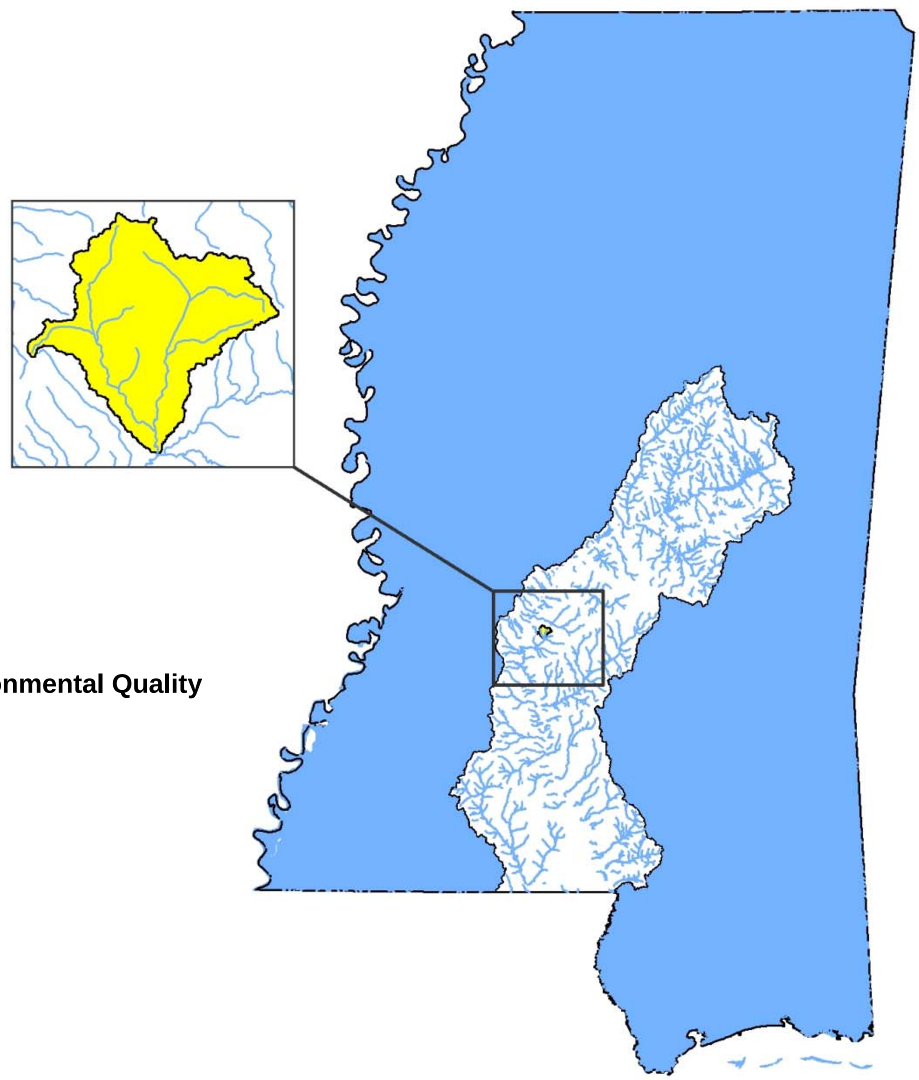
FINAL TMDL
August 2013

Total Maximum Daily Load For Cadmium In Indian Creek,

Rankin County, Mississippi Pearl River Basin

48
Cd
112.411



PREPARED BY
Mississippi Department of Environmental Quality
Office of Pollution Control

MDEQ
PO Box 2261
Jackson, MS 39225-2261
(601) 961-5171
www.deq.state.ms.us

Mississippi Department of
Environmental Quality

FOREWORD

The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's current Section 303(d) List of Impaired Water Bodies. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, modifications to the water quality standards or criteria, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	D	10	Deka	da
10^{-2}	centi	C	10^{2}	Hecto	h
10^{-3}	milli	M	10^{3}	Kilo	k
10^{-6}	micro	µ	10^{6}	Mega	M
10^{-9}	nano	N	10^{9}	Giga	G
10^{-12}	pico	P	10^{12}	Tera	T
10^{-15}	femto	F	10^{15}	Peta	P
10^{-18}	atto	A	10^{18}	Exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	µg/l * cfs	Gm/day	2.45

TABLE OF CONTENTS

FIGURES

TABLES

TMDL INFORMATION PAGE

Table 1. Listing Information

Name	ID	County	HUC	Impaired Use	Causes
Indian Creek	510212	Rankin	3180002	Aquatic Life Support	Cadmium
Near Pearl from headwaters to confluence with Steen Creek					

Table 2. Water Quality Criteria*

Parameter	Beneficial use	Water Quality Criteria	
Cadmium	Aquatic Life Support	Acute (CMC) 0.75 µg/l	Chronic (CCC) 0.12 µg/l

* Criteria based on *National Recommended Water Quality Criteria*, United States Environmental Protection Agency (EPA, 2006) At a hardness of 36.3 mg/l

Table 3. Total Maximum Daily Load for Indian Creek

	WLA grams/day	LA grams/day	MOS	TMDL grams/day
Dissolved Cadmium	0	0.0208	Implicit	**0.0208**

*At a hardness of 36.3 mg/l

EXECUTIVE SUMMARY

Indian Creek segment 510212 was included in the Mississippi 2012 Section 303(d) List of Impaired Water bodies as impaired due to cadmium. The stream was initially listed in 2008. Indian Creek, shown in figure 1, is in the Pearl River Basin just northeast of Florence in Rankin County. Indian Creek flows for 4 miles in a southern direction from its headwaters to the confluence with Steen Creek.

