in clear to turbid water in the backwaters of large rivers and especially in their associated oxbow lakes.
Morone saxatilis	striped bass	Y	N	Found in the Little River watershed; significant fisheries exist in the Red River; spawning occurs in strong currents of large rivers.
Centrarchidae	**Sunfishes**			
Ambloplites ariommus	shadow bass	N	N	Found in the Little River watershed; inhabits clear mountain streams of moderate to high gradient above the fall line, where it is found in rocky bottomed pools often near large boulders.
Lepomis cyanellus	green sunfish	Y	N	Found in the Little River watershed; a highly adaptable species and can be found in almost every type of aquatic habitat in Arkansas.
Lepomis gulosus	warmouth	N	N	Found in the Little River watershed; primarily a lowland species inhabiting oxbow lakes, quiet waters of bayous and rivers, and swamps having mud and detritus bottoms; prefers clear water and thick growths of aquatic vegetation and is often found near submerged stumps, logs, and cypress knees; will tolerate moderate levels of turbidity.
Lepomis humilis	orangespotted sunfish	Y	Y	Found in the Little River watershed; has wide ecological tolerances and is indifferent to bottom type; tolerates high turbidity and extensive fluctuations in water level; most commonly found in turbid or clear lowland waters over a mud and detritus bottom.
Lepomis macrochirus	bluegill	Y	Y	Confirmed collection.
Lepomis marginatus	dollar sunfish	N	N	Found in the Little River watershed; one of the least common sunfishes in Arkansas; found in swamps and small sluggish creeks and bayous having clear water, usually moderate to heavy vegetation, and mud and detritus bottoms.
Lepomis megalotis	longear sunfish	Y	Y	Confirmed collection; occurs in a variety of habitats statewide; most abundant in small, clear, upland streams with rocky bottoms and permanent or semi-permanent flow; typically found in pools.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Lepomis microlophus	redear sunfish	Y	Y	Found in the Little River watershed; prefers warm, clear waters without current and with an abundance of stumps, logs, brush, and other aquatic vegetation; usually found over a mud and detritus bottom.
Lepomis punctatus	spotted sunfish	N	N	Found in the Little River watershed; found in streams, rivers, and oxbow lakes in the lowlands; Inhabits quiet or sluggish, clear waters usually with much aquatic vegetation and other cover and with mud and detritus bottoms.
Lepomis symmetricus	bantam sunfish	N	N	Found in the Little River watershed; a lowland species inhabiting swamps, oxbow lakes, and sluggish backwaters of creeks and bayous; always found in association with aquatic vegetation and submerged logs and stumps over a detritus and mud bottom in shallow water; apparently very tolerant of high turbidity and siltation, but is often found in clear waters.
Micropterus dolomieu	smallmouth bass	N	N	Found in the Little River watershed; mainly an inhabitant of cool, clear mountain streams with permanent flow and rocky bottoms.
Micropterus punctulatus	spotted bass	Y	Y	Confirmed collection; primarily an inhabitant of larger streams and rivers; occurs in larger lowland streams; most abundant in streams having clear water, permanent flow, and gravel bottoms where it is usually found in deep pools.
Micropterus salmoides	largemouth bass	Y	Y	Confirmed collection; found statewide in all drainages.
Pomoxis annularis	white crappie	Y	Y	Confirmed collection; wide ecological tolerances but prefers quiet waters and is almost always found near brush piles, the tops of fallen trees, or standing timber; more tolerant of turbidity than most sunfishes.
Pomoxis nigromaculatus	black crappie	N	N	Found in the Little River watershed; occupies essentially the same habitat as white crappie - however it seems to dominate in clear, vegetated, more acidic waters, while the white crappie dominates in richer, more turbid, alkaline waters.
Elassomatidae	**Pygmy Sunfishes**			
Elassoma zonatum	banded pygmy sunfish	N	N	Found in the Little River watershed; lowland species inhabiting swamps, bayous, creeks, and oxbow lakes; found in quiet, heavily vegetated waters over mud and detritus bottom.
Percidae	**Perches**			
Ammocrypta clara	western sand darter	Y	N	Collected in the Red River; inhabits moderate-sized rivers where it is usually found in slight to moderate current over a sandy bottom.
Ammocrypta vivax	scaly sand darter	Y	N	Found in the Little River watershed; found in moderate-sized rivers in moderate current over a sandy bottom.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Crystallaria asprella	crystal darter	N	N	Found in the Little River watershed; inhabits the lower reaches of moderate-sized rivers, mainly below the fall line, where it is typically found in strong current over a sand or fine gravel substrate.
Etheostoma chlorosomum	bluntnose darter	N	N	Found in the Red River watershed; a lowland species occurring in sluggish streams, bayous, swamps, and oxbow lakes; usually found over a bottom of mud and detritus or sand.
Etheostoma collettei	creole darter	N	N	Found in the Little River drainage; quite rare in the Little River system; in Coastal Plain streams it is often found over a hard clay or mud substrate.
Etheostoma fusiforme	swamp darter	N	N	Found in the Little River drainage; not a common species in Arkansas and is never abundant at any locality; usually found in swamps, bayous, and oxbow lakes in areas of little or no current over a bottom of mud and detritus.
Etheostoma gracile	slough darter	N	N	Found in the Little River drainage; lowland species found in bayous, sloughs, oxbow lakes, and creeks in areas with sluggish or no current; prefers a bottom of mud, covered with plant debris and some aquatic vegetation, but is sometimes found over a sand and fine gravel bottom.
Etheostoma histrio	Harlequin darter	N	N	Found in the Little River drainage; occurs primarily in large creeks and small to moderate-sized rivers usually in moderate to swift current in riffles over fine to coarse gravel or broken shale; no known collections below Lake Millwood.
Etheostoma nigrum	Johnny darter	N	N	Found in the Little River drainage; rather uncommon in Arkansas; found mainly in creeks and small rivers in the Ouachita mountains; occurs in moderate to high gradient streams where it is usually found in slow current near the edges of pools having a sand or a mixed sand and gravel bottom.
Etheostoma parvipinne	goldstripe darter	N	N	Found in the Little River drainage; inhabits small, spring-fed, shallow feeder streams or spring branches of low to moderate gradient with a sand bottom and generally lack rooted aquatic vegetation.
Etheostoma proeliare	cypress darter	N	N	Found in the Little River drainage; most abundant in lowlands where it occurs in bayous, oxbow lakes, swamps , and streams in little or no current over a soft mud and detritus bottom.
Etheostoma radiosum	orangebelly darter	N	N	Found in the Little River drainage; found in small, high-gradient creeks to moderate-sized rivers with clear water where it often occurs in large numbers in gravel and rubble-bottomed riffles with moderate to swift current.

Table G.1. Reference list and collection data for fish evaluation (continued).

Scientific Name	Common Name	Expected in the Little River (Reference)	Observed in Pooled Collections	Notes
Etheostoma spectabile	orangethroat darter	N	N	Found in the Little River drainage; primarily an upland species; prefers small headwater creeks and spring-runs where it is found in shallow riffles of slow to moderate current over a gravel or rubble substrate.
Etheostoma stigmaeum	speckled darter	N	N	Found in the Little River drainage; most abundant in clear, small- to medium-sized streams of high to moderate gradient.
Etheostoma whipplei	redfin darter	N	N	Found in the Little River drainage; most abundant in small-to-medium sized streams of high gradient where it is found in gravel-bottomed riffles.
Percina caprodes	logperch	Y	Y	Confirmed collection; one of the most adaptable darters, occurring in a variety of habitats in Arkansas including mountain streams, moderate and large-sized rivers of medium to low gradient, oxbow lakes, and impoundments.
Percina copelandi	channel darter	N	N	Found in the Little River drainage; found primarily in small to moderate-sized rivers and large creeks where it typically occurs in riffles of moderate to swift current over a gravel or rocky substrate; prefers clear water and a silt-free bottom.
Percina pantherina	leopard darter	N	N	Found in the Little River drainage; endemic to the Little River system; found only in the Mountain Fork and Cossatot rivers on southwestern Arkansas.
Percina phoxocephala	slenderhead darter	N	N	Found in the Little River drainage; most frequently inhabits gravel or rocky riffles with moderate to swift current and clear water in moderate-sized rivers and large creeks.
Percina sciera	dusky dater	Y	Y	Found in the Little River drainage; found in creeks and small-to-medium sized rivers of low gradient with clear water and permanent current; usually occurs in riffles in slow to moderate current over a gravel bottom and is often found in accumulations of sticks and leaves.
Percina shumardi	river darter	Y	Y	Found in the Little River drainage; inhabits the largest rivers and the lower reaches of medium-sized lowland rivers; found in deeper, lower ends of riffles and raceways over a gravel and rubble substrates often at depths of 2 feet or more; in Red River it is found in moderate to swift current over a sand bottom.
Sciaenidae	**Drums**			
Aplodinotus grunniens	freshwater drum	Y	Y	Confirmed collection; inhabits deep pools of medium to large rivers and large impoundments.

APPENDIX H

Toxicity Test Methodology

TEST PROTOCOL TO EVALUATE TDS TOXICITY

The objective of this testing is to evaluate the toxic threshold for total dissolved solids (TDS), sulfate, and chloride in water that is representative of the mixture of the SWEPCO plant effluent and the Little River at critical flow (26% effluent). The approach is to evaluate chronic toxicity to *Ceriodaphnia dubia* in a series of increasing TDS concentrations in the river matrix to identify a threshold for chronic toxicity to *C. dubia.* This threshold sets an upper limit for site-specific minerals criteria because a discharge that is toxic due to mineral concentrations must be avoided.

1.0 IONIC MAKEUP OF THE TEST SAMPLE

Preparation of the spiked test solution depends on the specific objectives of the evaluation. The question addressed herein is how high the discharge can drive downstream ion concentrations before the receiving stream becomes toxic, as defined by sub-lethal effects to *C. dubia* (evaluated per guidance by the US Environmental Protection Agency [EPA] 2002).

In this case, the effluent is cooling tower blowdown and is essentially a concentrated receiving stream. The appropriate ion proportions are therefore the proportions seen in undiluted effluent. However, the effluent also contains other chemicals that are part of routine cooling tower operation. These chemicals might affect the toxicity of the ions present. Therefore the appropriate matrix for spiking is a mixture of effluent and receiving stream that corresponds to the critical dilution of 26%. Accordingly, this evaluation used a mixture of 26% effluent + 74% receiving stream as the basic matrix that was spiked with inorganic salts in proportions that matched those seen in undiluted effluent.

The first step in developing this protocol was to identify the major ions contributing to TDS in the effluent sample. Table H.1 presents the methods used in the analysis of selected ions. Results of the analysis of a grab sample collected on April 11, 2013, from the plant effluent are presented in Table H.2. The calculated TDS concentration (the sum of the measured ions with total alkalinity expressed as milligrams per liter of bicarbonate) was 1,462 mg/L, which is 104%

of the measured TDS concentration. Part of the "excess" of measured ions might be due to analytical error, but is more likely due to the presence of colloidal forms of ions (e.g., calcium and magnesium hydroxides, carbonates, and sulfates), which are not present in the TDS measurement because the TDS analysis involves sample filtration. Nonetheless, the results show that the selected ions account for the majority of the ions present in the sample. The summary presented in Table 2 indicates that sodium is the dominant cation both in terms of ionic strength (as indicated by the percent composition as mEq) and mass. To a lesser extent sulfate is the dominant anion relative to chloride and bicarbonate.

Table H.1. Analytical methods for ion analyses.

Ion	Analytical Method
Sodium (Na^{+})	EPA 200.7
Calcium (Ca^{++})	EPA 200.7
Magnesium (Mg^{++})	EPA 200.7
Potassium (K^{+})	EPA 200.7
Chloride (Cl^{-})	EPA 300.0
Sulfate (SO_4^{-2})	EPA 300.0
Bicarbonate (HCO_3^{-})	SM4500-CO_2D*
Total Alkalinity	SM2320B
TDS	SM2540C

Hardness is known to ameliorate the toxic effects of both chloride and sulfate (Lasier and Hardin 2010, Soucek 2007, Soucek and Kennedy 2005, Soucek et al. 2011), and the increase of ionic strength that occurs in the cooling tower will increase hardness along with all other ions. The sample spiking procedure used herein held hardness constant and attempted to manipulate only the minerals of interest (TDS, chloride, and sulfate) and other major ions (bicarbonate) while holding hardness constant. This approach results in a "worse case" simulation in which the effects of increased hardness are not present.

Table H.2. Ionic makeup of plant effluent sample collected on April 11, 2013.

Ion	Concentration (mg/L)	Percent of Total					
		Mass		mMoles		mEq	
		Cations	Anions	Cations	Anions	Cations	Anions
Na^{+}	380	76.8		84.8		88.9	
K^{+}	23	4.7		3.0		2.1	
Ca^{++}	86	17.4		11.0		7.4	
Mg^{++}	5.5	1.1		1.2		1.6	
Cl^{-}	170		17.3		31.2		29.3
SO_4^{-2}	450		45.9		30.5		50.8
HCO_3^{-}	217		36.7		38.4		19.8
Total Alkalinity	360						
Total Hardness	237						
Hardness as Ca^{++}	215						
Hardness as Mg^{++}	23						
Measured TDS	1,400						
Calculated TDS*	1,462						
pH	7.9						

*Sum of measured ions

The approach to conducting the threshold evaluation was to spike a mixture of 24% effluent with 76% receiving stream to approximately six times the existing concentrations of TDS, and then prepare a chronic test exposure series by serially diluting the spiked mixture using unspiked mixture as diluent. In this way, the chloride, sulfate, sodium, and bicarbonate concentrations were manipulated while other aspects of the sample matrix (hardness, organic ligands, clays) remained relatively unchanged.

2.0 PREPARATION OF TEST EXPOSURES

A spreadsheet was developed to calculate ion concentrations resulting from various mixtures of inorganic salts. Using this program, it was possible to identify a mixture of salts that very closely matched the ionic strength and makeup of effluent based on the April 11, 2013, sample. This spreadsheet program was then used to develop the recipe for preparing a spiked river sample containing approximately six times the TDS of the mixture sample. This spiked

sample was then used to prepare five test exposures of serially diluting the six-times spiked mixture with unspiked mixture using a dilution factor of 0.5. This resulted in a test with five spiked test exposures, an unspiked mixture, and a laboratory control, for a total of seven test exposures. The calculated amounts of reagent to add to the river sample to produce the nominal six-times spiked exposure are provided in Table H.3

Table H.3. Summary of inorganic salt additions to result in a six-times spiked concentration of the unspiked river sample, based on the sample collected on April 11, 2013.

Reagent	mg/ L of Mixture
NaCl	1,320
Na_2SO_4	3,900
$NaHCO_3$	1,800
$MgCl_2$	22
CaO	120
KCl	45

3.0 DATA ANALYSIS

Survival and reproduction data will be statistically analyzed using appropriate parametric or non-parametric tests to calculate the no-observed-effect concentration (NOEC), the lowest-observed-effect concentration (LOEC), and the 25% inhibition concentration (IC25) values per EPA (2002). For the purposes of this study, the IC25 will be the preferred endpoint to represent a toxic TDS threshold.

Analytically determined concentrations of selected analytes (sulfate, chloride, hardness, alkalinity, and TDS) and test conductivity measurements in each exposure solution for each day's renewal were examined to verify correct preparation of test exposures, document changes in the ionic strength and makeup of the six-times spike mixture used to prepare daily exposure renewals and to provide concentrations for the calculation of test endpoints. The IC25, NOEC, and LOEC values were calculated for TDS, sulfate, and chloride using the average of the measured concentrations from each day's renewal. These endpoints provided an estimate of the toxic threshold for TDS, sulfate, and chloride in the plant effluent/receiving stream mixture.

The information and analysis presented above provides the overall approach and its justification for performing the spiked river sample test. The specific test protocol to follow is presented following section.

4.0 SAMPLING AND TESTING PROTOCOL

All sample spiking, analytical testing and toxicity tests was conducted by American Interplex Corporation Laboratories (AIC), which is certified by the Arkansas Department of Environmental Quality (ADEQ) for the required analyses. As part of preliminary testing arrangements, AIC reviewed this protocol and determined the volume of water needed for the testing.

4.1 Sample Collection

The approximately 7.6 liters (2 gallons) of Little River sample and effluent were collected on April 22, 2013 as grab samples. Sampling was conducted by FTN personnel.

4.2 Toxicity Testing and Associated Measurements

Prior to testing AIC made routine preparations for conducting a 3-brood survival and reproduction test using *C. dubia.*

4.2.1 Sample Preparation

1. Collect aliquots of the effluent and Little River samples to analyze for the following:

- Sodium
- Potassium
- Calcium
- Magnesium
- Chloride
- Sulfate
- Total Alkalinity
- pH
- TDS

2. Prepare the effluent mixture (EM) by mixing 26% effluent and 74% Red River samples.

3. Prepare spiked effluent mixture (SEM) according to Table H.4.

4. Prepare a sufficient volume of SEM and unspiked EM (UEM) to accommodate all toxicity test renewals and subsamples for chemical analyses.

5. Aerate the SEM overnight to allow solution to equilibrate.

6. Collect an aliquot of SEM to analyze for the parameters listed above.

7. Store all samples under refrigeration per normal sample storage protocol. Note any changes in the spiked or unspiked samples during storage such as the formation of precipitates.

Table H.4. Summary of inorganic salt additions to the unspiked effluent mixture to prepare the spiked effluent mixture.

Reagent	Amount (g) to Add Per 1,000 mL of Unspiked Effluent Mixture
NaCl	1.32
Na_2SO_4	3.90
MgC12	0.022
$NaHCO_3$	1.80
CaO	0.12
KCl	0.045

4.2.2 Test Exposures

1. Prepare five test exposures by diluting SEM with UEM using a 0.5x dilution factor. This will result in test exposures of 100%, 50% 25% 12.5% and 6.25% as SEM diluted with UEM.

2. Prepare an additional exposure of UEM.

3. Include a laboratory performance control using moderately hard water.

4. The test will have a total of seven exposures: five exposures SEM diluted with UEM, one exposure of UEM, and a laboratory control.

4.2.3 Test Maintenance, Renewals, and Chemical Analyses

1. At the beginning of the toxicity test (day 1) collect aliquots of the 6.25% and 25% renewal solutions for the analysis of chloride, sulfate, TDS, hardness, and total alkalinity.

2. Perform the toxicity test per routine protocol for EPA Method 1002.0

3. Include initial conductivity measurements in all exposures with each day's renewal.

4. On day 3 and the last renewal day of the test, collect aliquots of the UEM, 6.25%, 25%, and 100% renewal solutions for the analysis of chloride, sulfate, TDS, hardness, and total alkalinity.

4.2.4 Reporting

Prepare a report of the results per normal report content. There is no need to conduct any statistical analysis of the results because all end points (NOEC, IC25, etc.) will be calculated using measured concentrations.

5.0 LITERATURE CITED

EPA. 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. Fourth edition. EPA-821-R-02-013. Office of Water. Washington, DC.

Lasier, P.J., and I.R. Hardin. 2010. Observed and predicted reproduction of *Ceriodaphnia dubia* exposed to chloride, sulfate, and bicarbonate. *Environ. Toxicol. Chem.* 29: 347-358.

Soucek, D.J. 2007. Comparison of hardness and chloride regulated acute effects of sodium sulfate on two freshwater crustaceans. *Environ. Toxicol. Chem.* 26: 773-253.

Soucek, D.J., and A.J. Kennedy. 2005. Effects of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates. *Environ. Toxicol. Chem.* 24:1204-1210.

Soucek, D.J., T.K. Linton, C.D. Tarr, A. Dickinson, N. Wickramanayake, C.G. Delos, and L.A. Cruz. 2011. Influence of water hardness and sulfate on the acute toxicity of chloride to sensitive freshwater invertebrates. *Environ. Toxicol. Chem.* 30: 930-938.

APPENDIX I

Toxicity Test Laboratory Data

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

SAMPLE INFORMATION

Project Description:
Two (2) water sample(s) received on April 11, 2013
Domtar UAA Feasibility
06395-0101-001

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
166500-1	~~U/S Red River 4/11/13 1245~~ Little River Turk	11-Apr-2013 1245	Incorrect entry based on incorrect COC
166500-2	~~Domtar Effluent 4/11/13 1135~~	11-Apr-2013 1135	

Qualifiers:
D Result is from a secondary dilution factor
H Analytical holding time exceeded regulatory requirements

TOD 4/11/13

Case Narrative:
Table II of 40 CFR Part 136.3 indicates analysis of pH, Total Residual Chlorine, and Dissolved Oxygen are to be performed on site or immediately after collection. American Interplex Corporation analyzes these parameters as soon as possible after laboratory receipt.

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", 21st edition.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Incorrect entry based on incorrect COC PDP 11/11/13

ANALYTICAL RESULTS

AIC No. 166500-1
Sample Identification: U/S ~~Red River~~ Little River 4/11/13 1245

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**33** Analyzed: 11-Apr-2013 1618 by 302	1	**mg/l** Batch: W43205	
Total Dissolved Solids SM 2540 C	Prep: 11-Apr-2013 1620 by 302	**140** Analyzed: 12-Apr-2013 1304 by 302	10	**mg/l** Batch: W43197	
pH SM 4500-H+ B		**7.8** Analyzed: 11-Apr-2013 1620 by 302		**Units** Batch: W43192	H
Calcium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**15** Analyzed: 15-Apr-2013 1722 by 305	0.1	**mg/l** Batch: S34425	
Magnesium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**4.4** Analyzed: 15-Apr-2013 1722 by 305	0.03	**mg/l** Batch: S34425	
Potassium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**3.3** Analyzed: 15-Apr-2013 1722 by 305	1	**mg/l** Batch: S34425	
Sodium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**7.9** Analyzed: 15-Apr-2013 1722 by 305	1	**mg/l** Batch: S34425	
Chloride EPA 300.0	Prep: 11-Apr-2013 1649 by 07	**8.4** Analyzed: 12-Apr-2013 0134 by 07	0.2	**mg/l** Batch: S34409	
Sulfate EPA 300.0	Prep: 11-Apr-2013 1649 by 07	**13** Analyzed: 12-Apr-2013 0134 by 07	0.2	**mg/l** Batch: S34409	

AIC No. 166500-2
Sample Identification: ~~Domtar Effluent~~ Turk 4/11/13 1135

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**360** Analyzed: 11-Apr-2013 1618 by 302	1	**mg/l** Batch: W43205	
Total Dissolved Solids SM 2540 C	Prep: 11-Apr-2013 1620 by 302	**1400** Analyzed: 12-Apr-2013 1304 by 302	10	**mg/l** Batch: W43197	
pH SM 4500-H+ B		**7.9** Analyzed: 11-Apr-2013 1620 by 302		**Units** Batch: W43192	H
Calcium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**86** Analyzed: 15-Apr-2013 1727 by 305	0.1	**mg/l** Batch: S34425	
Magnesium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**5.5** Analyzed: 15-Apr-2013 1727 by 305	0.03	**mg/l** Batch: S34425	
Potassium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**23** Analyzed: 15-Apr-2013 1727 by 305	1	**mg/l** Batch: S34425	
Sodium EPA 200.7	Prep: 15-Apr-2013 1040 by 100	**380** Analyzed: 16-Apr-2013 1243 by 305	10	**mg/l** Batch: S34425	D Dil: 10
Chloride EPA 300.0	Prep: 11-Apr-2013 1649 by 07	**170** Analyzed: 12-Apr-2013 0200 by 07	2	**mg/l** Batch: S34409	D Dil: 10
Sulfate EPA 300.0	Prep: 11-Apr-2013 1649 by 07	**450** Analyzed: 12-Apr-2013 0200 by 07	2	**mg/l** Batch: S34409	D Dil: 10

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

DUPLICATE RESULTS

Analyte		AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
pH		166475-1	8.0 Units				11Apr13 1112 by 93		H
	Batch: W43192	Duplicate	8.1 Units	1.87	5.00		11Apr13 1113 by 93		H
Total Dissolved Solids		166470-1	39 mg/l			11Apr13 1416 by 302	12Apr13 1304 by 302		
	Batch: W43197	Duplicate	36 mg/l	8.00	10.0	11Apr13 1417 by 302	12Apr13 1304 by 302		
Alkalinity as CaCO3		166464-1	140 mg/l				11Apr13 1540 by 302		
	Batch: W43205	Duplicate	140 mg/l	0.00	20.0		11Apr13 1540 by 302		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
pH	-	100	98.0-102			W43192		11Apr13 1113 by 93		
Calcium	10 mg/l	106	85.0-115			S34425	15Apr13 1041 by 100	15Apr13 1659 by 305		
Magnesium	10 mg/l	105	85.0-115			S34425	15Apr13 1041 by 100	15Apr13 1659 by 305		
Potassium	10 mg/l	105	85.0-115			S34425	15Apr13 1041 by 100	15Apr13 1659 by 305		
Sodium	10 mg/l	103	85.0-115			S34425	15Apr13 1041 by 100	15Apr13 1659 by 305		
Chloride	20 mg/l	101	90.0-110			S34409	11Apr13 1614 by 07	11Apr13 2050 by 07		
Sulfate	20 mg/l	103	90.0-110			S34409	11Apr13 1614 by 07	11Apr13 2050 by 07		

MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	166563-1	10 mg/l	101	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1704 by 305		
	166563-1	10 mg/l	101	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1709 by 305		
	Relative Percent Difference:		0.00696	20.0	S34425				
Magnesium	166563-1	10 mg/l	99.4	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1704 by 305		
	166563-1	10 mg/l	99.5	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1709 by 305		
	Relative Percent Difference:		0.0851	20.0	S34425				
Potassium	166563-1	10 mg/l	99.8	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1704 by 305		
	166563-1	10 mg/l	99.8	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1709 by 305		
	Relative Percent Difference:		0.0649	20.0	S34425				
Sodium	166563-1	10 mg/l	98.7	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1704 by 305		
	166563-1	10 mg/l	98.7	75.0-125	S34425	15Apr13 1041 by 100	15Apr13 1709 by 305		
	Relative Percent Difference:		0.0459	20.0	S34425				
Chloride	166489-1	20 mg/l	106	80.0-120	S34409	11Apr13 1614 by 07	11Apr13 2116 by 07		
	166489-1	20 mg/l	102	80.0-120	S34409	11Apr13 1614 by 07	11Apr13 2142 by 07		
	Relative Percent Difference:		3.12	10.0	S34409				
Sulfate	166489-1	20 mg/l	109	80.0-120	S34409	11Apr13 1614 by 07	11Apr13 2116 by 07		
	166489-1	20 mg/l	107	80.0-120	S34409	11Apr13 1614 by 07	11Apr13 2142 by 07		
	Relative Percent Difference:		2.03	10.0	S34409				

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Alkalinity as CaCO3	< 1 mg/l	1	1	W43205-1		11Apr13 1540 by 302	
Total Dissolved Solids	< 10 mg/l	10	10	W43197-1	11Apr13 1417 by 302	12Apr13 1304 by 302	
Calcium	< 0.1 mg/l	0.1	0.1	S34425-1	15Apr13 1041 by 100	15Apr13 1654 by 305	
Magnesium	< 0.03 mg/l	0.03	0.03	S34425-1	15Apr13 1041 by 100	15Apr13 1654 by 305	
Potassium	< 1 mg/l	1	1	S34425-1	15Apr13 1041 by 100	15Apr13 1654 by 305	
Sodium	< 1 mg/l	1	1	S34425-1	15Apr13 1041 by 100	15Apr13 1654 by 305	
Chloride	< 0.2 mg/l	0.2	0.2	S34409-1	11Apr13 1614 by 07	11Apr13 2024 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S34409-1	11Apr13 1614 by 07	11Apr13 2024 by 07	

166500

ftn Turk

06 510-0010-002

Date	Project Name	Project No.	Project Manager (Print)	Page 1 of 1
04/11/13	~~Domtar~~ UAA Feasibility	~~06395-0101-001~~	Jim Malcolm	

Report / Bill to:	Submitted by:
FTN Associates, Ltd.. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738	FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738
Sampler Signature(s)	Recorded By (Print) Jeff Ward

Parameters (Method Number)

Lab Turn-Around-Time
- ☐ 24 Hours
- ☐ 48 Hours
- ☒ Normal
- ☐ Other: Due: __/__/__

SAMPLE DESCRIPTION

	Sample Identification	Date	Time	Matrix* W	Matrix* S	Matrix* O	No. of Containers	Comp	Grab	TDS, Cl, SO4	pH	Total Alkalinity	Ca, Mg, K, Na				Detection Limits: Parameter	Detection Limit
1	~~Little River~~ U/S Red River	4/11/13	1245	X			2		X	X	X	X	X					
2	Domtar Effluent	4/11/13	1135	X			2		X	X	X	X	X					
	Turk Incorrect entries RDD 11/11/13																	
							Container Type											
							Preservative											

* Matrix: W = Water S = Soil O = Other

G = Glass P= Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate

NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
	Jeff Ward	4/11/13	15:40				
Relinquished By (Signature)	Print Name	Date	Time	Received By Laboratory (Signature)	Print Name	Date	Time
					Shana Bichase	4-11-13	1540

Sampler Remarks: please e-mail results **as well as the .csv file** to jtm@ftn-assoc.com & jlw@ftn-assoc.com

Laboratory Remarks:

2.c

Revision Date 11/22/02

May 6, 2013

Test Results of
Second Quarter
Chronic 7-Day Renewal
Biomonitoring Testing
for
~~Domtar~~ Effluent
(26% Effluent + 74% River spiked with salts)

Control No. 166826-1

Tank

POD Incorrect entry based on incorrect COC 11/11/14

Incorrect entries discussed w/ samplers & determined that samples were actually taken from the Little R. & SWEPCO (Tank) Effluent. (JLW & RPG)

Prepared for:

Mr. Jim Malcolm
FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Prepared by:

AMERICAN INTERPLEX CORPORATION
8600 Kanis Road
Little Rock, AR 72204-2322

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Re: Chronic 7-Day Renewal utilizing *Ceriodaphnia dubia*
Domtar Effluent - (26% Effluent + 74% River spiked with salts)
NPDES Permit No. AR

Dear Mr. Jim Malcolm:

This report is the analytical results and supporting information for the samples submitted to American Interplex Corporation (AIC). The following results are applicable only to the sample identified by the control number referenced above. Accurate assessment of the data requires access to the entire document. Each section of the report has been reviewed and approved by the laboratory director or qualified designee.

Testing procedures and Quality Assurance were in accordance with "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA-821-R-02-013, Fourth Edition, October 2002. Test results are summarized below:

The control is unspiked effluent mixture.

Chronic *Ceriodaphnia dubia* screen: The No Observable Effects Concentration for survival and reproduction is 25% and 6.25% respectively.

AMERICAN INTERPLEX CORPORATION

John Overbey
Laboratory Director

PDF cc: FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
jtm@ftn-assoc.com

FTN Associates, Ltd.
ATTN: Mr. Pat Downey
pjd@ftn-assoc.com

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Ceriodaphnia dubia Survival and Reproduction
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I. Control Acceptance Criteria

Ceriodaphnia dubia Method 1002.0

CRITERIA	RESULTS	PASS/FAIL
Control Survival > or = 80%	100	PASS
Control Reproduction > or = 15 per Surviving Female	17.3	PASS
Control CV < or = 40% per Surviving Female	11.6	PASS
Reproduction Minimum Significant Difference 13 to 47%	15.2	PASS
Critical Dilution CV < or = 40%	0.00	PASS

II. Outlined Report

A. Introduction

1. Permit Number: AR
2. Test Requirements: Chronic Biomonitoring, Quarterly
   Test Method 1002.0
3. Receiving Stream: U/S Red River

B. Source of Effluent/Dilution Water

1. Effluent Samples:
   a. Sampling Point: Domtar Effluent
   b. Chemical Data:

Analysis	Sample 1	Sample 2	Sample 3
Dissolved oxygen (mg/l)	7.2	NA	NA
pH (standard units)	9.0	NA	NA
Alkalinity (mg/l as CaCO3)	NA	NA	NA
Hardness (mg/l as CaCO3)	NA	NA	NA
Conductivity (umhos/cm)	NA	NA	NA
Residual Chlorine (mg/l)	NA	NA	NA
Ammonia as N (mg/l)	NA	NA	NA

2. Dilution Water Samples: Unspiked Effluent Mixture
   a. Dates Collected: April 24, 2013
   b. Chemical Data:

Analysis	Sample 1	Sample 2	Sample 3
Dissolved oxygen (mg/l)	7.0	7.8	7.2
pH (standard units)	7.8	8.2	7.6
Alkalinity (mg/l as CaCO3)	140	NA	NA
Hardness (mg/l as CaCO3)	55	NA	NA
Conductivity (umhos/cm)	NA	NA	NA
Residual Chlorine (mg/l)	NA	NA	NA

C. Test Methods
1. Test methods used:
Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, EPA-821-R-02-013; test Method 1002.0, *Ceriodaphnia dubia* Survival and Reproduction.
2. Endpoint: No Observable Effects Concentration (NOEC)
3. Test Conditions:

Ceriodaphnia dubia Survival and Growth Method 1002.0

Date & Time Test Initiated:	April 25, 2013 at 1455
Date & Time Test Terminated:	May 2, 2013 at 1435
Type & Volume of Test Chamber:	30 ml disposable beaker
Volume of Sample:	15 ml
Number of Organisms per replicate:	1
Number of Replicates per dilution:	10

4. Acclimation of test organisms: Obtained from in-house cultures
5. Test Temperature: 25 +/- 1 degree Celsius

D. Test Organisms
1. Scientific Name
a. Test 1002.0 *Ceriodaphnia dubia*

III. Data Analysis
The data was analyzed using American Interplex Corporation's Laboratory Information Management Software based on Toxstat.

Ceriodaphnia dubia survival data was analyzed with Fisher's Exact Test. Reproduction data was analyzed using Shapiro-Wilk's and analyzed with Steel's Many-One Rank Test to determine the No Observable Effects Concentration (NOEC) for Reproduction. Dunnett's Test was used to calculate the PMSD.

IV. Standard Reference Toxicants

American Interplex Corporation has an ongoing test organism culturing program. The sensitivity of the offspring is determined by performing a standard reference toxicant test with each effluent test. Sodium chloride in synthetic moderately hard water is used as prescribed in EPA-821-R-02-013.

Ceriodaphnia dubia

Chronic reference tests are performed monthly.
A chronic reference test was performed on April 2, 2013 at 1510 to April 9, 2013 at 1500
The results were as follows: (Control No. 166187-2.)
Survival LC-50: 1732 mg/l
Growth IC-25: 1250 mg/l
Growth PMSD: 8.05

V. Chemical Analysis/Quality Control

Parameter	Method	% Recovery	Relative % Difference
Alkalinity	SM 2320 B	NA	1.37
Hardness	EPA 200.7	99.2	0.910
pH	SM 4500-H+ B	101	0.00
Conductivity	EPA 120.1	104	0.656

VI. Organism History

Ceriodaphnia dubia

Date: April 25, 2013
Age: <24 hours
Source: In-house culture
Water Chemistry Record:
Alkalinity: 57-64 mg/l
Hardness: 80-100 mg/l
Temperature: 25 deg.C

VII. Results Summary *Ceriodaphnia dubia*, Cladoceran Survival and Reproduction Test -- Method 1002.0

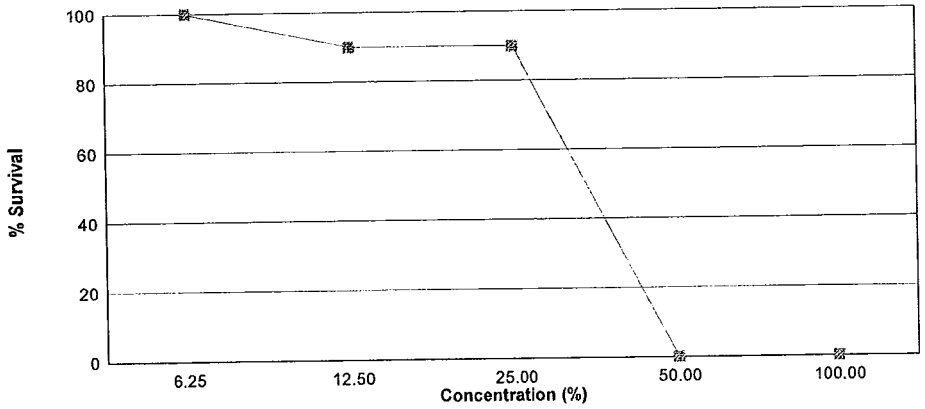
Neonates are exposed in a static renewal system to different concentrations of effluent with dilution water until 60% of surviving control organisms have three broods of offspring with an average of at least 15 young per female.

Effluent dilutions for this test were 6.25 %, 12.5 %, 25.0 %, 50.0 %, 100 % in accordance with the NPDES permit.

The low flow or 'critical' dilution is specified in the NPDES permit as 100 % effluent.

The test was initiated on April 25, 2013 at 1455 and continued through May 2, 2013 at 1435. Statistical analyses were performed on the observed data and the no observable effects concentrations (NOECs) were as follows:

a.) NOEC survival = 25 % effluent
b.) NOEC reproduction = 12.5 % effluent



Summary of the 7-day *Ceriodaphnia dubia* Survival and Reproduction Data		
Concentration	Percent Survival	Mean Reproduction
Control	100	17.3
6.25 %	100	15.9
12.5 %	90.0	14.1
25.0 %	90.0	11.9 *
50.0 %	0.00 *	--
100 %	0.00 *	--

*Significant difference when compared to the control (p=0.05)

Appendix A1: Test 1002.0

Ceriodaphnia dubia Survival and Reproduction

Date and Time Test Initiated: April 25, 2013 at 1455
Date and Time Test Terminated: May 2, 2013 at 1435

Concentration: Control													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	0	0	0	0	0	0	0	0	0	10	0.00
2	0	0	0	0	0	0	0	0	0	0	0	10	0.00
3	0	0	0	0	0	0	0	0	0	0	0	10	0.00
4	3	2	2	3	3	2	2	3	2	3	25	10	2.50
5	4	0	0	3	0	5	0	6	0	0	18	10	1.80
6	0	4	4	0	6	0	5	0	5	4	28	10	2.80
7	11	10	13	9	10	9	11	12	8	9	102	10	10.2
8													
TOTAL	18	16	19	15	19	16	18	21	15	16	173	10	17.3

Concentration: 6.25 %													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	0	0	0	0	0	0	0	0	0	10	0.00
2	0	0	0	0	0	0	0	0	0	0	0	10	0.00
3	0	0	0	0	0	0	0	0	0	0	0	10	0.00
4	4	2	2	3	3	2	2	3	2	2	25	10	2.50
5	4	0	0	0	5	0	0	4	0	0	13	10	1.30
6	0	3	4	5	0	4	5	4	0	5	30	10	3.00
7	9	10	9	11	9	9	10	5	9	10	91	10	9.10
8													
TOTAL	17	15	15	19	17	15	17	16	11	17	159	10	15.9

Concentration: 12.5 %													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	0	0	0	0	0	0	0	0	0	10	0.00
2	0	0	0	0	0	0	0	0	0	0	0	10	0.00
3	0	0	X	0	0	0	0	0	0	0	0	9	0.00
4	4	3	X	3	2	3	3	2	1	2	23	9	2.56
5	6	0	X	5	0	0	0	0	2	0	13	9	1.44
6	5	4	X	8	0	6	4	5	3	4	39	9	4.33
7	6	9	X	0	6	10	9	8	7	11	66	9	7.33
8													
TOTAL	21	16	0	16	8	19	16	15	13	17	141	10	14.1

Appendix A1: Test 1002.0

Ceriodaphnia dubia Survival and Reproduction

Date and Time Test Initiated: April 25, 2013 at 1455
Date and Time Test Terminated: May 2, 2013 at 1435

Concentration: 25.0 %													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	0	0	X	0	0	0	0	0	0	9	0.00
2	0	0	0	0	X	0	0	0	0	0	0	9	0.00
3	0	0	0	0	X	0	0	0	0	0	0	9	0.00
4	1	2	2	3	X	2	2	3	2	0	17	9	1.89
5	2	0	4	0	X	3	0	4	0	5	18	9	2.00
6	4	5	4	5	X	5	4	4	3	0	34	9	3.78
7	4	7	0	6	X	9	8	2	8	6	50	9	5.56
8													
TOTAL	11	14	10	14	0	19	14	13	13	11	119	10	11.9

Concentration: 50.0 %													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	X	0	0	0	X	X	0	X	0	6	0.00
2	X	X	X	X	X	X	X	X	X	X	0	0	0.00
3	X	X	X	X	X	X	X	X	X	X	0	0	0.00
4	X	X	X	X	X	X	X	X	X	X	0	0	0.00
5	X	X	X	X	X	X	X	X	X	X	0	0	0.00
6	X	X	X	X	X	X	X	X	X	X	0	0	0.00
7	X	X	X	X	X	X	X	X	X	X	0	0	0.00
8													
TOTAL	0	0	0	0	0	0	0	0	0	0	0	10	0.00

Concentration: 100 %													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	X	X	X	X	X	X	X	X	X	X	0	0	0.00
2	X	X	X	X	X	X	X	X	X	X	0	0	0.00
3	X	X	X	X	X	X	X	X	X	X	0	0	0.00
4	X	X	X	X	X	X	X	X	X	X	0	0	0.00
5	X	X	X	X	X	X	X	X	X	X	0	0	0.00
6	X	X	X	X	X	X	X	X	X	X	0	0	0.00
7	X	X	X	X	X	X	X	X	X	X	0	0	0.00
8													
TOTAL	0	0	0	0	0	0	0	0	0	0	0	10	0.00

Appendix A2: Statistics

Ceriodaphnia dubia Survival

Fisher's Exact Test

Identification	Alive	Dead	Total Animals
Control	10	0	10
6.25 %	10	0	10
Total	20	0	20

Critical Fisher's value (10,10,10) (alpha=0.05) is 6. b value is 10. Since b is greater than 6 there is NO SIGNIFICANT DIFFERENCE between CONTROL and TREATMENT at the 0.05 level.

Fisher's Exact Test

Identification	Alive	Dead	Total Animals
Control	10	0	10
12.5 %	9	1	10
Total	19	1	20

Critical Fisher's value (10,10,10) (alpha=0.05) is 6. b value is 9. Since b is greater than 6 there is NO SIGNIFICANT DIFFERENCE between CONTROL and TREATMENT at the 0.05 level.

Fisher's Exact Test

Identification	Alive	Dead	Total Animals
Control	10	0	10
25.0 %	9	1	10
Total	19	1	20

Critical Fisher's value (10,10,10) (alpha=0.05) is 6. b value is 9. Since b is greater than 6 there is NO SIGNIFICANT DIFFERENCE between CONTROL and TREATMENT at the 0.05 level.

Fisher's Exact Test

Identification	Alive	Dead	Total Animals
Control	10	0	10
50.0 %	0	10	10
Total	10	10	20

Critical Fisher's value (10,10,10) (alpha=0.05) is 6. b value is 0. Since b is less than or equal to 6 there is A SIGNIFICANT DIFFERENCE between CONTROL and TREATMENT at the 0.05 level.

Appendix A2: Statistics

Ceriodaphnia dubia Survival

Fisher's Exact Test			
Identification	Alive	Dead	Total Animals
Control	10	0	10
100 %	0	10	10
Total	10	10	20

Critical Fisher's value (10,10,10) (alpha=0.05) is 6. b value is 0. Since b is less than or equal to 6 there is A SIGNIFICANT DIFFERENCE between CONTROL and TREATMENT at the 0.05 level.

Summary of Fisher's Exact Test				
Group	Identification	Exposed	Dead	Sig 0.05
0	Control	10	0	
1	6.25 %	10	0	
2	12.5 %	10	1	
3	25.0 %	10	1	
4	50.0 %	10	10	*
5	100 %	10	10	*

Appendix A2: Statistics

Ceriodaphnia dubia Reproduction

Shapiro - Wilk's Test for Normality		No Transformation
D = 618.8		
W = 0.8445		
Critical W = 0.919	(alpha = 0.01, N = 40)	
Critical W = 0.94	(alpha = 0.05, N = 40)	
Data FAIL normality test (alpha = 0.01).		

Steel's Many-One Rank Test					No Transformation
Ho:Control<Treatment					
Group	Identification	Rank Sum	Critical Value	DF	Sig 0.05
1	Control				
2	6.25 %	89.50	77.00	10.00	
3	12.5 %	89.00	77.00	10.00	
4	25 %	63.00	77.00	10.00	*
Critical values are 1 tailed (k=3)					

Appendix A2: Statistics

Ceriodaphnia dubia Reproduction

Dunnett's Test for PMSD Calculation (excluding deaths if applicable)

ANOVA Table — No Transformation

SOURCE	DF	SS	MS	F
Between	3	80.71	26.9	3.802
Within (Error)	34	240.6	7.076	
Total	37	321.3		

Critical F = 4.42 (alpha = 0.01, df = 3,34)
2.88 (alpha = 0.05, df = 3,34)

Since F > Critical F REJECT Ho: All equal (alpha = 0.05)

Dunnett's Test - Table 1 of 2 — No Transformation

Ho:Control<Treatment

Group	Identification	Transformed Mean	Mean In Original Units	T Stat	Sig 0.05
1	Control	17.3	17.3		
2	6.25 %	15.9	15.9	1.177	
3	12.5 %	15.667	15.667	1.336	
4	25 %	13.222	13.222	3.337	*

Dunnett's critical value = 2.15 (1 Tailed, alpha = 0.05, df [used] = 3,30) (Actual df = 3,34)
WARNING - Unequal replicate sizes. Critical values assuming equal replicate sizes have been used.

