UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

JAN 05 2011

Steve Drown
Manager, Water Division
Arkansas Department of Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317

RE: Site-specific Water Quality Standards Revisions Associated with Jonesboro City Water and Light, in Craighead County, Arkansas

Dear Mr. Drown:

Thank you for your recent letter, dated November 2, 2010, requesting review and approval of several site-specific water quality standards revisions to Regulation No. 2, *Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas* for Unnamed Tributary to Big Creek, Big Creek Ditch, and Bayou DeView in the delta ecoregion of Arkansas. These streams are also the receiving waterbodies for a discharge from Jonesboro City Water and Light waste treatment facility, in Craighead County, Arkansas. Your letter included a request for U.S. Environmental Protection Agency (EPA) approval of the removal of site-specific criteria for chloride, sulfate, and total dissolved solids (TDS) in the above mentioned streams.

We have completed our review of your request for approval of these site-specific water quality standards revisions. Based upon the supporting documentation, the site-specific criteria for Bayou DeView and associated waterbodies have been demonstrated as appropriate to protect the designated uses in Unnamed Tributary to Big Creek Ditch, as well as the designated uses in downstream Big Creek Ditch and Bayou DeView. For these reasons, EPA approves the proposed site-specific criteria. Further, EPA has determined that approval of the site-specific criteria for chloride, sulfate, and TDS will have no effect upon federally listed threatened and endangered species.

A detailed explanation as well as the rationale for EPA's approval decision is provided in the enclosed record of decision. I would like to acknowledge the efforts of the Pollution Control and Ecology Commission, and particularly ADEQ, in the development of these revised standards. We look forward to working with you on future efforts. If you have any questions or concerns, please contact me at (214) 665-7101, or have your staff contact Matt Hubner at (214) 665-9736.

Sincerely yours,

Miguel I. Flores
Director
Water Quality Protection Division

Enclosure

Enclosure

RECORD OF DECISION:
EPA APPROVAL OF SITE-SPECIFIC REVISIONS TO THE ARKANSAS WATER QUALITY STANDARDS

Site-specific Minerals Criteria for
Bayou DeView
Big Creek
Craighead County, Arkansas

U.S. Environmental Protection Agency – Region 6

January 2011

RECORD OF DECISION: EPA APPROVAL OF SITE-SPECIFIC REVISIONS TO THE ARKANSAS WATER QUALITY STANDARDS

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Bayou DeView
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I. INTRODUCTION

Background

As described in §303(c) of the Clean Water Act (CWA) and in the standards regulation within the Code of Federal Regulations (CFR) at 40 CFR §131.20, states and authorized tribes have primary responsibility to develop and adopt water quality standards to protect their waters. State and tribal water quality standards consist of three primary components: beneficial uses, criteria to support those uses, and an antidegradation policy. In addition, CWA §303(c)(1) and 40 CFR §131.20 require states to hold public hearings at least once every three years to review and, as appropriate, modify and adopt standards. Under 40 CFR §131.21, EPA reviews new and revised surface water quality standards that have been adopted by states and authorized tribes. Authority to approve or disapprove new and/or revised standards submitted to EPA for review has been delegated to the Water Quality Protection Division Director in Region 6. Tribal or state water quality standards are not considered effective under the CWA until approved by EPA.[1]

The purpose of this record of decision is to provide the basis for the Environmental Protection Agency's (EPA) approval of water quality standards revisions to Regulation No. 2: *Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas* adopted by the Arkansas Pollution Control and Ecology Commission (APC&EC) in Minute Order 10-12 and further described in the subsection below titled "Summary of Revised Provisions."

Chronology of Events

April 9, 2010	A third party, Jonesboro City Water and Light (JCWL), filed a petition with the APC&EC to amend Regulation No. 2.
April 22, 2010	JCWL filed a petitioner's substitution to Exhibit A to Petition to Initiate Third-Party Rulemaking to Amend Regulation No. 2

[1] "Alaska rule" [*Federal Register*: April 27, 2000 (Volume 65, Number 82)]

April 23, 2010	The APC&EC initiated the rulemaking proceeding via Minute Order 10-12.
April 28, 2010 – April 29, 2010	Public notice of the proposed rule-making was published.
June 17, 2010	Public hearing on the proposed rule-making was held in Jonesboro, Arkansas.
July 1, 2010	Public comment period ended on the proposed changes to Regulation No. 2.
July 6, 2010	Responsiveness summary was filed with the APC&EC.
September 24, 2010	Teresa Marks, Director, Arkansas Department of Environmental Quality (ADEQ), signed Minute Order 10-35 adopting changes to Regulation No. 2.
November 12, 2010	Miguel I. Flores, Director, Water Quality Protection Division, EPA Region 6, received letter from Steve Drown, Water Division Chief, ADEQ, requesting EPA approval of the adopted revisions and transmitting the water quality standards submission package.