The cadmium criteria are calculated based on the hardness of the water at the time of sampling. For this water body segment, the lowest hardness value during the assessment period was 36.3 mg/l. The applicable chronic criterion for cadmium would be 0.12 μg/l at that hardness. This is the target for this TMDL.

Monitoring indicates the cadmium criteria are violated in Indian Creek. The cadmium is coming from groundwater contamination from Exide Technologies which is currently under an order from the Commission on Environmental Quality for a remediation plan.

Exide Technologies is currently performing an MDEQ approved Corrective Action Study to evaluate whether it is feasible to reduce cadmium concentrations in groundwater prior to discharge to Indian Creek to the extent that cadmium concentrations in surface water are below the water quality standard. An initial update of the Corrective Action Study baseline investigation activities was submitted by Exide Technologies. A second status update was provided in January, 2013. Preliminary findings of the Corrective Action Study are promising.

Figure 1. Indian Creek site photograph

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is cadmium. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

Mississippi Department of Environmental Quality (MDEQ) identified Indian Creek as impaired by cadmium levels elevated above the cadmium toxicity chronic criteria for fresh water streams (USEPA National Water Quality Criteria). Indian Creek is in Rankin County. This is a 4 mile stream which begins northeast of Florence and ends at the confluence with Steen Creek. The watershed is shown in Figure 2.

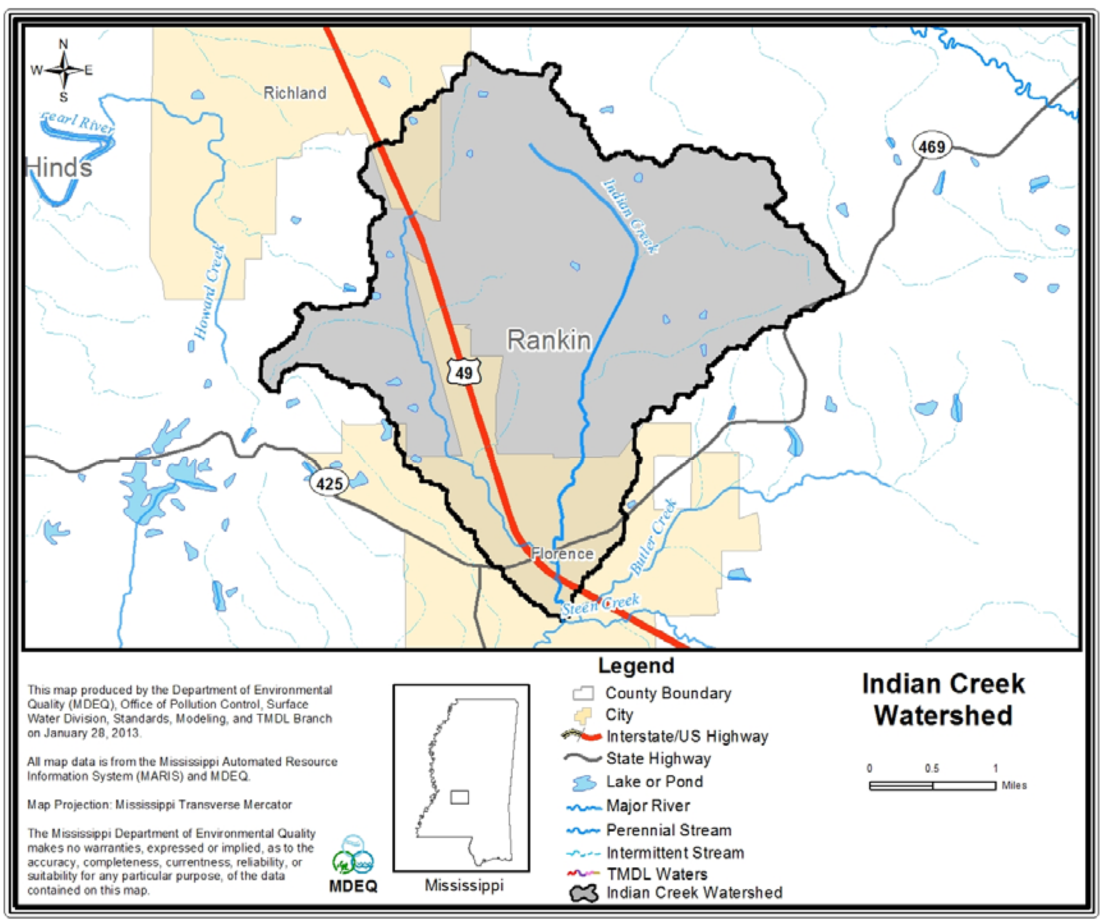


Figure 2. Indian Creek Watershed

1.2 Applicable Water body Segment Use

Designated beneficial uses and water quality criteria are established by the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters. WPC-2 (MDEQ, 2012). The designated use for Indian Creek as defined by the regulations is Fish and Wildlife.