Dunnett's Test - Table 2 of 2 — No Transformation

Ho:Control<Treatment

Group	Identification	Num of Reps	Min Sig Diff (In Orig. Units)	% of Control	Difference From Control
1	Control	10			
2	6.25 %	10	2.558	14.8	1.4
3	12.5 %	9	2.628	15.2	1.633
4	25 %	9	2.628	15.2	4.078

Appendix A3: Water Chemistry

Routine Chemical and Physical Data

Date and Time Test Initiated: April 25, 2013 at 1032
Date and Time Test Terminated: May 2, 2013 at 1435

Effluent Conc.: Control		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial	7.0	7.7	7.8	8.7	7.2	7.9	7.6
	Final	8.4	8.2	8.0	7.7	8.5	7.5	7.1
pH, units	Initial	7.8	7.9	8.2	8.2	7.6	7.6	7.9
	Final	8.5	8.4	8.4	8.4	8.5	8.1	8.0
Alkalinity, mg CaCO3/l		140	NA	NA	NA	NA	NA	NA
Hardness, mg CaCO3/l		55	NA	NA	NA	NA	NA	NA
Conductivity, umhos/cm		NA	NA	NA	NA	NA	NA	NA
Res. Chlorine, mg/l		NA	NA	NA	NA	NA	NA	NA

Effluent Conc.: 6.25 %		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial	7.1	7.6	7.7	7.5	7.0	7.6	7.3
	Final	8.4	8.1	7.9	7.6	8.3	7.4	7.1
pH, units	Initial	8.3	8.2	8.5	8.5	7.9	7.8	8.0
	Final	8.6	8.6	8.6	8.6	8.7	8.4	8.3

Effluent Conc.: 12.5 %		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial	7.0	7.6	7.6	7.5	7.2	7.8	7.7
	Final	8.4	8.0	7.9	7.6	8.4	7.5	7.2
pH, units	Initial	8.6	8.5	8.6	8.6	8.6	8.3	8.4
	Final	8.7	8.7	8.7	8.6	8.8	8.5	8.5

Appendix A3: Water Chemistry

Routine Chemical and Physical Data

Date and Time Test Initiated: April 25, 2013 at 1032
Date and Time Test Terminated: May 2, 2013 at 1435

Effluent Conc.: 25.0 %		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial	6.9	7.6	7.4	7.6	7.3	7.7	7.4
	Final	8.4	8.1	7.9	7.6	8.3	7.4	7.1
pH, units	Initial	8.8	8.8	8.8	8.8	8.6	8.6	8.6
	Final	8.9	8.8	8.9	8.8	8.9	8.7	8.7

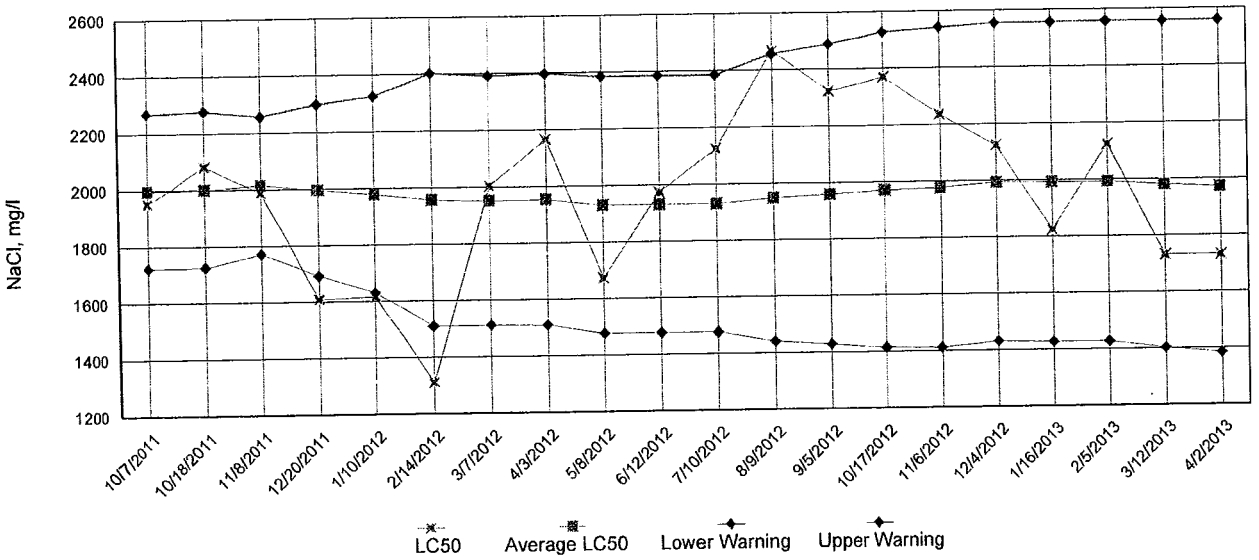
Effluent Conc.: 50.0 %		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial	7.1	7.9	NA	NA	NA	NA	NA
	Final	7.9	7.9	NA	NA	NA	NA	NA
pH, units	Initial	8.9	9.0	NA	NA	NA	NA	NA
	Final	9.0	9.0	NA	NA	NA	NA	NA

Effluent Conc.: 100 %		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial	7.2	7.6	NA	NA	NA	NA	NA
	Final	8.1	NA	NA	NA	NA	NA	NA
pH, units	Initial	9.0	9.0	NA	NA	NA	NA	NA
	Final	9.2	NA	NA	NA	NA	NA	NA

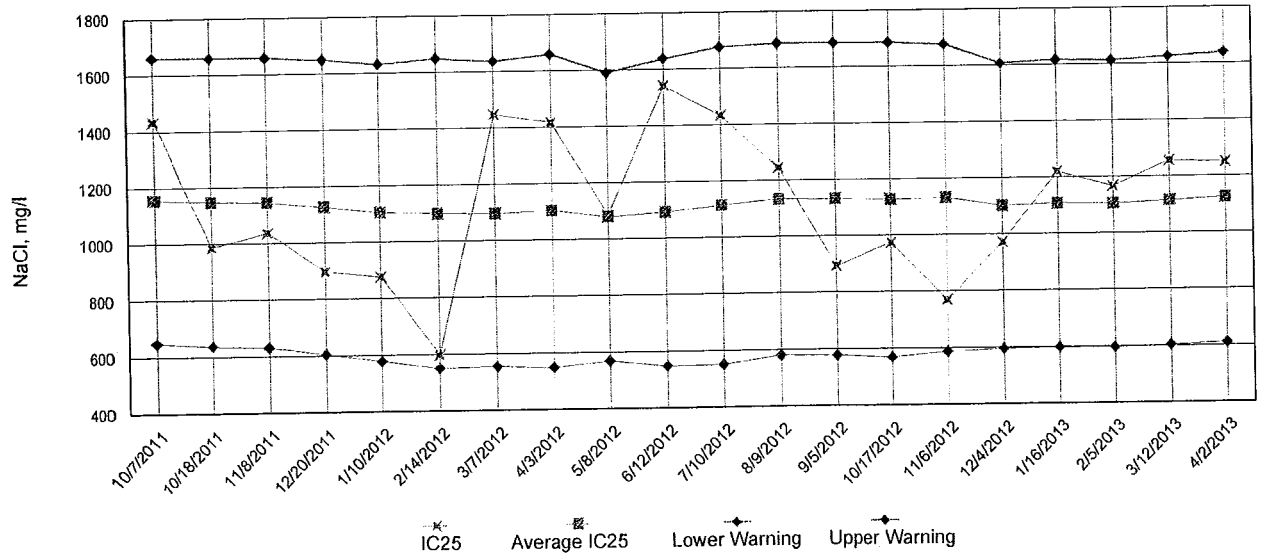
Appendix A4: Test 1002.0

Chronic Reference Toxicant, *Ceriodaphnia dubia*

LC50 Survival Data



IC25 Reproduction Data



ftn

065110-0010-002

166826

Date	Project Name	Project No.	Project Manager (Print)	Page 1 of 1
04/22/13	~~DOMTAR~~ Turk	~~06395-0101-001~~	Jim Malcolm/Pat Downey	

Report / Bill to:	Submitted by:
FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738	FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738
Sampler Signature(s)	Recorded By (Print) Jeff Ward

Parameters (Method Number)

Lab Turn-Around-Time
- ☐ 24 Hours
- ☐ 48 Hours
- ☒ Normal
- ☐ Other: Due: __/__/__

SAMPLE DESCRIPTION

Sample Identification	Date	Time	Matrix* W	Matrix* S	Matrix* O	No. of Containers	Comp	Grab	Spiked Sample Testing per protocol provided by Pat Downey
Turk									
~~Domtar Effluent~~	4/22/13	1125	X			2		X	X
~~U/S Red River~~	4/22/13	1230	X			4		X	X
Little up of Turk									
Incorrect Entry									
POD 11/11/13									
						Container Type			P
						Preservative			NO

Detection Limits

Parameter	Detection Limit

* Matrix: W = Water S = Soil O = Other

G = Glass P = Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate

NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
	Jeff Ward	~~4/22/13~~	1745		Blake G. Jeffcoat	23 Apr 13	08:00
Relinquished By (Signature)	Print Name	Date	Time	Received By Laboratory (Signature)	Print Name	Date	Time
	Blake J Gaffcoat	23 Apr 13	09:40		Shana Williams	4-23-13	9:40

Sample Remarks: please e-mail results **as well as the .csv file** to pjd@ftn-assoc.com , jtm@ftn-assoc.com & jlw@ftn-assoc.com

Laboratory Remarks:

2 c

Revision Date 11/22/02

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211

This report contains the analytical results and supporting information for samples submitted on April 11, 2013. 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: FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
jtm@ftn-assoc.com

FTN Associates, Ltd.
ATTN: Mr. Jeff Ward
jlw@ftn-assoc.com

AMERICAN INTERPLEX CORPORATION
LABORATORIES

May 6, 2013

Test Results of
Second Quarter
Chronic 7-Day Renewal
Biomonitoring Testing
for
Unspiked Effluent Mixture
(26% Effluent + 74% River)

Control No. 166826-2

Prepared for:

Mr. Jim Malcolm
FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Prepared by:

AMERICAN INTERPLEX CORPORATION
8600 Kanis Road
Little Rock, AR 72204-2322

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Re: Chronic 7-Day Renewal utilizing *Ceriodaphnia dubia*
Unspiked Effluent Mixture - (26% Effluent + 74% River)
NPDES Permit No. AR

Dear Mr. Jim Malcolm:

This report is the analytical results and supporting information for the samples submitted to American Interplex Corporation (AIC). The following results are applicable only to the sample identified by the control number referenced above. Accurate assessment of the data requires access to the entire document. Each section of the report has been reviewed and approved by the laboratory director or qualified designee.

Testing procedures and Quality Assurance were in accordance with "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA-821-R-02-013, Fourth Edition, October 2002. Test results are summarized below:

The control is moderately hard water.

Chronic *Ceriodaphnia dubia* screen: No statistically significant difference was noted between the control and the effluent mixture.

AMERICAN INTERPLEX CORPORATION

John Overbey
Laboratory Director

PDF cc: FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
jtm@ftn-assoc.com

FTN Associates, Ltd.
ATTN: Mr. Pat Downey
pjd@ftn-assoc.com

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Ceriodaphnia dubia Survival and Reproduction
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A3: Water Chemistry
A4: Reference Toxicant

Appendix B: Chains of Custody

I. Control Acceptance Criteria

Ceriodaphnia dubia Method 1002.0

CRITERIA	RESULTS	PASS/FAIL
Control Survival > or = 80%	100	PASS
Control Reproduction > or = 15 per Surviving Female	18.3	PASS
Control CV < or = 40% per Surviving Female	13.1	PASS
Reproduction Minimum Significant Difference 13 to 47%	9.36	BELOW
Critical Dilution CV < or = 40%	11.6	PASS

II. Outlined Report

A. Introduction

1. Permit Number: AR
2. Test Requirements: Chronic Biomonitoring, Quarterly
   Test Method 1002.0
3. Receiving Stream:

B. Source of Effluent/Dilution Water

1. Effluent Samples:
   a. Sampling Point: Unspiked Effluent Mixture
   b. Chemical Data:

Analysis	Sample 1	Sample 2	Sample 3
Dissolved oxygen (mg/l)			
pH (standard units)			
Alkalinity (mg/l as CaCO3)			
Hardness (mg/l as CaCO3)			
Conductivity (umhos/cm)			
Residual Chlorine (mg/l)			
Ammonia as N (mg/l)			

2. Dilution Water Samples: Synthetic Moderately Hard Water #3980
   a. Dates Prepared: April 12 through April 26, 2013
   b. Chemical Data:

Analysis	Sample 1	Sample 2	Sample 3
Dissolved oxygen (mg/l)			
pH (standard units)			
Alkalinity (mg/l as CaCO3)			
Hardness (mg/l as CaCO3)			
Conductivity (umhos/cm)			
Residual Chlorine (mg/l)			

C. Test Methods
1. Test methods used:
Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, EPA-821-R-02-013; test Method 1002.0, *Ceriodaphnia dubia* Survival and Reproduction.
2. Endpoint: No Observable Effects Concentration (NOEC)
3. Test Conditions:

Ceriodaphnia dubia Survival and Growth Method 1002.0

Date & Time Test Initiated:	April 25, 2013 at 1455
Date & Time Test Terminated:	May 2, 2013 at 1435
Type & Volume of Test Chamber:	30 ml disposable beaker
Volume of Sample:	15 ml
Number of Organisms per replicate:	1
Number of Replicates per dilution:	10

4. Acclimation of test organisms: Obtained from in-house cultures
5. Test Temperature: 25 +/- 1 degree Celsius

D. Test Organisms
1. Scientific Name
a. Test 1002.0 *Ceriodaphnia dubia*

III. Data Analysis
The data was analyzed using American Interplex Corporation's Laboratory Information Management Software based on Toxstat.

Ceriodaphnia dubia survival data was analyzed with Fisher's Exact Test. Reproduction data was analyzed using Shapiro-Wilk's and Bartlett's test and analyzed with Dunnett's Test to determine the No Observable Effects Concentration (NOEC) for Reproduction.

IV. Standard Reference Toxicants

American Interplex Corporation has an ongoing test organism culturing program. The sensitivity of the offspring is determined by performing a standard reference toxicant test with each effluent test. Sodium chloride in synthetic moderately hard water is used as prescribed in EPA-821-R-02-013.

Ceriodaphnia dubia

Chronic reference tests are performed monthly.
A chronic reference test was performed on April 2, 2013 at 1510 to April 9, 2013 at 1500
The results were as follows: (Control No. 166187-2.)
Survival LC-50: 1732 mg/l
Growth IC-25: 1250 mg/l
Growth PMSD: 8.05

V. Chemical Analysis/Quality Control

Parameter	Method	% Recovery	Relative % Difference
Alkalinity	SM 2320 B	NA	1.37
Hardness	EPA 200.7	99.2	0.910
pH	SM 4500-H+ B	101	0.00
Conductivity	EPA 120.1	104	0.656

VI. Organism History

Ceriodaphnia dubia

Date: April 25, 2013
Age: <24 hours
Source: In-house culture
Water Chemistry Record:
Alkalinity: 57-64 mg/l
Hardness: 80-100 mg/l
Temperature: 25 deg.C

VII. Results Summary *Ceriodaphnia dubia*, Cladoceran Survival and Reproduction Test -- Method 1002.0

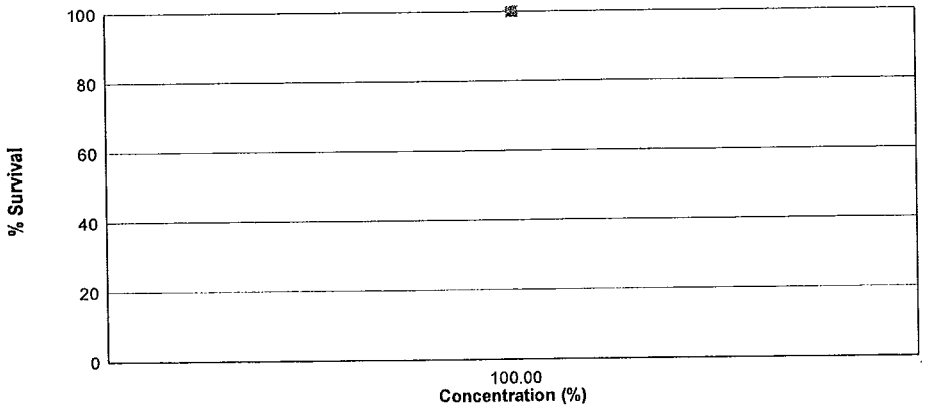
Neonates are exposed in a static renewal system to different concentrations of effluent with dilution water until 60% of surviving control organisms have three broods of offspring with an average of at least 15 young per female.

Effluent dilutions for this test were 100 % in accordance with the NPDES permit.

The low flow or 'critical' dilution is specified in the NPDES permit as 100 % effluent.

The test was initiated on April 25, 2013 at 1455 and continued through May 2, 2013 at 1435. Statistical analyses were performed on the observed data and the no observable effects concentrations (NOECs) were as follows:

a.) NOEC survival = 100 % effluent
b.) NOEC reproduction = 100 % effluent



Summary of the 7-day *Ceriodaphnia dubia* Survival and Reproduction Data		
Concentration	Percent Survival	Mean Reproduction
Control	100	18.3
100 %	100	17.3

Appendix A1: Test 1002.0

Ceriodaphnia dubia Survival and Reproduction

Date and Time Test Initiated: April 25, 2013 at 1455
Date and Time Test Terminated: May 2, 2013 at 1435

Concentration: Control													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	0	0	0	0	0	0	0	0	0	10	0.00
2	0	0	0	0	0	0	0	0	0	0	0	10	0.00
3	0	0	0	0	0	0	0	0	0	0	0	10	0.00
4	4	3	2	2	3	3	3	2	3	3	28	10	2.80
5	6	0	0	5	5	6	0	0	0	0	22	10	2.20
6	0	4	5	0	6	0	4	4	6	5	34	10	3.40
7	12	10	12	12	2	9	10	8	11	13	99	10	9.90
8													
TOTAL	22	17	19	19	16	18	17	14	20	21	183	10	18.3

Concentration: 100 %													
Day	Replicate										No. of Young	No. of Adults	Young per Adult
	1	2	3	4	5	6	7	8	9	10			
1	0	0	0	0	0	0	0	0	0	0	0	10	0.00
2	0	0	0	0	0	0	0	0	0	0	0	10	0.00
3	0	0	0	0	0	0	0	0	0	0	0	10	0.00
4	3	2	2	3	3	2	2	3	2	3	25	10	2.50
5	4	0	0	3	0	5	0	6	0	0	18	10	1.80
6	0	4	4	0	6	0	5	0	5	4	28	10	2.80
7	11	10	13	9	10	9	11	12	8	9	102	10	10.2
8													
TOTAL	18	16	19	15	19	16	18	21	15	16	173	10	17.3

Appendix A2: Statistics

Ceriodaphnia dubia Survival

Fisher's Exact Test			
Identification	Alive	Dead	Total Animals
Control	10	0	10
100 %	10	0	10
Total	20	0	20

Critical Fisher's value (10,10,10) (alpha=0.05) is 6. b value is 10. Since b is greater than 6 there is NO SIGNIFICANT DIFFERENCE between CONTROL and TREATMENT at the 0.05 level.

Summary of Fisher's Exact Test				
Group	Identification	Exposed	Dead	Sig 0.05
0	Control	10	0	
1	100 %	10	0	

Appendix A2: Statistics

Ceriodaphnia dubia Reproduction

Shapiro - Wilk's Test for Normality		No Transformation
D = 88.2		
W = 0.9554		
Critical W = 0.868	(alpha = 0.01, N = 20)	
Critical W = 0.905	(alpha = 0.05, N = 20)	
Data PASS normality test (alpha = 0.01).		

Bartlett's Test for Homogeneity of Variance		No Transformation
Calculated B1 statistic = 0.2853		
Critical B = 6.635	(alpha = 0.01, df = 1)	
Data PASS B1 homogeneity test at 0.01 level.		

Appendix A2: Statistics

Ceriodaphnia dubia Reproduction

ANOVA Table				No Transformation
SOURCE	DF	SS	MS	F
Between	1	5	5	1.02
Within (Error)	18	88.2	4.9	
Total	19	93.2		

Critical F = 8.28 (alpha = 0.01, df = 1,18)
4.41 (alpha = 0.05, df = 1,18)

Since F < Critical F FAIL TO REJECT Ho: All equal (alpha = 0.05)

Dunnett's Test - Table 1 of 2					No Transformation
Ho:Control<Treatment					
Group	Identification	Transformed Mean	Mean In Original Units	T Stat	Sig 0.05
1	Control	18.3	18.3		
2	100 %	17.3	17.3	1.01	

Dunnett's critical value = 1.73 (1 Tailed, alpha = 0.05, df = 1,18)

Dunnett's Test - Table 2 of 2					No Transformation
Ho:Control<Treatment					
Group	Identification	Num of Reps	Min Sig Diff (In Orig. Units)	% of Control	Difference From Control
1	Control	10			
2	100 %	10	1.713	9.36	1

Title: SWEPCO spiked effluent TDS IC25
File: TURKIC25.IN Transform: NO TRANSFORMATION

GRP	IDENTIFICATION	MEAN	SMOOTHED MEAN	CONCENTRATION
1	Control	17.3000	17.3000	0.0000
2	1050	15.9000	15.9000	1050.0000
3	1266	14.1000	14.1000	1266.0000
4	2200	11.9000	11.9000	2200.0000
5	3285	0.0000	0.0000	3285.0000

ICp estimate with p = 25 is 1743.6136

Bootstrap results using 480 iterations:

Mean = 1701.9552 Standard Deviation = 387.6677
95% Confidence Interval: (1165.3220 , 2303.8830)

Title: SWEPCO spiked effluent chloride IC25
File: CLIC25 .IN Transform: NO TRANSFORMATION

GRP	IDENTIFICATION	MEAN	SMOOTHED MEAN	CONCENTRATION
1	Control	17.3000	17.3000	0.0000
2	143	15.9000	15.9000	143.0000
3	171	14.1000	14.1000	171.0000
4	290	11.9000	11.9000	290.0000
5	690	0.0000	0.0000	690.0000

ICp estimate with p = 25 is 231.8523

Bootstrap results using 480 iterations:

Mean = 228.3825 Standard Deviation = 54.2155
95% Confidence Interval: (156.7813 , 328.7324)

Title: SWEPCO spiked effluent sulfate IC25
File: SO4IC25 .IN Transform: NO TRANSFORMATION

GRP	IDENTIFICATION	MEAN	SMOOTHED MEAN	CONCENTRATION
1	Control	17.3000	17.3000	0.0000
2	317	15.9000	15.9000	317.0000
3	432	14.1000	14.1000	432.0000
4	760	11.9000	11.9000	760.0000
5	1289	0.0000	0.0000	1289.0000

ICp estimate with p = 25 is 599.7273

Bootstrap results using 480 iterations:

Mean = 589.4611 Standard Deviation = 144.0931
95% Confidence Interval: (374.5000 , 809.3470)

Appendix A3: Water Chemistry

Routine Chemical and Physical Data

Date and Time Test Initiated: April 25, 2013 at 1032
Date and Time Test Terminated: May 2, 2013 at 1435

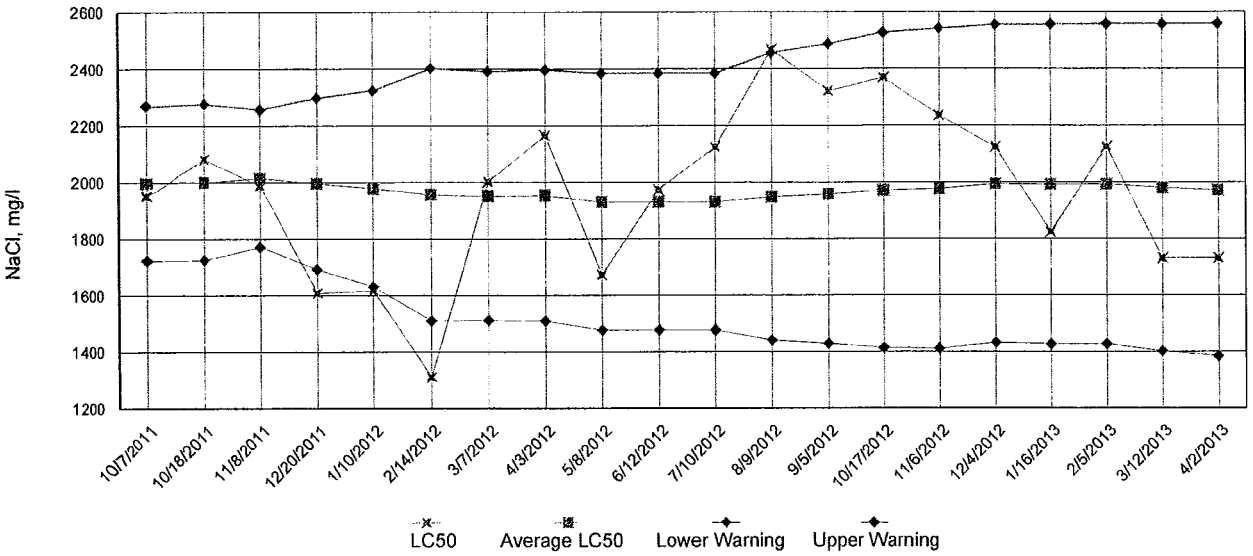
Effluent Conc.: Control		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial							
	Final							
pH, units	Initial							
	Final							
Alkalinity, mg CaCO3/l			NA		NA		NA	NA
Hardness, mg CaCO3/l			NA		NA		NA	NA
Conductivity, umhos/cm			NA		NA		NA	NA
Res. Chlorine, mg/l			NA		NA		NA	NA

Effluent Conc.: 100 %		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO, mg/l	Initial							
	Final							
pH, units	Initial							
	Final							
Alkalinity, mg CaCO3/l			NA		NA		NA	NA
Hardness, mg CaCO3/l			NA		NA		NA	NA
Conductivity, umhos/cm			NA		NA		NA	NA
Res. Chlorine, mg/l			NA		NA		NA	NA

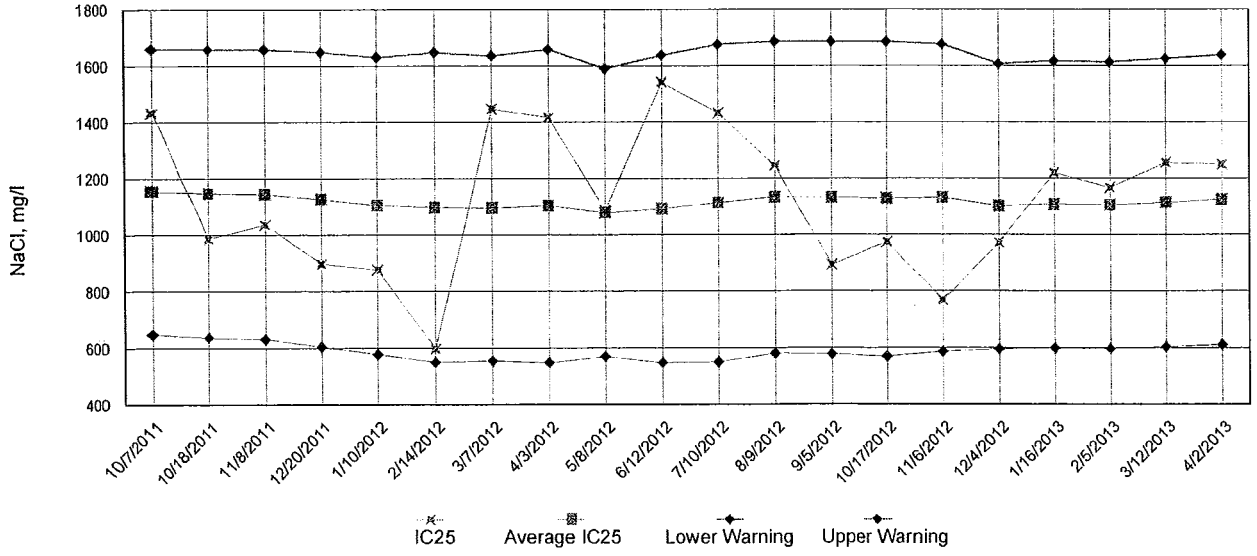
Appendix A4: Test 1002.0

Chronic Reference Toxicant, *Ceriodaphnia dubia*

LC50 Survival Data



IC25 Reproduction Data



ftn

06510-0010-002

166826

Date	Project Name	Project No.	Project Manager (Print)	Page 1 of 1
04/22/13	~~DOMTAR~~ Tork	~~06395-0101-001~~	Jim Malcolm/Pat Downey	

Report / Bill to:	Submitted by:
FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738	FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738
Sampler Signature(s)	Recorded By (Print) Jeff Ward

Parameters (Method Number)

Lab Turn-Around-Time

- ☐ 24 Hours
- ☐ 48 Hours
- ☒ Normal
- ☐ Other: Due: __/__/__

SAMPLE DESCRIPTION

Sample Identification	Date	Time	Matrix* W	Matrix* S	Matrix* O	No. of Containers	Comp	Grab	Spiked Sample Testing per protocol provided by Pat Downey
Tork POD 11/11/13									
~~Domtar Effluent~~	4/22/13	1125	X			2		X	X
~~U/S Red River~~	4/22/13	1230	X			4		X	X
Incorrect entry									
Container Type									P
Preservative									NO

Detection Limits

Parameter	Detection Limit

* Matrix: W = Water S = Soil O = Other

G = Glass P = Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate

NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
	Jeff Ward	4/22/13	1745		Blake Griffin	4/23/13	08:00
Relinquished By (Signature)	Print Name	Date	Time	Received By Laboratory (Signature)	Print Name	Date	Time
	Blake J Griffin	4/23/13	09:40		Shara Williams	4-23-13	9:40

Sampler Remarks: please e-mail results as well as the .csv file to pjd@ftn-assoc.com , jtm@ftn-assoc.com & jlw@ftn-assoc.com

Laboratory Remarks:

2c

Revision Date 11/22/02

AMERICAN INTERPLEX CORPORATION
LABORATORIES

May 13, 2013
Control No. 166827

FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211

This report contains the analytical results and supporting information for samples submitted on April 23, 2013. 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: FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
jtm@ftn-assoc.com

FTN Associates, Ltd.
ATTN: Mr. Pat Downey
pjd@ftn-assoc.com

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

SAMPLE INFORMATION

Project Description:
One (1) water sample(s) received on April 23, 2013
06395-0101-001
DOMTAR

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
166827-1	EFF		
166827-2	River		
166827-3	26% Eff 74% River		
166827-4	6.25% Day 1		
166827-5	25% Day 1		
166827-6	100% Day 1		
166827-7	6.25% Day 3		
166827-8	25% Day 3		
166827-9	26% Eff 74% River Day 3		
166827-10	6.25% Last Renewal Day		
166827-11	25% Last Renewal Day		
166827-12	26% Eff 74% River Last Day		

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

Case Narrative:
Table II of 40 CFR Part 136.3 indicates analysis of pH, Total Residual Chlorine, and Dissolved Oxygen are to be performed on site or immediately after collection. American Interplex Corporation analyzes these parameters as soon as possible after laboratory receipt.

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", 21st edition.
"American Society for Testing and Materials" (ASTM).
"Association of Analytical Chemists" (AOAC).

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 166827-1
Sample Identification: EFF

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**350** Analyzed: 25-Apr-2013 0919 by 93	1	**mg/l** Batch: W43345	
Total Dissolved Solids SM 2540 C	Prep: 26-Apr-2013 0942 by 302	**1400** Analyzed: 29-Apr-2013 1439 by 302	10	**mg/l** Batch: W43366	
pH SM 4500-H+ B	Prep: 24-Apr-2013 1429 by 308	**7.9** Analyzed: 24-Apr-2013 1545 by 308		**Units** Batch: W43336	
Calcium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**100** Analyzed: 26-Apr-2013 1135 by 305	1	**mg/l** Batch: S34504	D Dil: 10
Magnesium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**5.7** Analyzed: 25-Apr-2013 1820 by 305	0.03	**mg/l** Batch: S34504	
Potassium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**21** Analyzed: 25-Apr-2013 1820 by 305	1	**mg/l** Batch: S34504	
Sodium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**340** Analyzed: 26-Apr-2013 1135 by 305	10	**mg/l** Batch: S34504	D Dil: 10
Chloride EPA 300.0	Prep: 24-Apr-2013 1550 by 07	**160** Analyzed: 24-Apr-2013 1904 by 07	2	**mg/l** Batch: S34503	D Dil: 10
Sulfate EPA 300.0	Prep: 24-Apr-2013 1550 by 07	**370** Analyzed: 24-Apr-2013 1904 by 07	2	**mg/l** Batch: S34503	D Dil: 10

AIC No. 166827-2
Sample Identification: River

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**67** Analyzed: 25-Apr-2013 0919 by 93	1	**mg/l** Batch: W43345	
Total Dissolved Solids SM 2540 C	Prep: 26-Apr-2013 0942 by 302	**310** Analyzed: 29-Apr-2013 1439 by 302	10	**mg/l** Batch: W43366	
pH SM 4500-H+ B	Prep: 24-Apr-2013 1429 by 308	**8.3** Analyzed: 24-Apr-2013 1545 by 308		**Units** Batch: W43336	
Calcium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**34** Analyzed: 25-Apr-2013 1825 by 305	0.1	**mg/l** Batch: S34504	
Magnesium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**10** Analyzed: 25-Apr-2013 1825 by 305	0.03	**mg/l** Batch: S34504	
Potassium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**4.9** Analyzed: 25-Apr-2013 1825 by 305	1	**mg/l** Batch: S34504	
Sodium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**42** Analyzed: 25-Apr-2013 1825 by 305	1	**mg/l** Batch: S34504	
Chloride EPA 300.0	Prep: 24-Apr-2013 1550 by 07	**52** Analyzed: 24-Apr-2013 1927 by 07	2	**mg/l** Batch: S34503	D Dil: 10
Sulfate EPA 300.0	Prep: 24-Apr-2013 1550 by 07	**51** Analyzed: 24-Apr-2013 1927 by 07	2	**mg/l** Batch: S34503	D Dil: 10

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3 Innwood Circle, Suite 220
Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 166827-3
Sample Identification: 26% Eff 74% River

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**140** Analyzed: 25-Apr-2013 0919 by 93	1	**mg/l** Batch: W43345	
Total Dissolved Solids SM 2540 C	Prep: 26-Apr-2013 0942 by 302	**570** Analyzed: 29-Apr-2013 1439 by 302	10	**mg/l** Batch: W43366	
pH SM 4500-H+ B	Prep: 24-Apr-2013 1429 by 308	**8.1** Analyzed: 24-Apr-2013 1545 by 308		**Units** Batch: W43336	
Calcium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**47** Analyzed: 25-Apr-2013 1829 by 305	0.1	**mg/l** Batch: S34504	
Magnesium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**7.7** Analyzed: 25-Apr-2013 1829 by 305	0.03	**mg/l** Batch: S34504	
Potassium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**8.1** Analyzed: 25-Apr-2013 1829 by 305	1	**mg/l** Batch: S34504	
Sodium EPA 200.7	Prep: 25-Apr-2013 0848 by 100	**120** Analyzed: 26-Apr-2013 1138 by 305	10	**mg/l** Batch: S34504	D Dil: 10
Chloride EPA 300.0	Prep: 24-Apr-2013 1550 by 07	**78** Analyzed: 24-Apr-2013 2059 by 07	2	**mg/l** Batch: S34503	D Dil: 10
Sulfate EPA 300.0	Prep: 24-Apr-2013 1550 by 07	**130** Analyzed: 24-Apr-2013 2059 by 07	2	**mg/l** Batch: S34503	D Dil: 10

AIC No. 166827-4
Sample Identification: 6.25% Day 1

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**210** Analyzed: 29-Apr-2013 1052 by 93	1	**mg/l** Batch: W43382	
Total Dissolved Solids SM 2540 C	Prep: 26-Apr-2013 0942 by 302	**990** Analyzed: 29-Apr-2013 1439 by 302	10	**mg/l** Batch: W43366	
Chloride EPA 300.0	Prep: 25-Apr-2013 1542 by 07	**140** Analyzed: 26-Apr-2013 0004 by 07	2	**mg/l** Batch: S34507	D Dil: 10
Sulfate EPA 300.0	Prep: 25-Apr-2013 1542 by 07	**310** Analyzed: 26-Apr-2013 0004 by 07	2	**mg/l** Batch: S34507	D Dil: 10
Hardness as CaCO3 SM 2340 B	Prep: 29-Apr-2013 1456 by 100	**150** Analyzed: 30-Apr-2013 1642 by 270	5	**mg/l** Batch: S34526	D Dil: 5

AIC No. 166827-5
Sample Identification: 25% Day 1

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**380** Analyzed: 29-Apr-2013 1052 by 93	1	**mg/l** Batch: W43382	
Total Dissolved Solids SM 2540 C	Prep: 26-Apr-2013 0942 by 302	**2100** Analyzed: 29-Apr-2013 1439 by 302	20	**mg/l** Batch: W43366	

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Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 166827-5 (Continued)
Sample Identification: 25% Day 1

Analyte		Result	RL	Units	Qualifier
Chloride		**290**	2	**mg/l**	D
EPA 300.0	Prep: 25-Apr-2013 1542 by 07	Analyzed: 26-Apr-2013 0027 by 07		Batch: S34507	Dil: 10
Sulfate		**680**	20	**mg/l**	D
EPA 300.0	Prep: 25-Apr-2013 1542 by 07	Analyzed: 26-Apr-2013 1244 by 07		Batch: S34507	Dil: 100
Hardness as CaCO3		**150**	5	**mg/l**	D
SM 2340 B	Prep: 29-Apr-2013 1456 by 100	Analyzed: 30-Apr-2013 1646 by 270		Batch: S34526	Dil: 5

AIC No. 166827-6
Sample Identification: 100% Day 1

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**1700**	1	**mg/l**	
SM 2320 B		Analyzed: 29-Apr-2013 1052 by 93		Batch: W43382	
Total Dissolved Solids		**6000**	40	**mg/l**	
SM 2540 C	Prep: 26-Apr-2013 0942 by 302	Analyzed: 29-Apr-2013 1439 by 302		Batch: W43366	
Chloride		**810**	20	**mg/l**	D
EPA 300.0	Prep: 25-Apr-2013 1542 by 07	Analyzed: 26-Apr-2013 1309 by 07		Batch: S34507	Dil: 100
Sulfate		**2500**	20	**mg/l**	D
EPA 300.0	Prep: 25-Apr-2013 1542 by 07	Analyzed: 26-Apr-2013 1309 by 07		Batch: S34507	Dil: 100
Hardness as CaCO3		**610**	5	**mg/l**	D
SM 2340 B	Prep: 29-Apr-2013 1456 by 100	Analyzed: 30-Apr-2013 1650 by 270		Batch: S34526	Dil: 5

AIC No. 166827-7
Sample Identification: 6.25% Day 3

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**210**	1	**mg/l**	
SM 2320 B		Analyzed: 29-Apr-2013 1052 by 93		Batch: W43382	
Total Dissolved Solids		**1200**	10	**mg/l**	
SM 2540 C	Prep: 29-Apr-2013 1623 by 285	Analyzed: 30-Apr-2013 1349 by 285		Batch: W43385	
Chloride		**150**	2	**mg/l**	D
EPA 300.0	Prep: 29-Apr-2013 1033 by 07	Analyzed: 29-Apr-2013 1041 by 07		Batch: S34522	Dil: 10
Sulfate		**330**	2	**mg/l**	D
EPA 300.0	Prep: 29-Apr-2013 1033 by 07	Analyzed: 29-Apr-2013 1041 by 07		Batch: S34522	Dil: 10
Hardness as CaCO3		**150**	5	**mg/l**	D
SM 2340 B	Prep: 29-Apr-2013 1456 by 100	Analyzed: 30-Apr-2013 1655 by 270		Batch: S34526	Dil: 5

AIC No. 166827-8
Sample Identification: 25% Day 3

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**400**	1	**mg/l**	
SM 2320 B		Analyzed: 29-Apr-2013 1052 by 93		Batch: W43382	

AMERICAN INTERPLEX CORPORATION
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3 Innwood Circle, Suite 220
Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 166827-8 (Continued)
Sample Identification: 25% Day 3

Analyte		Result	RL	Units	Qualifier
Total Dissolved Solids		**2400**	20	mg/l	
SM 2540 C	Prep: 29-Apr-2013 1623 by 285	Analyzed: 30-Apr-2013 1349 by 285		Batch: W43385	
Chloride		**310**	2	mg/l	D
EPA 300.0	Prep: 29-Apr-2013 1033 by 07	Analyzed: 29-Apr-2013 1104 by 07		Batch: S34522	Dil: 10
Sulfate		**690**	20	mg/l	D
EPA 300.0	Prep: 29-Apr-2013 1033 by 07	Analyzed: 29-Apr-2013 1258 by 07		Batch: S34522	Dil: 100
Hardness as CaCO3		**150**	5	mg/l	D
SM 2340 B	Prep: 29-Apr-2013 1456 by 100	Analyzed: 30-Apr-2013 1659 by 270		Batch: S34526	Dil: 5

AIC No. 166827-9
Sample Identification: 26% Eff 74% River Day 3

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**150**	1	mg/l	
SM 2320 B		Analyzed: 29-Apr-2013 1052 by 93		Batch: W43382	
Total Dissolved Solids		**630**	10	mg/l	
SM 2540 C	Prep: 29-Apr-2013 1623 by 285	Analyzed: 30-Apr-2013 1349 by 285		Batch: W43385	
Chloride		**83**	2	mg/l	D
EPA 300.0	Prep: 29-Apr-2013 1033 by 07	Analyzed: 29-Apr-2013 1127 by 07		Batch: S34522	Dil: 10
Sulfate		**140**	2	mg/l	D
EPA 300.0	Prep: 29-Apr-2013 1033 by 07	Analyzed: 29-Apr-2013 1127 by 07		Batch: S34522	Dil: 10
Hardness as CaCO3		**160**	5	mg/l	D
SM 2340 B	Prep: 29-Apr-2013 1456 by 100	Analyzed: 30-Apr-2013 1704 by 270		Batch: S34526	Dil: 5

AIC No. 166827-10
Sample Identification: 6.25% Last Renewal Day

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3		**210**	1	mg/l	
SM 2320 B		Analyzed: 06-May-2013 0941 by 93		Batch: W43460	
Total Dissolved Solids		**960**	20	mg/l	
SM 2540 C	Prep: 03-May-2013 1346 by 302	Analyzed: 06-May-2013 1341 by 302		Batch: W43441	
Chloride		**140**	2	mg/l	D
EPA 300.0	Prep: 03-May-2013 1423 by 07	Analyzed: 03-May-2013 1517 by 07		Batch: S34556	Dil: 10
Sulfate		**310**	2	mg/l	D
EPA 300.0	Prep: 03-May-2013 1423 by 07	Analyzed: 03-May-2013 1517 by 07		Batch: S34556	Dil: 10
Hardness as CaCO3		**150**	1	mg/l	
SM 2340 B	Prep: 06-May-2013 1018 by 100	Analyzed: 06-May-2016 1926 by 270		Batch: S34564	

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ANALYTICAL RESULTS

AIC No. 166827-11
Sample Identification: 25% Last Renewal Day

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**400** Analyzed: 06-May-2013 0941 by 93	1	**mg/l** Batch: W43460	
Total Dissolved Solids SM 2540 C	Prep: 03-May-2013 1346 by 302	**2100** Analyzed: 06-May-2013 1341 by 302	20	**mg/l** Batch: W43441	
Chloride EPA 300.0	Prep: 03-May-2013 1423 by 07	**270** Analyzed: 03-May-2013 1543 by 07	2	**mg/l** Batch: S34556	D Dil: 10
Sulfate EPA 300.0	Prep: 03-May-2013 1423 by 07	**910** Analyzed: 03-May-2013 1752 by 07	20	**mg/l** Batch: S34556	D Dil: 100
Hardness as CaCO3 SM 2340 B	Prep: 06-May-2013 1018 by 100	**150** Analyzed: 06-May-2016 1947 by 270	1	**mg/l** Batch: S34564	

AIC No. 166827-12
Sample Identification: 26% Eff 74% River Last Day

Analyte		Result	RL	Units	Qualifier
Alkalinity as CaCO3 SM 2320 B		**140** Analyzed: 06-May-2013 0941 by 93	1	**mg/l** Batch: W43460	
Total Dissolved Solids SM 2540 C	Prep: 03-May-2013 1346 by 302	**570** Analyzed: 06-May-2013 1341 by 302	20	**mg/l** Batch: W43441	
Chloride EPA 300.0	Prep: 03-May-2013 1423 by 07	**78** Analyzed: 03-May-2013 1726 by 07	2	**mg/l** Batch: S34556	D Dil: 10
Sulfate EPA 300.0	Prep: 03-May-2013 1423 by 07	**140** Analyzed: 03-May-2013 1726 by 07	2	**mg/l** Batch: S34556	D Dil: 10
Hardness as CaCO3 SM 2340 B	Prep: 06-May-2013 1018 by 100	**160** Analyzed: 06-May-2016 1952 by 270	1	**mg/l** Batch: S34564	