Summary of Revised Provisions

By letter dated November 2, 2010, from Steve Drown, ADEQ, to Miguel Flores, EPA Region 6, ADEQ requested EPA approval of several site-specific water quality standards revisions to Regulation No. 2, *Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas* for Bayou DeView and Big Creek Ditch in the delta ecoregion of Arkansas. Unnamed Tributary to Big Creek Ditch, Big Creek Ditch, and Bayou DeView are the receiving waterbodies for discharges from JCWL in Craighead County, Arkansas.

The letter included a request for EPA approval of site-specific criteria for chloride, sulfate, and total dissolved solids (TDS) for the three waterbodies. A request for domestic water supply use removal was not included as proposed values did not exceed the drinking water criteria. This record of decision applies to the site-specific water quality criteria revisions for the waterbodies identified above, and are further outlined in Table 1 below.

II. REVISED PROVISIONS EPA IS APPROVING

In accordance with the requirements found in Regulation No. 2.306 of the Arkansas water quality standards, JCWL contracted with FTN Associates, Ltd., to complete a use

attainability analysis (UAA) of Bayou DeView and associated waterbodies. The purpose of the UAA was to provide scientific justification to support revised site-specific water quality criteria for chloride, sulfate, and TDS for these waterbodies.

Table 1. Site-specific water quality criteria revisions for Bayou DeView submitted by ADEQ to EPA for review and approval (Concentrations in mg/L).

Reach Description	Current Criteria			Proposed Criteria		
	Chloride	Sulfate	TDS	Chloride	Sulfate	TDS
Unnamed Tributary from outfall 001 to Big Creek Ditch	48	37.3	411	71*	60*	453*
Big Creek Ditch from Unnamed Trib to Whistle Ditch	48	37.3	411	58*	49*	411
Bayou DeView from Whistle Ditch to Highway 14	20	30	270	48	38*	411
Bayou DeView from Highway 14 south	20	30	270	48	37.3	411

*Proposed values greater than ecoregion standards

Domestic Water Supply Use Removal

As noted above, the domestic water supply designated use was not proposed for removal in this UAA. This designated use is associated with chloride, sulfate, and total dissolved solids (TDS) criteria of 250 mg/L, 250 mg/L, and 500 mg/L, respectively. The proposed criteria values for the waterbodies, as seen in Table 1, are numbered well below the use thresholds.

Site-specific Water Quality Criteria for Chloride, Sulfate, and TDS

Criteria Derivation

Revised water quality criteria for chloride, sulfate, and TDS were adopted in the Bayou DeView watershed by the APC&EC on September 24, 2010. The derivation of these site-specific criteria is summarized below.

JCWL west treatment plant is not currently planning to increase loadings of minerals in effluent from outfall *001*. Proposed criteria resulting from this study were derived from calculating the 95th percentile of concentrations from data collected September 2008 through May 2009 at outfall *001*. Downstream concentrations were calculated and predicted using steady state mass balance modeling under critical conditions.

The resulting criteria, as seen in Table 1, are elevated compared to ecoregion values in Unnamed Tributary to Big Creek (chloride, sulfate, and TDS) and Big Creek Ditch (chloride and sulfate). The proposed criteria seek to remove the current water quality standards for Bayou DeView (chloride, 20 mg/L; sulfate, 30 mg/L; and TDS, 270 mg/L)

and replace them with EPA-approved criteria for the Delta ecoregion, in Arkansas. The exception is that mass balance calculations predict the upper reach of Bayou DeView to have a greater sulfate concentration (38 mg/L versus the ecoregion value of 37.3 mg/L)

Use Support Justification

The most sensitive designated use to minerals is the designated aquatic life use for Bayou DeView and associated waterbodies (channel-altered delta ecoregion perennial stream fishery). According to the Arkansas water quality standards, the fisheries use "provides for the protection and propagation of fish, shellfish and other forms of aquatic life."

The UAA study for Bayou DeView utilizes site-specific information and a weight-of-evidence approach to provide the necessary scientific justification that the maximum site-specific water quality criteria for chloride, sulfate, and TDS will support the designated aquatic life use for Bayou DeView and associated waterbodies. Specifically, the UAA study report provides four primary points of evidence to support the revised criteria for chloride, sulfate, and TDS.

First, a summary of results from weekly sampling from September 2008 through May 2009 demonstrates that effluent from outfall 001 did not typically result in exceedances of ecoregion values for chloride, sulfates, and TDS in downstream stations. In instances where exceedances of ecoregion values occurred, concentrations were typically less than proposed criteria and well below designated drinking water use criteria values.

Second, analytical results from September 2008 chronic toxicity testing of 100% effluent indicated that maximum chloride, sulfate, and TDS concentrations of 75 mg/L, 59 mg/L, and 450 mg/L, respectively, were not lethally or sub-lethally toxic to *P. promelas* or *C. dubia* in standard aquatic toxicity tests.

