# HALLIBURTON ENERGY SERVICES, INC.

# DRESSER INDUSTRIES-MAGCOBAR
# FORMER MINE SITE

# NOTICE OF INTENT OF AN
# ENVIRONMENTAL IMPROVEMENT PROJECT

**OCTOBER 29, 2014**

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Prepared for

Halliburton Energy Services, Inc.
3000 North Sam Houston Parkway East
Houston, TX 77032

Prepared by

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

FTN No. 6750-110

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# EXECUTIVE SUMMARY

Halliburton Energy Services, Inc. (HESI) hereby submits a Notice of Intent (NOI) for an Environmental Improvement Project (EIP) wherein HESI seeks a temporary modification of the water quality standards for dissolved minerals (total dissolved solids [TDS], sulfate, and chloride) in Chamberlain Creek, Cove Creek, Lucinda Creek, Reyburn Creek, Rusher Creek, and Scull Creek (which includes Clearwater Lake), all of which are associated with the Dresser Industries – Magcobar (DIM) former mine site. The DIM former mine site ceased mining activities in 1977. The EIP process was established by statute and adopted by the Arkansas Pollution Control and Ecology Commission (APCEC) and is found in APCEC's Regulation No. 2, Appendix B (APCEC 2014). HESI requests approval of the EIP NOI by the Arkansas Department of Environmental Quality (ADEQ) in order to implement remedial actions for the DIM former mine site concurrent with obtaining a temporary modification of the dissolved minerals water quality criteria for the streams referenced herein.

The DIM former mine site qualifies for an EIP under Section 1 of Appendix B of Regulation No. 2 because it is a former mineral extraction site that would benefit from a long-term environmental remediation project that would otherwise be frustrated by rigid application of state water quality standards. The following EIP NOI meets all applicable requirements of Regulation No. 2, Appendix B. HESI proposes to develop and submit any necessary permanent water quality standards for dissolved minerals through a Use Attainability Analysis (UAA) for the above-referenced waterbodies upon completion of the ADEQ-approved remedial action for the former DIM mine site and after stabilization of site conditions. The proposed temporary dissolved minerals water quality standards during the EIP are as follows:

- Chamberlain Creek: 2,261 mg/L for TDS; 1,384 mg/L for sulfate; 68 mg/L for chloride.
- Cove Creek: 500 mg/L for TDS; 250 mg/L for sulfate.
- Lucinda Creek, Reyburn Creek, Rusher Creek, Scull Creek, and Clearwater Lake: 500 mg/L for TDS; 250 mg/L for sulfate.

Chloride concentrations above the ecoregion-based reference stream values associated with this site only occur in the Pit Lake water, the treated effluent and therefore Chamberlain Creek, and Cove Creek downstream of Chamberlain Creek. Site reclamation activities are not expected to expose new chloride sources. HESI is proposing temporary chloride criteria for Chamberlain Creek as discussed in Section 5. For Cove Creek, although historical data show occasional chloride concentrations higher than the ecoregion reference stream value, less than 10% of the data for the period of record were equal to or higher than the reference stream value.

The following sections of this EIP NOI address the specific requirements of Appendix B of Regulation No. 2:

- Section 3 — Description of Waterbodies/Stream Segments Affected by the Project and Existing Ambient Water Quality for the Use of Criteria at Issue;
- Section 4 — Affected Dissolved Minerals Reference Stream Values;
- Section 5 — Proposed Modifications to Water Quality Standards;
- Section 6 — Proposed Remediation Activities and Plan; and
- Section 7 — EIP Schedule.

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# 1.0 INTRODUCTION AND REGULATORY AUTHORITY

In 1997, the Arkansas Legislature passed Act 401 to provide relief from a rigid application of state water quality standards during a long-term remediation project. The title of the Act is “An Act To Encourage Long-Term Environmental Projects; and For Other Purposes.” As stated in Act 401, “the purpose of this act is to preserve the state’s approach to establishing water quality standards, while also encouraging private enterprises to make significant improvements to closed or abandoned sites that are of such magnitude that more than three (3) years will be required to complete the project.” During the triennial review following passage of Act 401, the Arkansas Pollution Control and Ecology Commission (APCEC) incorporated the Act into Regulation No. 2 as Appendix B. Act 401 is commonly known as the “Environmental Improvement Project” (EIP).

The Dresser Industries-Magcobar (DIM) former mine site property located in Hot Spring County (Figure 1.1) was the site of open-pit and underground barite mining from 1939 to 1977. The site consists of a Pit Lake approximately 90 acres in areal extent and approximately 480 feet deep, and contains approximately 3.7 billion gallons of water. Spoil piles border the Pit Lake on the north, east, and west sides. These piles consist of overburden removed during open-pit mining. Pyrite-rich shale from the Stanley Formation comprises most of the approximately 20 million cubic yards of spoil. Tailings impoundments, the remnants of buildings, a water treatment plant, and alkaline sludge impoundments are also present at the site. Two reservoirs, Lucinda Lake and Clearwater Lake, were created in association with mining activities at the site but are not part of the site (NewFields 2007). The site lies on a surface water divide that drains west and east. Westerly drainage enters Cove Creek and then the Ouachita River approximately 5 miles downstream of the site (Figure 1.2). Easterly drainage via Reyburn Creek flows to Francois Creek approximately 7 miles downstream of the site, and then to the Saline River.

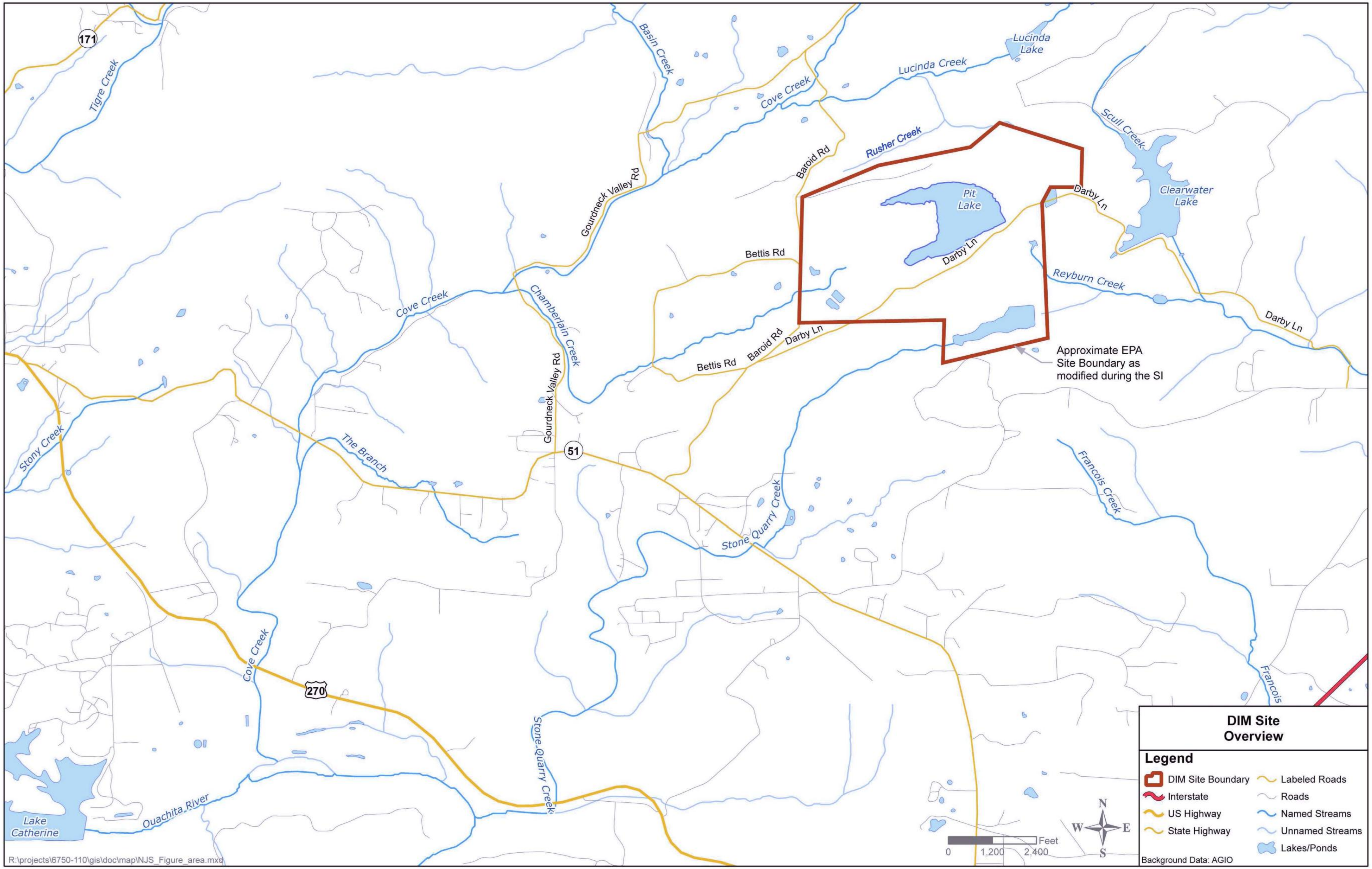


Figure 1.1. Site location map.

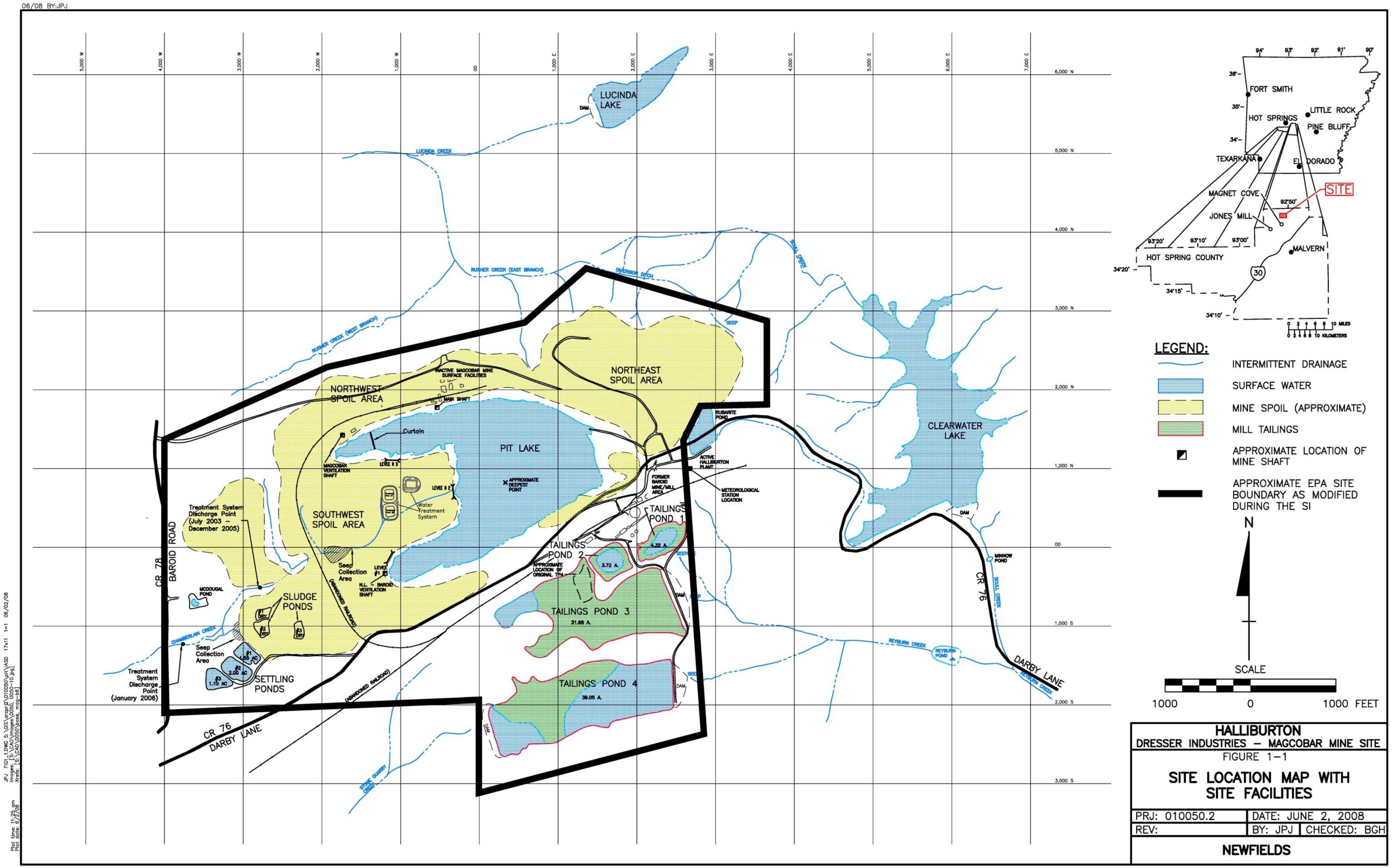


Figure 1.2. Site location map showing site facilities (from NewFields 2009).

After mining and associated dewatering activities at the site ended in 1977, the open pit filled with water that is acidic as a result of precipitation infiltrating through adjacent pyrite-rich spoil piles (acid rock drainage [ARD]) before entering the pit. To prevent the overflow of acidic water from the Pit Lake to downstream waterbodies, Pit Lake water is treated to neutralize pH and precipitate metals before discharge into Chamberlain Creek, which joins Cove Creek south of the property (Figure 1.1). The pH of the Pit Lake water is raised by the addition of lime into the first reactor in the treatment system. Soda ash is added into the second reactor as an additional pH adjustment and then a separate pH control system in the third reactor adds acid to lower the pH of the treated water back to discharge standards of between 6 and 9 su. Notwithstanding treatment of Pit Lake water, the discharge to Chamberlain Creek will result in dissolved minerals (total dissolved solids [TDS], sulfate and chloride) concentrations in Chamberlain Creek and Cove Creek that exceed current ecoregion-based reference stream values. Site stormwater runoff also impacts Lucinda Creek, Reyburn Creek, Rusher Creek, and Scull Creek (which includes Clearwater Lake), resulting in elevated minerals concentrations in those waterbodies due to ARD.

Pursuant to an Administrative Settlement (LIS 00-126) with the Arkansas Department of Environmental Quality (ADEQ), Halliburton Energy Services, Inc. (HESI) completed the following: (a) design and construction of Interim Remedial Measures (IRMs), (b) a Site Investigation (SI), and (c) a Feasibility Study (FS). The primary IRMs included construction of the water treatment system discussed above and additional levees near the Pit Lake. The SI summarized monitoring data from the site and provided interpretations of the various data. The SI was approved by ADEQ on June 15, 2007, and an addendum to the SI, which was prepared and submitted at ADEQ's request, was approved by ADEQ on December 21, 2007 (NewFields 2007). With the approval of the December 2007 addendum, the FS process was initiated, and HESI developed the Initial Alternatives Screening Document (IASD) (NewFields 2008) that summarized previous site findings and developed a comprehensive suite of remedial alternatives. ADEQ approved the IASD in February 2009, and the IASD became the first five chapters of the FS, which was submitted to ADEQ in August 2009 (NewFields 2009).

ADEQ approved the FS, which included a proposed remedial action for the site, in September 2009.

Following receipt of the FS, ADEQ prepared a draft Remedial Action Decision Document (RADD), which included ADEQ's screening of alternatives and selection of a proposed remedial action for the site as well as selection of proposed remedial action levels and effectiveness monitoring requirements. The draft RADD was provided to HESI in September 2010. These primary project documents were reviewed in preparing this EIP NOI, and the background information and data contained in the documents are considered essential support for this EIP Notice of Intent (NOI). The SI (which was revised to include information provided in the Addendum to the SI) is included as Appendix A to this document. The IASD comprised the first five chapters of the FS, and the FS is included as Appendix B to this document.

For the purpose of the EIP NOI, the EIP NOI Remediation Plan referred to in APCEC Regulation No. 2, Appendix B, is based on the RADD prepared by ADEQ. Reclamation of the DIM former mine site is expected to address the low pH and elevated metals that affect drainages from the site (e.g., low pH and dissolved metals result in toxicity reported in Chamberlain Creek and in Cove Creek immediately downstream from the Chamberlain Creek inflow). However, dissolved minerals in these receiving streams, which are also elevated due to former mining activities, will likely remain elevated above ecoregion reference stream values after remediation. In the case of Chamberlain Creek and Cove Creek, treatment and discharge of the Pit Lake water effectively neutralizes pH and removes dissolved metals but it does not significantly reduce dissolved minerals concentrations in the effluent. The feasibility of adding reverse osmosis (RO) unit to the existing water treatment plant was considered. RO units use a system of membranes to remove dissolved materials from water streams, but the use of RO for treating the Pit Lake water was determined to be impractical because (a) RO units for this site would generate large quantities of high-concentration "reject" water that are infeasible to dispose of in an environmentally sustainable manner, and (b) the cost of purchasing and operating RO units for this site is prohibitively expensive. Based on calculations related to the volume of water to be treated and assuming a reject stream volume of 20%, 300 gallons per minute of reject would be generated. This volume would result in disposal trucks being filled in less than 20 minutes. It would be necessary to haul this high concentration of reject water long distances for proper disposal.

In addition, minerals concentrations downstream of reclaimed areas are expected to remain elevated above background due to (a) the dissolution of minerals as water percolates through deeper spoil that is not affected either by active or passive reclamation, which subsequently enters downstream drainage pathways/receiving streams, and (b) runoff exposure to those isolated portions of the surficial spoil material that neither active nor passive reclamation specifically addresses. Depending upon the length of the subsurface flow path through which the percolation travels, dissolution of minerals and transport downstream may continue to occur for years or even decades.