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DUPLICATE RESULTS

Analyte		AIC No.	Result	RPD	RPD Limit	Preparation Date	Analysis Date	Dil	Qual
pH		166827-1	7.9 Units			24Apr13 1429 by 308	24Apr13 1545 by 308		
	Batch: W43336	Duplicate	7.9 Units	0.126	5.00	24Apr13 1429 by 308	24Apr13 1545 by 308		
Alkalinity as CaCO3		166827-1	350 mg/l				25Apr13 0919 by 93		
	Batch: W43345	Duplicate	350 mg/l	0.287	20.0		25Apr13 1006 by 93		
Total Dissolved Solids		166871-1	51 mg/l			26Apr13 0942 by 302	29Apr13 1439 by 302		
	Batch: W43366	Duplicate	54 mg/l	5.71	10.0	26Apr13 0943 by 302	29Apr13 1439 by 302		
Total Dissolved Solids		166876-1	600 mg/l			26Apr13 0942 by 302	29Apr13 1439 by 302		
	Batch: W43366	Duplicate	620 mg/l	3.28	10.0	26Apr13 0943 by 302	29Apr13 1439 by 302		
Alkalinity as CaCO3		166921-1	1600 mg/l				29Apr13 1052 by 93		
	Batch: W43382	Duplicate	1600 mg/l	0.00	20.0		29Apr13 1823 by 93		
Total Dissolved Solids		166939-1	190 mg/l			29Apr13 1623 by 285	30Apr13 1349 by 285		
	Batch: W43385	Duplicate	180 mg/l	4.75	10.0	29Apr13 1623 by 285	30Apr13 1349 by 285		
Total Dissolved Solids		167062-1	77 mg/l			03May13 1022 by 302	06May13 1341 by 302		
	Batch: W43441	Duplicate	70 mg/l	9.52	10.0	03May13 1022 by 302	06May13 1341 by 302		
Total Dissolved Solids		167069-1	250 mg/l			03May13 1346 by 302	06May13 1341 by 302		
	Batch: W43441	Duplicate	270 mg/l	6.92	10.0	03May13 1347 by 302	06May13 1341 by 302		
Alkalinity as CaCO3		167055-4	1700 mg/l				06May13 0941 by 93		
	Batch: W43460	Duplicate	1700 mg/l	1.18	20.0		06May13 0941 by 93		

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	%	Limits	RPD	Limit	Batch	Preparation Date	Analysis Date	Dil	Qual
pH	-	101	98.0-102			W43336	24Apr13 1429 by 308	24Apr13 1545 by 308		
Calcium	10 mg/l	99.8	85.0-115			S34504	25Apr13 0849 by 100	25Apr13 1759 by 305		
Magnesium	10 mg/l	99.1	85.0-115			S34504	25Apr13 0849 by 100	25Apr13 1759 by 305		
Potassium	10 mg/l	101	85.0-115			S34504	25Apr13 0849 by 100	25Apr13 1759 by 305		
Sodium	10 mg/l	101	85.0-115			S34504	25Apr13 0849 by 100	25Apr13 1759 by 305		
Chloride	20 mg/l	95.1	90.0-110			S34503	24Apr13 1551 by 07	24Apr13 1710 by 07		
Chloride	20 mg/l	94.7	90.0-110			S34507	25Apr13 1543 by 07	25Apr13 1904 by 07		
Chloride	20 mg/l	96.0	90.0-110			S34522	29Apr13 1004 by 07	29Apr13 1053 by 07		
Chloride	20 mg/l	108	90.0-110			S34556	03May13 1000 by 07	03May13 1139 by 07		
Sulfate	20 mg/l	93.8	90.0-110			S34503	24Apr13 1551 by 07	24Apr13 1710 by 07		
Sulfate	20 mg/l	93.8	90.0-110			S34507	25Apr13 1543 by 07	25Apr13 1904 by 07		
Sulfate	20 mg/l	96.2	90.0-110			S34522	29Apr13 1004 by 07	29Apr13 1053 by 07		
Sulfate	20 mg/l	109	90.0-110			S34556	03May13 1000 by 07	03May13 1139 by 07		

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MATRIX SPIKE SAMPLE RESULTS

Analyte	Sample	Spike Amount	%	Limits	Batch	Preparation Date	Analysis Date	Dil	Qual
Calcium	166857-1	10 mg/l	-	75.0-125	S34504	25Apr13 0849 by 100	26Apr13 1121 by 305	50	X
	166857-1	10 mg/l	-	75.0-125	S34504	25Apr13 0849 by 100	26Apr13 1125 by 305	50	X D
	Relative Percent Difference:		10.2	20.0	S34504				
Magnesium	166857-1	10 mg/l	89.5	75.0-125	S34504	25Apr13 0849 by 100	25Apr13 1804 by 305		
	166857-1	10 mg/l	90.4	75.0-125	S34504	25Apr13 0849 by 100	25Apr13 1810 by 305		
	Relative Percent Difference:		0.777	20.0	S34504				
Potassium	166857-1	10 mg/l	101	75.0-125	S34504	25Apr13 0849 by 100	25Apr13 1804 by 305		
	166857-1	10 mg/l	104	75.0-125	S34504	25Apr13 0849 by 100	25Apr13 1810 by 305		
	Relative Percent Difference:		0.923	20.0	S34504				
Sodium	166857-1	10 mg/l	-	75.0-125	S34504	25Apr13 0849 by 100	26Apr13 1121 by 305	50	X
	166857-1	10 mg/l	-	75.0-125	S34504	25Apr13 0849 by 100	26Apr13 1125 by 305	50	X D
	Relative Percent Difference:		1.10	20.0	S34504				
Chloride	166853-2	20 mg/l	99.7	80.0-120	S34503	24Apr13 1551 by 07	24Apr13 1733 by 07		
	166853-2	20 mg/l	99.2	80.0-120	S34503	24Apr13 1551 by 07	24Apr13 1756 by 07		
	Relative Percent Difference:		0.446	10.0	S34503				
Chloride	166888-1	20 mg/l	95.9	80.0-120	S34507	25Apr13 1543 by 07	25Apr13 1930 by 07		
	166888-1	20 mg/l	96.5	80.0-120	S34507	25Apr13 1543 by 07	25Apr13 1953 by 07		
	Relative Percent Difference:		0.630	10.0	S34507				
Chloride	166939-1	20 mg/l	103	80.0-120	S34522	29Apr13 1004 by 07	29Apr13 1118 by 07		
	166939-1	20 mg/l	109	80.0-120	S34522	29Apr13 1004 by 07	29Apr13 1144 by 07		
	Relative Percent Difference:		5.95	10.0	S34522				
Chloride	167062-1	20 mg/l	106	80.0-120	S34556	03May13 1000 by 07	03May13 1204 by 07		
	167062-1	20 mg/l	104	80.0-120	S34556	03May13 1000 by 07	03May13 1230 by 07		
	Relative Percent Difference:		0.902	10.0	S34556				
Sulfate	166853-2	20 mg/l	97.5	80.0-120	S34503	24Apr13 1551 by 07	24Apr13 1733 by 07		
	166853-2	20 mg/l	96.9	80.0-120	S34503	24Apr13 1551 by 07	24Apr13 1756 by 07		
	Relative Percent Difference:		0.662	10.0	S34503				
Sulfate	166888-1	20 mg/l	98.0	80.0-120	S34507	25Apr13 1543 by 07	25Apr13 1930 by 07		
	166888-1	20 mg/l	98.4	80.0-120	S34507	25Apr13 1543 by 07	25Apr13 1953 by 07		
	Relative Percent Difference:		0.406	10.0	S34507				
Sulfate	166939-1	20 mg/l	101	80.0-120	S34522	29Apr13 1004 by 07	29Apr13 1118 by 07		
	166939-1	20 mg/l	106	80.0-120	S34522	29Apr13 1004 by 07	29Apr13 1144 by 07		
	Relative Percent Difference:		4.53	10.0	S34522				
Sulfate	167062-1	20 mg/l	108	80.0-120	S34556	03May13 1000 by 07	03May13 1204 by 07		
	167062-1	20 mg/l	107	80.0-120	S34556	03May13 1000 by 07	03May13 1230 by 07		
	Relative Percent Difference:		1.46	10.0	S34556				

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LABORATORY BLANK RESULTS

Analyte	Result	RL	PQL	QC Sample	Preparation Date	Analysis Date	Qual
Alkalinity as CaCO3	< 1 mg/l	1	1	W43345-1		25Apr13 0919 by 93	
Alkalinity as CaCO3	< 1 mg/l	1	1	W43382-1		29Apr13 1052 by 93	
Alkalinity as CaCO3	< 1 mg/l	1	1	W43460-1		06May13 0941 by 93	
Total Dissolved Solids	< 10 mg/l	10	10	W43366-1	26Apr13 0943 by 302	29Apr13 1439 by 302	
Total Dissolved Solids	< 10 mg/l	10	10	W43385-1	29Apr13 1623 by 285	30Apr13 1349 by 285	
Total Dissolved Solids	< 10 mg/l	10	10	W43441-1	03May13 1022 by 302	06May13 1341 by 302	
Calcium	< 0.1 mg/l	0.1	0.1	S34504-1	25Apr13 0849 by 100	25Apr13 1755 by 305	
Magnesium	< 0.03 mg/l	0.03	0.03	S34504-1	25Apr13 0849 by 100	25Apr13 1755 by 305	
Potassium	< 1 mg/l	1	1	S34504-1	25Apr13 0849 by 100	25Apr13 1755 by 305	
Sodium	< 1 mg/l	1	1	S34504-1	25Apr13 0849 by 100	25Apr13 1755 by 305	
Chloride	< 0.2 mg/l	0.2	0.2	S34503-1	24Apr13 1551 by 07	24Apr13 1648 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S34503-1	24Apr13 1551 by 07	24Apr13 1648 by 07	
Chloride	< 0.2 mg/l	0.2	0.2	S34507-1	25Apr13 1543 by 07	25Apr13 1838 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S34507-1	25Apr13 1543 by 07	25Apr13 1838 by 07	
Chloride	< 0.2 mg/l	0.2	0.2	S34522-1	29Apr13 1004 by 07	29Apr13 1027 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S34522-1	29Apr13 1004 by 07	29Apr13 1027 by 07	
Chloride	< 0.2 mg/l	0.2	0.2	S34556-1	03May13 1000 by 07	03May13 1113 by 07	
Sulfate	< 0.2 mg/l	0.2	0.2	S34556-1	03May13 1000 by 07	03May13 1113 by 07	

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0610-0010-002

166827
166826

Date	Project Name	Project No.	Project Manager (Print)	Page 1 of 1
04/22/13	~~DOMTAR~~ Turk	~~06395-0101-001~~	Jim Malcolm/Pat Downey	

Report / Bill to:	Submitted by:
FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738	FTN Associates, Ltd. 3 Innwood Circle, Suite 220 Little Rock, AR 72211 (501) 225-7779 • Fax (501) 225-6738
Sampler Signature(s)	Recorded By (Print) Jeff Ward

SAMPLE DESCRIPTION

Sample Identification	Date	Time	Matrix* W	Matrix* S	Matrix* O	No. of Containers	Comp	Grab	Spiked Sample Testing per protocol provided by Pat Downey
Turk ~~Domtar Effluent~~ S	4/22/13	1125	X			2		X	X
U/S ~~Red~~ Little River	4/22/13	1230	X			4		X	X
TSD 11/11/13									
Incorrect entry									
						Container Type			P
						Preservative			NO

Parameters (Method Number)

Lab Turn-Around-Time

- ☐ 24 Hours
- ☐ 48 Hours
- ☒ Normal
- ☐ Other: Due: __/__/__

Detection Limits

Parameter	Detection Limit

* Matrix: W = Water S = Soil O = Other

G = Glass P = Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate

NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
	Jeff Ward	4/22/13	1745		Blake G.	4/23/13	08:00
Relinquished By (Signature)	Print Name	Date	Time	Received By Laboratory (Signature)	Print Name	Date	Time
	Blake J G.	23 Apr 13	09:40		Shana Williams	4-23-13	9:40

Sampler Remarks: please e-mail results as well as the .csv file to pjd@ftn-assoc.com , jtm@ftn-assoc.com & jlw@ftn-assoc.com

Laboratory Remarks:

2c

Revision Date 11/22/02

Title: SWEPCO spiked effluent TDS IC25
File: TURKIC25.IN Transform: NO TRANSFORMATION

GRP	IDENTIFICATION	MEAN	SMOOTHED MEAN	CONCENTRATION
1	Control	17.3000	17.3000	0.0000
2	1050	15.9000	15.9000	1050.0000
3	1266	14.1000	14.1000	1266.0000
4	2200	11.9000	11.9000	2200.0000
5	3285	0.0000	0.0000	3285.0000

ICp estimate with p = 25 is 1743.6136

Bootstrap results using 480 iterations:

Mean = 1701.9552 Standard Deviation = 387.6677
95% Confidence Interval: (1165.3220 , 2303.8830)

Title: SWEPCO spiked effluent chloride IC25
File: CLIC25 .IN Transform: NO TRANSFORMATION

GRP	IDENTIFICATION	MEAN	SMOOTHED MEAN	CONCENTRATION
1	Control	17.3000	17.3000	0.0000
2	143	15.9000	15.9000	143.0000
3	171	14.1000	14.1000	171.0000
4	290	11.9000	11.9000	290.0000
5	690	0.0000	0.0000	690.0000

ICp estimate with p = 25 is 231.8523

Bootstrap results using 480 iterations:

Mean = 228.3825 Standard Deviation = 54.2155
95% Confidence Interval: (156.7813 , 328.7324)

Title: SWEPCO spiked effluent sulfate IC25
File: SO4IC25 .IN Transform: NO TRANSFORMATION

GRP	IDENTIFICATION	MEAN	SMOOTHED MEAN	CONCENTRATION
1	Control	17.3000	17.3000	0.0000
2	317	15.9000	15.9000	317.0000
3	432	14.1000	14.1000	432.0000
4	760	11.9000	11.9000	760.0000
5	1289	0.0000	0.0000	1289.0000

ICp estimate with p = 25 is 599.7273

Bootstrap results using 480 iterations:

Mean = 589.4611 Standard Deviation = 144.0931
95% Confidence Interval: (374.5000 , 809.3470)

APPENDIX J

Schematic Diagram of LA-QUAL Model

FIGURE J.1 LA-QUAL SCHEMATIC DIAGRAM

For simulation of TDS in the Red River, McKinney Bayou, and Sulphur River

LA-QUAL reach numbers are shown in boxes. LA-QUAL reaches correspond to assessment reaches.

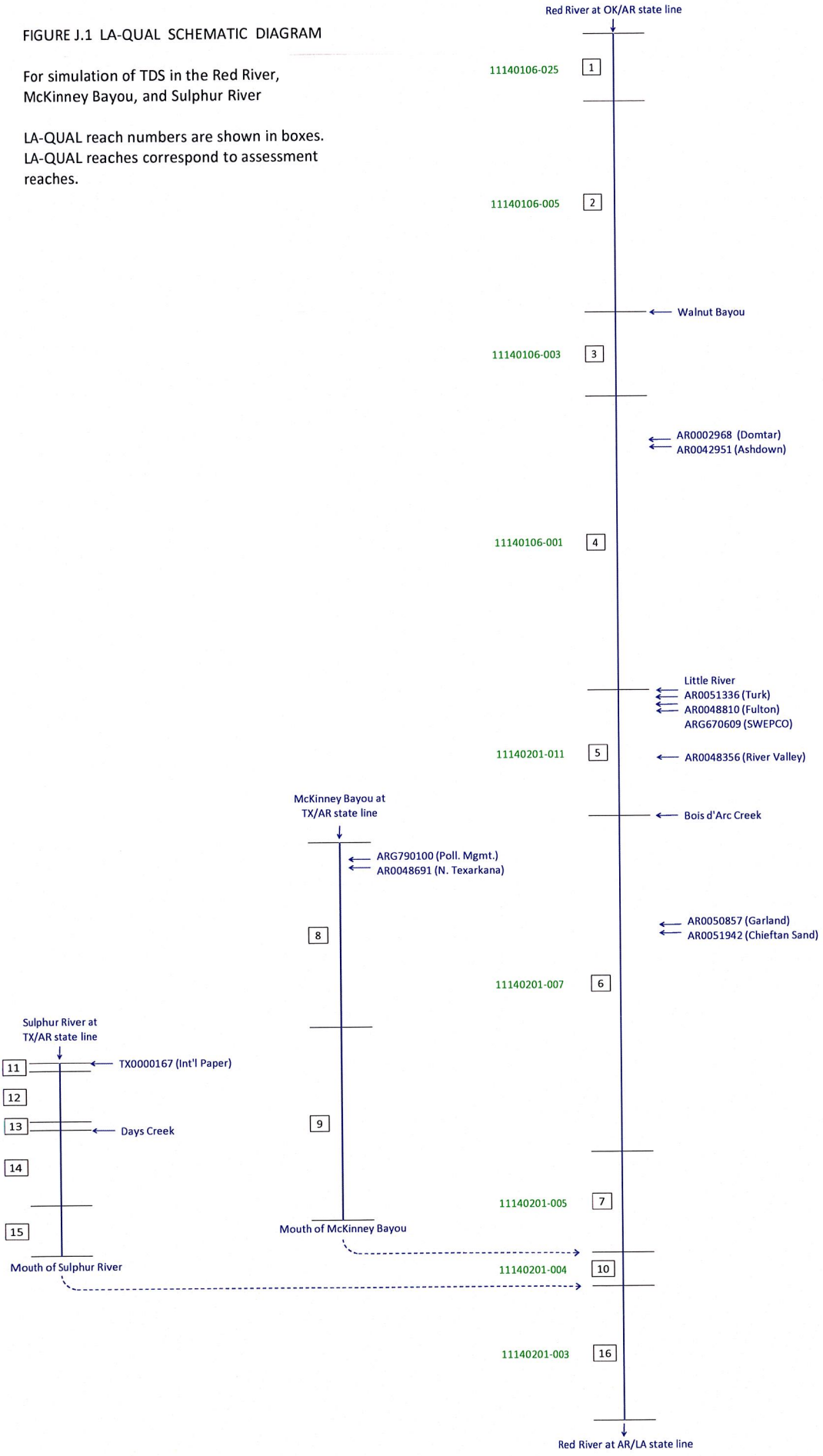


TABLE J.1 7Q10 TDS MASS BUDGET CALCULATIONS FOR TURK DISCHARGE TO LITTLE RIVER

See schematic diagram regarding relative location of withdrawals, discharge, etc.

CALCULATIONS FOR LITTLE RIVER DOWNSTREAM OF TURK

Flow in Little River upstream of withdrawals & discharge:	Q1 =	154	cfs	from Turk permit (p. 31 of Fact Sheet)
Conc. in Little River upstream of withdrawals & discharge:	C1 =	98	mg/L	90th percentile of AEP & FTN data 2010 - 2013
Flow for withdrawals by Turk and City of Hope combined:	Q2 =	23.85	cfs	ADEQ comments on draft UAA (14.5 cfs + 9.35 cfs)
Conc. for withdrawals by Turk and City of Hope combined:	C2 =	98	mg/L	same as C1
Flow for Turk discharge:	Q3 =	3.34	cfs	design flow (2.16 MGD)
Conc. for Turk discharge:	C3 =	1620	mg/L	est. effluent conc. with add'l water cycling

Flow in Little River downstream of Turk: $Q4 = Q1 - Q2 + Q3 =$ 133.49 cfs — 154 cfs − 23.85 cfs + 3.34 cfs

Conc. in Little River downstream of Turk:

$$C4 = (Q1 \times C1 - Q2 \times C2 + Q3 \times C3) / Q4$$
$$= (154 \text{ cfs} \times 98 \text{ mg/L} - 23.85 \text{ cfs} \times 98 \text{ mg/L} + 3.34 \text{ cfs} \times 1620 \text{ mg/L}) / 133.49 \text{ cfs}$$
$$= 136.1 \text{ mg/L}$$

PERCENT OF LOAD IN RED RIVER FROM TURK DISCHARGE:

Load discharged by Turk =	Q3 × C3 × conv. factors =	(3.34 cfs × 0.6463 MGD/cfs) × 1620 mg/L × 8.345 =	2.918E+4 lbs/day
Total load in Red River =	Q6 × C6 × conv. factors =	(1373.49 cfs × 0.6463 MGD/cfs) × 781 mg/L × 8.345 =	5.785E+6 lbs/day

Percent of total Red River load coming from Turk = 100% × (2.918E+4 / 5.785E+6) = 0.50%

FILE: R:\PROJECTS\06510-0010-002\TECH\MINERAL UAA\MASS BUDGET\CALCULATED CONCS DOWNSTREAM OF TURK DISCHARGE.XLSX

TABLE J.2 FLOW BALANCE FOR RED RIVER IN ARKANSAS -- 7Q10 CONDITIONS

General approach: Use historical conditions to estimate tributary flows and diffuse inflows so that total flows will match 7Q10 flows at USGS flow gages. Then use those ambient inflows with design flows for point sources to get critical conditions for the LA-QUAL model.

Ambient flow per unit area based on USGS flow gage for Red River at Index, AR (calculations in 2012 TMDL have been corrected here):

Published 7Q10 flow for Red River at Index =	1240 cfs	USGS 2008 low flow report
Avg. effl. flow from City of Ashdown = 0.77 MGD =	1.2 cfs	Apr 2008 - Mar 2013 avg from ECHO web site
Avg. effl. flow from Domtar Ashdown = 50.8 MGD =	78.6 cfs	Apr 2008 - Mar 2013 avg from ECHO web site
Ambient portion of 7Q10 flow at Index =	1160.2 cfs	7Q10 minus historical point source flows
Contributing drainage area at Index =	42,094 mi2	USGS drainage area book for Red River basin
Ambient 7Q10 flow per mi2 at Index =	0.02756 cfs/mi2	Ambient flow divided by drainage area

Ambient flow per unit area based on USGS flow gage for Red River at Spring Bank, AR (no change from 2012 TMDL):

Ambient 7Q10 flow per mi2 at Spring Bank =	0.02752 cfs/mi2	7Q10 flow calculated by FTN (1403 cfs) divided by contributing drainage area (50,973 mi2)

Flows from different sources for each reach of the Red River reach:

Equations for columns E, I, K, & N: E = D – C; I = (E – G) * Flow per mi2 at Index or Spring Bank; K = B + H + I + J; N = (Flow at downstream end of prev. reach) + H + I + M

	--- Historical conditions ---										--- "Design" conditions ---	
A Stream name and reach number	B Flow at upstream end of this reach of Red River (cfs)	C Contrib. drainage area at u/s end of reach (mi2)	D Contrib. drainage area at d/s end of reach (mi2)	E Drainage area entering this reach (mi2)	F Major trib entering this reach of Red R.?	G Drainage area of major trib (mi2)	H Ambient flow from major trib (cfs)	I Diffuse flow directly entering this reach of Red R. (cfs)	J Historical flow for point sources entering this reach or trib. (cfs)	K Flow at downstream end of this reach of Red River (cfs)	M Design flow for point sources entering this reach or trib. (cfs)	N Flow at downstream end of this reach of Red River (cfs)
Red River 11140106-025	1146 41582 mi2 × flow per mi2 at Index gage	41,582	41,700	118	no	0	0	3.25	0	1149.25	0	1149.25
Red River 11140106-005	1149.25	41,700	41,784	84	no	0	0	2.32	0	1151.57	0	1151.57
Red River 11140106-003	1151.57	41,784	41,939	155	Walnut Bayou	134	3.69 134 mi2 × flow per mi2 at Index gage	0.58	0	1155.84	0	1155.84
Red River 11140106-001	1155.84	41,939	42,131	192	no	0	0	5.29	79.8 78.6 (Domtar) + 1.2 (City of Ashdown)	1240.93	88.97 87.264 (Domtar) + 1.702 (City of Ashdown)	1250.1
Red River 11140201-011	1240.93	42,131	46,421	4,290	Little River	4,239	130.15 Flow just upstream of Turk (value specified by ADEQ in comments on draft report)	1.40	0.39 0 (Turk started in 2012) + 0 (SWEPCO started in 2010) + 0.031 (City of Fulton) + 0.356 (River Valley Animal Foods)	1372.87	4.07 3.342 (Turk) + 0 (SWEPCO is void) + 0.077 (City of Fulton) + 0.650 (River Valley Animal Foods)	1385.72
Red River 11140201-007	1372.87	46,421	46,761	340	Bois D'Arc Creek	293	1.24 Bois D'Arc Creek flow at mouth in 2012 TMDL	1.29	0.002 0.002 (City of Garland) + 0 (Chieftain Sand didn't discharge)	1375.4	0.27 0.116 (City of Garland) + 0.155 (Chieftain Sand)	1388.52
Red River 11140201-005	1375.4	46,761	46,869	108	no	0	0	2.97	0	1378.37	0	1391.49
Red River 11140201-004	1378.37	46,869	47,224	355	McKinney Bayou	340	1.372 McKinney B. headwater + diffuse inflow in 2012 TMDL	0.41	1.474 0.004 (Pollution Mgmt.) + 1.47 (N. Texarkana)	1381.63	1.474 0.004 (Pollution Mgmt.) + 1.47 (N. Texarkana)	1394.75
Red River 11140201-003	1381.63	47,224	50,984	3,760	Sulphur River	3,748	23.46 Sulphur R. headwater + diffuse inflow + Days Creek inflow (from 2012 TMDL)	0.33	0 0 (IP does not discharge during 7Q10 conditions)	1405.42	0 0 (IP does not discharge during 7Q10 conditions)	1418.54

Check to make sure calculated flows are close to 7Q10 values at USGS flow gages:

Published 7Q10 flow at Index gage (within reach 11140106-001) =	1240 cfs (USGS 2008 report)
Calculated flow at downstream end of reach 11140106-001 =	1240.93 cfs (includes small diffuse inflow downstream of gage)
7Q10 flow for Spring Bank gage data (in reach 11140201-003) =	1403 cfs (calculated by FTN using 1997 - 2011 daily data)
Calculated flow at downstream end of reach 11140201-003 =	1405.42 cfs (includes small diffuse inflow downstream of gage)

Changes from flows used in 2012 TMDLs for dissolved minerals:

* The headwater flow for the Red River was re-calculated. In the 2012 TMDL, the historical point source flow was inadvertently not subtracted from 7Q10 at the gage.
* The flow per unit area for the Index gage was re-calculated using only the ambient portion of the published 7Q10 (this was related to the error in the previous bullet).
* The Little River flow was corrected to be the value upstream of Turk. The 2012 TMDL used the Little River flow rate immediately downstream of Turk's discharge.
* The design flows for Domtar and for Tyson River Valley Animal Foods were corrected. Both values were too high in the 2012 TMDL.

TABLE J.3 FLOW BALANCE FOR RED RIVER IN ARKANSAS -- HARMONIC MEAN CONDITIONS

Ambient flow per unit area based on USGS flow gage for Red River at Index, AR:

Harmonic mean flow for Red River at Index =	4,341 cfs	Calculated for 40 yrs (Oct 1973 - Sep 2013)
Avg. effl. flow from City of Ashdown = 0.77 MGD =	1.2 cfs	Apr 2008 - Mar 2013 avg from ECHO web site
Avg. effl. flow from Domtar Ashdown = 50.8 MGD =	78.6 cfs	Apr 2008 - Mar 2013 avg from ECHO web site
Ambient portion of harm. mean flow at Index =	4,261.2 cfs	Harmonic mean minus historical point source flows
Contributing drainage area at Index =	42,094 mi2	USGS drainage area book for Red River basin
Ambient harmonic mean flow per mi2 at Index =	0.10123 cfs/mi2	Ambient flow divided by drainage area

Ambient flow per unit area for inflows to Red River between Index gage and Spring Bank gage:

Harmonic mean flow for Red River at Spring Bank =	6,763 cfs	Median of Spring Bank flows when Index is near harmonic mean
Inflow between Index and Spring Bank gages =	2,422 cfs	Harmonic mean flow at Spring Bank minus harmonic mean flow at Index
Contributing drainage area at Spring Bank =	50,973 mi2	USGS drainage area book for Red River basin
Drainage area betw. Index and Spring Bank gages =	8,879 mi2	Drainage area at Spring Bank minus drainage area at Index
Harm. mean flow per mi2 betw. Index & Spring Bank =	0.27278 cfs/mi2	Inflow (2422) divided by drainage area (8879)

Flows from different sources for each reach of the Red River in Arkansas:

Equations for columns E, I, K, & N: E = D – C; I = (E – G) * Flow per mi2 at Index or betw. gages; K = B + H + I + J; N = (Flow at downstream end of prev. reach) + H + I + M

								--- Historical conditions ---			--- "Design" conditions ---	
A	B	C	D	E	F	G	H	I	J	K	M	N
Stream name and reach number	Flow at upstream end of this reach of Red River (cfs)	Contrib. drainage area at u/s end of reach (mi2)	Contrib. drainage area at d/s end of reach (mi2)	Drainage area entering this reach (mi2)	Major trib entering this reach of Red R.?	Drainage area of major trib (mi2)	Ambient flow from major trib (cfs)	Diffuse flow directly entering this reach of Red R. (cfs)	Historical flow for point sources entering this reach or trib. (cfs)	Flow at downstream end of this reach of Red River (cfs)	Design flow for point sources entering this reach or trib. (cfs)	Flow at downstream end of this reach of Red River (cfs)
Red River 11140106-025	4209.35 41582 mi2 × flow per mi2 at Index gage	41,582	41,700	118	no	0	0	11.95	0	4221.3	0	4221.3
Red River 11140106-005	4221.3	41,700	41,784	84	no	0	0	8.5	0	4229.8	0	4229.8
Red River 11140106-003	4229.8	41,784	41,939	155	Walnut Bayou	134	13.56 134 mi2 × flow per mi2 at Index gage	2.13	0	4245.49	0	4245.49
Red River 11140106-001	4245.49	41,939	42,131	192	no	0	0	19.44	79.8 78.6 (Domtar) + 1.2 (City of Ashdown)	4344.73	88.97 87.264 (Domtar) + 1.702 (City of Ashdown)	4353.9
Red River 11140201-011	4344.73	42,131	46,421	4,290	Little River	4,239	1156.31 4239 mi2 × flow per mi2 between Index & Spring Bank	13.91	0.39 0 (Turk started in 2012) + 0 (SWEPCO started in 2010) + 0.031 (City of Fulton) + 0.356 (River Valley Animal Foods)	5515.34	4.07 3.342 (Turk) + 0 (SWEPCO is void) + 0.077 (City of Fulton) + 0.650 (River Valley Animal Foods)	5528.19
Red River 11140201-007	5515.34	46,421	46,761	340	Bois D'Arc Creek	293	79.92 293 mi2 × flow per mi2 between Index & Spring Bank	12.82	0.002 0.002 (City of Garland) + 0 (Chieftain Sand didn't discharge)	5608.08	0.27 0.116 (City of Garland) + 0.155 (Chieftain Sand)	5621.20
Red River 11140201-005	5608.08	46,761	46,869	108	no	0	0	29.46	0	5637.54	0	5650.66
Red River 11140201-004	5637.54	46,869	47,224	355	McKinney Bayou	340	91.276 See footnote #1 below	4.09	1.474 0.004 (Pollution Mgmt.) + 1.47 (N. Texarkana)	5734.38	1.474 0.004 (Pollution Mgmt.) + 1.47 (N. Texarkana)	5747.50
Red River 11140201-003	5734.38	47,224	50,984	3,760	Sulphur River	3,748	728.88 See footnote #2 below	3.27	293.5 293.5 (IP flow is equal to Sulphur River flow above outfall)	6760.03	293.5 293.5 (IP flow is equal to Sulphur River flow above outfall)	6773.15

Notes: 1. Total flow at mouth of McKinney Bayou = 340 mi2 × 0.27278 cfs per mi2 = 92.75 cfs. This consists of 1.474 cfs of effluent and 91.276 cfs of ambient flow. The ambient flow includes 2.685 cfs of headwater inflow and 88.592 cfs of diffuse inflow. See Table J.4 for more details.

2. Total flow at mouth of Sulphur River = 3748 mi2 × 0.27278 cfs per mi2 = 1022.38 cfs. This consists of 293.5 cfs of effluent from IP and 728.88 cfs of ambient flow. The ambient flow includes 293.5 cfs upstream of IP's discharge, 241.87 cfs from Days Creek, and 193.51 cfs of diffuse inflow. See Table J.5 for more details.

Check to make sure calculated flows are close to harmonic mean values at USGS flow gages:

Harmonic mean flow at Index gage (within reach 11140106-001) =	4341 cfs	(calculated using data for Oct 1973 - Sep 2013)
Calculated flow at downstream end of reach 11140106-001 =	4344.73 cfs	(includes some diffuse inflow downstream of gage)
Harmonic mean flow at Spring Bank gage (in reach 11140201-003) =	6763 cfs	(estimated by FTN for Oct 1973 - Sep 2013)
Calculated flow at downstream end of reach 11140201-003 =	6760.03 cfs	

TABLE J.4 CALCULATIONS TO DIVIDE TOTAL FLOW FOR McKINNEY BAYOU AMONG INDIVIDUAL REACHES IN LA-QUAL FOR HARMONIC MEAN FLOW CONDITIONS

Total flow at mouth of McKinney Bayou = 92.75 cfs (from Red River flow balance on previous tab of this spreadsheet)

Effluent flows (OK to use design flows because they are so small):

N. Texarkana WWTP (AR0048691):	0.95 MGD =	1.47 cfs
Pollution Mgmt, Inc. (ARG790100):	0.0024 MGD =	0.004 cfs

Total ambient flow at mouth = 91.276 cfs
Drainage area at d/s end of reach 012 (mouth) = 340 mi2
Ambient flow per unit area = 0.2685 cfs / mi2

Drainage area at headwater = 10 mi2 (assumed -- same as in 2012 TMDL)
Flow at headwater = 2.685 cfs (drainage area × flow per unit area)

Drainage area at d/s end of reach 014 = 175 mi2
Drainage area entering reach 014 = 165 mi2 (D.A. at d/s end minus D.A. at u/s end)
Flow entering reach 014 = 44.296 cfs (drainage area × flow per unit area)

Drainage area at d/s end of reach 012 = 340 mi2
Drainage area entering reach 012 = 165 mi2 (D.A. at d/s end minus D.A. at u/s end)
Flow entering reach 012 = 44.296 cfs (drainage area × flow per unit area)

Compare sum of inflows to the total inflow from Red River flow balance:

1.474	cfs for point sources
2.685	cfs for headwater
44.296	cfs for diffuse inflow to reach 014
44.296	cfs for diffuse inflow to reach 012
92.751	cfs = sum of calculated inflows

--> Acceptable flow balance (within 0.01 cfs)

FILE: R:\PROJECTS\06510-0010-002\TECH\MINERAL UAA\MASS BUDGET\FLOW BALANCE FOR LA-QUAL MODEL.XLSX

TABLE J.5 CALCULATIONS TO DIVIDE TOTAL FLOW FOR SULPHUR RIVER AMONG INDIVIDUAL REACHES IN LA-QUAL FOR HARMONIC MEAN FLOW CONDITIONS

Total flow at mouth of Sulphur River =	1022.38	cfs (from Red River flow balance on previous tab of this spreadsheet)
Release from Wright Patman Dam =	293.5	cfs (7-day avg rel. when Index is at harm. mean)
International Paper Texarkana discharge =	293.5	cfs (effl. flow can be 100% of dam release in Jan.)
Point sources in Days Creek watershed =	18.95	cfs (sum of average flows for 6 discharges)
Ambient inflow to Sulphur River in AR =	416.43	cfs (flow at mouth minus dam release minus Days Crk pt. sources minus IP Tex. flow)
Drainage area of Sulphur River at mouth =	3,748	mi2 (USGS drainage area book)
Drainage area of Sulphur R. at TX/AR state line =	3,479	mi2 (USGS drainage area book)
Drainage area for ambient inflow in AR =	269	mi2 (D.A. at mouth minus D.A. at state line)
Ambient inflow per mi2 for Sulphur River in AR =	1.55	cfs/mi2 (ambient inflow divided by D.A.)
Drainage area at d/s end of reach -008 =	3,480	mi2
Incremental drainage area for reach -008 =	1	mi2
Diffuse inflow along reach -008 =	1.55	cfs (increm. D.A. times inflow per mi2)
Drainage area at d/s end of reach -006 =	3,542	mi2 (USGS drainage area book)
Incremental drainage area for reach -006 =	62	mi2
Diffuse inflow along reach -006 =	95.98	cfs (increm. D.A. times inflow per mi2)
Drainage area at d/s end of reach -004 =	3,563	mi2 (USGS drainage area book)
Incremental drainage area for reach -004 =	21	mi2
Diffuse inflow along reach -004 =	32.51	cfs (increm. D.A. times inflow per mi2)
Days Creek drainage area =	144	mi2 (USGS drainage area book)
Ambient inflow from Days Creek =	222.92	cfs (Days Creek D.A. times inflow per mi2)
Total inflow from Days Creek =	241.87	cfs (ambient inflow + point source flows)
Drainage area at d/s end of reach -002 =	3,742	mi2 (USGS drainage area book)
Incremental drainage area for reach -002 =	35	mi2 (excluding Days Creek drainage area)
Diffuse inflow along reach -002 =	54.18	cfs (increm. D.A. times inflow per mi2)
Drainage area at d/s end of reach -001 (mouth) =	3,748	mi2 (USGS drainage area book)
Incremental drainage area for reach -001 =	6	mi2
Diffuse inflow along reach -001 =	9.29	cfs (increm. D.A. times inflow per mi2)

Compare sum of inflows to the total inflow from Red River flow balance:

293.5	cfs for flow immed. upstream of IP Texarkana
293.5	cfs for IP Texarkana
1.55	cfs for diffuse inflow along reach -008
95.98	cfs for diffuse inflow along reach -006
32.51	cfs for diffuse inflow along reach -004
241.87	cfs for Days Creek
54.18	cfs for diffuse inflow along reach -002
9.29	cfs for diffuse inflow along reach -001
1022.38	cfs = sum of calculated inflows

--> Acceptable flow balance (within 0.01 cfs)

APPENDIX K

Model Output for 7Q10 Conditions

```
LA-QUAL Version 9.08
Louisiana Department of Environmental Quality

Input file is R:\projects\06510-0010-002\tech\Mineral UAA\Mass budget\RedRv_7Q10_proposed_criteria.txt
Running in steady-state mode using LA defaults
Output produced at 14:15 on 07/23/2014

$$$ DATA TYPE 1 (TITLES AND CONTROL CARDS) $$$

CARD TYPE       CONTROL TITLES

TITLE01         LA-QUAL Model for Red River/McKinney/Sulphur
TITLE02         Low Flow (7Q10); corrected flow balance; proposed crite
CNTROL03   NO   METRIC UNITS
ENDATA01

$$$ DATA TYPE 2 (MODEL OPTIONS) $$$

CARD TYPE       MODEL OPTION

MODOPT01   NO   TEMPERATURE
MODOPT02   NO   SALINITY
MODOPT03  YES   CONSERVATIVE              Chloride                    mg/L     Cl
MODOPT04  YES   CONSERVATIVE              Sulfate                     mg/L     SO4
MODOPT05   NO   DISSOLVED OXYGEN
MODOPT06   NO   BOD2 BIOC
MODOPT07   NO   NITROGEN
MODOPT08   NO   PHOSPHORUS
MODOPT09   NO   PHYTOPLANKTON
MODOPT10   NO   PERIPHYTON
MODOPT11   NO   COLIFORM
MODOPT12  YES   NONCONSERVATIVE           Total Dissolved Solids      mg/L     TDS
ENDATA02

$$$ DATA TYPE 3 (PROGRAM CONSTANTS) $$$

CARD TYPE       DESCRIPTION OF CONSTANT                          VALUE

PROGRAM         HYDRAULIC CALCULATION METHOD       =          2.00000 (widths and depths)
PROGRAM         MAXIMUM ITERATION LIMIT            =        999.00000
ENDATA03

$$$ DATA TYPE 4 (TEMPERATURE CORRECTION CONSTANTS FOR RATE COEFFICIENTS) $$$

 CARD TYPE     RATE CODE     THETA VALUE

ENDATA04

$$$ CONSTANTS TYPE 5 (TEMPERATURE DATA) $$$
```

CARD TYPE DESCRIPTION OF CONSTANT VALUE

ENDATA05

$$$ DATA TYPE 6 (PHYTOPLANKTON CONSTANTS) $$$

CARD TYPE DESCRIPTION OF CONSTANT VALUE

ENDATA06

$$$ DATA TYPE 7 (PERIPHYTON CONSTANTS) $$$

CARD TYPE DESCRIPTION OF CONSTANT VALUE

ENDATA07

$$$ DATA TYPE 8 (REACH IDENTIFICATION DATA) $$$

CARD TYPE	REACH	ID	NAME	BEGIN REACH mi		END REACH mi	ELEM LENGTH mi	REACH LENGTH mi	ELEMS PER RCH	BEGIN ELEM NUM	END ELEM NUM
REACH ID	1	RR	Red River 11140106-025	264.70	TO	256.70	0.1000	8.00	80	1	80
REACH ID	2	RR	Red River 11140106-005	256.70	TO	231.40	0.1000	25.30	253	81	333
REACH ID	3	RR	Red River 11140106-003	231.40	TO	221.60	0.1000	9.80	98	334	431
REACH ID	4	RR	Red River 11140106-001	221.60	TO	186.80	0.1000	34.80	348	432	779
REACH ID	5	RR	Red River 11140201-011	186.80	TO	171.60	0.1000	15.20	152	780	931
REACH ID	6	RR	Red River 11140201-007	171.60	TO	131.50	0.1000	40.10	401	932	1332
REACH ID	7	RR	Red River 11140201-005	131.50	TO	119.50	0.1000	12.00	120	1333	1452
REACH ID	8	MK	McKinney Bayou 11140201-014	44.70	TO	23.10	0.1000	21.60	216	1453	1668
REACH ID	9	MK	McKinney Bayou 11140201-012	23.10	TO	0.00	0.1000	23.10	231	1669	1899
REACH ID	10	RR	Red River 11140201-004	119.50	TO	115.50	0.1000	4.00	40	1900	1939
REACH ID	11	SR	Sulphur River 11140302-008	22.80	TO	22.00	0.1000	0.80	8	1940	1947
REACH ID	12	SR	Sulphur River 11140302-006	22.00	TO	15.50	0.1000	6.50	65	1948	2012
REACH ID	13	SR	Sulphur River 11140302-004	15.50	TO	14.80	0.1000	0.70	7	2013	2019
REACH ID	14	SR	Sulphur River 11140302-002	14.80	TO	6.30	0.1000	8.50	85	2020	2104
REACH ID	15	SR	Sulphur River 11140302-001	6.30	TO	0.00	0.1000	6.30	63	2105	2167
REACH ID	16	RR	Red River 11140201-003	115.50	TO	100.00	0.1000	15.50	155	2168	2322

ENDATA08

$$$ DATA TYPE 9 (ADVECTIVE HYDRAULIC COEFFICIENTS) $$$

CARD TYPE	REACH	ID	WIDTH "A"	WIDTH "B"	WIDTH "C"	DEPTH "D"	DEPTH "E"	DEPTH "F"	SLOPE	MANNINGS "N"
HYDR-1	1	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	2	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	3	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	4	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	5	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	6	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000

HYDR-1	7	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	8	MK	0.000	0.000	50.000	0.000	0.000	5.000	0.00000	0.000
HYDR-1	9	MK	0.000	0.000	50.000	0.000	0.000	5.000	0.00000	0.000
HYDR-1	10	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	11	SR	0.000	0.000	200.000	0.000	0.000	8.000	0.00000	0.000
HYDR-1	12	SR	0.000	0.000	200.000	0.000	0.000	8.000	0.00000	0.000
HYDR-1	13	SR	0.000	0.000	200.000	0.000	0.000	8.000	0.00000	0.000
HYDR-1	14	SR	0.000	0.000	200.000	0.000	0.000	8.000	0.00000	0.000
HYDR-1	15	SR	0.000	0.000	200.000	0.000	0.000	8.000	0.00000	0.000
HYDR-1	16	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000

ENDATA09

$$$ DATA TYPE 10 (DISPERSIVE HYDRAULIC COEFFICIENTS) $$$

CARD TYPE	REACH ID	TIDAL RANGE	DISPERSION "A"	DISPERSION "B"	DISPERSION "C"	DISPERSION "D"