Third, habitat assessments were conducted in the waterbodies and at locations upstream and downstream of the confluence of the unnamed tributary with Big Creek Ditch. An assessment was also conducted at a nearby reference stream. The assessments showed that upstream and reference habitats were markedly different due to channelization of Big Creek Ditch and Bayou DeView. Upstream and reference sites exhibited greater riparian vegetation, dynamic water flows, as well as in-stream habitat suitable for the support of more diverse aquatic communities compared to the other stations in the upper reaches of Bayou DeView and Big Creek Ditch.

Fourth, a comparison of site-specific water quality monitoring data in combination with fish and benthic macroinvertebrate monitoring data for sites mentioned in the habitat component indicate that existing ambient chloride, sulfate, and TDS concentrations do not limit the benthic communities in these waterbodies. Comparisons between upstream and reference sites in both macroinvertebrate and fish investigations indicate that there are differences in overall diversity to the downstream stations. However, when the data is coupled to the habitat profiles, it is apparent that the disparity in habitat quality is the likely candidate for such differences. Both macroinvertebrate and fish studies support the

existence of functioning aquatic communities at all locations. Key and indicator channel-altered Delta ecoregion species were identified at the sample locations.

Based upon the above supporting site-specific documentation and the summary of available toxicity information for acute and chronic lethality effects of chloride, sulfate, and TDS provided in Appendix A of this record of decision, EPA approves the site-specific chloride, sulfate, and TDS criteria identified in Table 1 for Unnamed Tributary to Big Creek Ditch, Big Creek Ditch, and Bayou DeView.

APPENDIX A:
SUMMARY OF AVAILABLE TOXICITY INFORMATION FOR ACUTE AND CHRONIC LETHALITY EFFECTS OF CHLORIDE, SULFATE, AND TOTAL DISSOLVED SOLIDS (TDS)

BACKGROUND

EPA has published CWA §304(a) recommendations for chloride,[1] but has not developed aquatic life criteria for sulfate and TDS. The recommended chloride criteria for protection of aquatic life are 860 mg/L for acute toxicity and 230 mg/L for chronic toxicity. These values were derived following the Agency's procedures.[2] In total, EPA's criteria document for chloride includes acute data for twelve freshwater species. Data from numerous invertebrates were included in the calculation of EPA's recommended criteria including the following organisms: cladocerans, snail, isopod, midges, caddisfly, and mosquito larva. The most sensitive organism, based on species mean acute values, was *Daphnia magna*. The LC_{50} concentration (lethal concentration for 50% of the test organisms in a set period of time) associated with this ranking was 1470 mg/L of sodium chloride. EPA's criteria document also includes three chronic tests, in which *D. magna* was the most sensitive organism with a chronic LC_{50} of 372 mg/l for tests with sodium chloride.

For the purposes of this summary, EPA also considered available toxicity information for chloride, sulfate and TDS. As discussed above, the Agency has published an aquatic life criteria document for chloride, which includes some toxicity data. A study funded by the Gas Research Institute (GRI) evaluated toxicity of saline waters to freshwater organisms.[3] This study evaluated toxicity of four major cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) and three major anions (HCO_3^{-}, SO_4^{-} and Cl^{-}) to the fathead minnow (*Pimphales promelas*) and two invertebrates (*Ceriodaphnia dubia* and *D. magna*). The relative toxicity to the fathead minnow and *C. dubia*, in order of decreasing toxicity was:

$$K^{+} > HCO_3^{-} > Mg^{++} > Cl^{-} > SO_4^{-}$$

The toxicity to *D. magna* followed a similar pattern, with bicarbonate and magnesium reversed. Sodium and calcium were not found to be toxic to the test species at the concentrations tested (range of 14 mg/L to 3960 mg/L).

The GRI study developed equations to predict the survival of the test organisms at concentrations of the major ions. The results of these equations indicate that mortality for the fathead minnow and the two invertebrate species does not occur until chloride concentrations are over 1000

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[1] U.S. Environmental Protection Agency. 1988. *Ambient Water Quality Criteria for Chloride*. Office of Water - Regulations and Standards, Washington D.C.

[2] U.S. Environmental Protection Agency. 1985b. *Guidelines for Deriving National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses.* Office of Water Regulations and Standards, Washington, DC. 45 F.R. 79341, November 28, 1980, as amended at 50 F.R. 30784, July 29, 1985.

[3] Gas Research Institute. 1992. *Development of a Salinity/Toxicity Relationship to Predict Acute Toxicity of Saline Waters to Freshwater Organisms*. Prepared by David R. Mount, ENSR Consulting and Engineering and David D. Gully, University of Wyoming.

mg/L. Tests used in the GRI study indicate that sulfate is less toxic than chloride and that mortality does not occur until concentrations are over 2000 mg/L.