HESI is therefore requesting temporary modifications of the dissolved minerals (TDS, sulfate, and/or chloride) water quality standards in Chamberlain Creek, Cove Creek, Lucinda Creek, Reyburn Creek, Rusher Creek, and Scull Creek, as well as Clearwater Lake. This EIP NOI proposes temporary water quality standards for dissolved minerals for these affected waterbodies. The temporary water quality standards shall remain effective through completion of the remediation construction activities, stabilization of site conditions, and approval of any necessary permanent water quality standards for dissolved minerals through a Use Attainability Analysis (UAA) and pursuant to Appendix B of Regulation No. 2 (APCEC 2014). Section 7.0 of this NOI provides an estimated schedule for EIP activities.

This EIP NOI meets all applicable requirements of Appendix B of Regulation No. 2 (APCEC 2014). The following sections of this EIP NOI address the specific requirements of Appendix B of Regulation No. 2:

- Section 3 — Description of Waterbodies/Stream Segments Affected by the Project and Existing Ambient Water Quality for the Use of Criteria at Issue;
- Section 4 — Affected Dissolved Minerals Reference Stream Values;
- Section 5 — Proposed Modifications to Water Quality Standards;
- Section 6 — Proposed Remediation Activities and Plan; and
- Section 7 — EIP Schedule.

# 2.0 BACKGROUND

The DIM former mine site is a historical barite ore underground and open-pit mining operation that began in 1939 and continued until 1977. The operations created a large open pit that has filled with acidic mine-impacted water since mining activity ended in 1977. Milling operations at the site ceased in 1982.

The site is located in Hot Spring County and is situated on approximately 600 acres one mile northeast of Magnet Cove, Arkansas (Figure 1.1). The property is approximately bounded on the north by Rusher Creek. Baroid Road makes up the western boundary. Scull Creek and Clearwater Lake are on the eastern edge of the site and the southern boundary is adjacent to Stone Quarry Creek. Most of the property surrounding the site is undeveloped.

## 2.1 Current Site Description

The site consists of a pit approximately 90 acres in areal extent and approximately 480 feet deep filled with about 3.7 billion gallons of water (Pit Lake). Spoil piles border the pit on the north, east, and west sides. These piles are made up of overburden removed during open-pit mining. Pyrite-rich shale from the Stanley Formation comprises most of the approximately 20 million cubic yards of spoil.

Tailings impoundments, the remnants of buildings, a water treatment plant, and alkaline sludge impoundments are also present at the site. Two reservoirs, Lucinda Lake and Clearwater Lake, were created as process water sources for mining operations.

After mining and associated dewatering activities at the site ended in 1977, the open pit slowly filled with water. The water that filled the pit is acidic as a result of precipitation infiltrating through adjacent spoil piles before entering the pit, and is commonly referred to as ARD. As rain water filters through spoil piles, in this case pyrite-rich shale, sulfide from pyrite interacts with water and oxygen to form a dilute sulfuric acid solution. The acid in turn mobilizes soluble metals and minerals in surrounding rocks, which impacts surface water.

### 2.1.1 Hydrology

Located in a topographically high area, the site is situated on a drainage divide with five related basins (Figure 2.1). These drainage basins are associated with Chamberlain Creek, Rusher Creek (which drains to Lucinda Creek), Scull Creek (which includes Clearwater Lake), Reyburn Creek, and Stone Quarry Creek. The mine Pit Lake sub-watershed is located at the head of the Chamberlain Creek watershed. A majority of the excavated mine spoil is present in the Chamberlain Creek/Pit Lake watershed, with lesser amounts in the Rusher Creek and Scull Creek watersheds. Tailings impoundments are associated with the Reyburn Creek watershed, and to a lesser extent, the Stone Quarry Creek watershed. Cove Creek, which ultimately flows to the Ouachita River, receives discharge from the Rusher Creek, Lucinda Creek, and Chamberlain Creek watersheds. Scull Creek flows into Reyburn Creek, which flows into Francois Creek and ultimately to the other major drainage in the region, the Saline River. The creeks near the site are mostly intermittent; Cove Creek and part of Reyburn Creek flow perennially.

### 2.1.2 Geology

The DIM former mine site resides in a structurally folded area of the Ouachita Mountains made up of anticlines (upward folds) and synclines (troughs) that trend generally northeast to southwest. The Pit Lake and most of the spoil piles are located in a structure known as the Chamberlain Creek Syncline that plunges toward the southwest. Sedimentary rocks exposed at the site, from oldest to youngest, include: the Ordovician-aged Big Fork Chert and Polk Creek Shale; the Silurian-aged Blaylock Sandstone and Missouri Mountain Shale; the Mississippian/Devonian-aged Arkansas Novaculite; and the Mississippian-aged Stanley Formation (Scull 1958). The Stanley Formation is present at the core or center of the Chamberlain Creek Syncline and represents most of the overburden rock (spoil) that was excavated during open-pit and underground mining operations. Pyrite-rich shale makes up most of the Stanley Formation.

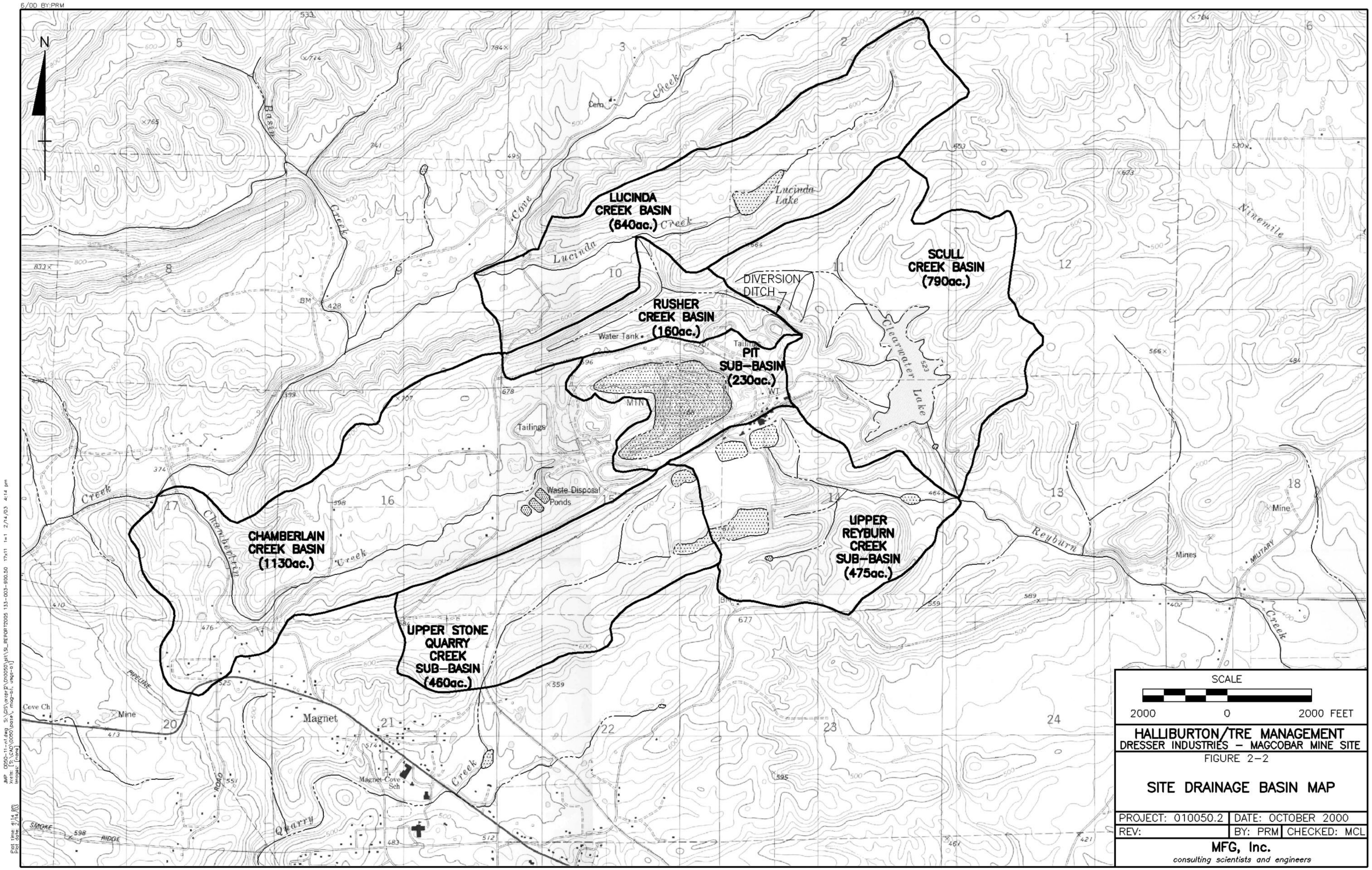


Figure 2.1. Site drainage basin map (from NewFields 2007a).

### 2.1.3 Hydrogeology

Groundwater flow from most of the site (including the Pit Lake and most of the spoil piles) is influenced by site topography and geologic structure. Groundwater flows to the southwest along the axis of the Chamberlain Creek Syncline. Most of the site is topographically situated at the head of the Chamberlain Creek drainage, which flows west. Geologically, the upturned bedding of the Chamberlain Creek Syncline minimizes groundwater flow from the Pit Lake to the north, east, or south. Two groundwater zones have been identified in the vicinity of the site. A shallow zone exists in the near-surface soil. A deeper groundwater system exists in bedrock residuum and fractured bedrock. This deeper zone is known as the bedrock system. The shallow zone is relatively thin, and the lateral and vertical hydraulic conductivity of the shallow zone are regarded as low. The deep bedrock system within the Chamberlain Creek Syncline was historically used as a source of drinking water, with a number of potable water wells located several thousand feet west of the site, within the syncline. A municipal water system was installed for this area in 2005 and locally affected residents are currently using water from this system.

## 2.2 Regulatory Background

HESI entered into an Administrative Settlement (LIS 00-126) with ADEQ effective July 7, 2000, pursuant to the Arkansas Remedial Action Trust Fund Act (Arkansas Code Annotated §8-7-501, *et seq.*). The Administrative Settlement required that HESI conduct IRMs, an SI, and an FS. The SI and FS are included as Appendices A and B, respectively, to this EIP NOI.

IRMs were implemented shortly after the Administrative Settlement was signed, with the construction of Levee #1 to provide additional freeboard for the then-rising level of the Pit Lake. Additional IRMs were implemented from 2000 to 2003, including the following:

- Construction of two additional levees (#2 and #3),
- Raising of the height of Levees #1 and #2,

- Construction and operation of a water treatment system to allow for controlled discharge from the mine pit and improvement of the water quality in Chamberlain Creek (by removing dissolved metals and adjusting the pH of the water to between 6.0 and 9.0 in order to meet the limitations of NPDES Permit No. AR0049794), and
- Installation of a capture system for Chamberlain Creek that collects and pumps runoff and seepage to the Pit Lake for subsequent treatment.

The majority of the SI activities were performed from 2000 to early 2003. In May 2003, ADEQ issued Consent Administrative Order (CAO) LIS No. 03-061. The CAO provided for completion and operation of the water treatment system, temporary modified permit limits, and 24-month water quality and biological monitoring (FTN 2005). During the summer of 2003, the Chamberlain Creek capture/pump system began operating in order to collect acidic runoff and seepage in the upper portion of the creek. This collected water is routed to the Pit Lake.

The SI was approved by ADEQ on June 15, 2007 (NewFields 2007). An SI Clarification Technical Memorandum was submitted to ADEQ on November 30, 2007. ADEQ approved the SI Clarification Technical Memorandum and authorized the FS process to commence on December 21, 2007. An IASD was prepared and submitted to ADEQ on November 3, 2008. The IASD summarized environmental issues at the site and presented remedial alternatives for the site using a screening method developed by the US Environmental Protection Agency (EPA) (EPA 1988). ADEQ approved the IASD in February 2009. The IASD comprises the first five chapters of the FS, which was submitted to ADEQ in August 2009 and approved in September 20010 (NewFields 2009).

ADEQ began developing a RADD for the DIM former mine site in 2010 and issued a draft RADD in September of that year. The RADD describes alternatives for remedial action to address releases from historical activities at the site and proposes a remedy to address those impacts.

In 2004, ADEQ placed a 9.6-mile segment of Cove Creek on the Arkansas 303(d) List of Impaired Waterbodies [303(d) list] from the mouth of Cove Creek to its confluence with Chamberlain Creek, as not attaining its fisheries designated use due to low pH and dissolved metals (copper and zinc). In 2006, the same 9.6-mile segment of Cove Creek was listed as impaired for aquatic life and domestic, industrial, and agricultural water supply, due to depressed pH and elevated sulfate, TDS, zinc, beryllium, and copper. In 2008, the 9.6-mile segment of Cove Creek was placed on the 303(d) list as not attaining its aquatic life and domestic, industrial, and agricultural water supply uses due to elevated sulfate, TDS, zinc, and beryllium; however, the standards for pH and copper in Cove Creek were assessed as being attained.

In 2006 and 2008, a 2.5-mile segment of Chamberlain Creek from its headwater to its confluence with Cove Creek was placed on the 303(d) list as not attaining its aquatic life and domestic, industrial, and agricultural water supply uses due to low pH and high concentrations of cadmium, zinc, beryllium, and copper. Elevated chloride, sulfate, and TDS were also included in the listing.

In 2006 and 2008, a 2.2-mile segment of Lucinda Creek from its headwater to its confluence with Cove Creek was placed on the 303(d) list as not attaining its aquatic life and domestic, industrial, and agricultural water supply uses due to depressed pH and elevated concentrations of zinc and beryllium, as well as sulfate.

These streams have been affected by releases from the DIM former mine site. The 2008 ADEQ 303(d) list is the current, EPA-approved impairment listing at the time of this writing.

## 2.3 Summary of Environmental Site Risks

Infiltration of rain water flows through spoil piles, causing ARD. Much of the ARD drains to the Pit Lake, but acidic runoff also drains directly to surrounding local drainage basins. Studies performed as part of the SI indicated that the Pit Lake potentially loses as much as 40 gallons of water per minute to the bedrock groundwater system. Some of this water may resurface in lower Chamberlain Creek and possibly other downstream areas.

Theoretical excess lifetime cancer risks and non-carcinogenic hazards are acceptable for relevant human receptors to environmental media affected by the DIM former mine site. Because these theoretical lifetime cancer risks and non-carcinogenic hazards are acceptable, ADEQ did not propose any remedial activities to protect human receptors in the draft RADD.

Adverse effects on aquatic receptors have been observed in Cove, Scull, Reyburn, Rusher, Lucinda, and Chamberlain creeks and Clearwater Lake. These adverse aquatic effects result from depressed pH, which increases mobilization of metals from soils and spoil, and increases the bioavailability and toxicity of metals in the water. The depressed pH in the site's surface waters results from ARD seepage and infiltration from mine spoil piles and tailings. Elevated dissolved minerals concentrations in the site drainages are also a result of ARD, and dissolved minerals concentrations in site drainages generally exceed ecoregion reference stream values. The primary source of dissolved minerals in Chamberlain Creek is the treated Pit Lake water, although low-pH water, dissolved metals, and dissolved minerals enter Chamberlain Creek in ARD runoff that is not currently collected by the Chamberlain Creek capture/pump system.

# 3.0 DESCRIPTION OF WATERBODIES/STREAM SEGMENTS AFFECTED BY THE PROJECT AND EXISTING AMBIENT WATER QUALITY FOR THE USE OF CRITERIA AT ISSUE

The waterbodies affected by the DIM former mine site and listed in the EIP NOI are Chamberlain Creek (which drains to Cove Creek), Cove Creek, Lucinda Creek, Reyburn Creek, Rusher Creek (which drains to Lucinda Creek, thence to Cove Creek), and Scull Creek (which includes Clearwater Lake).

Figures 1.1, 1.2, and 2.1 provide the site location (including waterbodies/streams in the project area), site layout, and watersheds of each waterbody, respectively. Figure 3.1 provides the locations of monitoring stations associated with the site.

Descriptions of waterbody stream characteristics and water quality data provided in the SI (NewFields 2007) and the FS (NewFields 2009) are summarized throughout this section. The information and data from the SI and FS were supplemented with water quality data retrieved from ADEQ's Surface Water Quality database and with data from surface water quality/biological sampling during spring of 2012. The SI and FS are included as Appendices A and B, respectively. The water quality data sets are compiled in Appendix E.

## 3.1 Physical Characteristics

### 3.1.1 Chamberlain Creek

Chamberlain Creek is an intermittent stream with a total watershed of approximately 1,130 acres draining into Cove Creek. Chamberlain Creek is impacted by low-pH surface and subsurface water produced from mining overburden spoil pile areas at the site. Chamberlain Creek receives stormwater and seepage from the western spoil piles as well as discharge from the water treatment system. The water treatment system treats and discharges water from the Pit Lake into the headwaters of Chamberlain Creek. There is a man-made impoundment north of Chamberlain Creek that is fed by a small stream that drains the watershed to the west. The water course below this impoundment drains to Chamberlain Creek as a braided stream.