ENDATA10

$$$ DATA TYPE 11 (INITIAL CONDITIONS) $$$

CARD TYPE	REACH ID	TEMP	SALIN	DO	NH3-N	NO3-N	PO4-P	CHL A	PERIP	BOD1	BOD2	ORG-N	ORG-P
COLI	TDS	Cl	SO4										
			deg C	ppt	mg/L	mg/L	mg/L	mg/L	µg/L	mg/ft²	mg/L	mg/L	mg/L	mg/L
#/100mL	mg/L	mg/L	mg/L											
INITIAL	1	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	658.10	174.80	145.40											
INITIAL	2	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	658.10	174.80	145.40											
INITIAL	3	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	658.10	174.80	145.40											
INITIAL	4	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	658.10	174.80	145.40											
INITIAL	5	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	571.60	141.70	123.00											
INITIAL	6	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	592.20	167.10	134.10											
INITIAL	7	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	592.20	167.10	134.10											
INITIAL	8	MK	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	441.80	103.60	72.50											
INITIAL	9	MK	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	492.80	114.60	49.60											
INITIAL	10	RR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	592.20	167.10	134.10											
INITIAL	11	SR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	194.80	20.80	33.20											
INITIAL	12	SR	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	194.80	20.80	33.20											

```
INITIAL          13   SR    30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   194.80    20.80    33.20
INITIAL          14   SR    30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   194.80    20.80    33.20
INITIAL          15   SR    30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   194.80    20.80    33.20
INITIAL          16   RR    30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   527.00   125.00   114.00
ENDATA11

$$$ DATA TYPE 12 (REAERATION, SEDIMENT OXYGEN DEMAND, BOD COEFFICIENTS) $$$
                                                                                  AEROB                 SETTLD     ANAER     AEROB
ANAER       BOD2
CARD      RCH  RCH  K2                        K2        K2        K2    BKGRND      BOD       BOD       SOD       BOD       BOD2      BOD2
BOD2    HYDR TO
TYPE      NUM    ID  OPT                     "A"       "B"       "C"       SOD     DECAY      SETT     AVAIL     DECAY     DECAY      SETT
DECAY       BOD1
                                                                          mg/ft²/d  per day      ft/d      frac  per day   per day      ft/d
per day   per day

ENDATA12

$$$ DATA TYPE 13 (NITROGEN AND PHOSPHORUS COEFFICIENTS) $$$
                                          SETTLD                BKGRND    BKGRND                                          SETTLD
CARD TYPE       REACH  ID       ORG-N     ORG-N      ORGN       NH3       NH3       PO4     DENIT      ORGP      ORGP      ORGP
                             DECA      SETT      AVAIL      DECA      SRCE      SRCE      RATE      DECA      SETT      AVAIL
                           per day      ft/d       frac  per day  mg/ft²/d  mg/ft²/d  per day  per day      ft/d       frac

ENDATA13

$$$ DATA TYPE 14 (ALGAE PHYTOPLANKTON AND PERIPHYTON COEFFICIENTS) $$$
                                                                  MAX                           MAX
CARD TYPE       REACH  ID     SECCHI    CHL A:     PHYTO     PHYTO     PHYTO     PHYTO     PERIP     PERIP     PERIP      BANK
                             DEPTH     ALGAE      SETT      DEATH      GROW      RESP     DEATH      GROW      RESP   SHADING
                                ft      frac      ft/d  per day  per day  per day  per day  per day  per day  per day      frac

ENDATA14

$$$ DATA TYPE 15 (COLIFORM AND NONCONSERVATIVE COEFFICIENTS) $$$

CARD TYPE       REACH  ID    COLIFORM       NCM       NCM
                             DIE-OFF     DECAY      SETT
                             per day   per day      ft/d

COEF-4            1    RR      0.000     0.000     0.000
COEF-4            2    RR      0.000     0.000     0.000
COEF-4            3    RR      0.000     0.000     0.000
COEF-4            4    RR      0.000     0.000     0.000
COEF-4            5    RR      0.000     0.000     0.000
COEF-4            6    RR      0.000     0.000     0.000
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COEF-4	7	RR	0.000	0.000	0.000
COEF-4	8	MK	0.000	0.000	0.000
COEF-4	9	MK	0.000	0.000	0.000
COEF-4	10	RR	0.000	0.000	0.000
COEF-4	11	SR	0.000	0.000	0.000
COEF-4	12	SR	0.000	0.000	0.000
COEF-4	13	SR	0.000	0.000	0.000
COEF-4	14	SR	0.000	0.000	0.000
COEF-4	15	SR	0.000	0.000	0.000
COEF-4	16	RR	0.000	0.000	0.000

ENDATA15

$$$ DATA TYPE 16 (INCREMENTAL DATA FOR FLOW, TEMPERATURE, SALINITY, AND CONSERVATIVES) $$$

CARD TYPE	REACH	ID	OUTFLOW cfs	INFLOW cfs	TEMP deg C	SALIN ppt	Cl mg/L	SO4 mg/L	IN/DIST	OUT/DIST
INCR-1	1	RR	0.00000	3.25000	30.00	0.00	44.40	34.90	0.40625	0.00000
INCR-1	2	RR	0.00000	2.32000	30.00	0.00	44.40	34.90	0.09170	0.00000
INCR-1	3	RR	0.00000	0.58000	30.00	0.00	44.40	34.90	0.05918	0.00000
INCR-1	4	RR	0.00000	5.29000	30.00	0.00	44.40	34.90	0.15201	0.00000
INCR-1	5	RR	0.00000	1.40000	30.00	0.00	25.00	17.30	0.09211	0.00000
INCR-1	6	RR	0.00000	1.29000	30.00	0.00	25.00	17.30	0.03217	0.00000
INCR-1	7	RR	0.00000	2.97000	30.00	0.00	25.00	17.30	0.24750	0.00000
INCR-1	8	MK	0.00000	0.66600	30.00	0.00	44.40	34.90	0.03083	0.00000
INCR-1	9	MK	0.00000	0.66600	30.00	0.00	44.40	34.90	0.02883	0.00000
INCR-1	10	RR	0.00000	0.41000	30.00	0.00	25.00	17.30	0.10250	0.00000
INCR-1	11	SR	0.00000	0.00100	30.00	0.00	39.50	33.80	0.00125	0.00000
INCR-1	12	SR	0.00000	0.06100	30.00	0.00	39.50	33.80	0.00938	0.00000
INCR-1	13	SR	0.00000	0.02100	30.00	0.00	39.50	33.80	0.03000	0.00000
INCR-1	14	SR	0.00000	0.03500	30.00	0.00	39.50	33.80	0.00412	0.00000
INCR-1	15	SR	0.00000	0.00600	30.00	0.00	39.50	33.80	0.00095	0.00000
INCR-1	16	RR	0.00000	0.33000	30.00	0.00	25.00	17.30	0.02129	0.00000

ENDATA16

$$$ DATA TYPE 17 (INCREMENTAL DATA FOR DO, BOD, AND NITROGEN) $$$

CARD TYPE	REACH	ID	DO mg/L	BOD1 mg/L	ORG-N mg/L	NH3-N mg/L	NO3-N mg/L	BOD2 mg/L

ENDATA17

$$$ DATA TYPE 18 (INCREMENTAL DATA FOR PHOSPHORUS, PHYTOPLANKTON, COLIFORM, AND NONCONSERVATIVES) $$$

CARD TYPE	REACH	ID	PO4 mg/L	PHYTO CHL A µg/L	COLI #/100mL	TDS mg/L	ORGP mg/L
INCR-3	1	RR	0.00	0.00	0.00	296.60	0.00
INCR-3	2	RR	0.00	0.00	0.00	296.60	0.00
INCR-3	3	RR	0.00	0.00	0.00	296.60	0.00

INCR-3	4	RR	0.00	0.00	0.00	296.60	0.00
INCR-3	5	RR	0.00	0.00	0.00	183.50	0.00
INCR-3	6	RR	0.00	0.00	0.00	183.50	0.00
INCR-3	7	RR	0.00	0.00	0.00	183.50	0.00
INCR-3	8	MK	0.00	0.00	0.00	296.60	0.00
INCR-3	9	MK	0.00	0.00	0.00	296.60	0.00
INCR-3	10	RR	0.00	0.00	0.00	183.50	0.00
INCR-3	11	SR	0.00	0.00	0.00	219.00	0.00
INCR-3	12	SR	0.00	0.00	0.00	219.00	0.00
INCR-3	13	SR	0.00	0.00	0.00	219.00	0.00
INCR-3	14	SR	0.00	0.00	0.00	219.00	0.00
INCR-3	15	SR	0.00	0.00	0.00	219.00	0.00
INCR-3	16	RR	0.00	0.00	0.00	183.50	0.00

ENDATA18

$$$ DATA TYPE 19 (NONPOINT SOURCE DATA) $$$

CARD TYPE	REACH	ID	BOD1	ORG-N	COLI	TDS	DO	BOD2	ORG-P
			lb/d	lb/d	#/day		lb/d	lb/d	lb/d

ENDATA19

$$$ DATA TYPE 20 (HEADWATER FOR FLOW, TEMPERATURE, SALINITY AND CONSERVATIVES) $$$

CARD TYPE	ELEMENT	NAME	UNIT	FLOW m^3/s	FLOW cfs	TEMP deg C	SALIN ppt	Cl mg/L	SO4 mg/L	HDW DISP EXCHG frac
HDWTR-1	1	Red River	0	32.45539	1146.00000	30.00	0.00	269.000	224.000	0.000
HDWTR-1	1453	McKinney Bayou	0	0.00113	0.04000	30.00	0.00	44.400	34.900	0.000
HDWTR-1	1940	Sulphur River	0	0.36817	13.00000	30.00	0.00	13.700	19.000	0.000

ENDATA20

$$$ DATA TYPE 21 (HEADWATER DATA FOR DO, BOD, AND NITROGEN) $$$

CARD TYPE	ELEMENT	NAME	DO	BOD#1	ORG-N	NH3-N	NO3-N	BOD2
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L

ENDATA21

$$$ DATA TYPE 22 (HEADWATER DATA FOR PHOSPHORUS, PHYTOPLANKTON, COLIFORM, AND NONCONSERVATIVES) $$$

CARD TYPE	ELEMENT	NAME	PO4-P	PHYTO CHL A	COLI	TDS	ORG-P
			mg/L	µg/L	#/100mL	mg/L	mg/L
HDWTR-3	1	Red River	0.00	0.00	0.00	891.00	0.00
HDWTR-3	1453	McKinney Bayou	0.00	0.00	0.00	296.60	0.00
HDWTR-3	1940	Sulphur River	0.00	0.00	0.00	145.50	0.00

ENDATA22

$$$ DATA TYPE 23 (JUNCTION DATA) $$$

CARD TYPE	JUNCTION ELEMENT	UPSTRM ELEMENT	RIVER KILOM	NAME
JUNCTION	1900	1452	119.50	McKinney Bayou to Red River
JUNCTION	2168	1939	115.50	Sulphur River to Red River

ENDATA23

$$$ DATA TYPE 24 (WASTELOAD DATA FOR FLOW, TEMPERATURE, SALINITY, AND CONSERVATIVES) $$$

CARD TYPE	ELEMENT	RMILE	NAME	FLOW m^3/s	FLOW cfs	FLOW MGD	TEMP deg C	SALIN ppt	Cl mg/L	SO4 mg/L
WSTLD-1	334	231.40	Walnut Bayou	0.10450	3.69000	2.385	30.00	0.00	44.400	34.900
WSTLD-1	485	216.30	AR0002968 - Domtar	2.47137	87.26400	56.409	30.00	0.00	210.000	591.000
WSTLD-1	486	216.20	AR0042951 - Ashdown	0.04820	1.70200	1.100	30.00	0.00	250.000	200.000
WSTLD-1	780	186.80	Little River	3.68592	130.14999	84.131	30.00	0.00	8.000	7.000
WSTLD-1	781	186.70	AR0051136 - Turk	0.09465	3.34200	2.160	30.00	0.00	250.000	200.000
WSTLD-1	788	186.00	AR0048810 - Fulton	0.00218	0.07700	0.050	30.00	0.00	250.000	200.000
WSTLD-1	789	185.90	ARG670609 - void	0.00000	0.00000	0.000	30.00	0.00	0.000	0.000
WSTLD-1	855	179.30	AR0048356 - Tyson RV	0.02192	0.77400	0.500	30.00	0.00	400.000	800.000
WSTLD-1	932	171.60	Bois d'Arc Creek	0.03515	1.24100	0.802	30.00	0.00	25.000	17.300
WSTLD-1	1059	158.90	AR0050857 - Garland	0.00329	0.11600	0.075	30.00	0.00	250.000	200.000
WSTLD-1	1070	157.80	AR0051942 - Chf Sand	0.00439	0.15500	0.100	30.00	0.00	250.000	200.000
WSTLD-1	1472	42.80	ARG790100 - Poll Mgt	0.00011	0.00400	0.003	30.00	0.00	180.000	60.000
WSTLD-1	1473	42.70	AR0048691 - N Texark	0.04163	1.47000	0.950	30.00	0.00	180.000	60.000
WSTLD-1	1941	22.70	TX0000167 - IP Tex	0.00000	0.00000	0.000	30.00	0.00	120.000	180.000
WSTLD-1	2020	14.80	Days Creek	0.29283	10.34000	6.684	30.00	0.00	39.500	33.800

ENDATA24

$$$ DATA TYPE 25 (WASTELOAD DATA FOR DO, BOD, AND NITROGEN) $$$

CARD TYPE	ELEMENT	NAME	DO mg/L	BOD mg/L	% BOD RMVL	ORG-N mg/L	NH3-N mg/L	% NITRIF	NO3-N mg/L	BOD2 mg/L

ENDATA25

$$$ DATA TYPE 26 (WASTELOAD DATA FOR PHOSPHORUS, PHYTOPLANTON, COLIFORM, AND NONCONSERVATIVES) $$$

CARD TYPE	ELEMENT	NAME	PO4-P mg/L	PHYTO CHL A µg/L	COLI #/100mL	TDS mg/L	ORG-P mg/L
WSTLD-3	334	Walnut Bayou	0.00	0.00	0.00	296.60	0.00
WSTLD-3	485	AR0002968 - Domtar	0.00	0.00	0.00	1638.00	0.00
WSTLD-3	486	AR0042951 - Ashdown	0.00	0.00	0.00	540.00	0.00
WSTLD-3	780	Little River	0.00	0.00	0.00	98.00	0.00
WSTLD-3	781	AR0051136 - Turk	0.00	0.00	0.00	1620.00	0.00
WSTLD-3	788	AR0048810 - Fulton	0.00	0.00	0.00	500.00	0.00
WSTLD-3	789	ARG670609 - void	0.00	0.00	0.00	0.00	0.00
WSTLD-3	855	AR0048356 - Tyson RV	0.00	0.00	0.00	2000.00	0.00

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WSTLD-3          932     Bois d'Arc Creek          0.00      0.00      0.00    183.50      0.00
WSTLD-3         1059     AR0050857 - Garland       0.00      0.00      0.00    500.00      0.00
WSTLD-3         1070     AR0051942 - Chf Sand      0.00      0.00      0.00    500.00      0.00
WSTLD-3         1472     ARG790100 - Poll Mgt      0.00      0.00      0.00    480.00      0.00
WSTLD-3         1473     AR0048691 - N Texark      0.00      0.00      0.00    480.00      0.00
WSTLD-3         1941     TX0000167 - IP Tex        0.00      0.00      0.00    855.00      0.00
WSTLD-3         2020     Days Creek                0.00      0.00      0.00    219.00      0.00
ENDATA26

$$$ DATA TYPE 27 (LOWER BOUNDARY CONDITIONS) $$$

CARD TYPE    CONSTITUENT                    CONCENTRATION

ENDATA27

$$$ DATA TYPE 28 (DAM DATA) $$$

CARD TYPE     ELEMENT   NAME                  EQN      "A"       "B"       "H"

ENDATA28

$$$ DATA TYPE 29 (SENSITIVITY ANALYSIS DATA) $$$

CARD TYPE       PARAMETER     COL 1     COL 2     COL 3     COL 4     COL 5     COL 6     COL 7     COL 8

ENDATA29

$$$ DATA TYPE 30 (PLOT CONTROL CARDS) $$$

PLOT1
RCH   1  2  3  4  5  6  7 10 16
PLOT2
RCH   8  9
PLOT3
RCH  11 12 13 14 15
ENDATA30

$$$ DATA TYPE 31 (OVERLAY PLOT DATA) $$$


OVERLAY1 OVERLAY_Red.ovl
OVERLAY2 OVERLAY_McKinney.ovl
OVERLAY3 OVERLAY_Sulphur.ovl
ENDATA31



     .....NO ERRORS DETECTED IN INPUT DATA
     .....HYDRAULIC CALCULATIONS COMPLETED
     .....TRIDIAGONAL MATRIX TERMS INITIALIZED
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.....CONSTITUENT CALCULATIONS COMPLETED
.....GRAPHICS DATA FOR PLOT 1 WRITTEN TO UNIT 11
.....GRAPHICS DATA FOR PLOT 2 WRITTEN TO UNIT 12
.....GRAPHICS DATA FOR PLOT 3 WRITTEN TO UNIT 13

INTERMEDIATE REPORT
Temperature
deg C

LA-QUAL Model for Red River/McKinney/Sulphur
Low Flow (7Q10); corrected flow balance; proposed crite

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	11	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	21	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	31	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	41	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	51	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	61	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	71	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	81	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	91	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	101	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	111	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	121	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	131	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	141	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	151	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	161	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	171	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	181	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	191	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	201	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	211	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	221	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	231	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	241	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	251	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	261	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	271	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	281	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	291	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	301	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	311	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	321	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	331	30.00	30.00	30.00							
RR	3	334	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	344	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	354	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

RR	3	364	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	374	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	384	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	394	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	404	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	414	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	424	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
RR	4	432	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	442	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	452	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	462	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	472	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	482	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	492	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	502	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	512	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	522	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	532	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	542	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	552	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	562	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	572	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	582	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	592	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	602	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	612	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	622	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	632	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	642	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	652	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	662	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	672	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	682	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	692	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	702	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	712	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	722	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	732	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	742	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	752	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	762	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	772	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
RR	5	780	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	790	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	800	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	810	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	820	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	830	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	840	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	850	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

RR	5	860	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	870	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	880	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	890	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	900	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	910	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	920	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	930	30.00	30.00								
RR	6	932	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	942	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	952	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	962	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	972	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	982	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	992	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1002	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1012	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1022	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1032	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1042	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1052	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1062	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1072	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1082	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1092	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1102	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1112	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1122	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1132	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1142	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1152	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1162	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1172	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1182	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1192	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1202	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1212	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1222	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1232	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1242	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1252	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1262	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1272	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1282	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1292	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1302	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1312	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1322	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1332	30.00									
RR	7	1333	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

RR	7	1343	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1353	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1363	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1373	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1383	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1393	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1403	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1413	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1423	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1433	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1443	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1900	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1910	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1920	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1930	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2168	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2178	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2188	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2198	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2208	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2218	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2228	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2238	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2248	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2258	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2268	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2278	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2288	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2298	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2308	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2318	30.00	30.00	30.00	30.00	30.00					
MK	8	1453	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1463	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1473	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1483	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1493	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1503	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1513	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1523	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1533	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1543	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1553	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1563	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1573	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1583	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1593	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1603	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1613	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1623	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1633	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

MK	8	1643	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1653	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1663	30.00	30.00	30.00	30.00	30.00	30.00				
MK	9	1669	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1679	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1689	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1699	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1709	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1719	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1729	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1739	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1749	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1759	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1769	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1779	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1789	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1799	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1809	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1819	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1829	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1839	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1849	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1859	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1869	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1879	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1889	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1899	30.00									
SR	11	1940	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
SR	12	1948	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1958	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1968	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1978	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1988	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1998	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	2008	30.00	30.00	30.00	30.00	30.00					
SR	13	2013	30.00	30.00	30.00	30.00	30.00	30.00	30.00			
SR	14	2020	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2030	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2040	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2050	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2060	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2070	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2080	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2090	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2100	30.00	30.00	30.00	30.00	30.00					
SR	15	2105	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2115	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2125	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2135	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2145	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

SR	15	2155	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2165	30.00	30.00	30.00							

INTERMEDIATE REPORT
Salinity
ppt

LA-QUAL Model for Red River/McKinney/Sulphur
Low Flow (7Q10); corrected flow balance; proposed crite

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	121	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	131	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	141	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	151	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	161	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	171	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	191	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	211	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	221	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	231	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	241	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	251	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	261	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	271	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	281	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	291	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	301	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	311	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	321	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	331	0.00	0.00	0.00							
RR	3	334	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	344	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	354	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	364	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	374	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RR	3	384	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	394	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	404	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	414	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	424	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
RR	4	432	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	442	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	452	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	462	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	472	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	482	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	492	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	502	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	512	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	522	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	532	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	542	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	552	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	562	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	572	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	582	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	592	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	602	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	612	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	622	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	632	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	642	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	652	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	662	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	672	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	682	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	692	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	702	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	712	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	722	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	732	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	742	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	752	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	762	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	772	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
RR	5	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	790	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	810	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	820	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	840	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	860	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	870	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RR	5	880	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	890	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	930	0.00	0.00								
RR	6	932	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	942	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	952	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	962	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	982	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	992	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1032	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1042	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1052	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1062	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1072	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1092	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1122	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1132	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1142	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1152	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1162	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1172	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1182	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1192	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1222	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1232	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1242	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1252	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1262	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1272	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1282	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1292	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1302	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1312	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1322	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1332	0.00									
RR	7	1333	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1343	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1353	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RR	7	1363	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1373	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1383	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1393	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1403	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1413	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1433	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1443	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2168	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2178	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2188	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2208	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2218	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2228	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2238	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2248	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2258	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2268	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2278	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2288	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2298	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2308	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2318	0.00	0.00	0.00	0.00	0.00					
MK	8	1453	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1463	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1473	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1483	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1493	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1503	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1513	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1523	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1533	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1543	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1553	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1563	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1573	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1583	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1593	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1603	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1613	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1623	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1633	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1643	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1653	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

MK	8	1663	0.00	0.00	0.00	0.00	0.00	0.00				
MK	9	1669	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1679	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1689	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1699	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1709	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1719	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1729	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1739	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1749	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1759	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1769	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1779	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1799	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1809	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1819	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1829	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1839	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1849	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1859	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1869	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1879	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1889	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	9	1899	0.00									
SR	11	1940	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
SR	12	1948	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	12	1958	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	12	1968	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	12	1978	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	12	1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	12	1998	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	12	2008	0.00	0.00	0.00	0.00	0.00					
SR	13	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
SR	14	2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2060	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2070	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2090	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	14	2100	0.00	0.00	0.00	0.00	0.00					
SR	15	2105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	15	2115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	15	2125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	15	2135	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	15	2145	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	15	2155	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SR	15	2165	0.00	0.00	0.00							

INTERMEDIATE REPORT
Chloride
mg/L

LA-QUAL Model for Red River/McKinney/Sulphur
Low Flow (7Q10); corrected flow balance; proposed crite

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	268.99	268.98	268.98	268.97	268.96	268.95	268.94	268.94	268.93	268.92
RR	1	11	268.91	268.90	268.90	268.89	268.88	268.87	268.86	268.86	268.85	268.84
RR	1	21	268.83	268.82	268.82	268.81	268.80	268.79	268.78	268.78	268.77	268.76
RR	1	31	268.75	268.74	268.74	268.73	268.72	268.71	268.70	268.70	268.69	268.68
RR	1	41	268.67	268.67	268.66	268.65	268.64	268.63	268.63	268.62	268.61	268.60
RR	1	51	268.59	268.59	268.58	268.57	268.56	268.55	268.55	268.54	268.53	268.52
RR	1	61	268.51	268.51	268.50	268.49	268.48	268.47	268.47	268.46	268.45	268.44
RR	1	71	268.43	268.43	268.42	268.41	268.40	268.39	268.39	268.38	268.37	268.36
RR	2	81	268.36	268.36	268.36	268.36	268.35	268.35	268.35	268.35	268.35	268.35
RR	2	91	268.34	268.34	268.34	268.34	268.34	268.33	268.33	268.33	268.33	268.33
RR	2	101	268.33	268.32	268.32	268.32	268.32	268.32	268.32	268.31	268.31	268.31
RR	2	111	268.31	268.31	268.30	268.30	268.30	268.30	268.30	268.30	268.29	268.29
RR	2	121	268.29	268.29	268.29	268.28	268.28	268.28	268.28	268.28	268.28	268.27
RR	2	131	268.27	268.27	268.27	268.27	268.27	268.26	268.26	268.26	268.26	268.26
RR	2	141	268.25	268.25	268.25	268.25	268.25	268.25	268.24	268.24	268.24	268.24
RR	2	151	268.24	268.24	268.23	268.23	268.23	268.23	268.23	268.22	268.22	268.22
RR	2	161	268.22	268.22	268.22	268.21	268.21	268.21	268.21	268.21	268.20	268.20
RR	2	171	268.20	268.20	268.20	268.20	268.19	268.19	268.19	268.19	268.19	268.19
RR	2	181	268.18	268.18	268.18	268.18	268.18	268.17	268.17	268.17	268.17	268.17
RR	2	191	268.17	268.16	268.16	268.16	268.16	268.16	268.16	268.15	268.15	268.15
RR	2	201	268.15	268.15	268.14	268.14	268.14	268.14	268.14	268.14	268.13	268.13
RR	2	211	268.13	268.13	268.13	268.12	268.12	268.12	268.12	268.12	268.12	268.11
RR	2	221	268.11	268.11	268.11	268.11	268.11	268.10	268.10	268.10	268.10	268.10
RR	2	231	268.09	268.09	268.09	268.09	268.09	268.09	268.08	268.08	268.08	268.08
RR	2	241	268.08	268.08	268.07	268.07	268.07	268.07	268.07	268.06	268.06	268.06
RR	2	251	268.06	268.06	268.06	268.05	268.05	268.05	268.05	268.05	268.05	268.04
RR	2	261	268.04	268.04	268.04	268.04	268.03	268.03	268.03	268.03	268.03	268.03
RR	2	271	268.02	268.02	268.02	268.02	268.02	268.01	268.01	268.01	268.01	268.01
RR	2	281	268.01	268.00	268.00	268.00	268.00	268.00	268.00	267.99	267.99	267.99
RR	2	291	267.99	267.99	267.98	267.98	267.98	267.98	267.98	267.98	267.97	267.97
RR	2	301	267.97	267.97	267.97	267.97	267.96	267.96	267.96	267.96	267.96	267.95
RR	2	311	267.95	267.95	267.95	267.95	267.95	267.94	267.94	267.94	267.94	267.94
RR	2	321	267.94	267.93	267.93	267.93	267.93	267.93	267.92	267.92	267.92	267.92
RR	2	331	267.92	267.92	267.91							
RR	3	334	267.20	267.20	267.20	267.20	267.19	267.19	267.19	267.19	267.19	267.19
RR	3	344	267.19	267.19	267.19	267.18	267.18	267.18	267.18	267.18	267.18	267.18
RR	3	354	267.18	267.18	267.17	267.17	267.17	267.17	267.17	267.17	267.17	267.17
RR	3	364	267.16	267.16	267.16	267.16	267.16	267.16	267.16	267.16	267.16	267.15
RR	3	374	267.15	267.15	267.15	267.15	267.15	267.15	267.15	267.15	267.14	267.14
RR	3	384	267.14	267.14	267.14	267.14	267.14	267.14	267.14	267.13	267.13	267.13
RR	3	394	267.13	267.13	267.13	267.13	267.13	267.13	267.12	267.12	267.12	267.12

RR	3	404	267.12	267.12	267.12	267.12	267.12	267.11	267.11	267.11	267.11	267.11
RR	3	414	267.11	267.11	267.11	267.10	267.10	267.10	267.10	267.10	267.10	267.10
RR	3	424	267.10	267.10	267.09	267.09	267.09	267.09	267.09	267.09		
RR	4	432	267.09	267.08	267.08	267.08	267.07	267.07	267.07	267.07	267.06	267.06
RR	4	442	267.06	267.05	267.05	267.05	267.05	267.04	267.04	267.04	267.03	267.03
RR	4	452	267.03	267.02	267.02	267.02	267.02	267.01	267.01	267.01	267.00	267.00
RR	4	462	267.00	267.00	266.99	266.99	266.99	266.98	266.98	266.98	266.98	266.97
RR	4	472	266.97	266.97	266.96	266.96	266.96	266.95	266.95	266.95	266.95	266.94
RR	4	482	266.94	266.94	266.93	262.94	262.92	262.91	262.91	262.91	262.91	262.90
RR	4	492	262.90	262.90	262.90	262.89	262.89	262.89	262.89	262.88	262.88	262.88
RR	4	502	262.87	262.87	262.87	262.87	262.86	262.86	262.86	262.86	262.85	262.85
RR	4	512	262.85	262.85	262.84	262.84	262.84	262.83	262.83	262.83	262.83	262.82
RR	4	522	262.82	262.82	262.82	262.81	262.81	262.81	262.81	262.80	262.80	262.80
RR	4	532	262.80	262.79	262.79	262.79	262.78	262.78	262.78	262.78	262.77	262.77
RR	4	542	262.77	262.77	262.76	262.76	262.76	262.76	262.75	262.75	262.75	262.74
RR	4	552	262.74	262.74	262.74	262.73	262.73	262.73	262.73	262.72	262.72	262.72
RR	4	562	262.72	262.71	262.71	262.71	262.70	262.70	262.70	262.70	262.69	262.69
RR	4	572	262.69	262.69	262.68	262.68	262.68	262.68	262.67	262.67	262.67	262.67
RR	4	582	262.66	262.66	262.66	262.65	262.65	262.65	262.65	262.64	262.64	262.64
RR	4	592	262.64	262.63	262.63	262.63	262.63	262.62	262.62	262.62	262.61	262.61
RR	4	602	262.61	262.61	262.60	262.60	262.60	262.60	262.59	262.59	262.59	262.59
RR	4	612	262.58	262.58	262.58	262.57	262.57	262.57	262.57	262.56	262.56	262.56
RR	4	622	262.56	262.55	262.55	262.55	262.55	262.54	262.54	262.54	262.54	262.53
RR	4	632	262.53	262.53	262.52	262.52	262.52	262.52	262.51	262.51	262.51	262.51
RR	4	642	262.50	262.50	262.50	262.50	262.49	262.49	262.49	262.48	262.48	262.48
RR	4	652	262.48	262.47	262.47	262.47	262.47	262.46	262.46	262.46	262.46	262.45
RR	4	662	262.45	262.45	262.45	262.44	262.44	262.44	262.43	262.43	262.43	262.43
RR	4	672	262.42	262.42	262.42	262.42	262.41	262.41	262.41	262.41	262.40	262.40
RR	4	682	262.40	262.39	262.39	262.39	262.39	262.38	262.38	262.38	262.38	262.37
RR	4	692	262.37	262.37	262.37	262.36	262.36	262.36	262.36	262.35	262.35	262.35
RR	4	702	262.34	262.34	262.34	262.34	262.33	262.33	262.33	262.33	262.32	262.32
RR	4	712	262.32	262.32	262.31	262.31	262.31	262.30	262.30	262.30	262.30	262.29
RR	4	722	262.29	262.29	262.29	262.28	262.28	262.28	262.28	262.27	262.27	262.27
RR	4	732	262.27	262.26	262.26	262.26	262.25	262.25	262.25	262.25	262.24	262.24
RR	4	742	262.24	262.24	262.23	262.23	262.23	262.23	262.22	262.22	262.22	262.21
RR	4	752	262.21	262.21	262.21	262.20	262.20	262.20	262.20	262.19	262.19	262.19
RR	4	762	262.19	262.18	262.18	262.18	262.18	262.17	262.17	262.17	262.16	262.16
RR	4	772	262.16	262.16	262.15	262.15	262.15	262.15	262.14	262.14		
RR	5	780	238.18	238.20	238.20	238.20	238.20	238.20	238.20	238.19	238.19	238.19
RR	5	790	238.19	238.19	238.19	238.19	238.19	238.18	238.18	238.18	238.18	238.18
RR	5	800	238.18	238.18	238.17	238.17	238.17	238.17	238.17	238.17	238.17	238.16
RR	5	810	238.16	238.16	238.16	238.16	238.16	238.16	238.15	238.15	238.15	238.15
RR	5	820	238.15	238.15	238.15	238.14	238.14	238.14	238.14	238.14	238.14	238.14
RR	5	830	238.13	238.13	238.13	238.13	238.13	238.13	238.13	238.12	238.12	238.12
RR	5	840	238.12	238.12	238.12	238.12	238.12	238.11	238.11	238.11	238.11	238.11
RR	5	850	238.11	238.11	238.10	238.10	238.10	238.19	238.19	238.19	238.19	238.18
RR	5	860	238.18	238.18	238.18	238.18	238.18	238.18	238.17	238.17	238.17	238.17
RR	5	870	238.17	238.17	238.17	238.16	238.16	238.16	238.16	238.16	238.16	238.16
RR	5	880	238.16	238.15	238.15	238.15	238.15	238.15	238.15	238.15	238.14	238.14
RR	5	890	238.14	238.14	238.14	238.14	238.14	238.13	238.13	238.13	238.13	238.13

RR	5	900	238.13	238.13	238.12	238.12	238.12	238.12	238.12	238.12	238.12	238.11
RR	5	910	238.11	238.11	238.11	238.11	238.11	238.11	238.10	238.10	238.10	238.10
RR	5	920	238.10	238.10	238.10	238.09	238.09	238.09	238.09	238.09	238.09	238.09
RR	5	930	238.09	238.08								
RR	6	932	237.89	237.89	237.89	237.89	237.89	237.89	237.89	237.89	237.89	237.89
RR	6	942	237.89	237.89	237.89	237.89	237.89	237.89	237.88	237.88	237.88	237.88
RR	6	952	237.88	237.88	237.88	237.88	237.88	237.88	237.88	237.88	237.88	237.88
RR	6	962	237.88	237.88	237.88	237.88	237.88	237.87	237.87	237.87	237.87	237.87
RR	6	972	237.87	237.87	237.87	237.87	237.87	237.87	237.87	237.87	237.87	237.87
RR	6	982	237.87	237.87	237.87	237.87	237.87	237.86	237.86	237.86	237.86	237.86
RR	6	992	237.86	237.86	237.86	237.86	237.86	237.86	237.86	237.86	237.86	237.86
RR	6	1002	237.86	237.86	237.86	237.86	237.86	237.85	237.85	237.85	237.85	237.85
RR	6	1012	237.85	237.85	237.85	237.85	237.85	237.85	237.85	237.85	237.85	237.85
RR	6	1022	237.85	237.85	237.85	237.85	237.85	237.84	237.84	237.84	237.84	237.84
RR	6	1032	237.84	237.84	237.84	237.84	237.84	237.84	237.84	237.84	237.84	237.84
RR	6	1042	237.84	237.84	237.84	237.84	237.84	237.83	237.83	237.83	237.83	237.83
RR	6	1052	237.83	237.83	237.83	237.83	237.83	237.83	237.83	237.83	237.83	237.83
RR	6	1062	237.83	237.83	237.83	237.83	237.83	237.83	237.83	237.82	237.83	237.82
RR	6	1072	237.82	237.82	237.82	237.82	237.82	237.82	237.82	237.82	237.82	237.82
RR	6	1082	237.82	237.82	237.82	237.82	237.82	237.82	237.82	237.82	237.82	237.81
RR	6	1092	237.81	237.81	237.81	237.81	237.81	237.81	237.81	237.81	237.81	237.81
RR	6	1102	237.81	237.81	237.81	237.81	237.81	237.81	237.81	237.81	237.81	237.80
RR	6	1112	237.80	237.80	237.80	237.80	237.80	237.80	237.80	237.80	237.80	237.80
RR	6	1122	237.80	237.80	237.80	237.80	237.80	237.80	237.80	237.80	237.80	237.79
RR	6	1132	237.79	237.79	237.79	237.79	237.79	237.79	237.79	237.79	237.79	237.79
RR	6	1142	237.79	237.79	237.79	237.79	237.79	237.79	237.79	237.79	237.79	237.78
RR	6	1152	237.78	237.78	237.78	237.78	237.78	237.78	237.78	237.78	237.78	237.78
RR	6	1162	237.78	237.78	237.78	237.78	237.78	237.78	237.78	237.78	237.77	237.77
RR	6	1172	237.77	237.77	237.77	237.77	237.77	237.77	237.77	237.77	237.77	237.77
RR	6	1182	237.77	237.77	237.77	237.77	237.77	237.77	237.77	237.77	237.76	237.76
RR	6	1192	237.76	237.76	237.76	237.76	237.76	237.76	237.76	237.76	237.76	237.76
RR	6	1202	237.76	237.76	237.76	237.76	237.76	237.76	237.76	237.76	237.75	237.75
RR	6	1212	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75
RR	6	1222	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.74	237.74
RR	6	1232	237.74	237.74	237.74	237.74	237.74	237.74	237.74	237.74	237.74	237.74
RR	6	1242	237.74	237.74	237.74	237.74	237.74	237.74	237.74	237.74	237.73	237.73
RR	6	1252	237.73	237.73	237.73	237.73	237.73	237.73	237.73	237.73	237.73	237.73
RR	6	1262	237.73	237.73	237.73	237.73	237.73	237.73	237.73	237.73	237.72	237.72
RR	6	1272	237.72	237.72	237.72	237.72	237.72	237.72	237.72	237.72	237.72	237.72
RR	6	1282	237.72	237.72	237.72	237.72	237.72	237.72	237.72	237.72	237.71	237.71
RR	6	1292	237.71	237.71	237.71	237.71	237.71	237.71	237.71	237.71	237.71	237.71
RR	6	1302	237.71	237.71	237.71	237.71	237.71	237.71	237.71	237.70	237.70	237.70
RR	6	1312	237.70	237.70	237.70	237.70	237.70	237.70	237.70	237.70	237.70	237.70
RR	6	1322	237.70	237.70	237.70	237.70	237.70	237.70	237.70	237.69	237.69	237.69
RR	6	1332	237.69									
RR	7	1333	237.69	237.69	237.68	237.68	237.67	237.67	237.67	237.66	237.66	237.66
RR	7	1343	237.65	237.65	237.64	237.64	237.64	237.63	237.63	237.63	237.62	237.62
RR	7	1353	237.61	237.61	237.61	237.60	237.60	237.59	237.59	237.59	237.58	237.58
RR	7	1363	237.58	237.57	237.57	237.56	237.56	237.56	237.55	237.55	237.55	237.54
RR	7	1373	237.54	237.53	237.53	237.53	237.52	237.52	237.52	237.51	237.51	237.50

RR	7	1383	237.50	237.50	237.49	237.49	237.48	237.48	237.48	237.47	237.47	237.47
RR	7	1393	237.46	237.46	237.45	237.45	237.45	237.44	237.44	237.44	237.43	237.43
RR	7	1403	237.42	237.42	237.42	237.41	237.41	237.41	237.40	237.40	237.39	237.39
RR	7	1413	237.39	237.38	237.38	237.38	237.37	237.37	237.36	237.36	237.36	237.35
RR	7	1423	237.35	237.34	237.34	237.34	237.33	237.33	237.33	237.32	237.32	237.31
RR	7	1433	237.31	237.31	237.30	237.30	237.30	237.29	237.29	237.28	237.28	237.28
RR	7	1443	237.27	237.27	237.27	237.26	237.26	237.25	237.25	237.25	237.24	237.24
RR	10	1900	236.99	236.99	236.98	236.98	236.98	236.98	236.98	236.98	236.97	236.97
RR	10	1910	236.97	236.97	236.97	236.97	236.97	236.96	236.96	236.96	236.96	236.96
RR	10	1920	236.96	236.96	236.95	236.95	236.95	236.95	236.95	236.94	236.94	236.94
RR	10	1930	236.94	236.94	236.94	236.94	236.93	236.93	236.93	236.93	236.93	236.93
RR	16	2168	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.42
RR	16	2178	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.42
RR	16	2188	233.42	233.42	233.42	233.42	233.42	233.42	233.42	233.41	233.41	233.41
RR	16	2198	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41
RR	16	2208	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41
RR	16	2218	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41	233.41
RR	16	2228	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40
RR	16	2238	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40
RR	16	2248	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40	233.40
RR	16	2258	233.40	233.40	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39
RR	16	2268	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39
RR	16	2278	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39	233.39
RR	16	2288	233.39	233.39	233.39	233.39	233.39	233.38	233.38	233.38	233.38	233.38
RR	16	2298	233.38	233.38	233.38	233.38	233.38	233.38	233.38	233.38	233.38	233.38
RR	16	2308	233.38	233.38	233.38	233.38	233.38	233.38	233.38	233.38	233.38	233.38
RR	16	2318	233.38	233.38	233.38	233.38	233.38					
MK	8	1453	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40
MK	8	1463	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	49.53
MK	8	1473	171.00	170.76	170.51	170.27	170.02	169.78	169.54	169.30	169.06	168.82
MK	8	1483	168.58	168.34	168.10	167.87	167.63	167.40	167.17	166.93	166.70	166.47
MK	8	1493	166.24	166.02	165.79	165.56	165.33	165.11	164.88	164.66	164.44	164.22
MK	8	1503	164.00	163.78	163.56	163.34	163.12	162.90	162.69	162.47	162.26	162.04
MK	8	1513	161.83	161.62	161.41	161.19	160.98	160.78	160.57	160.36	160.15	159.95
MK	8	1523	159.74	159.54	159.33	159.13	158.93	158.72	158.52	158.32	158.12	157.92
MK	8	1533	157.72	157.53	157.33	157.13	156.94	156.74	156.55	156.35	156.16	155.97
MK	8	1543	155.78	155.59	155.40	155.21	155.02	154.83	154.64	154.45	154.27	154.08
MK	8	1553	153.90	153.71	153.53	153.34	153.16	152.98	152.80	152.62	152.44	152.26
MK	8	1563	152.08	151.90	151.72	151.54	151.37	151.19	151.01	150.84	150.66	150.49
MK	8	1573	150.32	150.14	149.97	149.80	149.63	149.46	149.29	149.12	148.95	148.78
MK	8	1583	148.61	148.45	148.28	148.11	147.95	147.78	147.62	147.45	147.29	147.13
MK	8	1593	146.97	146.80	146.64	146.48	146.32	146.16	146.00	145.84	145.68	145.53
MK	8	1603	145.37	145.21	145.05	144.90	144.74	144.59	144.43	144.28	144.13	143.97
MK	8	1613	143.82	143.67	143.52	143.36	143.21	143.06	142.91	142.76	142.61	142.47
MK	8	1623	142.32	142.17	142.02	141.88	141.73	141.58	141.44	141.29	141.15	141.00
MK	8	1633	140.86	140.72	140.57	140.43	140.29	140.15	140.01	139.87	139.73	139.59
MK	8	1643	139.45	139.31	139.17	139.03	138.89	138.75	138.62	138.48	138.34	138.21
MK	8	1653	138.07	137.94	137.80	137.67	137.53	137.40	137.27	137.13	137.00	136.87
MK	8	1663	136.74	136.61	136.48	136.35	136.22	136.09				
MK	9	1669	135.96	135.84	135.72	135.60	135.48	135.36	135.24	135.13	135.01	134.89

MK	9	1679	134.77	134.65	134.54	134.42	134.30	134.19	134.07	133.95	133.84	133.72
MK	9	1689	133.61	133.49	133.38	133.26	133.15	133.04	132.92	132.81	132.70	132.59
MK	9	1699	132.47	132.36	132.25	132.14	132.03	131.92	131.81	131.70	131.59	131.48
MK	9	1709	131.37	131.26	131.15	131.04	130.94	130.83	130.72	130.61	130.51	130.40
MK	9	1719	130.29	130.19	130.08	129.97	129.87	129.76	129.66	129.55	129.45	129.34
MK	9	1729	129.24	129.14	129.03	128.93	128.83	128.72	128.62	128.52	128.42	128.32
MK	9	1739	128.21	128.11	128.01	127.91	127.81	127.71	127.61	127.51	127.41	127.31
MK	9	1749	127.21	127.11	127.02	126.92	126.82	126.72	126.62	126.53	126.43	126.33
MK	9	1759	126.24	126.14	126.04	125.95	125.85	125.76	125.66	125.57	125.47	125.38
MK	9	1769	125.28	125.19	125.09	125.00	124.91	124.81	124.72	124.63	124.53	124.44
MK	9	1779	124.35	124.26	124.16	124.07	123.98	123.89	123.80	123.71	123.62	123.53
MK	9	1789	123.44	123.35	123.26	123.17	123.08	122.99	122.90	122.81	122.72	122.63
MK	9	1799	122.55	122.46	122.37	122.28	122.19	122.11	122.02	121.93	121.85	121.76
MK	9	1809	121.67	121.59	121.50	121.42	121.33	121.25	121.16	121.08	120.99	120.91
MK	9	1819	120.82	120.74	120.65	120.57	120.49	120.40	120.32	120.24	120.15	120.07
MK	9	1829	119.99	119.91	119.82	119.74	119.66	119.58	119.50	119.42	119.34	119.25
MK	9	1839	119.17	119.09	119.01	118.93	118.85	118.77	118.69	118.61	118.53	118.46
MK	9	1849	118.38	118.30	118.22	118.14	118.06	117.98	117.91	117.83	117.75	117.67
MK	9	1859	117.59	117.52	117.44	117.36	117.29	117.21	117.13	117.06	116.98	116.91
MK	9	1869	116.83	116.75	116.68	116.60	116.53	116.45	116.38	116.30	116.23	116.16
MK	9	1879	116.08	116.01	115.93	115.86	115.79	115.71	115.64	115.57	115.49	115.42
MK	9	1889	115.35	115.28	115.20	115.13	115.06	114.99	114.91	114.84	114.77	114.70
MK	9	1899	114.63									
SR	11	1940	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70		
SR	12	1948	13.70	13.71	13.71	13.71	13.71	13.71	13.72	13.72	13.72	13.72
SR	12	1958	13.72	13.72	13.73	13.73	13.73	13.73	13.73	13.74	13.74	13.74
SR	12	1968	13.74	13.74	13.74	13.75	13.75	13.75	13.75	13.75	13.76	13.76
SR	12	1978	13.76	13.76	13.76	13.77	13.77	13.77	13.77	13.77	13.77	13.78
SR	12	1988	13.78	13.78	13.78	13.78	13.79	13.79	13.79	13.79	13.79	13.79
SR	12	1998	13.80	13.80	13.80	13.80	13.80	13.81	13.81	13.81	13.81	13.81
SR	12	2008	13.82	13.82	13.82	13.82	13.82					
SR	13	2013	13.83	13.83	13.84	13.85	13.85	13.86	13.86			
SR	14	2020	25.18	25.18	25.18	25.18	25.18	25.18	25.18	25.18	25.18	25.18
SR	14	2030	25.18	25.18	25.18	25.18	25.18	25.18	25.19	25.19	25.19	25.19
SR	14	2040	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19
SR	14	2050	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19
SR	14	2060	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19
SR	14	2070	25.19	25.19	25.19	25.19	25.19	25.19	25.20	25.20	25.20	25.20
SR	14	2080	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
SR	14	2090	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
SR	14	2100	25.20	25.20	25.20	25.20	25.20					
SR	15	2105	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
SR	15	2115	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
SR	15	2125	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
SR	15	2135	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20
SR	15	2145	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.20	25.21	25.21
SR	15	2155	25.21	25.21	25.21	25.21	25.21	25.21	25.21	25.21	25.21	25.21
SR	15	2165	25.21	25.21	25.21							

INTERMEDIATE REPORT
Sulfate
mg/L

LA-QUAL Model for Red River/McKinney/Sulphur
Low Flow (7Q10); corrected flow balance; proposed crite

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	223.99	223.99	223.98	223.97	223.97	223.96	223.95	223.95	223.94	223.93