1.3 Applicable Water body Segment Standard

The standard for cadmium is hardness-dependent and requires sampling for hardness to coincide with the cadmium sample. The minimum standard was selected for this TMDL which was developed using the most conservative hardness value (36.3 mg/L) from samples taken at five monitoring stations on Indian Creek during the five year assessment period.

$$\text{Chronic Cadmium Standard} = e^{(0.7409[\ln(hardness)]-4.719)}$$

$$= e^{(0.7409[\ln(36.3)]-4.719)}$$

$$= 0.12\ \mu g/l$$

$$\text{Acute Cadmium Standard} = e^{(1.0166[\ln(hardness)]-3.924)}$$

$$= e^{(1.0166[\ln(36.3)]-3.924)}$$

$$= 0.75\ \mu g/l$$

Table 4. TMDL Target for Total Cadmium (EPA, 2006)

Parameter	Fresh Water	
	Acute	Chronic
Cadmium	0.75 µg/l	0.12 µg/l

*At a hardness of 36.3 mg/l

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The TMDL target is based on the minimum hardness fresh water chronic criterion of 0.12 μg/l.

2.2 Discussion of Cadmium

Cadmium is a relatively rare element that is a minor nutrient for plants at low concentrations (Lane and Morel 2000; Lee et al. 1995; Price and Morel 1990), but is toxic to aquatic life at concentrations only slightly higher. Because of the variety of forms of cadmium (Callahan et al. 1979) and lack of definitive information about their relative toxicities, no available analytical measurement is known to be ideal for expressing aquatic life criteria for cadmium.

The approach taken by U.S. EPA involves the use of conversion factors (CF), that when applied to the total metal concentration, gives a dissolved metal concentration. Thus, the CF corresponds to the percent of the total recoverable metal that is dissolved. These CFs were determined by conducting a number of “simulation tests” using solutions simulating those used in the toxicity tests that were most important in the derivation of aquatic life criteria for each metal (static, flow-through, fed, and unfed conditions that typified standard acute and chronic toxicity tests from which criteria are derived). The intent was to mimic the way criteria would have been derived if dissolved metal had been measured in each of the toxicity tests (Lussier et al. 1995; Stephan 1995; Univ. of Wisconsin Superior 1995). For certain metals like cadmium, these CFs are hardness dependent. Cadmium is more easily absorbed by an aquatic organism’s gills in softer water. If the water is harder than the cadmium binds to calcium and is not as bioavailable.

2.3 Inventory of Available Water Quality Monitoring Data

Monitoring began in 2003 to determine the cadmium concentration in Indian Creek. During this study, 67 samples were collected from five different monitoring stations on Indian Creek. The samples were analyzed for dissolved cadmium, dissolved lead, and hardness. The locations of the water quality monitoring stations are shown in Figure 3. The sample results which were assessed for the Section 303(d) impaired waters list are shown in Table 5. The additional data available both prior to the assessed data and since that assessment are shown in Table 6. Most of the samples exceed the chronic criteria and TMDL target which are displayed in red text in Tables 5 and 6.

Exide provided these data to MDEQ using laboratory qualifiers. These data are presented in Appendix A at the end of the document.