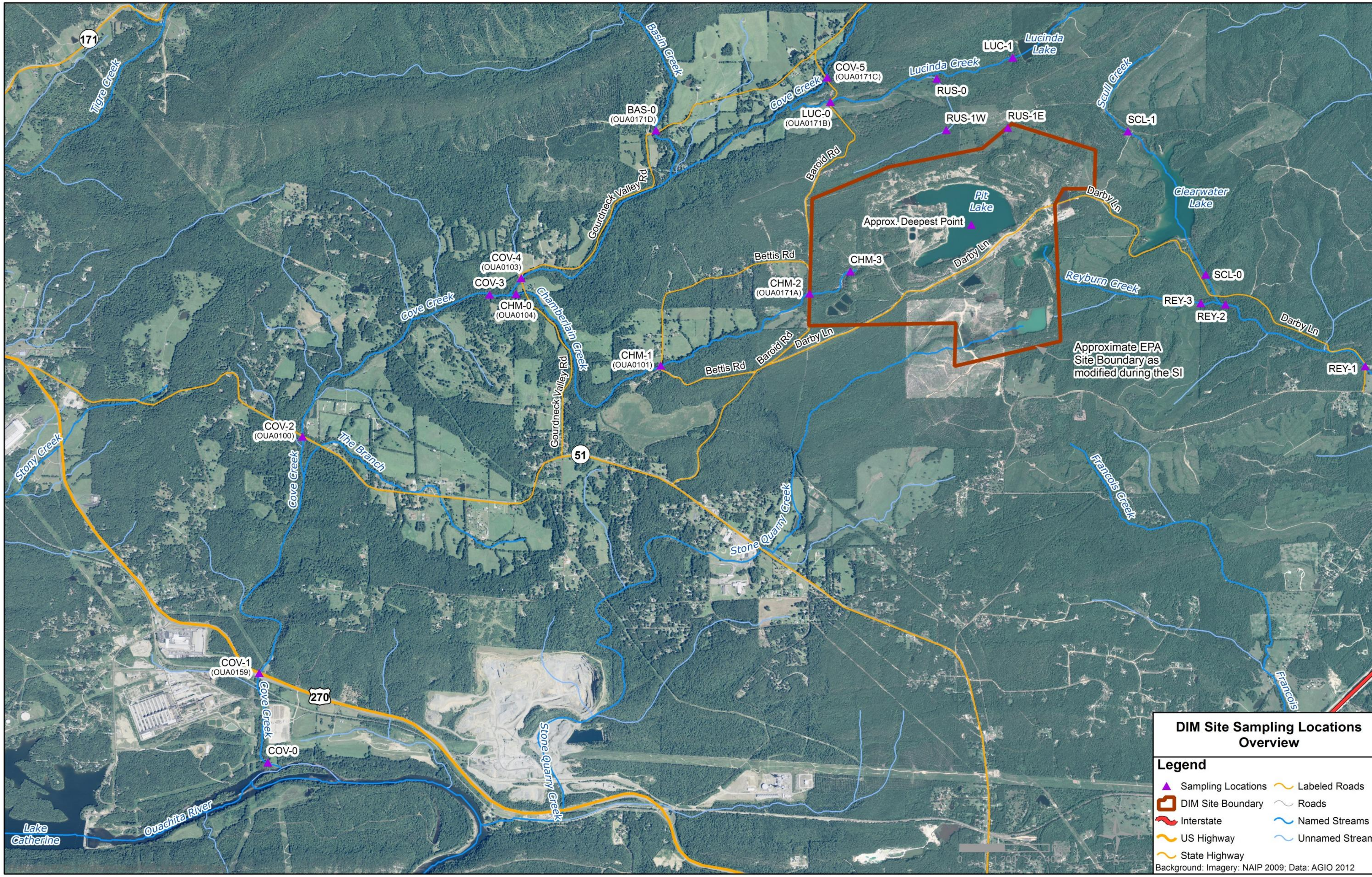


Figure 3.1. Sampling locations.

Chamberlain Creek enters Cove Creek between Cove Creek Station COV-4 and COV-3 (CHM-0, see Figure 3.1). Iron staining is evident along the length of the stream due to iron hydroxide precipitation and is a characteristic of the low-pH water in the stream.

### 3.1.2 Rusher Creek

Rusher Creek is an ephemeral stream with a total watershed of approximately 160 acres draining due north from the Pit Lake into Lucinda Creek, then into Cove Creek. Rusher Creek appears to largely convey stormwater and has two main forks (East Rusher Creek [RUS-1E] and West Rusher Creek [RUS-1W]; see Figure 3.1). During storm events, flows in West Rusher Creek are generally higher. During normal flow conditions, it appears that Rusher Creek does not contribute much flow to Lucinda Creek. Rusher Creek is an ephemeral stream.

Two small tributaries contribute runoff and seepage to East Rusher Creek from the northeast spoil area (Figure 1.2). The major tributary to East Rusher Creek (the western tributary) drains the area between the northeast spoil area and the Pit Lake, and joins East Rusher Creek approximately 500 feet east of its confluence with West Rusher Creek.

West Rusher Creek collects runoff and seepage from the northwest spoil area (Figure 1.2).

### 3.1.3 Lucinda Creek

Lucinda Creek is an intermittent drainage northeast of the Pit Lake with a watershed of approximately 640 acres that flows into Cove Creek just downstream of COV-5 and upstream of Basin Creek and COV-4 (Figure 3.1). Lucinda Creek downstream of Lucinda Lake receives ARD from spoil piles in the Rusher Creek watershed. Some of the flow in Lucinda Creek at LUC-0 is derived from Rusher Creek, which flows from the site area and is the only significant tributary to Lucinda Creek. The Lucinda Creek basin contains Lucinda Lake, a reservoir that was originally constructed to serve as a source of water for the historical milling operations at the site. Lucinda Lake is located up-gradient from the site and is not affected by the site. The majority of non-storm event flow in Lucinda Creek at the Cove Creek confluence is from Lucinda Lake (LUC-1).

### 3.1.4 Cove Creek

Cove Creek is a perennial stream with a watershed of approximately 9,700 acres draining into the Ouachita River downstream of the Lake Catherine Remmel Dam (Figure 1.1). Monitoring stations COV-5 (upstream of Lucinda Creek) and COV-4 are located upstream of the Chamberlain Creek confluence, and stations COV-3, COV-2, COV-1, and COV-0 are located downstream of Chamberlain Creek (see Figure 3.1). On occasion, a white precipitate (aluminum hydroxide) is evident in Cove Creek on its bed immediately downstream of the Chamberlain Creek inflow. The precipitate results as the low-pH water in Chamberlain Creek is neutralized by mixing with Cove Creek water. The stream substrate is composed of large angular materials (moderately embedded), bedrock outcrops, large pools, calcite outcrops, larger bedrock, interspersed gravels, and cobbles (moderately embedded).

### 3.1.5 Scull Creek/Clearwater Lake

Scull Creek is an intermittent stream above Clearwater Lake with a total watershed of approximately 790 acres. The Scull Creek drainage collects ARD runoff and seepage from the northeast spoil area and ultimately flows into Clearwater Lake (Figure 1.2). Clearwater Lake is a reservoir that was constructed to serve as a source of water for the historical milling and mining operations at the site. Clearwater Lake covers approximately 62 acres with a maximum depth of 35 feet.

Scull Creek northeast (upstream) of Clearwater Lake has four major ephemeral tributaries: three entering from the southwest (potentially impacted by spoil) and one entering from the northeast. There is also a diversion ditch to the north of the northeast spoil area that was constructed during mining to convey ARD from the spoil area to East Rusher Creek rather than allowing the runoff to reach Scull Creek and Clearwater Lake.

Scull Creek is a small tributary to Reyburn Creek, averaging less than 5 feet in width. Substrates within Scull Creek are generally embedded.

### 3.1.6 Reyburn Creek

Upper Reyburn Creek is an intermittent stream with a sub-basin that drains an area of approximately 475 acres including the majority of the tailings impoundment area. Reyburn Creek originates below the mill tailings from Tailings Ponds No. 1, 2, 3, and 4 (Figure 1.2). Drainage from the Scull Creek/Clearwater Lake basin enters Reyburn Creek southeast of the site. Reyburn Creek becomes perennial at this point, flowing into Francois Creek, which eventually flows into the Saline River (Figure 1.1).

The headwaters for Reyburn Creek are located in the area of the site tailings impoundments, and contain a number of seeps that originate below the tailings impoundments. The most significant tributary to Reyburn Creek in the site vicinity is Scull Creek. Scull Creek below Clearwater Lake flows in a southeasterly direction into Reyburn Creek, which flows in a generally easterly direction for several miles before its confluence with Francois Creek. Reyburn Creek upstream of the Scull Creek confluence and below the tailings impoundments (REY-3) is a very small channelized stream that in the past had been diverted from its original stream banks. Substrates are heavily cemented and embedded. Downstream of Scull Creek at REY-2, the substrate was even more embedded than at the upstream site. A dull gray precipitate appears to cement the substrates firmly in place. This precipitate may be a function of the change in water quality below Scull Creek. Flow between REY-2 and REY-1 increased by slightly more than double during all flow conditions. Significant tributaries are not present, and therefore much of this flow may be originating from groundwater. Given the geologic setting, this is not unexpected because the upturned rock beds that form the prominent ridge where REY-1 is located should form a groundwater flow barrier, forcing the up-gradient groundwater flow to discharge at the surface.

## 3.2 Chemical and In Situ Characteristics

### 3.2.1 Chamberlain Creek

Poor water quality (i.e., low pH and elevated dissolved minerals) in Chamberlain Creek can adversely affect Cove Creek. The spoil piles and shallow groundwater are impacting the water quality in Chamberlain Creek. Seeps occur at the base of the spoil areas and shallow groundwater emerges into Chamberlain Creek. Chamberlain Creek has the highest concentrations of dissolved minerals, although data indicate that water quality in Chamberlain Creek and Cove Creek has improved with the operation and discharge of the water treatment system (FTN 2005). TDS concentrations at the uppermost monitoring station (CHM-3; see Figure 3.1) range from 2,510 to 5,000 mg/L, and TDS concentrations at the Chamberlain Creek monitoring station at the confluence of Chamberlain Creek and Cove Creek (CHM-0) range from 210 to 2,100 mg/L. Sulfate concentrations range from 2,010 to 3,200 mg/L at CHM-3 and 38 to 1,380 mg/L at CHM-0. Chloride concentrations range from 1.1 to 11 mg/L at CHM-3 and from 0.51 to 129 mg/L at CHM-0. Table 3.1 presents a statistical summary of water quality data collected from the Chamberlain Creek monitoring stations from 2000 to 2012.

### 3.2.2 Rusher Creek

ARD has depressed the pH in Rusher Creek with mean pH values of 3.5 and 3.7 in West and East Rusher Creek, respectively. TDS and sulfate concentrations are relatively low with a mean sulfate concentration of 87 mg/L and a mean TDS concentration of 138 mg/L at the mouth of Rusher Creek (RUS-0; see Figure 3.1). Runoff and seepage from the northeast spoil area, conveyed by the two tributaries, contribute the majority of acidity and dissolved solids to East Rusher Creek. West Rusher Creek is impacted by spoil from the northwest spoil area. Table 3.2 presents a statistical summary of water quality data collected from the Rusher Creek monitoring stations from 2000 to 2012.

### 3.2.3 Lucinda Creek

Lucinda Creek at LUC-0 is impaired due to slightly elevated minerals concentrations and moderately low pH, largely due to discharges from Rusher Creek. The pH of Lucinda Creek at LUC-0 (Figure 3.1) ranges from 4.3 to 6.1. TDS concentrations range from 36 to 82 mg/L, and sulfate concentrations range from 17 to 72 mg/L. During higher precipitation periods, Rusher Creek discharges water of poor quality. Despite the limited quality of Rusher Creek and its effects on Lucinda Creek, the SI concluded that Cove Creek is not significantly affected by the Lucinda Creek discharge. Table 3.3 presents a statistical summary of water quality data collected from the Lucinda Creek monitoring stations from 2000 to 2012.

Table 3.1. Summary of Chamberlain Creek water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | CHM-3 | CHM-2 | CHM-1.5 | CHM-1 | CHM-0.5 | CHM-0 |
|---|---|---|---|---|---|---|---|
| Alkalinity, Total (mg/L) | Min | | <1.0 | | <1.0 | | <1.0 |
| | Mean | <1.0 | 3.6 | | 7.6 | <1.0 | 9.3 |
| | Max | | 86 | | 22 | | 28 |
| Ammonia-Nitrogen (mg/L) | Min | | 0.0025 | | <0.030 | | <0.030 |
| | Mean | | 0.033 | | 0.016 | | 0.017 |
| | Max | | 0.48 | | 0.034 | | 0.040 |
| Biochemical Oxygen Demand (mg/L) | Min | | <0.10 | | | | 0.10 |
| | Mean | | 0.34 | | | | 0.35 |
| | Max | | 2.2 | | | | 0.95 |
| Bromide (mg/L) | Min | | <0.01 | | <0.01 | | 0.020 |
| | Mean | | 0.010 | | 0.025 | | 0.050 |
| | Max | | 0.14 | | 0.16 | | 0.10 |
| Chloride (mg/L) | Min | 1.1 | 1.1 | | 2.0 | | 0.51 |
| | Mean | 4.3 | 28 | | 21 | 51 | 22 |
| | Max | 11 | 69 | | 57 | | 129 |
| Cyanide (mg/L) | Min | | | | | | |
| | Mean | | 0.0050 | | | | 0.050 |
| | Max | | | | | | |
| Dissolved Oxygen (mg/L) | Min | | 4.8 | | 4.1 | | 0.010 |
| | Mean | | 7.7 | 9.8 | 9.5 | | 9.3 |
| | Max | | 12 | | 13 | | 13 |
| Fluoride (mg/L) | Min | | <0.01 | | 0.040 | | 0.080 |
| | Mean | | 0.63 | | 0.51 | | 0.58 |
| | Max | | 4.4 | | 1.4 | | 1.9 |
| Hardness as Ca and Mg (mg/L) | Min | 939 | 365 | | 157 | | 113 |
| | Mean | 997 | 1055 | | 572 | | 563 |
| | Max | 1055 | 2090 | | 1180 | | 1400 |
| Inorganic Nitrogen (nitrogen) | Min | | <0.010 | | 0.039 | | <0.010 |
| | Mean | | 0.020 | | 0.10 | | 0.11 |
| | Max | | 0.37 | | 0.27 | | 0.54 |
| Orthophosphate (mg/L) | Min | | <0.005 | | <0.005 | | <0.005 |
| | Mean | | 0.010 | | 0.0076 | | 0.0092 |
| | Max | | 0.20 | | 0.024 | | 0.097 |
| pH (su) | Min | | 2.7 | 4.8 | 3.1 | | 3.3 |
| | Mean | | 3.7 | | 4.2 | | 4.6 |
| | Max | | 6.8 | | 5.6 | | 7.9 |
| Specific Conductance (µS) | Min | | 25 | | 259 | | 196 |
| | Mean | | 1758 | 2305 | 1066 | | 1335 |
| | Max | | 4288 | | 2078 | | 6370 |
| Sulfate (mg/L) | Min | 2,010 | <0.04 | | 180 | | 38 |
| | Mean | 2,605 | 1,377 | | 739 | 1,200 | 635 |
| | Max | 3,200 | 3,730 | | 1,350 | | 1,380 |

| Parameter | Statistic | CHM-3 | CHM-2 | CHM-1.5 | CHM-1 | CHM-0.5 | CHM-0 |
|---|---|---|---|---|---|---|---|
| Total Recoverable Cadmium (µg/L) | Min | | <1 | | <1 | | <1 |
| | Mean | | 1.1 | | 1.1 | | 0.54 |
| | Max | | 5.0 | | 2.5 | | 1.2 |
| Dissolved Cadmium (µg/L) | Min | <4 | <0.1 | | <0.1 | | <0.1 |
| | Mean | 3.1 | 2.8 | | 0.82 | <2 | 0.81 |
| | Max | 4.2 | 133 | | 4.8 | | 2.7 |
| Total Recoverable Calcium (mg/L) | Min | | 60 | | 31 | | 26 |
| | Mean | | 159 | | 155 | | 138 |
| | Max | | 458 | | 352 | | 311 |
| Dissolved Calcium (mg/L) | Min | 142 | 51 | | 22 | | 26 |
| | Mean | 147 | 212 | <2 | 148 | | 131 |
| | Max | 152 | 458 | | 341 | | 372 |
| Total Recoverable Chromium (µg/L) | Min | | <1 | | <1 | | <1 |
| | Mean | | 1.3 | | 1.0 | | 0.50 |
| | Max | | 6.2 | | 2.5 | | 0.50 |
| Dissolved Chromium (µg/L) | Min | | 0.20 | | <0.1 | | 0.18 |
| | Mean | | 0.88 | | 0.55 | | 0.48 |
| | Max | | 6.6 | | 1.3 | | 4.3 |
| Total Recoverable Cobalt (µg/L) | Min | | 16 | | 21 | | 18 |
| | Mean | | 76 | | 58 | | 41 |
| | Max | | 451 | | 153 | | 85 |
| Dissolved Cobalt (µg/L) | Min | 620 | 14 | | 19 | | 0.28 |
| | Mean | 710 | 307 | | 83 | | 68 |
| | Max | 760 | 1100 | | 500 | | 221 |
| Total Recoverable Copper (µg/L) | Min | | 1.6 | | 1.8 | | 0.50 |
| | Mean | | 12 | | 12 | | 8.7 |
| | Max | | 73 | | 28 | | 23 |
| Dissolved Copper (µg/L) | Min | 26 | <1 | | 2.5 | | <1 |
| | Mean | 75 | 23 | | 16 | | 13 |
| | Max | 149 | 164 | | 77 | | 79 |
| Total Recoverable Iron (µg/L) | Min | | 606 | | 202 | | 10 |
| | Mean | | 2,376 | | 755 | | 331 |
| | Max | | 14,500 | | 1,740 | | 852 |
| Dissolved Iron (µg/L) | Min | 18,000 | 397 | | 93 | | 10 |
| | Mean | 33,450 | 18,038 | | 957 | | 587 |
| | Max | 68,400 | 100,000 | | 4,230 | | 3,690 |
| Total Recoverable Lead (µg/L) | Min | | <1 | | <1 | | <1 |
| | Mean | | 1.0 | | 1.1 | | 0.50 |
| | Max | | 5.0 | | 2.5 | | 0.50 |
| Dissolved Lead (µg/L) | Min | 2.1 | <0.10 | | 0.12 | | 0.15 |
| | Mean | 2.7 | 2.1 | | 0.73 | | 1.4 |
| | Max | 3.2 | 35 | | 3.6 | | 2.6 |