CHLORIDE

In addition to the above information, a search of EPA's ECOTOX database[4] was conducted for toxicity of sodium chloride and calcium chloride to fish species. The ECOTOX database included 153 freshwater acute (test duration less than or equal to 96 hours) LC_{50} results and two freshwater chronic (test duration greater than 96 hours) LC_{50} results for sodium chloride and calcium chloride for the following eleven freshwater species: American eel, goldfish, Crucian carp, western mosquitofish, eastern mosquitofish, bluegill, striped bass, rainbow trout, medaka-high eyes, fathead minnow, and sailfin mollies (see Tables 1 and 2 below). Sodium chloride and calcium chloride acute LC_{50} results for these freshwater fish species ranged from 1000 mg/L to 21,450 mg/L. The two chronic LC_{50} concentrations were for the goldfish and blue gill and were equal to 4324 mg/L and 10,650 mg/L, respectively.

EPA also conducted a search of EPA's ECOTOX database for effects of sodium chloride and calcium chloride to invertebrate species. The ECOTOX database included 111 freshwater acute (test duration less than or equal to 96 hours) LC_{50} results and 27 freshwater chronic (test duration greater than 96 hours) LC_{50} results for sodium chloride and calcium chloride for several species included within the following general groups: insects, crustaceans, worms, and molluscs (see Tables 3 and 4 below). Sodium chloride and calcium chloride acute LC_{50} results ranged from 649 mg/L to 44,425 mg/L. With the exception of two sodium chloride chronic LC_{50} concentrations for *C. dubia* of 280 mg/L and 330 mg/L, chronic LC_{50} concentrations for sodium chloride ranged from 910 mg/L to 7500 mg/L. While the two chronic LC_{50} concentrations for *C. dubia* were relatively low, fourteen additional sodium chloride chronic LC_{50} concentrations for *C. dubia* ranged from 910 mg/L to 2000 mg/L.

Table 1. Acute freshwater LC_{50} values for sodium chloride and calcium chloride for fish species from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Anguilla rostrata*	American eel	17880	593
Sodium chloride (NaCl)	*Anguilla rostrata*	American eel	21450	592
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6170	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6180	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6800	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6800	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6800	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6950	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	6950	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7000	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7000	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7050	2145

[4] U.S. Environmental Protection Agency. 2002. ECOTOX User Guide: ECOTOXicology Database System. Version 2.0. Available: http:/www.epa.gov/ecotox/.

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Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7050	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7150	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7200	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7200	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7200	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7300	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7341	5230
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7350	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7388	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7400	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7400	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7550	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7600	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7650	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7850	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7900	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7900	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7900	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7950	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7950	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	7950	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8050	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8200	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8350	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8400	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8500	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8530	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8800	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	8800	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9270	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9600	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9750	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9800	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9850	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9900	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9950	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	9980	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	10000	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	10100	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	10200	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	10270	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	10400	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	10450	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	11050	2145
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	11050	2145
Sodium chloride (NaCl)	*Carassius carassius*	Crucian carp	13750	915
Sodium chloride (NaCl)	*Gambusia affinis*	Western mosquitofish	17550	508
Sodium chloride (NaCl)	*Gambusia affinis*	Western mosquitofish	18100	508
Sodium chloride (NaCl)	*Gambusia affinis*	Western mosquitofish	18100	508

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Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Calcium chloride	*Gambusia affinis*	Western mosquitofish	13400	508
Calcium chloride	*Gambusia affinis*	Western mosquitofish	13400	508
Calcium chloride	*Gambusia affinis*	Western mosquitofish	13400	508
Sodium chloride (NaCl)	*Gambusia holbrooki*	Eastern mosquitofish	11540	6176
Sodium chloride (NaCl)	*Lepomis macrochirus*	Bluegill	1294.6	8037
Sodium chloride (NaCl)	*Lepomis macrochirus*	Bluegill	5840	45826
Sodium chloride (NaCl)	*Lepomis macrochirus*	Bluegill	12946	5683
Sodium chloride (NaCl)	*Lepomis macrochirus*	Bluegill	12946	949
Sodium chloride (NaCl)	*Lepomis macrochirus*	Bluegill	14125	915
Calcium chloride	*Lepomis macrochirus*	Bluegill	8350	915
Calcium chloride	*Lepomis macrochirus*	Bluegill	9500	930
Calcium chloride	*Lepomis macrochirus*	Bluegill	9500	930
Calcium chloride	*Lepomis macrochirus*	Bluegill	10650	8037
Calcium chloride	*Lepomis macrochirus*	Bluegill	10650	5683
Calcium chloride	*Lepomis macrochirus*	Bluegill	11300	930
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	1000	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	1000	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	1500	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	3000	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	5000	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	5000	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	5000	2012
Sodium chloride (NaCl)	*Morone saxatilis*	Striped bass	7000	2012
Sodium chloride (NaCl)	*Oncorhynchus mykiss*	Rainbow trout,donaldson trout	6094	56474
Sodium chloride (NaCl)	*Oncorhynchus mykiss*	Rainbow trout,donaldson trout	6094	58703
Sodium chloride (NaCl)	*Oncorhynchus mykiss*	Rainbow trout,donaldson trout	7461	56474
Sodium chloride (NaCl)	*Oncorhynchus mykiss*	Rainbow trout,donaldson trout	7461	58703
Calcium chloride	*Oryzias latipes*	Medaka, high-eyes	1000	12497
Calcium chloride	*Oryzias latipes*	Medaka, high-eyes	1000	12497
Calcium chloride	*Oryzias latipes*	Medaka, high-eyes	1000	12497
Calcium chloride	*Oryzias latipes*	Medaka, high-eyes	1000	12497
Calcium chloride	*Oryzias latipes*	Medaka, high-eyes	1000	12497
Calcium chloride	*Oryzias latipes*	Medaka, high-eyes	1000	12497
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	6390	18272
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	6510	18272
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	6570	45826
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7050	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7050	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7050	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7100	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7100	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7100	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7200	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7200	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7200	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7200	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7300	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7400	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7400	2145