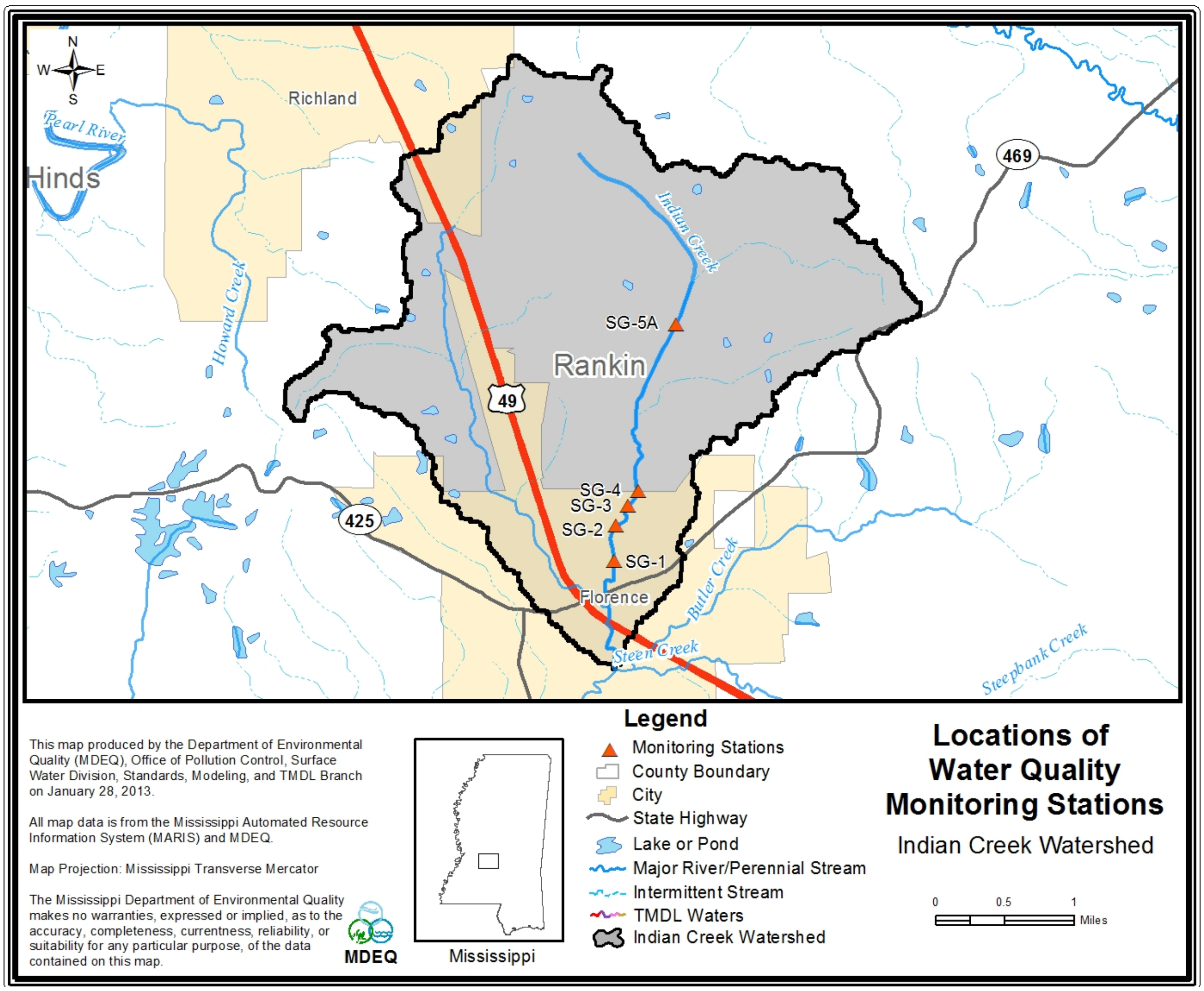


Figure 3. Locations of Water Quality Monitoring Stations

Table 5. Cadmium Loading for Indian Creek (values that violate standard are shown in red)

Date	Monitoring Station	Hardness (mg/l)	Dissolved Cadmium Chronic Criteria (µg/l)	Dissolved Cadmium (µg/l)
02/20/2004	1	44.7	0.14	0.980
02/20/2004	2	44.6	0.14	0.560
02/20/2004	3	39.0	0.13	0.200
02/20/2004	4	36.3	0.12	0.200
02/20/2004	5A	41.3	0.13	0.200
04/22/2004	1	99.0	0.24	0.490
04/22/2004	2	83.7	0.22	1.200
04/22/2004	3	72.6	0.20	0.064
04/22/2004	4	58.6	0.17	0.049
04/22/2004	5A	56.7	0.17	0.049
04/19/2005	1	53.4	0.16	1.400
04/19/2005	2	45.5	0.14	0.480
04/19/2005	3	43.8	0.14	0.190
04/19/2005	4	39.3	0.13	0.029
04/19/2005	5A	42.1	0.13	0.029
04/17/2006	1	77.7	0.21	0.900
04/17/2006	2	65.1	0.18	0.980
04/17/2006	3	61.3	0.18	0.410
04/17/2006	4	47.3	0.15	0.029
04/17/2006	5A	87.5	0.22	0.029
04/24/2007	1	79.7	0.21	0.650
04/24/2007	2	68.0	0.19	0.500
04/24/2007	3	65.7	0.18	0.280
04/24/2007	4	51.0	0.15	0.023
04/25/2007	5A	110.0	0.26	0.025
04/23/2008	1	89.3	0.23	2.300
04/23/2008	2	69.8	0.19	0.550
04/23/2008	3	70.6	0.19	1.000
04/23/2008	4	49.9	0.15	1.000
04/23/2008	5A	102.0	0.25	1.000
05/07/2008	1	89.0	0.23	2.300
05/07/2008	5A	89.5	0.23	0.033

Table 6. Additional Cadmium Loadings for Indian Creek (Not collected during assessment period)

Date	Monitoring Station	Hardness (mg/l)	Dissolved Cadmium Chronic Criteria (µg/l)	Dissolved Cadmium (µg/l)
04/30/2003	1	76.0	0.20	0.240
11/24/2003	1	28	0.10	0.920
11/26/2003	1	50.8	0.15	2.000
04/30/2009	1	77.2	0.21	1.900
04/27/2010	1	89.8	0.23	1.400
04/14/2011	1	67.3	0.19	1.200
05/01/2012	1	57.3	0.17	0.547
04/30/2003	2	64.0	0.18	0.900
11/24/2003	2	27.2	0.10	0.830
11/26/2003	2	39.6	0.13	1.200
04/30/2009	2	67.2	0.19	0.430
04/27/2010	2	73.7	0.20	0.500
04/14/2011	2	66.7	0.19	0.780
05/01/2012	2	65.0	0.18	1.210
04/30/2003	3	55.0	0.16	0.500
11/24/2003	3	28.0	0.10	0.340
11/26/2003	3	36.1	0.12	0.670
04/30/2009	3	59.1	0.17	0.260
04/27/2010	3	70.6	0.19	0.16
04/14/2011	3	60.9	0.17	0.220
05/01/2012	3	57.2	0.17	0.161
04/30/2003	4	41.0	0.13	0.500
11/24/2003	4	24.5	0.09	0.300
11/26/2003	4	25.2	0.09	0.970
04/30/2009	4	47.4	0.15	0.037
04/28/2010	4	68.4	0.19	0.045
04/14/2011	4	49.6	0.15	0.095
05/01/2012	4	43.5	0.14	0.038
04/30/2003	5/5A	76.0	0.16	0.500
11/24/2003	5/5A	27.9	0.10	0.720
11/26/2003	5/5A	28.0	0.10	0.310

Table 6. (Continued) Additional Cadmium Loadings for Indian Creek (Not collected during assessment period)

Date	Monitoring Station	Hardness (mg/l)	Dissolved Cadmium Chronic Criteria (µg/l)	Dissolved Cadmium (µg/l)
04/30/2009	5/5A	71.1	0.19	0.044
04/28/2010	5/5A	103.0	0.25	0.045
04/14/2011	5/5A	67.9	0.19	0.095
05/01/2012	5/5A	61.3	0.18	0.043

SOURCE ASSESSMENT

3.1 Assessment of Point Sources

There are no current point sources of cadmium in this watershed. There is one stormwater NPDES permitted facility in the Indian Creek watershed, Exide Florence Oxide Plant MS0047945, indicated on the Figure 4 map, however, it is not permitted to discharge cadmium.