RR	1	11	223.93	223.92	223.91	223.91	223.90	223.89	223.89	223.88	223.87	223.87
RR	1	21	223.86	223.85	223.85	223.84	223.83	223.83	223.82	223.81	223.81	223.80
RR	1	31	223.79	223.79	223.78	223.77	223.77	223.76	223.75	223.75	223.74	223.73
RR	1	41	223.72	223.72	223.71	223.70	223.70	223.69	223.68	223.68	223.67	223.66
RR	1	51	223.66	223.65	223.64	223.64	223.63	223.62	223.62	223.61	223.60	223.60
RR	1	61	223.59	223.58	223.58	223.57	223.56	223.56	223.55	223.54	223.54	223.53
RR	1	71	223.52	223.52	223.51	223.50	223.50	223.49	223.48	223.48	223.47	223.46
RR	2	81	223.46	223.46	223.46	223.46	223.46	223.46	223.45	223.45	223.45	223.45
RR	2	91	223.45	223.45	223.44	223.44	223.44	223.44	223.44	223.44	223.44	223.43
RR	2	101	223.43	223.43	223.43	223.43	223.43	223.43	223.42	223.42	223.42	223.42
RR	2	111	223.42	223.42	223.41	223.41	223.41	223.41	223.41	223.41	223.41	223.40
RR	2	121	223.40	223.40	223.40	223.40	223.40	223.40	223.39	223.39	223.39	223.39
RR	2	131	223.39	223.39	223.38	223.38	223.38	223.38	223.38	223.38	223.38	223.37
RR	2	141	223.37	223.37	223.37	223.37	223.37	223.37	223.36	223.36	223.36	223.36
RR	2	151	223.36	223.36	223.35	223.35	223.35	223.35	223.35	223.35	223.35	223.34
RR	2	161	223.34	223.34	223.34	223.34	223.34	223.34	223.33	223.33	223.33	223.33
RR	2	171	223.33	223.33	223.33	223.32	223.32	223.32	223.32	223.32	223.32	223.31
RR	2	181	223.31	223.31	223.31	223.31	223.31	223.31	223.30	223.30	223.30	223.30
RR	2	191	223.30	223.30	223.30	223.29	223.29	223.29	223.29	223.29	223.29	223.28
RR	2	201	223.28	223.28	223.28	223.28	223.28	223.28	223.27	223.27	223.27	223.27
RR	2	211	223.27	223.27	223.27	223.26	223.26	223.26	223.26	223.26	223.26	223.25
RR	2	221	223.25	223.25	223.25	223.25	223.25	223.25	223.24	223.24	223.24	223.24
RR	2	231	223.24	223.24	223.24	223.23	223.23	223.23	223.23	223.23	223.23	223.23
RR	2	241	223.22	223.22	223.22	223.22	223.22	223.22	223.21	223.21	223.21	223.21
RR	2	251	223.21	223.21	223.21	223.20	223.20	223.20	223.20	223.20	223.20	223.20
RR	2	261	223.19	223.19	223.19	223.19	223.19	223.19	223.18	223.18	223.18	223.18
RR	2	271	223.18	223.18	223.18	223.17	223.17	223.17	223.17	223.17	223.17	223.17
RR	2	281	223.16	223.16	223.16	223.16	223.16	223.16	223.16	223.15	223.15	223.15
RR	2	291	223.15	223.15	223.15	223.14	223.14	223.14	223.14	223.14	223.14	223.14
RR	2	301	223.13	223.13	223.13	223.13	223.13	223.13	223.13	223.12	223.12	223.12
RR	2	311	223.12	223.12	223.12	223.11	223.11	223.11	223.11	223.11	223.11	223.11
RR	2	321	223.10	223.10	223.10	223.10	223.10	223.10	223.10	223.09	223.09	223.09
RR	2	331	223.09	223.09	223.09							
RR	3	334	222.48	222.48	222.48	222.48	222.48	222.48	222.48	222.48	222.48	222.48
RR	3	344	222.47	222.47	222.47	222.47	222.47	222.47	222.47	222.47	222.47	222.47
RR	3	354	222.47	222.46	222.46	222.46	222.46	222.46	222.46	222.46	222.46	222.46
RR	3	364	222.46	222.45	222.45	222.45	222.45	222.45	222.45	222.45	222.45	222.45
RR	3	374	222.45	222.44	222.44	222.44	222.44	222.44	222.44	222.44	222.44	222.44
RR	3	384	222.44	222.44	222.43	222.43	222.43	222.43	222.43	222.43	222.43	222.43
RR	3	394	222.43	222.43	222.42	222.42	222.42	222.42	222.42	222.42	222.42	222.42
RR	3	404	222.42	222.42	222.42	222.41	222.41	222.41	222.41	222.41	222.41	222.41
RR	3	414	222.41	222.41	222.41	222.40	222.40	222.40	222.40	222.40	222.40	222.40

RR	3	424	222.40	222.40	222.40	222.39	222.39	222.39	222.39	222.39			
RR	4	432	222.39	222.39	222.38	222.38	222.38	222.38	222.37	222.37	222.37	222.37	
RR	4	442	222.36	222.36	222.36	222.36	222.35	222.35	222.35	222.35	222.34	222.34	
RR	4	452	222.34	222.34	222.33	222.33	222.33	222.33	222.32	222.32	222.32	222.32	
RR	4	462	222.31	222.31	222.31	222.31	222.30	222.30	222.30	222.30	222.29	222.29	
RR	4	472	222.29	222.29	222.29	222.28	222.28	222.28	222.28	222.27	222.27	222.27	
RR	4	482	222.27	222.26	222.26	248.13	248.06	248.05	248.05	248.05	248.05	248.04	
RR	4	492	248.04	248.04	248.04	248.03	248.03	248.03	248.03	248.02	248.02	248.02	
RR	4	502	248.02	248.01	248.01	248.01	248.01	248.00	248.00	248.00	247.99	247.99	
RR	4	512	247.99	247.99	247.98	247.98	247.98	247.98	247.97	247.97	247.97	247.97	
RR	4	522	247.96	247.96	247.96	247.96	247.95	247.95	247.95	247.95	247.94	247.94	
RR	4	532	247.94	247.93	247.93	247.93	247.93	247.92	247.92	247.92	247.92	247.91	
RR	4	542	247.91	247.91	247.91	247.90	247.90	247.90	247.90	247.89	247.89	247.89	
RR	4	552	247.89	247.88	247.88	247.88	247.87	247.87	247.87	247.87	247.86	247.86	
RR	4	562	247.86	247.86	247.85	247.85	247.85	247.85	247.84	247.84	247.84	247.84	
RR	4	572	247.83	247.83	247.83	247.83	247.82	247.82	247.82	247.81	247.81	247.81	
RR	4	582	247.81	247.80	247.80	247.80	247.80	247.79	247.79	247.79	247.79	247.78	
RR	4	592	247.78	247.78	247.78	247.77	247.77	247.77	247.77	247.76	247.76	247.76	
RR	4	602	247.75	247.75	247.75	247.75	247.74	247.74	247.74	247.74	247.73	247.73	
RR	4	612	247.73	247.73	247.72	247.72	247.72	247.72	247.71	247.71	247.71	247.71	
RR	4	622	247.70	247.70	247.70	247.69	247.69	247.69	247.69	247.68	247.68	247.68	
RR	4	632	247.68	247.67	247.67	247.67	247.67	247.66	247.66	247.66	247.66	247.65	
RR	4	642	247.65	247.65	247.65	247.64	247.64	247.64	247.63	247.63	247.63	247.63	
RR	4	652	247.62	247.62	247.62	247.62	247.61	247.61	247.61	247.61	247.60	247.60	
RR	4	662	247.60	247.60	247.59	247.59	247.59	247.59	247.58	247.58	247.58	247.57	
RR	4	672	247.57	247.57	247.57	247.56	247.56	247.56	247.56	247.55	247.55	247.55	
RR	4	682	247.55	247.54	247.54	247.54	247.54	247.53	247.53	247.53	247.53	247.52	
RR	4	692	247.52	247.52	247.51	247.51	247.51	247.51	247.50	247.50	247.50	247.50	
RR	4	702	247.49	247.49	247.49	247.49	247.48	247.48	247.48	247.48	247.47	247.47	
RR	4	712	247.47	247.47	247.46	247.46	247.46	247.46	247.45	247.45	247.45	247.44	
RR	4	722	247.44	247.44	247.44	247.43	247.43	247.43	247.43	247.42	247.42	247.42	
RR	4	732	247.42	247.41	247.41	247.41	247.41	247.40	247.40	247.40	247.40	247.39	
RR	4	742	247.39	247.39	247.38	247.38	247.38	247.38	247.37	247.37	247.37	247.37	
RR	4	752	247.36	247.36	247.36	247.36	247.35	247.35	247.35	247.35	247.34	247.34	
RR	4	762	247.34	247.34	247.33	247.33	247.33	247.33	247.32	247.32	247.32	247.31	
RR	4	772	247.31	247.31	247.31	247.30	247.30	247.30	247.30	247.29			
RR	5	780	224.63	224.57	224.57	224.57	224.57	224.57	224.57	224.57	224.56	224.56	
RR	5	790	224.56	224.56	224.56	224.56	224.55	224.55	224.55	224.55	224.55	224.55	
RR	5	800	224.55	224.54	224.54	224.54	224.54	224.54	224.54	224.54	224.54	224.53	
RR	5	810	224.53	224.53	224.53	224.53	224.53	224.53	224.52	224.52	224.52	224.52	
RR	5	820	224.52	224.52	224.52	224.51	224.51	224.51	224.51	224.51	224.51	224.51	
RR	5	830	224.51	224.50	224.50	224.50	224.50	224.50	224.50	224.50	224.49	224.49	
RR	5	840	224.49	224.49	224.49	224.49	224.49	224.48	224.48	224.48	224.48	224.48	
RR	5	850	224.48	224.48	224.48	224.47	224.47	224.79	224.79	224.79	224.79	224.79	
RR	5	860	224.79	224.78	224.78	224.78	224.78	224.78	224.78	224.78	224.78	224.77	
RR	5	870	224.77	224.77	224.77	224.77	224.77	224.77	224.76	224.76	224.76	224.76	
RR	5	880	224.76	224.76	224.76	224.75	224.75	224.75	224.75	224.75	224.75	224.75	
RR	5	890	224.75	224.74	224.74	224.74	224.74	224.74	224.74	224.74	224.73	224.73	
RR	5	900	224.73	224.73	224.73	224.73	224.73	224.72	224.72	224.72	224.72	224.72	
RR	5	910	224.72	224.72	224.72	224.71	224.71	224.71	224.71	224.71	224.71	224.71	

RR	5	920	224.70	224.70	224.70	224.70	224.70	224.70	224.70	224.69	224.69	224.69
RR	5	930	224.69	224.69								
RR	6	932	224.50	224.50	224.50	224.50	224.50	224.50	224.50	224.50	224.50	224.50
RR	6	942	224.50	224.50	224.50	224.50	224.50	224.50	224.50	224.50	224.49	224.49
RR	6	952	224.49	224.49	224.49	224.49	224.49	224.49	224.49	224.49	224.49	224.49
RR	6	962	224.49	224.49	224.49	224.49	224.49	224.49	224.49	224.49	224.49	224.48
RR	6	972	224.48	224.48	224.48	224.48	224.48	224.48	224.48	224.48	224.48	224.48
RR	6	982	224.48	224.48	224.48	224.48	224.48	224.48	224.48	224.48	224.48	224.48
RR	6	992	224.47	224.47	224.47	224.47	224.47	224.47	224.47	224.47	224.47	224.47
RR	6	1002	224.47	224.47	224.47	224.47	224.47	224.47	224.47	224.47	224.47	224.47
RR	6	1012	224.47	224.46	224.46	224.46	224.46	224.46	224.46	224.46	224.46	224.46
RR	6	1022	224.46	224.46	224.46	224.46	224.46	224.46	224.46	224.46	224.46	224.46
RR	6	1032	224.46	224.46	224.46	224.45	224.45	224.45	224.45	224.45	224.45	224.45
RR	6	1042	224.45	224.45	224.45	224.45	224.45	224.45	224.45	224.45	224.45	224.45
RR	6	1052	224.45	224.45	224.45	224.45	224.44	224.44	224.44	224.44	224.44	224.44
RR	6	1062	224.44	224.44	224.44	224.44	224.44	224.44	224.44	224.44	224.43	224.43
RR	6	1072	224.43	224.43	224.43	224.43	224.43	224.43	224.43	224.43	224.43	224.43
RR	6	1082	224.43	224.43	224.43	224.43	224.43	224.43	224.42	224.42	224.42	224.42
RR	6	1092	224.42	224.42	224.42	224.42	224.42	224.42	224.42	224.42	224.42	224.42
RR	6	1102	224.42	224.42	224.42	224.42	224.42	224.42	224.42	224.41	224.41	224.41
RR	6	1112	224.41	224.41	224.41	224.41	224.41	224.41	224.41	224.41	224.41	224.41
RR	6	1122	224.41	224.41	224.41	224.41	224.41	224.41	224.41	224.41	224.40	224.40
RR	6	1132	224.40	224.40	224.40	224.40	224.40	224.40	224.40	224.40	224.40	224.40
RR	6	1142	224.40	224.40	224.40	224.40	224.40	224.40	224.40	224.40	224.40	224.39
RR	6	1152	224.39	224.39	224.39	224.39	224.39	224.39	224.39	224.39	224.39	224.39
RR	6	1162	224.39	224.39	224.39	224.39	224.39	224.39	224.39	224.39	224.39	224.39
RR	6	1172	224.38	224.38	224.38	224.38	224.38	224.38	224.38	224.38	224.38	224.38
RR	6	1182	224.38	224.38	224.38	224.38	224.38	224.38	224.38	224.38	224.38	224.38
RR	6	1192	224.38	224.38	224.37	224.37	224.37	224.37	224.37	224.37	224.37	224.37
RR	6	1202	224.37	224.37	224.37	224.37	224.37	224.37	224.37	224.37	224.37	224.37
RR	6	1212	224.37	224.37	224.37	224.36	224.36	224.36	224.36	224.36	224.36	224.36
RR	6	1222	224.36	224.36	224.36	224.36	224.36	224.36	224.36	224.36	224.36	224.36
RR	6	1232	224.36	224.36	224.36	224.36	224.35	224.35	224.35	224.35	224.35	224.35
RR	6	1242	224.35	224.35	224.35	224.35	224.35	224.35	224.35	224.35	224.35	224.35
RR	6	1252	224.35	224.35	224.35	224.35	224.35	224.34	224.34	224.34	224.34	224.34
RR	6	1262	224.34	224.34	224.34	224.34	224.34	224.34	224.34	224.34	224.34	224.34
RR	6	1272	224.34	224.34	224.34	224.34	224.34	224.34	224.33	224.33	224.33	224.33
RR	6	1282	224.33	224.33	224.33	224.33	224.33	224.33	224.33	224.33	224.33	224.33
RR	6	1292	224.33	224.33	224.33	224.33	224.33	224.33	224.33	224.32	224.32	224.32
RR	6	1302	224.32	224.32	224.32	224.32	224.32	224.32	224.32	224.32	224.32	224.32
RR	6	1312	224.32	224.32	224.32	224.32	224.32	224.32	224.32	224.32	224.31	224.31
RR	6	1322	224.31	224.31	224.31	224.31	224.31	224.31	224.31	224.31	224.31	224.31
RR	6	1332	224.31									
RR	7	1333	224.31	224.30	224.30	224.29	224.29	224.29	224.28	224.28	224.28	224.27
RR	7	1343	224.27	224.26	224.26	224.26	224.25	224.25	224.25	224.24	224.24	224.24
RR	7	1353	224.23	224.23	224.22	224.22	224.22	224.21	224.21	224.21	224.20	224.20
RR	7	1363	224.19	224.19	224.19	224.18	224.18	224.18	224.17	224.17	224.16	224.16
RR	7	1373	224.16	224.15	224.15	224.15	224.14	224.14	224.14	224.13	224.13	224.12
RR	7	1383	224.12	224.12	224.11	224.11	224.11	224.10	224.10	224.09	224.09	224.09
RR	7	1393	224.08	224.08	224.08	224.07	224.07	224.07	224.06	224.06	224.05	224.05

RR	7	1403	224.05	224.04	224.04	224.04	224.03	224.03	224.02	224.02	224.02	224.01
RR	7	1413	224.01	224.01	224.00	224.00	223.99	223.99	223.99	223.98	223.98	223.98
RR	7	1423	223.97	223.97	223.97	223.96	223.96	223.95	223.95	223.95	223.94	223.94
RR	7	1433	223.94	223.93	223.93	223.92	223.92	223.92	223.91	223.91	223.91	223.90
RR	7	1443	223.90	223.90	223.89	223.89	223.88	223.88	223.88	223.87	223.87	223.87
RR	10	1900	223.50	223.50	223.50	223.50	223.50	223.50	223.50	223.49	223.49	223.49
RR	10	1910	223.49	223.49	223.49	223.49	223.48	223.48	223.48	223.48	223.48	223.48
RR	10	1920	223.47	223.47	223.47	223.47	223.47	223.47	223.47	223.46	223.46	223.46
RR	10	1930	223.46	223.46	223.46	223.45	223.45	223.45	223.45	223.45	223.45	223.45
RR	16	2168	220.17	220.17	220.17	220.17	220.17	220.17	220.17	220.17	220.17	220.17
RR	16	2178	220.17	220.17	220.17	220.17	220.17	220.17	220.17	220.17	220.17	220.17
RR	16	2188	220.17	220.17	220.17	220.17	220.17	220.16	220.16	220.16	220.16	220.16
RR	16	2198	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.16
RR	16	2208	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.16
RR	16	2218	220.16	220.16	220.16	220.16	220.16	220.16	220.16	220.15	220.15	220.15
RR	16	2228	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15
RR	16	2238	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15
RR	16	2248	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.15	220.14
RR	16	2258	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14
RR	16	2268	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14
RR	16	2278	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14	220.14
RR	16	2288	220.14	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13
RR	16	2298	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13
RR	16	2308	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13	220.13
RR	16	2318	220.13	220.13	220.13	220.13	220.12					
MK	8	1453	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90
MK	8	1463	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	35.85
MK	8	1473	58.33	58.29	58.24	58.20	58.15	58.11	58.06	58.02	57.97	57.93
MK	8	1483	57.89	57.84	57.80	57.75	57.71	57.67	57.62	57.58	57.54	57.50
MK	8	1493	57.45	57.41	57.37	57.33	57.29	57.24	57.20	57.16	57.12	57.08
MK	8	1503	57.04	57.00	56.96	56.92	56.88	56.84	56.80	56.76	56.72	56.68
MK	8	1513	56.64	56.60	56.56	56.52	56.48	56.44	56.40	56.36	56.33	56.29
MK	8	1523	56.25	56.21	56.17	56.14	56.10	56.06	56.02	55.99	55.95	55.91
MK	8	1533	55.88	55.84	55.80	55.77	55.73	55.69	55.66	55.62	55.59	55.55
MK	8	1543	55.52	55.48	55.45	55.41	55.38	55.34	55.31	55.27	55.24	55.20
MK	8	1553	55.17	55.13	55.10	55.07	55.03	55.00	54.96	54.93	54.90	54.86
MK	8	1563	54.83	54.80	54.77	54.73	54.70	54.67	54.63	54.60	54.57	54.54
MK	8	1573	54.51	54.47	54.44	54.41	54.38	54.35	54.32	54.28	54.25	54.22
MK	8	1583	54.19	54.16	54.13	54.10	54.07	54.04	54.01	53.98	53.95	53.92
MK	8	1593	53.89	53.86	53.83	53.80	53.77	53.74	53.71	53.68	53.65	53.62
MK	8	1603	53.59	53.56	53.53	53.50	53.47	53.45	53.42	53.39	53.36	53.33
MK	8	1613	53.30	53.27	53.25	53.22	53.19	53.16	53.14	53.11	53.08	53.05
MK	8	1623	53.02	53.00	52.97	52.94	52.92	52.89	52.86	52.84	52.81	52.78
MK	8	1633	52.76	52.73	52.70	52.68	52.65	52.62	52.60	52.57	52.55	52.52
MK	8	1643	52.49	52.47	52.44	52.42	52.39	52.37	52.34	52.31	52.29	52.26
MK	8	1653	52.24	52.21	52.19	52.16	52.14	52.11	52.09	52.07	52.04	52.02
MK	8	1663	51.99	51.97	51.94	51.92	51.90	51.87				
MK	9	1669	51.85	51.83	51.80	51.78	51.76	51.74	51.72	51.69	51.67	51.65
MK	9	1679	51.63	51.61	51.58	51.56	51.54	51.52	51.50	51.48	51.46	51.43
MK	9	1689	51.41	51.39	51.37	51.35	51.33	51.31	51.29	51.27	51.24	51.22

MK	9	1699	51.20	51.18	51.16	51.14	51.12	51.10	51.08	51.06	51.04	51.02
MK	9	1709	51.00	50.98	50.96	50.94	50.92	50.90	50.88	50.86	50.84	50.82
MK	9	1719	50.80	50.78	50.76	50.74	50.72	50.70	50.68	50.66	50.64	50.62
MK	9	1729	50.60	50.59	50.57	50.55	50.53	50.51	50.49	50.47	50.45	50.43
MK	9	1739	50.41	50.40	50.38	50.36	50.34	50.32	50.30	50.28	50.27	50.25
MK	9	1749	50.23	50.21	50.19	50.17	50.16	50.14	50.12	50.10	50.08	50.07
MK	9	1759	50.05	50.03	50.01	49.99	49.98	49.96	49.94	49.92	49.91	49.89
MK	9	1769	49.87	49.85	49.84	49.82	49.80	49.78	49.77	49.75	49.73	49.72
MK	9	1779	49.70	49.68	49.66	49.65	49.63	49.61	49.60	49.58	49.56	49.55
MK	9	1789	49.53	49.51	49.50	49.48	49.46	49.45	49.43	49.41	49.40	49.38
MK	9	1799	49.37	49.35	49.33	49.32	49.30	49.28	49.27	49.25	49.24	49.22
MK	9	1809	49.20	49.19	49.17	49.16	49.14	49.12	49.11	49.09	49.08	49.06
MK	9	1819	49.05	49.03	49.02	49.00	48.98	48.97	48.95	48.94	48.92	48.91
MK	9	1829	48.89	48.88	48.86	48.85	48.83	48.82	48.80	48.79	48.77	48.76
MK	9	1839	48.74	48.73	48.71	48.70	48.68	48.67	48.65	48.64	48.62	48.61
MK	9	1849	48.59	48.58	48.56	48.55	48.54	48.52	48.51	48.49	48.48	48.46
MK	9	1859	48.45	48.43	48.42	48.41	48.39	48.38	48.36	48.35	48.34	48.32
MK	9	1869	48.31	48.29	48.28	48.27	48.25	48.24	48.22	48.21	48.20	48.18
MK	9	1879	48.17	48.15	48.14	48.13	48.11	48.10	48.09	48.07	48.06	48.05
MK	9	1889	48.03	48.02	48.01	47.99	47.98	47.97	47.95	47.94	47.93	47.91
MK	9	1899	47.90									
SR	11	1940	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00		
SR	12	1948	19.00	19.00	19.00	19.01	19.01	19.01	19.01	19.01	19.01	19.01
SR	12	1958	19.01	19.01	19.02	19.02	19.02	19.02	19.02	19.02	19.02	19.02
SR	12	1968	19.02	19.02	19.03	19.03	19.03	19.03	19.03	19.03	19.03	19.03
SR	12	1978	19.03	19.04	19.04	19.04	19.04	19.04	19.04	19.04	19.04	19.04
SR	12	1988	19.04	19.05	19.05	19.05	19.05	19.05	19.05	19.05	19.05	19.05
SR	12	1998	19.06	19.06	19.06	19.06	19.06	19.06	19.06	19.06	19.06	19.06
SR	12	2008	19.07	19.07	19.07	19.07	19.07					
SR	13	2013	19.07	19.08	19.08	19.08	19.09	19.09	19.09			
SR	14	2020	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59
SR	14	2030	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59
SR	14	2040	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59
SR	14	2050	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59
SR	14	2060	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59
SR	14	2070	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59	25.59
SR	14	2080	25.59	25.59	25.59	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	14	2090	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	14	2100	25.60	25.60	25.60	25.60	25.60					
SR	15	2105	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	15	2115	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	15	2125	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	15	2135	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	15	2145	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	15	2155	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60	25.60
SR	15	2165	25.60	25.60	25.60							

INTERMEDIATE REPORT
Total Dissolved Solids
mg/L

LA-QUAL Model for Red River/McKinney/Sulphur
Low Flow (7Q10); corrected flow balance; proposed crite

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	890.98	890.96	890.94	890.92	890.89	890.87	890.85	890.83	890.81	890.79
RR	1	11	890.77	890.75	890.73	890.70	890.68	890.66	890.64	890.62	890.60	890.58
RR	1	21	890.56	890.54	890.52	890.49	890.47	890.45	890.43	890.41	890.39	890.37
RR	1	31	890.35	890.33	890.30	890.28	890.26	890.24	890.22	890.20	890.18	890.16
RR	1	41	890.14	890.12	890.09	890.07	890.05	890.03	890.01	889.99	889.97	889.95
RR	1	51	889.93	889.91	889.88	889.86	889.84	889.82	889.80	889.78	889.76	889.74
RR	1	61	889.72	889.69	889.67	889.65	889.63	889.61	889.59	889.57	889.55	889.53
RR	1	71	889.51	889.48	889.46	889.44	889.42	889.40	889.38	889.36	889.34	889.32
RR	2	81	889.31	889.31	889.30	889.30	889.29	889.29	889.28	889.28	889.27	889.27
RR	2	91	889.26	889.26	889.26	889.25	889.25	889.24	889.24	889.23	889.23	889.22
RR	2	101	889.22	889.21	889.21	889.20	889.20	889.19	889.19	889.18	889.18	889.17
RR	2	111	889.17	889.17	889.16	889.16	889.15	889.15	889.14	889.14	889.13	889.13
RR	2	121	889.12	889.12	889.11	889.11	889.10	889.10	889.09	889.09	889.08	889.08
RR	2	131	889.07	889.07	889.07	889.06	889.06	889.05	889.05	889.04	889.04	889.03
RR	2	141	889.03	889.02	889.02	889.01	889.01	889.00	889.00	888.99	888.99	888.98
RR	2	151	888.98	888.98	888.97	888.97	888.96	888.96	888.95	888.95	888.94	888.94
RR	2	161	888.93	888.93	888.92	888.92	888.91	888.91	888.90	888.90	888.89	888.89
RR	2	171	888.89	888.88	888.88	888.87	888.87	888.86	888.86	888.85	888.85	888.84
RR	2	181	888.84	888.83	888.83	888.82	888.82	888.81	888.81	888.80	888.80	888.80
RR	2	191	888.79	888.79	888.78	888.78	888.77	888.77	888.76	888.76	888.75	888.75
RR	2	201	888.74	888.74	888.73	888.73	888.72	888.72	888.71	888.71	888.71	888.70
RR	2	211	888.70	888.69	888.69	888.68	888.68	888.67	888.67	888.66	888.66	888.65
RR	2	221	888.65	888.64	888.64	888.63	888.63	888.62	888.62	888.62	888.61	888.61
RR	2	231	888.60	888.60	888.59	888.59	888.58	888.58	888.57	888.57	888.56	888.56
RR	2	241	888.55	888.55	888.54	888.54	888.53	888.53	888.53	888.52	888.52	888.51
RR	2	251	888.51	888.50	888.50	888.49	888.49	888.48	888.48	888.47	888.47	888.46
RR	2	261	888.46	888.45	888.45	888.44	888.44	888.44	888.43	888.43	888.42	888.42
RR	2	271	888.41	888.41	888.40	888.40	888.39	888.39	888.38	888.38	888.37	888.37
RR	2	281	888.36	888.36	888.35	888.35	888.35	888.34	888.34	888.33	888.33	888.32
RR	2	291	888.32	888.31	888.31	888.30	888.30	888.29	888.29	888.28	888.28	888.27
RR	2	301	888.27	888.26	888.26	888.26	888.25	888.25	888.24	888.24	888.23	888.23
RR	2	311	888.22	888.22	888.21	888.21	888.20	888.20	888.19	888.19	888.18	888.18
RR	2	321	888.17	888.17	888.17	888.16	888.16	888.15	888.15	888.14	888.14	888.13
RR	2	331	888.13	888.12	888.12							
RR	3	334	886.23	886.22	886.22	886.22	886.21	886.21	886.21	886.20	886.20	886.20
RR	3	344	886.20	886.19	886.19	886.19	886.18	886.18	886.18	886.17	886.17	886.17
RR	3	354	886.16	886.16	886.16	886.16	886.15	886.15	886.15	886.14	886.14	886.14
RR	3	364	886.13	886.13	886.13	886.13	886.12	886.12	886.12	886.11	886.11	886.11
RR	3	374	886.10	886.10	886.10	886.09	886.09	886.09	886.09	886.08	886.08	886.08
RR	3	384	886.07	886.07	886.07	886.06	886.06	886.06	886.05	886.05	886.05	886.05
RR	3	394	886.04	886.04	886.04	886.03	886.03	886.03	886.02	886.02	886.02	886.02
RR	3	404	886.01	886.01	886.01	886.00	886.00	886.00	885.99	885.99	885.99	885.98
RR	3	414	885.98	885.98	885.98	885.97	885.97	885.97	885.96	885.96	885.96	885.95

RR	3	424	885.95	885.95	885.95	885.94	885.94	885.94	885.93	885.93		
RR	4	432	885.92	885.91	885.91	885.90	885.89	885.88	885.88	885.87	885.86	885.85
RR	4	442	885.84	885.84	885.83	885.82	885.81	885.81	885.80	885.79	885.78	885.77
RR	4	452	885.77	885.76	885.75	885.74	885.74	885.73	885.72	885.71	885.70	885.70
RR	4	462	885.69	885.68	885.67	885.67	885.66	885.65	885.64	885.63	885.63	885.62
RR	4	472	885.61	885.60	885.60	885.59	885.58	885.57	885.56	885.56	885.55	885.54
RR	4	482	885.53	885.53	885.52	938.30	937.75	937.74	937.73	937.72	937.72	937.71
RR	4	492	937.70	937.69	937.68	937.68	937.67	937.66	937.65	937.64	937.64	937.63
RR	4	502	937.62	937.61	937.61	937.60	937.59	937.58	937.57	937.57	937.56	937.55
RR	4	512	937.54	937.54	937.53	937.52	937.51	937.50	937.50	937.49	937.48	937.47
RR	4	522	937.47	937.46	937.45	937.44	937.43	937.43	937.42	937.41	937.40	937.40
RR	4	532	937.39	937.38	937.37	937.36	937.36	937.35	937.34	937.33	937.33	937.32
RR	4	542	937.31	937.30	937.29	937.29	937.28	937.27	937.26	937.26	937.25	937.24
RR	4	552	937.23	937.22	937.22	937.21	937.20	937.19	937.18	937.18	937.17	937.16
RR	4	562	937.15	937.15	937.14	937.13	937.12	937.11	937.11	937.10	937.09	937.08
RR	4	572	937.08	937.07	937.06	937.05	937.04	937.04	937.03	937.02	937.01	937.01
RR	4	582	937.00	936.99	936.98	936.97	936.97	936.96	936.95	936.94	936.94	936.93
RR	4	592	936.92	936.91	936.90	936.90	936.89	936.88	936.87	936.87	936.86	936.85
RR	4	602	936.84	936.83	936.83	936.82	936.81	936.80	936.80	936.79	936.78	936.77
RR	4	612	936.76	936.76	936.75	936.74	936.73	936.73	936.72	936.71	936.70	936.69
RR	4	622	936.69	936.68	936.67	936.66	936.66	936.65	936.64	936.63	936.62	936.62
RR	4	632	936.61	936.60	936.59	936.59	936.58	936.57	936.56	936.55	936.55	936.54
RR	4	642	936.53	936.52	936.52	936.51	936.50	936.49	936.48	936.48	936.47	936.46
RR	4	652	936.45	936.45	936.44	936.43	936.42	936.41	936.41	936.40	936.39	936.38
RR	4	662	936.38	936.37	936.36	936.35	936.34	936.34	936.33	936.32	936.31	936.31
RR	4	672	936.30	936.29	936.28	936.27	936.27	936.26	936.25	936.24	936.24	936.23
RR	4	682	936.22	936.21	936.20	936.20	936.19	936.18	936.17	936.17	936.16	936.15
RR	4	692	936.14	936.13	936.13	936.12	936.11	936.10	936.10	936.09	936.08	936.07
RR	4	702	936.06	936.06	936.05	936.04	936.03	936.03	936.02	936.01	936.00	936.00
RR	4	712	935.99	935.98	935.97	935.96	935.96	935.95	935.94	935.93	935.93	935.92
RR	4	722	935.91	935.90	935.89	935.89	935.88	935.87	935.86	935.86	935.85	935.84
RR	4	732	935.83	935.82	935.82	935.81	935.80	935.79	935.79	935.78	935.77	935.76
RR	4	742	935.75	935.75	935.74	935.73	935.72	935.72	935.71	935.70	935.69	935.68
RR	4	752	935.68	935.67	935.66	935.65	935.65	935.64	935.63	935.62	935.61	935.61
RR	4	762	935.60	935.59	935.58	935.58	935.57	935.56	935.55	935.55	935.54	935.53
RR	4	772	935.52	935.51	935.51	935.50	935.49	935.48	935.48	935.47		
RR	5	780	856.49	858.33	858.33	858.33	858.32	858.32	858.31	858.31	858.28	858.28
RR	5	790	858.27	858.27	858.27	858.26	858.26	858.25	858.25	858.24	858.24	858.23
RR	5	800	858.23	858.23	858.22	858.22	858.21	858.21	858.20	858.20	858.19	858.19
RR	5	810	858.18	858.18	858.18	858.17	858.17	858.16	858.16	858.15	858.15	858.14
RR	5	820	858.14	858.14	858.13	858.13	858.12	858.12	858.11	858.11	858.10	858.10
RR	5	830	858.10	858.09	858.09	858.08	858.08	858.07	858.07	858.06	858.06	858.05
RR	5	840	858.05	858.05	858.04	858.04	858.03	858.03	858.02	858.02	858.01	858.01
RR	5	850	858.01	858.00	858.00	857.99	857.99	858.62	858.62	858.61	858.61	858.60
RR	5	860	858.60	858.59	858.59	858.59	858.58	858.58	858.57	858.57	858.56	858.56
RR	5	870	858.55	858.55	858.54	858.54	858.54	858.53	858.53	858.52	858.52	858.51
RR	5	880	858.51	858.50	858.50	858.50	858.49	858.49	858.48	858.48	858.47	858.47
RR	5	890	858.46	858.46	858.46	858.45	858.45	858.44	858.44	858.43	858.43	858.42
RR	5	900	858.42	858.41	858.41	858.41	858.40	858.40	858.39	858.39	858.38	858.38
RR	5	910	858.37	858.37	858.37	858.36	858.36	858.35	858.35	858.34	858.34	858.33

RR	5	920	858.33	858.33	858.32	858.32	858.31	858.31	858.30	858.30	858.29	858.29
RR	5	930	858.29	858.28								
RR	6	932	857.68	857.67	857.67	857.67	857.67	857.67	857.67	857.66	857.66	857.66
RR	6	942	857.66	857.66	857.66	857.65	857.65	857.65	857.65	857.65	857.65	857.64
RR	6	952	857.64	857.64	857.64	857.64	857.64	857.64	857.63	857.63	857.63	857.63
RR	6	962	857.63	857.63	857.62	857.62	857.62	857.62	857.62	857.62	857.61	857.61
RR	6	972	857.61	857.61	857.61	857.61	857.60	857.60	857.60	857.60	857.60	857.60
RR	6	982	857.60	857.59	857.59	857.59	857.59	857.59	857.59	857.58	857.58	857.58
RR	6	992	857.58	857.58	857.58	857.57	857.57	857.57	857.57	857.57	857.57	857.56
RR	6	1002	857.56	857.56	857.56	857.56	857.56	857.56	857.55	857.55	857.55	857.55
RR	6	1012	857.55	857.55	857.54	857.54	857.54	857.54	857.54	857.54	857.53	857.53
RR	6	1022	857.53	857.53	857.53	857.53	857.52	857.52	857.52	857.52	857.52	857.52
RR	6	1032	857.52	857.51	857.51	857.51	857.51	857.51	857.51	857.50	857.50	857.50
RR	6	1042	857.50	857.50	857.50	857.49	857.49	857.49	857.49	857.49	857.49	857.48
RR	6	1052	857.48	857.48	857.48	857.48	857.48	857.48	857.47	857.44	857.44	857.44
RR	6	1062	857.44	857.44	857.43	857.43	857.43	857.43	857.43	857.43	857.38	857.38
RR	6	1072	857.38	857.38	857.38	857.38	857.38	857.37	857.37	857.37	857.37	857.37
RR	6	1082	857.37	857.36	857.36	857.36	857.36	857.36	857.36	857.35	857.35	857.35
RR	6	1092	857.35	857.35	857.35	857.34	857.34	857.34	857.34	857.34	857.34	857.34
RR	6	1102	857.33	857.33	857.33	857.33	857.33	857.33	857.32	857.32	857.32	857.32
RR	6	1112	857.32	857.32	857.31	857.31	857.31	857.31	857.31	857.31	857.30	857.30
RR	6	1122	857.30	857.30	857.30	857.30	857.30	857.29	857.29	857.29	857.29	857.29
RR	6	1132	857.29	857.28	857.28	857.28	857.28	857.28	857.28	857.27	857.27	857.27
RR	6	1142	857.27	857.27	857.27	857.26	857.26	857.26	857.26	857.26	857.26	857.26
RR	6	1152	857.25	857.25	857.25	857.25	857.25	857.25	857.24	857.24	857.24	857.24
RR	6	1162	857.24	857.24	857.23	857.23	857.23	857.23	857.23	857.23	857.22	857.22
RR	6	1172	857.22	857.22	857.22	857.22	857.22	857.21	857.21	857.21	857.21	857.21
RR	6	1182	857.21	857.20	857.20	857.20	857.20	857.20	857.20	857.19	857.19	857.19
RR	6	1192	857.19	857.19	857.19	857.18	857.18	857.18	857.18	857.18	857.18	857.18
RR	6	1202	857.17	857.17	857.17	857.17	857.17	857.17	857.16	857.16	857.16	857.16
RR	6	1212	857.16	857.16	857.15	857.15	857.15	857.15	857.15	857.15	857.14	857.14
RR	6	1222	857.14	857.14	857.14	857.14	857.14	857.13	857.13	857.13	857.13	857.13
RR	6	1232	857.13	857.12	857.12	857.12	857.12	857.12	857.12	857.11	857.11	857.11
RR	6	1242	857.11	857.11	857.11	857.10	857.10	857.10	857.10	857.10	857.10	857.10
RR	6	1252	857.09	857.09	857.09	857.09	857.09	857.09	857.08	857.08	857.08	857.08
RR	6	1262	857.08	857.08	857.07	857.07	857.07	857.07	857.07	857.07	857.06	857.06
RR	6	1272	857.06	857.06	857.06	857.06	857.06	857.05	857.05	857.05	857.05	857.05
RR	6	1282	857.05	857.04	857.04	857.04	857.04	857.04	857.04	857.03	857.03	857.03
RR	6	1292	857.03	857.03	857.03	857.02	857.02	857.02	857.02	857.02	857.02	857.02
RR	6	1302	857.01	857.01	857.01	857.01	857.01	857.01	857.00	857.00	857.00	857.00
RR	6	1312	857.00	857.00	856.99	856.99	856.99	856.99	856.99	856.99	856.98	856.98
RR	6	1322	856.98	856.98	856.98	856.98	856.98	856.97	856.97	856.97	856.97	856.97
RR	6	1332	856.97									
RR	7	1333	856.95	856.94	856.93	856.92	856.91	856.89	856.88	856.87	856.86	856.85
RR	7	1343	856.83	856.82	856.81	856.80	856.79	856.77	856.76	856.75	856.74	856.73
RR	7	1353	856.71	856.70	856.69	856.68	856.67	856.65	856.64	856.63	856.62	856.61
RR	7	1363	856.59	856.58	856.57	856.56	856.55	856.53	856.52	856.51	856.50	856.49
RR	7	1373	856.47	856.46	856.45	856.44	856.43	856.41	856.40	856.39	856.38	856.37
RR	7	1383	856.35	856.34	856.33	856.32	856.31	856.29	856.28	856.27	856.26	856.25
RR	7	1393	856.23	856.22	856.21	856.20	856.19	856.17	856.16	856.15	856.14	856.13

RR	7	1403	856.11	856.10	856.09	856.08	856.07	856.05	856.04	856.03	856.02	856.01
RR	7	1413	855.99	855.98	855.97	855.96	855.95	855.93	855.92	855.91	855.90	855.89
RR	7	1423	855.87	855.86	855.85	855.84	855.83	855.81	855.80	855.79	855.78	855.77
RR	7	1433	855.75	855.74	855.73	855.72	855.71	855.69	855.68	855.67	855.66	855.65
RR	7	1443	855.63	855.62	855.61	855.60	855.59	855.57	855.56	855.55	855.54	855.53
RR	10	1900	854.58	854.57	854.57	854.56	854.56	854.55	854.55	854.54	854.54	854.53
RR	10	1910	854.53	854.52	854.52	854.51	854.51	854.50	854.50	854.49	854.49	854.48
RR	10	1920	854.48	854.47	854.47	854.46	854.46	854.45	854.45	854.44	854.44	854.43
RR	10	1930	854.43	854.42	854.42	854.41	854.41	854.40	854.40	854.39	854.39	854.38
RR	16	2168	843.20	843.20	843.20	843.20	843.19	843.19	843.19	843.19	843.19	843.19
RR	16	2178	843.19	843.19	843.19	843.19	843.18	843.18	843.18	843.18	843.18	843.18
RR	16	2188	843.18	843.18	843.18	843.18	843.17	843.17	843.17	843.17	843.17	843.17
RR	16	2198	843.17	843.17	843.17	843.17	843.16	843.16	843.16	843.16	843.16	843.16
RR	16	2208	843.16	843.16	843.16	843.16	843.15	843.15	843.15	843.15	843.15	843.15
RR	16	2218	843.15	843.15	843.15	843.15	843.15	843.14	843.14	843.14	843.14	843.14
RR	16	2228	843.14	843.14	843.14	843.14	843.14	843.13	843.13	843.13	843.13	843.13
RR	16	2238	843.13	843.13	843.13	843.13	843.13	843.12	843.12	843.12	843.12	843.12
RR	16	2248	843.12	843.12	843.12	843.12	843.12	843.11	843.11	843.11	843.11	843.11
RR	16	2258	843.11	843.11	843.11	843.11	843.11	843.10	843.10	843.10	843.10	843.10
RR	16	2268	843.10	843.10	843.10	843.10	843.10	843.09	843.09	843.09	843.09	843.09
RR	16	2278	843.09	843.09	843.09	843.09	843.09	843.08	843.08	843.08	843.08	843.08
RR	16	2288	843.08	843.08	843.08	843.08	843.08	843.07	843.07	843.07	843.07	843.07
RR	16	2298	843.07	843.07	843.07	843.07	843.07	843.06	843.06	843.06	843.06	843.06
RR	16	2308	843.06	843.06	843.06	843.06	843.06	843.05	843.05	843.05	843.05	843.05
RR	16	2318	843.05	843.05	843.05	843.05	843.05					
MK	8	1453	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60
MK	8	1463	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	303.54
MK	8	1473	467.83	467.50	467.17	466.83	466.50	466.18	465.85	465.52	465.20	464.87
MK	8	1483	464.55	464.23	463.91	463.59	463.27	462.96	462.64	462.33	462.02	461.71
MK	8	1493	461.39	461.09	460.78	460.47	460.17	459.86	459.56	459.25	458.95	458.65
MK	8	1503	458.35	458.06	457.76	457.46	457.17	456.88	456.58	456.29	456.00	455.71
MK	8	1513	455.42	455.14	454.85	454.57	454.28	454.00	453.72	453.44	453.16	452.88
MK	8	1523	452.60	452.32	452.05	451.77	451.50	451.22	450.95	450.68	450.41	450.14
MK	8	1533	449.87	449.60	449.34	449.07	448.81	448.54	448.28	448.02	447.76	447.50
MK	8	1543	447.24	446.98	446.72	446.47	446.21	445.96	445.70	445.45	445.20	444.94
MK	8	1553	444.69	444.44	444.20	443.95	443.70	443.45	443.21	442.96	442.72	442.48
MK	8	1563	442.23	441.99	441.75	441.51	441.27	441.03	440.80	440.56	440.32	440.09
MK	8	1573	439.85	439.62	439.39	439.16	438.92	438.69	438.46	438.24	438.01	437.78
MK	8	1583	437.55	437.33	437.10	436.88	436.65	436.43	436.21	435.98	435.76	435.54
MK	8	1593	435.32	435.10	434.88	434.67	434.45	434.23	434.02	433.80	433.59	433.37
MK	8	1603	433.16	432.95	432.74	432.53	432.32	432.11	431.90	431.69	431.48	431.27
MK	8	1613	431.07	430.86	430.66	430.45	430.25	430.04	429.84	429.64	429.44	429.24
MK	8	1623	429.04	428.84	428.64	428.44	428.24	428.04	427.85	427.65	427.45	427.26
MK	8	1633	427.07	426.87	426.68	426.49	426.29	426.10	425.91	425.72	425.53	425.34
MK	8	1643	425.15	424.96	424.78	424.59	424.40	424.22	424.03	423.85	423.66	423.48
MK	8	1653	423.30	423.11	422.93	422.75	422.57	422.39	422.21	422.03	421.85	421.67
MK	8	1663	421.49	421.31	421.14	420.96	420.78	420.61				
MK	9	1669	420.44	420.28	420.12	419.95	419.79	419.63	419.47	419.31	419.15	418.99
MK	9	1679	418.83	418.67	418.51	418.35	418.20	418.04	417.88	417.72	417.57	417.41
MK	9	1689	417.26	417.10	416.95	416.79	416.64	416.49	416.33	416.18	416.03	415.88

MK	9	1699	415.72	415.57	415.42	415.27	415.12	414.97	414.82	414.67	414.52	414.38
MK	9	1709	414.23	414.08	413.93	413.79	413.64	413.50	413.35	413.21	413.06	412.92
MK	9	1719	412.77	412.63	412.48	412.34	412.20	412.06	411.91	411.77	411.63	411.49
MK	9	1729	411.35	411.21	411.07	410.93	410.79	410.65	410.51	410.38	410.24	410.10
MK	9	1739	409.96	409.83	409.69	409.55	409.42	409.28	409.15	409.01	408.88	408.74
MK	9	1749	408.61	408.47	408.34	408.21	408.08	407.94	407.81	407.68	407.55	407.42
MK	9	1759	407.29	407.16	407.03	406.90	406.77	406.64	406.51	406.38	406.25	406.12
MK	9	1769	405.99	405.87	405.74	405.61	405.49	405.36	405.23	405.11	404.98	404.86
MK	9	1779	404.73	404.61	404.48	404.36	404.24	404.11	403.99	403.87	403.74	403.62
MK	9	1789	403.50	403.38	403.26	403.14	403.02	402.89	402.77	402.65	402.53	402.41
MK	9	1799	402.30	402.18	402.06	401.94	401.82	401.70	401.59	401.47	401.35	401.23
MK	9	1809	401.12	401.00	400.88	400.77	400.65	400.54	400.42	400.31	400.19	400.08
MK	9	1819	399.97	399.85	399.74	399.62	399.51	399.40	399.29	399.17	399.06	398.95
MK	9	1829	398.84	398.73	398.62	398.50	398.39	398.28	398.17	398.06	397.95	397.84
MK	9	1839	397.74	397.63	397.52	397.41	397.30	397.19	397.09	396.98	396.87	396.76
MK	9	1849	396.66	396.55	396.44	396.34	396.23	396.13	396.02	395.91	395.81	395.70
MK	9	1859	395.60	395.50	395.39	395.29	395.18	395.08	394.98	394.87	394.77	394.67
MK	9	1869	394.57	394.46	394.36	394.26	394.16	394.06	393.96	393.85	393.75	393.65
MK	9	1879	393.55	393.45	393.35	393.25	393.15	393.05	392.95	392.86	392.76	392.66
MK	9	1889	392.56	392.46	392.36	392.27	392.17	392.07	391.97	391.88	391.78	391.68
MK	9	1899	391.59									
SR	11	1940	145.50	145.50	145.50	145.50	145.50	145.50	145.50	145.51		
SR	12	1948	145.51	145.52	145.52	145.53	145.53	145.54	145.54	145.55	145.55	145.56
SR	12	1958	145.56	145.57	145.57	145.58	145.59	145.59	145.60	145.60	145.61	145.61
SR	12	1968	145.62	145.62	145.63	145.63	145.64	145.64	145.65	145.65	145.66	145.66
SR	12	1978	145.67	145.68	145.68	145.69	145.69	145.70	145.70	145.71	145.71	145.72
SR	12	1988	145.72	145.73	145.73	145.74	145.74	145.75	145.75	145.76	145.76	145.77
SR	12	1998	145.78	145.78	145.79	145.79	145.80	145.80	145.81	145.81	145.82	145.82
SR	12	2008	145.83	145.83	145.84	145.84	145.85					
SR	13	2013	145.87	145.88	145.90	145.92	145.93	145.95	145.97			
SR	14	2020	178.21	178.21	178.21	178.21	178.21	178.21	178.21	178.21	178.21	178.21
SR	14	2030	178.21	178.22	178.22	178.22	178.22	178.22	178.22	178.22	178.22	178.22
SR	14	2040	178.22	178.22	178.22	178.22	178.22	178.23	178.23	178.23	178.23	178.23
SR	14	2050	178.23	178.23	178.23	178.23	178.23	178.23	178.23	178.23	178.23	178.24
SR	14	2060	178.24	178.24	178.24	178.24	178.24	178.24	178.24	178.24	178.24	178.24
SR	14	2070	178.24	178.24	178.24	178.25	178.25	178.25	178.25	178.25	178.25	178.25
SR	14	2080	178.25	178.25	178.25	178.25	178.25	178.25	178.25	178.25	178.26	178.26
SR	14	2090	178.26	178.26	178.26	178.26	178.26	178.26	178.26	178.26	178.26	178.26
SR	14	2100	178.26	178.26	178.27	178.27	178.27					
SR	15	2105	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27
SR	15	2115	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27
SR	15	2125	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27
SR	15	2135	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27
SR	15	2145	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.27	178.28	178.28
SR	15	2155	178.28	178.28	178.28	178.28	178.28	178.28	178.28	178.28	178.28	178.28
SR	15	2165	178.28	178.28	178.28							

.....EXECUTION COMPLETED

APPENDIX L

Model Output for Harmonic Mean Conditions

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LA-QUAL Version 9.08
Louisiana Department of Environmental Quality

Input file is R:\projects\06510-0010-002\tech\Mineral UAA\Mass budget\RedRv_HarMean_proposed_criteria.txt
Running in steady-state mode using LA defaults
Output produced at 07:13 on 01/03/2014

$$$ DATA TYPE 1 (TITLES AND CONTROL CARDS) $$$

CARD TYPE       CONTROL TITLES

TITLE01         LA-QUAL Model for Red River/McKinney/Sulphur
TITLE02         Harmonic mean flow with proposed criteria in AR
CNTROL03   NO   METRIC UNITS
ENDATA01

$$$ DATA TYPE 2 (MODEL OPTIONS) $$$

CARD TYPE       MODEL OPTION

MODOPT01    NO  TEMPERATURE
MODOPT02    NO  SALINITY
MODOPT03   YES  CONSERVATIVE            Chloride                    mg/L     Cl
MODOPT04   YES  CONSERVATIVE            Sulfate                     mg/L     SO4
MODOPT05    NO  DISSOLVED OXYGEN
MODOPT06    NO  BOD2 BIOC
MODOPT07    NO  NITROGEN
MODOPT08    NO  PHOSPHORUS
MODOPT09    NO  PHYTOPLANKTON
MODOPT10    NO  PERIPHYTON
MODOPT11    NO  COLIFORM
MODOPT12   YES  NONCONSERVATIVE         Total Dissolved Solids      mg/L     TDS
ENDATA02

$$$ DATA TYPE 3 (PROGRAM CONSTANTS) $$$

CARD TYPE       DESCRIPTION OF CONSTANT                     VALUE

PROGRAM         HYDRAULIC CALCULATION METHOD      =       2.00000 (widths and depths)
PROGRAM         MAXIMUM ITERATION LIMIT           =     999.00000
ENDATA03

$$$ DATA TYPE 4 (TEMPERATURE CORRECTION CONSTANTS FOR RATE COEFFICIENTS) $$$

 CARD TYPE     RATE CODE     THETA VALUE

ENDATA04

$$$ CONSTANTS TYPE 5 (TEMPERATURE DATA) $$$
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CARD TYPE DESCRIPTION OF CONSTANT VALUE

ENDATA05

$$$ DATA TYPE 6 (PHYTOPLANKTON CONSTANTS) $$$

CARD TYPE DESCRIPTION OF CONSTANT VALUE

ENDATA06

$$$ DATA TYPE 7 (PERIPHYTON CONSTANTS) $$$

CARD TYPE DESCRIPTION OF CONSTANT VALUE

ENDATA07

$$$ DATA TYPE 8 (REACH IDENTIFICATION DATA) $$$

CARD TYPE	REACH	ID	NAME	BEGIN REACH mi		END REACH mi	ELEM LENGTH mi	REACH LENGTH mi	ELEMS PER RCH	BEGIN ELEM NUM	END ELEM NUM
REACH ID	1	RR	Red River 11140106-025	264.70	TO	256.70	0.1000	8.00	80	1	80
REACH ID	2	RR	Red River 11140106-005	256.70	TO	231.40	0.1000	25.30	253	81	333
REACH ID	3	RR	Red River 11140106-003	231.40	TO	221.60	0.1000	9.80	98	334	431
REACH ID	4	RR	Red River 11140106-001	221.60	TO	186.80	0.1000	34.80	348	432	779
REACH ID	5	RR	Red River 11140201-011	186.80	TO	171.60	0.1000	15.20	152	780	931
REACH ID	6	RR	Red River 11140201-007	171.60	TO	131.50	0.1000	40.10	401	932	1332
REACH ID	7	RR	Red River 11140201-005	131.50	TO	119.50	0.1000	12.00	120	1333	1452
REACH ID	8	MK	McKinney Bayou 11140201-014	44.70	TO	23.10	0.1000	21.60	216	1453	1668
REACH ID	9	MK	McKinney Bayou 11140201-012	23.10	TO	0.00	0.1000	23.10	231	1669	1899
REACH ID	10	RR	Red River 11140201-004	119.50	TO	115.50	0.1000	4.00	40	1900	1939
REACH ID	11	SR	Sulphur River 11140302-008	22.80	TO	22.00	0.1000	0.80	8	1940	1947
REACH ID	12	SR	Sulphur River 11140302-006	22.00	TO	15.50	0.1000	6.50	65	1948	2012
REACH ID	13	SR	Sulphur River 11140302-004	15.50	TO	14.80	0.1000	0.70	7	2013	2019
REACH ID	14	SR	Sulphur River 11140302-002	14.80	TO	6.30	0.1000	8.50	85	2020	2104
REACH ID	15	SR	Sulphur River 11140302-001	6.30	TO	0.00	0.1000	6.30	63	2105	2167
REACH ID	16	RR	Red River 11140201-003	115.50	TO	100.00	0.1000	15.50	155	2168	2322

ENDATA08

$$$ DATA TYPE 9 (ADVECTIVE HYDRAULIC COEFFICIENTS) $$$

CARD TYPE	REACH	ID	WIDTH "A"	WIDTH "B"	WIDTH "C"	DEPTH "D"	DEPTH "E"	DEPTH "F"	SLOPE	MANNINGS "N"
HYDR-1	1	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	2	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	3	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	4	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	5	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000
HYDR-1	6	RR	0.000	0.000	500.000	0.000	0.000	10.000	0.00000	0.000

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HYDR-1        7   RR      0.000       0.000      500.000       0.000       0.000      10.000     0.00000   0.000
HYDR-1        8   MK      0.000       0.000       50.000       0.000       0.000       5.000     0.00000   0.000
HYDR-1        9   MK      0.000       0.000       50.000       0.000       0.000       5.000     0.00000   0.000
HYDR-1       10   RR      0.000       0.000      500.000       0.000       0.000      10.000     0.00000   0.000
HYDR-1       11   SR      0.000       0.000      200.000       0.000       0.000       8.000     0.00000   0.000
HYDR-1       12   SR      0.000       0.000      200.000       0.000       0.000       8.000     0.00000   0.000
HYDR-1       13   SR      0.000       0.000      200.000       0.000       0.000       8.000     0.00000   0.000
HYDR-1       14   SR      0.000       0.000      200.000       0.000       0.000       8.000     0.00000   0.000
HYDR-1       15   SR      0.000       0.000      200.000       0.000       0.000       8.000     0.00000   0.000
HYDR-1       16   RR      0.000       0.000      500.000       0.000       0.000      10.000     0.00000   0.000
ENDATA09

$$$ DATA TYPE 10 (DISPERSIVE HYDRAULIC COEFFICIENTS) $$$

CARD TYPE  REACH  ID     TIDAL      DISPERSION      DISPERSION      DISPERSION      DISPERSION
                          RANGE        "A"             "B"             "C"             "D"

ENDATA10

$$$ DATA TYPE 11 (INITIAL CONDITIONS) $$$

CARD TYPE       REACH  ID     TEMP     SALIN       DO     NH3-N     NO3-N     PO4-P     CHL A     PERIP      BOD1      BOD2     ORG-N     ORG-P
COLI       TDS          Cl       SO4
                                deg C      ppt     mg/L      mg/L      mg/L      mg/L      µg/L     mg/ft²      mg/L      mg/L      mg/L      mg/L
#/100mL      mg/L      mg/L      mg/L

INITIAL           1    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    658.10    174.80    145.40
INITIAL           2    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    658.10    174.80    145.40
INITIAL           3    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    658.10    174.80    145.40
INITIAL           4    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    658.10    174.80    145.40
INITIAL           5    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    571.60    141.70    123.00
INITIAL           6    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    592.20    167.10    134.10
INITIAL           7    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    592.20    167.10    134.10
INITIAL           8    MK     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    441.80    103.60     72.50
INITIAL           9    MK     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    492.80    114.60     49.60
INITIAL          10    RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    592.20    167.10    134.10
INITIAL          11    SR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    194.80     20.80     33.20
INITIAL          12    SR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00    194.80     20.80     33.20
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INITIAL          13   SR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   194.80    20.80     33.20
INITIAL          14   SR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   194.80    20.80     33.20
INITIAL          15   SR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   194.80    20.80     33.20
INITIAL          16   RR     30.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00   527.00   125.00    114.00
ENDATA11

$$$ DATA TYPE 12 (REAERATION, SEDIMENT OXYGEN DEMAND, BOD COEFFICIENTS) $$$
                                                                                AEROB                SETTLD     ANAER     AEROB
ANAER      BOD2
CARD     RCH  RCH  K2                    K2        K2        K2      BKGRND      BOD       BOD        SOD       BOD      BOD2      BOD2
BOD2   HYDR TO
TYPE     NUM   ID  OPT                  "A"       "B"       "C"        SOD      DECAY      SETT      AVAIL     DECAY     DECAY     SETT
DECAY      BOD1
                                                                  mg/ft²/d   per day      ft/d       frac   per day   per day      ft/d
per day   per day

ENDATA12

$$$ DATA TYPE 13 (NITROGEN AND PHOSPHORUS COEFFICIENTS) $$$
                                                SETTLD                BKGRND    BKGRND                                          SETTLD
CARD TYPE      REACH  ID       ORG-N     ORG-N     ORGN       NH3       NH3       PO4     DENIT      ORGP      ORGP      ORGP
                              DECA      SETT      AVAIL      DECA      SRCE      SRCE      RATE      DECA      SETT      AVAIL
                           per day      ft/d       frac   per day  mg/ft²/d  mg/ft²/d   per day   per day      ft/d       frac

ENDATA13

$$$ DATA TYPE 14 (ALGAE PHYTOPLANKTON AND PERIPHYTON COEFFICIENTS) $$$
                                                                      MAX                                MAX
CARD TYPE      REACH  ID     SECCHI    CHL A:     PHYTO     PHYTO     PHYTO     PHYTO     PERIP     PERIP     PERIP      BANK
                            DEPTH     ALGAE      SETT     DEATH      GROW      RESP     DEATH      GROW      RESP   SHADING
                               ft      frac      ft/d   per day   per day   per day   per day   per day   per day      frac

ENDATA14

$$$ DATA TYPE 15 (COLIFORM AND NONCONSERVATIVE COEFFICIENTS) $$$

CARD TYPE      REACH  ID    COLIFORM       NCM       NCM
                            DIE-OFF     DECAY      SETT
                            per day   per day      ft/d

COEF-4             1   RR      0.000     0.000     0.000
COEF-4             2   RR      0.000     0.000     0.000
COEF-4             3   RR      0.000     0.000     0.000
COEF-4             4   RR      0.000     0.000     0.000
COEF-4             5   RR      0.000     0.000     0.000
COEF-4             6   RR      0.000     0.000     0.000
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COEF-4	7	RR	0.000	0.000	0.000
COEF-4	8	MK	0.000	0.000	0.000
COEF-4	9	MK	0.000	0.000	0.000
COEF-4	10	RR	0.000	0.000	0.000
COEF-4	11	SR	0.000	0.000	0.000
COEF-4	12	SR	0.000	0.000	0.000
COEF-4	13	SR	0.000	0.000	0.000
COEF-4	14	SR	0.000	0.000	0.000
COEF-4	15	SR	0.000	0.000	0.000
COEF-4	16	RR	0.000	0.000	0.000

ENDATA15

$$$ DATA TYPE 16 (INCREMENTAL DATA FOR FLOW, TEMPERATURE, SALINITY, AND CONSERVATIVES) $$$

CARD TYPE	REACH	ID	OUTFLOW cfs	INFLOW cfs	TEMP deg C	SALIN ppt	Cl mg/L	SO4 mg/L	IN/DIST	OUT/DIST
INCR-1	1	RR	0.00000	11.95000	30.00	0.00	44.40	34.90	1.49375	0.00000
INCR-1	2	RR	0.00000	8.50000	30.00	0.00	44.40	34.90	0.33597	0.00000
INCR-1	3	RR	0.00000	2.13000	30.00	0.00	44.40	34.90	0.21735	0.00000
INCR-1	4	RR	0.00000	19.44000	30.00	0.00	44.40	34.90	0.55862	0.00000
INCR-1	5	RR	0.00000	13.91000	30.00	0.00	25.00	17.30	0.91513	0.00000
INCR-1	6	RR	0.00000	12.82000	30.00	0.00	25.00	17.30	0.31970	0.00000
INCR-1	7	RR	0.00000	29.46000	30.00	0.00	25.00	17.30	2.45500	0.00000
INCR-1	8	MK	0.00000	44.29600	30.00	0.00	44.40	34.90	2.05074	0.00000
INCR-1	9	MK	0.00000	44.29600	30.00	0.00	44.40	34.90	1.91758	0.00000
INCR-1	10	RR	0.00000	4.09000	30.00	0.00	25.00	17.30	1.02250	0.00000
INCR-1	11	SR	0.00000	1.55000	30.00	0.00	39.50	33.80	1.93750	0.00000
INCR-1	12	SR	0.00000	95.98000	30.00	0.00	39.50	33.80	14.76615	0.00000
INCR-1	13	SR	0.00000	32.51000	30.00	0.00	39.50	33.80	46.44287	0.00000
INCR-1	14	SR	0.00000	54.18000	30.00	0.00	39.50	33.80	6.37412	0.00000
INCR-1	15	SR	0.00000	9.29000	30.00	0.00	39.50	33.80	1.47460	0.00000
INCR-1	16	RR	0.00000	3.27000	30.00	0.00	25.00	17.30	0.21097	0.00000

ENDATA16

$$$ DATA TYPE 17 (INCREMENTAL DATA FOR DO, BOD, AND NITROGEN) $$$

CARD TYPE	REACH	ID	DO mg/L	BOD1 mg/L	ORG-N mg/L	NH3-N mg/L	NO3-N mg/L	BOD2 mg/L

ENDATA17

$$$ DATA TYPE 18 (INCREMENTAL DATA FOR PHOSPHORUS, PHYTOPLANKTON, COLIFORM, AND NONCONSERVATIVES) $$$

CARD TYPE	REACH	ID	PO4 mg/L	PHYTO CHL A µg/L	COLI #/100mL	TDS mg/L	ORGP mg/L
INCR-3	1	RR	0.00	0.00	0.00	296.60	0.00
INCR-3	2	RR	0.00	0.00	0.00	296.60	0.00
INCR-3	3	RR	0.00	0.00	0.00	296.60	0.00

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INCR-3            4   RR        0.00       0.00       0.00     296.60       0.00
INCR-3            5   RR        0.00       0.00       0.00     183.50       0.00
INCR-3            6   RR        0.00       0.00       0.00     183.50       0.00
INCR-3            7   RR        0.00       0.00       0.00     183.50       0.00
INCR-3            8   MK        0.00       0.00       0.00     296.60       0.00
INCR-3            9   MK        0.00       0.00       0.00     296.60       0.00
INCR-3           10   RR        0.00       0.00       0.00     183.50       0.00
INCR-3           11   SR        0.00       0.00       0.00     219.00       0.00
INCR-3           12   SR        0.00       0.00       0.00     219.00       0.00
INCR-3           13   SR        0.00       0.00       0.00     219.00       0.00
INCR-3           14   SR        0.00       0.00       0.00     219.00       0.00
INCR-3           15   SR        0.00       0.00       0.00     219.00       0.00
INCR-3           16   RR        0.00       0.00       0.00     183.50       0.00
ENDATA18

$$$ DATA TYPE 19 (NONPOINT SOURCE DATA) $$$

CARD TYPE       REACH  ID        BOD1       ORG-N       COLI        TDS         DO       BOD2      ORG-P
                                  lb/d       lb/d      #/day                   lb/d       lb/d       lb/d

ENDATA19

$$$ DATA TYPE 20 (HEADWATER FOR FLOW, TEMPERATURE, SALINITY AND CONSERVATIVES) $$$

                                                                                                                HDW DISP
CARD TYPE       ELEMENT    NAME                    UNIT       FLOW        FLOW      TEMP      SALIN        Cl        SO4       EXCHG
                                                              m³/s         cfs    deg C       ppt      mg/L       mg/L        frac

HDWTR-1           1        Red River                  0 119.21127 4209.35010     30.00      0.00   269.000    224.000       0.000
HDWTR-1        1453        McKinney Bayou             0   0.07604    2.68500     30.00      0.00    44.400     34.900       0.000
HDWTR-1        1940        Sulphur River              0   8.31209  293.50000     30.00      0.00    13.700     19.000       0.000
ENDATA20

$$$ DATA TYPE 21 (HEADWATER DATA FOR DO, BOD, AND NITROGEN) $$$

CARD TYPE       ELEMENT    NAME                          DO       BOD#1      ORG-N      NH3-N      NO3-N       BOD2
                                                        mg/L        mg/L       mg/L       mg/L       mg/L       mg/L

ENDATA21

$$$ DATA TYPE 22 (HEADWATER DATA FOR PHOSPHORUS, PHYTOPLANKTON, COLIFORM, AND NONCONSERVATIVES) $$$

                                                                   PHYTO
CARD TYPE       ELEMENT    NAME                       PO4-P      CHL A       COLI        TDS      ORG-P
                                                        mg/L        µg/L    #/100mL       mg/L       mg/L

HDWTR-3           1        Red River                  0.00       0.00       0.00     891.00       0.00
HDWTR-3        1453        McKinney Bayou             0.00       0.00       0.00     296.60       0.00
HDWTR-3        1940        Sulphur River              0.00       0.00       0.00     145.50       0.00
ENDATA22

$$$ DATA TYPE 23 (JUNCTION DATA) $$$
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CARD TYPE	JUNCTION ELEMENT	UPSTRM ELEMENT	RIVER KILOM	NAME
JUNCTION	1900	1452	119.50	McKinney Bayou to Red River
JUNCTION	2168	1939	115.50	Sulphur River to Red River

ENDATA23

$$$ DATA TYPE 24 (WASTELOAD DATA FOR FLOW, TEMPERATURE, SALINITY, AND CONSERVATIVES) $$$

CARD TYPE	ELEMENT	RMILE	NAME	FLOW m^3/s	FLOW cfs	FLOW MGD	TEMP deg C	SALIN ppt	Cl mg/L	SO4 mg/L
WSTLD-1	334	231.40	Walnut Bayou	0.38403	13.56000	8.765	30.00	0.00	44.400	34.900
WSTLD-1	485	216.30	AR0002968 - Domtar	2.47137	87.26400	56.409	30.00	0.00	210.000	591.000
WSTLD-1	486	216.20	AR0042951 - Ashdown	0.04820	1.70200	1.100	30.00	0.00	250.000	200.000
WSTLD-1	780	186.80	Little River	32.74738	1156.31006	747.453	30.00	0.00	8.000	7.000
WSTLD-1	781	186.70	AR0051136 - Turk	0.09465	3.34200	2.160	30.00	0.00	250.000	200.000
WSTLD-1	788	186.00	AR0048810 - Fulton	0.00218	0.07700	0.050	30.00	0.00	250.000	200.000
WSTLD-1	789	185.90	ARG670609 - void	0.00000	0.00000	0.000	30.00	0.00	0.000	0.000
WSTLD-1	855	179.30	AR0048356 - Tyson RV	0.02192	0.77400	0.500	30.00	0.00	400.000	800.000
WSTLD-1	932	171.60	Bois d'Arc Creek	2.26338	79.92000	51.661	30.00	0.00	25.000	17.300
WSTLD-1	1059	158.90	AR0050857 - Garland	0.00329	0.11600	0.075	30.00	0.00	250.000	200.000
WSTLD-1	1070	157.80	AR0051942 - Chf Sand	0.00439	0.15500	0.100	30.00	0.00	250.000	200.000
WSTLD-1	1472	42.80	ARG790100 - Poll Mgt	0.00011	0.00400	0.003	30.00	0.00	180.000	60.000
WSTLD-1	1473	42.70	AR0048691 - N Texark	0.04163	1.47000	0.950	30.00	0.00	180.000	60.000
WSTLD-1	1941	22.70	TX0000167 - IP Tex	8.31209	293.50000	189.722	30.00	0.00	120.000	180.000
WSTLD-1	2020	14.80	Days Creek	6.84990	241.87000	156.348	30.00	0.00	39.500	33.800

ENDATA24

$$$ DATA TYPE 25 (WASTELOAD DATA FOR DO, BOD, AND NITROGEN) $$$

CARD TYPE	ELEMENT	NAME	DO mg/L	BOD mg/L	% BOD RMVL	ORG-N mg/L	NH3-N mg/L	% NITRIF	NO3-N mg/L	BOD2 mg/L

ENDATA25

$$$ DATA TYPE 26 (WASTELOAD DATA FOR PHOSPHORUS, PHYTOPLANTON, COLIFORM, AND NONCONSERVATIVES) $$$

CARD TYPE	ELEMENT	NAME	PO4-P mg/L	PHYTO CHL A µg/L	COLI #/100mL	TDS mg/L	ORG-P mg/L
WSTLD-3	334	Walnut Bayou	0.00	0.00	0.00	296.60	0.00
WSTLD-3	485	AR0002968 - Domtar	0.00	0.00	0.00	1638.00	0.00
WSTLD-3	486	AR0042951 - Ashdown	0.00	0.00	0.00	540.00	0.00
WSTLD-3	780	Little River	0.00	0.00	0.00	98.00	0.00
WSTLD-3	781	AR0051136 - Turk	0.00	0.00	0.00	1620.00	0.00
WSTLD-3	788	AR0048810 - Fulton	0.00	0.00	0.00	500.00	0.00
WSTLD-3	789	ARG670609 - void	0.00	0.00	0.00	0.00	0.00
WSTLD-3	855	AR0048356 - Tyson RV	0.00	0.00	0.00	2000.00	0.00

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WSTLD-3          932     Bois d'Arc Creek          0.00      0.00      0.00    183.50      0.00
WSTLD-3         1059     AR0050857 - Garland       0.00      0.00      0.00    500.00      0.00
WSTLD-3         1070     AR0051942 - Chf Sand      0.00      0.00      0.00    500.00      0.00
WSTLD-3         1472     ARG790100 - Poll Mgt      0.00      0.00      0.00    480.00      0.00
WSTLD-3         1473     AR0048691 - N Texark      0.00      0.00      0.00    480.00      0.00
WSTLD-3         1941     TX0000167 - IP Tex        0.00      0.00      0.00    855.00      0.00
WSTLD-3         2020     Days Creek                0.00      0.00      0.00    219.00      0.00
ENDATA26

$$$ DATA TYPE 27 (LOWER BOUNDARY CONDITIONS) $$$

CARD TYPE    CONSTITUENT                    CONCENTRATION

ENDATA27

$$$ DATA TYPE 28 (DAM DATA) $$$

CARD TYPE     ELEMENT   NAME                  EQN      "A"       "B"       "H"

ENDATA28

$$$ DATA TYPE 29 (SENSITIVITY ANALYSIS DATA) $$$

CARD TYPE       PARAMETER     COL 1     COL 2     COL 3     COL 4     COL 5     COL 6     COL 7     COL 8

ENDATA29

$$$ DATA TYPE 30 (PLOT CONTROL CARDS) $$$

PLOT1
RCH   1  2  3  4  5  6  7 10 16
PLOT2
RCH   8  9
PLOT3
RCH  11 12 13 14 15
ENDATA30

$$$ DATA TYPE 31 (OVERLAY PLOT DATA) $$$


OVERLAY1 OVERLAY_Red.ovl
OVERLAY2 OVERLAY_McKinney.ovl
OVERLAY3 OVERLAY_Sulphur.ovl
ENDATA31



     .....NO ERRORS DETECTED IN INPUT DATA
     .....HYDRAULIC CALCULATIONS COMPLETED
     .....TRIDIAGONAL MATRIX TERMS INITIALIZED
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     .....CONSTITUENT CALCULATIONS COMPLETED
     .....GRAPHICS DATA FOR PLOT 1 WRITTEN TO UNIT 11
     .....GRAPHICS DATA FOR PLOT 2 WRITTEN TO UNIT 12
     .....GRAPHICS DATA FOR PLOT 3 WRITTEN TO UNIT 13

INTERMEDIATE REPORT                                    LA-QUAL Model for Red River/McKinney/Sulphur
 Temperature                                           Harmonic mean flow with proposed criteria in AR
     deg C
```