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Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7400	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7400	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7400	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7450	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7500	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7500	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7500	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7500	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7550	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7600	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7650	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7650	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7650	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7650	5230
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7650	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7650	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7700	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7750	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7750	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7800	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7800	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7950	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	7950	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8100	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8150	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8150	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8200	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8200	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8280	18272
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8300	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8300	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8300	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8300	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8400	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8700	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8800	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	8800	2145
Sodium chloride (NaCl)	*Pimephales promelas*	Fathead minnow	9000	2145
Calcium chloride	*Pimephales promelas*	Fathead minnow	4630	18272
Calcium chloride	*Pimephales promelas*	Fathead minnow	6560	18272
Calcium chloride	*Pimephales promelas*	Fathead minnow	6660	18272
Sodium chloride (NaCl)	*Poecilia latipinna*	Sailfin molly	16595	915
Sodium chloride (NaCl)	*Poecilia latipinna*	Sailfin molly	18735	915

Table 2. Chronic freshwater LC_{50} values for sodium chloride and calcium chloride for fish species from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Carassius auratus*	Goldfish	4324	10487
Calcium chloride	*Lepomis macrochirus*	Bluegill	10650	949

Table 3. Acute freshwater LC_{50} values for sodium chloride and calcium chloride for invertebrate species from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	32000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	32000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	26000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	32000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	23000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	24000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	26000	2050
Sodium chloride (NaCl)	*Argia sp.*	Damselfly	24000	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	5600	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	10000	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	5600	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	10000	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	5100	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	8250	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	5100	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	8250	2050
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	16439	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	17008	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	23817	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	25064	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	25190	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	25786	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	14899	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	22457	19999
Sodium chloride (NaCl)	*Caenorhabditis elegans*	Nematode	24829	19999
Calcium chloride	*Caenorhabditis elegans*	Nematode	44425	18605
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	3380	18272
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1960	18272
Calcium chloride	*Ceriodaphnia dubia*	Water flea	1830	18272
Calcium chloride	*Ceriodaphnia dubia*	Water flea	2260	18272
Sodium chloride (NaCl)	*Cricotopus trifasciatus*	Midge	6221	6244
Sodium chloride (NaCl)	*Culex sp.*	Mosquito	10500	915
Sodium chloride (NaCl)	*Culex sp.*	Mosquito	10200	915
Calcium chloride	*Daphnia hyalina*	Water flea	3000	5339
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	3412	915
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	3412	2465