The WLA will be set to zero. This may be modified in the future depending on the remediation plan ultimately approved. Should a discharge permit be issued, the WLA may need to be adjusted within the TMDL allotment process for the remediation activities.

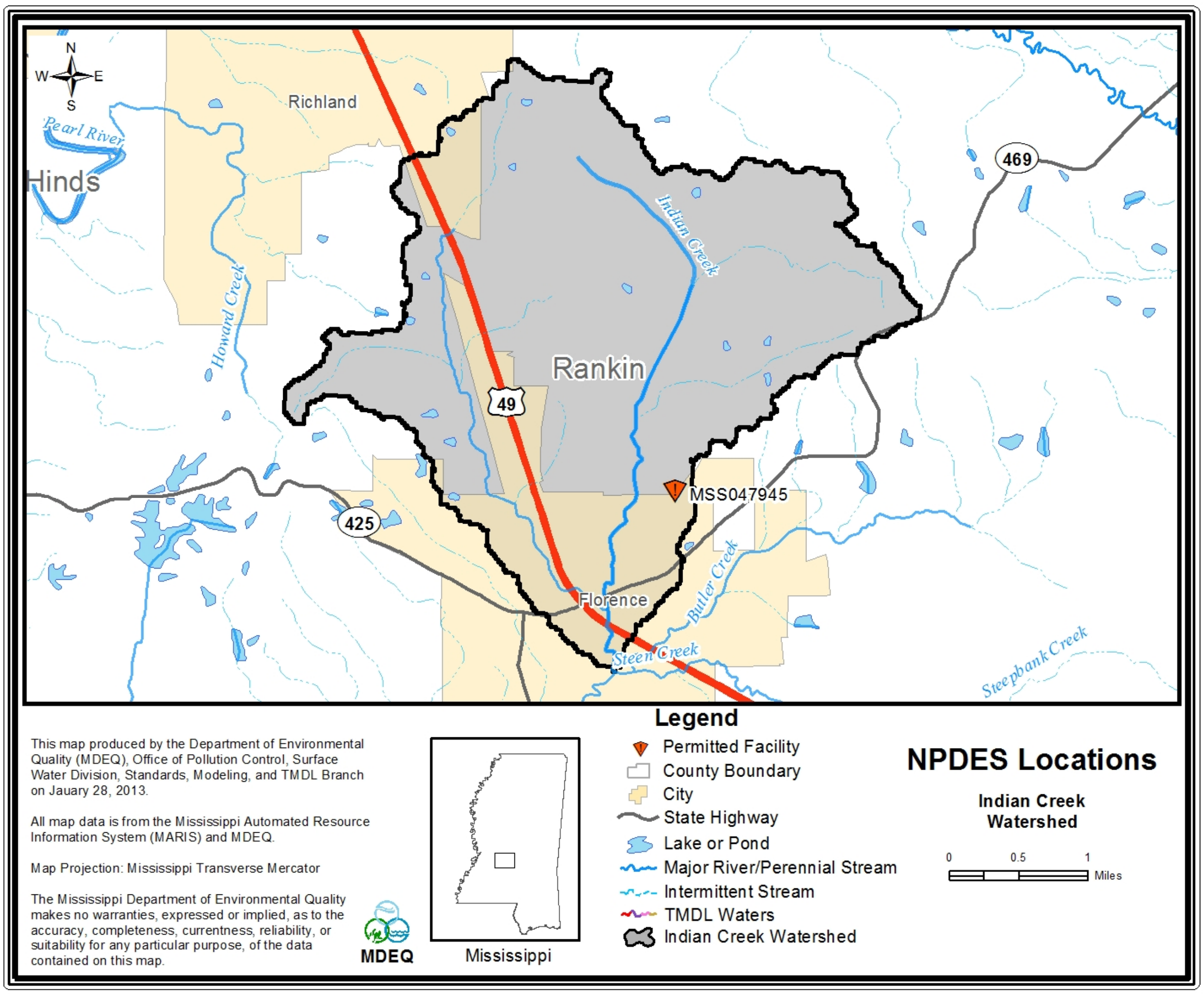


Figure 4. Location of NPDES facility on Indian Creek

3.2 Assessment of Nonpoint Sources

The 6,206-acre drainage area of the Indian Creek watershed contains many different landuse types, including urban, forests, cropland, pasture, and wetlands. The landuse information is based on the National Land Cover Dataset (NLCD2006). NLCD2006 is based primarily on the unsupervised classification of Landsat Enhanced Thematic Mapper+ (ETM+) circa 2006 satellite data. Table 7 shows the landuse distribution in number of acres.

Soil borings were taken from an area where Exide Technologies housed a used battery refurbishment operation in the 1980's. These borings showed that cadmium levels still persist above the cadmium drinking water Maximum Contaminant Level (MCL) of 0.005 mg/L down-gradient of this area. This implies that groundwater is the likely source of cadmium in Indian Creek.