Table 3.1. Summary of Chamberlain Creek water quality monitoring data, 2000 to 2012 (continued).

| Parameter | Statistic | CHM-3 | CHM-2 | CHM-1.5 | CHM-1 | CHM-0.5 | CHM-0 |
|---|---|---|---|---|---|---|---|
| Temperature (º C) | Min | | 5.5 | | 5.6 | | 6.9 |
| | Mean | | 11 | 11 | 15 | | 16 |
| | Max | | 29 | | 26 | | 26 |
| Total Dissolved Solids (mg/L) | Min | 2,510 | 790 | | 304 | | 210 |
| | Mean | 3,835 | 2,078 | | 1,062 | 1,800 | 973 |
| | Max | 5,000 | 4,800 | | 1,970 | | 2,100 |
| Total Kjeldahl Nitrogen (mg/L) | Min | | <0.050 | | <0.050 | | <0.050 |
| | Mean | | 0.097 | | 0.085 | | 0.089 |
| | Max | | 0.76 | | 0.39 | | 0.25 |
| Total Organic Carbon (mg/L) | Min | | 0.21 | | 0.36 | | 0.05 |
| | Mean | | 0.66 | | 0.89 | | 0.85 |
| | Max | | 2.4 | | 1.7 | | 1.9 |
| Total Phosphorus (mg/L) | Min | | <0.010 | | <0.010 | | <0.010 |
| | Mean | | 0.015 | | 0.014 | | 0.016 |
| | Max | | 0.13 | | 0.052 | | 0.071 |
| Total Suspended Solids (mg/L) | Min | | <1.00 | | <1.00 | | <1.00 |
| | Mean | | 2.3 | | 3.8 | | 2.1 |
| | Max | | 17 | | 38 | | 7.0 |
| Turbidity (NTU) | Min | | 0.20 | | 0.65 | | 0.20 |
| | Mean | | 2.3 | | 3.7 | | 2.1 |
| | Max | | 15 | | 31 | | 7 |
| ORP (mV) | Min | | | | 0.0 | | |
| | Mean | | | | 523 | | |
| | Max | | | | 730 | | |
| Acidity (mg/L) | Min | | | | 23 | | |
| | Mean | | | | 44 | | |
| | Max | | | | 64 | | |
| Total Recoverable Aluminum (µg/L) | Min | | 1,980 | | 1,700 | | 929 |
| | Mean | | 15,005 | | 8,552 | | 5,833 |
| | Max | | 109,000 | | 30,700 | | 15,900 |
| Dissolved Aluminum (µg/L) | Min | 26,000 | 303 | | 473 | | 363 |
| | Mean | 55,225 | 28,133 | | 11,165 | | 9,983 |
| | Max | 102,000 | 120,000 | | 72,500 | | 37,500 |
| Total Recoverable Antimony (µg/L) | Min | | <10 | | <10 | | <10 |
| | Mean | | 9.0 | | 9.7 | | <10 |
| | Max | | 50 | | 25 | | <10 |
| Dissolved Antimony (µg/L) | Min | | <5 | | <5 | | <5 |
| | Mean | | 4.1 | | 5.0 | | <5 |
| | Max | | 25 | | 13 | | <5 |
| Total Recoverable Arsenic (µg/L) | Min | | <1 | | <1 | | <1 |
| | Mean | | 1.2 | | 1.2 | | 32 |
| | Max | | 5.0 | | 2.5 | | 75 |

| Parameter | Statistic | CHM-3 | CHM-2 | CHM-1.5 | CHM-1 | CHM-0.5 | CHM-0 |
|---|---|---|---|---|---|---|---|
| Total Recoverable Magnesium (mg/L) | Min | | 30 | | 19 | | 13 |
| | Mean | | 62 | | 48 | | 41 |
| | Max | | 189 | | 90 | | 87 |
| Dissolved Magnesium (mg/L) | Min | 142 | 31 | | 18 | | 9.9 |
| | Mean | 153 | 84 | | 50 | | 47 |
| | Max | 164 | 222 | | 134 | | 90 |
| Total Recoverable Manganese (µg/L) | Min | | 2,020 | | 2,320 | | 2,100 |
| | Mean | | 11,238 | | 7,161 | | 5,206 |
| | Max | | 77,100 | | 22,500 | | 14,400 |
| Dissolved Manganese (µg/L) | Min | 52,200 | 1,780 | | 2,080 | | 1,600 |
| | Mean | 67,000 | 38,068 | | 9,352 | | 9,377 |
| | Max | 75,000 | 160,000 | | 46,800 | | 27,400 |
| Total Recoverable Nickel (µg/L) | Min | | 25 | | 27 | | 25 |
| | Mean | | 135 | | 101 | | 73 |
| | Max | | 789 | | 279 | | 158 |
| Dissolved Nickel (µg/L) | Min | 1,160 | <2 | | 28 | | 16 |
| | Mean | 1,548 | 357 | | 138 | | 118 |
| | Max | 1,900 | 1,600 | | 780 | | 460 |
| Total Recoverable Potassium (mg/L) | Min | | 1.8 | | 1.4 | | 1.6 |
| | Mean | | 3.5 | | 3.7 | | 3.8 |
| | Max | | 7.6 | | 7.2 | | 6.9 |
| Dissolved Potassium (mg/L) | Min | | 1.7 | | 1.4 | | 0.10 |
| | Mean | | 4.3 | | 3.8 | | 3.5 |
| | Max | | 8.8 | | 7.2 | | 7.4 |
| Total Recoverable Selenium (µg/L) | Min | | <2 | | <2 | | <2 |
| | Mean | | 2.3 | | 1.9 | | <2 |
| | Max | | 10 | | 5.0 | | <2 |
| Dissolved Selenium (µg/L) | Min | | <0.5 | | <0.5 | | 0.50 |
| | Mean | 4.2 | 20 | | 1.2 | <2 | 7.8 |
| | Max | | 561 | | 2.5 | | 110 |
| Total Recoverable Silica (mg/L) | Min | | 3.1 | | 4.9 | | 6.7 |
| | Mean | | 14 | | 15 | | 15 |
| | Max | | 65 | | 27 | | 26 |
| Dissolved Silica (mg/L) | Min | | 3.0 | | 4.9 | | 7.1 |
| | Mean | | 13 | | 14 | | 17 |
| | Max | | 65 | | 27 | | 38 |
| Total Recoverable Silver (µg/L) | Min | | <5 | | <5 | | <5 |
| | Mean | | 4.5 | | 5.0 | | <5 |
| | Max | | 25 | | 13 | | <5 |
| Dissolved Silver (µg/L) | Min | | <0.5 | | <0.5 | | <0.5 |
| | Mean | | 0.67 | | 0.97 | | 1.9 |
| | Max | | 5.0 | | 2.5 | | <7 |

Table 3.1. Summary of Chamberlain Creek water quality monitoring data, 2000 to 2012 (continued).

| Parameter | Statistic | CHM-3 | CHM-2 | CHM-1.5 | CHM-1 | CHM-0.5 | CHM-0 | Parameter | Statistic | CHM-3 | CHM-2 | CHM-1.5 | CHM-1 | CHM-0.5 | CHM-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Arsenic (µg/L) | Min | | <0.5 | | <0.5 | | <0.5 | Total Recoverable Sodium (mg/L) | Min | | 2.9 | | 3.1 | | 3.6 |
| | Mean | | 1.1 | | 1.1 | | 0.41 | | Mean | | 15 | | 18 | | 17 |
| | Max | | 22 | | 1.9 | | 1.7 | | Max | | 60 | | 50 | | 47 |
| Total Recoverable Barium (µg/L) | Min | | <10 | | 15.20 | | <10 | Dissolved Sodium (mg/L) | Min | | 1.9 | | 3.1 | | 2.7 |
| | Mean | | 14 | | 41 | | 0.86 | | Mean | | 21 | | 17 | | 17 |
| | Max | | 60 | | 77 | | 2.4 | | Max | | 64 | | 49 | | 46 |
| Dissolved Barium (µg/L) | Min | 8.7 | 4.4 | | 14 | | 0.25 | Total Recoverable Thallium (µg/L) | Min | | <2.5 | | <2.5 | | <2.5 |
| | Mean | 10 | 10 | | 37 | | 34 | | Mean | | 2.3 | | 2.4 | | <2.5 |
| | Max | 13 | 44 | | 66 | | 64 | | Max | | 13 | | 6.3 | | <2.5 |
| Total Recoverable Beryllium (µg/L) | Min | | <0.5 | | <0.5 | | <0.5 | Dissolved Thallium (µg/L) | Min | | <0.5 | | <0.5 | | <0.5 |
| | Mean | | 1.7 | | 1.3 | | 0.86 | | Mean | | 0.41 | | 0.50 | | <0.5 |
| | Max | | 12 | | 3.6 | | 2.4 | | Max | | 2.5 | | 1.3 | | <0.5 |
| Dissolved Beryllium (µg/L) | Min | 8.8 | 0.15 | | 0.22 | | 0.05 | Total Recoverable Vanadium (µg/L) | Min | | <2.5 | | <2.5 | | <2.5 |
| | Mean | 9.2 | 3.5 | | 1.6 | | 1.8 | | Mean | | 2.3 | | 2.4 | | 1.3 |
| | Max | 9.6 | 14 | | 9.0 | | 5.2 | | Max | | 13 | | 6.3 | | 1.3 |
| Total Recoverable Boron (µg/L) | Min | | 29 | | 40 | | 36 | Dissolved Vanadium (µg/L) | Min | | <0.5 | | <0.5 | | <0.5 |
| | Mean | | 261 | | 327 | | 294 | | Mean | | 0.67 | | 0.54 | | 0.68 |
| | Max | | 952 | | 782 | | 742 | | Max | | 6.3 | | 1.3 | | 5.4 |
| Dissolved Boron (µg/L) | Min | | 2.3 | | 42 | | 0.050 | Total Recoverable Zinc (µg/L) | Min | | 59 | | 57 | | 57 |
| | Mean | | 192 | | 319 | | 248 | | Mean | | 298 | | 230 | | 171 |
| | Max | | 937 | | 792 | | 786 | | Max | | 1670 | | 578 | | 350 |
| | | | | | | | | Dissolved Zinc (µg/L) | Min | 2,660 | 12 | | 60 | | 25 |
| | | | | | | | | | Mean | 3,155 | 812 | | 314 | | 315 |
| | | | | | | | | | Max | 3,600 | 3,600 | | 1,770 | | 1,030 |

*Single values in the table indicate the only data point.

Table 3.2. Summary of Rusher Creek water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | RUS-1W | RUS-1E | RUS-0 | Parameter | Statistic | RUS-1W | RUS-1E | RUS-0 |
|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total (mg/L) | Min | <1 | <1 | <1 | Dissolved Cadmium (µg/L) | Min | 0.50 | 0.40 | 0.40 |
| | Mean | <1 | <1 | <1 | | Mean | 1.3 | 1.2 | 1.2 |
| | Max | <1 | <1 | <1 | | Max | <4 | <4 | <4 |
| Chloride (mg/L) | Min | 1.6 | 1.50 | 1.50 | Dissolved Calcium (mg/L) | Min | 8.4 | 21 | 9.7 |
| | Mean | 1.9 | 1.90 | 1.70 | | Mean | 9.2 | 22 | 12 |
| | Max | 2.2 | 2.20 | 2.00 | | Max | 9.9 | 24 | 15 |
| Dissolved Oxygen (mg/L) | Min | 4.2 | 6.90 | 8.38 | Dissolved Cobalt (µg/L) | Min | 60 | 9.3 | |
| | Mean | 6.1 | 8.10 | 9.69 | | Mean | 60 | 35 | |
| | Max | 7.9 | 9.30 | 11.00 | | Max | 60 | 60 | |
| Hardness as Ca and Mg (mg/L) | Min | | | 14.00 | Dissolved Copper (µg/L) | Min | 13 | <6 | <6 |
| | Mean | 51.50 | | 47.25 | | Mean | 24 | 10 | 16 |
| | Max | | | 80.50 | | Max | 35 | 18 | 28 |
| pH (su) | Min | 3.50 | 3.57 | 3.75 | Dissolved Iron (µg/L) | Min | 20 | 140 | |
| | Mean | 3.54 | 3.73 | 4.28 | | Mean | 37 | 720 | |
| | Max | 3.58 | 3.88 | 4.81 | | Max | 54 | 1,300 | |
| Specific Conductance (µS) | Min | 310.0 | 294.0 | 57.6 | Dissolved Lead (µg/L) | Min | | | |
| | Mean | 315.5 | 343.0 | 178.3 | | Mean | <40 | <40 | |
| | Max | 321.0 | 392.0 | 299 | | Max | | | |
| Sulfate (mg/L) | Min | 120.0 | 110.0 | 23 | Dissolved Magnesium (mg/L) | Min | 4.5 | 15 | 10 |
| | Mean | 115.7 | 146.7 | 87 | | Mean | 5.5 | 16 | 13 |
| | Max | 140 | 190 | 160 | | Max | 6.5 | 18 | 15 |
| Temperature (º C) | Min | 14.4 | 14.70 | 15.40 | Dissolved Manganese (µg/L) | Min | 5,700 | 1,600 | |
| | Mean | 16.2 | 17.29 | 16.11 | | Mean | 5,770 | 3,000 | |
| | Max | 17.9 | 19.87 | 16.81 | | Max | 5,840 | 4,400 | |
| Total Dissolved Solids (mg/L) | Min | 150.0 | 200.0 | 44.00 | Dissolved Nickel (µg/L) | Min | 54 | 78 | 11 |
| | Mean | 193.3 | 243.3 | 138.0 | | Mean | 72 | 124 | 61 |
| | Max | 220.0 | 280.0 | 230.0 | | Max | 90 | 170 | 110 |
| ORP (mV) | Min | 309 | 196 | | Dissolved Potassium (mg/L) | Min | | | |
| | Mean | 405 | 249 | 333 | | Mean | <1 | | <1 |
| | Max | 500 | 301 | | | Max | | | |
| Acidity (mg/L) | Min | | | | Dissolved Selenium (µg/L) | Min | | | |
| | Mean | 61 | 19 | 17 | | Mean | <2 | | <70 |
| | Max | | | | | Max | | | |
| Dissolved Aluminum (µg/L) | Min | 6,200 | 990 | 1,400 | Dissolved Silver (µg/L) | Min | | | |
| | Mean | 9,350 | 5,015 | 6,150 | | Mean | <7 | | |
| | Max | 12,500 | 9,040 | 10,900 | | Max | | | |
| Dissolved Barium (µg/L) | Min | 30 | 27 | | Dissolved Sodium (mg/L) | Min | | | |
| | Mean | 31 | 32 | | | Mean | 1.9 | | 1.8 |
| | Max | 31 | 36 | | | Max | | | |
| Dissolved Beryllium (µg/L) | Min | 0.76 | 0.49 | <0.3 | Dissolved Zinc (µg/L) | Min | | 160 | 19 |
| | Mean | 0.83 | 0.85 | 0.58 | | Mean | 90 | 295 | 120 |
| | Max | 0.90 | 1.2 | 1.0 | | Max | | 430 | 220 |