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	11	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	21	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	31	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	41	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	51	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	61	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	1	71	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	81	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	91	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	101	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	111	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	121	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	131	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	141	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	151	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	161	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	171	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	181	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	191	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	201	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	211	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	221	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	231	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	241	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	251	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	261	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	271	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	281	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	291	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	301	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	311	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	321	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	2	331	30.00	30.00	30.00							
RR	3	334	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	344	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	354	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

RR	3	364	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	374	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	384	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	394	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	404	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	414	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	3	424	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
RR	4	432	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	442	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	452	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	462	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	472	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	482	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	492	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	502	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	512	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	522	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	532	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	542	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	552	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	562	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	572	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	582	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	592	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	602	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	612	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	622	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	632	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	642	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	652	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	662	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	672	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	682	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	692	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	702	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	712	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	722	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	732	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	742	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	752	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	762	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	4	772	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
RR	5	780	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	790	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	800	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	810	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	820	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	830	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	840	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	850	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

RR	5	860	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	870	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	880	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	890	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	900	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	910	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	920	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	5	930	30.00	30.00								
RR	6	932	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	942	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	952	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	962	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	972	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	982	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	992	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1002	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1012	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1022	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1032	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1042	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1052	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1062	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1072	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1082	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1092	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1102	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1112	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1122	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1132	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1142	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1152	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1162	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1172	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1182	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1192	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1202	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1212	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1222	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1232	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1242	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1252	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1262	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1272	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1282	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1292	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1302	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1312	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1322	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	6	1332	30.00									
RR	7	1333	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

RR	7	1343	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1353	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1363	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1373	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1383	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1393	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1403	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1413	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1423	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1433	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	7	1443	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1900	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1910	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1920	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	10	1930	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2168	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2178	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2188	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2198	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2208	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2218	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2228	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2238	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2248	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2258	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2268	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2278	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2288	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2298	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2308	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
RR	16	2318	30.00	30.00	30.00	30.00	30.00					
MK	8	1453	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1463	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1473	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1483	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1493	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1503	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1513	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1523	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1533	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1543	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1553	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1563	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1573	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1583	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1593	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1603	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1613	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1623	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1633	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

MK	8	1643	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1653	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	8	1663	30.00	30.00	30.00	30.00	30.00	30.00				
MK	9	1669	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1679	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1689	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1699	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1709	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1719	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1729	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1739	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1749	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1759	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1769	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1779	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1789	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1799	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1809	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1819	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1829	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1839	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1849	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1859	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1869	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1879	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1889	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
MK	9	1899	30.00									
SR	11	1940	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
SR	12	1948	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1958	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1968	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1978	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1988	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	1998	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	12	2008	30.00	30.00	30.00	30.00	30.00					
SR	13	2013	30.00	30.00	30.00	30.00	30.00	30.00	30.00			
SR	14	2020	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2030	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2040	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2050	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2060	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2070	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2080	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2090	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	14	2100	30.00	30.00	30.00	30.00	30.00					
SR	15	2105	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2115	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2125	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2135	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2145	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00

SR	15	2155	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
SR	15	2165	30.00	30.00	30.00							

INTERMEDIATE REPORT
Salinity
ppt

LA-QUAL Model for Red River/McKinney/Sulphur
Harmonic mean flow with proposed criteria in AR

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	1	71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	121	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	131	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	141	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	151	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	161	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	171	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	191	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	211	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	221	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	231	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	241	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	251	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	261	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	271	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	281	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	291	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	301	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	311	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	321	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	2	331	0.00	0.00	0.00							
RR	3	334	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	344	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	354	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	364	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	374	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RR	3	384	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	394	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	404	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	414	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	3	424	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
RR	4	432	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	442	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	452	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	462	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	472	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	482	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	492	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	502	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	512	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	522	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	532	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	542	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	552	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	562	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	572	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	582	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	592	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	602	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	612	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	622	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	632	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	642	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	652	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	662	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	672	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	682	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	692	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	702	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	712	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	722	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	732	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	742	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	752	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	762	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	4	772	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
RR	5	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	790	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	810	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	820	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	840	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	860	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	870	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RR	5	880	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	890	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	5	930	0.00	0.00								
RR	6	932	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	942	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	952	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	962	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	982	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	992	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1032	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1042	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1052	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1062	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1072	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1092	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1122	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1132	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1142	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1152	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1162	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1172	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1182	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1192	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1222	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1232	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1242	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1252	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1262	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1272	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1282	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1292	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1302	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1312	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1322	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	6	1332	0.00									
RR	7	1333	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1343	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1353	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RR	7	1363	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1373	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1383	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1393	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1403	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1413	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1433	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	7	1443	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	10	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2168	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2178	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2188	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2208	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2218	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2228	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2238	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2248	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2258	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2268	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2278	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2288	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2298	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2308	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RR	16	2318	0.00	0.00	0.00	0.00	0.00						
MK	8	1453	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1463	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1473	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1483	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1493	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1503	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1513	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1523	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1533	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1543	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1553	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1563	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1573	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1583	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1593	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1603	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1613	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1623	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1633	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1643	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MK	8	1653	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

MK	8	1663	0.00	0.00	0.00	0.00	0.00	0.00					
MK	9	1669	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1679	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1689	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1699	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1709	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1719	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1729	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1739	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1749	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1759	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1769	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1779	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1789	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1799	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1809	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1819	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1829	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1839	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1849	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1859	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1869	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1879	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1889	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MK	9	1899	0.00										
SR	11	1940	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
SR	12	1948	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	12	1958	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	12	1968	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	12	1978	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	12	1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	12	1998	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	12	2008	0.00	0.00	0.00	0.00	0.00						
SR	13	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
SR	14	2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2060	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2070	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2090	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	14	2100	0.00	0.00	0.00	0.00	0.00						
SR	15	2105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	15	2115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	15	2125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	15	2135	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	15	2145	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	15	2155	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SR	15	2165	0.00	0.00	0.00								

INTERMEDIATE REPORT
Chloride
mg/L

LA-QUAL Model for Red River/McKinney/Sulphur
Harmonic mean flow with proposed criteria in AR

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	268.99	268.98	268.98	268.97	268.96	268.95	268.94	268.94	268.93	268.92
RR	1	11	268.91	268.90	268.90	268.89	268.88	268.87	268.86	268.86	268.85	268.84
RR	1	21	268.83	268.82	268.82	268.81	268.80	268.79	268.79	268.78	268.77	268.76
RR	1	31	268.75	268.75	268.74	268.73	268.72	268.71	268.71	268.70	268.69	268.68
RR	1	41	268.67	268.67	268.66	268.65	268.64	268.63	268.63	268.62	268.61	268.60
RR	1	51	268.59	268.59	268.58	268.57	268.56	268.55	268.55	268.54	268.53	268.52
RR	1	61	268.52	268.51	268.50	268.49	268.48	268.48	268.47	268.46	268.45	268.44
RR	1	71	268.44	268.43	268.42	268.41	268.40	268.40	268.39	268.38	268.37	268.36
RR	2	81	268.36	268.36	268.36	268.36	268.36	268.35	268.35	268.35	268.35	268.35
RR	2	91	268.34	268.34	268.34	268.34	268.34	268.34	268.33	268.33	268.33	268.33
RR	2	101	268.33	268.33	268.32	268.32	268.32	268.32	268.32	268.31	268.31	268.31
RR	2	111	268.31	268.31	268.31	268.30	268.30	268.30	268.30	268.30	268.30	268.29
RR	2	121	268.29	268.29	268.29	268.29	268.28	268.28	268.28	268.28	268.28	268.28
RR	2	131	268.27	268.27	268.27	268.27	268.27	268.26	268.26	268.26	268.26	268.26
RR	2	141	268.26	268.25	268.25	268.25	268.25	268.25	268.25	268.24	268.24	268.24
RR	2	151	268.24	268.24	268.23	268.23	268.23	268.23	268.23	268.23	268.22	268.22
RR	2	161	268.22	268.22	268.22	268.22	268.21	268.21	268.21	268.21	268.21	268.20
RR	2	171	268.20	268.20	268.20	268.20	268.20	268.19	268.19	268.19	268.19	268.19
RR	2	181	268.18	268.18	268.18	268.18	268.18	268.18	268.17	268.17	268.17	268.17
RR	2	191	268.17	268.17	268.16	268.16	268.16	268.16	268.16	268.15	268.15	268.15
RR	2	201	268.15	268.15	268.15	268.14	268.14	268.14	268.14	268.14	268.14	268.13
RR	2	211	268.13	268.13	268.13	268.13	268.12	268.12	268.12	268.12	268.12	268.12
RR	2	221	268.11	268.11	268.11	268.11	268.11	268.11	268.10	268.10	268.10	268.10
RR	2	231	268.10	268.09	268.09	268.09	268.09	268.09	268.09	268.08	268.08	268.08
RR	2	241	268.08	268.08	268.08	268.07	268.07	268.07	268.07	268.07	268.06	268.06
RR	2	251	268.06	268.06	268.06	268.06	268.05	268.05	268.05	268.05	268.05	268.05
RR	2	261	268.04	268.04	268.04	268.04	268.04	268.03	268.03	268.03	268.03	268.03
RR	2	271	268.03	268.02	268.02	268.02	268.02	268.02	268.01	268.01	268.01	268.01
RR	2	281	268.01	268.01	268.00	268.00	268.00	268.00	268.00	268.00	267.99	267.99
RR	2	291	267.99	267.99	267.99	267.98	267.98	267.98	267.98	267.98	267.98	267.97
RR	2	301	267.97	267.97	267.97	267.97	267.97	267.96	267.96	267.96	267.96	267.96
RR	2	311	267.95	267.95	267.95	267.95	267.95	267.95	267.94	267.94	267.94	267.94
RR	2	321	267.94	267.94	267.93	267.93	267.93	267.93	267.93	267.92	267.92	267.92
RR	2	331	267.92	267.92	267.92							
RR	3	334	267.20	267.20	267.20	267.20	267.20	267.19	267.19	267.19	267.19	267.19
RR	3	344	267.19	267.19	267.19	267.19	267.18	267.18	267.18	267.18	267.18	267.18
RR	3	354	267.18	267.18	267.18	267.17	267.17	267.17	267.17	267.17	267.17	267.17
RR	3	364	267.17	267.17	267.16	267.16	267.16	267.16	267.16	267.16	267.16	267.16
RR	3	374	267.15	267.15	267.15	267.15	267.15	267.15	267.15	267.15	267.15	267.14
RR	3	384	267.14	267.14	267.14	267.14	267.14	267.14	267.14	267.14	267.13	267.13
RR	3	394	267.13	267.13	267.13	267.13	267.13	267.13	267.13	267.12	267.12	267.12

RR	3	404	267.12	267.12	267.12	267.12	267.12	267.12	267.11	267.11	267.11	267.11
RR	3	414	267.11	267.11	267.11	267.11	267.10	267.10	267.10	267.10	267.10	267.10
RR	3	424	267.10	267.10	267.10	267.09	267.09	267.09	267.09	267.09		
RR	4	432	267.09	267.08	267.08	267.08	267.08	267.07	267.07	267.07	267.06	267.06
RR	4	442	267.06	267.05	267.05	267.05	267.05	267.04	267.04	267.04	267.03	267.03
RR	4	452	267.03	267.03	267.02	267.02	267.02	267.01	267.01	267.01	267.01	267.00
RR	4	462	267.00	267.00	266.99	266.99	266.99	266.98	266.98	266.98	266.98	266.97
RR	4	472	266.97	266.97	266.96	266.96	266.96	266.96	266.95	266.95	266.95	266.94
RR	4	482	266.94	266.94	266.93	265.79	265.78	265.77	265.77	265.77	265.77	265.76
RR	4	492	265.76	265.76	265.75	265.75	265.75	265.75	265.74	265.74	265.74	265.73
RR	4	502	265.73	265.73	265.73	265.72	265.72	265.72	265.71	265.71	265.71	265.71
RR	4	512	265.70	265.70	265.70	265.69	265.69	265.69	265.69	265.68	265.68	265.68
RR	4	522	265.67	265.67	265.67	265.67	265.66	265.66	265.66	265.66	265.65	265.65
RR	4	532	265.65	265.64	265.64	265.64	265.64	265.64	265.63	265.63	265.62	265.62
RR	4	542	265.62	265.62	265.61	265.61	265.61	265.60	265.60	265.60	265.60	265.59
RR	4	552	265.59	265.59	265.58	265.58	265.58	265.58	265.57	265.57	265.57	265.56
RR	4	562	265.56	265.56	265.56	265.55	265.55	265.55	265.54	265.54	265.54	265.54
RR	4	572	265.53	265.53	265.53	265.52	265.52	265.52	265.52	265.51	265.51	265.51
RR	4	582	265.50	265.50	265.50	265.50	265.49	265.49	265.49	265.48	265.48	265.48
RR	4	592	265.48	265.47	265.47	265.47	265.46	265.46	265.46	265.46	265.45	265.45
RR	4	602	265.45	265.45	265.44	265.44	265.44	265.43	265.43	265.43	265.43	265.42
RR	4	612	265.42	265.42	265.41	265.41	265.41	265.41	265.40	265.40	265.40	265.39
RR	4	622	265.39	265.39	265.39	265.38	265.38	265.38	265.37	265.37	265.37	265.37
RR	4	632	265.36	265.36	265.36	265.35	265.35	265.35	265.35	265.34	265.34	265.34
RR	4	642	265.33	265.33	265.33	265.33	265.32	265.32	265.32	265.31	265.31	265.31
RR	4	652	265.31	265.30	265.30	265.30	265.29	265.29	265.29	265.29	265.28	265.28
RR	4	662	265.28	265.27	265.27	265.27	265.27	265.26	265.26	265.26	265.25	265.25
RR	4	672	265.25	265.25	265.24	265.24	265.24	265.24	265.23	265.23	265.23	265.22
RR	4	682	265.22	265.22	265.22	265.21	265.21	265.21	265.20	265.20	265.20	265.20
RR	4	692	265.19	265.19	265.19	265.18	265.18	265.18	265.18	265.17	265.17	265.17
RR	4	702	265.16	265.16	265.16	265.16	265.15	265.15	265.15	265.14	265.14	265.14
RR	4	712	265.14	265.13	265.13	265.13	265.12	265.12	265.12	265.12	265.11	265.11
RR	4	722	265.11	265.10	265.10	265.10	265.10	265.09	265.09	265.09	265.08	265.08
RR	4	732	265.08	265.08	265.07	265.07	265.07	265.07	265.06	265.06	265.06	265.05
RR	4	742	265.05	265.05	265.05	265.04	265.04	265.04	265.03	265.03	265.03	265.03
RR	4	752	265.02	265.02	265.02	265.01	265.01	265.01	265.01	265.00	265.00	265.00
RR	4	762	264.99	264.99	264.99	264.99	264.98	264.98	264.98	264.97	264.97	264.97
RR	4	772	264.97	264.96	264.96	264.96	264.95	264.95	264.95	264.95		
RR	5	780	211.02	211.04	211.04	211.04	211.03	211.03	211.03	211.03	211.02	211.02
RR	5	790	211.02	211.01	211.01	211.01	211.00	211.00	211.00	211.00	210.99	210.99
RR	5	800	210.99	210.98	210.98	210.98	210.97	210.97	210.97	210.96	210.96	210.96
RR	5	810	210.96	210.95	210.95	210.95	210.94	210.94	210.94	210.93	210.93	210.93
RR	5	820	210.92	210.92	210.92	210.92	210.91	210.91	210.91	210.90	210.90	210.90
RR	5	830	210.89	210.89	210.89	210.88	210.88	210.88	210.88	210.87	210.87	210.87
RR	5	840	210.86	210.86	210.86	210.85	210.85	210.85	210.84	210.84	210.84	210.84
RR	5	850	210.83	210.83	210.83	210.82	210.82	210.84	210.84	210.84	210.83	210.83
RR	5	860	210.83	210.82	210.82	210.82	210.82	210.81	210.81	210.81	210.80	210.80
RR	5	870	210.80	210.79	210.79	210.79	210.78	210.78	210.78	210.78	210.77	210.77
RR	5	880	210.77	210.76	210.76	210.76	210.75	210.75	210.75	210.74	210.74	210.74
RR	5	890	210.74	210.73	210.73	210.73	210.72	210.72	210.72	210.71	210.71	210.71