Table 7. Landuse Distribution in Number of Acres and Percentage of Total

	Water	Barren	Forest	Croplands	Pasture	Urban	Wetland	Total
Area (acres)	36.9	947.6	2607.6	84.3	984.3	1012.8	532.2	6,205.7
Percentage	0.6%	15.3 %	42.0 %	1.4 %	15.9 %	16.2 %	8.6 %	100 %

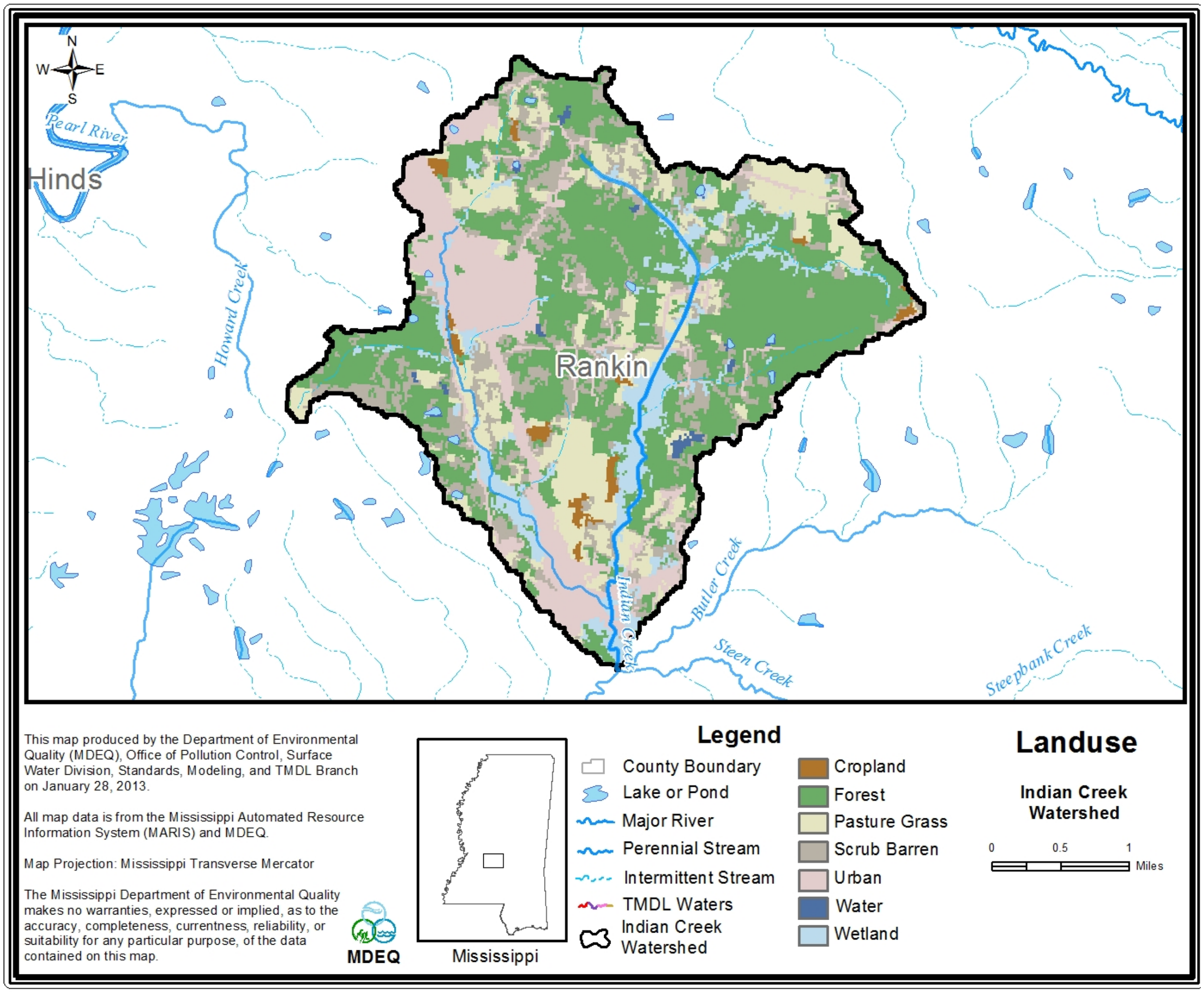


Figure 5. Indian Creek Landuse Distribution

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of the TMDL target. The Margin of Safety (MOS) is implicit based on conservative assumptions. The TMDL is based on the fresh water chronic cadmium toxicity criterion multiplied by the 7Q10 flow in the stream. The WLA and LA portions of the TMDL are allocated from the allowable daily load.

4.1 Calculation of the TMDL

The TMDL is calculated by multiplying the estimated 7Q10 flow in Indian Creek by the fresh water chronic cadmium toxicity criterion. By using this mass balance calculation, the maximum safe value of the cadmium load was calculated. The 7Q10 flow for Indian Creek was found by comparing the drainage area of Indian Creek to the drainage area of Steen Creek which has a known 7Q10 and establishing a 7Q10 to drainage area ratio. The conversion factor is a combination of converting cfs to MGD and converting pounds to grams.

Calculation of TMDL:
0.071 cfs (7Q10 flow) * 0.00012 mg/l (criterion) * 2446.68 (conversion) = .0208 grams per day (TMDL) at a hardness of 36.3 mg/l

Calculation of 7Q10 flow:
0.6 cfs (Steen Creek 7Q10) * 9.7 square miles (Indian Creek D.A.) / 82.1square miles (Steen Creek D.A.) = 0.071cfs (Indian Creek 7Q10)

4.2 Wasteload Allocations

There are currently no point sources discharging cadmium, therefore, the wasteload allocation is zero. Future adjustment of the allocation may be completed based on the remediation plan.

4.3 Load Allocations

The load allocation developed for this TMDL is an estimation of the acceptable contribution of all nonpoint sources in the watershed. The calculated total of the allowable yield of cadmium for the Indian Creek watershed without exceeding the applicable water quality criteria is 0.0208 grams/day based on protective hardness.