Table 3.3. Summary of Lucinda Creek water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | LUC-0 |
|---|---|---|
| Alkalinity, Total (mg/L) | Min | <1 |
| | Mean | 2.1 |
| | Max | 9.3 |
| Ammonia-Nitrogen (mg/L) | Min | <0.03 |
| | Mean | <0.03 |
| | Max | 0.032 |
| Biochemical Oxygen Demand (mg/L) | Min | 0.04 |
| | Mean | 0.79 |
| | Max | 5.0 |
| Bromide (mg/L) | Min | <0.01 |
| | Mean | <0.01 |
| | Max | 0.080 |
| Chloride (mg/L) | Min | 0.94 |
| | Mean | 1.5 |
| | Max | 2.0 |
| Cyanide (mg/L) | Min | |
| | Mean | |
| | Max | |
| Dissolved Oxygen (mg/L) | Min | 1.3 |
| | Mean | 9.3 |
| | Max | 13 |
| Fluoride (mg/L) | Min | <0.01 |
| | Mean | 0.12 |
| | Max | 0.24 |
| Hardness as Ca and Mg (mg/L) | Min | 3.0 |
| | Mean | 21 |
| | Max | 132 |
| Inorganic Nitrogen (nitrogen) | Min | <0.01 |
| | Mean | 0.10 |
| | Max | 0.77 |
| Orthophosphate (mg/L) | Min | <0.005 |
| | Mean | 0.0064 |
| | Max | 0.041 |
| pH (su) | Min | 4.3 |
| | Mean | 4.9 |
| | Max | 6.1 |
| Specific conductance (µS) | Min | 45 |
| | Mean | 64 |
| | Max | 115 |
| Sulfate (mg/L) | Min | 17 |
| | Mean | 30 |
| | Max | 72 |

| Parameter | Statistic | LUC-0 |
|---|---|---|
| ORP (mV) | Min | -47 |
| | Mean | 244 |
| | Max | 428 |
| Acidity (mg/L) | Min | <5 |
| | Mean | 5.7 |
| | Max | 12 |
| Total Recoverable Antimony (µg/L) | Min | <10 |
| | Mean | <10 |
| | Max | <10 |
| Dissolved Antimony (µg/L) | Min | <5 |
| | Mean | <5 |
| | Max | <5 |
| Total Recoverable Arsenic (µg/L) | Min | <1 |
| | Mean | <1 |
| | Max | <1 |
| Dissolved Arsenic (µg/L) | Min | <0.5 |
| | Mean | <0.5 |
| | Max | 1.5 |
| Total Recoverable Barium (µg/L) | Min | <10 |
| | Mean | 80 |
| | Max | 102 |
| Dissolved Barium (µg/L) | Min | 16 |
| | Mean | 94 |
| | Max | 331 |
| Total Recoverable Beryllium (µg/L) | Min | <0.5 |
| | Mean | <0.5 |
| | Max | <0.5 |
| Dissolved Beryllium (µg/L) | Min | <0.1 |
| | Mean | 0.17 |
| | Max | 0.30 |
| Total Recoverable Boron (µg/L) | Min | <25 |
| | Mean | <25 |
| | Max | <25 |
| Dissolved Boron (µg/L) | Min | <4 |
| | Mean | 11 |
| | Max | 41 |
| Total Recoverable Cadmium (µg/L) | Min | <1 |
| | Mean | <1 |
| | Max | <1 |
| Dissolved Cadmium (µg/L) | Min | <1.4 |
| | Mean | 0.27 |
| | Max | 4.0 |

| Parameter | Statistic | LUC-0 |
|---|---|---|
| Total Phosphorus (mg/L) | Min | <0.01 |
| | Mean | 0.021 |
| | Max | 0.25 |
| Total Suspended Solids (mg/L) | Min | <1 |
| | Mean | 3.3 |
| | Max | 83 |
| Turbidity (NTU) | Min | 0.09 |
| | Mean | 7.3 |
| | Max | 193 |
| Total Recoverable Aluminum (µg/L) | Min | <1 |
| | Mean | 871 |
| | Max | 2,050 |
| Dissolved Aluminum (µg/L) | Min | 64 |
| | Mean | 757 |
| | Max | 1,940 |
| Total Recoverable Cobalt (µg/L) | Min | <1 |
| | Mean | 7.2 |
| | Max | 13 |
| Dissolved Cobalt (µg/L) | Min | <0.5 |
| | Mean | 6.8 |
| | Max | 27 |
| Total Recoverable Copper (µg/L) | Min | <1 |
| | Mean | 2.8 |
| | Max | 6.3 |
| Dissolved Copper (µg/L) | Min | <0.5 |
| | Mean | 2.8 |
| | Max | 9.5 |
| Total Recoverable Iron (µg/L) | Min | <50 |
| | Mean | 66 |
| | Max | 190 |
| Dissolved Iron (µg/L) | Min | <20 |
| | Mean | 112 |
| | Max | 2,390 |
| Total Recoverable Lead (µg/L) | Min | <1 |
| | Mean | <1 |
| | Max | <1 |
| Dissolved Lead (µg/L) | Min | <0.1 |
| | Mean | 1.1 |
| | Max | <40 |
| Total Recoverable Magnesium (mg/L) | Min | <0.01 |
| | Mean | 2.5 |
| | Max | 3.9 |

| Parameter | Statistic | LUC-0 |
|---|---|---|
| Dissolved Nickel (µg/L) | Min | <0.5 |
| | Mean | 12 |
| | Max | 25 |
| Total Recoverable Potassium (mg/L) | Min | <1 |
| | Mean | <1 |
| | Max | 1.2 |
| Dissolved Potassium (mg/L) | Min | <0.3 |
| | Mean | 0.88 |
| | Max | 4.2 |
| Total Recoverable Selenium (µg/L) | Min | <2 |
| | Mean | <2 |
| | Max | <2 |
| Dissolved Selenium (µg/L) | Min | <0.5 |
| | Mean | 2.2 |
| | Max | 70 |
| Total Recoverable Silica (mg/L) | Min | <0.2 |
| | Mean | 8.4 |
| | Max | 13 |
| Dissolved Silica (mg/L) | Min | 1.6 |
| | Mean | 8.7 |
| | Max | 14 |
| Total Recoverable Silver (µg/L) | Min | <5 |
| | Mean | <5 |
| | Max | <5 |
| Dissolved Silver (µg/L) | Min | <0.5 |
| | Mean | 0.53 |
| | Max | <7 |
| Total Recoverable Sodium (mg/L) | Min | <0.04 |
| | Mean | 1.2 |
| | Max | 2.1 |
| Dissolved Sodium (mg/L) | Min | 0.29 |
| | Mean | 1.4 |
| | Max | 2.2 |
| Total Recoverable Thallium (µg/L) | Min | <2.4 |
| | Mean | <2.4 |
| | Max | <2.4 |
| Dissolved Thallium (µg/L) | Min | <0.5 |
| | Mean | <0.5 |
| | Max | <0.5 |
| Total Recoverable Vanadium (µg/L) | Min | <2.4 |
| | Mean | <2.4 |
| | Max | <2.4 |

Table 3.3. Summary of Lucinda Creek water quality monitoring data, 2000 to 2012 (continued).

| Parameter | Statistic | LUC-0 | Parameter | Statistic | LUC-0 | Parameter | Statistic | LUC-0 | Parameter | Statistic | LUC-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (º C) | Min | 6.2 | Total Recoverable Calcium (mg/L) | Min | <0.4 | Dissolved Magnesium (mg/L) | Min | 0.44 | Dissolved Vanadium (µg/L) | Min | <1 |
| | Mean | 15 | | Mean | 3.3 | | Mean | 2.5 | | Mean | <1 |
| | Max | 26 | | Max | 4.8 | | Max | 3.9 | | Max | <1 |
| Total Dissolved Solids (mg/L) | Min | 36 | Dissolved Calcium (mg/L) | Min | 0.65 | Total Recoverable Manganese (µg/L) | Min | <1 | Total Recoverable Zinc (µg/L) | Min | <3 |
| | Mean | 53 | | Mean | 3.3 | | Mean | 694 | | Mean | 27 |
| | Max | 82 | | Max | 4.9 | | Max | 1,100 | | Max | 63 |
| Total Kjeldahl Nitrogen (mg/L) | Min | <0.05 | Total Recoverable Chromium (µg/L) | Min | <1 | Dissolved Manganese (µg/L) | Min | 132 | Dissolved Zinc (µg/L) | Min | 4.6 |
| | Mean | 0.11 | | Mean | <1 | | Mean | 756 | | Mean | 28 |
| | Max | 0.91 | | Max | <1 | | Max | 1,809 | | Max | 61 |
| Total Organic Carbon (mg/L) | Min | <1 | Dissolved Chromium (µg/L) | Min | <0.4 | Total Recoverable Nickel (µg/L) | Min | <2.4 | | | |
| | Mean | 1.1 | | Mean | <0.4 | | Mean | 14 | | | |
| | Max | 5.2 | | Max | 1.1 | | Max | 26 | | | |

*Single values in the table indicate the only data point.

### 3.2.4 Cove Creek

The SI and FS determined that the effects in Cove Creek are generally limited to the reach below its confluence with Chamberlain Creek, and the effects vary as a result of the volume of flow from Chamberlain Creek. Conditions in Cove Creek were observed to improve when Chamberlain Creek was not flowing. Data indicate that the water quality in Chamberlain Creek and Cove Creek has improved due to the discharge from the Pit Lake water treatment system that became operational in June 2003 (FTN 2005). The pH at the Cove Creek monitoring station downstream of the confluence with Chamberlain Creek (COV-3, see Figure 3.1) ranges from 4.6 to 7.3, sulfate concentrations range from 14 to 440 mg/L, and TDS concentrations range from 62 to 640 mg/L. Table 3.4 presents a statistical summary of water quality data collected from the Cove Creek monitoring stations from 2000 to 2012.

### 3.2.5 Scull Creek/Clearwater Lake

Scull Creek collects stormwater, ARD runoff, and seepage from the northeast spoil area, causing its waters to have a pH around 3.0. Clearwater Lake has a pH of around 4.5. The Scull Creek (SCL-0; see Figure 3.1) monitoring station at the mouth (below Clearwater Lake) has TDS concentrations ranging from 50 to 94 mg/L and sulfate concentrations ranging from 10 to 63 mg/L. There is an increase in TDS within Scull Creek with no apparent surface water inflows, which suggests that shallow groundwater impacted by ARD may be entering Scull Creek. Table 3.5 presents a statistical summary of water quality data collected from the Scull Creek monitoring stations from 2000 to 2012, and Table 3.6 presents a statistical summary of water quality data collected from Clearwater Lake from 2000 to 2012.

Table 3.4. Summary of Cove Creek water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | COV-5 | COV-4 | COV-3 | COV-2 | COV-1.5 | COV-1B | COV-1 |
|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total (mg/L) | Min | 0.5 | 4.0 | <1.0 | <1 | | | <1 |
| | Mean | 6.6 | 13.9 | 11.1 | 18.5 | | <1 | 21.2 |
| | Max | 22.0 | 26.7 | 33.0 | 67.8 | | | 64.6 |
| Ammonia-Nitrogen (mg/L) | Min | 0.015 | 0.002 | <0.03 | <0.03 | | | <0.03 |
| | Mean | 0.015 | 0.011 | <0.03 | 0.016 | | | <0.03 |
| | Max | 0.015 | 0.030 | <0.03 | 0.054 | | | 0.097 |
| Biochemical Oxygen Demand (mg/L) | Min | 0.12 | | | 0.05 | | | -0.18 |
| | Mean | 0.51 | | | 0.65 | | | 0.36 |
| | Max | 1.00 | | | 1.53 | | | 1.05 |
| Bromide (mg/L) | Min | <0.01 | <0.01 | <0.01 | <0.01 | | | <0.01 |
| | Mean | 0.007 | 0.010 | 0.015 | 0.010 | | | <0.01 |
| | Max | 0.030 | 0.010 | 0.050 | 0.140 | | | 0.079 |
| Chloride (mg/L) | Min | 1.23 | 1.60 | 0.30 | 0.93 | | | 1.66 |
| | Mean | 2.19 | 2.15 | 6.82 | 8.21 | 2.50 | <0.2 | 6.32 |
| | Max | 3.20 | 2.80 | 19.70 | 42.00 | | | 70.60 |
| Cyanide (mg/L) | Min | | | | | | | |
| | Mean | <0.01 | | | <0.01 | | | |
| | Max | | | | | | | |
| Dissolved Oxygen (mg/L) | Min | 3.36 | | 5.20 | 6.00 | | | 6.90 |
| | Mean | 9.43 | | 9.25 | 9.05 | 9.51 | | 9.53 |
| | Max | 13.50 | | 13.20 | 13.30 | | | 13.50 |
| Fluoride (mg/L) | Min | 0.01 | 0.06 | 0.16 | <0.01 | | | 0.08 |
| | Mean | 0.06 | 0.11 | 0.22 | 0.26 | | | 0.22 |
| | Max | 0.15 | 0.15 | 0.37 | 0.82 | | | 0.45 |
| Hardness as Ca and Mg (mg/L) | Min | 7.00 | 2.00 | 30.00 | 16.00 | | | 21.00 |
| | Mean | 11.24 | 19.79 | 144.36 | 161.90 | | | 137.95 |
| | Max | 30.00 | 33.00 | 400.00 | 860.00 | | | 490.00 |
| Inorganic Nitrogen (nitrogen) | Min | 0.005 | | <0.01 | <0.01 | | | <0.05 |
| | Mean | 0.208 | | 0.081 | 0.089 | | | 0.108 |
| | Max | 0.870 | | 0.278 | 0.777 | | | 0.892 |
| Orthophosphate (mg/L) | Min | <0.005 | 0.005 | <0.005 | <0.005 | | | <0.005 |
| | Mean | 0.0079 | 0.011 | 0.009 | 0.012 | | | 0.010 |
| | Max | 0.044 | 0.018 | 0.028 | 0.11 | | | 0.070 |
| pH (su) | Min | 5.4 | | 4.6 | 4.7 | | | 4.3 |
| | Mean | 6.1 | | 5.8 | 6.5 | 7.3 | | 6.6 |
| | Max | 6.8 | | 7.3 | 7.9 | | | 8.3 |
| Specific conductance (µS) | Min | 14 | | 11 | 40 | | | 64 |
| | Mean | 29 | | 314 | 287 | 120 | | 305 |
| | Max | 60 | | 898 | 870 | | | 837 |
| Sulfate (mg/L) | Min | 3.5 | 7.8 | 14 | <0.2 | | | 7.8 |
| | Mean | 5.5 | 11 | 155 | 173 | 20 | <0.2 | 117 |
| | Max | 16 | 21 | 440 | 1050 | | | 538 |

| Parameter | Statistic | COV-5 | COV-4 | COV-3 | COV-2 | COV-1.5 | COV-1B | COV-1 |
|---|---|---|---|---|---|---|---|---|
| Total Recoverable Cadmium (µg/L) | Min | <1 | | <1 | <1 | | | <1 |
| | Mean | <1 | | <1 | <1 | | | <1 |
| | Max | <1 | | <1 | <1 | | | <1 |
| Dissolved Cadmium (µg/L) | Min | <0.10 | <0.01 | <0.1 | <0.14 | | | <0.14 |
| | Mean | <0.14 | 0.60 | 0.56 | 0.15 | <2 | | 0.68 |
| | Max | <4.0 | <4 | 5.0 | 2.0 | | | 15 |
| Total Recoverable Calcium (mg/L) | Min | 1.4 | | 7.4 | 2.6 | | | 11 |
| | Mean | 1.8 | | 31 | 40 | | | 43 |
| | Max | 2.7 | | 102 | 162 | | | 132 |
| Dissolved Calcium (mg/L) | Min | 1.4 | 0.1 | 7.1 | 3.9 | | | 5.9 |
| | Mean | 2.7 | 6.0 | 35 | 47 | 13 | <0.1 | 36 |
| | Max | 8.4 | 9.9 | 111 | 250 | | | 138 |
| Total Recoverable Chromium (µg/L) | Min | <1 | | <1 | <1 | | | <1 |
| | Mean | <1 | | <1 | <1 | | | <1 |
| | Max | <1 | | <1 | <1 | | | <1 |
| Dissolved Chromium (µg/L) | Min | 0.20 | <0.10 | <0.1 | <0.4 | | | <0.4 |
| | Mean | 0.25 | 0.46 | 0.21 | <0.4 | | | 0.37 |
| | Max | 0.81 | 0.83 | 0.38 | 10 | | | 8.4 |
| Total Recoverable Cobalt (µg/L) | Min | <1 | | <1 | <1 | | | <1 |
| | Mean | <1 | | 6.9 | 5.5 | | | 3.1 |
| | Max | <1 | | 17 | 17 | | | 6.6 |
| Dissolved Cobalt (µg/L) | Min | <0.50 | <0.50 | <0.5 | <0.5 | | | <0.5 |
| | Mean | 0.56 | 1.7 | 9.5 | 7.4 | 2.0 | | 6.8 |
| | Max | 3.2 | <10 | 50 | 40 | | | 34 |
| Total Recoverable Copper (µg/L) | Min | <1 | | <1 | <1 | | | <1 |
| | Mean | 0.59 | | 2.0 | 1.9 | | | 1.0 |
| | Max | 2.0 | | 4.9 | 6.9 | | | 3.3 |
| Dissolved Copper (µg/L) | Min | <0.5 | 0.60 | 0.69 | <0.5 | | | <0.5 |
| | Mean | 1.3 | 3.9 | 2.8 | 2.7 | <1 | | 3.9 |
| | Max | 31 | 50 | 7.7 | 84 | | | 82 |
| Total Recoverable Iron (µg/L) | Min | 22 | | 82 | <50 | | | 22 |
| | Mean | 73 | | 158 | 152 | | | 74 |
| | Max | 443 | | 270 | 964 | | | 229 |
| Dissolved Iron (µg/L) | Min | 10 | 15 | <20 | <20 | | | <20 |
| | Mean | 46 | 155 | 76 | 56 | 420 | | 40 |
| | Max | 234 | 630 | 460 | 1,400 | | | 800 |
| Total Recoverable Lead (µg/L) | Min | <1 | | <1 | <1 | | | <1 |
| | Mean | <1 | | <1 | <1 | | | <1 |
| | Max | <1 | | <1 | <1 | | | <1 |
| Dissolved Lead (µg/L) | Min | 0.05 | <0.40 | <0.1 | <0.1 | | | <0.1 |
| | Mean | 0.14 | 0.45 | 0.20 | 0.24 | 0.61 | | 0.87 |
| | Max | 3.8 | 1.7 | 1.1 | 9.5 | | | 14 |

Table 3.4. Summary of Cove Creek water quality monitoring data, 2000 to 2012 (continued).