Enclosure

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	6380	18272
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	6447	915
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	3310	915
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	3318	2465
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	4745	13712
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	4770	18272
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	5020	14713
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	5600	14713
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	5600	14713
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	6027	14713
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	6027	14713
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	5874	915
Sodium chloride (NaCl)	*Daphnia magna*	Water flea	3114	915
Calcium chloride	*Daphnia magna*	Water flea	649	915
Calcium chloride	*Daphnia magna*	Water flea	759	915
Calcium chloride	*Daphnia magna*	Water flea	759	2465
Calcium chloride	*Daphnia magna*	Water flea	759	915
Calcium chloride	*Daphnia magna*	Water flea	1838	915
Calcium chloride	*Daphnia magna*	Water flea	1838	2465
Calcium chloride	*Daphnia magna*	Water flea	2770	18272
Calcium chloride	*Daphnia magna*	Water flea	3005	915
Calcium chloride	*Daphnia magna*	Water flea	3250	18272
Calcium chloride	*Daphnia magna*	Water flea	3526	915
Sodium chloride (NaCl)	*Daphnia pulex*	Water flea	1470	45826
Sodium chloride (NaCl)	*Daphnia pulex*	Water flea	3050	45826
Sodium chloride (NaCl)	*Erpobdella punctata*	Red leech	10000	2050
Sodium chloride (NaCl)	*Erpobdella punctata*	Red leech	7500	2050
Sodium chloride (NaCl)	*Erpobdella punctata*	Red leech	7500	2050
Sodium chloride (NaCl)	*Erpobdella punctata*	Red leech	7500	2050
Sodium chloride (NaCl)	*Gyraulus circumstriatus*	Flatly coiled gyraulus	10000	2050
Sodium chloride (NaCl)	*Gyraulus circumstriatus*	Flatly coiled gyraulus	10000	2050
Sodium chloride (NaCl)	*Gyraulus circumstriatus*	Flatly coiled gyraulus	3700	2050
Sodium chloride (NaCl)	*Gyraulus circumstriatus*	Flatly coiled gyraulus	3200	2050
Sodium chloride (NaCl)	*Helisoma campanulatum*	Ramshorn snail	10000	2050
Sodium chloride (NaCl)	*Helisoma campanulatum*	Ramshorn snail	7500	2050
Sodium chloride (NaCl)	*Helisoma campanulatum*	Ramshorn snail	6150	2050
Sodium chloride (NaCl)	*Helisoma campanulatum*	Ramshorn snail	6150	2050
Sodium chloride (NaCl)	*Hydroptila angusta*	Caddisfly	6621	6244
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	7500	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	6950	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	6800	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	6200	2050
Sodium chloride (NaCl)	*Lirceus fontinalis*	Aquatic sowbug	2970	45826
Sodium chloride (NaCl)	*Lymnaea sp.*	Pond snail	3412	915

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Lymnaea sp.*	Pond snail	3388	915
Calcium chloride	*Lymnaea sp.*	Pond snail	2573	915
Calcium chloride	*Lymnaea sp.*	Pond snail	3094	915
Calcium chloride	*Lymnaea sp.*	Pond snail	3308	915
Calcium chloride	*Lymnaea sp.*	Pond snail	4485	915
Sodium chloride (NaCl)	*Nais variabilis*	Oligochaete	2569	6244
Sodium chloride (NaCl)	*Physa gyrina*	Pouch snail	2540	45826
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	4200	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	4800	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	5600	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	7500	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	3700	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	4250	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	5600	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	6950	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	3500	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	4250	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	5600	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	6200	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	3500	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	4100	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	5100	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	6200	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	2250	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	2400	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	1550	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	1950	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	1250	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	1250	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	1100	2050
Sodium chloride (NaCl)	*Sphaerium sp.*	Orb cockle, fingernail clam	1150	2050

Table 4. Chronic freshwater LC_{50} values for sodium chloride for invertebrate species from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	7200	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	6800	2050
Sodium chloride (NaCl)	*Asellus communis*	Aquatic sowbug	6150	2050
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	280	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	330	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	910	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1170	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1430	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1640	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1710	11152

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1740	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1830	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1830	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1830	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1940	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1940	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1940	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	1940	11152
Sodium chloride (NaCl)	*Ceriodaphnia dubia*	Water flea	2000	45168
Sodium chloride (NaCl)	*Erpobdella punctata*	Red leech	7500	2050
Sodium chloride (NaCl)	*Gyraulus circumstriatus*	Flatly coiled gyraulus	3200	2050
Sodium chloride (NaCl)	*Helisoma campanulatum*	Ramshorn snail	6150	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	6200	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	5800	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	5800	2050
Sodium chloride (NaCl)	*Limnodrilus hoffmeisteri*	Tubificid worm, Oligochaete	5800	2050
Sodium chloride (NaCl)	*Physa heterostropha*	Pond snail, pneumonate snail	5100	2050

SULFATE

A search of EPA's ECOTOX database was also conducted for toxicity of sodium sulfate and calcium sulfate to fish species. The ECOTOX database included 27 freshwater acute (test duration less than or equal to 96 hours) LC_{50} results and two freshwater chronic (test duration greater than 96 hours) LC_{50} results for sodium sulfate and calcium sulfate for the following four freshwater species: bluegill, fathead minnow, sailfin mollies, and western mosquitofish (see Tables 5 and 6 below). Sodium sulfate and calcium sulfate acute LC_{50} results for these freshwater fish species ranged from 1970 mg/L to 56,000 mg/L. The two chronic LC_{50} concentrations were for the western mosquitofish and were equal to 2200 and 3200 mg/L.