4.4 Incorporation of a Margin of Safety

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this TMDL is implicit.

4.5 Seasonality

Seasonality is not considered an issue in this TMDL because groundwater is the source of cadmium in Indian Creek.

CONCLUSION

Cadmium was addressed through a total cadmium target based on USEPA criteria. This TMDL recommends further monitoring for cadmium using clean techniques and accurate testing methods to monitor the restoration of the watershed.

A corrective action plan was prepared for Exide Technologies. The primary objective is to evaluate the feasibility and effectiveness of an enhanced bioremediation project for the in-situ treatment of cadmium in groundwater at the site. Through injection wells, an organic carbon amendment (lactate, ethanol, or emulsified oil) will be introduced into the subsurface to provide an energy source for indigenous sulfate-reducing microorganisms to convert existing sulfate in groundwater to sulfide. The cadmium is expected to form insoluble cadmium sulfide precipitates with iron sulfide, which will precipitate from solution and be sequestered in the soil. This will reduce the concentration and mobility of cadmium in groundwater.

5.1 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper. The public will be given an opportunity to review the TMDLs and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. Anyone wishing to become a member of the TMDL mailing list should contact Greg Jackson at Greg_Jackson@deq.state.ms.us.

All comments should be directed to Greg Jackson at Greg_Jackson@deq.state.ms.us or Greg Jackson, MDEQ, PO Box 2261, Jackson, MS 39225. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered water body may be based upon a similar, unaltered or least impaired, water body or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving water body.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a water body have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each water body or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Evaluated Water body: The group of listings on the 1998 Mississippi Section 303(d) for which there are insufficient data to make an assessment call.

Geometric mean: the nth root of the product of n numbers. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

Impaired Water body: any water body that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all cattle and land applied fecal coliform that enter a receiving water body. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^{4}$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, (d_1, d_2, d_3) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24 + 123 + 16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a water body at which water quality standards can be maintained.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10 .... Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BMP .... Best Management Practice

CWA .... Clean Water Act

DMR .... Discharge Monitoring Report

EPA .... Environmental Protection Agency

GIS .... Geographic Information System

HUC .... Hydrologic Unit Code

LA .... Load Allocation

MARIS .... State of Mississippi Automated Information System

MDEQ .... Mississippi Department of Environmental Quality

MOS .... Margin of Safety

NRCS .... National Resource Conservation Service

NPDES .... National Pollution Discharge Elimination System

USGS .... United States Geological Survey

WLA .... Waste Load Allocation

REFERENCES

CRC Handbook of Chemistry and Physics, 60th Edition, CRC Press, Boca Raton.

EPA. 1988. *Ambient Water Quality Criteria for Cadmium -1988.* United States Environmental Protection Agency.

EPA. 1996. Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels.*

EPA. 2006. *National Recommended Water Quality Criteria.* United States Environmental Protection Agency.

Horner, 1992. Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation. In R.W. Beck and Associates. Covington Master Drainage Plan. King County Surface Water Management Division, Seattle, WA.

Keenan, Kleinfelter, Wood. 1980. *General College Chemistry*, 6th Edition. Harper & Row, Inc. San Francisco.

Metccalf and Eddy. 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*. 3rd Edition. McGraw-Hill, Inc., New York.

MDEQ. 1994. *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification.* Office of Pollution Control.

MDEQ. 2007. *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Office of Pollution Control.

MDEQ. 2006. *Mississippi List of Waterbodies, Pursuant to Section 303(d) of the Clean Water Act*. Office of Pollution Control.

MDEQ. 1999. *Mississippi Water Quality Assessment, Pursuant to Section 305(b) of the Clean Water Act*. Office of Pollution Control.

USGS. 1992. *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics for Ungaged Sites On Streams In Mississippi.*

EPA. 2001. *2001 Update of Ambient Water Quality Criteria for Cadmium* .

APPENDIX A

Table 1
Dissolved Cadmium Surface Water Analytical Results
Former Chloride Metals Site
Florence, Mississippi