| Parameter | Statistic | COV-5 | COV-4 | COV-3 | COV-2 | COV-1.5 | COV-1B | COV-1 |
|---|---|---|---|---|---|---|---|---|
| Temperature (º C) | Min | 5.9 | | 6.4 | 4.0 | | | 3.0 |
| | Mean | 15 | | 18 | 17 | 16 | | 16 |
| | Max | 25 | | 27 | 31 | | | 30 |
| Total Dissolved Solids (mg/L) | Min | 20 | 24 | 62 | 36 | | | 42 |
| | Mean | 34 | 48 | 253 | 281 | 82 | <10 | 206 |
| | Max | 72 | 84 | 640 | 1,500 | | | 793 |
| Total Kjeldahl Nitrogen (mg/L) | Min | 0.025 | <0.05 | <0.05 | <0.05 | | | <0.05 |
| | Mean | 0.078 | 0.11 | 0.072 | 0.17 | | | 0.13 |
| | Max | 0.19 | 0.19 | 0.16 | 0.70 | | | 0.91 |
| Total Organic Carbon (mg/L) | Min | 0.50 | 0.60 | 0.49 | 0.40 | | | 0.36 |
| | Mean | 1.1 | 1.2 | 0.88 | 1.2 | | | 1.1 |
| | Max | 2.3 | 1.8 | 1.5 | 7.1 | | | 3.4 |
| Total Phosphorus (mg/L) | Min | 0.0050 | 0.020 | <0.01 | <0.01 | | | <0.01 |
| | Mean | 0.027 | 0.031 | 0.023 | 0.030 | | | 0.022 |
| | Max | 0.072 | 0.079 | 0.041 | 0.22 | | | 0.22 |
| Total Suspended Solids (mg/L) | Min | <1.0 | <1.0 | <1.0 | <1.0 | | | <1.0 |
| | Mean | 2.1 | 1.4 | 3.5 | 6.0 | | | 4.8 |
| | Max | 28 | 3.0 | 7.5 | 95 | | | 21 |
| Turbidity (NTU) | Min | 0.90 | 1.0 | 0.70 | 0.38 | | | 0.39 |
| | Mean | 3.4 | 2.3 | 2.9 | 6.0 | | | 3.4 |
| | Max | 19 | 6.3 | 6.6 | 102 | | | 16 |
| Total Recoverable Aluminum (µg/L) | Min | 28 | | 56 | 46 | | | 27 |
| | Mean | 74 | | 929 | 679 | | | 427 |
| | Max | 136 | | 2610 | 3090 | | | 3160 |
| Dissolved Aluminum (µg/L) | Min | <20 | 26 | 25 | <20 | | | <20 |
| | Mean | 39 | 129 | 871 | 223 | 120 | | 178 |
| | Max | 170 | 270 | 5380 | 3160 | | | 1216 |
| Total Recoverable Antimony (µg/L) | Min | <10 | | <10 | <10 | | | <10 |
| | Mean | <10 | | <10 | <10 | | | <10 |
| | Max | <10 | | <10 | <10 | | | <10 |
| Dissolved Antimony (µg/L) | Min | <5 | | <5 | <5 | | | <5 |
| | Mean | <5 | | <5 | <5 | | | <5 |
| | Max | <5 | | <5 | <5 | | | <5 |
| Total Recoverable Arsenic (µg/L) | Min | <1 | | <1 | <1 | | | <1 |
| | Mean | <1 | | <1 | <1 | | | 0.54 |
| | Max | <1 | | <1 | 2.9 | | | 1.4 |
| Dissolved Arsenic (µg/L) | Min | <0.5 | <0.5 | <0.5 | <0.5 | | | <0.5 |
| | Mean | <0.5 | 0.93 | <0.5 | <0.5 | | | <0.5 |
| | Max | <0.5 | 1.0 | 0.85 | 2.4 | | | 1.4 |
| Total Recoverable Barium (µg/L) | Min | 62 | | 45 | 26 | | | 46 |
| | Mean | 92 | | 64 | 65 | | | 63 |
| | Max | 140 | | 99 | 154 | | | 92 |

| Parameter | Statistic | COV-5 | COV-4 | COV-3 | COV-2 | COV-1.5 | COV-1B | COV-1 |
|---|---|---|---|---|---|---|---|---|
| Total Recoverable Magnesium (mg/L) | Min | 0.79 | | 0.44 | <0.1 | | | 3.0 |
| | Mean | 1.0 | | 8.4 | 9.8 | | | 11 |
| | Max | 1.3 | | 22 | 42 | | | 36 |
| Dissolved Magnesium (mg/L) | Min | 0.78 | 0.30 | 0.12 | 0.18 | | | 1.7 |
| | Mean | 1.1 | 1.6 | 9.7 | 11.6 | 2.7 | <0.03 | 10 |
| | Max | 2.1 | 2.7 | 30 | 63 | | | 36 |
| Total Recoverable Manganese (µg/L) | Min | 2 | | 37 | 11 | | | 39 |
| | Mean | 7 | | 789 | 670 | | | 512 |
| | Max | 29 | | 1,750 | 2,350 | | | 2,070 |
| Dissolved Manganese (µg/L) | Min | 1 | 25 | 8 | <0.5 | | | 12 |
| | Mean | 10 | 71 | 997 | 989 | 18 | | 881 |
| | Max | 64 | 158 | 4,720 | 4,110 | | | 3,310 |
| Total Recoverable Nickel (µg/L) | Min | <2.5 | | <2.5 | <2.4 | | | <2.4 |
| | Mean | <2.5 | | 14 | 12 | | | 8 |
| | Max | <2.5 | | 32 | 36 | | | 16 |
| Dissolved Nickel (µg/L) | Min | <0.5 | 1.3 | <0.5 | <0.5 | | | <0.5 |
| | Mean | 0.75 | 4.2 | 19 | 16 | <10 | | 14 |
| | Max | 0.77 | 10 | 73 | 70 | | | 50 |
| Total Recoverable Potassium (mg/L) | Min | 0.50 | | 0.85 | 1.0 | | | 0.99 |
| | Mean | 0.75 | | 1.4 | 1.8 | | | 1.8 |
| | Max | 1.2 | | 2.3 | 4.4 | | | 3.6 |
| Dissolved Potassium (mg/L) | Min | 0.23 | 0.46 | 0.68 | <0.5 | | | 0.23 |
| | Mean | 0.77 | 0.84 | 1.6 | <0.5 | | <1 | 1.8 |
| | Max | 2.3 | 1.3 | 3.2 | 4.6 | | | 3.9 |
| Total Recoverable Selenium (µg/L) | Min | <2 | | <2 | <2 | | | <2 |
| | Mean | <2 | | <2 | <2 | | | <2 |
| | Max | <2 | | <2 | <2 | | | <2 |
| Dissolved Selenium (µg/L) | Min | <0.5 | <0.5 | <1 | <0.5 | | | <0.5 |
| | Mean | <0.5 | 3.4 | 5.3 | <0.5 | | | 4.9 |
| | Max | <70 | 9.3 | 70 | 6.6 | | | 7.4 |
| Total Recoverable Silica (mg/L) | Min | 7.1 | | 8.9 | 7.8 | | | 7.8 |
| | Mean | 8.5 | | 11 | 12 | | | 12 |
| | Max | 10 | | 14 | 15 | | | 15 |
| Dissolved Silica (mg/L) | Min | 6.5 | | 8.2 | 5.4 | | | 7.9 |
| | Mean | 8.2 | | 11 | 11 | | | 12 |
| | Max | 11 | | 15 | 17 | | | 16 |
| Total Recoverable Silver (µg/L) | Min | <5 | | <5 | <5 | | | <5 |
| | Mean | <5 | | <5 | <5 | | | <5 |
| | Max | <5 | | <5 | <5 | | | <5 |
| Dissolved Silver (µg/L) | Min | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| | Mean | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| | Max | <0.5 | | 0.50 | <0.5 | | | <0.5 |

Table 3.4. Summary of Cove Creek water quality monitoring data, 2000 to 2012 (continued).

| Parameter | Statistic | COV-5 | COV-4 | COV-3 | COV-2 | COV-1.5 | COV-1B | COV-1 |
|---|---|---|---|---|---|---|---|---|
| Dissolved Barium (µg/L) | Min | 66 | 8.8 | 45 | 21 | | | 20 |
| | Mean | 96 | 76 | 64 | 64 | 84 | | 67 |
| | Max | 166 | 122 | 110 | 146 | | | 173 |
| Total Recoverable Beryllium (µg/L) | Min | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| | Mean | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| | Max | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| Dissolved Beryllium (µg/L) | Min | <0.1 | <0.10 | 0.05 | <0.1 | | | <0.1 |
| | Mean | <0.1 | 0.21 | 0.23 | 0.17 | <2 | | 0.12 |
| | Max | <2.0 | <2 | 0.90 | <2 | | | 0.50 |
| Total Recoverable Boron (µg/L) | Min | 12 | | 13 | 12 | | | 12 |
| | Mean | 12 | | 61 | 75 | | | 81 |
| | Max | 12 | | 191 | 362 | | | 318 |
| Dissolved Boron (µg/L) | Min | 2.0 | 4.5 | 14 | <4 | | | <4 |
| | Mean | 7.3 | 6.0 | 77 | 75 | | | 60 |
| | Max | 16 | 9.8 | 266 | 360 | | | 310 |
| ORP (mV) | Min | 235 | | 191 | 206 | | | -299 |
| | Mean | 352 | | 427 | 367 | 205 | | 371 |
| | Max | 510 | | 588 | 570 | | | 650 |
| Acidity (mg/L) | Min | | | <5 | | | | |
| | Mean | <5 | | 7.9 | | | | |
| | Max | | | 19 | | | | |
| Fecal Coliforms (colony-forming units per 100 mL) | Min | | | | | | | |
| | Mean | 49 | | | 29 | | | 6.0 |
| | Max | | | | | | | |

| Parameter | Statistic | COV-5 | COV-4 | COV-3 | COV-2 | COV-1.5 | COV-1B | COV-1 |
|---|---|---|---|---|---|---|---|---|
| Total Recoverable Sodium (mg/L) | Min | 1.1 | | 1.7 | 0.88 | | | 2.2 |
| | Mean | 1.6 | | 4.8 | 6.3 | | | 6.8 |
| | Max | 2.3 | | 13 | 23 | | | 20 |
| Dissolved Sodium (mg/L) | Min | 1.0 | 1.1 | 1.8 | 0.060 | | | 2.1 |
| | Mean | 1.8 | 2.2 | 5.5 | 7.6 | | <1 | 6.4 |
| | Max | 3.0 | 6.6 | 15 | 43 | | | 21 |
| Total Recoverable Thallium (µg/L) | Min | <2.4 | | <2.4 | <2.4 | | | <2.4 |
| | Mean | <2.4 | | <2.4 | <2.4 | | | <2.4 |
| | Max | <2.4 | | <2.4 | <2.4 | | | <2.4 |
| Dissolved Thallium (µg/L) | Min | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| | Mean | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| | Max | <0.5 | | <0.5 | <0.5 | | | <0.5 |
| Total Recoverable Vanadium (µg/L) | Min | <2.4 | | <2.4 | <2.4 | | | <2.4 |
| | Mean | <2.4 | | <2.4 | <2.4 | | | <2.4 |
| | Max | <2.4 | | <2.4 | 3.47 | | | <2.4 |
| Dissolved Vanadium (µg/L) | Min | 0.50 | <0.5 | <0.5 | <1 | | | <1 |
| | Mean | 0.52 | 1.0 | <0.5 | <1 | | | 1.9 |
| | Max | 0.89 | 1.6 | 1.7 | 12 | | | 29 |
| Total Recoverable Zinc (µg/L) | Min | <3 | | <3 | <3 | | | <3 |
| | Mean | 2.0 | | 32 | 29 | | | 19 |
| | Max | 8.2 | | 82 | 93 | | | 92 |
| Dissolved Zinc (µg/L) | Min | <1 | 2.2 | 2.1 | <1 | | | <1 |
| | Mean | 3.5 | 9.0 | 46 | 49 | <10 | | 32 |
| | Max | 20 | 38 | 190 | 562 | | | 110 |

*Single values in the table indicate the only data point.

Table 3.5. Summary of Scull Creek water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | SCL-1D | SCL-1 | SCL-0 | Parameter | Statistic | SCL-1D | SCL-1 | SCL-0 |
|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total (mg/L) | Min | | <1 | <1 | Dissolved Copper (µg/L) | Min | | <6 | 0.50 |
| | Mean | 6.8 | 2.6 | 8.1 | | Mean | | 6.5 | 4.2 |
| | Max | | 6.8 | 18 | | Max | | 14 | 9.8 |
| Chloride (mg/L) | Min | | 1.7 | 2.0 | Dissolved Iron (µg/L) | Min | | 50 | 98 |
| | Mean | 1.8 | 2.2 | 2.6 | | Mean | | 653 | 200 |
| | Max | | 3.0 | 3.4 | | Max | | 1,300 | 260 |
| Hardness as Ca and Mg (mg/L) | Min | | | 34 | Dissolved Lead (µg/L) | Min | | 0.30 | 0.10 |
| | Mean | | | 40 | | Mean | | 10 | 8.2 |
| | Max | | | 44 | | Max | | <40 | <40 |
| Sulfate (mg/L) | Min | | 5.0 | 10 | Dissolved Magnesium (mg/L) | Min | | 0.30 | 2.1 |
| | Mean | 4.5 | 179 | 32 | | Mean | 0.94 | 20 | 4.0 |
| | Max | | 430 | 63 | | Max | | 43 | 5.4 |
| Total Dissolved Solids (mg/L) | Min | | 33 | 50 | Dissolved Manganese (µg/L) | Min | | 4,600 | 440.0 |
| | Mean | 28 | 265 | 74 | | Mean | | 9,365 | 1,754 |
| | Max | | 570 | 94 | | Max | | 19,000 | 4,000 |
| Dissolved Aluminum (µg/L) | Min | | 5,000 | 30 | Dissolved Nickel (µg/L) | Min | | | <10 |
| | Mean | | 12,013 | 959 | | Mean | | | 38 |
| | Max | | 24,900 | 2,800 | | Max | | | 150 |
| Dissolved Barium (µg/L) | Min | | 51 | 11 | Dissolved Potassium (mg/L) | Min | | | |
| | Mean | | 54 | 86 | | Mean | <1 | <1 | <1 |
| | Max | | 56 | 169 | | Max | | | |
| Dissolved Beryllium (µg/L) | Min | | 1.0 | 0.10 | Dissolved Selenium (µg/L) | Min | | <2 | <2 |
| | Mean | | 1.4 | 0.55 | | Mean | | <2 | 24 |
| | Max | | 2.2 | 2.0 | | Max | | <2 | 70 |
| Dissolved Cadmium (µg/L) | Min | | 0.10 | 0.10 | Dissolved Silver (µg/L) | Min | | <7 | <7 |
| | Mean | | 1.2 | 1.5 | | Mean | | <7 | <7 |
| | Max | | <4 | 4.0 | | Max | | <7 | <7 |
| Dissolved Calcium (mg/L) | Min | | 0.10 | 7.6 | Dissolved Sodium (mg/L) | Min | | | |
| | Mean | 3.2 | 17 | 9.8 | | Mean | 1.4 | 1.4 | 2.4 |
| | Max | | 34 | 12 | | Max | | | |
| Dissolved Cobalt (µg/L) | Min | | 45 | 10 | Dissolved Zinc (µg/L) | Min | | 120 | 10 |
| | Mean | | 82 | 16 | | Mean | | 248 | 80 |
| | Max | | 170 | 53 | | Max | | 500 | 320 |

*Single values in the table indicate the only data point.

Table 3.6. Summary of Clearwater Lake water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | CRL-4S | CRL-4B | CRL-1S | CRL-1B |
|---|---|---|---|---|---|
| Alkalinity, Total (mg/L) | Min | | | | |
| | Mean | <1 | <1 | <1 | <1 |
| | Max | | | | |
| Chloride (mg/L) | Min | | | | |
| | Mean | 2.0 | 2.2 | 2.1 | 2.1 |
| | Max | | | | |
| Sulfate (mg/L) | Min | | | | |
| | Mean | 62 | 67 | 63 | 66 |
| | Max | | | | |
| Total Dissolved Solids (mg/L) | Min | | | | |
| | Mean | 100 | 120 | 110 | 110 |
| | Max | | | | |
| Dissolved Calcium (mg/L) | Min | | | | |
| | Mean | 8.8 | 9.4 | 8.6 | 8.9 |
| | Max | | | | |
| Dissolved Magnesium (mg/L) | Min | | | | |
| | Mean | 6.3 | 6.8 | 6.2 | 6.3 |
| | Max | | | | |
| Dissolved Potassium (mg/L) | Min | | | | |
| | Mean | <1 | <1 | <1 | <1 |
| | Max | | | | |
| Dissolved Sodium (mg/L) | Min | | | | |
| | Mean | 2.3 | 2.5 | 2.2 | 2.3 |
| | Max | | | | |

*Single values in the table indicate the only data point.

### 3.2.6 Reyburn Creek

Reyburn Creek has low pH and elevated minerals concentrations at both of the Reyburn Creek sites that were monitored. Reyburn Creek receives drainage from the tailings ponds and Scull Creek. The Reyburn Creek monitoring station below the Scull Creek confluence (REY-2; see Figure 3.1) has measured sulfate concentrations ranging from 50 to 150 mg/L and TDS concentrations ranging from 94 to 240 mg/L. Table 3.7 presents a statistical summary of water quality data collected from the Reyburn Creek monitoring stations from 2000 to 2012.