EPA also conducted a search of EPA's ECOTOX database for effects of sodium sulfate and calcium sulfate to invertebrate species. The ECOTOX database included 29 freshwater acute (test duration less than or equal to 96 hours) LC_{50} results and two freshwater EC_{50} results (one acute and one chronic (test duration greater than 96 hours)) for sodium sulfate and calcium sulfate for the following invertebrate species: scud (Amphipoda), water fleas (*C. dubia* and *D. magna*), mosquitos (*Culex sp.*), mayflies (*Tricorythus sp.*), and the pond snail (egg life stage) (*Lymnaea sp.*) (see Tables 7 and 8 below). Sodium sulfate and calcium sulfate acute LC_{50} results for invertebrate species other than the pond snail ranged from 630 mg/L to 13,350 mg/L. For the pond snail (egg life stage), two out of four acute LC_{50} values fell below 480 mg/L, with a range in LC_{50} values from 3.55 mg/L to 5401 mg/L. One of the two EC_{50} concentrations was for the water flea *C. dubia* which had a 48-hour acute EC_{50} value of 3150.21 mg/L. The other EC_{50} concentration was for the water flea *D. magna*, which had a 100.8-hour chronic EC_{50} value of 4547 mg/L.

Table 5. Acute freshwater LC_{50} values for sodium sulfate and calcium sulfate for four fish species from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
sodium sulfate	*Gambusia affinis*	western mosquitofish	3710	508
sodium sulfate	*Gambusia affinis*	western mosquitofish	3940	508
sodium sulfate	*Gambusia affinis*	western mosquitofish	5350	508
sodium sulfate	*Gambusia affinis*	western mosquitofish	5400	508
sodium sulfate	*Gambusia affinis*	western mosquitofish	5670	508
sodium sulfate	*Gambusia affinis*	western mosquitofish	7800	508
calcium sulfate	*Gambusia affinis*	western mosquitofish	56000	508
calcium sulfate	*Gambusia affinis*	western mosquitofish	56000	508
calcium sulfate	*Gambusia affinis*	western mosquitofish	56000	508
calcium sulfate	*Lepomis macrochirus*	bluegill	2980	5683
calcium sulfate	*Lepomis macrochirus*	bluegill	2980	949
sodium sulfate	*Lepomis macrochirus*	bluegill	3040	8037
sodium sulfate	*Lepomis macrochirus*	bluegill	4380	8037
sodium sulfate	*Lepomis macrochirus*	bluegill	12500	930
sodium sulfate	*Lepomis macrochirus*	bluegill	12750	930
sodium sulfate	*Lepomis macrochirus*	bluegill	13000	930
sodium sulfate	*Lepomis macrochirus*	bluegill	13500	5683
sodium sulfate	*Lepomis macrochirus*	bluegill	13500	949
sodium sulfate	*Lepomis macrochirus*	bluegill	17500	915
calcium sulfate	*Pimephales promelas*	fathead minnow	1970	18272
calcium sulfate	*Pimephales promelas*	fathead minnow	1970	18272
calcium sulfate	*Pimephales promelas*	fathead minnow	1970	18272
sodium sulfate	*Pimephales promelas*	fathead minnow	7960	18272
sodium sulfate	*Pimephales promelas*	fathead minnow	7960	18272
sodium sulfate	*Pimephales promelas*	fathead minnow	8080	18272
sodium sulfate	*Poecilia latipinna*	sailfin molly	15996	915
sodium sulfate	*Poecilia latipinna*	sailfin molly	20040	915

Table 6. Chronic freshwater LC_{50} values for sodium sulfate for the western mosquitofish (*Gambusia affinis*) from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Cocentration (mg/L)	Ecotox Ref #
sodium sulfate	*Gambusia affinis*	western mosquitofish	2200	508
sodium sulfate	*Gambusia affinis*	western mosquitofish	3200	508

Table 7. Acute freshwater LC_{50} values for sodium sulfate and calcium sulfate for invertebrate species from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
sodium sulfate	Amphipoda	scud order	880	915
sodium sulfate	Amphipoda	scud order	880	915
sodium sulfate	Amphipoda	scud order	1110	915
sodium sulfate	Amphipoda	scud order	2380	915
calcium sulfate	*Ceriodaphnia dubia*	water flea	1910	18272

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
calcium sulfate	*Ceriodaphnia dubia*	water flea	1940	18272
calcium sulfate	*Ceriodaphnia dubia*	water flea	1970	18272
sodium sulfate	*Ceriodaphnia dubia*	water flea	3080	18272
sodium sulfate	*Ceriodaphnia dubia*	water flea	3590	18272
sodium sulfate	*Culex sp.*	mosquito	11430	915
sodium sulfate	*Culex sp.*	mosquito	13350	915
sodium sulfate	*Daphnia magna*	water flea	630	915
sodium sulfate	*Daphnia magna*	water flea	725	915
calcium sulfate	*Daphnia magna*	water flea	1970	18272
sodium sulfate	*Daphnia magna*	water flea	2564	915
sodium sulfate	*Daphnia magna*	water flea	2564	2465
sodium sulfate	*Daphnia magna*	water flea	4547	915
sodium sulfate	*Daphnia magna*	water flea	4580	18272
sodium sulfate	*Daphnia magna*	water flea	6100	915
sodium sulfate	*Daphnia magna*	water flea	6290	18272
sodium sulfate	*Daphnia magna*	water flea	6800	915
sodium sulfate	*Daphnia magna*	water flea	7616	13712
sodium sulfate	*Daphnia magna*	water flea	8384	915
sodium sulfate	*Daphnia magna*	water flea	8384	2465
sodium sulfate	*Lymnaea sp.*	pond snail	3.553	915
sodium sulfate	*Lymnaea sp.*	pond snail	5.4	915
sodium sulfate	*Lymnaea sp.*	pond snail	5400	915
sodium sulfate	*Lymnaea sp.*	pond snail	5401	915
sodium sulfate	*Tricorythus sp.*	mayfly	660	17845