Date	Station	Event	Hardness (mg/L)	National Cadmium SWQC	Dissolved Cadmium Result (ug/L)	Cd Reporting Limit	Cadmium Instrument Detection Limit
4/30/2003	SG-1	Low Flow	78.0	0.20	2.40	0.5	NA
11/24/2003	SG-1	High Flow	28.0	0.10	0.92 U	5	0.3
11/28/2003	SG-1	Low Flow	50.8	0.15	2.00	5	0.3
2/20/2004	SG-1	Low Flow	44.7	0.14	0.98 J	5	.04
4/22/2004	SG-1	Low Flow	99.0	0.24	0.049 U	1.0	0.049
4/19/2005	SG-1	Low Flow	53.4	0.16	1.40	1.0	0.043
4/17/2006	SG-1	Low Flow	77.7	0.21	0.9 B	1.0	0.29
4/24/2007	SG-1	Low Flow	79.7	0.21	0.65 B	1.0	0.023
4/23/2008	SG-1	Low Flow	89.3	0.23	2.30	1.0	0.11
5/7/2008	SG-1	Low Flow	89.0	0.23	2.30	1.0	0.22
4/30/2009	SG-1	Low Flow	77.2	0.21	1.90	0.15	0.037
4/27/2010	SG-1	Low Flow	89.8	0.23	1.40	0.045	0.045
4/14/2011	SG-1	Low Flow	67.3	0.19	1.20	0.5	0.095
5/1/2012	SG-1	Low Flow	57.3	0.17	0.547	0.025	NA
4/30/2003	SG-2	Low Flow	64	0.18	0.90	0.5	NA
11/24/2003	SG-2	High Flow	27.2	0.10	0.83 U	5	0.3
11/28/2003	SG-2	Low Flow	39.6	0.13	1.20	5	0.3
2/20/2004	SG-2	Low Flow	44.8	0.14	0.56 J	5	.04
4/22/2004	SG-2	Low Flow	83.7	0.22	1.20	1.0	0.049
4/19/2005	SG-2	Low Flow	45.5	0.14	0.48 J	1.0	0.043
4/17/2006	SG-2	Low Flow	65.1	0.18	0.98 B	1.0	0.29
4/24/2007	SG-2	Low Flow	68.0	0.19	0.5 B	1.0	0.023
4/23/2008	SG-2	Low Flow	69.8	0.19	0.55 J	1.0	0.11
4/30/2009	SG-2	Low Flow	67.2	0.19	0.43 B	0.15	0.037
4/27/2010	SG-2	Low Flow	73.7	0.20	0.50	0.045	0.045
4/14/2011	SG-2	Low Flow	66.7	0.19	0.78	0.5	0.095
5/1/2012	SG-2	Low Flow	65	0.18	1.21	0.025	NA
4/30/2003	SG-3	Low Flow	55	0.16	0.5 U	0.5	NA
11/24/2003	SG-3	High Flow	28.0	0.10	0.34 U	5	0.3
11/28/2003	SG-3	Low Flow	38.1	0.12	0.67	5	0.3
2/20/2004	SG-3	Low Flow	39.0	0.13	0.2 U	5	.04
4/22/2004	SG-3	Low Flow	72.8	0.20	0.064 J	1.0	0.049
4/19/2005	SG-3	Low Flow	43.8	0.14	0.19 J	1.0	0.043
4/17/2006	SG-3	Low Flow	61.3	0.18	0.41 B	1.0	0.29
4/24/2007	SG-3	Low Flow	65.7	0.18	0.28 B	1.0	0.023
4/23/2008	SG-3	Low Flow	70.8	0.19	1 U	1.0	0.11
4/30/2009	SG-3	Low Flow	59.1	0.17	0.26 B	0.15	0.037
4/27/2010	SG-3	Low Flow	70.8	0.19	0.16	0.045	0.045
4/14/2011	SG-3	Low Flow	60.9	0.17	0.22 J	0.5	0.095
5/1/2012	SG-3	Low Flow	57.2	0.17	0.161	0.025	NA
4/30/2003	SG-4	Low Flow	41	0.13	0.5 U	0.5	NA
11/24/2003	SG-4	High Flow	24.5	0.09	0.3 U	5	0.3
11/28/2003	SG-4	Low Flow	25.2	0.09	0.97	5	0.3
2/20/2004	SG-4	Low Flow	38.3	0.12	0.2 U	5	.04
4/22/2004	SG-4	Low Flow	58.6	0.17	0.049 U	1.0	0.049
4/19/2005	SG-4	Low Flow	39.3	0.13	0.029 U	1.0	0.043
4/17/2006	SG-4	Low Flow	47.3	0.15	0.029 U	1.0	0.29
4/24/2007	SG-4	Low Flow	51.0	0.15	0.023 U	1.0	0.023
4/23/2008	SG-4	Low Flow	49.9	0.15	1 U	1.0	0.11
4/30/2009	SG-4	Low Flow	47.4	0.15	0.037 U	0.15	0.037
4/28/2010	SG-4	Low Flow	68.4	0.19	0.045 U	0.045	0.045
4/14/2011	SG-4	Low Flow	49.6	0.15	0.095 U	0.5	0.095
5/1/2012	SG-4	Low Flow	43.5	0.14	0.038	0.025	NA
4/30/2003	SG-5 / SG-5A	Low Flow	76	0.18	0.5 U	0.5	NA
11/24/2003	SG-5 / SG-5A	High Flow	27.9	0.10	0.72 U	5	0.3
11/28/2003	SG-5 / SG-5A	Low Flow	28.0	0.10	0.31 J	5	0.3
2/20/2004	SG-5 / SG-5A	Low Flow	41.3	0.13	0.2 U	5	.04
4/22/2004	SG-5 / SG-5A	Low Flow	56.7	0.17	0.049 U	1.0	0.049
4/19/2005	SG-5 / SG-5A	Low Flow	42.1	0.13	0.029 U	1.0	0.043
4/17/2006	SG-5 / SG-5A	Low Flow	87.5	0.22	0.029 U	1.0	0.29
4/25/2007	SG-5 / SG-5A	Low Flow	110.0	0.26	0.025 B	1.0	0.023
4/23/2008	SG-5 / SG-5A	Low Flow	102	0.25	1 U	1.0	0.11
5/7/2008	SG-5 / SG-5A	Low Flow	89.5	0.23	0.033 J	1.0	0.22
4/30/2009	SG-5 / SG-5A	Low Flow	71.1	0.19	0.044 B	0.15	0.037
4/28/2010	SG-5 / SG-5A	Low Flow	103	0.25	0.045 U	0.045	0.045
4/14/2011	SG-5 / SG-5A	Low Flow	67.9	0.19	0.095 U	0.5	0.095
5/1/2012	SG-5 / SG-5A	Low Flow	61.3	0.18	0.043	0.025	NA
		Average Hardness:	60.1				

Notes:

(shaded) Indicates cadmium level exceeds SWQC.

U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J / B The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

R The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.

UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

NA Not available