Table 3.7. Summary of Reyburn Creek water quality monitoring data, 2000 to 2012.*

| Parameter | Statistic | REY-3 | REY-2 | Parameter | Statistic | REY-3 | REY-2 |
|---|---|---|---|---|---|---|---|
| Alkalinity, Total (mg/L) | Min | <1 | <1 | Dissolved Copper (µg/L) | Min | <6 | 2.4 |
| | Mean | <1 | 2.93 | | Mean | <6 | 4.1 |
| | Max | 1.0 | 8.4 | | Max | 9.8 | 6.0 |
| Chloride (mg/L) | Min | 2.1 | 2.0 | Dissolved Iron (µg/L) | Min | 81 | 91 |
| | Mean | 3.0 | 2.8 | | Mean | 282 | 396 |
| | Max | 5.0 | 4.3 | | Max | 480 | 1,250 |
| Hardness as Ca and Mg (mg/L) | Min | 40 | 61 | Dissolved Lead (µg/L) | Min | 0.20 | 0.20 |
| | Mean | 100 | 87 | | Mean | 8.4 | 8.2 |
| | Max | 174 | 128 | | Max | <40 | <40 |
| Sulfate (mg/L) | Min | 120 | 50 | Dissolved Magnesium (mg/L) | Min | 3.0 | 4.9 |
| | Mean | 157 | 91 | | Mean | 7.0 | 6.2 |
| | Max | 230 | 150 | | Max | 11 | 7.9 |
| Total Dissolved Solids (mg/L) | Min | 180 | 94 | Dissolved Manganese (µg/L) | Min | 1,600 | 1 |
| | Mean | 258 | 159 | | Mean | 2,924 | 1,672 |
| | Max | 400 | 240 | | Max | 4,170 | 3,010 |
| Dissolved Aluminum (µg/L) | Min | 500 | 140 | Dissolved Nickel (µg/L) | Min | 17 | <10 |
| | Mean | 1,760 | 2,112 | | Mean | 55 | 34 |
| | Max | 2,700 | 7,840 | | Max | 140 | 59 |
| Dissolved Barium (µg/L) | Min | 21 | 77 | Dissolved Potassium (mg/L) | Min | | |
| | Mean | 41 | 100 | | Mean | <1 | |
| | Max | 74 | 152 | | Max | | |
| Dissolved Beryllium (µg/L) | Min | 0.48 | <0.3 | Dissolved Selenium (µg/L) | Min | <2 | <2 |
| | Mean | 0.70 | 0.66 | | Mean | 24 | 24 |
| | Max | 2.0 | 2.0 | | Max | 70 | 70 |
| Dissolved Cadmium (µg/L) | Min | 0.50 | 0.30 | Dissolved Silver (µg/L) | Min | <7 | |
| | Mean | 1.6 | 1.5 | | Mean | <7 | |
| | Max | 4.0 | 4.0 | | Max | <7 | |
| Dissolved Calcium (mg/L) | Min | 11 | 16 | Dissolved Sodium (mg/L) | Min | | |
| | Mean | 32 | 25 | | Mean | 12 | |
| | Max | 52 | 38 | | Max | | |
| Dissolved Cobalt (µg/L) | Min | 7.3 | <7 | Dissolved Zinc (µg/L) | Min | 40 | 53 |
| | Mean | 22 | 8.8 | | Mean | 120 | 93 |
| | Max | 52 | 17 | | Max | 300 | 120 |

*Single values in the table indicate the only data point.

## 3.3 Biological Characteristics

The following is a preliminary evaluation of water quality in the receiving streams affected by the DIM former mine site as indicated by fish and benthic macroinvertebrate communities. The conclusions are based on a preliminary review of April 2012 biological sampling in the waterbodies. The biological sampling data provided in Section 3.3 suggest that effects to the aquatic communities appear to be due to ARD nonpoint source runoff. However, the toxicity testing results discussed in Section 5.1 demonstrate that the effects are due to constituents associated with ARD nonpoint source runoff such as low pH and dissolved metals, rather than elevated dissolved minerals. Low pH and the resulting dissolved metals will be addressed through implementation of the Remediation Plan for this EIP.

Significant historical biological data for the site drainages from the period of 2000 to 2005 is provided in Appendices A and D. In addition, between May 2007 and June 2009, ADEQ collected 14 samples from the mouth of Chamberlain Creek and 11 samples from Cove Creek immediately downstream of Chamberlain Creek for 96-hour acute toxicity testing (*Ceriodaphnia dubia* and *Pimephales promelas*). Tables 3.8 and 3.9 provide a summary of the instream ADEQ toxicity testing data. EPA's Region 6 laboratory in Houston, TX, conducted the analyses. The results from Chamberlain Creek show that toxicity is evident to both *C. dubia* and *P. promelas* in 14 of 14 samples. The results from Cove Creek immediately downstream of Chamberlain Creek show that toxicity is evident to *C. dubia* in 6 of 11 samples and to *P. promelas* in 4 of 11 samples. As discussed above and in Section 5, this toxicity appears to be due to ARD nonpoint sources that will be addressed through implementation of the Remediation Plan for this EIP (Appendix C).

Table 3.8. ADEQ/EPA toxicity data for Chamberlain Creek.

| Sampling Date | Percent Mortality | |
|---|---|---|
| | ***Ceriodaphnia dubia*** | ***Pimephales promelas*** |
| 04/16/2007 | 65.0* | 82.5* |
| 06/25/2007 | 100.0* | 100.0* |
| 08/20/2007 | 100.0* | 100.0* |
| 10/22/2007 | 90.0* | 65.0* |
| 12/03/2007 | 80.0* | 100.0* |
| 01/28/2008 | 100.0* | 70.0* |
| 03/24/2008 | 100.0* | 100.0* |
| 05/12/2008 | 100.0* | 100.0* |
| 07/07/2008 | 100.0* | 100.0* |
| 09/08/2008 | 100.0* | 100.0* |
| 11/03/2008 | * | * |
| 02/02/2009 | 100.0* | 100.0* |
| 03/23/2009 | 100.0* | 100.0* |
| 05/11/2009 | 100.0* | 100.0* |

*Significantly different ($p \geq 0.95$) from control.

Table 3.9. ADEQ/EPA toxicity data for Cove Creek.

| Sampling Date | Percent Mortality | |
|---|---|---|
| | ***Ceriodaphnia dubia*** | ***Pimephales promelas*** |
| 10/22/2007 | 55.0* | 5.0 |
| 12/03/2007 | 10.0 | 0.0 |
| 01/28/2008 | 10.0 | 0.0 |
| 03/24/2008 | 90.0* | 100.0* |
| 05/12/2008 | 85.0* | 5.0 |
| 07/07/2008 | 25.0 | 20.0 |
| 09/08/2008 | 100.0* | 100.0* |
| 11/03/2008 | 20.0 | 0.0 |
| 02/02/2009 | 25.0 | 98.0* |
| 03/23/2009 | 90.0* | 47.5 |
| 05/11/2009 | 60.0* | 100.0* |

*Significantly different ($p \geq 0.95$) from the control.

The April 2012 data (Appendix F) can be divided into two sets of sampling locations based on waterbody size and source of pollutants from the DIM former mine site. The three Cove Creek stations (COV-1, COV-3 and COV-4; Table 3.10, see Figure 3.1) can be evaluated separately as a group due to the size of Cove Creek and input of pollutants from a single source (i.e., Chamberlain Creek). Sampling stations on Chamberlain Creek, Reyburn Creek, Scull Creek, Lucinda Creek, and Rusher Creek are all habitat-limited (due to small watershed/channel size and low flows) and are all affected by nonpoint sources of ARD from the site (NewFields 2007).

### 3.3.1 Fish Communities

The COV-4 and COV-3 sample locations are immediately upstream and downstream, respectively, of the mouth of Chamberlain Creek; COV-1 is approximately 5 miles downstream of the mouth of Chamberlain Creek (Figure 3.1). All three stations show the expected representation of fish families, with minnows, sunfish and darters dominating the fish communities (Table 3.10). The percent composition of individuals among families varies, due in part to habitat differences. The impact of Chamberlain Creek on the Cove Creek fish community is seen at COV-3, where there is a smaller proportion of minnows (19.5% at COV-3 versus 61.4% and 48.7% at COV-1 and COV-4, respectively) and lower overall relative abundance (catch per unit effort [CPUE] is 28.1 at COV-3 versus 65.6 and 64.6 for COV-1 and COV-4, respectively). Higher minnow abundance and overall abundance at COV-1, which is nearer to the mouth of Cove Creek, suggests downstream recovery.

Fish communities in Reyburn Creek, Scull Creek, Lucinda Creek, and Rusher Creek (Table 3.11) show the effects of small watershed/channel size and intermittent flows. The absence of fish in Chamberlain Creek indicates the effects of nonpoint ARD.

Table 3.10. Summary of fish community composition at sampling stations on Cove Creek.

| Family | % of Taxa | | | % of Individuals | | |
|---|---|---|---|---|---|---|
| | COV-1 | COV-3 | COV-4 | COV-1 | COV-3 | COV-4 |
| Cyprinidae | 29.4 | 33.3 | 33.3 | 61.4 | 19.5 | 48.7 |
| Catostomidae | 5.9 | 8.3 | 8.3 | 0.6 | 1.3 | 0.7 |
| Ictaluridae | 5.9 | 8.3 | 8.3 | 3.1 | 3.9 | 0.7 |
| Fundulidae | 11.8 | 16.7 | 16.7 | 4.4 | 18.6 | 12.9 |
| Centrarchidae | 29.4 | 25.0 | 25.0 | 22.3 | 39.8 | 13.3 |
| Percidae | 17.6 | 8.3 | 8.3 | 8.2 | 16.9 | 23.7 |
| Total Taxa | 17 | 12 | 12 | | | |
| Overall Relative Abundance (CPUE)* | 65.6 | 28.1 | 64.6 | | | |

*Note: Catch per unit effort is the number of fish captures per 10 minutes of pedal-down time.

Table 3.11. Summary of fish community composition Reyburn Creek, Scull Creek, Lucinda Creek, and Rusher Creek.

| Species | SCL-0 | SCL-1 | REY-2 | REY-3 | CHM-0 | CHM-1 | CHM-2 | LUC-0 | RUS-0 |
|---|---|---|---|---|---|---|---|---|---|
| Goldstripe darter | + | + | + | + | NFC | NFC | NFC | NFC | NFC |
| Redfin darter | | | + | | | | | | |
| Creek chubsucker | + | | | | | | | | |
| Green sunfish | + | | | | | | | | |
| Longear sunfish | + | | | | | | | | |

Notes: + = present; NFC = no fish captured

### 3.3.2 Benthic Communities

Benthic communities in Cove Creek show similar community composition in percent of ephemeroptera/plecoptera/trichoptera taxa (%EPT) with a decrease in taxa richness and %EPT individuals from upstream of the mouth of Chamberlain Creek to the COV-1 location (Table 3.12). Recovery of the benthic community at COV-1 is not evident with these metrics. In general, increases in taxa richness and/or EPT are seen moving downstream in these drainages due to reductions in nonpoint ARD input.

Table 3.12. Summary of benthic communities from all sampling locations.

| Sampling Location | Number of Taxa | %EPT taxa | % EPT Individuals |
|---|---|---|---|
| COV-1 | 8 | 37.5 | 9.9 |
| COV-3 | 11 | 36.4 | 15.8 |
| COV-4 | 13 | 38.5 | 21.6 |
| SCL-0 | 7 | 14.3 | 2.1 |
| SCL-1 | 5 | 0.0 | 0.0 |
| REY-2 | 8 | 37.5 | 6.3 |
| REY-3 | 2 | 50.0 | 1.0 |
| CHM-0 | 6 | 16.7 | 1.7 |
| CHM-1 | 7 | 14.3 | 3.9 |
| CHM-2 | 1 | 0.0 | 0.0 |
| LUC-0 | 2 | 0.0 | 0.0 |
| RUS-0 | 8 | 25.0 | 3.4 |

### 3.3.3 Conclusions

The impacts of point and nonpoint source pollutants associated with ARD on biological communities are evident in both the fish and benthic macroinvertebrate communities of Cove Creek and other sampled waterbodies. Habitat and low flows further limit biological communities in the smaller waterbodies (Chamberlain Creek, Reyburn Creek, Scull Creek, Lucinda Creek, and Rusher Creek).

# 4.0 AFFECTED DISSOLVED MINERALS REFERENCE STREAM VALUES

Cove Creek and its tributaries are located in the Ouachita Mountains ecoregion, and Reyburn Creek and Scull Creek are located in the Gulf Coastal Plain ecoregion (APCEC 2014).

The ecoregion reference stream values for dissolved minerals for each receiving waterbody are listed below in Table 4.1.

Table 4.1. Ecoregion dissolved minerals reference stream values for the receiving waterbodies (APCEC 2014).

| | | Reference Stream Values (mg/L) | | |
|---|---|---|---|---|
| **Ecoregion** | **Waterbody Name** | **TDS** | **Sulfate** | **Chloride** |
| Ouachita Mountains | Chamberlain Creek | 128 | 15 | 6 |
| Ouachita Mountains | Cove Creek | 128 | 15 | 6 |
| Ouachita Mountains | Lucinda Creek | 128 | 15 | 6 |
| Ouachita Mountains | Rusher Creek | 128 | 15 | 6 |
| Gulf Coastal Plain | Reyburn Creek | 123 | 31 | 14 |
| Gulf Coastal Plain | Scull Creek | 123 | 31 | 14 |

Proposed temporary modifications to the ecoregion-based reference stream values for the waterbodies listed above are discussed in Section 5.0.

# 5.0 MODIFICATIONS SOUGHT

HESI proposes modified water quality standards in this EIP NOI for dissolved minerals in the site drainages and Cove Creek. The Remediation Plan will address low pH in site runoff as well as elevated dissolved metals in the site drainages. It is expected, based on experience at other Arkansas former mine sites undergoing remediation, that dissolved minerals concentrations in the site runoff (and site drainages) will be reduced, but not to levels that are below the Arkansas ecoregion-based reference stream values.

Justification for the temporary water quality standards (i.e., “modifications”) as part of an EIP for this site is as follows:

1. The current levels of dissolved minerals found in Cove Creek, Lucinda Creek, Rusher Creek, Reyburn Creek, Scull Creek, Clearwater Lake, and the treated water treatment system effluent that discharges to Chamberlain Creek are protective of “fishable/swimmable” uses (as required by Section 4(a) of Appendix B to Regulation No. 2).
2. The DIM former mine site meets the applicability requirements found in Regulation No. 2, Appendix B (APCEC 2014) as the basis for an EIP.

Justification for the EIP NOI proposed temporary water quality standards is further discussed below.

## 5.1 Protection of Fishable/Swimmable Uses

The proposed temporary water quality standards for dissolved minerals in Chamberlain Creek (i.e., 2,261 mg/L for TDS; 1,384 mg/L for sulfate; and 68 mg/L for chloride) are based on the dissolved minerals levels of Pit Lake water, which reflect years of accumulated ARD site drainage. The Pit Lake water treatment system adjusts pH and treats dissolved metals in the Pit Lake water but does not lower dissolved minerals levels. This treated effluent from the Pit Lake is discharged to upper Chamberlain Creek and comprises the majority of the flow in this creek. Table 5.1 provides measured TDS, sulfate and chloride concentrations from treated Pit Lake water that were used for preparation of NPDES discharge monitoring report (DMR) submittals from June 2003 through June 2012. Only DMR sampling dates that correspond with quarterly toxicity testing from the period of record, and then only those events that resulted in no toxicity (100% survival), were included in Table 5.1. During the interval of June 2003 through June 2012, there were four episodes of effluent toxicity (in February 2005, April 2005, December 2006, and February 2010). The critical dilution for each test was 100% treated effluent. During the February 2005 testing event, lethal and sublethal effects were observed for both *Ceriodaphnia dubia* and *Pimephales promelas.* The no-observed-effect concentration (NOEC) was 42% for both lethal and sublethal effects to *P. promelas.* Lethal effects to *C. dubia* during the February 2005 testing event resulted in an NOEC of 75% and sublethal effects resulted in an NOEC of 56%. During the April 2005 testing event, lethal and sublethal effects were observed for *P. promelas*, resulting in an NOEC of 75%, and sublethal effects were observed for *C. dubia*, resulting in an NOEC of 56%. However, the data from the 2005 toxicity events were analyzed and the effects to the fish and water flea are likely to have resulted from the presence of a pathogen, rather than a characteristic of the effluent, and the use of a slimicide (which was discontinued), respectively. During the December 2006 event, sublethal effects were observed for *C. dubia*, resulting in an NOEC of 75%. During the February 2010 testing event, sublethal effects were observed for *C. dubia*, resulting in an NOEC of 56%.

The dissolved minerals concentrations used for calculation of the proposed criteria do not include the data points from the sampling events listed above (during which lethal and/or sublethal effects were observed). Therefore, toxicity due to dissolved minerals is not expected to result from the proposed temporary water quality standards for the affected site drainages (see Section 6.2 for a more detailed discussion of the proposed temporary water quality standards during remediation).