RR	5	900	210.71	210.70	210.70	210.70	210.69	210.69	210.69	210.68	210.68	210.68
RR	5	910	210.67	210.67	210.67	210.67	210.66	210.66	210.66	210.65	210.65	210.65
RR	5	920	210.64	210.64	210.64	210.63	210.63	210.63	210.63	210.62	210.62	210.62
RR	5	930	210.61	210.61								
RR	6	932	207.96	207.96	207.96	207.96	207.96	207.96	207.96	207.96	207.96	207.95
RR	6	942	207.95	207.95	207.95	207.95	207.95	207.95	207.95	207.95	207.95	207.94
RR	6	952	207.94	207.94	207.94	207.94	207.94	207.94	207.94	207.94	207.93	207.93
RR	6	962	207.93	207.93	207.93	207.93	207.93	207.93	207.93	207.93	207.92	207.92
RR	6	972	207.92	207.92	207.92	207.92	207.92	207.92	207.92	207.92	207.91	207.91
RR	6	982	207.91	207.91	207.91	207.91	207.91	207.91	207.91	207.91	207.90	207.90
RR	6	992	207.90	207.90	207.90	207.90	207.90	207.90	207.90	207.89	207.89	207.89
RR	6	1002	207.89	207.89	207.89	207.89	207.89	207.89	207.89	207.88	207.88	207.88
RR	6	1012	207.88	207.88	207.88	207.88	207.88	207.88	207.88	207.87	207.87	207.87
RR	6	1022	207.87	207.87	207.87	207.87	207.87	207.87	207.86	207.86	207.86	207.86
RR	6	1032	207.86	207.86	207.86	207.86	207.86	207.86	207.85	207.85	207.85	207.85
RR	6	1042	207.85	207.85	207.85	207.85	207.85	207.85	207.84	207.84	207.84	207.84
RR	6	1052	207.84	207.84	207.84	207.84	207.84	207.84	207.83	207.83	207.83	207.83
RR	6	1062	207.83	207.83	207.83	207.83	207.83	207.83	207.82	207.82	207.82	207.82
RR	6	1072	207.82	207.82	207.82	207.82	207.82	207.82	207.82	207.81	207.81	207.81
RR	6	1082	207.81	207.81	207.81	207.81	207.81	207.81	207.81	207.80	207.80	207.80
RR	6	1092	207.80	207.80	207.80	207.80	207.80	207.80	207.79	207.79	207.79	207.79
RR	6	1102	207.79	207.79	207.79	207.79	207.79	207.79	207.78	207.78	207.78	207.78
RR	6	1112	207.78	207.78	207.78	207.78	207.78	207.78	207.77	207.77	207.77	207.77
RR	6	1122	207.77	207.77	207.77	207.77	207.77	207.77	207.76	207.76	207.76	207.76
RR	6	1132	207.76	207.76	207.76	207.76	207.76	207.75	207.75	207.75	207.75	207.75
RR	6	1142	207.75	207.75	207.75	207.75	207.75	207.74	207.74	207.74	207.74	207.74
RR	6	1152	207.74	207.74	207.74	207.74	207.74	207.73	207.73	207.73	207.73	207.73
RR	6	1162	207.73	207.73	207.73	207.73	207.72	207.72	207.72	207.72	207.72	207.72
RR	6	1172	207.72	207.72	207.72	207.72	207.71	207.71	207.71	207.71	207.71	207.71
RR	6	1182	207.71	207.71	207.71	207.71	207.70	207.70	207.70	207.70	207.70	207.70
RR	6	1192	207.70	207.70	207.70	207.70	207.69	207.69	207.69	207.69	207.69	207.69
RR	6	1202	207.69	207.69	207.69	207.68	207.68	207.68	207.68	207.68	207.68	207.68
RR	6	1212	207.68	207.68	207.68	207.67	207.67	207.67	207.67	207.67	207.67	207.67
RR	6	1222	207.67	207.67	207.67	207.66	207.66	207.66	207.66	207.66	207.66	207.66
RR	6	1232	207.66	207.66	207.65	207.65	207.65	207.65	207.65	207.65	207.65	207.65
RR	6	1242	207.65	207.65	207.64	207.64	207.64	207.64	207.64	207.64	207.64	207.64
RR	6	1252	207.64	207.64	207.63	207.63	207.63	207.63	207.63	207.63	207.63	207.63
RR	6	1262	207.63	207.63	207.62	207.62	207.62	207.62	207.62	207.62	207.62	207.62
RR	6	1272	207.62	207.61	207.61	207.61	207.61	207.61	207.61	207.61	207.61	207.61
RR	6	1282	207.61	207.60	207.60	207.60	207.60	207.60	207.60	207.60	207.60	207.60
RR	6	1292	207.60	207.59	207.59	207.59	207.59	207.59	207.59	207.59	207.59	207.59
RR	6	1302	207.59	207.58	207.58	207.58	207.58	207.58	207.58	207.58	207.58	207.58
RR	6	1312	207.57	207.57	207.57	207.57	207.57	207.57	207.57	207.57	207.57	207.57
RR	6	1322	207.56	207.56	207.56	207.56	207.56	207.56	207.56	207.56	207.56	207.56
RR	6	1332	207.55									
RR	7	1333	207.55	207.54	207.53	207.52	207.51	207.51	207.50	207.49	207.48	207.47
RR	7	1343	207.47	207.46	207.45	207.44	207.43	207.43	207.42	207.41	207.40	207.39
RR	7	1353	207.39	207.38	207.37	207.36	207.35	207.35	207.34	207.33	207.32	207.31
RR	7	1363	207.31	207.30	207.29	207.28	207.28	207.27	207.26	207.25	207.24	207.24
RR	7	1373	207.23	207.22	207.21	207.20	207.20	207.19	207.18	207.17	207.16	207.16

RR	7	1383	207.15	207.14	207.13	207.12	207.12	207.11	207.10	207.09	207.08	207.08
RR	7	1393	207.07	207.06	207.05	207.04	207.04	207.03	207.02	207.01	207.00	207.00
RR	7	1403	206.99	206.98	206.97	206.96	206.96	206.95	206.94	206.93	206.93	206.92
RR	7	1413	206.91	206.90	206.89	206.89	206.88	206.87	206.86	206.85	206.85	206.84
RR	7	1423	206.83	206.82	206.81	206.81	206.80	206.79	206.78	206.77	206.77	206.76
RR	7	1433	206.75	206.74	206.73	206.73	206.72	206.71	206.70	206.70	206.69	206.68
RR	7	1443	206.67	206.66	206.66	206.65	206.64	206.63	206.62	206.62	206.61	206.60
RR	10	1900	204.01	204.01	204.01	204.00	204.00	204.00	203.99	203.99	203.99	203.98
RR	10	1910	203.98	203.98	203.97	203.97	203.97	203.96	203.96	203.96	203.96	203.95
RR	10	1920	203.95	203.95	203.94	203.94	203.94	203.93	203.93	203.93	203.92	203.92
RR	10	1930	203.92	203.91	203.91	203.91	203.90	203.90	203.90	203.89	203.89	203.89
RR	16	2168	181.43	181.43	181.43	181.43	181.43	181.43	181.43	181.43	181.43	181.43
RR	16	2178	181.43	181.43	181.43	181.43	181.43	181.43	181.43	181.43	181.43	181.42
RR	16	2188	181.42	181.42	181.42	181.42	181.42	181.42	181.42	181.42	181.42	181.42
RR	16	2198	181.42	181.42	181.42	181.42	181.42	181.42	181.42	181.42	181.42	181.42
RR	16	2208	181.41	181.41	181.41	181.41	181.41	181.41	181.41	181.41	181.41	181.41
RR	16	2218	181.41	181.41	181.41	181.41	181.41	181.41	181.41	181.41	181.41	181.41
RR	16	2228	181.41	181.40	181.40	181.40	181.40	181.40	181.40	181.40	181.40	181.40
RR	16	2238	181.40	181.40	181.40	181.40	181.40	181.40	181.40	181.40	181.40	181.40
RR	16	2248	181.40	181.40	181.39	181.39	181.39	181.39	181.39	181.39	181.39	181.39
RR	16	2258	181.39	181.39	181.39	181.39	181.39	181.39	181.39	181.39	181.39	181.39
RR	16	2268	181.39	181.39	181.38	181.38	181.38	181.38	181.38	181.38	181.38	181.38
RR	16	2278	181.38	181.38	181.38	181.38	181.38	181.38	181.38	181.38	181.38	181.38
RR	16	2288	181.38	181.38	181.38	181.37	181.37	181.37	181.37	181.37	181.37	181.37
RR	16	2298	181.37	181.37	181.37	181.37	181.37	181.37	181.37	181.37	181.37	181.37
RR	16	2308	181.37	181.37	181.37	181.37	181.36	181.36	181.36	181.36	181.36	181.36
RR	16	2318	181.36	181.36	181.36	181.36	181.36					
MK	8	1453	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40
MK	8	1463	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.40	44.48
MK	8	1473	68.01	67.45	66.92	66.41	65.92	65.46	65.01	64.59	64.18	63.78
MK	8	1483	63.41	63.04	62.69	62.36	62.03	61.72	61.42	61.12	60.84	60.57
MK	8	1493	60.30	60.05	59.80	59.56	59.33	59.10	58.89	58.67	58.47	58.27
MK	8	1503	58.07	57.88	57.70	57.52	57.35	57.18	57.01	56.85	56.69	56.54
MK	8	1513	56.39	56.25	56.10	55.96	55.83	55.70	55.57	55.44	55.32	55.20
MK	8	1523	55.08	54.96	54.85	54.74	54.63	54.52	54.42	54.32	54.22	54.12
MK	8	1533	54.02	53.93	53.84	53.75	53.66	53.57	53.49	53.40	53.32	53.24
MK	8	1543	53.16	53.08	53.00	52.93	52.85	52.78	52.71	52.64	52.57	52.50
MK	8	1553	52.44	52.37	52.31	52.24	52.18	52.12	52.06	52.00	51.94	51.88
MK	8	1563	51.82	51.77	51.71	51.66	51.60	51.55	51.50	51.45	51.40	51.35
MK	8	1573	51.30	51.25	51.20	51.16	51.11	51.06	51.02	50.97	50.93	50.89
MK	8	1583	50.84	50.80	50.76	50.72	50.68	50.64	50.60	50.56	50.52	50.48
MK	8	1593	50.44	50.41	50.37	50.33	50.30	50.26	50.23	50.19	50.16	50.12
MK	8	1603	50.09	50.06	50.02	49.99	49.96	49.93	49.90	49.87	49.84	49.81
MK	8	1613	49.78	49.75	49.72	49.69	49.66	49.63	49.60	49.58	49.55	49.52
MK	8	1623	49.50	49.47	49.44	49.42	49.39	49.37	49.34	49.32	49.29	49.27
MK	8	1633	49.24	49.22	49.19	49.17	49.15	49.12	49.10	49.08	49.06	49.03
MK	8	1643	49.01	48.99	48.97	48.95	48.93	48.91	48.89	48.86	48.84	48.82
MK	8	1653	48.80	48.78	48.76	48.75	48.73	48.71	48.69	48.67	48.65	48.63
MK	8	1663	48.61	48.60	48.58	48.56	48.54	48.52				
MK	9	1669	48.51	48.49	48.48	48.46	48.44	48.43	48.41	48.40	48.38	48.37

MK	9	1679	48.35	48.34	48.32	48.31	48.29	48.28	48.26	48.25	48.24	48.22
MK	9	1689	48.21	48.19	48.18	48.17	48.15	48.14	48.13	48.11	48.10	48.09
MK	9	1699	48.07	48.06	48.05	48.04	48.02	48.01	48.00	47.99	47.97	47.96
MK	9	1709	47.95	47.94	47.92	47.91	47.90	47.89	47.88	47.87	47.85	47.84
MK	9	1719	47.83	47.82	47.81	47.80	47.79	47.78	47.77	47.75	47.74	47.73
MK	9	1729	47.72	47.71	47.70	47.69	47.68	47.67	47.66	47.65	47.64	47.63
MK	9	1739	47.62	47.61	47.60	47.59	47.58	47.57	47.56	47.55	47.54	47.53
MK	9	1749	47.52	47.51	47.50	47.50	47.49	47.48	47.47	47.46	47.45	47.44
MK	9	1759	47.43	47.42	47.41	47.41	47.40	47.39	47.38	47.37	47.36	47.36
MK	9	1769	47.35	47.34	47.33	47.32	47.31	47.31	47.30	47.29	47.28	47.27
MK	9	1779	47.27	47.26	47.25	47.24	47.23	47.23	47.22	47.21	47.20	47.20
MK	9	1789	47.19	47.18	47.17	47.17	47.16	47.15	47.14	47.14	47.13	47.12
MK	9	1799	47.12	47.11	47.10	47.10	47.09	47.08	47.07	47.07	47.06	47.05
MK	9	1809	47.05	47.04	47.03	47.03	47.02	47.01	47.01	47.00	46.99	46.99
MK	9	1819	46.98	46.98	46.97	46.96	46.96	46.95	46.94	46.94	46.93	46.93
MK	9	1829	46.92	46.91	46.91	46.90	46.90	46.89	46.88	46.88	46.87	46.87
MK	9	1839	46.86	46.85	46.85	46.84	46.84	46.83	46.83	46.82	46.81	46.81
MK	9	1849	46.80	46.80	46.79	46.79	46.78	46.78	46.77	46.76	46.76	46.75
MK	9	1859	46.75	46.74	46.74	46.73	46.73	46.72	46.72	46.71	46.71	46.70
MK	9	1869	46.70	46.69	46.69	46.68	46.68	46.67	46.67	46.66	46.66	46.65
MK	9	1879	46.65	46.64	46.64	46.63	46.63	46.62	46.62	46.61	46.61	46.60
MK	9	1889	46.60	46.60	46.59	46.59	46.58	46.58	46.57	46.57	46.56	46.56
MK	9	1899	46.55									
SR	11	1940	13.72	66.83	66.82	66.81	66.80	66.80	66.79	66.78		
SR	12	1948	66.71	66.64	66.57	66.51	66.44	66.37	66.31	66.24	66.18	66.11
SR	12	1958	66.05	65.98	65.92	65.85	65.79	65.73	65.66	65.60	65.54	65.47
SR	12	1968	65.41	65.35	65.29	65.23	65.17	65.11	65.05	64.99	64.93	64.87
SR	12	1978	64.81	64.75	64.69	64.63	64.58	64.52	64.46	64.40	64.35	64.29
SR	12	1988	64.23	64.18	64.12	64.07	64.01	63.96	63.90	63.85	63.79	63.74
SR	12	1998	63.68	63.63	63.58	63.52	63.47	63.42	63.37	63.31	63.26	63.21
SR	12	2008	63.16	63.11	63.05	63.00	62.95					
SR	13	2013	62.80	62.64	62.49	62.33	62.18	62.04	61.89			
SR	14	2020	56.23	56.22	56.21	56.20	56.19	56.18	56.16	56.15	56.14	56.13
SR	14	2030	56.12	56.11	56.10	56.09	56.08	56.07	56.06	56.04	56.03	56.02
SR	14	2040	56.01	56.00	55.99	55.98	55.97	55.96	55.95	55.94	55.93	55.92
SR	14	2050	55.90	55.89	55.88	55.87	55.86	55.85	55.84	55.83	55.82	55.81
SR	14	2060	55.80	55.79	55.78	55.77	55.76	55.75	55.74	55.72	55.71	55.70
SR	14	2070	55.69	55.68	55.67	55.66	55.65	55.64	55.63	55.62	55.61	55.60
SR	14	2080	55.59	55.58	55.57	55.56	55.55	55.54	55.53	55.52	55.51	55.50
SR	14	2090	55.49	55.48	55.47	55.46	55.45	55.44	55.43	55.42	55.41	55.40
SR	14	2100	55.39	55.38	55.37	55.36	55.35					
SR	15	2105	55.34	55.34	55.34	55.34	55.34	55.33	55.33	55.33	55.33	55.32
SR	15	2115	55.32	55.32	55.32	55.31	55.31	55.31	55.31	55.31	55.30	55.30
SR	15	2125	55.30	55.30	55.29	55.29	55.29	55.29	55.28	55.28	55.28	55.28
SR	15	2135	55.28	55.27	55.27	55.27	55.27	55.26	55.26	55.26	55.26	55.26
SR	15	2145	55.25	55.25	55.25	55.25	55.24	55.24	55.24	55.24	55.23	55.23
SR	15	2155	55.23	55.23	55.23	55.22	55.22	55.22	55.22	55.21	55.21	55.21
SR	15	2165	55.21	55.21	55.20							

INTERMEDIATE REPORT
Sulfate
mg/L

LA-QUAL Model for Red River/McKinney/Sulphur
Harmonic mean flow with proposed criteria in AR

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	223.99	223.99	223.98	223.97	223.97	223.96	223.95	223.95	223.94	223.93
RR	1	11	223.93	223.92	223.91	223.91	223.90	223.89	223.89	223.88	223.87	223.87
RR	1	21	223.86	223.85	223.85	223.84	223.83	223.83	223.82	223.81	223.81	223.80
RR	1	31	223.79	223.79	223.78	223.77	223.77	223.76	223.75	223.75	223.74	223.73
RR	1	41	223.73	223.72	223.71	223.71	223.70	223.69	223.69	223.68	223.67	223.67
RR	1	51	223.66	223.65	223.65	223.64	223.63	223.63	223.62	223.61	223.61	223.60
RR	1	61	223.59	223.59	223.58	223.57	223.57	223.56	223.55	223.55	223.54	223.53
RR	1	71	223.53	223.52	223.51	223.51	223.50	223.49	223.49	223.48	223.47	223.47
RR	2	81	223.46	223.46	223.46	223.46	223.46	223.46	223.46	223.45	223.45	223.45
RR	2	91	223.45	223.45	223.45	223.44	223.44	223.44	223.44	223.44	223.44	223.44
RR	2	101	223.43	223.43	223.43	223.43	223.43	223.43	223.43	223.42	223.42	223.42
RR	2	111	223.42	223.42	223.42	223.41	223.41	223.41	223.41	223.41	223.41	223.41
RR	2	121	223.40	223.40	223.40	223.40	223.40	223.40	223.40	223.39	223.39	223.39
RR	2	131	223.39	223.39	223.39	223.38	223.38	223.38	223.38	223.38	223.38	223.38
RR	2	141	223.37	223.37	223.37	223.37	223.37	223.37	223.36	223.36	223.36	223.36
RR	2	151	223.36	223.36	223.36	223.35	223.35	223.35	223.35	223.35	223.35	223.35
RR	2	161	223.34	223.34	223.34	223.34	223.34	223.34	223.33	223.33	223.33	223.33
RR	2	171	223.33	223.33	223.33	223.32	223.32	223.32	223.32	223.32	223.32	223.32
RR	2	181	223.31	223.31	223.31	223.31	223.31	223.31	223.30	223.30	223.30	223.30
RR	2	191	223.30	223.30	223.30	223.29	223.29	223.29	223.29	223.29	223.29	223.29
RR	2	201	223.28	223.28	223.28	223.28	223.28	223.28	223.27	223.27	223.27	223.27
RR	2	211	223.27	223.27	223.27	223.26	223.26	223.26	223.26	223.26	223.26	223.26
RR	2	221	223.25	223.25	223.25	223.25	223.25	223.25	223.24	223.24	223.24	223.24
RR	2	231	223.24	223.24	223.24	223.23	223.23	223.23	223.23	223.23	223.23	223.23
RR	2	241	223.22	223.22	223.22	223.22	223.22	223.22	223.21	223.21	223.21	223.21
RR	2	251	223.21	223.21	223.21	223.20	223.20	223.20	223.20	223.20	223.20	223.20
RR	2	261	223.19	223.19	223.19	223.19	223.19	223.19	223.18	223.18	223.18	223.18
RR	2	271	223.18	223.18	223.18	223.17	223.17	223.17	223.17	223.17	223.17	223.17
RR	2	281	223.16	223.16	223.16	223.16	223.16	223.16	223.15	223.15	223.15	223.15
RR	2	291	223.15	223.15	223.15	223.14	223.14	223.14	223.14	223.14	223.14	223.14
RR	2	301	223.13	223.13	223.13	223.13	223.13	223.13	223.12	223.12	223.12	223.12
RR	2	311	223.12	223.12	223.12	223.11	223.11	223.11	223.11	223.11	223.11	223.11
RR	2	321	223.10	223.10	223.10	223.10	223.10	223.10	223.09	223.09	223.09	223.09
RR	2	331	223.09	223.09	223.09							
RR	3	334	222.48	222.48	222.48	222.48	222.48	222.48	222.48	222.48	222.48	222.47
RR	3	344	222.47	222.47	222.47	222.47	222.47	222.47	222.47	222.47	222.47	222.47
RR	3	354	222.46	222.46	222.46	222.46	222.46	222.46	222.46	222.46	222.46	222.46
RR	3	364	222.45	222.45	222.45	222.45	222.45	222.45	222.45	222.45	222.45	222.45
RR	3	374	222.44	222.44	222.44	222.44	222.44	222.44	222.44	222.44	222.44	222.44
RR	3	384	222.44	222.43	222.43	222.43	222.43	222.43	222.43	222.43	222.43	222.43
RR	3	394	222.43	222.42	222.42	222.42	222.42	222.42	222.42	222.42	222.42	222.42
RR	3	404	222.42	222.41	222.41	222.41	222.41	222.41	222.41	222.41	222.41	222.41
RR	3	414	222.41	222.41	222.40	222.40	222.40	222.40	222.40	222.40	222.40	222.40

RR	3	424	222.40	222.40	222.39	222.39	222.39	222.39	222.39	222.39			
RR	4	432	222.39	222.38	222.38	222.38	222.38	222.38	222.37	222.37	222.37	222.37	
RR	4	442	222.36	222.36	222.36	222.36	222.35	222.35	222.35	222.35	222.34	222.34	
RR	4	452	222.34	222.34	222.33	222.33	222.33	222.33	222.32	222.32	222.32	222.32	
RR	4	462	222.31	222.31	222.31	222.31	222.30	222.30	222.30	222.30	222.29	222.29	
RR	4	472	222.29	222.29	222.28	222.28	222.28	222.28	222.27	222.27	222.27	222.27	
RR	4	482	222.26	222.26	222.26	229.68	229.66	229.66	229.66	229.66	229.65	229.65	
RR	4	492	229.65	229.65	229.64	229.64	229.64	229.64	229.63	229.63	229.63	229.63	
RR	4	502	229.62	229.62	229.62	229.62	229.61	229.61	229.61	229.61	229.60	229.60	
RR	4	512	229.60	229.60	229.59	229.59	229.59	229.59	229.58	229.58	229.58	229.58	
RR	4	522	229.57	229.57	229.57	229.57	229.56	229.56	229.56	229.56	229.55	229.55	
RR	4	532	229.55	229.55	229.54	229.54	229.54	229.54	229.53	229.53	229.53	229.53	
RR	4	542	229.52	229.52	229.52	229.52	229.51	229.51	229.51	229.51	229.50	229.50	
RR	4	552	229.50	229.50	229.49	229.49	229.49	229.49	229.48	229.48	229.48	229.48	
RR	4	562	229.47	229.47	229.47	229.47	229.46	229.46	229.46	229.46	229.45	229.45	
RR	4	572	229.45	229.45	229.44	229.44	229.44	229.44	229.43	229.43	229.43	229.43	
RR	4	582	229.42	229.42	229.42	229.42	229.41	229.41	229.41	229.41	229.40	229.40	
RR	4	592	229.40	229.40	229.39	229.39	229.39	229.39	229.38	229.38	229.38	229.38	
RR	4	602	229.37	229.37	229.37	229.37	229.36	229.36	229.36	229.36	229.35	229.35	
RR	4	612	229.35	229.35	229.34	229.34	229.34	229.34	229.33	229.33	229.33	229.33	
RR	4	622	229.32	229.32	229.32	229.32	229.31	229.31	229.31	229.31	229.30	229.30	
RR	4	632	229.30	229.30	229.29	229.29	229.29	229.29	229.28	229.28	229.28	229.28	
RR	4	642	229.27	229.27	229.27	229.27	229.26	229.26	229.26	229.26	229.25	229.25	
RR	4	652	229.25	229.25	229.24	229.24	229.24	229.24	229.23	229.23	229.23	229.23	
RR	4	662	229.22	229.22	229.22	229.22	229.21	229.21	229.21	229.21	229.20	229.20	
RR	4	672	229.20	229.20	229.19	229.19	229.19	229.19	229.18	229.18	229.18	229.18	
RR	4	682	229.17	229.17	229.17	229.17	229.16	229.16	229.16	229.16	229.15	229.15	
RR	4	692	229.15	229.15	229.14	229.14	229.14	229.14	229.13	229.13	229.13	229.13	
RR	4	702	229.12	229.12	229.12	229.12	229.11	229.11	229.11	229.11	229.10	229.10	
RR	4	712	229.10	229.10	229.09	229.09	229.09	229.09	229.08	229.08	229.08	229.08	
RR	4	722	229.07	229.07	229.07	229.07	229.06	229.06	229.06	229.06	229.05	229.05	
RR	4	732	229.05	229.05	229.04	229.04	229.04	229.04	229.03	229.03	229.03	229.03	
RR	4	742	229.02	229.02	229.02	229.02	229.01	229.01	229.01	229.01	229.00	229.00	
RR	4	752	229.00	229.00	228.99	228.99	228.99	228.99	228.98	228.98	228.98	228.98	
RR	4	762	228.97	228.97	228.97	228.97	228.96	228.96	228.96	228.96	228.95	228.95	
RR	4	772	228.95	228.95	228.94	228.94	228.94	228.94	228.93	228.93			
RR	5	780	182.36	182.37	182.36	182.36	182.36	182.35	182.35	182.35	182.35	182.34	
RR	5	790	182.34	182.34	182.34	182.33	182.33	182.33	182.32	182.32	182.32	182.32	
RR	5	800	182.31	182.31	182.31	182.31	182.30	182.30	182.30	182.29	182.29	182.29	
RR	5	810	182.29	182.28	182.28	182.28	182.27	182.27	182.27	182.27	182.26	182.26	
RR	5	820	182.26	182.26	182.25	182.25	182.25	182.24	182.24	182.24	182.24	182.23	
RR	5	830	182.23	182.23	182.23	182.22	182.22	182.22	182.21	182.21	182.21	182.21	
RR	5	840	182.20	182.20	182.20	182.20	182.19	182.19	182.19	182.18	182.18	182.18	
RR	5	850	182.18	182.17	182.17	182.17	182.17	182.25	182.25	182.24	182.24	182.24	
RR	5	860	182.24	182.23	182.23	182.23	182.22	182.22	182.22	182.22	182.21	182.21	
RR	5	870	182.21	182.21	182.20	182.20	182.20	182.19	182.19	182.19	182.19	182.18	
RR	5	880	182.18	182.18	182.18	182.18	182.17	182.17	182.17	182.16	182.16	182.16	182.16
RR	5	890	182.15	182.15	182.15	182.15	182.14	182.14	182.14	182.13	182.13	182.13	
RR	5	900	182.13	182.12	182.12	182.12	182.12	182.11	182.11	182.11	182.10	182.10	
RR	5	910	182.10	182.10	182.09	182.09	182.09	182.09	182.08	182.08	182.08	182.07	

RR	5	920	182.07	182.07	182.07	182.06	182.06	182.06	182.06	182.05	182.05	182.05
RR	5	930	182.04	182.04								
RR	6	932	179.69	179.69	179.69	179.69	179.69	179.69	179.69	179.69	179.69	179.68
RR	6	942	179.68	179.68	179.68	179.68	179.68	179.68	179.68	179.68	179.68	179.68
RR	6	952	179.67	179.67	179.67	179.67	179.67	179.67	179.67	179.67	179.67	179.67
RR	6	962	179.67	179.66	179.66	179.66	179.66	179.66	179.66	179.66	179.66	179.66
RR	6	972	179.66	179.66	179.65	179.65	179.65	179.65	179.65	179.65	179.65	179.65
RR	6	982	179.65	179.65	179.65	179.64	179.64	179.64	179.64	179.64	179.64	179.64
RR	6	992	179.64	179.64	179.64	179.64	179.63	179.63	179.63	179.63	179.63	179.63
RR	6	1002	179.63	179.63	179.63	179.63	179.62	179.62	179.62	179.62	179.62	179.62
RR	6	1012	179.62	179.62	179.62	179.62	179.62	179.61	179.61	179.61	179.61	179.61
RR	6	1022	179.61	179.61	179.61	179.61	179.61	179.61	179.60	179.60	179.60	179.60
RR	6	1032	179.60	179.60	179.60	179.60	179.60	179.60	179.60	179.59	179.59	179.59
RR	6	1042	179.59	179.59	179.59	179.59	179.59	179.59	179.59	179.59	179.58	179.58
RR	6	1052	179.58	179.58	179.58	179.58	179.58	179.58	179.58	179.58	179.58	179.57
RR	6	1062	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57	179.57
RR	6	1072	179.57	179.56	179.56	179.56	179.56	179.56	179.56	179.56	179.56	179.56
RR	6	1082	179.56	179.56	179.55	179.55	179.55	179.55	179.55	179.55	179.55	179.55
RR	6	1092	179.55	179.55	179.55	179.54	179.54	179.54	179.54	179.54	179.54	179.54
RR	6	1102	179.54	179.54	179.54	179.53	179.53	179.53	179.53	179.53	179.53	179.53
RR	6	1112	179.53	179.53	179.53	179.53	179.52	179.52	179.52	179.52	179.52	179.52
RR	6	1122	179.52	179.52	179.52	179.52	179.52	179.51	179.51	179.51	179.51	179.51
RR	6	1132	179.51	179.51	179.51	179.51	179.51	179.51	179.50	179.50	179.50	179.50
RR	6	1142	179.50	179.50	179.50	179.50	179.50	179.50	179.50	179.49	179.49	179.49
RR	6	1152	179.49	179.49	179.49	179.49	179.49	179.49	179.49	179.49	179.48	179.48
RR	6	1162	179.48	179.48	179.48	179.48	179.48	179.48	179.48	179.48	179.48	179.47
RR	6	1172	179.47	179.47	179.47	179.47	179.47	179.47	179.47	179.47	179.47	179.47
RR	6	1182	179.46	179.46	179.46	179.46	179.46	179.46	179.46	179.46	179.46	179.46
RR	6	1192	179.46	179.45	179.45	179.45	179.45	179.45	179.45	179.45	179.45	179.45
RR	6	1202	179.45	179.45	179.44	179.44	179.44	179.44	179.44	179.44	179.44	179.44
RR	6	1212	179.44	179.44	179.43	179.43	179.43	179.43	179.43	179.43	179.43	179.43
RR	6	1222	179.43	179.43	179.43	179.42	179.42	179.42	179.42	179.42	179.42	179.42
RR	6	1232	179.42	179.42	179.42	179.42	179.41	179.41	179.41	179.41	179.41	179.41
RR	6	1242	179.41	179.41	179.41	179.41	179.41	179.40	179.40	179.40	179.40	179.40
RR	6	1252	179.40	179.40	179.40	179.40	179.40	179.40	179.39	179.39	179.39	179.39
RR	6	1262	179.39	179.39	179.39	179.39	179.39	179.39	179.39	179.38	179.38	179.38
RR	6	1272	179.38	179.38	179.38	179.38	179.38	179.38	179.38	179.38	179.37	179.37
RR	6	1282	179.37	179.37	179.37	179.37	179.37	179.37	179.37	179.37	179.37	179.36
RR	6	1292	179.36	179.36	179.36	179.36	179.36	179.36	179.36	179.36	179.36	179.36
RR	6	1302	179.35	179.35	179.35	179.35	179.35	179.35	179.35	179.35	179.35	179.35
RR	6	1312	179.35	179.34	179.34	179.34	179.34	179.34	179.34	179.34	179.34	179.34
RR	6	1322	179.34	179.34	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33
RR	6	1332	179.33									
RR	7	1333	179.32	179.31	179.31	179.30	179.29	179.28	179.28	179.27	179.26	179.26
RR	7	1343	179.25	179.24	179.23	179.23	179.22	179.21	179.21	179.20	179.19	179.19
RR	7	1353	179.18	179.17	179.16	179.16	179.15	179.14	179.14	179.13	179.12	179.11
RR	7	1363	179.11	179.10	179.09	179.09	179.08	179.07	179.07	179.06	179.05	179.04
RR	7	1373	179.04	179.03	179.02	179.02	179.01	179.00	179.00	178.99	178.98	178.97
RR	7	1383	178.97	178.96	178.95	178.95	178.94	178.93	178.92	178.92	178.91	178.90
RR	7	1393	178.90	178.89	178.88	178.88	178.87	178.86	178.85	178.85	178.84	178.83

RR	7	1403	178.83	178.82	178.81	178.80	178.80	178.79	178.78	178.78	178.77	178.76
RR	7	1413	178.76	178.75	178.74	178.73	178.73	178.72	178.71	178.71	178.70	178.69
RR	7	1423	178.69	178.68	178.67	178.66	178.66	178.65	178.64	178.64	178.63	178.62
RR	7	1433	178.62	178.61	178.60	178.59	178.59	178.58	178.57	178.57	178.56	178.55
RR	7	1443	178.55	178.54	178.53	178.52	178.52	178.51	178.50	178.50	178.49	178.48
RR	10	1900	176.17	176.16	176.16	176.16	176.16	176.15	176.15	176.15	176.14	176.14
RR	10	1910	176.14	176.14	176.13	176.13	176.13	176.12	176.12	176.12	176.12	176.11
RR	10	1920	176.11	176.11	176.10	176.10	176.10	176.10	176.09	176.09	176.09	176.09
RR	10	1930	176.08	176.08	176.08	176.07	176.07	176.07	176.07	176.06	176.06	176.06
RR	16	2168	160.27	160.27	160.27	160.27	160.27	160.27	160.27	160.27	160.27	160.27
RR	16	2178	160.27	160.26	160.26	160.26	160.26	160.26	160.26	160.26	160.26	160.26
RR	16	2188	160.26	160.26	160.26	160.26	160.26	160.26	160.26	160.26	160.26	160.26
RR	16	2198	160.26	160.26	160.26	160.26	160.25	160.25	160.25	160.25	160.25	160.25
RR	16	2208	160.25	160.25	160.25	160.25	160.25	160.25	160.25	160.25	160.25	160.25
RR	16	2218	160.25	160.25	160.25	160.25	160.25	160.25	160.24	160.24	160.24	160.24
RR	16	2228	160.24	160.24	160.24	160.24	160.24	160.24	160.24	160.24	160.24	160.24
RR	16	2238	160.24	160.24	160.24	160.24	160.24	160.24	160.24	160.24	160.23	160.23
RR	16	2248	160.23	160.23	160.23	160.23	160.23	160.23	160.23	160.23	160.23	160.23
RR	16	2258	160.23	160.23	160.23	160.23	160.23	160.23	160.23	160.23	160.23	160.23
RR	16	2268	160.23	160.22	160.22	160.22	160.22	160.22	160.22	160.22	160.22	160.22
RR	16	2278	160.22	160.22	160.22	160.22	160.22	160.22	160.22	160.22	160.22	160.22
RR	16	2288	160.22	160.22	160.22	160.21	160.21	160.21	160.21	160.21	160.21	160.21
RR	16	2298	160.21	160.21	160.21	160.21	160.21	160.21	160.21	160.21	160.21	160.21
RR	16	2308	160.21	160.21	160.21	160.21	160.21	160.21	160.20	160.20	160.20	160.20
RR	16	2318	160.20	160.20	160.20	160.20	160.20					
MK	8	1453	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90
MK	8	1463	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.90	34.91
MK	8	1473	39.27	39.17	39.07	38.97	38.88	38.80	38.72	38.64	38.56	38.49
MK	8	1483	38.42	38.35	38.29	38.22	38.16	38.11	38.05	38.00	37.94	37.89
MK	8	1493	37.84	37.80	37.75	37.71	37.66	37.62	37.58	37.54	37.50	37.47
MK	8	1503	37.43	37.40	37.36	37.33	37.30	37.27	37.23	37.20	37.18	37.15
MK	8	1513	37.12	37.09	37.07	37.04	37.02	36.99	36.97	36.94	36.92	36.90
MK	8	1523	36.88	36.86	36.83	36.81	36.79	36.77	36.75	36.74	36.72	36.70
MK	8	1533	36.68	36.66	36.65	36.63	36.61	36.60	36.58	36.57	36.55	36.54
MK	8	1543	36.52	36.51	36.49	36.48	36.46	36.45	36.44	36.43	36.41	36.40
MK	8	1553	36.39	36.38	36.36	36.35	36.34	36.33	36.32	36.31	36.30	36.28
MK	8	1563	36.27	36.26	36.25	36.24	36.23	36.22	36.21	36.20	36.20	36.19
MK	8	1573	36.18	36.17	36.16	36.15	36.14	36.13	36.12	36.12	36.11	36.10
MK	8	1583	36.09	36.08	36.08	36.07	36.06	36.05	36.05	36.04	36.03	36.03
MK	8	1593	36.02	36.01	36.00	36.00	35.99	35.98	35.98	35.97	35.97	35.96
MK	8	1603	35.95	35.95	35.94	35.94	35.93	35.92	35.92	35.91	35.91	35.90
MK	8	1613	35.90	35.89	35.88	35.88	35.87	35.87	35.86	35.86	35.85	35.85
MK	8	1623	35.84	35.84	35.83	35.83	35.82	35.82	35.81	35.81	35.81	35.80
MK	8	1633	35.80	35.79	35.79	35.78	35.78	35.77	35.77	35.77	35.76	35.76
MK	8	1643	35.75	35.75	35.75	35.74	35.74	35.73	35.73	35.73	35.72	35.72
MK	8	1653	35.72	35.71	35.71	35.70	35.70	35.70	35.69	35.69	35.69	35.68
MK	8	1663	35.68	35.68	35.67	35.67	35.67	35.66				
MK	9	1669	35.66	35.66	35.65	35.65	35.65	35.65	35.64	35.64	35.64	35.63
MK	9	1679	35.63	35.63	35.63	35.62	35.62	35.62	35.62	35.61	35.61	35.61
MK	9	1689	35.60	35.60	35.60	35.60	35.59	35.59	35.59	35.59	35.58	35.58

MK	9	1699	35.58	35.58	35.58	35.57	35.57	35.57	35.57	35.56	35.56	35.56
MK	9	1709	35.56	35.55	35.55	35.55	35.55	35.55	35.54	35.54	35.54	35.54
MK	9	1719	35.54	35.53	35.53	35.53	35.53	35.52	35.52	35.52	35.52	35.52
MK	9	1729	35.51	35.51	35.51	35.51	35.51	35.51	35.50	35.50	35.50	35.50
MK	9	1739	35.50	35.49	35.49	35.49	35.49	35.49	35.49	35.48	35.48	35.48
MK	9	1749	35.48	35.48	35.47	35.47	35.47	35.47	35.47	35.47	35.46	35.46
MK	9	1759	35.46	35.46	35.46	35.46	35.45	35.45	35.45	35.45	35.45	35.45
MK	9	1769	35.45	35.44	35.44	35.44	35.44	35.44	35.44	35.43	35.43	35.43
MK	9	1779	35.43	35.43	35.43	35.43	35.42	35.42	35.42	35.42	35.42	35.42
MK	9	1789	35.42	35.41	35.41	35.41	35.41	35.41	35.41	35.41	35.41	35.40
MK	9	1799	35.40	35.40	35.40	35.40	35.40	35.40	35.39	35.39	35.39	35.39
MK	9	1809	35.39	35.39	35.39	35.39	35.38	35.38	35.38	35.38	35.38	35.38
MK	9	1819	35.38	35.38	35.38	35.37	35.37	35.37	35.37	35.37	35.37	35.37
MK	9	1829	35.37	35.37	35.36	35.36	35.36	35.36	35.36	35.36	35.36	35.36
MK	9	1839	35.36	35.35	35.35	35.35	35.35	35.35	35.35	35.35	35.35	35.35
MK	9	1849	35.34	35.34	35.34	35.34	35.34	35.34	35.34	35.34	35.34	35.34
MK	9	1859	35.33	35.33	35.33	35.33	35.33	35.33	35.33	35.33	35.33	35.33
MK	9	1869	35.33	35.32	35.32	35.32	35.32	35.32	35.32	35.32	35.32	35.32
MK	9	1879	35.32	35.31	35.31	35.31	35.31	35.31	35.31	35.31	35.31	35.31
MK	9	1889	35.31	35.31	35.31	35.30	35.30	35.30	35.30	35.30	35.30	35.30
MK	9	1899	35.30									
SR	11	1940	19.01	99.46	99.43	99.41	99.39	99.37	99.35	99.33		
SR	12	1948	99.16	99.00	98.84	98.68	98.52	98.36	98.20	98.04	97.88	97.72
SR	12	1958	97.57	97.41	97.26	97.10	96.95	96.80	96.65	96.50	96.35	96.20
SR	12	1968	96.05	95.90	95.75	95.61	95.46	95.31	95.17	95.03	94.88	94.74
SR	12	1978	94.60	94.46	94.32	94.18	94.04	93.90	93.76	93.62	93.49	93.35
SR	12	1988	93.22	93.08	92.95	92.81	92.68	92.55	92.42	92.28	92.15	92.02
SR	12	1998	91.89	91.76	91.64	91.51	91.38	91.25	91.13	91.00	90.88	90.75
SR	12	2008	90.63	90.51	90.38	90.26	90.14					
SR	13	2013	89.76	89.38	89.02	88.65	88.29	87.94	87.58			
SR	14	2020	73.99	73.97	73.94	73.91	73.89	73.86	73.83	73.81	73.78	73.75
SR	14	2030	73.73	73.70	73.67	73.65	73.62	73.60	73.57	73.54	73.52	73.49
SR	14	2040	73.46	73.44	73.41	73.39	73.36	73.34	73.31	73.28	73.26	73.23
SR	14	2050	73.21	73.18	73.16	73.13	73.10	73.08	73.05	73.03	73.00	72.98
SR	14	2060	72.95	72.93	72.90	72.88	72.85	72.83	72.80	72.77	72.75	72.72
SR	14	2070	72.70	72.67	72.65	72.62	72.60	72.58	72.55	72.53	72.50	72.48
SR	14	2080	72.45	72.43	72.40	72.38	72.35	72.33	72.30	72.28	72.25	72.23
SR	14	2090	72.21	72.18	72.16	72.13	72.11	72.08	72.06	72.04	72.01	71.99
SR	14	2100	71.96	71.94	71.92	71.89	71.87					
SR	15	2105	71.86	71.86	71.85	71.85	71.84	71.83	71.83	71.82	71.82	71.81
SR	15	2115	71.81	71.80	71.80	71.79	71.78	71.78	71.77	71.77	71.76	71.76
SR	15	2125	71.75	71.75	71.74	71.73	71.73	71.72	71.72	71.71	71.71	71.70
SR	15	2135	71.70	71.69	71.69	71.68	71.67	71.67	71.66	71.66	71.65	71.65
SR	15	2145	71.64	71.64	71.63	71.63	71.62	71.61	71.61	71.60	71.60	71.59
SR	15	2155	71.59	71.58	71.58	71.57	71.57	71.56	71.55	71.55	71.54	71.54
SR	15	2165	71.53	71.53	71.52							

INTERMEDIATE REPORT
Total Dissolved Solids
mg/L

LA-QUAL Model for Red River/McKinney/Sulphur
Harmonic mean flow with proposed criteria in AR