Table 8. Acute and chronic freshwater EC_{50} values for sodium sulfate for water fleas from EPA's ECOTOX database.

Chemical Name	Scientific Name	Common Name	Concentration (mg/L)	Ecotox Ref #
sodium sulfate	*Ceriodaphnia dubia*	water flea	3150.21	20672
sodium sulfate	*Daphnia magna*	water flea	4547	2462

There is a general lack of data available as to the toxicity of dissolved minerals on freshwater mussel species. However, a previous use attainability analysis (UAA) study report associated with site-specific revisions for Ditch No. 27, Ditch No. 6, and the Tyronza River in the delta ecoregion of Arkansas (prepared by FTN & Associates, Ltd.) presented some unpublished data on acute sulfate toxicity for juvenile fatmucket mussels (*Lampsilis siliquoidea*) at various levels of hardness and chloride. This data was obtained from Dr. David Soucek (Illinois Natural History Survey; 607 East Peabody Drive; Champaign, IL 61820) and is summarized in Table 9 below.

Table 9. Acute toxicity (96 h LC_{50}) of sulfate to juvenile fatmucket mussels (*Lampsilis siliquoidea*), at various levels of hardness and chloride.

Hardness (mg/L)	Chloride (mg/L)	96h LC_{50} (Sulfate, mg/L)
100	25	3377
300	25	3525
500	25	3729
100	5	1727
100	33	1822

In addition, another study was conducted by Soucek and Kennedy (2005)[5] which provides acute and chronic sulfate toxicity data for the fingernail clam (*Sphaerium simile*). The study included three rounds of 96-hour toxicity tests (each with three to five *S. simile* juveniles per treatment). A mean acute LC_{50} value of 2078 mg/L was calculated for *S. simile*, as well as a chronic LC_{10} value of 1502 mg/L.

TOTAL DISSOLVED SOLIDS (TDS)

Information on toxicity of TDS to aquatic life is limited. The ECOTOX database does not include tests using TDS. EPA's "Red Book" reports that freshwater fish have survived in waters with TDS concentrations of 10,000 mg/L.[6] TDS levels may have physical toxicity effects by altering the osmotic pressure. The State of Pennsylvania recently incorporated an aquatic life criterion for osmotic pressure in its water quality standards to replace a TDS criterion of 1500 mg/L, on the basis that the two criteria provide the same level of protection to aquatic life. TDS concentrations of less than 1200 mg/L are not likely to affect invertebrate species such as cladocerans.

EPA uses two screening levels equal to 1000 mg/L and 2000 mg/L for evaluation of TDS criteria. The value of 1000 mg/L is based on EPA's Technical Support Document[7] which recommends that freshwater toxicity testing organisms be used when the receiving water salinity is less than 1000 mg/L and that marine organisms be used when salinity equals or exceeds 1000 mg/L. The TDS screening level of 2000 mg/L was obtained from the 1994 EPA Region 6 "Strategy for Evaluating and Addressing Impacts of Total Dissolved Solids in Freshwater Invertebrate Species Toxicity Testing."[8] The strategy states that TDS concentrations greater than 2000 mg/L are needed in order to conclude that TDS is the source of toxicity in a toxicity identification evaluation.

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[5] Soucek, David, and Alan Kennedy. 2005. "Effects of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates." *Environmental Toxicology and Chemistry*. Volume 24, No. 5, pages 1204-1210.

[6] U.S. Environmental Protection Agency. 1976. Quality Criteria for Water ("Red Book"). U.S. Environmental Protection Agency, Washington, D.C. PB-263 943.

[7] U.S. Environmental Protection Agency. 1991. *Technical Support Document For Water Quality-based Toxics Control*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA/505/2-90-001.

[8] Ferguson, Jack. "Strategy for Evaluating and Addressing Impacts of Total Dissolved Solids in Freshwater Invertebrate Species Toxicity Testing." Memo to various internal EPA Region 6 staff and to State water quality contacts. U.S. Environmental Protection Agency, Region 6, Dallas, Texas. 20 Jan. 1994.

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