Table 5.1. Measured values at Outfall 001 for DMR reporting.

| Date | TDS (mg/L) | Sulfate (mg/L) | Chloride (mg/L) | Percent Survival (%) |
|---|---|---|---|---|
| 06/18/2003 | 1,923 | 1,290 | 65.5 | 100 |
| 07/23/2003 | 2,200 | 1,320 | 62.3 | 100 |
| 09/17/2003 | 2,300 | 1,340 | 61.8 | 100 |
| 10/22/2003 | 2,200 | 1,380 | 67.6 | 100 |
| 11/12/2003 | 2,200 | 1,370 | 63.3 | 100 |
| 12/10/2003 | 2,300 | 1,390 | 67.8 | 100 |
| 03/17/2004 | 2,184 | 1,290 | 67.7 | 100 |
| 04/21/2004 | 2,048 | 1,370 | 70.8 | 100 |
| 05/20/2004 | 2,240 | 1,340 | 61.5 | 100 |
| 06/16/2004 | 2,200 | 1,300 | 60.6 | 100 |
| 08/18/2004 | 2,200 | 1,350 | 63.9 | 100 |
| 12/15/2004 | 2,000 | 1,270 | 16.9 | 100 |
| 03/23/2005 | 2,200 | 1,390 | 63.9 | 100 |
| 05/04/2005 | 2,100 | 1,180 | 52.0 | 100 |
| 06/08/2005 | 2,100 | 1,210 | 59.5 | 100 |
| 07/19/2005 | 2,100 | 1,070 | 48.1 | 100 |
| 08/16/2005 | 2,200 | 1,330 | 59.7 | 100 |
| 10/11/2005 | 2,200 | 1,360 | 58.7 | 100 |
| 12/13/2005 | 2,100 | 1,360 | 50.6 | 100 |
| 12/05/2007 | 2,100 | 1,330 | 60.7 | 100 |
| 02/19/2009 | 1,900 | 1,190 | 49.8 | 100 |
| 04/15/2009 | 1,900 | 1,090 | 47.6 | 100 |
| 06/04/2009 | 1,700 | 1,010 | 40.3 | 100 |
| 10/15/2009 | 1,700 | 938 | 39.2 | 100 |
| 04/15/2010 | 1,800 | 841 | 35.1 | 100 |
| 06/17/2010 | 1,800 | 899 | 39.1 | 100 |
| 01/13/2011 | 1,900 | 1,130 | 43.9 | 100 |
| 02/15/2011 | 1,900 | 1,120 | 53.4 | 100 |
| 04/14/2011 | 1,900 | 936 | 42.7 | 100 |
| 06/16/2011 | 1,800 | 1,200 | 45.7 | 100 |
| 12/07/2011 | 1,600 | 1,050 | 38.1 | 100 |
| 02/08/2012 | 1,800 | 874 | 43.5 | 100 |
| 04/12/2012 | 1,800 | 953 | 38.4 | 100 |
| 06/14/2012 | 1,800 | 740 | 40.4 | 100 |
| 95$^{th}$ Percentile | **2,261** | **1,384** | **67.7** | |

## 5.2 Applicable Regulatory Requirements for an EIP

The DIM site meets the applicability requirements for an EIP found in Regulation No. 2, Appendix B (APCEC 2014). Section 2.308 of Regulation No. 2 supports the development of site-specific criteria, and ADEQ and EPA have historically supported development of site-specific criteria based on Regulation No. 2 and considering conditions found in 40 CFR 131.10(g) (and Regulation No. 2, Section 2.303). The following conditions at 40 CFR 131.10(g) support temporary modification of the dissolved minerals ecoregion-based reference stream values at the DIM former mine site:

- "(3) 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;" and
- "(6) 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."

Furthermore, 40 CFR 131.11(b)(1)(ii) provides states with the opportunity to adopt water quality criteria that are "modified to reflect site-specific conditions." Site-specific criteria, as with all water quality criteria, must be based on a sound scientific rationale in order to protect the designated use(s).

# 6.0 PROPOSED REMEDIATION PLAN

The proposed EIP NOI Remediation Plan for the DIM former mine site reflects the RADD issued by ADEQ. The EIP NOI Remediation Plan is found in Appendix C. Remediation at the DIM former mine site is expected to address the low pH and elevated metals that affect drainages from the site. However, it is anticipated that although dissolved minerals concentrations will improve in the receiving streams, the concentrations will remain elevated above ecoregion-based reference stream values after remediation. Appendix B of Regulation No. 2 (APCEC 2014) includes the following requirements for the Remediation Plan for an EIP:

“(A) A description of the existing conditions, including identification of the conditions limiting the attainment of the water quality standards;

(B) A description of the proposed water quality standard modification, both during and post project;

(C) A description of the proposed remediation plan; and

(D) The anticipated collateral effects, if any, of the Remediation Plan.”

These requirements are addressed below.

## 6.1 Existing Conditions Limiting Attainment of the Water Quality Standards

Regulation No. 2 (APCEC 2014) requires that the Remediation Plan include a “description of the existing conditions, including identification of the conditions limiting the attainment of the water quality standards.” Water quality standards for dissolved minerals in drainages from the site have been affected by the mining and placement of spoil at the site. Existing conditions include spoil piles that border the pit on the north, east, and west sides. These piles are made up of overburden removed during open-pit mining. Pyrite-rich shale from the Stanley Formation comprises most of the approximately 20 million cubic yards of spoil.

After mining and associated dewatering activities at the DIM former mine site ended in 1977, the open pit slowly filled with water due to precipitation and runoff. A portion of the runoff from the site continues to run into the pit. Runoff from the site also enters the drainages from the site including Lucinda, Rusher, Scull, Reyburn, Chamberlain, Stone Quarry, and Cove creeks. As precipitation filters through the spoil piles, in this case pyrite-rich shale, sulfide from pyrite associates with water and oxygen to form a dilute sulfuric acid solution known as ARD. The acid in turn mobilizes soluble metals and minerals in surrounding rocks, causing elevated contaminants in surface water entering the pit and the site drainage pathways. The acidic runoff results in elevated dissolved minerals concentrations that exceed ecoregion-based reference stream values. Section 3.0 provides a more detailed description of the existing water quality conditions in the various surface waterbodies at the DIM former mine site. As explained in Section 3.0, dissolved minerals concentrations in the site runoff, as measured in the site drainages, are significantly lower than minerals concentrations in the Pit Lake.

The presence of spoil at the site limits attainment of Arkansas water quality standards in site drainage pathways. Implementation of the Remediation Plan is expected to address the low pH of the runoff and also dissolved metals that are mobilized due to the low pH. Experience at other former Arkansas mine sites affected by ARD has shown, however, that remediation can improve (or lower) the concentrations of dissolved minerals in site runoff but is unlikely to attain levels below the ecoregion-based reference stream values. The Pit Lake water, which displays significantly higher concentrations of dissolved minerals, will have to continue to be treated and discharged to maintain the water level. This discharge comprises a majority of the flow in Chamberlain Creek and a portion of the flow in Cove Creek, which receives Chamberlain Creek inflow. The Pit Lake water does not enter the remaining site drainages, which flow primarily in response to rain events.

## 6.2 Proposed Water Quality Standard Modification During the Remediation Project

Regulation No. 2, Appendix B (APCEC 2014) requires that the Remediation Plan include "a description of the proposed water quality standard modification, both during and post project." The Remediation Plan for this EIP NOI, which reflects the RADD issued by ADEQ, is attached as Appendix C.

The proposed temporary water quality standards are discussed below.

### 6.2.1 Chamberlain Creek

Effluent monitoring data from Outfall 001 for TDS, sulfate, and chloride were compiled for the period of June 2003 through June 2012, to correspond with biomonitoring sampling dates (see Section 5.1 and Table 5.1). The proposed temporary criteria are based on the $95^{th}$ percentile of the measured values of TDS, sulfate, and chloride that correspond to a biomonitoring sampling event that resulted in no toxicity. The $95^{th}$ percentile value is proposed for two reasons: (1) it represents a conservative upper bound of the data set without unreasonably biasing the proposed temporary standard to a higher value by using the maximum value measured, and (2) the $95^{th}$ percentile value as a statistical representation of a site-specific criterion has been proposed and accepted on numerous occasions by ADEQ and EPA in similar situations for permanent criterion changes. The proposed temporary criteria are as follows:

- TDS: 2,261 mg/L,
- Sulfate: 1,384 mg/L, and
- Chloride: 68 mg/L.

### 6.2.2 Cove Creek

The proposed temporary criteria are based on the EPA secondary drinking water standards for TDS and sulfate (EPA 2009). The water treatment system discharge into Chamberlain Creek will be managed by HESI as a hydrograph-controlled release (HCR) to maintain dissolved minerals in Cove Creek below these proposed values. This discharge has been managed similarly using an HCR approach since 2003 to discharge the water from the water treatment system to Chamberlain Creek, thence to Cove Creek, under the authority of the 2003 CAO (LIS No. 03-061).

The proposed temporary criteria for Cove Creek are as follows:

- TDS: 500 mg/L, and
- Sulfate: 250 mg/L.

### 6.2.3 Lucinda Creek, Rusher Creek, Scull Creek, Clearwater Lake, and Reyburn Creek

The proposed temporary criteria are based on the EPA secondary drinking water standards for TDS and sulfate (EPA 2009). These streams primarily flow only in response to wet conditions, and historical data (Appendix A and Section 3) show that these proposed levels are infrequently exceeded in site runoff that flows through these drainages. Chloride values in these site drainages generally meet ecoregion-based reference stream values. The proposed temporary criteria are as follows:

- TDS: 500 mg/L, and
- Sulfate: 250 mg/L.

## 6.3 Proposed Water Quality Standard Modification After the Remediation Project

Regulation No. 2, Appendix B (APCEC 2014) requires that the Remediation Plan include “a description of the proposed water quality standard modification, both during and post project.”

Dissolved minerals concentrations in the Pit Lake, the Pit Lake treated effluent, Chamberlain Creek, Cove Creek, Lucinda Creek, Rusher Creek, Scull Creek, and Reyburn Creek will remain elevated above ecoregion-based reference stream values even after implementation of the Remediation Plan. Experience at other Arkansas former mine sites has shown the levels of dissolved minerals in site drainages will improve (decrease) due to remediation activities, but will not attain ecoregion-based reference stream values. Dissolved minerals concentrations in Chamberlain Creek and Cove Creek, both of which will continue to receive treated effluent from the Pit Lake water treatment system, will remain elevated even after remediation activities are completed. This conclusion is based on the fact that the Pit Lake water quality, due to years of accumulation, will remain essentially unchanged by the remediation although site runoff is expected to be improved substantially. Pit Lake water is discharged under the authority of NDPES Permit No. AR0049794 (see Section 2.0). The discharge has demonstrated that it can meet metals permit limitations, demonstrating that the pH adjustment and subsequent metals removal successfully removes toxicity in this waste stream. This indicates that, despite the elevated dissolved minerals levels in the discharge, the proposed temporary water quality standards for Chamberlain Creek do not result in aquatic life impairments as observed in Chamberlain Creek during the SI and subsequent ADEQ and HESI sampling. It is therefore expected that the proposed post-remediation water quality standards will be similar to the temporary water quality standards proposed above for Chamberlain Creek and Cove Creek. Per Regulation No. 2, Appendix B (APCEC 2014), a UAA will be prepared after remediation is complete to support proposed final Arkansas water quality standards for dissolved minerals in Chamberlain Creek and Cove Creek.

In general, much of the site runoff from disturbed areas will flow to the Pit Lake for treatment; however, there will be areas of previously disturbed land and/or spoils placement that will not be able to be collected and routed to the Pit Lake. Shallow subsurface percolation to site drainages will likely occur and dissolved minerals concentrations above background values in these drainages are likely for some period of time. It is unknown at this time what sulfate and TDS concentrations will occur in the site drainages other than Chamberlain Creek and Cove Creek after reclamation activities are completed and conditions have “stabilized.” Monitoring of the drainages, post-reclamation and post-stabilization, will be necessary to determine if permanent site-specific criteria for sulfate and/or TDS will be necessary. The post-remediation proposed Arkansas water quality standards for the remaining site drainages will be based on results from the post-remediation monitoring program of these drainages.

### 6.4 Proposed Remediation Plan

Proposed reclamation activities at the DIM former mine site are set forth in the EIP NOI Remediation Plan, which is based upon ADEQ’s RADD. The Remediation Plan satisfies APCEC Regulation No. 2, Appendix B (APCEC 2014). The Remediation Plan is found in Appendix C to this EIP NOI.

## 6.5 Anticipated Collateral Effects

Regulation No. 2, Appendix B (APCEC 2014) requires that the Remediation Plan describe "the anticipated collateral effects [of the Remediation], if any." Construction activities associated with the remediation have the potential to temporarily cause additional ARD and subsequent downstream pH depressions, increases in metals concentrations, and increased solids/turbidity downstream from the site. Downstream dissolved minerals concentrations may increase during the earthwork activities due to exposure of pyritic materials. Appropriate, engineered best management practices (BMPs) will be designed and implemented in association with the construction activities. Applicable stormwater construction permits, stormwater pollution prevention plans (SWPPPs), training, maintenance, and monitoring activities will be implemented in coordination with the ADEQ Water Division staff to protect downstream drainages. Plans detailing the BMPs will be prepared and included in the remediation construction SWPPP, and a copy of the SWPPP will be provided to ADEQ for review prior to initiating construction activities. The Remediation Plan will also include effectiveness monitoring during the remediation activities.

Additionally, HESI will address potential Clean Water Act Section 401/404 issues as appropriate. If streams are expected to be impacted during construction activities, HESI will apply for a Short-Term Activity Authorization with ADEQ.

# 7.0 EIP SCHEDULE

## 7.1 Project Deliverables

HESI shall submit the following five primary project deliverable documents in connection with the selected remedy for the site:

- Effectiveness Monitoring Plan (EMP),
- Remedial Design Plan (RDP),
- Remedial Action Implementation Work Plan (RAIWP),
- Operations and Maintenance (O&M) Plan, and
- Construction Completion Report (CCR).

ADEQ approval of the final EMP, final RDP, and final RAIWP will be required prior to the commencement of remedial construction activities. Summary discussions of the contents and structure of each deliverable are provided below.

The EMP will address, at a minimum, requirements found in the EIP NOI Remediation Plan that are based on the ADEQ RADD. The EMP will address surface water monitoring and groundwater monitoring. The EMP will include sampling locations, sampling frequency, analytical parameters, and the sampling and analytical methods to be utilized.

The RDP will include engineering drawings and construction specifications necessary to complete the selected remedy at the site along with a narrative discussion of preliminary construction considerations and a summary of anticipated O&M requirements. The RDP will contain sufficient detail to serve as a basis for seeking bids from construction contractors.

The RAIWP will provide a detailed discussion of how the remedial action will be implemented. The RAIWP will include the following:

- Implementation approach and final construction schedule;
- Names and contact information for key personnel for HESI, ADEQ, and contractors;

- Information on how the construction work will be staged (locations of temporary management trailers, sanitary infrastructure, water and power supplies, etc.);
- Summary information for best management practices that are expected to be required;
- Summary of relevant quality assurance/quality control processes;
- A Site Security Plan; and
- A Health and Safety Plan (HASP).

The O&M Plan will provide descriptions of the long-term O&M requirements for the remedial action. The O&M Plan will identify necessary O&M activities as well as the frequency and duration of the expected O&M actions.

The CCR will provide final as-built construction drawings stamped by the engineer of record and final construction specifications, along with a narrative description of any design deviations from the designs set forth in the RDP and corresponding rationale.

## 7.2 Anticipated Schedule Related to Remediation Activities

This schedule is tentative and is dependent on the effective date of the EIP. The schedule is contingent on construction occurring primarily during the summer months. The schedule also assumes that ADEQ comments will be received within 2 months of each submittal.

| Schedule | Total Time Interval (months) | Activity |
|---|---|---|
| Upon approval of EIP | | HESI begins developing engineering and design for construction project. |
| Within 2 months of EIP approval | 2 | HESI develops and submits draft EMP for ADEQ review and approval. |
| Within 4 months of receipt of ADEQ comments on draft EMP | 8 | HESI submits final EMP to ADEQ.<br><br>HESI initiates water quality monitoring at the site per RADD requirements. |

| Schedule | Total Time Interval (months) | Activity |
|---|---|---|
| Within 6 months of ADEQ approval of final EMP | 16 | HESI develops and submits draft RDP for ADEQ review and approval. |
| Within 4 months of receipt of ADEQ comments on draft RDP | 22 | HESI submits final RDP to ADEQ. |
| Within 6 months of ADEQ approval of final RDP | 30 | HESI develops and submits draft RAIWP for ADEQ review and approval. |
| Within 6 months of receipt of ADEQ comments on draft RAIWP | 38 | HESI submits final RAIWP. |
| Within 48 months of ADEQ approval of final RAIWP | 88 | HESI initiates and completes remediation construction activities. This remediation site work start-up is weather-dependent and assumes construction will occur primarily during the summer months. |
| Within 28 months of initiation of construction activities | ~68 | HESI develops and submits draft O&M Plan for ADEQ review and approval. |
| Within 4 months of receipt of ADEQ comments on draft O&M Plan | ~74 | HESI submits final O&M Plan to ADEQ. |
| Within 6 months of completion of remediation construction activities | 94 | HESI develops and submits CCR to ADEQ. |
| For 24 months following completion of remediation construction activities | 112 | HESI performs post-construction monitoring to evaluate water quality. If the monitoring data indicate the possible need for post-project modified water quality standards for minerals, HESI submits a UAA study plan during this time. |
| Within 36 months of end of 24-month post-project monitoring period | 148 | If the expected modified water quality criteria for minerals are necessary at the end of the post-project monitoring period, HESI develops and submits a UAA report justifying revised post-remediation Arkansas water quality standards and initiates third-party rulemaking. This timeframe includes review of the UAA and proposed post-project Arkansas water quality standards by ADEQ, APCEC, and EPA. |

| Schedule | Total Time Interval (months) | Activity |
|---|---|---|
| Within 12 months of completion of third-party rulemaking process and UAA approval by APCEC and EPA | 160 | ADEQ implements post-project water quality standards and incorporates into NPDES permit. |

HESI proposes that ADEQ, EPA, and HESI confer annually by video conference or meeting to evaluate the status of the project. Such conferences/meetings would commence approximately one year from EPA's approval of the EIP and would continue to the end of the EIP. In addition, HESI will provide an annual written update on remediation activities to ADEQ and EPA approximately 2 weeks prior to each annual discussion. HESI reserves its right to seek an extension of the EIP, subject to approval by EPA and ADEQ, and requests that such approval shall not be unreasonably withheld by the regulatory agencies. HESI would then present the extension request to the Commission (APCEC) for review and approval through a third-party rulemaking process. If an extension of the EIP is requested, the third-party rulemaking would include, if appropriate, a provision for retaining the temporary dissolved minerals water quality standards during the extended period.

# 8.0 REFERENCES


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