ID	RCH	ELEM	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
RR	1	1	890.98	890.96	890.94	890.92	890.89	890.87	890.85	890.83	890.81	890.79
RR	1	11	890.77	890.75	890.73	890.71	890.68	890.66	890.64	890.62	890.60	890.58
RR	1	21	890.56	890.54	890.52	890.50	890.47	890.45	890.43	890.41	890.39	890.37
RR	1	31	890.35	890.33	890.31	890.29	890.26	890.24	890.22	890.20	890.18	890.16
RR	1	41	890.14	890.12	890.10	890.08	890.05	890.03	890.01	889.99	889.97	889.95
RR	1	51	889.93	889.91	889.89	889.87	889.85	889.82	889.80	889.78	889.76	889.74
RR	1	61	889.72	889.70	889.68	889.66	889.64	889.61	889.59	889.57	889.55	889.53
RR	1	71	889.51	889.49	889.47	889.45	889.43	889.41	889.38	889.36	889.34	889.32
RR	2	81	889.32	889.31	889.31	889.30	889.30	889.29	889.29	889.28	889.28	889.27
RR	2	91	889.27	889.26	889.26	889.26	889.25	889.25	889.24	889.24	889.23	889.23
RR	2	101	889.22	889.22	889.21	889.21	889.20	889.20	889.19	889.19	889.18	889.18
RR	2	111	889.17	889.17	889.17	889.16	889.16	889.15	889.15	889.14	889.14	889.13
RR	2	121	889.13	889.12	889.12	889.11	889.11	889.10	889.10	889.09	889.09	889.08
RR	2	131	889.08	889.08	889.07	889.07	889.06	889.06	889.05	889.05	889.04	889.04
RR	2	141	889.03	889.03	889.02	889.02	889.01	889.01	889.00	889.00	888.99	888.99
RR	2	151	888.99	888.98	888.98	888.97	888.97	888.96	888.96	888.95	888.95	888.94
RR	2	161	888.94	888.93	888.93	888.92	888.92	888.91	888.91	888.90	888.90	888.90
RR	2	171	888.89	888.89	888.88	888.88	888.87	888.87	888.86	888.86	888.85	888.85
RR	2	181	888.84	888.84	888.83	888.83	888.82	888.82	888.81	888.81	888.81	888.80
RR	2	191	888.80	888.79	888.79	888.78	888.78	888.77	888.77	888.76	888.76	888.75
RR	2	201	888.75	888.74	888.74	888.73	888.73	888.72	888.72	888.72	888.71	888.71
RR	2	211	888.70	888.70	888.69	888.69	888.68	888.68	888.67	888.67	888.66	888.66
RR	2	221	888.65	888.65	888.64	888.64	888.63	888.63	888.63	888.62	888.62	888.61
RR	2	231	888.61	888.60	888.60	888.59	888.59	888.58	888.58	888.57	888.57	888.56
RR	2	241	888.56	888.55	888.55	888.54	888.54	888.54	888.53	888.53	888.52	888.52
RR	2	251	888.51	888.51	888.50	888.50	888.49	888.49	888.48	888.48	888.47	888.47
RR	2	261	888.46	888.46	888.46	888.45	888.45	888.44	888.44	888.43	888.43	888.42
RR	2	271	888.42	888.41	888.41	888.40	888.40	888.39	888.39	888.38	888.38	888.37
RR	2	281	888.37	888.37	888.36	888.36	888.35	888.35	888.34	888.34	888.33	888.33
RR	2	291	888.32	888.32	888.31	888.31	888.30	888.30	888.29	888.29	888.28	888.28
RR	2	301	888.28	888.27	888.27	888.26	888.26	888.25	888.25	888.24	888.24	888.23
RR	2	311	888.23	888.22	888.22	888.21	888.21	888.20	888.20	888.20	888.19	888.19
RR	2	321	888.18	888.18	888.17	888.17	888.16	888.16	888.15	888.15	888.14	888.14
RR	2	331	888.13	888.13	888.12							
RR	3	334	886.23	886.23	886.22	886.22	886.22	886.22	886.21	886.21	886.21	886.20
RR	3	344	886.20	886.20	886.19	886.19	886.19	886.19	886.18	886.18	886.18	886.17
RR	3	354	886.17	886.17	886.16	886.16	886.16	886.15	886.15	886.15	886.15	886.14
RR	3	364	886.14	886.14	886.13	886.13	886.13	886.12	886.12	886.12	886.11	886.11
RR	3	374	886.11	886.11	886.10	886.10	886.10	886.09	886.09	886.09	886.08	886.08
RR	3	384	886.08	886.07	886.07	886.07	886.07	886.06	886.06	886.06	886.05	886.05
RR	3	394	886.05	886.04	886.04	886.04	886.04	886.03	886.03	886.03	886.02	886.02
RR	3	404	886.02	886.01	886.01	886.01	886.00	886.00	886.00	886.00	885.99	885.99
RR	3	414	885.99	885.98	885.98	885.98	885.97	885.97	885.97	885.96	885.96	885.96

RR	3	424	885.96	885.95	885.95	885.95	885.94	885.94	885.94	885.93		
RR	4	432	885.93	885.92	885.91	885.90	885.90	885.89	885.88	885.87	885.86	885.86
RR	4	442	885.85	885.84	885.83	885.83	885.82	885.81	885.80	885.79	885.79	885.78
RR	4	452	885.77	885.76	885.76	885.75	885.74	885.73	885.73	885.72	885.71	885.70
RR	4	462	885.69	885.69	885.68	885.67	885.66	885.66	885.65	885.64	885.63	885.62
RR	4	472	885.62	885.61	885.60	885.59	885.59	885.58	885.57	885.56	885.56	885.55
RR	4	482	885.54	885.53	885.52	900.66	900.51	900.50	900.50	900.49	900.48	900.47
RR	4	492	900.47	900.46	900.45	900.44	900.43	900.43	900.42	900.41	900.40	900.40
RR	4	502	900.39	900.38	900.37	900.36	900.36	900.35	900.34	900.33	900.33	900.32
RR	4	512	900.31	900.30	900.29	900.29	900.28	900.27	900.26	900.26	900.25	900.24
RR	4	522	900.23	900.23	900.22	900.21	900.20	900.19	900.19	900.18	900.17	900.16
RR	4	532	900.16	900.15	900.14	900.13	900.12	900.12	900.11	900.10	900.09	900.09
RR	4	542	900.08	900.07	900.06	900.05	900.05	900.04	900.03	900.02	900.02	900.01
RR	4	552	900.00	899.99	899.98	899.98	899.97	899.96	899.95	899.95	899.94	899.93
RR	4	562	899.92	899.92	899.91	899.90	899.89	899.88	899.88	899.87	899.86	899.85
RR	4	572	899.85	899.84	899.83	899.82	899.81	899.81	899.80	899.79	899.78	899.78
RR	4	582	899.77	899.76	899.75	899.74	899.74	899.73	899.72	899.71	899.71	899.70
RR	4	592	899.69	899.68	899.68	899.67	899.66	899.65	899.64	899.64	899.63	899.62
RR	4	602	899.61	899.61	899.60	899.59	899.58	899.57	899.57	899.56	899.55	899.54
RR	4	612	899.54	899.53	899.52	899.51	899.50	899.50	899.49	899.48	899.47	899.47
RR	4	622	899.46	899.45	899.44	899.44	899.43	899.42	899.41	899.40	899.40	899.39
RR	4	632	899.38	899.37	899.37	899.36	899.35	899.34	899.33	899.33	899.32	899.31
RR	4	642	899.30	899.30	899.29	899.28	899.27	899.27	899.26	899.25	899.24	899.23
RR	4	652	899.23	899.22	899.21	899.20	899.20	899.19	899.18	899.17	899.16	899.16
RR	4	662	899.15	899.14	899.13	899.13	899.12	899.11	899.10	899.10	899.09	899.08
RR	4	672	899.07	899.06	899.06	899.05	899.04	899.03	899.03	899.02	899.01	899.00
RR	4	682	898.99	898.99	898.98	898.97	898.96	898.96	898.95	898.94	898.93	898.93
RR	4	692	898.92	898.91	898.90	898.89	898.89	898.88	898.87	898.86	898.86	898.85
RR	4	702	898.84	898.83	898.82	898.82	898.81	898.80	898.79	898.79	898.78	898.77
RR	4	712	898.76	898.76	898.75	898.74	898.73	898.72	898.72	898.71	898.70	898.69
RR	4	722	898.69	898.68	898.67	898.66	898.66	898.65	898.64	898.63	898.62	898.62
RR	4	732	898.61	898.60	898.59	898.59	898.58	898.57	898.56	898.55	898.55	898.54
RR	4	742	898.53	898.52	898.52	898.51	898.50	898.49	898.49	898.48	898.47	898.46
RR	4	752	898.45	898.45	898.44	898.43	898.42	898.42	898.41	898.40	898.39	898.39
RR	4	762	898.38	898.37	898.36	898.35	898.35	898.34	898.33	898.32	898.32	898.31
RR	4	772	898.30	898.29	898.29	898.28	898.27	898.26	898.25	898.25		
RR	5	780	730.31	730.84	730.83	730.82	730.81	730.80	730.79	730.78	730.77	730.76
RR	5	790	730.75	730.74	730.73	730.72	730.71	730.71	730.70	730.69	730.68	730.67
RR	5	800	730.66	730.65	730.64	730.63	730.62	730.62	730.61	730.60	730.59	730.58
RR	5	810	730.57	730.56	730.55	730.54	730.53	730.52	730.52	730.51	730.50	730.49
RR	5	820	730.48	730.47	730.46	730.45	730.44	730.43	730.42	730.42	730.41	730.40
RR	5	830	730.39	730.38	730.37	730.36	730.35	730.34	730.33	730.32	730.32	730.31
RR	5	840	730.30	730.29	730.28	730.27	730.26	730.25	730.24	730.23	730.22	730.22
RR	5	850	730.21	730.20	730.19	730.18	730.17	730.34	730.33	730.32	730.31	730.30
RR	5	860	730.29	730.28	730.28	730.27	730.26	730.25	730.24	730.23	730.22	730.21
RR	5	870	730.20	730.19	730.19	730.18	730.17	730.16	730.15	730.14	730.13	730.12
RR	5	880	730.11	730.10	730.09	730.09	730.08	730.07	730.06	730.05	730.04	730.03
RR	5	890	730.02	730.01	730.00	729.99	729.99	729.98	729.97	729.96	729.95	729.94
RR	5	900	729.93	729.92	729.91	729.90	729.90	729.89	729.88	729.87	729.86	729.85
RR	5	910	729.84	729.83	729.82	729.81	729.80	729.80	729.79	729.78	729.77	729.76

RR	7	1403	718.97	718.95	718.92	718.90	718.88	718.85	718.83	718.81	718.78	718.76
RR	7	1413	718.74	718.71	718.69	718.67	718.64	718.62	718.60	718.57	718.55	718.53
RR	7	1423	718.50	718.48	718.46	718.43	718.41	718.39	718.36	718.34	718.32	718.29
RR	7	1433	718.27	718.25	718.22	718.20	718.18	718.15	718.13	718.11	718.08	718.06
RR	7	1443	718.04	718.02	717.99	717.97	717.95	717.92	717.90	717.88	717.85	717.83
RR	10	1900	711.06	711.05	711.05	711.04	711.03	711.02	711.01	711.00	710.99	710.98
RR	10	1910	710.97	710.96	710.95	710.94	710.93	710.92	710.91	710.90	710.90	710.89
RR	10	1920	710.88	710.87	710.86	710.85	710.84	710.83	710.82	710.81	710.80	710.79
RR	10	1930	710.78	710.77	710.76	710.75	710.74	710.74	710.73	710.72	710.71	710.70
RR	16	2168	660.83	660.83	660.82	660.82	660.82	660.82	660.82	660.82	660.82	660.81
RR	16	2178	660.81	660.81	660.81	660.81	660.81	660.81	660.80	660.80	660.80	660.80
RR	16	2188	660.80	660.80	660.79	660.79	660.79	660.79	660.79	660.79	660.79	660.78
RR	16	2198	660.78	660.78	660.78	660.78	660.78	660.78	660.77	660.77	660.77	660.77
RR	16	2208	660.77	660.77	660.77	660.76	660.76	660.76	660.76	660.76	660.76	660.75
RR	16	2218	660.75	660.75	660.75	660.75	660.75	660.75	660.74	660.74	660.74	660.74
RR	16	2228	660.74	660.74	660.74	660.73	660.73	660.73	660.73	660.73	660.73	660.73
RR	16	2238	660.72	660.72	660.72	660.72	660.72	660.72	660.71	660.71	660.71	660.71
RR	16	2248	660.71	660.71	660.71	660.70	660.70	660.70	660.70	660.70	660.70	660.70
RR	16	2258	660.69	660.69	660.69	660.69	660.69	660.69	660.69	660.68	660.68	660.68
RR	16	2268	660.68	660.68	660.68	660.68	660.67	660.67	660.67	660.67	660.67	660.67
RR	16	2278	660.66	660.66	660.66	660.66	660.66	660.66	660.66	660.65	660.65	660.65
RR	16	2288	660.65	660.65	660.65	660.65	660.64	660.64	660.64	660.64	660.64	660.64
RR	16	2298	660.64	660.63	660.63	660.63	660.63	660.63	660.63	660.62	660.62	660.62
RR	16	2308	660.62	660.62	660.62	660.62	660.61	660.61	660.61	660.61	660.61	660.61
RR	16	2318	660.61	660.60	660.60	660.60	660.60					
MK	8	1453	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60
MK	8	1463	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.60	296.71
MK	8	1473	328.53	327.78	327.06	326.37	325.71	325.08	324.48	323.90	323.35	322.82
MK	8	1483	322.31	321.81	321.34	320.89	320.45	320.02	319.61	319.22	318.84	318.47
MK	8	1493	318.11	317.77	317.43	317.11	316.79	316.49	316.19	315.91	315.63	315.36
MK	8	1503	315.09	314.84	314.59	314.35	314.11	313.88	313.66	313.44	313.23	313.02
MK	8	1513	312.82	312.62	312.43	312.24	312.06	311.88	311.70	311.53	311.36	311.20
MK	8	1523	311.04	310.88	310.73	310.58	310.44	310.29	310.15	310.01	309.88	309.75
MK	8	1533	309.62	309.49	309.36	309.24	309.12	309.00	308.89	308.77	308.66	308.55
MK	8	1543	308.45	308.34	308.24	308.13	308.03	307.94	307.84	307.74	307.65	307.56
MK	8	1553	307.47	307.38	307.29	307.21	307.12	307.04	306.96	306.88	306.80	306.72
MK	8	1563	306.64	306.57	306.49	306.42	306.34	306.27	306.20	306.13	306.06	306.00
MK	8	1573	305.93	305.86	305.80	305.74	305.67	305.61	305.55	305.49	305.43	305.37
MK	8	1583	305.31	305.26	305.20	305.14	305.09	305.03	304.98	304.93	304.88	304.82
MK	8	1593	304.77	304.72	304.67	304.62	304.58	304.53	304.48	304.43	304.39	304.34
MK	8	1603	304.30	304.25	304.21	304.16	304.12	304.08	304.04	303.99	303.95	303.91
MK	8	1613	303.87	303.83	303.79	303.75	303.71	303.68	303.64	303.60	303.56	303.53
MK	8	1623	303.49	303.46	303.42	303.38	303.35	303.32	303.28	303.25	303.21	303.18
MK	8	1633	303.15	303.12	303.08	303.05	303.02	302.99	302.96	302.93	302.90	302.87
MK	8	1643	302.84	302.81	302.78	302.75	302.72	302.69	302.67	302.64	302.61	302.58
MK	8	1653	302.56	302.53	302.50	302.48	302.45	302.42	302.40	302.37	302.35	302.32
MK	8	1663	302.30	302.27	302.25	302.23	302.20	302.18				
MK	9	1669	302.16	302.13	302.11	302.09	302.07	302.05	302.03	302.01	301.99	301.97
MK	9	1679	301.95	301.93	301.91	301.89	301.87	301.85	301.83	301.81	301.79	301.77
MK	9	1689	301.75	301.73	301.71	301.69	301.68	301.66	301.64	301.62	301.60	301.59

MK	9	1699	301.57	301.55	301.53	301.52	301.50	301.48	301.47	301.45	301.43	301.42
MK	9	1709	301.40	301.38	301.37	301.35	301.33	301.32	301.30	301.29	301.27	301.26
MK	9	1719	301.24	301.23	301.21	301.20	301.18	301.17	301.15	301.14	301.12	301.11
MK	9	1729	301.09	301.08	301.06	301.05	301.04	301.02	301.01	301.00	300.98	300.97
MK	9	1739	300.95	300.94	300.93	300.91	300.90	300.89	300.88	300.86	300.85	300.84
MK	9	1749	300.82	300.81	300.80	300.79	300.77	300.76	300.75	300.74	300.72	300.71
MK	9	1759	300.70	300.69	300.68	300.67	300.65	300.64	300.63	300.62	300.61	300.60
MK	9	1769	300.58	300.57	300.56	300.55	300.54	300.53	300.52	300.51	300.50	300.49
MK	9	1779	300.47	300.46	300.45	300.44	300.43	300.42	300.41	300.40	300.39	300.38
MK	9	1789	300.37	300.36	300.35	300.34	300.33	300.32	300.31	300.30	300.29	300.28
MK	9	1799	300.27	300.26	300.25	300.24	300.23	300.23	300.22	300.21	300.20	300.19
MK	9	1809	300.18	300.17	300.16	300.15	300.14	300.13	300.13	300.12	300.11	300.10
MK	9	1819	300.09	300.08	300.07	300.06	300.06	300.05	300.04	300.03	300.02	300.01
MK	9	1829	300.01	300.00	299.99	299.98	299.97	299.97	299.96	299.95	299.94	299.93
MK	9	1839	299.93	299.92	299.91	299.90	299.89	299.89	299.88	299.87	299.86	299.86
MK	9	1849	299.85	299.84	299.83	299.83	299.82	299.81	299.80	299.80	299.79	299.78
MK	9	1859	299.78	299.77	299.76	299.75	299.75	299.74	299.73	299.73	299.72	299.71
MK	9	1869	299.71	299.70	299.69	299.68	299.68	299.67	299.66	299.66	299.65	299.64
MK	9	1879	299.64	299.63	299.63	299.62	299.61	299.61	299.60	299.59	299.59	299.58
MK	9	1889	299.57	299.57	299.56	299.56	299.55	299.54	299.54	299.53	299.52	299.52
MK	9	1899	299.51									
SR	11	1940	145.55	500.06	499.97	499.88	499.79	499.69	499.60	499.51		
SR	12	1948	498.81	498.11	497.41	496.72	496.03	495.35	494.67	493.99	493.32	492.64
SR	12	1958	491.98	491.31	490.65	489.99	489.34	488.68	488.03	487.39	486.75	486.11
SR	12	1968	485.47	484.84	484.21	483.58	482.95	482.33	481.71	481.10	480.48	479.87
SR	12	1978	479.27	478.66	478.06	477.46	476.87	476.27	475.68	475.09	474.51	473.93
SR	12	1988	473.35	472.77	472.19	471.62	471.05	470.49	469.92	469.36	468.80	468.24
SR	12	1998	467.69	467.14	466.59	466.04	465.50	464.95	464.41	463.88	463.34	462.81
SR	12	2008	462.28	461.75	461.22	460.70	460.18					
SR	13	2013	458.55	456.95	455.37	453.81	452.26	450.74	449.24			
SR	14	2020	391.05	390.94	390.83	390.71	390.60	390.48	390.37	390.26	390.14	390.03
SR	14	2030	389.92	389.81	389.69	389.58	389.47	389.36	389.24	389.13	389.02	388.91
SR	14	2040	388.80	388.69	388.58	388.46	388.35	388.24	388.13	388.02	387.91	387.80
SR	14	2050	387.69	387.58	387.47	387.36	387.25	387.14	387.04	386.93	386.82	386.71
SR	14	2060	386.60	386.49	386.38	386.28	386.17	386.06	385.95	385.84	385.74	385.63
SR	14	2070	385.52	385.42	385.31	385.20	385.10	384.99	384.88	384.78	384.67	384.56
SR	14	2080	384.46	384.35	384.25	384.14	384.04	383.93	383.83	383.72	383.62	383.51
SR	14	2090	383.41	383.30	383.20	383.10	382.99	382.89	382.79	382.68	382.58	382.47
SR	14	2100	382.37	382.27	382.17	382.06	381.96					
SR	15	2105	381.94	381.91	381.89	381.87	381.84	381.82	381.79	381.77	381.75	381.72
SR	15	2115	381.70	381.68	381.65	381.63	381.61	381.58	381.56	381.53	381.51	381.49
SR	15	2125	381.46	381.44	381.42	381.39	381.37	381.35	381.32	381.30	381.28	381.25
SR	15	2135	381.23	381.21	381.18	381.16	381.13	381.11	381.09	381.06	381.04	381.02
SR	15	2145	380.99	380.97	380.95	380.92	380.90	380.88	380.85	380.83	380.81	380.78
SR	15	2155	380.76	380.74	380.71	380.69	380.67	380.64	380.62	380.60	380.57	380.55
SR	15	2165	380.53	380.50	380.48							

.....EXECUTION COMPLETED

APPENDIX M

Agency Correspondence Regarding Drinking Water Use Removal

Arkansas Natural Resources Commission

J. Randy Young, PE
Executive Director

101 East Capitol, Suite 350
Little Rock, Arkansas 72201
http://www.anrc.arkansas.gov/

Phone: (501) 682-1611
Fax: (501) 682-3991
E-mail: anrc@arkansas.gov

Mike Beebe
Governor

December 8, 2013

Mr. Jim Malcolm
Environmental Scientist
FTN ASSOCIATES, LTD.
3 Innwood Circle, Suite 220
Little Rock, Arkansas 72211-2449

RE: Domestic Water Supply Determination
FTN # R06510-0010-002

Dear Mr. Malcolm:

In accordance with the State of Arkansas Continuing Planning Process and APCEC Regulation #2 requirements, Commission staff has reviewed the proposed removal of the Designated Domestic Water Supply Use from the reach of the Red River below the Little River inflow and Louisiana state line. There are no existing or planned public water supply uses documented for this reach of the Red River. Therefore, the removal of the domestic water supply use designation does not conflict with the Arkansas Water Plan at this time.

If you have questions, don't hesitate to contact us at 501-3830.

Sincerely,

Kenneth W. Brazil, P.E.
Engineer Supervisor, Water Management

KWB/ddavis

Arkansas Department of Health

4815 West Markham Street • Little Rock, Arkansas 72205-3867 • Telephone (501) 661-2000
Governor Mike Beebe
Nathaniel Smith, MD, MPH, Director and State Health Officer

Engineering Section, Slot 37 Ph 501-661-2623 Fax 501-661-2032
www.HealthyArkansas.com/eng/ After Hours Emergency 501-661-2136

RECEIVED
NOV 08 2013

November 4, 2013

Jim Malcolm
FTN Associates
3 Innwood Circle, Suite 220
Little Rock, AR 72211-2449

RE: ADH No. 32-5707, FTN Project R06510-0010-002,
Red River UAA, Little River County, Arkansas

Dear Mr. Malcolm,

A staff review has been made of the information received on the referenced project. The stream segment in question has not been approved, nor is it under consideration, for use as a public water system source. Therefore, the Engineering Section has no objection to this stream segment being removed from the *Domestic Water Supply Use* designation.

If you have any questions or comments, please coordinate them through Brad Jones at 501-661-2067.

Sincerely,

Lyle Godfrey, P.E.
Chief, Technical Support
Engineering Section

SY:DT:LG:DR:bj

APPENDIX N

Alternatives Analysis Calculations

SWEPCO Facility
Options for UAA Analysis

Option 1 - Provide RO treatment for partial flow then discharge to Little River
For discussion of factors, see report text.

FACTORS:		
Design Flow :	2.16 mgd	
Average Flow:	1.44 mgd	1000 gpm
Capital cost factor - single stage	$2.13 per gallon	
Capital cost factor - three stage	$3.20 per gallon	
Operating cost factor	0.001 per gallon treated	
Operating utilization factor	0.8	
Disposal cost	$0.28 per gallon	
Reject Rate (each stage)	0.30	
TDS Conc of Discharge	1620 mg/L	
RO Treatment single stage	100 mg/L	
RO treatment goal	500 mg/L	

CALCULATIONS:
Blend water to achieve 500 mg/L

Qt + Qu = 2.16 mgd
Qt = 2.16-Qu
Solve for Qu
Qt*100 + Qu81620 = (Qt + Qu)*500
(2.16-Qu)*100+1620*Qu = 2.16*500

Qu= 0.57 mgd
check: 0.568421
Qt = 2.16-.57 = 1.6
check: 1.591579

CAPITAL COST

Capital Cost = 1.6 mgd*$3.20 = $5.12 MM
check $5.09 MM

OPERATING COST

Calculate annual flow

Qt + Qu = 1.44 mgd
Qt = 1.44-Qu
Solve for Qu
Qt*100 + Qu*1620 = (Qt + Qu)*500
(1.44-Qu)*100+1620*Qu = 1.44*500
Qu=.38 mgd

check: 0.38
Qt=1.44-Qu

check: 1.06

Operating Cost (not including disposal) = $0.001/gallon * .8* 1.06 *365 = $310,000

check $0.31 MM

Disposal Cost
Each pass of RO will have a reject rate of 30%
1st stage - 1.06 mgd* 0.3 *1440= 220 gpm
2nd stage - 220 gpm x 0.3 =66 gpm
3rd stage - 66 gpm x 0.3 = 20 gpm

check: 19.86228 call 20

On average, use 20 gpm and adjust for utilization factor

Annual disposal volume = 20 * 1440 *365*.8 = 8.4 MG

check: 8409600

Cost of Disposal $2,350,000 per year

SWEPCO FACILITY
Options for UAA Analysis

Option 2 - Provide RO treatment for full flow; discharge through existing outfall to Little River
For discussion of factors, see report text.

FACTORS:

Design Flow :	2.16 mgd	
Average Flow:	1.44 mgd	1000 gpm
Capital cost factor - single stage	$2.13 per gallon	
Capital cost factor - three stage	$3.20 per gallon	
Operating cost factor	0.001 per gallon treated	
Operating utilization factor	0.8	
Disposal cost	$0.28 per gallon	
Reject Rate (each stage)	0.30	
TDS Conc of Discharge	1620 mg/L	

CALCULATIONS:

CAPITAL COST

Capital Cost = 2.16 mgd*$3.20 = $6.9 MM

check $6.91 MM

OPERATING COST

Operating Cost (not incl disposal)based on factors = $0.001/gallon * .8* 1.44 *365 = $420,000

check $0.42 MM

Disposal Cost
Each pass of RO will have a reject rate of 30%
1st stage - 1000 x 0.3 = 300 gpm
2nd stage - 300 gpm x 0.3 =90 gpm
3rd stage - 90 gpm x 0.3 = 27 gpm

check: 30

Check the max % solids with above scenario.
(Maximum TDS is about 50,000 for RO.)

If initial TDS is 1620 mg/L (from F. Mills email)(dated 10/30/13)
1.44 mgd x 1620 = 27 gpm x CF
CF=1.44*694*1620/27 = 60,000 should be ok. (3rd stage may be limited under max conditions.)
check 53965.44

On average, use 30 gpm and adjust for utilization factor

Annual disposal volume = 30 * 1440 *365*.8 = 12.6 MG

check: 12614400

Cost of Disposal $3,530,000

PRELIMINARY ESTIMATE DETAIL WORKSHEET
SWEPCO FACILITY - EXTEND PIPELINE

AREA _____ Proj Mgr: Jim Malcolm

Option 3 - Extend Pipeline to Red River

DATE 14-Nov-13 BY FTN

LINE NO.	RESPONS. COMPANY	RESPONS. INDIV.	DESCRIPTION	QTY. EST.	UOM	UNIT COST	TOTALS	BASIS (attach support)
1	FTN	RMR	ROW acquisition	2600	LF	$3	$7,800	
2	FTN	RMR	Boring under river with 16-inch pipe	800	LF	$375	$300,000	
3	FTN	RMR	Pipeline buried - use 16-inch polyethylene	1800	LF	$60	$108,000	
4	FTN	RMR	New Outfall structure	1	LS	$20,000	$20,000	
5	FTN	RMR	Connection to existing outfall	1	LS	$8,000	$8,000	
7	FTN	RMR					$0	
8	FTN	RMR					$0	
					Subtotal		**$443,800**	

Subtotal	$443,800
Contingency @ 20%	$88,760
Equipment Total	**$533,000**
Engineering & Environmental @20%	$106,600
Total	**$640,000**

Cost of Brackish Groundwater Desalination in Texas

12-06
September 2012

Jorge Arroyo and Saqib Shirazi
Innovative Water Technologies
Texas Water Development Board

Purpose of paper

To provide sample water production costs of brackish groundwater desalination in Texas.

Summary of Results

The capital cost of desalination plants is site specific. Factors such as depth, location and quality of the source water, and concentrate disposal method have the potential to substantially impact the capital cost of a project. Operation and maintenance will also vary from plant to plant in response to factors such as source water quality, power costs, age of the plant, and personnel allocated to the plant. Nevertheless, the cost of completed plants is a useful reference to estimate the cost of future projects with similar characteristics.

In collaboration with various utilities and consultants, we examined six brackish groundwater desalination plants completed in the last decade and arrived at the following conclusions:

- Capital cost range from $2.03 to $3.91 per gallon of installed capacity;
- Operation and maintenance costs range from $0.53 to $1.16 per 1,000 gallons of water produced; and
- Total production cost of water ranges from $1.09 to $2.40 per thousand gallons or $357 to $782 per acre-foot.

Background

In 1961 one of the first seawater desalination demonstration plants to be built in the United States was located at the Dow Chemical Complex in Freeport, Texas (The Dow Chemical Company, 1960; The Dow Chemical Company, 1961; Lomax, 2008). The first community desalting plant in Texas, designed to provide a public water supply, was installed at Port Mansfield in 1965. The plant had a design capacity of 250,000 gallons per day and used electrodialysis as the primary method of desalination (U.S. Department of Interior, 1966). Currently, there are 44 municipal brackish water desalination facilities in Texas, with a design capacity of about 120 million gallons per day or about 134,400 acre-feet per year.

In spite of this history and current status, desalination is relatively new when compared to other better-known water management strategies in Texas, and this lack of familiarity prompts questions about its costs. Desalination costs vary considerably by location based on a number of issues including feed water source, feed water quality, plant size, process type and design, intake type, pre- and post-treatment processes, concentrate disposal method, regulatory issues, land costs, and conveyance of water to and from the plant.

There are cost estimating tools that incorporate some of these variables. One such tool is the U.S. Bureau of Reclamation planning level estimating procedures for seawater and surface water brackish desalination facilities. Estimating procedures include nomographs to calculate the impact of selected variables, such as the cost of power, in the cost of desalination projects (U.S. Bureau of Reclamation, 2003). Another of Reclamation's products is WTCost©, a database and computer program with cost algorithms for different types of desalination pre-treatment and treatment technologies.

This paper provides a cost reference for brackish groundwater desalination in Texas on the basis of recently completed projects and projects currently under construction.

Cost Factors

The total production cost of desalinated water includes the cost of capital or debt service and operation and maintenance costs. Debt service costs are a function of the total capital cost of the project, the interest on the capital, and the loan payback period. The operation and maintenance costs are a function of chemical, power, equipment replacement, and labor costs. There are several approaches to calculate and report the cost of water. One approach assigns the debt service to the actual production volume (Wilf, 2007). Another alternative is to calculate the debt service load on the basis of a life-cycle analysis and use an efficiency factor [also known as plant operating factor] to estimate actual production volume instead of the design production capacity (Sturdivant and others, 2009). In this paper, the unit production cost (UPC) of desalinated water is calculated as follows:

Equation 1 - Unit Production Cost

$$UPC = \frac{Annual\ Debt\ Service}{Plant\ Design\ Capacity \times Plant\ Operating\ factor} + \frac{Operation\ and\ Maintenance}{Production\ Volume}$$

Many factors affect the capital and operational costs of desalination facilities (Graves & Choeffel, 2004; Younos, 2005). Below is an illustration of commonly recognized cost factors for desalination systems (Figure 1).

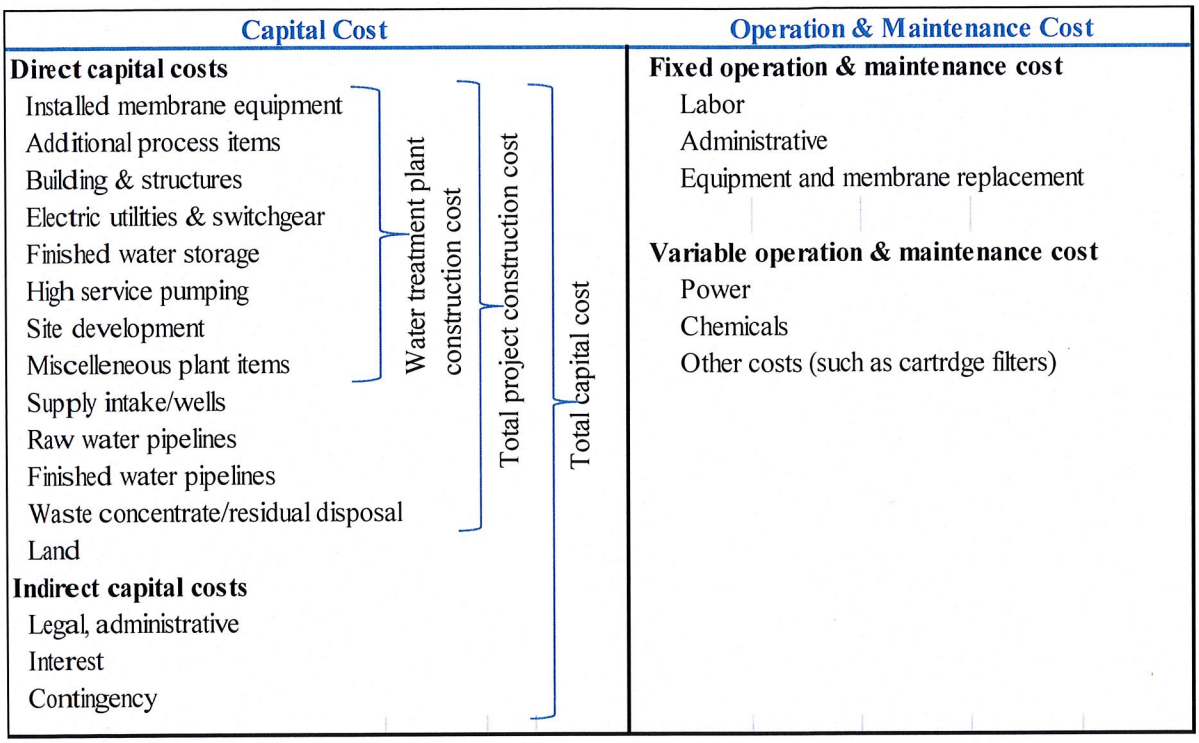


Figure 1 - Key factors for capital and operation and maintenance costs of a desalination facility (Bergman, 2012).

Projects Samples and Costs Analysis

Project Samples

Our review of brackish groundwater desalination costs considered two sets of samples. In the first set, we collected data from a sample of recently completed brackish groundwater desalination plants in Texas. In the second set, we collected data from a sample of brackish groundwater desalination projects that are currently under construction in Texas.

The sample of recently completed brackish groundwater desalination projects consists of six facilities (year of installation noted in brackets):

- North Alamo Water Supply Corporation, three facilities:
    - Lasara, Willacy County (2005)
    - Owassa, Hidalgo County (2008)
    - Doolittle, Hidalgo County (2008)
- North Cameron Regional Water Supply Corporation, Cameron County (2007)
- Southmost Regional Water Authority, Cameron County (2004)
- El Paso Water Utilities' Kay Bailey Hutchison Brackish Groundwater Desalination Plant. El Paso County (2007)

The sample of projects currently under construction consists of three projects:

- North Alamo Water Supply Corporation- Donna, Hidalgo County
- City of Roscoe, Nolan County

- Fort Hancock Water Conservation Improvement District, Hudspeth County

Costs Analysis

Our estimates of production cost do not include any infrastructure to connect the facility to the distribution system. The cost, thus, should reflect extracting and delivering the source water to the treatment plant, treating and conditioning the water for delivery, and discharging the concentrate for disposal. We worked with representatives from the respective utilities and used TWDB records to obtain relevant capital and operation and maintenance cost information.

The completed projects have different plant start dates. To facilitate the comparison of capital costs, we normalized the capital costs for all projects to 2011 dollar equivalents. We used the Engineering News Record (ENR) construction average annual indices to estimate the trended capital costs for each project.

Equation 2 – Capital Costs Trending Formula

$$Capital\ Cost_{\$2011} = Capital\ Cost_{\$installation\ year} \times \frac{ENR\ Index_{2011}}{ENR\ Index_{installation\ year}}$$

The [trended] annual debt service was calculated by amortizing the trended capital cost over a 20-year period (n) and a 5.5 percent interest rate (i), as follows:

Equation 3 - Annual Debt Service

$$Annual\ Debt\ Service = Capital\ Cost \times \left(\frac{i}{1-(1+i)^{-n}}\right)$$

Where,

i= annual interest rate for capital borrowing

n= number of year to repay the debt

Results

Table 1 reports the unit production cost of desalinated brackish groundwater for the sample of recently completed projects. These costs are estimates of what the production cost of water would be if the plants had been built in the year 2011 and if the unit operation and maintenance costs observed on the basis of actual operation to-date were maintained. Unit production cost of desalinated brackish groundwater ranges from $357 per acre-foot (North Alamo Water Supply Corporation plant at Doolittle) to $782 per acre-foot (North Cameron Regional Water Supply Corporation).

Table 1 - Trended water production costs of a sample of existing brackish groundwater desalination facilities.

Brackish Groundwater Desalination Plant	Desalination Design Capacity (MGD)[3]	Water Treatment Construction cost ($)		Capital Cost $\$_{2011}$/gal	Capital Cost $\$_{2011}$/AF	Power cost (¢/Kw-hr)	Production cost ($) per 1,000 Gallons			Water Production Cost ($ per Acre-Foot)
[Source water salinity; start-up year]	[Reverse osmosis treatment capacity; raw water blending capacity]	Original Cost	Trended Cost 2011				O&M	Debt	Total cost	
Lasara [2,500-3,000 mg/l; 2005]	1.2 [1; 0.2]	2,000,000	2,436,180	2.03	661.53	7.2	1.13	0.46	1.59	518
Doolittle [2,500-3,000 mg/l; 2008]	3.5 [3; 0.5]	8,000,000	8,731,736	2.49	812.93	6.9	0.53	0.56	1.09	357
Owassa [2,500-3,000 mg/l; 2008][1]	2 [1.5; 0.5]	5,850,000	6,385,082	3.19	1,040.29	5.9	0.6	0.72	1.32	431
North Cameron Regional WSC [3,500 mg/l; 2007][2]	1.25 [1; 0.25]	7,033,554	8,008,327	6.41	2,087.62	8	0.95	1.45	2.40	782
	2.5 [2; 0.5]	8,033,554	9,146,916	3.66	1,192.21	8	0.95	0.83	1.78	579
Southmost Regional Water Authority [3,500 mg/l; 2004]	7.5 [6; 1.5]	23,000,000	29,319,404	3.91	1,273.84	7.49	1.16	0.88	2.04	666
Kay Bailey Hutchison El Paso-Ft. Bliss [4,365 mg/l; 2007]	27.5 [15; 12.5]	91,000,000	103,611,599	3.77	1,227.71	8.35	0.65	0.85	1.50	489

Notes:

[1]Current production capacity of the plant is only 2 MGD. The plant will be capable of producing 3.5 MGD with the addition of a well. The capital cost includes expansion capabilities.

[2]The plant currently operates with only one well and produces as much as 1.25 MGD of product water. The plant will produce as much as 2.5 MGD with the addition of a well. The plant's capital cost includes expansion capabilities for up to 5 MGD of product water.

[3]The cost analysis used "1" as the plant operating factor.

AF = acre-foot, Kw-hr = kilowatt-hour, mg/l = milligrams per liter, MGD = millions of gallons per day, O&M = operation and maintenance, TDS = total dissolved solids, WSC = water supply corporation.

The capital cost in 2011 dollar equivalents of the sample of completed facilities ranges from $2.03 (North Alamo Water Supply Corporation Lasara) to $3.91 (Southmost Regional Water Authority) per gallon of installed capacity (Figure 2).

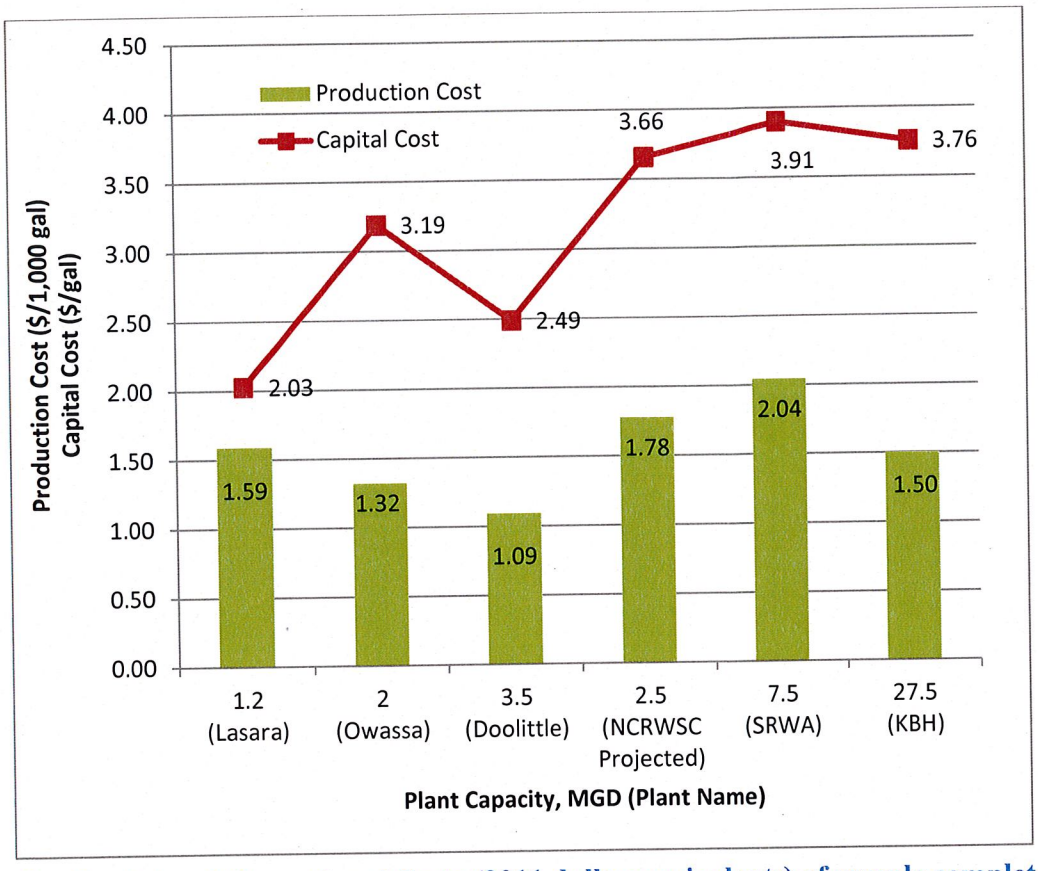


Figure 2 - Capital and Operational Costs (2011 dollar equivalents) of sample completed facilities

The projected total production cost of desalinated brackish water for a sample of projects that are currently under construction in Texas ranges from $280 per acre-foot to $1,064 per acre-foot (Table 2). The capital costs for the plants under construction were amortized on a 20-year 5.5 percent interest basis. Because these plants have not begun operation yet, the unit operation and maintenance costs were estimated on the basis of engineering analysis of the projects.

Although the desalination design capacities for the City of Roscoe and Forth Hancock Water Control and Improvement District (WCID) are almost same, the unit capital cost as well as the total production cost for these facilities is significantly different (Table 2). One of the primary reasons for such a significant difference in cost is that Forth Hancock WCID installs evaporation ponds to dispose the concentrate, while the City of Roscoe disposes the concentrate by surface water discharge. Construction cost of evaporation ponds increases the unit capital cost and the total production cost of desalinated water for Fort Hancock WCID.

Table 2 - Estimated water production cost of brackish groundwater desalination facilities under construction.

Brackish Groundwater Desalination Plant [Source water salinity]	Desalination Design Capacity (MGD)[1]	Water Treatment Plant's Capital Cost ($)	Unit Capital Cost		Power Cost (¢/Kw-hr)	Cost ($) per 1,000 Gallons			Water Production Cost ($ per Acre-Foot)
			$_{2011}$/gal	$_{2011}$/AF		O&M[2]	Debt	Total Production Cost	
Fort Hancock WCID [1,600-2,400 mg/l]	0.4	3,375,000	8.44	2,749	8.2	1.36	1.91	3.27	1,064
City of Roscoe [3,800 mg/l]	0.5	974,000	2.25	735	7	0.42	0.44	0.86	280
North Alamo WSC Donna [3,800 mg/l]	2.5	6,700,000	2.68	873	7	0.8	0.61	1.41	458

Notes:

[1]The cost analysis used "1" as the plant operating factor.

[2]O&M costs for these projects are estimated.

AF = acre-foot, Kw-hr = kilowatt-hour, mg/l = milligrams per liter, MGD = millions of gallons per day, O&M = operation and maintenance, TDS = total dissolved solids, WSC = water supply corporation.

Additional Considerations

Several methodologies researched for this paper provide a valuable reference for a systematic planning-level water production cost estimating for desalination facilities (U.S. Bureau of Reclamation, 2003; Wilf, 2007; Sturdivant and others, 2009). TWDB and Reclamation are in the process of applying Reclamation's WaterCost (WTCost©) estimating software to a larger sample of facilities completed in the state since 2000. This application will account for cost factors such as source water chemistry and location, recovery rate, blending ratio, energy recovery, power tariff, concentrate management strategy, and projected plant availability. A deliverable of this effort will be a set of cost curves to guide cost estimating of brackish groundwater desalination facilities in Texas.

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